Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Canada

Agriculture and Agri-Food Canada's Strategic Plan for Science

Agriculture and Agri-Food Canada's Strategic Plan for Science

Catalogue No. A59-91/2022E-PDF | ISBN 978-0-660-44866-4 | AAFC No. 13131E
Paru également en français sous le titre, *Plan stratégique pour la science d'Agriculture et Agroalimentaire Canada*
For more information, reach us at www.agr.gc.ca or call us toll-free at 1-855-773-0241.

CONTENTS

Message from the Assistant Deputy Ministers

For over 130 years, Agriculture and Agri-Food Canada (AAFC) has helped farmers produce safe and nutritious food. From developing new crop varieties and environmentally sustainable production systems to managing pests and diseases, supporting the food industry to increasing productivity in livestock, the knowledge generated through our scientific efforts have contributed to building a vibrant and prosperous agricultural sector for Canada.

The commodity-based approach has traditionally served Canada well. In an increasingly complex and intertwined world, we must be deliberate in our actions to address the needs of producers, the industry, Canadians, and citizens around the globe. Everything we do is interconnected.

The AAFC Strategic Plan for Science builds on our past successes and delivers a new vision to meet future challenges of the sector – one that is focused on economic sustainability while addressing key issues.

Achieving these outcomes won't be easy. We are constantly learning and adjusting to new and unfamiliar constraints while faced with pressures to respond quickly to the needs of the day. Nonetheless, technological advances have revolutionized our ability to study and understand data in ways never before possible. And the diversity of our workforce enables us to leverage a multitude of perspectives and expertise in achieving results.

The Strategic Plan is not just about the science. It guides us in our staffing direction: people and skills are critical to the future success of the Department. It's about how we organize ourselves to deliver results effectively and efficiently. Underpinning the key result areas is our ability to measure the impact of our efforts holistically, based on evidence. We must continue to conduct ourselves with scientific integrity to foster public trust at home and abroad.

We are motivated by this Plan – to be purposeful, to increase scientific openness, and to engage in greater interdisciplinary collaboration. Let's consider how our research can work in concert to tackle multiple problems at a time.

Together, we will push the boundaries of possibilities to advance our collective goals and leave a lasting impression for future generations.

Gilles Saindon Ph.D.
Assistant Deputy Minister

Andrew Goldstein
Associate Assistant Deputy Minister

Executive Summary

Agriculture and agri-food science has evolved at an incredible pace over the last two decades. New technologies have enabled major breakthroughs that resulted in direct improvement for the sector and consumers, bringing new players into the innovation ecosystem. At the same time, the world is facing major challenges as they relate to climate change, food security, and resources conservation, which will require a rethinking and transformation of our production systems for long-term sustainability. The Strategic Plan for Science is the Department's vision for the future of research and development (R&D) to adjust to the new reality and tackle the challenges of today and tomorrow. The change begins with a paradigm shift toward sustainable agriculture, which takes into consideration the environmental, social, and economic context in which all of our scientific activities are conducted.

This renewed strategic direction encompasses three pillars that go beyond just the science to explain how the organization will support the transformation:

1. **Mission-driven science**
2. **People first strategy**
3. **Organisational excellence**

The shift to a mission-driven strategy for project selection will allow AAFC scientists to work collaboratively on a selection of large, cross-sectoral challenges facing the sector and Canadians alike. These issues are complex and cannot be answered by one science team working in one area of study. Mission-driven science will draw together many teams working toward a similar goal.

The Missions are as follows:

1. **Mitigating and adapting to climate change**
2. **Increasing the resiliency of agro-ecosystems**
3. **Advancing the circular economy by developing value-added opportunities**
4. **Accelerating the digital transformation of agriculture and agri-food**

Our People First Strategy is integral to deliver on this ambitious science agenda. To stay on top, AAFC must continue to monitor emerging areas of science to recruit scientists that can steer the organization into the future. A human resources roadmap will do this, while ensuring diversity and inclusivity in the Department for optimal creativity and collaboration.

AAFC strives for science excellence and that starts with organisational excellence. As a federal institute, the Department aims to be a leader in science integrity and research conduct, including co-development of projects with Indigenous communities that are aligned with their aspirations as we work together along the path of reconciliation. Co-development is one aspect of our new knowledge mobilization strategy to ensure that our science is applicable on-farm so that end users reap the benefits of our research.

In order to ensure that our science makes a difference in the lives of Canadians, AAFC is shifting its performance measurement tools to those that are outcome-based. Each mission will have defined outcomes that are measurable, impactful, and easily discernable to ensure that we are accountable to Canadians, but also so that we know that we are making a positive impact with our research.

Pillars & Mission Areas

3 PILLARS

1. Mission-driven science p13
2. People first strategy p25
3. Organisational excellence p27

4 MISSION AREAS

1. Mitigating and adapting to climate change p17
2. Increasing the resiliency of agro-ecosystems p17
3. Advancing the circular economy by developing value-added opportunities p20
4. Accelerating the digital transformation of the agriculture and agri-food sector p20

Context for the Strategic Plan for AAFC Science

In Canada and abroad, an important transformation is taking place with respect to the role that publicly funded R&D plays to address the opportunities and challenges emerging from a changing agriculture and agri-food sector.

As AAFC looks to the future of Canada's agriculture sector, it is with a view to leveraging an evolving role as a science conductor, convenor, and collaborator to promote excellence in innovation for today's farming ventures while accelerating discovery for the farms of the future.

When the Department was created in 1867, its mandate was to help European settlers learn how to survive in a new world and give them the tools to be able to feed and sustain themselves off the land through the harsh Canadian winters. When the first five Dominion Farms were created, AAFC R&D saw crop scientists collecting and testing plant material from around the world to develop crops suitable for Canadian growing conditions, and maintaining national herds of livestock from the best available breeds, among other activities. The goal of these research activities was to mobilize the large-scale application of science to make agriculture production systems more reliable, and initiate a transition toward making agriculture an economic driver for the country. AAFC drew on traditional agricultural science disciplines, including agronomy, soil science, and plant pathology, to build a knowledge foundation upon which to develop solutions to the challenges faced by producers. As farming shifted from mixed farming for personal use to commercial farming, the Department leveraged R&D to bolster on-farm production, first to keep up with a growing population and later to expand Canada's markets for exports overseas. The latter work was pivotal in securing Canada's strong position internationally. These early efforts led to the creation of a national network of science facilities that can be mobilized to address issues of national importance, which remain today a significant Departmental strength.

As the country progressed through the 20th century, AAFC R&D efforts expanded from primarily food production to take on additional related critical concerns, such as resource conservation, food science, and emerging opportunities, including high-value bioproducts. These resulted in "game changers" in terms of economic and/or environmental impact, and provided the foundation upon which to address the sector's concerns about soil erosion, particle matter emissions, and international competitiveness. In addition, AAFC onboarded emerging disciplines, such as genomics, molecular biology, and bioinformatics. These changed the trajectory of knowledge creation by enabling the Department to capitalize on both the biological and data science revolutions.

The agriculture production landscape has changed significantly since the 1990s, with exponential technological growth, accelerating climate and biodiversity crises, and the evolution of consumer and market demands. At the same time, the agricultural innovation ecosystem has also grown significantly and has seen various non-traditional players join the field (robotics, earth observation, etc.). AAFC has supported this growth and transformation with direct scientific collaboration and successive rounds of Policy Frameworks—from the 2002 Agricultural Policy Framework to the more recent Canadian Agriculture Partnership in 2018—that include incentives to support science and innovation. AAFC will continue to enable growth in the innovation ecosystem while building on the strengths of all players to deliver results to the sector and Canadians. Successive AAFC Ministerial mandate letters and the United Nations Declaration on the Rights of Indigenous Peoples Act has made relationships and progress on relationships and cooperation a priority for AAFC and all other federal departments. In all aspects, collaboration is the way of the future, and diverse disciplines must work together on cross-cutting goals in an interdisciplinary manner.

As new players from private industry and academia enter the field of agricultural science, the possibilities for collaboration grow, and technologies can offer novel ways to address the desired multi-dimensional outcomes.

While major scientific breakthroughs have profoundly transformed and stimulated the growth of agriculture in Canada, the sector continues to face significant and evolving challenges, such as global trade volatility, severe weather events and effects of climate change, risks to animal and plant health, labour shortages, transportation limitations, and the need to maintain public trust. In addition, although Canada's food system has been resilient and adaptive during the COVID-19 crisis, the pandemic highlighted the need for resilient supply chains to ensure uninterrupted access to safe and affordable food.

The sector is also at the forefront of a number of opportunities that can further strengthen Canada's position internationally. For instance, the chance to lead the technology revolution by collaborating around automation, precision agriculture, and the transformation of Canada's production systems heralds a new era of diversity and inclusivity in agriculture management and stewardship approaches. The sector also has the potential to be a leader in research collaboration with Indigenous Peoples on the path of reconciliation. The expansion of market opportunities, as well as still-untapped potential in the bioeconomy, will continue to drive growth in the sector and Canada's economy.

A case study in no-till farming

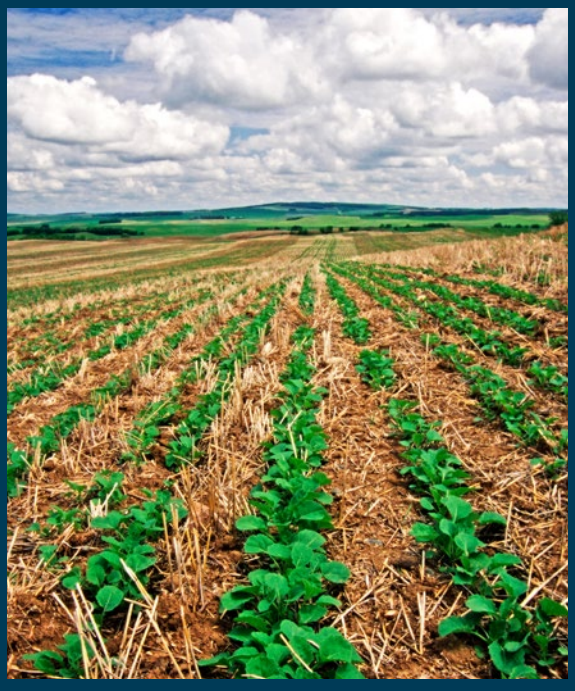
The development and introduction of conservation tillage (CT) and zero-tillage (ZT) systems in the 1970s was a major innovation that involved farmers, agronomists, scientists, and engineers —and the shift to these systems is one of the most significant agricultural innovations to have taken place on the Canadian Prairies in the last 40 years. These tillage systems have largely replaced traditional tillage systems—which relied more on summer fallow—that contributed to land degradation issues that plagued scientists studying the Prairies for more than a century.

In the past 20 years, the shift to CT and ZT has contributed a number of economic and agricultural benefits. No-till practices and continuous cropping lead to better soil moisture retention while also increasing planted acreage. CT practices also combat land and soil degradation, promote long-term agricultural sustainability, and benefit from the use of crop rotation to help break the life cycles of pests and diseases and to control weeds.

The economic benefits of ZT practices cannot be overstated. Compared to summer fallow, these practices yield double the capacity to produce crops, and cost less in terms of fuel, machinery, labour, and fertilizer (cropping with nitrogen fixation capacity).

CT also facilitated advances in crop breeding during the 1970s and 1980s that led to the creation of the pulse industry because new CT-enabled varieties of oilseeds and pulses could be used in rotation with cereal crops on the Prairies. Similarly, advances in crop breeding enabled the development of the canola industry when Dr. Keith Downey at the AAFC Research and Development Centre in Saskatoon introduced the first rapeseed containing less than 2% erucic acid and not more than 3 mg/g of glucosinolate in dry meal. The seed was later registered under the name "canola."

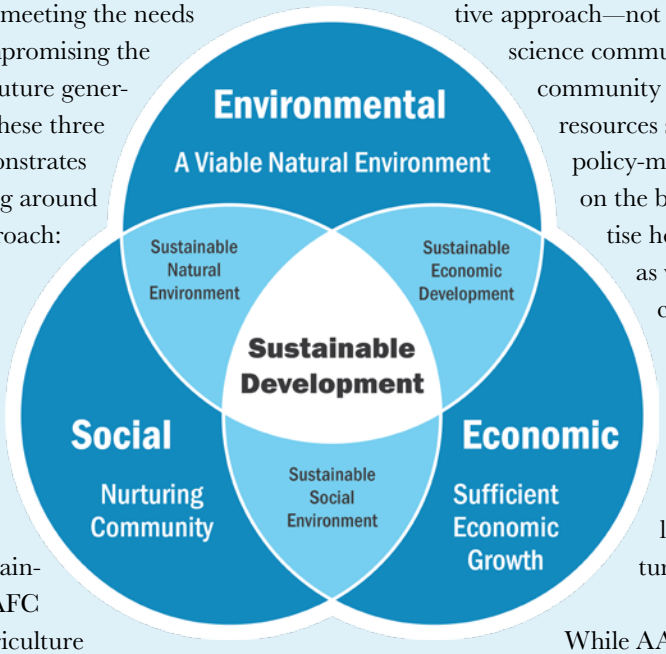
Today, more than 75% of prairie cropland is under some form of CT, with more than 50% under ZT. This adoption of sustainable and innovative practices in agriculture has enhanced productivity on Canadian farms and enabled a range of co-benefits that have increased the sector's environmental performance, with improvements in soil health, carbon sequestration, water quality, air quality, and biodiversity. This innovation is just one example of how science is a foundational and integral component of a robust agriculture sector.



A drive toward greater sustainability

Now more than ever, sustainability is—and will remain—a key driver of innovation in the face of mounting environmental challenges. With the climate crisis looming, research on incremental productivity gains will not protect the industry from the volatility of a changing environment. An effective response will require a paradigm shift.

Sustainable agriculture is the cornerstone that will support the Sustainable Canadian Agricultural Partnership. Under this paradigm, all actions will consider the environmental, economic, and social implications of agriculture to ensure we are meeting the needs of society today without compromising the ability to meet the needs of future generations. The indivisibility of these three pillars from each other demonstrates the necessary shift in thinking around agriculture as a systems approach: to succeed, agriculture must be environmentally friendly, socially responsible, and economically competitive.



The United Nations Sustainable Development Goals are a blueprint for achieving a better, more sustainable future for the world. AAFC will drive the sustainable agriculture science agenda over the next decade and build a coalition among science providers in Canada and abroad to support the mindset shift needed to tackle this critical challenge.

In addition, the United Nations Declaration on the Rights of Indigenous Peoples and its implementing legislation in Canada, the United Nations Declaration on the Rights of Indigenous Peoples Act, sets out the responsibility and opportunity for the federal government to take measures to help improve the economic and social conditions of Indigenous Peoples as well as the conservation and protection of the environment and productive capacity of their lands and resources.

Agricultural science will play a significant role in supporting Canada's contribution to the 2030 Sustainable Development Agenda, especially the goal of zero hunger. It will also contribute to the greenhouse gas emission reductions required under the Paris Accord. This forward-looking science agenda will equip AAFC to address the needs of today and help the agriculture sector prepare for the challenges of tomorrow.

Under this new paradigm, natural sciences, social sciences, and economics are intertwined. As problems become more complex, they require a more collaborative approach—not only within the agricultural science community, but among the wider community of climate scientists, natural resources scientists, social scientists, policy-makers, and others. Drawing on the broad range of science expertise housed in the Department, as well as a strong network of collaboration, AAFC will promote interdisciplinary and transdisciplinary science to address challenges and ensure that Canada is recognized as a world leader in sustainable agriculture and agri-food production.

While AAFC science leadership has contributed to many advantageous outcomes for the sector and Canada, its position in a future landscape calls for continued transformation alongside the sector it supports. In the interest of the public good and agriculture in general, like-minded organizations, including government researchers around the world, are starting to shift their focus to broad, cross-sectoral issues (otherwise known as grand challenges), including tackling climate change, increasing food security, and becoming more resilient in the face of increasingly complex risk pathways. This evolution will also require the Department to reinforce the public good role by emphasizing upstream, foundational, and public good agricultural research.

A Renewed Strategic Direction for AAFC Science

Advances in science and technology will continue to transform the agriculture and agri-food sector.

AAFC provides leadership in the growth and development of a competitive, innovative, and sustainable Canadian agriculture and agri-food sector. R&D is a key lever to addressing the challenges of the sector by bringing new solutions to various problems. The Department will continue to play a critical role in addressing national science priorities and will work with industry, academia, producers, and Indigenous partners to support the adoption of research.

Over the last decade or so, AAFC has structured its science approach around four strategic objectives:

- **increasing agricultural productivity;**
- **improving environmental performance;**
- **improving attributes for food and non-food uses;**
- **addressing threats to the agriculture and agri-food value chain.**

Although these objectives remain central to the success of agriculture in Canada, the evolution of the landscape and the increasing complexity and interconnectivity among issues warrant a more integrated approach. A shift toward the sustainable agriculture paradigm will promote a systems approach in which productivity, environmental performance, and resilience are central to the scientific questions the Department is contributing to solving.

In today's world, productivity cannot come at the expense of the environment, and vice-versa. AAFC's approach in the future will need to consider how to optimize yields in the face of climate change, factoring in increasingly complex risk pathways, long-term sustainability, and resiliency. Advances in biotechnologies, data analytics, precision agriculture, and other game-changing technologies will accelerate the science and innovation space to help meet the challenges of tomorrow. With this

renewed strategic direction, AAFC will play a pivotal role in public good science to tackle the grand challenges that affect agriculture and foster a culture of collaboration within the agriculture innovation ecosystem.

Grand challenges are more than ordinary research questions or priorities. They are global in scale, have the potential to be tractable despite being difficult to accomplish, require coordinated, collaborative, collective efforts, and capture the popular imagination and public sector support.

1 Mission-driven science

Mission-driven science focuses science on clearly defined goals and outcomes and injects urgency into the development of solutions for grand challenges. It considers ways to address big, complex challenges through coordination and promotes creativity in the science community to identify potential pathways for solutions. It provides a framework to ensure that resources are focused with directionality and intention toward creating transformation that can enable tangible outcomes more quickly and focuses on the ways that mission-driven science can add value to the sector. Mission-driven science will promote a variety of scientific approaches, including higher-risk transformative science, to ensure a sustainable, resilient, and profitable agriculture and agri-food sector by 2050 in four priority areas:

- **mitigating and adapting to climate change;**
- **increasing the resiliency of agro-ecosystems;**
- **advancing the circular economy by developing value-added opportunities;**
- **accelerating the digital transformation of the agriculture and agri-food sector.**

With a workforce that is nimble and national, AAFC is positioned to be a key contributor to finding solutions for these missions. To succeed, the Department will leverage integrated science teams to address cross-sectoral challenges.

PILLARS

PILLARS

These teams will bring together multiple disciplines, including economics, social science, and natural science, from across the Department and other science organizations (increasing the opportunity for producer and citizen science). They will also build relationships and collaborate with Indigenous partners to ensure that their knowledge, worldviews, and ways of knowing are ethically included in solutions to issues of national importance. When scientists from multiple areas of expertise work together on multi-dimensional problems, the outcomes are stronger, and end users see better results.

Even with an interdisciplinary and focused approach, no single organization can tackle any of these missions alone. Canada has a rich and diverse agriculture and agri-food innovation ecosystem that includes AAFC, provinces, academia, the private sector, Indigenous Peoples, and non-governmental organizations. The Department encourages collaboration in agricultural science to deliver the best possible results to Canadian producers. AAFC will continue to play a facilitator role in the Canadian agricultural innovation ecosystem, bringing industry, academia, and other government departments together to work collaboratively on the challenges that affect Canadians and the world. Through its partnership strategy, AAFC will build new collaborations with innovation ecosystem players and strengthen existing ones to accelerate research on its mission-driven science agenda. The Department will also look for other opportunities to leverage shared resources. Given that agricultural challenges are rarely limited to a single country, this strategy will include an international component to stimulate scientific innovation and support the proliferation of new technologies worldwide.

AAFC will continue to support the sector and use programming tools to build science capacity in the sector to drive the development of a knowledge economy that will create jobs and markets and stimulate innovation across the country. This approach will also help the sector capture new opportunities to expand economic development, diversification and competitive advantage, and accelerate the transition to sustainable agriculture.

AAFC research is supported by a variety of funding sources. The Department's science programming aims to integrate the sector into the broader innovation and science ecosystem to ensure that public and private investments are factored into the strategic planning and growth potential of agriculture and agri-food. Industry-driven funding is currently a dominant source with the AgriScience program and the Collaborative Framework representing the largest share of project funding. AAFC will continue to support industry priorities and also address the priorities of Indigenous Peoples, while shifting toward a funding model that mobilizes its resources toward mission-driven science. As missions are developed with a sustainable agriculture perspective, close ties with economic sustainability will remain a key element of AAFC science going forward, while also addressing the environment and social aspects.

Adaptation of crops across multiple ecozones

As a large country, Canada encompasses many different ecozones with different growing conditions. Historically, growing seasons were limited to the number of frost-free days, leaving many northern regions of Canada without adequate food for their populations. Crops were also limited to those suitable for the soil type, temperature, and precipitation rates of a specific region. But thanks to science, crops have now been adapted to many different ecozones in order to diversify production, increase yields, and lengthen growing seasons.

AAFC scientists have used two methods to address crop abiotic stressors (non-living factors, like drought, temperature, and environmental extremes): breeding and agronomic systems. For example, breeding crops for regionally suitable traits has allowed wheat and canola production across the Prairies, potatoes to be grown in Manitoba, and the wine-grape industry to expand from coast to coast. Agronomic systems work alongside breeding to change the climate in which a crop can be grown. An example is irrigation in regions with low precipitation rates, such as the northern prairies and B.C.'s Okanagan Valley. Another example of a common agronomic system is greenhouse production, which farmers often use to extend growing seasons or for winter production.

Durum wheat is an example of a crop that has been adapted to grow in a desert region of Saskatchewan that was once completely unfit for agricultural production. Researchers used both breeding for abiotic stressors and agronomic systems to adapt the durum wheat crop to this region. Now that a variety of durum wheat has been adapted to grow in Saskatchewan's hot, dry climate, the province accounts for 80% of all durum wheat grown in Canada and contributes 50% of the global supply.

Historically, corn was a crop suitable only for southern Ontario because it requires a mixture of heat and moisture to grow. AAFC began breeding corn in 1927 and eventually produced varieties with new genotypes that could grow in all of Canada's provinces. Most remarkable is the adaptation of some corn varieties for the prairie provinces, where the weather is dry (and quite cool in more northern regions). As of 2014, Alberta was growing 40,000 acres of corn where it was once impossible for the crop to survive.

Soybeans are another crop that was once only viable in southern Ontario, given the heat required to bring the plant to maturity. In the 1970s, AAFC was able to produce early-maturing soybean varieties that can grow in other regions of the country with cooler climates. Soybeans are now an integral part of the Canadian economy and are grown in Quebec, Manitoba, the Atlantic provinces, Saskatchewan, and Alberta.

Overall, these findings have laid the foundation for the seed industry to develop in Canada, which in turn resulted in an acceleration of the growth of the sector and an increase in the availability of different crops across the country.

Map - AAFC Research and Development Centres

MISSION AREAS

1 Mitigating and adapting to climate change

A profitable sector that excels in a low carbon economy

There is a lot of uncertainty around how climate change will affect Canadian agriculture. One thing that is clear is that in the years ahead, Canada can expect more extreme weather events, higher than average temperatures, and changes in precipitation patterns that increase the risks of floods and droughts. Ensuring Canadian agriculture remains competitive despite the changing climate must be a priority. For this to happen, the sector must become more resilient and able to adapt to climate stressors and threats (such as droughts, heat waves, pests, and diseases) without reverting to dependence on external inputs.

The sector must also look for ways to reduce greenhouse gas emissions and increase carbon sequestration on farms. To meet Canada's target of net-zero emissions by 2050, AAFC must continue to invest in research and innovation, clean technologies, and climate adaptation and mitigation strategies, and build climate resiliency across the country. Currently, there is no clear net-zero pathway for agriculture that does not compromise food production for Canada and the growing global population as well as the long-term viability of Canada's agriculture sector. Significant research mobilization will be needed to fully engage AAFC's extensive science capacity—and to supplement it by collaborating with academia to integrate broader expertise (beyond the disciplines traditionally associated with food production)—in order to discover new practices and technologies and develop a pathway to net zero by 2050.

Under this mission, science and innovation will enable outcomes (see Annex for details), including:

- **competitive net-zero or low-emission production systems;**
- **innovative practices to enable the sector to capture carbon effectively;**
- **climate adaptation solutions;**
- **sustainable food production in remote and northern communities.**

Owing to the nature of the research it undertakes, AAFC is positioned to impact a substantial proportion of Canada's landscape. The Department will continue to build and promote its discovery capacity so it can respond to emerging agri-environmental challenges related to climate change and adaptation. The Department will promote a systems approach that integrates agronomy and ecology to design the competitive and sustainable production systems of the future.

2 Increasing the resiliency of agro-ecosystems

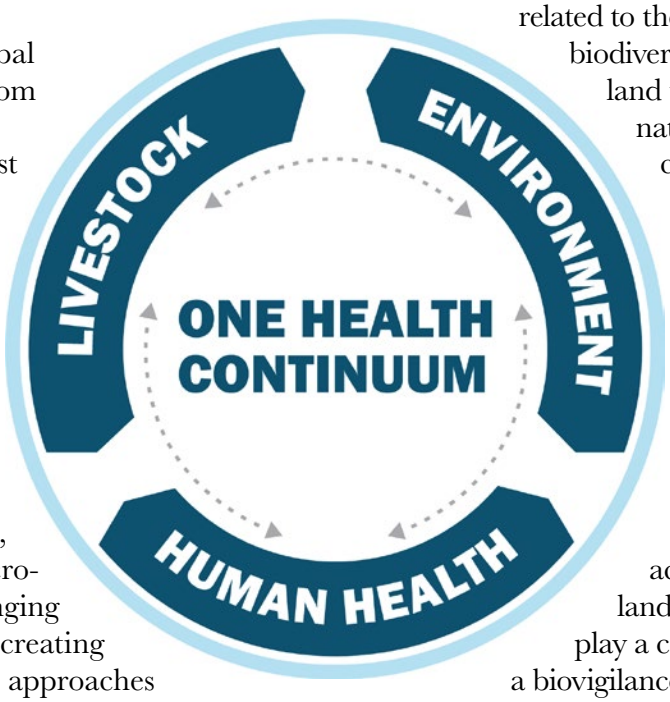
A competitive sector that manages stresses

A functional agro-ecosystem depends on a myriad of elements coming together, such as soil health, water availability and quality, ecological goods and services, and crop rotation to support production. AAFC needs to increase its

capacity to quantify landscape-level trade-offs to clarify interconnected pathways toward better agro-ecosystem sustainability and resilience. However, an integrated understanding of the elements on agricultural land in Canada and the drivers that impact it has remained elusive. This same basic knowledge gap makes it difficult to understand how multiple drivers—such as agricultural practices, landscape pattern, and climate change—shape biological communities or impact the delivery of ecological services. With this information, the Department will be able to work with the sector on ways to evolve our production systems, to make them resilient to stress, reducing losses in a pro-active way.

Under this mission, science and innovation will enable outcomes that include:

- **improved agro-ecosystem management with advanced analytics;**
- **enhanced and protected soil and water resources;**
- **enhanced biodiversity to stimulate productivity and resilience;**
- **reduced impacts of pests and diseases;**
- **increased awareness of pesticide alternatives;**
- **carbon, nitrogen and phosphorus cycles.**



Given the changing global environment, threats from invasive and emerging pests, and the loss of pest control options, producers are finding it ever more complex to keep their crops and animals healthy while remaining competitive. At the same time, the threat of emerging zoonotic pathogens is a global health concern, and the issue of antimicrobial resistance and changing consumer preference is creating a need for more holistic approaches to mitigate pathogens and diseases, such as those that use clean technologies, promote biodiversity and provide more integrated solutions. These integrated approaches will enable the agriculture sector to progress toward a One Health culture that recognizes that human, animal, plant, and environmental health are inextricably linked. Indigenous food systems are also typically circular and holistic with multiple positive benefits including community health and wellness, food security, environmental stewardship, and economic opportunities.

AAFC is well positioned to address questions related to the states and trends of biodiversity on agricultural land through its enduring national presence, national collections, multidisciplinary skill set, and digital agriculture platforms. Linking these data to broader agro-ecosystem analysis will enable new ways to promote a One Health approach, which will increase resiliency across the agricultural landscape. AAFC will also play a central role in promoting a biovigilance approach, which relies on a continuum of science-based activities to ensure that mitigation strategies are efficient, proactive, and do not create new problems.

Building the knowledge economy in the agri-food sector

Arguably the world's most important industry, agri-food is an integral component of the global food system. Thanks to consumer appetite for the next generation of food, an ever-expanding global population, dynamic diet trends, and the increasing pressures of environmental and climate change, the world has—and will continue to have—high expectations of the agri-food sector.

As the world's fifth largest exporter of agriculture and agri-food products, Canada is an important player in this global industry. The agri-food industry is one of the largest manufacturing sectors in Canada, contributing an estimated $139.3 billion to Canada's annual GDP and employing more than 2.1 million people. The Advisory Council on Economic Growth has emphasized Canada's immense agri-food potential due to its "large natural endowment of water and arable land, distinctive record of accomplishments in research, and exceptional base of companies and entrepreneurs." Innovation and competitiveness in science are key drivers in realizing these opportunities for sustainable growth.

Federal scientists at Canadian research centres have been on the forefront of agri-food science for decades, working to develop projects and innovations that can benefit industry, farmers and Canadians. One of the biggest areas of innovation in the agri-food sector today is the development of plant-based, planet-friendly alternatives to traditional products, such as "clean" food preservatives and plant-based meats.

For example:

As part of a collaborative research project under the umbrella of McGill University's Consortium for Research, Innovation and Transformation of Agrifood, scientists at AAFC's Saint-Hyacinthe Research and Development Centre are working to develop chemical-free ways to improve the shelf life and safety of fruit, vegetable, and meat products using biofilm technology.

Protein Industries Canada is developing high-protein, plant-based food products that—in addition to being healthier for people and the environment—can reduce greenhouse gas emissions related to food production, strengthen food security and the Canadian domestic supply chain, and provide value to Canadian-grown crops.

These are just two of many examples that show how Canada could leverage scientific advancements related to agri-food to become a global leader in the food revolution. Driven by goals for sustainability, food safety, and consumer demand, agri-science is an integral driver of innovation in the Canadian agri-food sector.

3

Advancing the circular economy by developing value-added opportunities

Attributes that meet market demands

The circular bioeconomy transforms the way AAFC looks at value chain and resource utilization. One aspect of resource-use efficiency includes managing waste by developing value-added streams or rebranding waste as input for products using emerging technologies and innovations. This work involves inspiring innovation that transects traditional commodity and sector silos. As part of this transformation, there are opportunities to rethink the production systems to promote more circular value chains. This circular approach also improves water-use efficiency and nutrient cycling in the agricultural landscape.

New value-added opportunities include renewable energy, chemicals, high-value bioproducts, other materials, as well as more classical food-processing value-added products, that give rise to new markets and stakeholders. A circular economy will also provide opportunities for the agri-food sector to develop new products that are sustainable and meet the demands of consumers in Canada and across the globe.

Under this mission, science and innovation will enable outcomes that include:

- **diverse production systems with multiple outputs and co-benefits;**
- **circular value chains that create new market opportunities;**
- **the prosperous transformation of food systems and revitalization of Indigenous food systems.**

New technologies are also enabling this evolution of the food system. New protein sources, such as insect farming, rely on by-products from primary agriculture, while emerging biotechnologies have enabled cellular agriculture to become a reality. This new landscape provides the perfect environment for the circular bioeconomy to grow and thrive in Canada.

4

Accelerating the digital transformation of the agriculture and agri-food sector

A productive and efficient data-driven sector

Digital technologies are playing a vital role in a sustainable and robust agriculture and agri-food sector. Data are being generated at rates that exceed the capacity of scientists to use them. Advances in predictive analytics, big data storage, communications, and processing will lead to innovative research methods and tools as well as the ability to describe,

MISSION AREAS

diagnose, predict, and prescribe. The application of meteorological, environmental, and biodiversity data to the large-scale analysis of agricultural landscapes will contribute to improved productivity, improved environmental performance, and the ability to assess progress in meeting climate change goals. Integrating bioinformatics with other data types can improve modelling and predictive capacity, reduce the impacts of threats, and increase productivity in the agriculture sector.

Under this mission, science and innovation will enable outcomes that include:

- **enhanced data-driven agriculture systems;**
- **evidence-based decision-making through efficient data acquisition and analysis;**
- **customizable solutions for different end users based on big data analytics;**
- **a better understanding of greenhouse gas emissions through a standardized inventory system.**

Digital technologies offer a way to share scientific results with a broad audience more rapidly. For example, AAFC is prioritizing the digitization of its national collections. This process will support the automation of key agricultural practices, including pest management and biodiversity preservation, while making the specimens from the collections and their characterization more accessible to the agriculture sector and Canadians at large. AAFC will support integrated crop and livestock production in digital farming, pasture management and climate-resilient cultivar development with a combination of novel genomics, phenomics, environment, and management strategies.

Over the next decade, digital transformation will accelerate in the sector—and in AAFC's science—to capitalize on opportunities, such as those arising from big data analytics, automation, and other labour-saving technologies.

The future is here:
Artificial intelligence in greenhouse production

AAFC scientists have joined artificial intelligence (AI) experts from Microsoft to prove that indoor farming—using greenhouses and vertical farming coupled with AI—has the potential to produce safe food quickly with fewer resources, including labour and pesticides.

AAFC scientists and Microsoft AI experts collaborated to produce cucumbers in greenhouses at Wageningen University & Research center (WUR) in the Netherlands. Their challenge was to use the fewest resources possible while controlling their greenhouses and managing crops remotely from other parts of the world. AAFC scientists joined Team Sonoma, which provided the Microsoft AI expertise.

From their office in Harrow, Ontario, AAFC researchers provided horticultural advice and monitored the crops at WUR. Starting with a high-density planting system, they adjusted the AI climate control based on crop performance and weather conditions to allow for best performance. Each day, they reviewed the cucumbers' growing conditions and gave care instructions to Team Sonoma.

This collaboration has served as a benchmark for researchers and industry to help develop AI for greenhouses. The combination of high profit and sustainability saw Team Sonoma produce 5 kg of cucumbers per square metre with a net profit that was 17% higher than that of local expert growers.

PILLARS

2 People first strategy

In order to deliver on this ambitious science agenda, AAFC will need to capitalize on the expertise of its people and national network of collaborators. Science excellence includes ensuring a diverse and inclusive workplace, embracing differences, and mobilizing diversity and expertise to conduct top-tier R&D. Key themes in this direction include:

- **building the workforce of the future by recruiting in emerging research areas;**
- **ensuring a diverse and inclusive workforce though a solid human resources roadmap;**
- **optimizing collaboration in shared spaces, both in person and virtually.**

With approximately 400 research scientists, 500 operations support staff and 1,100 other science professionals—supported by an additional 1,500 students, interns and post-doctoral fellows each year—AAFC mobilizes a national network of 20 R&D centres and 30 satellite locations to address key agricultural challenges.

To remain at the forefront of science, AAFC is leveraging a $70 million investment from Budget 2017 to bring new capacity to emerging areas like phenomics, predictive analytics, and clean technologies. This transformation will continue over the next decade to capitalize on the opportunities that emerging sciences and technologies (including digital technologies) bring and to generate better results for the sector and Canadians.

To guide this transformation, AAFC will rely on a solid Science Human Resources Roadmap to instill effective people management as a core principle of its day-to day culture, work environment, hiring practices, and leadership. This roadmap will consider regional context and collaboration opportunities to address issues of national interest while striving to find the right balance between traditional and newer disciplines. With this people-centred approach, AAFC strives to remain a science employer of choice that attracts and retains top talent.

With a paradigm shift toward agriculture sustainability and mission-driven science, there will be an evolution of AAFC's scientific activities. While its science will look different, its workforce talent will remain its most important asset. All AAFC scientists have something to contribute, and they will bring a unique perspective to address the missions and contribute to finding solutions to climate change, improving the resiliency of the agriculture sector, and capturing opportunities, such as the digitalization of the sector and growing the bioeconomy.

Business, human resource, and innovation studies have shown that workforce diversity increases creativity. It leads to enhanced efficiency, productivity, problem-solving, and customer satisfaction, and it improves morale, teamwork, and organisational performance.

AAFC has already undertaken hiring practices and programs meant to ensure that its workforce is representative of Canada's diversity. As part of its science capacity renewal, AAFC is committed to addressing gaps in the representation of its workforce, especially for women, Indigenous Peoples and people with disabilities. Capitalizing on the full extent of diversity within Canada will require AAFC to continue to remove systemic barriers in its hiring processes and career progression opportunities. AAFC will pay special attention to the participation and retention of outstanding scientists from all under-represented groups and ensure that new hires are brought into culturally safe and supportive work environments.

Co-location, space sharing, and virtual connectivity to stimulate collaboration are the ways of the future. Using a hub-and-spoke model, AAFC will create integrated science teams that can apply a systems approach to solve problems that arise. Housing integrated science teams together—within the Department and across departments—will reduce the risk of duplicating efforts and give AAFC scientists access to the latest technologies.

As it did for many organizations, the COVID-19 pandemic transformed the way AAFC works, including how it performs science. With many employees working from home, the shared space needed for collaborative work transitioned from a physical to a digital one. The pandemic forced the digitalization of scientists' practices, including data collection and analysis for investigations. This change has opened up new opportunities for collaboration. Digital technologies, among other exemplary practices, have allowed AAFC's scientists to remain productive despite the global disruption. AAFC will continue on this path of increased digitalization and is committed to promoting a hybrid work model in areas where it has the potential to increase efficiencies and strengthen collaboration.

PILLARS

3 Organisational excellence

AAFC strives for science excellence, not only in terms of the science it conducts, but in how it is conducted. Science excellence goes beyond the quality of the science to consider the alignment of science with societal needs, cultural perspectives, diversity, rigours in scientific approach, credibility, and impact. Key steps in this direction include:

- **developing a new approach to knowledge mobilization;**
- **showing leadership in supporting diversity and inclusiveness;**
- **focusing on Reconciliation and co-developing science projects that fulfill the needs of Indigenous communities;**
- **striving to meet the highest standards of integrity in research conduct.**

Promoting the multiple facets of science excellence

In 2019, AAFC released its Science Integrity Policy. The policy aims to foster an ethical culture and sets out expectations to support and promote integrity in the design, conduct, management, review, and communication of research, science, and related activities. With this policy, the Department aims to be recognized by employees, stakeholders, and the public as the most reliable and credible source of ethical research and scientific information.

Under this policy, AAFC is committed to ensuring that AAFC research and science conform to the highest standards of responsible research conduct and strives to follow relevant and applicable research practices honestly, accountably, openly, and fairly when developing and disseminating research and scientific knowledge. AAFC recognizes the importance of participating in research networks with national and international peers and scientific and professional societies. The latter are an important part of ensuring that scientists and researchers understand and are held to their communities' standards. AAFC is also committed to building relationships and partnerships with Indigenous communities to address their self-determined goals, values, and priorities as they relate to food systems and agricultural research and innovation. The Department will continue to foster and expand its partnerships with Indigenous communities to create benefits in community health and wellness, food sovereignty and security, research capacity, and environmental stewardship. Emphasis will be placed on Indigenous data sovereignty, respect and recognition of Indigenous knowledge systems, and social, environmental, and economic opportunities.

Towards this goal, AAFC has developed an Indigenous Strategy and initiated (and is co-leading) the interdepartmental Indigenous Science Technology, Engineering and Mathematics (I-STEM) cluster to foster collaboration, gain efficiencies, and accelerate development of good practices for science cooperation with Indigenous partners across 13 science-based Departments and Agencies.

Maximizing impact through knowledge mobilization

For maximum impact, knowledge generated by science needs to be mobilized to support action in the field, provide evidence for policy-making, and stimulate the knowledge economy. AAFC has a long history of collaborating with various players in the agriculture and agri-food sector to ensure that scientific results translate into applicable solutions. The Department will continue to harness the innovation ecosystem to accelerate commercialization, promote the adoption of improved agricultural practices, and facilitate the transfer of knowledge. Both co-development and government innovation

programs are integral to enhancing collaboration in the agricultural innovation ecosystem. The mission-driven approach proposed in this plan will strengthen this.

The Department will also continue to explore new ways of doing science that stimulates knowledge mobilization. An example is the Living Laboratories recently established across Canada, which are transforming how AAFC designs and delivers science. The Living Laboratories model will stimulate collaboration with stakeholders and Indigenous communities through a co-development model that allows for better uptake of science outcomes by employing a systems approach. This approach looks at a vast array of factors in the ecosystem to better understand the causes and effects of the issues at hand.

Science has a fundamental role to play in the development of evidence-based policy because it allows decision-makers to frame their policy decisions with the best available knowledge. In AAFC's mission-driven approach, scientists will work more directly with a broad range of experts, including policy-makers. Scientists will be able to provide information on readily available technologies that could have an immediate impact by increasing their rate of adoption. They can also identify missing pieces where further research is needed. Evidence-based policy decisions (driven by science) will provide clarity to the sector and enable the mindset shift that AAFC needs to solve complex issues and wicked problems (difficult social or cultural problems) today and in the future.

AAFC will continue to promote transparency in its science activities as another way to increase knowledge mobilization. The Department has put in place an open science action plan to provide greater public access to federal science in order to help Canadians understand the importance of its research and fulfill the Government of Canada's commitment to a more open government. AAFC's approach is to balance the value of intellectual property, the importance of safeguarding sensitive personal, Indigenous community, and national security information, and the potential value of making its science and research products available to act as catalysts for agricultural innovation and growth in Canada. The greater availability and accessibility of AAFC-produced data will make the Department's science more discoverable and reusable, leading to enhanced innovation and opportunities for collaboration. It will also increase socio-economic benefits for Canadians, transparency and public trust in government science, and engagement with the public, scientific community, and agricultural sector.

Removing systemic barriers

To address agricultural challenges, AAFC needs a multiplicity of views and players. AAFC will continue to engage other disciplines and types of knowledge in science projects, including Indigenous and other ways of

PILLARS

knowing. The Department will also continue to broaden the types of partners it works with, such as knowledge users, producers, the public, youth, Indigenous communities, and decision-makers. This approach will break down barriers to discovery by creating the right conditions for ideas to flourish.

This evolution of the Department's science activities will also be driven by a more intentional effort to recognize and include interdisciplinary, Indigenous, and other ways of knowing. For instance, Indigenous Peoples have spent thousands of years gathering knowledge from the land and living on it, so traditional knowledges (including local and traditional knowledges, traditional ecological knowledge, and Indigenous ways of knowing) are inherently valuable. However, governmental departments have historically privileged Western knowledge systems, often to the detriment of diverse Canadians whose knowledge and priorities are not visible in mainstream science and policy initiatives. Embracing diverse worldviews and ways of knowing will further support AAFC's mission to include the unique perspectives of its diverse scientists and citizens, and positively impact the quality of science it continues to do.

Given that many Indigenous communities suffer from food insecurity that has been perpetuated by years of serious systemic barriers, Indigenous agricultural science is of the utmost importance. AAFC created the Indigenous Science Liaison Office to ensure long-term relationship-building between AAFC and Indigenous communities across Canada in order to co-develop science projects that can benefit Indigenous communities. Relationships with Indigenous communities are and will be based on a foundation that prioritizes reciprocity, recognition of the inherent rights set forth in the United Nations Declaration on the Rights of Indigenous Peoples, and the appreciation of diverse worldviews. Reconciliation will remain a guiding principle of all activities and forward-looking decisions that include or may affect Canada's Indigenous communities.

Indigenous Peoples have systems in place that demonstrate distinct ways of knowing and traditional knowledges across communities. In recognition of this, AAFC will collaborate with Indigenous communities to address their self-determined needs, values, and priorities as they relate to food systems. The Department will continue to foster and expand its partnerships with Indigenous communities to create benefits in community health and wellness, food sovereignty and security, and environmental stewardship. The focus will be on Indigenous data sovereignty, respect and recognition of Indigenous knowledges, and economic opportunity. As an example of activities to support such goals, the I-STEM Cluster (Indigenous Science, Technology, Engineering, Mathematics) offers funding for Indigenous scientists and facilitates AAFC's Indigenous Student Recruitment Initiative (ISRI) to equip the next generation to explore agricultural science.

Assessing AAFC's Research Impact:

Performance measurement

Performance measurement in this strategic plan has two layers: AAFC will measure the impact of its science as well as the success of the plan itself.

The impact of AAFC's science

Globally, there is a shift taking place in the science world that values outcomes that go beyond the traditional measure of publications to ensure science makes a difference in people's lives. Social issues linked to science are becoming more important to Canadians and in agriculture: food security, food sovereignty, equity in food access, and climate change are top issues. As such, there is a need to have mechanisms in place that ensure science is not only having an impact in the scientific realm, but also in the daily lives of Canadians, delivering affordable, nutritious, equitable, and environmentally sustainable food.

Mission-driven science priorities are instrumental to ensuring that AAFC addresses emerging issues and to better measure the impact of

AAFC's science for Canadians. Not only will the outcome-based method of scientific study drive evidence-based policy—it will promote a clear intention for the science. This will make it easier to report the results of science, and will translate scientific discoveries into more cohesive narratives for external stakeholders. This includes measures of the impact of agricultural science investments and greater accuracy in sustainability metrics, especially those related to climate targets (for example, to develop the models and factors needed to translate program data on the adoption of specific practices into estimates of greenhouse gas emissions).

As mission-oriented science becomes a stronger driver of its science endeavours, AAFC will regularly evaluate the progress made on each mission. Data analytics will be at the core of this new performance management framework. The framework will rely on quantitative and qualitative data to give a comprehensive overview of the situation.

The success of AAFC's plan

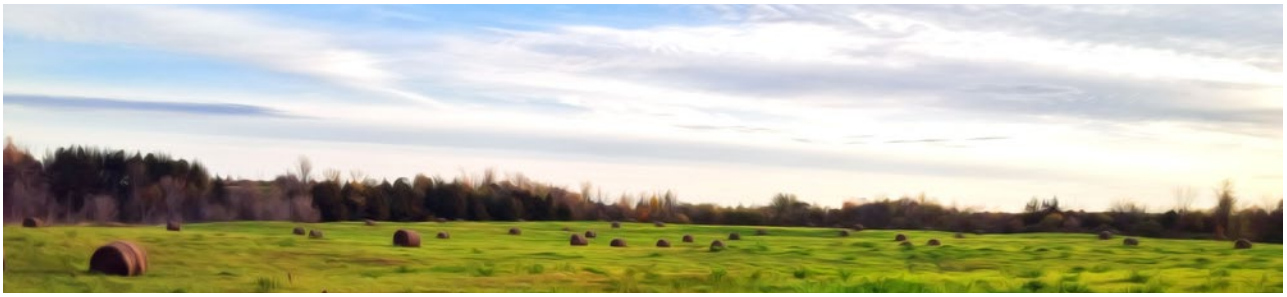
One of the objectives of this plan is to ensure that the Department delivers science in the most effective way. In other words, the direction from this plan will need to transpire in AAFC's programming and implementation of science. The Department will review the way the plan is used annually to ensure it continues to guide resource allocation and prepare the agricultural sectors for the challenges of tomorrow.

The Path Forward

The Strategic Plan for Science at AAFC will guide Canada's agricultural science agenda over the next ten years and help Canada maintain its position as a world-leading producer of safe and sustainable foods. To translate this information into activities and programs, AAFC will initiate a strategic planning exercise for science implementation. This planning exercise will include human resources and knowledge mobilization components as well as specific science strategies related to the identified outcomes.

Acknowledgements

To support the development of this strategic plan, an advisory group was tasked with identifying the science priorities that will ensure AAFC's science is impactful and will serve both the sector and Canadians in the changing context of food production and transformation. The group was composed of **Marie-Helene Beauchemin, Steve Javorek, Dr. Kelly Ross, Dr. Krista Gill, Dr. Erin Smith, Dr. Karen Fong, Dr. Keshav Singh, Dr. Wade Abbott, Dr. Mervin St. Luce, Dr. Kirby Nilsen, Dr. Renee Petri, Dr. Jeremy Dettman, Dr. Sampathkun Balamurugan, Dr. Chris Garnham, Dr. Heather McNairn, Dr. Warren Cardinal-McTeague, Dr. Rachid El Hafid.**



ANNEX

Detailed summary of mission-driven science priorities and outcomes

AAFC will accelerate research that will deliver results in the most important areas of challenge affecting the sector, with a greater focus on its mission-driven science agenda. Mission-driven science will promote a variety of scientific approaches, including higher-risk transformative science, to ensure a sustainable, resilient and profitable agriculture sector in 2050. To support its outcome-based science agenda, AAFC will target four priority areas:

- **mitigating and adapting to climate change;**
- **increasing the resiliency of agro-ecosystems;**
- **advancing the circular economy by developing value-added opportunities;**
- **accelerating the digital transformation of the agriculture sector.**

Under this mission-driven science, public R&D and innovation will result in outcomes related to these priorities. The priorities and outcomes highlighted in this annex are based on the Advisory Group White Paper. Here are the detailed descriptions of each priority-area, mission-driven science topic, vision and outcome.

Mitigating and adapting to climate change

A. Competitive net-zero or low-emission production systems: This will include clean technologies and the implementation of precision agricultural practices, real-time soil testing, remote sensing, and AI to support low-input agriculture. AAFC will also leverage the multidisciplinary nature of its scientific expertise to develop effective management strategies and clean technologies to reduce greenhouse gas emissions from livestock at each step of the production system. The fundamentals of such practices will complement the implementation of innovative clean technologies to reduce greenhouse gas emissions across the Canadian agricultural landscape. This will help Canada meet or exceed its greenhouse gas reduction targets and achieve net zero by 2050.

B. Developing and adopting innovative practices to enable the sector to capture carbon effectively: Because of the nature of its research, AAFC is uniquely positioned to develop carbon capture technology that could impact atmospheric carbon sequestration in Canada's agricultural landscape. The development and adoption of innovative cropping and livestock systems—not to mention and agronomic practices that enable the sector to farm carbon so effectively—will drive change using decision-support tools, such as the Internet of things and AI. These will empower beneficial management practices (BMPs), which can increase an agro-ecosystem's ability to sequester carbon through strategies for resilient soil health and diversity management. These strategies, in turn, will help mitigate climate change.

C. Climate adaptation solutions: AAFC will embrace nature-based solutions that proactively increase resilience to the impacts of climate extremes and climate-associated threats. The Department will strengthen these efforts by developing and delivering outcome-driven tools and crop-breeding strategies to mitigate climate risk at the production level.

D. Sustainable food production in the North: The warming climate in northern Canada comes with opportunities (new crops options and potential cost saving for year-round indoor production in the most northern regions) and challenges (expanding pest issues, deforestation). AAFC will play a pivotal role in developing sustainable production systems for these new areas and will support partnerships to ensure food security and sovereignty in remote areas.

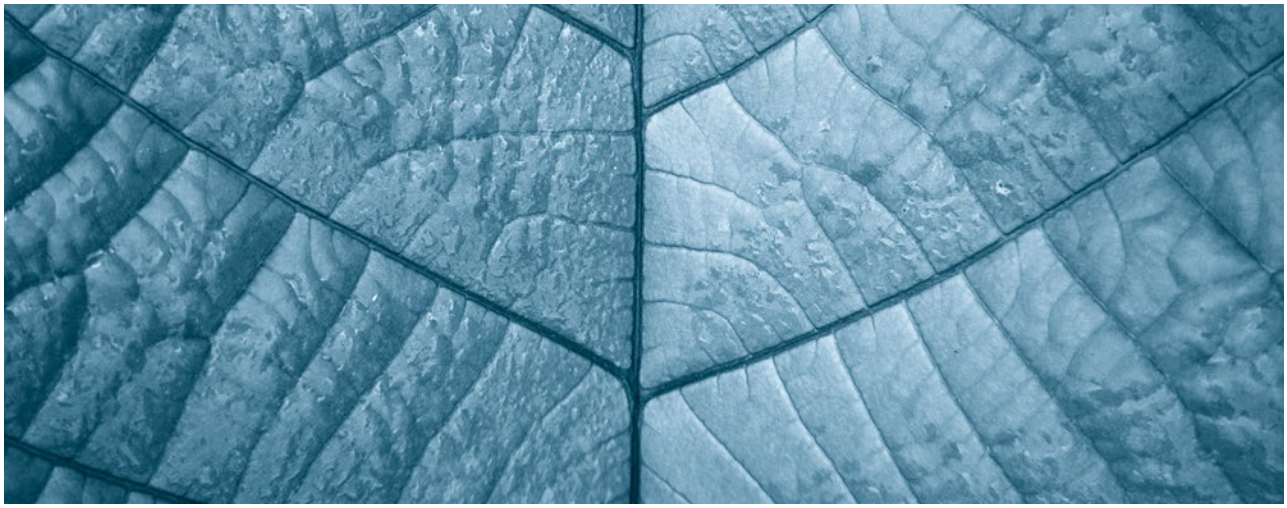
Increasing the resiliency of agro-ecosystems

A. Improved agro-ecosystem management with advanced analytics: AAFC will develop landscape-level analytics to simultaneously assess the interactive effects of agricultural activities, landscape pattern, and climate change on the environment, biodiversity, and food production. The resulting knowledge will maximize the co-benefits and enable the Department to develop solutions for producers that promote a more sustainable, resilient agro-ecosystem, with fewer trade-offs versus the classical approach. To understand the interactive factors that affect agro-ecosystem sustainability and resilience, AAFC will leverage digital agriculture platforms to synthesize multidisciplinary data and develop a new generation of landscape-level metrics to assess agricultural performance against environmental and biodiversity targets, standards, or desired states. The Department will distill complex data into decision-support systems for multiple stakeholders to guide actions to promote agro-ecosystem health at multiple scales, including the farm level.

B. Enhance and protect soil and water resources: AAFC will implement and build upon best management practices in soil conservation, improved cropping systems, and the circular system of integrated crop-livestock production to increase soil organic carbon content, develop climate-resilient soils, improve soil, air and water quality, and mitigate climate change.

C. Enhance biodiversity to stimulate productivity and resilience: AAFC will develop a coordinated strategy to benchmark sentinel taxa/groups (such as native pollinators, microbiome, aerial insect biomass) across various agro-ecosystems so that biodiversity changes (changes in ecological services) can be detected and their causes identified. This will increase the Department's understanding of biodiversity in the Canadian agricultural landscape and support efforts to preserve and benefit from its services. Diversity in agriculture will enhance the sector's resilience and ability to respond to disruptions and changes so it can enable adaptation and stability in supply chains.

D. Reduced impacts of pests and diseases through a biovigilance approach aligned with One Health: By using a more proactive biovigilance approach that involves monitoring and data analytics in forecasting and modelling—and by improving molecular and



biochemical tools to identify emerging pests and pathogens—the agriculture sector will be able to respond more rapidly and efficiently to emerging threats. AAFC will use molecular, genetic, and ecological approaches to understand the dynamics (such as impacts, threats, and novel sources of resistance) between the environment and pests, pathogens, and their natural enemies. This improved understanding will allow the Department to adapt agricultural practices to cope with environmental stressors and emerging threats. This includes understanding the circular pathways of microbiomes in the agricultural landscape to assess zoonotic pathogens and the transmission of antimicrobial resistance.

E. Increased availability and awareness of alternative pesticides: In response to evolving pressures, AAFC will develop lower-risk strategies to alleviate the impacts of pests and pathogens on plant health while maintaining a high standard of human and environmental health in Canada. The Department will cooperate with commercialization partners and regulators to reduce barriers to introducing innovative technologies for producers. Once sustainable technologies are in place, it will monitor the ongoing impacts and assess them continually using quantifiable metrics to ensure there are no detrimental effects on biodiversity, landscape patterns or the climate.

F. Carbon, nitrogen and phosphorus cycles in terrestrial ecosystems: AAFC will work to better integrate carbon, nitrogen, phosphorus, and other nutrient cycles, build upon BMPs (such as 4R Nutrient Stewardship, a framework to achieve cropping system goals using the right fertilizer source at the right rate and time and in the right place). The Department will also co-develop decision-support tools in precision agriculture at the landscape scale. This work will enhance nutrient use efficiency in Canadian crop production systems and, in turn, reduce nutrient loses.

Advancing the circular economy by developing value-added opportunities

A. Diverse production systems with multiple outputs and co-benefits: AAFC will promote a circular approach to drive whole-resource utilization across the food production value chain. It will do this by repositioning agricultural and agri-food waste and/or by-products as novel resources and contributing to reductions in energy, carbon, and water footprints in the food production value chain. The Department will use circular value chain concepts to 1) maximize value from resources and promote efficient resource use in agri-food production, and 2) support the development of novel and green technologies to harness value in secondary food and bioproduct processing streams.

B. Growth of the circular bioeconomy in the agricultural and agri-food sector: AAFC will promote circular bioeconomy concepts by supporting the discovery of new value-added opportunities. For example, it will support the development of value-added foods and bioproducts that ensure economic growth and food security by producing safe food and materials with superior nutritional, sensory, and functional attributes. The Department will accomplish this by developing plants, animals, and tools whose attributes promote resilient production systems and drive value chain prosperity, and by relying on advanced methods in biology while developing sustainable pre-harvest management techniques and food safety and storage risk mitigation strategies. This work will ensure the appropriate use of plants and animals, safe products with enhanced quality, and less impact on the environment.

C. A prosperous transformation of food systems: Keeping cultural, social, and ethical values in mind, AAFC will harness its emerging

research expertise to address sustainable food challenges. It will provide leadership and a better understanding of the impact of the adoption of emerging technologies (such as gene editing and cellular agriculture) on sustainable food production, and will investigate any associated barriers.

Accelerating the digital transformation of the agriculture sector

A. Enhanced data-driven agriculture systems: AAFC supports integrated crop and livestock production in digital farming, pasture management, and climate-resilient cultivar development with a combination of novel genomics, phenomics, environment, and management strategies. Data-driven agriculture combined with emerging AI and machine learning analytics can increase the domestic and international competitiveness of Canadian agriculture. Over the next ten years, data-driven agriculture will evolve toward more autonomous systems that apply at larger scales for many commodities.

B. Evidence-based decision-making through efficient data acquisition and analysis: AAFC leverages disruptive sensor technologies, platforms (in situ, drone, and satellite) and telecommunications developed by industry and academia to generate data to measure, detect, and monitor changing agricultural systems over space and time. Scientists will be able to access the digital data that AAFC collects from soils, crops, and animals for use across all research domains. These data are foundational in determining the state of the agricultural landscape. They drive evidence-based decision-making and short- and long-term forecasting.

C. Customizable solutions for different end users based on big data analytics: AAFC, industry and academia will co-develop advanced data analytics and algorithms—such as data mining, assimilation, AI, and machine learning—that harness big data to better describe, diagnose, predict, and prescribe appropriate actions. These tools enable the provision of customized advice to farmers, greater uptake of best management practices, and better farm system productivity. Unleashing the power of big data analytics can improve decision-making at all scales, enhance AAFC's ability to assess threats and respond proactively, and improve the agro-ecosystem's performance.

D. A better understanding of greenhouse gas emissions through a standardized inventory system: AAFC will improve the national greenhouse gas inventory reporting for agriculture activities and the verification of emission factors for Canada by developing standardized methodologies for measuring and reporting greenhouse gas emissions. By collaborating more effectively with other departments, the Department will improve its climate monitoring, which will in turn support the development of models and methodologies for more accurate accounting of greenhouse gas inventories.


CIBC


AAFC RESEARCH AN
DEVELOPMENT CENTR
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
Agassiz
Summerland
Lacombe
Lethbridge
Saskatoon
Swift Current
Brandon
Morden


D
ES
ATLANTIC REGIONS
St. John's
QUEBEC
ONTARIO
Charlottetown
Quebec
Fredericton
Kentville
Saint-Hyacinthe
Sherbrooke
Saint-Jean-sur-Richelieu
Ottawa
Guelph
London
Harrow