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Strategic Framework for Accelerating Sustainable Agriculture in Canada: Recommendations for Philanthropy

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A. Strategic recommendations for philanthropy to accelerate more sustainable agricultural systems in Canada.

EXECUTIVE SUMMARY

This report identifies strategic opportunities for philanthropy to contribute to advancing more sustainable agricultural systems in Canada. It was commissioned by a small group of Canadian philanthropic foundations interested in strengthening the focus and alignment of their work around agriculture and encouraging other philanthropic organizations to become more actively engaged with the sector.

The project was designed to answer the following question: *What strategic opportunities exist today for philanthropic foundations and their agriculture-focused partners and grantees to accelerate the shift towards sustainable agriculture in Canada?*

The analysis presented here is based on a desk-based survey of literature (including academic studies as well as government and think tank reports), more than 50 interviews with a wide range of experts and stakeholders, six focus groups (on payment for environmental services, beef, dairy, organics, novel proteins, and sustainable diets), as well as a two-day strategy workshop. The process was informed by an eight-member expert advisory group.

The research was concerned in the first instance with primary agricultural production in Canada. But the analysis reaches beyond the farm gate to encompass broader agri-food systems (including input provision, processing, distribution, and consumption) which are critical to understanding the forces driving environmentally harmful practices and allowing the identification of potentially important intervention points to accelerate the transition towards more sustainable agriculture in Canada.

The report outlines a broad framework for thinking about foundation activity to promote sustainable agriculture in Canada. It starts with a brief review of the agri-food system. Important observations here include the complex and highly diverse character of Canadian agriculture, with significant variation across regions, among the types of crops and livestock, in cultivation and management practices, scale of farm operations, and domestic or export-oriented production. The system is marked by sharp differentials of power, with a large number of primary producers and a relatively small number of major input providers (seed, fertilizer and equipment companies), processors and manufacturers, and major retailers (supermarkets) that each wield substantial market power. This offers both obstacles and opportunities for change.

While unmistakable progress has been made in recent decades in increasing the efficiency of Canadian farm operations, and some environmental improvements have been secured, the

cumulative pressures of the agri-food system on the environment is significant and increasing, notably in terms of greenhouse gas (GHG) emissions and biodiversity impacts.

The report introduces a transition framework that can help us think about change in large scale systems of production and consumption. Lessons that emerge from international experience in transitions include the importance of combining policy measures that support emerging beneficial approaches with those intended to discourage damaging practices, and of building coalitions linking proponents of alternative practices with more established players who appreciate the need for change. As compared to some other sectors (for example, electricity or road transport) agriculture remains at a relatively early stage of transition.

In presenting high-leverage, strategic opportunities to advance sustainable agriculture in Canada, this report is attentive to both the opportunities and limitations of philanthropy's interventions. Our assessment is that philanthropy has a number of strengths that set it apart from other funders, including the ability to be systemic and strategic, long term and engaged, flexible, and collaborative. Our recommendation and hope for this group of funders is that this report contributes to an on-going collaboration, including strategic co-funding and collective learning.

This report presents eight recommendations organized under three broad themes. The first theme encourages foundations, through the organizations and initiatives they support, to highlight critical challenges to sustainability represented by current agricultural systems. This activity should foreground the release of GHG emissions driving climate change and pressures on biodiversity. GHG emissions stem from nitrogen fertilizer production and use, animal agriculture (especially beef and dairy cattle), and on farm energy use. Biodiversity is impacted by multiple factors including land and water use as well as the growing use of pesticides (especially herbicides). The second theme focuses on promoting the adoption of a variety of environmentally sound practices, approaches and novel technologies, which can together advance the sustainability and resilience of agrifood systems, through experimentation and scale up, grounded knowledge development, and change-oriented coalitions. The third theme emphasises the need to expand the capacity of farmer and civil society organizations focused on sustainability to build a more diverse and innovative agri-food policy ecosystem. This theme also stresses the need to deepen the Canadian conversation about the future of agri-food systems, encouraging more public deliberation on 'sticky' but important issues like plant-based diets, energy crops, migrant farm labour, and farmland ownership.

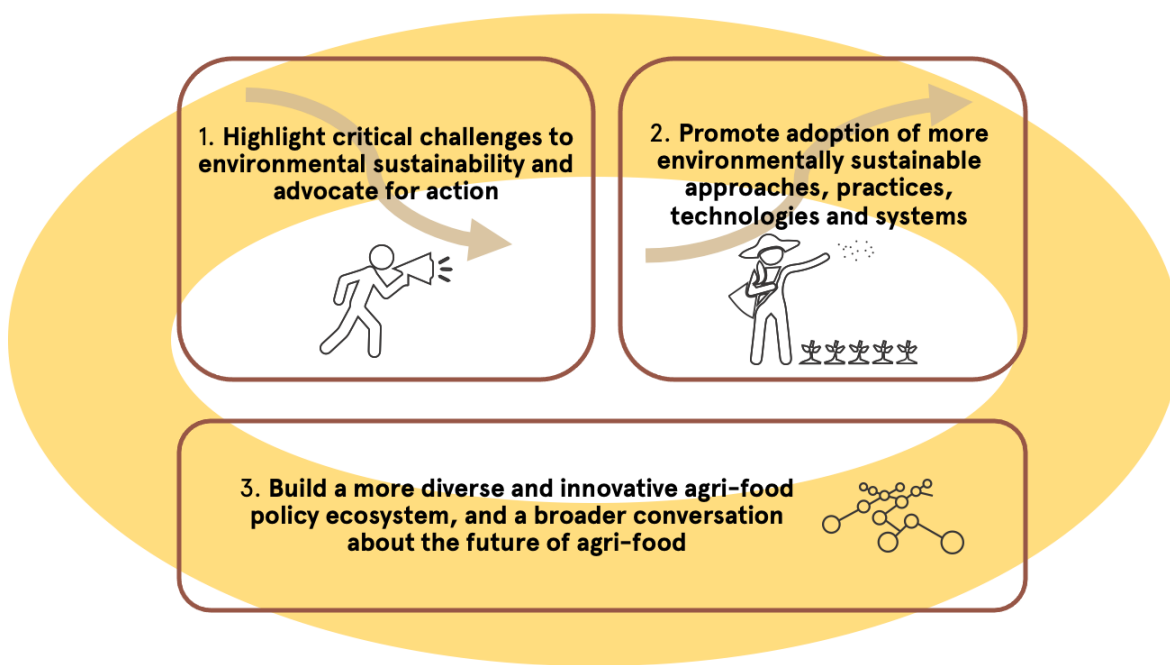
As Figure 1 (below) shows, these themes are closely inter-related and actions under all three headings need to be advanced if movement towards more sustainable agri-food systems is to be accelerated. Thus, for example, expanding the capacity of a greater variety of agrifood system voices (theme 3) helps both highlight negative impacts of current arrangements (theme 1), and encourage the uptake of more sustainable practices and systems (theme 2).

For each of the eight specific recommendations (listed in Table 1 below), the report provides examples of organizations operating in these spaces and/or projects which might benefit from

foundation support. We should stress, however, that we have not done a comprehensive review of all organizations in Canada active in these areas, and that more scoping will be needed for engagement with specific sub-sectors.

The report then provides an illustration of how the recommendations might be applied in three important subsectors: dairy, beef, and grains. In each case we provide snapshot of the subsector and then suggest the outlines of a possible engagement approach. The intent here is not to argue that these are the three sectors with which philanthropy should engage, nor to suggest that a sectoral approach is always the best one. Rather, the purpose of this section is to illustrate how the specific conditions in agricultural subsectors should be considered in building alliances and defining strategy, in cases where a sectoral approach is the most strategic one.

Figure 1: Themes



Throughout, the report emphasises the complex character of the agri-food system in Canada, including its diversity and its interconnection with global trends and international markets. Since the transition towards sustainability remains at an early stage, visions for a fully sustainable system remain contested. It remains unclear exactly which approaches will be critical to the sustainability of the system decades from today. Further, off-the-shelf, large-scale solutions to the environmental pressures of current agri-food production are not readily available, and there are multiple barriers to reform. Our view is that the system will require a variety of solutions in terms of systems, principles, and practices to produce more sustainable outcomes. It is also important to emphasize that there are already a range of activities taking place in the agri-food sector in Canada to develop and implement more sustainable approaches at the level of food production and harvesting practices, in particular. We stress the need to build on existing initiatives grounded in partnerships with farmers. In sum, it makes sense to pursue a variety of promising approaches in tandem, building on what is already happening that offers promise, and venturing into new territory where this is called for.

Each of the specific recommendations presented in Table 1 points to an important dimension of the reform effort. Integrated together and pursued over the span of a decade or more, they should allow foundations to make a substantial contribution to advancing the cause of sustainable agriculture in Canada. We are aware they cover a lot of ground. But such a broad perspective is necessary if foundations are to be able to situate their grant making and other activities within the overall context of the transition towards more sustainable agri-food systems.

Figure 2 illustrates the locations in the agri-food system where the recommended interventions would have an effect. While oversimplified, it provides a sense of the breadth and interconnected nature of the strategic framework. The red recommendation boxes point to areas of intended impact, but in many cases the interactions go both ways and are impossible to properly illustrate. The dotted lines between consumers and citizens indicate the dual role we all play.

Table 1: Summary of Recommendations

Note: Green highlighting in this table refer to the Priority Opportunities explained in the section below.

Theme 1

Highlight critical challenges to the environmental sustainability of the existing agri-food system in Canada, and advocate for action by government and industry to address these issues.

R1: Intensify education and advocacy work around the greenhouse gas emissions associated with farming practices	
R2: Engage on biodiversity issues, including:	a) Threat of urban encroachment on prime agricultural land
	b) Conversion of forests, wetlands and grasslands to cropland
	c) Human health and environmental impacts of pesticide use

Theme 2

Promote the adoption of more environmentally sustainable agricultural practices, technologies, and systems across Canada.

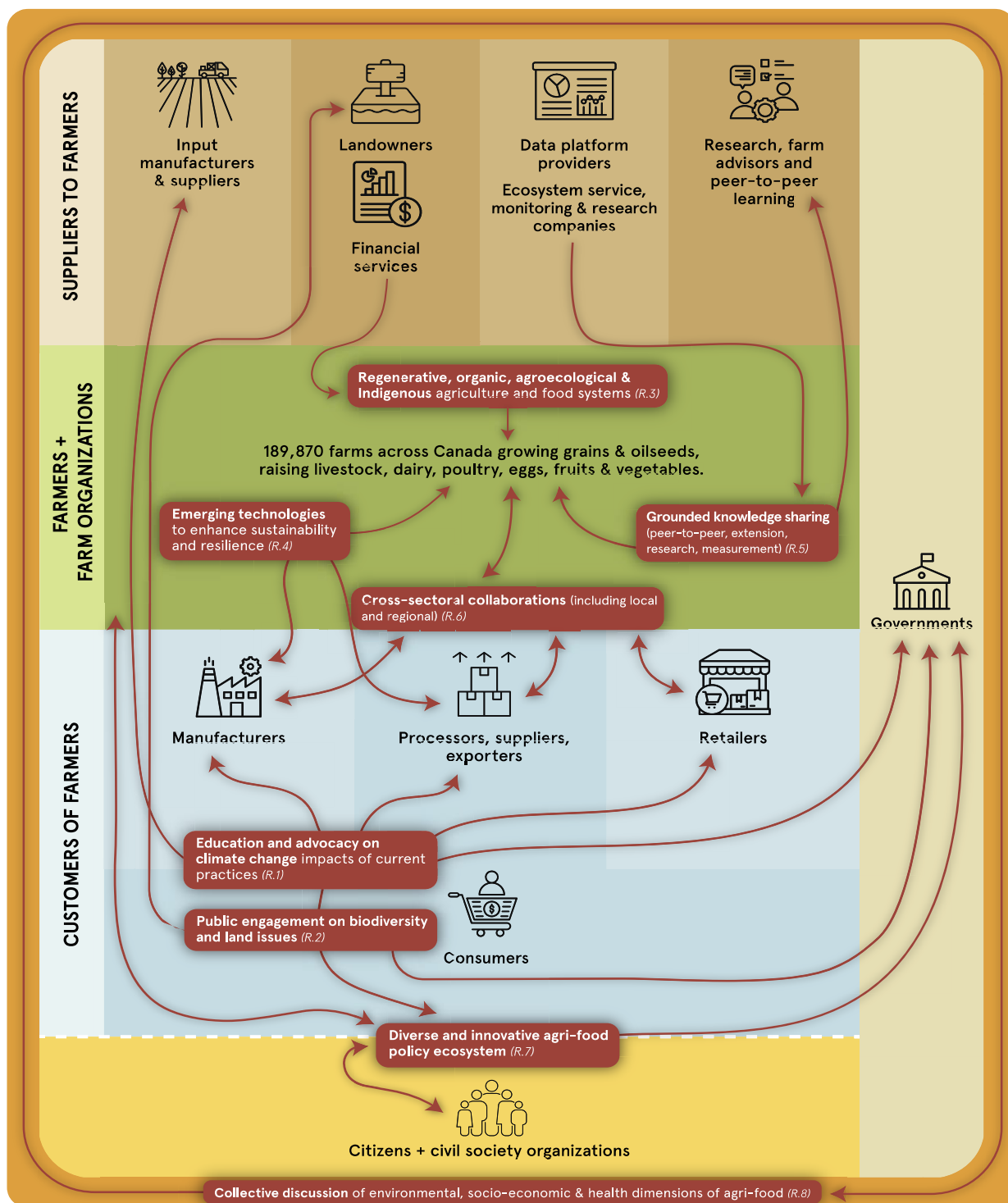
R3: Support the development and scale up of sustainable agricultural practices and systems, including:	a) Regenerative agriculture
	b) Organic agriculture
	c) Agroecological systems
	d) Indigenous agriculture and food systems
R4: Support emerging technologies with the potential to enhance the sustainability and resilience of agri-food systems (including through holistic technology assessments and life cycle analyses)	
R5: Expand grounded knowledge sharing , by supporting:	a) Peer-to-peer learning networks
	b) Revitalized extension programs
	c) Research
	d) Measurement and monitoring initiatives
R6: Encourage cross sectoral collaborations to advance more sustainable agri-food systems, particularly at the local and regional levels	

Theme 3

Build a more diverse and innovative agri-food policy ecosystem and a broader conversation about the future of agri-food

R7: Expand policy and communications capacities of farmer and civil society organizations focused on the sustainability of agri-food systems and their ability to coordinate actions	
R8: Support opportunities to deepen research that foregrounds the environmental sustainability of agriculture , and collective conversations about agriculture and agri-food systems in Canada	

Figure 2: Mapping of recommendations on Canada's agri-food system



PRIORITY OPPORTUNITIES

Notwithstanding the range of recommendations required for a systemic approach, we appreciate the very practical need **to pick just a few things to prioritize immediately** as foundations scale up their activities and deepen engagement with this sector. So, here **we formulate a short list of priority opportunities where foundation can begin to intervene right now, to maximize their potential longer-term impact.**

In thinking about these opportunities, we have in the first place considered the areas where there is currently some *momentum*: where there is an openness to change and actors within the sector have begun to initiate reform. The political conjuncture matters here as does engagement by incumbents. We have also favoured areas where foundations have *advantages* compared to other funders. They can be systematic and strategic, flexible, and collaborative, and engage over the long term. We have also considered areas where foundations may have some *prior experience* with funding and convening, such as supporting civil society actors to constructively influence government policy. A *potential for early wins* is also desirable, all the while keeping in mind the need to build steadily towards longer term goals.

These considerations suggest the following core priority opportunities:

1. Zeroing in on net zero

With the formulation of the ‘net zero by mid century’ goal at the 2015 Paris climate summit, climate mitigation efforts entered a new phase. For the first time the international community clearly articulated that addressing climate change requires an end to net additions of GHGs to the atmosphere and that just a few decades remain to achieve this objective if the most serious consequences of climate change are to be avoided. With the increasing experiential evidence of the impacts of climate change (droughts, floods, fires, etc.) over the past 18 months, the political salience of climate change has risen further.

Several of our interviewees emphasised that they have experienced a new openness among sector actors (including major firms, farmers organizations and governments) to reconsidering existing practices as the necessity of reaching net zero gains widespread acceptance. Conversations that were unthinkable as recently as three years ago are now beginning to happen as it becomes clear that (a) with a ramping up of climate mitigation efforts agricultural emissions will have to be brought under control, (b) reducing these emissions is impossible without major changes to existing farming practices, and (c) agriculture may in some cases represent a site for carbon sequestration (negative emissions – though the science remains uncertain on this front). Food and agriculture are also beginning to take a place on the

international stage on climate and environmental issues that they had not previously, for example in the UNFCCC Conference of the Parties.

Climate change is now by far the most politically salient global environmental issue. This issue should be harnessed as a catalyst, or motivator, for furthering sustainable agriculture more broadly. *By focusing activities on climate change and net zero, foundations can draw on this momentum and exploit this openness to accelerate reflection about the future of the sector and to build coalitions to implement practical change.* Net zero can provide a way in to explore broader sustainability challenges with current agricultural production (like biodiversity and the human health impacts of pesticides) and to widen the discussion about alternative futures. This approach would avoid the trap of ‘carbon tunnel vision’ decried by many in the food and agriculture sector. Still, net zero carbon can provide a unifying thread that runs through other recommendations made in this report. This GHG mitigation focus can also be linked to the necessities of climate adaption that are today becoming increasingly evident for farmers and rural communities.

(For details on climate change and net zero, see Recommendation 1)

Zeroing in on net zero is only the start, however. Once this target is named, and related sustainability goals brought clearly into view, the target needs to be linked to practical initiatives, such as furthering regenerative agriculture.

2. Amplifying the regenerative wave

Regenerative agriculture is now sparking interest and enthusiasm among many actors seeking to improve the sustainability of the agri-food system in Canada and internationally. It articulates a vision of sustainable agricultural practices that can protect and improve the soil, reduce expensive and environmentally damaging inputs, conserve water, increase biological diversity, diversify farm outputs, and revitalize farming communities. There are currently different interpretations of precisely what regenerative agriculture implies. The advantage of this situation is that regenerative agriculture is a relatively open and dynamic movement, one that allows farmers (on both large and smaller scale operations, producing a wide range of crops and livestock) to engage with different forms of alternative practice – with some representing significant shifts from conventional techniques. Ensuring that a broad range of public interest perspectives are active in these conversations can help regenerative agriculture attain its potential.

Interest from major food processors and retailers, farm organization and governments provide an opportunity for foundation support for and involvement in the building of widespread *reform-oriented projects and coalitions* with ready links to the net zero issue highlighted above. And while in some cases the regenerative name may be applied to rather modest amendments to environmentally harmful practices, these changes are beginning to be applied to large acreages. In doing so, they provide an opening for initiating serious conversations with wider

audiences about a sustainable future for farming. Both organic growers and proponents of agroecology – two other sustainable agriculture approaches – are influential in the regenerative agriculture movement. This creates the potential for important discussions, and the sharing of practices and lessons, across these different perspectives and approaches.

(For details on regenerative agriculture see Recommendation 3)

Supporting the regenerative agriculture movement offers an important entry point for furthering sustainable agriculture in Canada, and this movement depends on developing and sharing knowledge about more sustainable farming practices.

3. Mobilizing grounded knowledge for sustainability

Building peer-to-peer learning networks and revitalizing the research/practice link through extension services and independent agricultural advisors is critical to the adoption and scaling up of more sustainable agricultural practices. Several foundation funded groups are already developing peer-to-peer learning activities and a ramping up of this support and peer-to-peer learning activities could be done relatively easily.

Farm advisor/extension services are equally essential to provide farmers implementing novel practices with tailored technical assistance to address a range of immediate problems, from growing more diverse crops and integrating cover crops to adopting multi-paddock grazing systems. It is also vital to support ways *to connect researchers more closely with the practical problems faced by farmers on the ground*, building on and expanding some of the more successful elements of the Living Labs program and the remaining university research centres connected to extension work. Strengthening independent advisors and extensions services can help break the knowledge hegemony of input suppliers, and there are several emerging projects looking to do this which could be supported immediately. Another useful initiative would be to fund a national study of (a) the situation with respect to agricultural advisers/extension services in each geographic region across Canada and (b) the best practices in this area internationally, with the aim of developing suitable models for Canada. This could serve as a basis for future convening, funding, and advocacy.

(For details on peer-to-peer learning networks and revitalized extension programs, see Recommendation 5)

Creating a more robust sustainable agricultural sector that adopts regenerative practices with a supportive knowledge sharing environment also depends on visionary agricultural policy. To get this in place, especially at the federal and provincial levels, we need well networked, knowledgeable, farm and civil society organizations with the capacity to influence policy.

4. Strengthening farm and civil society voices for sustainability and local and regional coalitions for change

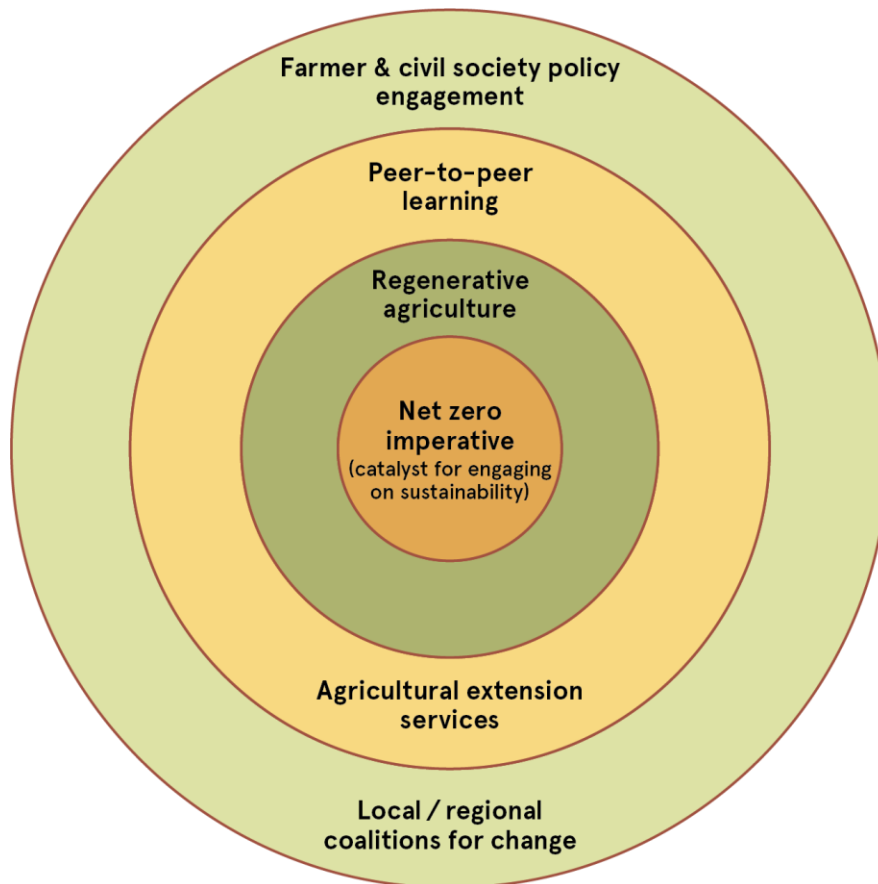
Strengthening the policy, communications, and organizational capacity of advocates for more sustainable farming practices must be a key priority for foundations. Supporting diverse local and regional farm organizations and a variety of civil society organizations can yield gains in the short, medium, and long term. Investing in these groups is comparatively easy to ramp up in the short term and will pay increasing dividends over time in terms of improved policy development and outcomes at multiple levels, from local to provincial and national policy. Foundations will be able to count on a wider cohort of analysts and collaborators which in turn will help them refine and amplify their granting and convening activities in the future. Building their communications and policy capacity and supporting coordination among them in the context of specific policy opportunities (such as the formulation of the next agricultural policy framework in 2027), is a strategic opportunity and high leverage point.

In tandem with amplifying emerging voices must come building of broad ‘coalitions of the willing’ – that can include some of the more powerful actors within the agri-food system (including processors, retailers, and others) who are open to change. While some agri-food industry players (such as traditional input suppliers) may be resistant to change because they see their existing business models threatened by an increasing movement towards sustainability (for example with a reduction in fertilizer or pesticide usage), others are increasingly sensitive to the issue. Only by building alliances between those anchored in mainstream and alternative approaches can unsustainable practices be overturned at scale. These coalitions can be particularly potent when organized at local and regional levels, where they can cross connect regional suppliers and consumers, draw on local/regional identities, be linked to economic development activities, help maintain or revitalize diverse food processing and distribution infrastructure, and build agency among reform-oriented actors.

For details on strengthening diverse voices, and supporting local/regional and national coalitions for change, see Recommendations 6 and 7.

Figure 2 (*The priority opportunities Bull’s Eye*) illustrates the relationships among these strategic priorities. Supporting diverse farm and civil society organizations will encourage more responsive agri-food system policy, while broad ‘coalitions of the willing’ will drive change forward at local and regional levels. In tandem, the growing commitment to net zero by diverse political and economic actors can be leveraged to channel resources into revitalized agricultural extension services, and peer-to-peer learning, to the benefit of the regenerative agriculture movement and the other innovative approaches with which this movement is in dialogue.

Figure 2: The Priority Opportunities Bull's Eye



B. Strategic recommendations for philanthropy to contribute to advancing more sustainable agricultural systems in Canada.

MAIN REPORT

Introduction

This report identifies strategic opportunities for philanthropy to contribute to advancing more sustainable agricultural systems in Canada. It was commissioned by a small group of Canadian family foundations interested in strengthening the focus and alignment of their work around agriculture and encouraging other philanthropic organizations to become more actively engaged with the sector.

This project was designed to answer the following question: *What strategic opportunities exist today for philanthropic foundations and their agriculture-focused partners and grantees to accelerate the shift towards sustainable agriculture in Canada?* The analysis presented here is based on a desk-based survey of literature (including academic studies as well as government and think tank reports), more than 50 interviews with a range of experts and stakeholders, six focus groups (on payment for environmental services, beef, dairy, organics, novel proteins, and sustainable diets), as well as a two-day strategy workshop. The process was informed by an eight-member expert advisory group. Further details on the interviews, focus groups, strategy workshop and expert advisory participants can be found in the Supplementary Materials.

Agriculture has long provided a foundation for Canada's economy, and the country is one of the world's largest agricultural exporters. Yet the sector continues to be associated with significant environmental impacts including the destruction of species habitat, air and water pollution, biodiversity loss and climate change. Although some progress has been made in recent decades, much remains to be done to increase the sustainability of Canada's agri-food systems.

The work presented here is concerned in the first instance with primary agricultural production in Canada. But the analysis reaches beyond the farm gate to encompass broader agri-food systems (including input provision, processing, distribution, and consumption) which are critical to understanding the forces driving environmentally harmful practices and allowing the identification of potentially important intervention points to accelerate the transition towards more sustainable agriculture in Canada.

Just what sustainable agriculture means in theory and practice is a matter of debate, with very different perspectives articulated by the stakeholders we consulted during the preparation of this report. For example, we spoke with experts who see sustainable agriculture primarily in

terms of what is sometimes referred to as “sustainable intensification,” which emphasizes the role of new technologies and large-scale operations in making agriculture more efficient, or producing “more with less or fewer inputs,” as one interviewee put it, thus resulting in fewer negative impacts. While this perspective is widely held, it de-emphasizes inherent ecological limits.

In contrast, we heard from other experts that sustainability requires nothing less than a paradigm shift towards a more circular economy that produces food without fossil fuels and minimizes ecologically harmful inputs and practices: “Agriculture is increasingly a linear system... with potash mines and phosphorus mines and oil wells at one end and... it all comes out the other end as food supplies and various things... Sustainable means circular flows of material powered by solar energy.” Other experts emphasized social, political, and economic factors that further unsustainable food production and consumption, including the impacts (on farmer and consumer choices) of corporate concentration in the agri-food sector, inequitable food distribution leading to high rates of food insecurity, as well as the impact (on Indigenous food systems) of the ongoing dynamics of settler-colonialism in Canada.

Finally, we also heard from experts who emphasize demand-side solutions, arguing that furthering sustainability requires changing consumer behavior to yield environmental benefits, by driving unsustainable models out of business (e.g., reducing or ending animal agriculture) or using consumer power to encourage changes towards greener production and distribution practices (e.g. local and minimally processed or packaged foods). For example, one academic analyst argued: “The food we eat... is probably the biggest driver of [un]sustainable agriculture.... There's no... good biodiversity or climate plans without moving to diets that are less... resource intensive like plant-based diets.”

Given these broad differences in perspectives on what sustainable agriculture means, it is important to note three things about the understanding of agricultural sustainability that underpins this report’s recommendations. First, when it comes to competing visions of what agricultural sustainability means in practice, we adopt a pluralistic approach – namely, being open to the potential benefits of multiple perspectives on sustainability even if they don’t entirely align with each other. From a transitions theory perspective (articulated in more detail in Section 3, below), various pathways to strengthen sustainability may exist at the same time, sometimes complementing, but sometimes also in tension with one another. Some of our interviewees emphasized this pluralistic approach: “We shouldn’t... make it one path only... [sustainability] has to be holistic and embrace a range of solutions and ideas and concepts... right from small scale farms at the very local level to the larger ones that are providing... export level production to deliver around the world.”

Second, while it is common to think of sustainability in terms of a ‘balance’ of economic, social, and environmental considerations, here we focus primarily on the environmental dimension. This approach recognizes that ecological integrity underpins economic activity and social well-being. In the context of sustainable agriculture, a focus on maintaining healthy soils, water, and biodiversity on agricultural lands in turn supports vibrant agricultural economies and rural

livelihoods.¹ After all, without the insight that the current development trajectory is undercutting the environmental conditions required for continued prosperity, the notion of sustainability would never have come to the fore. So, while the report engages with economic and social dimensions (including issues such as land ownership, farm debt, and migrant farm labor), its recommendations primarily relate to environmental sustainability.

Third, while there are some win-win situations, there are also inevitable tradeoffs. These often play out in terms of short vs long term impacts. For example, immediate increases in yields and exports (say by applying significant amounts of synthetic fertilizers) versus long-term soil health (by integrating livestock or undertaking longer crop rotations), or increased efficiency from large mechanized and specialized farms versus long-term resilience from smaller, more diversified farms.

The Canadian agricultural sector is complex and highly diverse, with significant variation across regions, among the types of crops and livestock, in cultivation and management practices, and in the scale of farm operations. We attempted to address this diversity by consulting stakeholders from different regions and sectors, from different points in agri-food supply chains, and with different types of expertise and experience (researchers, producers, representatives from trade organizations and government, industry consultants, and so on). While much of the discussion relates to the agricultural sector in general, we also offer a more detailed portrait of three important sub-sectors with significant environmental impacts: beef, dairy and the cultivation of field crops (see section 4). We also set aside some areas as outside the purview of this report either because their conditions are too different from traditional agriculture (for example, fisheries) or because of the unique nature of the challenge they pose (for example, food waste or animal welfare).

An on-going theme that runs through our work relates to striking the appropriate balance between on the one hand recognizing the efforts that have been made over the last few decades to improve environmental performance and the increasing interest which many in the sector are showing in sustainability, and on the other hand frankly acknowledging the very real problems which remain.

“Any information we have comparing our intensity . . . the amount of greenhouse gas emitted per unit of crop produced . . . [shows] it is among the lowest in the world. So generally speaking, . . . we’re pretty good”.

- *an industry representative*

Compared to the situation in some other countries, Canadian agricultural production does look ‘pretty good’ – for example, with lower rates of nitrogen fertilizer application per acre of field crops, or GHG emissions per pound of finished beef. And some in the farm community express frustration that the Canadian public does not sufficiently recognize efforts already made to practice sound stewardship, the GHG efficiencies already realized in Canadian agriculture

compared to other countries, or indeed the real difficulties farmers face in improving environmental outcomes while maintaining the viability of their operations. We recognize this sentiment and don't wish to add to the feelings of alienation we heard about.

On the other hand, only by recognizing problems and tracking performance can we hope to advance towards more sustainable practices in an increasingly dire context of climate change and biodiversity loss. For example, something must be done to address the 10-12% of Canada's GHG emissions that come from agriculture² even if, as some analysts contend, agriculture is among the more difficult sectors to address.³

It is also important to highlight that there are a number of industry-led initiatives that have recently joined the playing field of work on sustainable agriculture, including the [Canadian Agri-Food Sustainability Initiative](#), Canada's [National Index on Agri-Food Performance](#) project, and the [Canadian Alliance for Net Zero Agriculture](#). Far from indicating that there is no need for foundations to pitch in, the emergence of such initiatives rather underscores the importance of the issue and the opportunity for philanthropy to play a unique and vital role in collaboration with other actors to ensure such initiatives advance the public good.

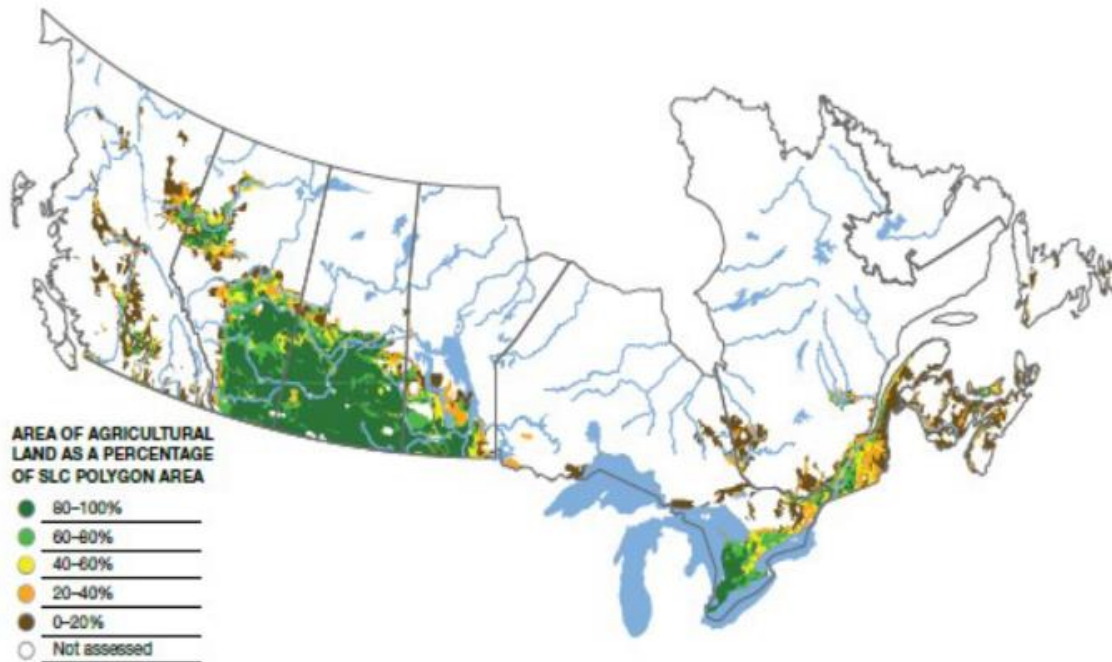
The report is organized into two main parts. The first defines the general context, providing a brief overview of Canadian agriculture and its major environmental impacts, as well as describing the transition perspective that provides the analytic frame for the study. The second focuses on the opportunities identified for foundations to promote more sustainable agriculture in Canada. This starts with a brief discussion of the role that foundations are best suited to play and the opportunity this presents. It then goes on to consider three major intervention areas with eight recommendations. Within these recommendations, we have pulled out a small set of focused opportunities that build on existing momentum, some offering short-term 'low-hanging fruit' and others representing long-term but critical areas for investment. Finally, we consider how these recommendations could apply to three specific sectors: beef, dairy and field crops.

Part 1: Context and overall approach

A) Canada's agri-food system⁴

Despite being the second largest country by land area, Canada ranks sixth in terms of area of cultivated land. Only 6.5% of the country's landmass is used for food production, largely because much of the country is situated too far north or possesses insufficiently rich soils for conventional forms of agriculture (see Figure 1). Thousands of years of pre-colonial agri-food management by Indigenous peoples—which included a range of practices from crop production to hunting, gathering, and wild rangeland tenure—retained an impressively fertile landscape. The colonization of this land by Europeans was uneven across the country, but it is fair to say that most of the land where food production takes place today was at one point either seized or acquired and enclosed by the Canadian state through coercive processes.⁵

Figure 1: Agricultural Land in Canada



This historical backdrop serves as one of the key sustainability challenges underpinning Canada's agri-food systems today, in two main ways: First, much of the country's agricultural land is under contested ownership, either because it occupies unceded Indigenous land, or it takes place on land that was taken through coercive means. This contested ownership is a long running social and economic sustainability challenge, as there are multiple claimants to Canada's agricultural land in production today. Second, much of the early colonial and early Canadian state's approaches to the expansion of agricultural land was to clear forests and plow and till minimally disturbed landscapes,⁶ which created a legacy of carbon emissions and significant wildlife habitat degradation. As examples, over 70% of historic wetlands have been degraded or lost in Canada, with 84% of this due to drainage for agriculture,⁷ and almost half of Canada's cumulative emissions of CO₂ since 1850 are from land use change.⁸ This legacy of ecological devastation tied to the origins of Canada's agricultural system is an important backdrop to discussions around sustainable agriculture today.

When it comes to current greenhouse gas emissions, the National Farmers Union estimates that the agricultural sector contributes about 83.2 Megatonnes of CO₂ equivalents (Mt CO₂e) – about 12.4% of Canada's GHG total.⁹ Note this estimate is higher than that often cited because it includes emissions from the manufacture of farm inputs, notably nitrogen fertilizer, which are counted elsewhere in Canada's national inventory reports.¹⁰

The development of agricultural land also had additional adverse impacts beyond a contribution to climate change and biodiversity decline. Namely, disturbed soils are more prone to erosion and do not retain water as well as healthy soils. This has contributed to a range of additional interconnected problems that agriculturalists continue to confront today. For instance, increased water runoff, combined with the application of both natural and synthetic fertilizers (as well as animal manure), has contributed to the eutrophication and contamination of many of Canada's rivers and lakes. Further, arid landscapes are less resistant to drought, and water used for irrigation in these areas has driven further stress on the water table.¹¹ In some cases, such as the decline of pollinator insect species and soil microorganisms, biodiversity decline has negatively impacted agricultural yields.¹²

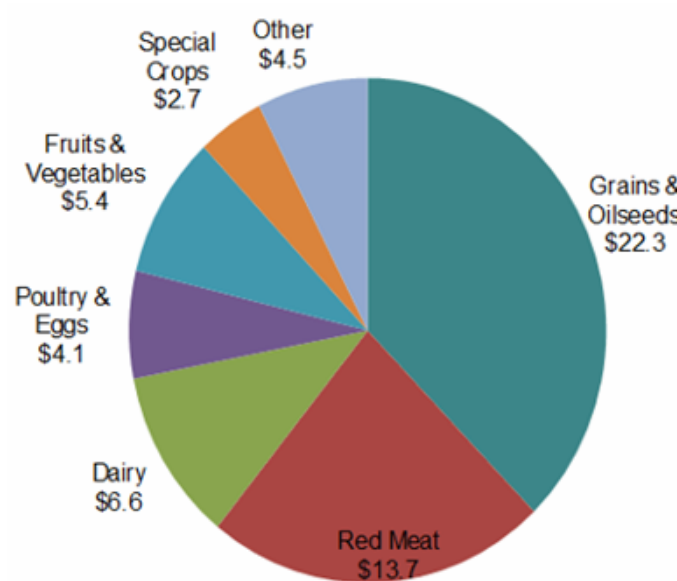
Multiple issues are relevant for assessing the environmental sustainability of Canadian agriculture today. These include greenhouse gas emissions, water quality, soil health, erosion, air pollutants, and biodiversity impacts, as well as factors such as the health and wellbeing of farmers, their employees, and their animals. From a climate change perspective, 20% of agricultural emissions come from on-farm energy use (primarily for equipment and heating) while 80% stem from agricultural practices (especially related to animal agriculture and the use of synthetic nitrogen fertilizers). The magnitude of specific challenges varies by sector, region, and on-farm practices. [Agriculture and Agri-Food Canada's Agri-Environmental Indicator Report Series \(2016\)](#) provides data on sustainability indicators for all of Canadian agriculture. While many indicators reveal ongoing challenges, the series also noted that important progress has been made on several fronts in Canada since 1990, including reducing soil erosion, reduced salinization, and improved air quality.

The Diversity of Agriculture in Canada

As Figure 2 shows, there is considerable diversity in this country's agri-food systems, in part because most of Canada's agricultural activity takes place in the lower latitudes of a very wide country spanning a range of biomes. In Saskatchewan, Manitoba and Alberta, most farmers grow wide expanses of wheat and canola, with increased diversification into pulses like lentils and chickpeas. Most of this production is exported by a few large grain trading companies. Beef and pork production are two other major export sectors, and both are integrated continentally. Most of Canada's pork is raised in Ontario, Quebec and Manitoba, and the majority is exported to the US, Japan and China, with only 32% consumed domestically.¹³ About half of Canada's 12 million beef cattle (or their meat) – mostly raised in Saskatchewan and Alberta – is exported, with over 70% of exports going to the US. Beef and hog farming and processing are thus subject to the rise and fall of North American and Asian market prices. A smaller, but growing, sector is greenhouse vegetables, based primarily in southwestern Ontario, BC, and Québec. In 2020, 837 farms in this sector produced \$1.8 billion of tomatoes, cucumbers, peppers and more. Only 20% of these vegetables are sold in Canada, with the rest exported to the US, Japan, and Taiwan, among other countries. The greenhouse and horticulture sectors in particular rely on tens of

thousands of migrant workers.¹⁴ Farms in other sectors are increasingly reliant on seasonal workers as well, especially in the context of the post-COVID 19 skilled labor crisis.

Figure 2: Farm market receipts, 2017, billions \$



Source: Canada's Agri-food sector, Agriculture and Agri-food Canada, 2019.¹⁵

In contrast to export-oriented sectors, poultry, egg, and dairy production in Canada—most significant in Québec and Ontario—is oriented to domestic markets. Farmers in these sectors are largely protected from international competition through supply management, a system that pays them through a formula related to the cost of production in exchange for controlling the amount produced. It is also notable that only a small percentage of very large (e.g. grain and oilseeds) and medium (e.g. dairy) farms (in terms of revenue) produce most of the agricultural products in this country, with many smaller farms producing less. As Figure 3 shows, in 2016, the 56% of farms with gross farm receipts of less than \$100,000 generated 5% of national farm revenues, while the 8% of farms with receipts of a million dollars or more generated 60% of total revenue. However, we also see a growing number of financially viable small farms producing for farmers markets and for Community Supported Agriculture (CSA) initiatives. Both experienced growth since the 1990s and were widely supported during the COVID pandemic by consumers seeking to strengthen local food system resilience, though it is unclear whether this growth is being sustained in a post-pandemic, inflationary context.

Figure 3: Distribution of farms and gross farm receipts, 2016.¹⁶

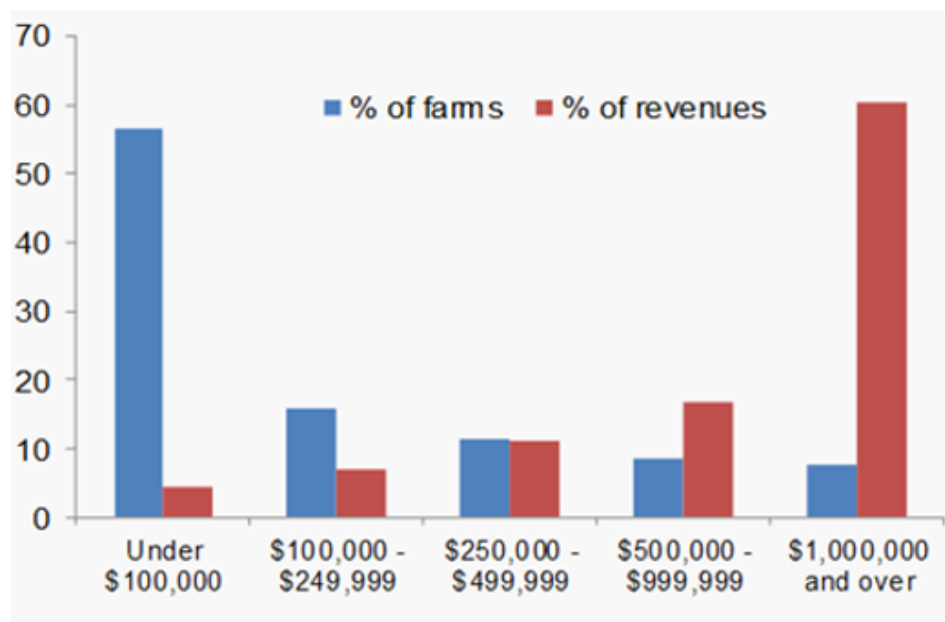
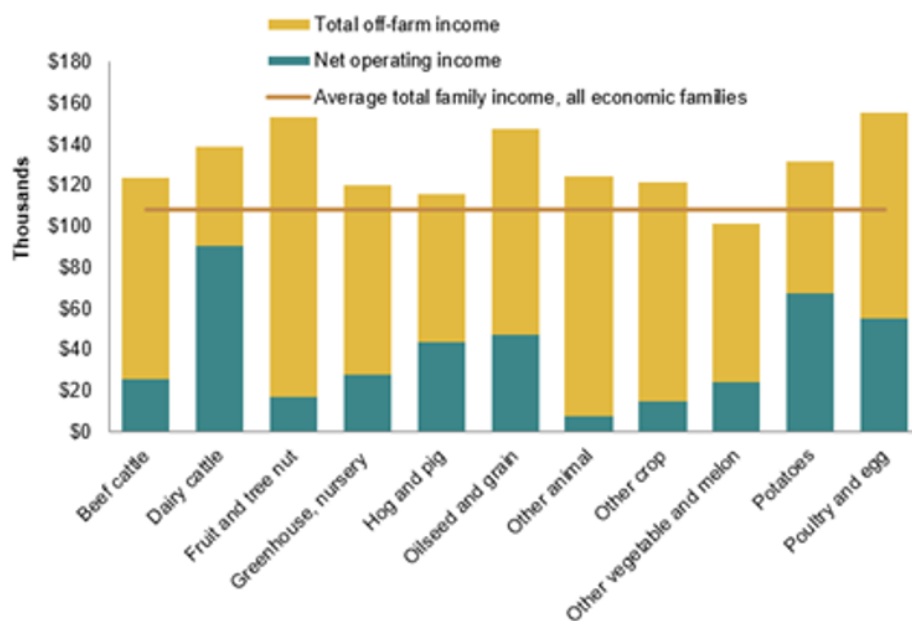


Figure 4 illustrates the relative contribution of off-farm income and net operating income for farm-owning families, illustrating these in relation to the average total family incomes of all economic families in Canada.

Figure 4: Farm family income in comparison to average total family income (2015)¹⁷



Canadian Diets

Food consumption in Canada has changed over time, and this has impacts on the sustainability of our agri-food system. However, it is important not to overstate the direct impact of Canadian diets on Canada's agri-food system. Some sectors (e.g. milk and poultry) are more affected by domestic markets, while others (e.g. beef and pork) are primarily driven by consumer demand in external markets.

Trends of the last fifty years include: increase in consumption of fast-food, ready-made meals, and restaurant meals; decrease in home cooking; decline in red meat and increase in chicken consumption; decline in per capita milk consumption and increased market penetration of alternative 'milks'; increased reliance on 'highly processed foods.' Year-round availability of a wide range of fruits and vegetables has also transformed supermarket shelves.

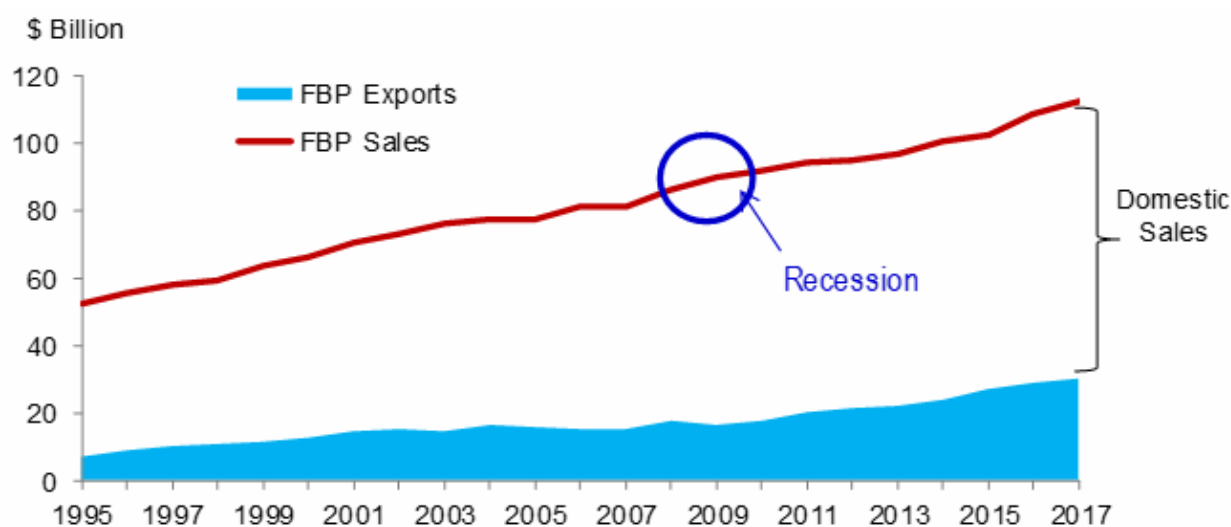
In the last five years, we have seen strong growth in alternatives to animal products, especially dairy milk alternatives like soy, oat, and almond milk (though less so in cheese replacements). When it comes to beef replacements (like 'beyond beef' burgers), some news coverage is suggesting that consumers are not turning to these items as quickly as expected, and some processors are therefore scaling back on the (pre-pandemic) rapid introduction of these products.

Canadian government advice plays some role, as well. The 2019 dietary guidelines note that, "while health is the primary focus of Canada's Dietary Guidelines, there are potential environmental benefits to improving current patterns of eating as outlined in the new guidelines. For example, there is evidence supporting a lesser environmental impact of majority plant-based diets." One study found that the healthcare costs of Canadians not meeting the 2007 dietary guidelines was \$13.8 billion/year (direct health care: CAD\$5.1 billion, indirect: CAD\$8.7 billion).¹⁸ However, on their own, national dietary guidelines appear to have limited impact in encouraging Canadians to eat more sustainable diets.

Canada's agri-food processing and distribution sector

Canada's Food and Beverage Processing sector is a key part of the agri-food system, with sales of \$112.6 billion in 2017. This sector is the primary market for Canadian agricultural products, processing about 42% of all agricultural products produced in Canada. This sector is also the main contributor to manufacturing GDP and the primary employer in the manufacturing sector. Figure 5 shows that this industry has grown gradually since the mid-1990s, both in domestic and export sales, even during the 'Great Recession' of 2008 to 2009 (when exports slumped).

Figure 5: Canadian Food and Beverage Processing Sales and Exports, 1995 to 2017¹⁹



This industry is primarily based in Ontario and Quebec. These two provinces accounted for 60% of the total value of all processed food shipments in 2017. However, meat processing is among the two or three largest food processing sub-industries (in terms of revenue from processed foods) in all Canadian provinces.

The dynamics of federalism play a role in how the Canadian agri-food processing and distribution sector operates. For example, shared constitutional jurisdiction over meat processing has led to two parallel sets of meat slaughtering rules in most provinces (federal and provincial). Federally inspected meat is allowed to be sold over provincial borders while provincially inspected meat is not. Smaller producers tend to use provincially-regulated plants, while larger producers use federal plants, selling into supermarkets.

The domestic vs. export orientation of different agri-food subsectors (e.g. pork vs. dairy) also has an impact on how these processing sectors operate. For example, as noted in the previous section, the supply-managed sectors (dairy and poultry) are more vulnerable to the demand of Canadian consumers for their products, and thus more sensitive to domestic consumer perception.

The local food movement, and other niche supply chains (e.g. organics), have led to some rebuilding of local and regional food infrastructure, but typically only for higher-end and value-added products. These markets are critical for the organic industry in particular.

The political economy of the Canadian agri-food system since the 1980s

Since the early 1980s there has been a shift in how governments have interpreted their role in protecting, promoting, and enticing producers to participate in domestic and global food

markets. For most of the twentieth century, Canada had a mostly protectionist agricultural economy, in which government regulations and subsidies shielded farmers from imported agri-food products that could undercut their market share, while also funding technological developments that ensured consumers access to inexpensive food. Farmer-supporting measures included a single-desk marketing board for western wheat (which ended in 2012) and the supply management systems mentioned above. Supply management allowed many mid-sized farmers to continue to make a living in dairy, poultry, and eggs, and has been lauded by some for integrating production costs into the price consumers pay for food. However, supply management has also been criticized for increasing the costs of these products and making it difficult for new players to enter these sectors. While some farmer-supporting policies (like supply management) have persisted to this day, we can also see a trend towards the corporatization and financialization of land, some offshoring, and the closure and downscaling of many smaller firms in the processing subsector (like small abattoirs, canneries, tanneries, etc.).

The Canadian agri-food system sits at the intersection between global forces (like international finance and trade) and agricultural sustainability. Canada is the fifth largest agricultural exporter (in terms of export value), with about half of all primary agricultural production being exported. This means that what happens on many Canadian farms is shaped by international finance and international markets. Further, Canada has signed trade agreements which have increasingly given market space to international trading partners in the United States and Europe (for instance, allowing greater imports of European cheeses and American dairy products). The implications of trade agreements are complex. They have not been uniformly detrimental or beneficial, but rather resulted in various sets of winners and losers, with the general trend being a political economic environment that makes it more difficult for smaller players to compete with bigger, corporate agglomerations.

Today, large corporate actors play a key role in providing inputs used in Canada's agricultural sector: seeds, fertilizers, and pesticides. Prices of these inputs have risen steadily for years, and critics argue that these increases relate to the way this sector is highly concentrated. With two or three companies supplying more than 66% of these products globally, farmers have little choice but to pay price increases. Canadian farmers keep about 5 cents of every dollar they earn, with the other 95 cents going to inputs (including machinery and labour). This is all further context for the discussion about a sustainability transition; it is oft-cited in the farm community that "it is hard to be green when you are in the red."

Additional considerations

There are several other important dynamics at work in the Canadian agri-food system that deserve mention. First, farming is increasingly data-driven or 'digitized'. For example, high tech tractors and sprayers using GPS technologies can identify where to deposit fertilizers to achieve maximum effect. The digital revolution in agriculture has implications for scale, however, as such machinery can be expensive to own and maintain, potentially putting pressure on smaller producers. Such implications suggest the importance of careful and holistic technology assessments that consider how new technologies will affect the way farming happens, potential

gender impacts, etc., in addition to life cycle analyses that consider overall environmental impacts of new and emerging technologies.

Second, since the 1980s, most provinces have significantly cut back on agricultural extension programs. As a result, as one interviewee noted, many “farmers only have companies to go to for help.” This extension gap is revisited below. Quebec is the only exception here, with ongoing (if imperfect) extension services. Quebec is distinct from other provinces in other ways. It has an active policy supporting organic agriculture (alongside only PEI) and its policies supporting new farmer entrants. Its agri-environmental policies more generally are also worth noting.

Finally, several interviewees commented that—unlike most of the previous decade—Canada has seen some political leadership at the federal level on agricultural sustainability issues since the election of the Trudeau Liberals in 2015. This has included some action to bring alignment between federal climate policies and agricultural policies, as we discuss below. Canada also adopted a policy process in the development of Canada’s 2019 dietary guidelines that deliberately excluded food industry lobbyists. Commentators noted that the 2019 Canada Food Guide better aligned with scientific advice than previous versions. Nonetheless, some critics argue that there remain important contradictions between various aspects of federal policy, such as the overall commitment to grow agricultural exports and the efforts (in the 2019 food policy) to support local food systems. We also note an ongoing need to address detrimental or inconsistent subsidies in the agri-food sector.

Heterogeneity and Sustainability

This backgrounder has sought to put the sustainability of agricultural practices on Canadian farms into geographic and political-economic context. One key message is that Canada’s farms are deeply heterogenous in terms of their form (specializing in different products) and scale (large vs. small). In addition to geography, these differences relate to their embeddedness within different types of market (domestic vs. export as well as local vs. commodity markets).

Further, sustainability impacts of agricultural practices differ significantly from farm to farm. In some cases, water withdrawals are an agricultural operation’s most significant environmental impact; in others it is methane emissions from livestock; in others is air and water pollutants associated with the production chain; in others still it is soil degradation, and so on. It is also important to recognize that some sustainability issues—in terms of their systemic impacts, e.g. GHG emissions—are especially urgent in the current context. Further, many farm operations remain financially precarious. As a result, while some sustainability practices may benefit farmers directly, farmers need to be assured that they can pay for any changes they may be asked to undertake for the public good.

What does all of this mean for how we engage with this system from the point of view of sustainability interventions? Agri-food sustainability in Canada is complex, wide-ranging, and likely requires multiple approaches. We now turn to discussing some of the efforts that have emerged in recent years to address these challenges.

Recent efforts to strengthen agricultural sustainability in Canada

Canadian agriculture has a history of working to address environmental challenges. The development and adoption of conservation tillage and no-till seeding in the 1990s, to address significant soil erosion issues from the 1920s until the 1980s,²⁰ is a prime example.²¹ That almost 40% of Canada's farms have developed environmental farm plans (a tool developed in the 1990s with the intent of allowing farmers to understand and address environmental challenges on their farms—albeit one without publicly reported outcomes) is another example.²²

The [Canadian Agricultural Partnership](#) is the federal-provincial-territorial agreement (formerly called Growing Forward) which co-funds provincial and federal farm cost-shared programs as well as agricultural insurance programs, which include sustainability supports. There are wide differences across provinces, depending on provincial government's priorities, and a need for improved coordination between programs, inside and outside government. Several federal government strategies are also relevant, including the [2030 Emissions Reduction Plan](#) and the [Sustainable Agriculture Strategy](#) which is currently under development, as well as numerous provincial policies.

In recent years, the federal government has launched or renewed several programs to advance agricultural sustainability, including:

- the [On-Farm Climate Action Fund](#) (Agricultural Climate Solutions program), supporting farmers to adopt practices that store carbon and reduce greenhouse gases, focused on nitrogen management, cover cropping and rotational grazing practices;
- the [Living Labs Initiative](#) bringing together farmers, scientists, and other to co-develop and test innovative technologies and on-farm practices to reduce greenhouse gas emissions and sequester carbon in real-world conditions;

As mentioned earlier, several other efforts have recently emerged to address sustainability challenges raised in this report, including:

- Canada's [National Index on Agri-Food Performance](#) which engages a broad coalition of private and public sector partners and is piloting an index featuring 20 key sustainability metrics to benchmark the sector's sustainability impacts.²³
- The [Canadian Agri-food Sustainability Initiative](#) (CASI), hosted by the Canadian Federation of Agriculture, working to streamline approaches to demonstrating sustainable production practices at the farm level through an online sustainability portal aggregating Canadian agricultural sustainability data and aligning with sustainability demands of global markets.
- The [Canadian Alliance for Net-Zero Agri-food \(CANZA\)](#), a nationwide coalition of stakeholders in the agricultural and food industry supported the Natural Step Canada, Smart Prosperity and the Arrell Food Institute, currently working to develop an accurate and scalable measurement, reporting and verification system for soil carbon as well as a national biodigester network.²⁴

B) Transitions and a transition perspective on sustainable agriculture

Transition studies examine change processes in large scale systems of social provisioning. These systems are in continual movement. Most changes are incremental, but occasionally there is a more widespread transformation of how a system operates. These more substantial changes are dubbed ‘transitions.’ The literature includes research on historical transitions, but most work is focused on ‘sustainability transitions’ that attempt to bring human production/consumption systems in line with ecological frontiers. Much of the early research was focused on transitions in energy and mobility systems, but there is now an increasing body of research focused on agri-food systems. Most of these studies deal with developments in specific regions outside of Canada and/or specific subsectors (for example, dairy, greenhouse production, etc.).²⁵

Although historical transitions display enormous variety, researchers have identified common patterns and features²⁶. Among the most important are:

- Their *multi-dimensional, multi-actor, and multi-causal character*. While popular accounts emphasize individual inventions or entrepreneurs, system change involves multiple adjustments to technologies, business practices, regulatory frameworks, and consumer behavior.
- The centrality of both *‘building up’ and ‘tearing down.’* Transitions give birth to novelties (technologies, business models, social practices) but they also entail the decline and replacement of older ways of doing things.
- *Pervasive uncertainty*. Transitions are messy. Development trajectories cannot fully be known in advance. Innovations may fail to live up to expectations, and shifting economic or political circumstances, societal countercurrents, or contingent events can stall, reverse, or reorient change. ‘Optimality’ is applicable neither to transition processes nor their outcomes, and there are always unintended consequences.
- Involvement of *distinct phases*. These typically include a relatively long *‘emergence’* period where shortcomings with existing arrangements are visible and trials of competing technologies and business models get underway; an expansionist *‘acceleration’* stage with convergence on standardized solutions, and wide scale adoption; and finally, *‘stabilization’* where new arrangements become dominant and adjustments with adjacent systems are completed.
- The *importance of ‘visions and narratives’* for mobilizing resources, coordinating investment, and overcoming resistance. At the outset, uncertainty is high, alternatives display weaknesses (higher costs, low functionality) and mesh poorly with the established system. Visions and narratives help bridge the gap between the long-term promise and the less-than-ideal reality of novel solutions.
- *Distributive consequences*. Transitions differentially impact businesses, workers, sectors, and regions. While society may gain from new arrangements, the lives of many will be upended. Struggles to redistribute these benefits and costs are ubiquitous.

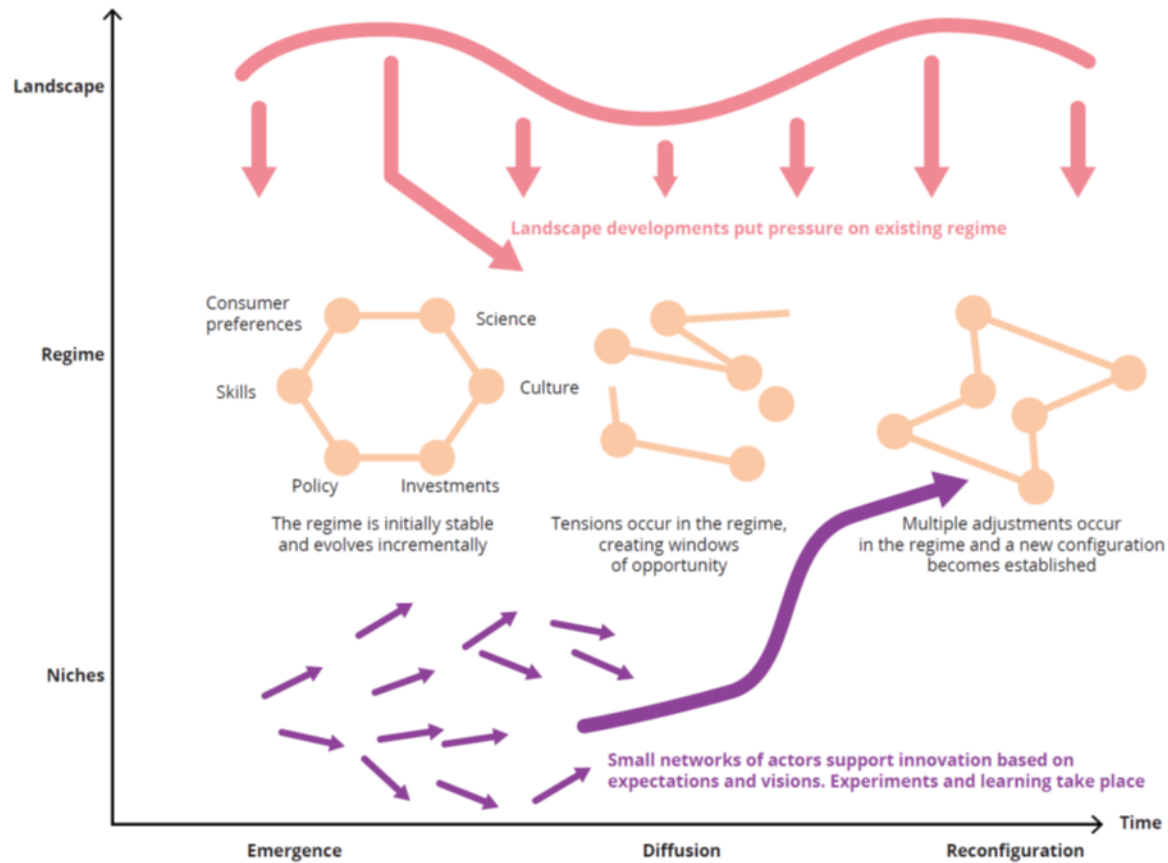
- *Politics, policy, and government* play a central role. With its legal authority, regulatory apparatus, and financial resources, governments can influence the pace and direction of change. Appeals to progress and the common good, justice and entitlement are staples of public debates around transitions.

Four analytical and conceptual frameworks have been particularly influential in the transition literature to date. *'Strategic niche management'* focuses on the critical role niches play in transitions. Identifying market segments where an emerging technology can mature is a classic function of entrepreneurship, but *'strategic niche management'* highlights the role policy can play in creating *'protected spaces'* where a new technology can gain experience, win consumer confidence, improve functionality, and drive down costs. This can take the form of public procurement, feed-in tariffs, or portfolio standards that guarantee a market share to an emerging technology. The *'functions of innovation systems'* approach starts from an understanding of the interdependent dimensions of successful innovation systems to identify problematic areas in specific (industry/sector/regional) innovation systems. It goes on to propose specific interventions (that could be adopted by investors or policy makers) to strengthen these systems so innovations can break out and accelerate transition processes. *'Transition management'* deals explicitly with techniques for orienting sustainability transitions, suggesting a variety of strategies and tools that can network innovators, coordinate programs of societal experimentation, build supportive coalitions, and scale emerging approaches.

By far the broadest and most influential framework to emerge from transition research is the *'multi-level perspective,'* a heuristic that integrates the different kinds of factors that drive or retard system change. The schema includes three primary analytical *'levels'*: *'the regime'*, the operative set of arrangements that dominate in a particular sector (including prevailing rules, technologies, actors, and business models); specialized *'niches'* where emerging alternatives are tested and strive to become more influential; and the *'landscape'*, the broader economic, social, and political environment within which regimes operate. Typically, system change requires developments at all three levels, as increasing landscape pressures aggravate difficulties of the prevailing regime, sometimes opening the door for maturing niche arrangements to break through and achieve a transformation of existing arrangements. For a visual representation, see Figure 6.

Of course, sustainability transitions are more complicated than this as interactions across the three levels can produce varied patterns of stability or change. Recent research has tended to emphasize the diversity of outcomes as dominant regimes adapt and adjust in response to pressures from emerging technologies and shifting economic and social circumstances.

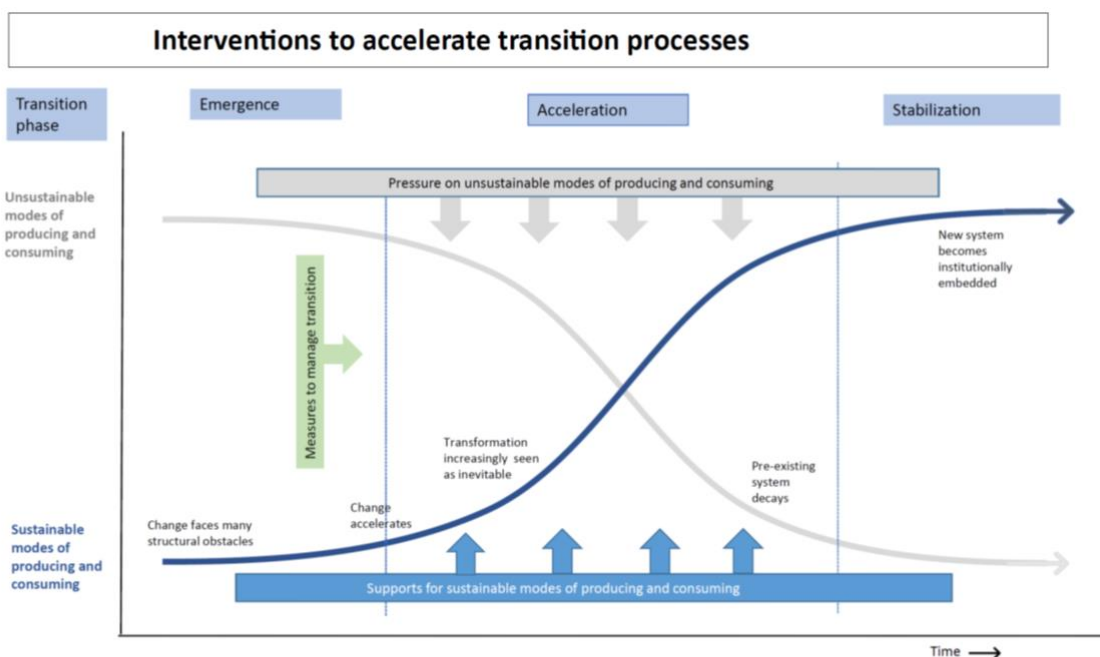
Figure 6: The multilevel perspective on sustainability transitions



Source: Based on Geels (2002).

Over the past few years transitions research has focused on approaches to accelerate transitions, especially the application of different 'policy mixes' (combinations of policy tools) at different stages of the transition process to accelerate change. Throughout the process attention is paid to (a) increasing pressure on the old regime (b) supporting emerging solutions and (c) orienting the change process as a whole (see Figure 7). But the ways in which this is best done vary with the progression of the transition. In the early phase (emergence) the emphasis is on experimentation and later attention (acceleration and stabilization phases) shifts to scale up and phase out.

Figure 7: Interventions to accelerate transition processes



Policy Goals	Example of policy measures in each transition phase		
	Emergence	Acceleration	Stabilization
To support more sustainable ways of producing and consuming	Support for R&D subsidies, experiments, pilots, public procurement, etc.	Feed in tariffs, portfolio standards, consumer subsidies to accelerate uptake. Public infrastructure investment, initiatives to mobilize private finance; regulatory reform	Wind down of financial supports, further regulatory adjustments, institutionalization
To discourage unsustainable practices and encourage system replacement	Sustainability disclosure requirements, monitoring, regulation of incumbents to signal need for change	Taxes, regulations to increase pressure on old regime. Subsidy removal. Introduction of phase-out measures, and support for communities impacted by transition (worker training, regional development strategies).	Retirement and 'buy-back schemes', measures for stranded assets. Bans.
To orient the transition: establish directionality, manage disruption, promote equity and justice, anticipate problems	Develop visions for alternative arrangements, signal directionality of change	Manage political tensions, promote equity and just transition; periodically re-evaluate policy mix, develop political spaces to build consensus for change; neutralize opponents	Continued support for impacted workers and communities. Deal with unanticipated consequences. Intersectoral adjustments
Notes: Individual policies can extend across phases, but center of gravity of policy mix evolves with transition phase. Supports for communities negatively impacted begins in mid-acceleration but continues into stabilization. Phase out is raised as acceleration takes off but is completed in stabilization, and so on			

How far are we along towards a sustainability transition? If we think particularly in terms of GHG emissions and movement to a net zero society, the sectors which are most advanced down transition pathways (in the acceleration phase) are power production (electricity) and mobility (through electrification of light duty transport). We know lots of ways to produce low carbon electricity and many jurisdictions are well on their way to phasing out coal-fired generation. Similarly, the electrification of light and medium duty vehicles is now accelerating.

In contrast, the agri-food system is at an earlier (emergence) stage of the sustainability transition in industrialized countries. There are several reasons for this, including the fact that some of the GHGs produced in agriculture (e.g. methane produced by cattle) are more difficult to abate (with existing technologies) than in other sectors. Further, while more sustainable

approaches to agricultural production and food distribution are emerging in many different contexts, these tend to operate at small scales and in protected markets. Niche innovations for large scale sustainable production and distribution are in development, but most are still experimental. Meanwhile, the 'regime' practices of the last fifty years still dominate in most agri-food sectors. As a result, the scalability of many currently proposed solutions remains unclear in the agri-food system.

Some of the observation/conclusions which emerge from the discussion of transitions in agri-food systems include that:

- Nature/technology interactions are particularly prominent in the agricultural sector, as productive systems remain directly dependent on natural circumstances (sunshine, water, weather, etc.) and biological/ecological processes. Future climate change impacts add further uncertainties to this direct dependence on nature.
- Place, locality, and geo-spatial circumstances are significant as agricultural systems are tied to local climate, soil, and water resources, etc. While value chains are often international (commodity trade, input providers, and so on) local networks, culture, traditions, regulations, and marketing strategies remain important.
- The atypical structure of the agri-food sector is significant. This takes the form of a relatively small number of input providers (seeds, fertilizer, chemicals, machinery); a large number of primary producers who make their own investment decisions; a very small group of processors, manufacturers, and major retailers; tens of thousands of commercial/institutional consumers and millions of individual households. This structure contrasts dramatically with the organization of other provisioning systems (such as energy and mobility, in which there are smaller numbers of key actor at all stages in the supply chain (other than consumption). It has important implications on at least two levels. First: Farmers are price-takers in this system, but also subject to a growing number of demands for doing things differently. Second: concentration in the input and processing sectors means actors in these sectors wield considerable influence when it comes to the governance of agri-food systems at national and international levels.²⁷
- Most of the changes towards sustainability observed in specific agri-food production/consumption systems over the past four decades have involved complex interactions between multiple niches and piecemeal regime adjustments rather than any direct overturning of dominant practices across the board. Further, the dispersed nature of the sector has meant widespread changes are likely to be spread over decades. Vermunt et al. write about slower "scaling up dynamics" in agriculture than in energy or transportation systems. They also suggest that sustainability innovations in agri-food may be "less likely to lead to reduced costs compared to previous studies on the energy and mobility domain."²⁸
- Rather than a simple flip to a new configuration, some sectors exhibit 'transformation pathways' where incumbents gradually adjust to new circumstances. The key to such pathways

appears to be that some incumbents come to realize that structural change is required to address issues that are bedeviling them.

- While cost considerations are critical determinants of farm level decision-making, they do not seem to be the only motivating element for farmer's choosing to adopt specific production practices. Calculations of risk and benefit, confidence in knowledge about alternatives, but also concepts of what is right or appropriate also play a role.
- Encouraging a diversity of production systems is favorable to changes as are multi-actor collaborations. According to the synthesis in Bilali (2019) 'Acceleration dynamics in the food domain are fueled via multi-actor collaborations'.²⁹
- Both the consumption (demand) and production (supply) are involved in system transformation. While production is driven by demand (i.e. producers respond to changing consumer preferences), demand is also actively shaped by the food industry which designs products (to attract consumers, reduce costs, etc.). Over the last few decades, the most important gains in the environmental sustainability in agri-food systems have been made on the production side with increased productivity and some movement towards less environmentally damaging practices. A recent study of the UK agri-food system suggested that over the thirty years between 1986 and 2017 per capita GHG emissions from the food system declined by 32%.³⁰ Two thirds of this change was due to supply-side changes, and one third to demand-side changes (including dietary shifts and waste reduction).
- Appreciating the conditions of change in particular production/consumption systems requires a detailed understanding of how these systems emerged and actually work. As in other sectors, multiple factors seem to interact in the sustainability advances seen in the agri-food system in various contexts to date: technological innovation, national government programs, the influence of input suppliers and food processors, producer initiatives, civil society action, shifts in international markets, changes in consumer behavior, action by local governments, and so on.

Part 2: Opportunities and recommendations

The role and potential of philanthropy

In searching out the most high-leverage, strategic opportunities to advance sustainable agriculture in Canada, we have been conscious of both the opportunities and limitations of philanthropy's interventions. Our assessment is that philanthropy has a number of strengths that set it apart from other funders, such as governments, companies, and individual donors, even if it must be said that these strengths aren't always used to full advantage:

- **Systemic and strategic:** Foundations have the ability to take a systemic approach to an issue like agriculture, but also to be strategic in their interventions, seeking out the

opportunities with the greatest impact and potential for public good rather than spreading dollars in response to demands of constituents or vested interests.

- **Long-term and engaged:** Contrary to governments responding to electoral cycles or companies to quarterly earnings, foundations have the luxury of being able to take a longer-term and holistic view and to act accordingly, for example by supporting initiatives for multiple years and to learn along with grantees in an on-going way.
- **Flexible:** Similarly, foundations have the possibility of being both patient and nimble. They can provide early funding quickly when a need is identified, and can pivot when change is required, such as when activities aren't working out as expected or the context shifts.
- **Collaborative:** Foundations can work behind the scenes and in collaboration with different partners rather than launching branded initiatives. They can 'stack on' support to what others are doing, adding funding where required to tip into impact, without needing to stake out new ground. Related to this, foundations have potential roles beyond funding, such as advocacy, amplifying voices, convening, and investing, while remaining ever conscious of the power that comes with holding the purse strings.

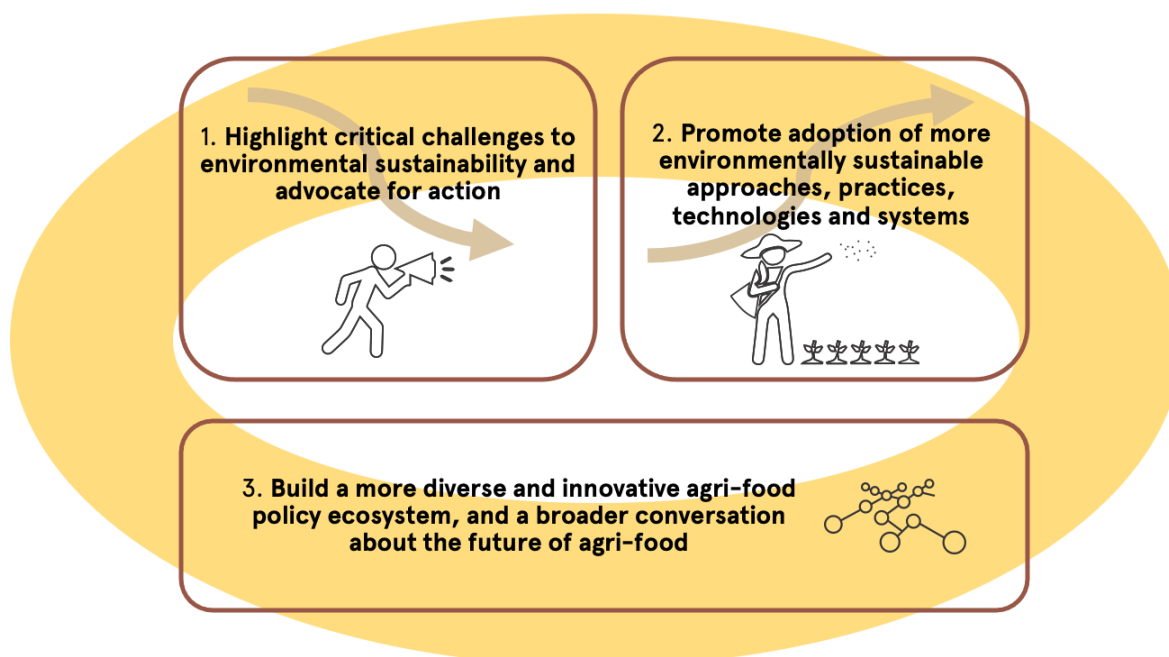
Our recommendation and hope for this group of funders is that this report contributes to an on-going collaboration, including strategic co-funding and collective learning. The advantage of a connected approach (without requiring adherence to one central strategy) is that funders can deliberately support complementary areas, and that when resources are thin for one funder, they can be provided by another, helping to ensure the continuity of initiatives. There are several successful Canadian funder collaboratives in other sectors which can provide lessons.

In addition, there are a number of international funder collaboratives on food and agriculture which, several interviewees stressed, Canadian funders are welcome to either join or learn from. These include [Funders for Regenerative Agriculture](#), the [Global Alliance for the Future of Food](#), the [Agroecology Fund](#), [European Climate Foundation](#), and [Sustainable Agriculture and Food Systems Funders](#). There are also investor networks that have been effective at influencing food companies and that welcome foundations as members: [Ceres Investor Network](#)³¹ [Food Emissions 50 initiative](#)³² and [FAIRR](#).³³ See Supplementary materials for contacts associated with these international groups.

The areas for strategic support and action identified in this report have of necessity been scoped rather superficially, and will require more research and discussion to identify the best partners and strategies. As discussed above, wherever relevant it will be important to work with existing initiatives and organizations to avoid reinventing wheels. However, we also strongly suggest that foundations be open to new initiatives and use mechanisms like requests for proposals or further scoping work to identify organizations and innovations that are not already known. While we have mentioned a number of organizations in the report in order to be concrete, we emphasize that these are examples as opposed to granting recommendations.

Recommendations

We have organized our recommendations around three central themes that point to critical and complementary levers which can accelerate movement towards sustainability in the agri-food system. They are captured in the following simple graphic.



Within each theme we highlight specific actions that can have the largest impact. The approach is tailored to a highly diverse agri-food sector (with variation among regions, crops, farm scale, and supply chains), where sustainability transitions remain at a relatively early phase, and we cannot yet offer a comprehensive vision of how fully sustainable agri-food systems would operate.

The first theme focuses on exposing the negative impacts of unsustainable practices, especially as related to greenhouse gas emissions, pesticide use, and land conversion. The point is not to place blame on individuals (especially farmers, who are often 'stuck' in the system), but to identify systemic problems and encourage change. The goal is to raise the pressure for change, notably on the government and 'incumbent' agribusiness and food companies benefiting from the current system and contributing to environmental degradation. Net zero GHG emissions goals adopted by Canada and other countries, as well as an increasing number of companies, offers a particularly fertile opportunity to reconsider the operation of the existing agri-food

system as an increasing number of actors (including food processing companies, large retailers, and many producers) are becoming convinced that existing practices cannot continue.

The second theme is about accelerating the development and deployment of more sustainable practices and approaches, particularly at the farm level. This means supporting innovation across the sector, experimenting with alternative technologies, cropping regimes, and farming systems, and encouraging the wider adoption of promising approaches. It is about working with farmers to support them in adopting or scaling out more sustainable approaches. Strengthening the movement towards regenerative practices and organic farming and supporting agroecological approaches, Indigenous agriculture, regional agri-food collaborations, and the incorporation of innovative technologies can—in very different ways—establish the feasibility of alternative approaches, potentially offering more sustainable futures. Supporting such innovations can advance transition, even if it is not clear that they are fully generalizable or can address the whole range of sustainability issues.

Initiatives from the third theme can add further momentum to change process by opening the policy system to new voices and alternative perspectives and facilitating more serious public and political discussion about social, economic, and environmental values embedded in the agri-food system. Opening the policy system will increase challenges to the status quo and should lead to improved policy design and implementation, and greater willingness of governments to support reform efforts in agriculture. Facilitating grounded public discussion and building institutional capacity to manage difficult and contentious issues can avoid undue polarization and open the path to further reform.

Across the three themes, different constellations and coalitions of actors can be mobilized, bringing different sets of assets to accelerate change.

Theme 1

Highlight critical challenges to the environmental sustainability of the existing agri-food system in Canada, and advocate for action by government and industry to address these issues.

It is difficult to secure transformation in any system when many of the main players do not accept the severity of the problem or recognize the scale of change required. While farm organizations, companies and government acknowledgement of environmental problems associated with Canadian agriculture has grown in the last five years, there are still voices that argue that the problems are often exaggerated and that ongoing efforts are already sufficient to deal with the most important issues. Strong producer pushback against the federal government's recent efforts to reduce emissions from nitrogen fertilizer use may have reflected weaknesses in government communications and program design, but it also points to substantial resistance to deeper change on the part of some agri-food system actors with a vested interest in maintaining the status quo or minimizing changes to it.

Focusing public attention on problematic aspects of current agricultural practices and pressing industry and government to address them, is therefore a critical element in any portfolio of activities to accelerate sustainability in the agricultural sector. This can drive change in at least three ways: 1) through the threat to corporate reputations; 2) by encouraging alternative consumption choices (which can in turn motivate retailers, food processors and investors to create supply chain change); and 3) through political pressure (which can motivate policy makers to use incentives and regulatory tools to drive change in this sector).

There is a wide range of environmental sustainability challenges that could be selected as a focus for action under this theme, including biodiversity loss, soil and water quality, and many socio-economic issues associated with the agri-food system. Based on their scale of environmental impact, relevance across the country, and potential vulnerability to critique, we recommend support for work on two critical issues: **GHG emissions from agriculture** (especially from synthetic nitrogen fertilizers as well as the GHGs associated with beef and dairy production) **and biodiversity issues**, especially the threat of urban encroachment on prime agricultural land, conversion of forests, wetlands and grasslands to cropland, and the environmental and human health impacts of toxic chemical usage, specifically agricultural pesticides.³⁴

The following subsections break down the rationale, focus of engagement and recommendations associated with these challenges.

Recommendation 1:

Intensify education and advocacy work around the greenhouse gas emissions associated with farming practices.

While many Canadians now understand that fossil fuel combustion is the major driver of climate change, the contribution of agriculture to the GHG emissions problem (especially the 80% of on farm emissions that are not energy related) is less well understood. Agriculture does not have a 2030 GHG reduction target in Canada's existing [Emissions Reduction Plan](#), nor is agriculture included in carbon pricing mechanisms or other major climate change legislation. A network of small subsidies still encourages fossil fuel consumption in the agricultural sector (for example red diesel). And while agriculture is increasingly discussed as a sector that can deliver 'negative emissions' (and there is interest from supply chain actors in securing sequestration credits from farm operations), there is a great deal of uncertainty about the scale of sequestration that could be delivered over the long term and very divergent opinions about the value and viability of carbon offsets in agriculture.³⁵

While several companies and agri-food sub-sectors are now championing change on GHG emissions and meeting net zero targets, advocacy is required to encourage broader engagement across the sector. For example, only six Canadian companies have joined the international [Science-based target initiative](#) to set targets for emissions reductions.³⁶ Governments can be called upon to remove subsidies that encourage unsustainable practices,

establish clear abatement targets, introduce and/or tighten regulations, and fund further research into problems and solutions. The target of a 30% reduction in fertilizer emissions by 2030 established by the federal government in 2020 is an important step, but it is just a first step.

Clearly, this work must be done carefully, to minimize backlash and amplification of feeling among farming communities that they are misunderstood. Still, powerful interests resistant to change will inevitably try to stir up such sentiment. Ways to mitigate these risks include: (a) directing the main weight of critique against the practices (i.e., not the farmers) and the large corporations (i.e., input suppliers whose products cause damage, manufacturers and retailers who are not taking ambitious action, corporate or very large scale landowners not adopting sustainable practices) and governments (who should adjust policy to encourage change); (b) pointing to positive experiences where these negative impacts are being reduced or eliminated (see the discussion under Theme 2 below); (c) avoiding extreme positions (i.e. “no GHGs or pesticides anywhere at any time”) while recognizing the real challenges of farming in a more environmentally sustainable manner; and (d) including in messaging the ways in which agriculture and other parts of the food system are increasingly being impacted by climate change, thus making the connection between how action to mitigate GHGs will also contribute to a better future for the sector itself.

To exemplify the positive work that is taking place, and what still needs to be done, consider the Canadian dairy and beef sectors. Both work with cows whose methane emissions make up a sizeable portion of Canada’s agricultural GHG output (methane comprises 62% of agriculture’s GHGs).³⁷ Each sector has seen significant efficiency gains in recent decades, reducing the GHG intensity of their herds,³⁸ but to date, only the dairy sector has committed to fully addressing its GHGs. In 2022, the Dairy Farmers of Canada (the organization representing all dairy farmers in Canada) committed to achieve net-zero by 2050. They intend to achieve this target by breeding for lower methane emitting cows as well as technological adaptations like biodigesters. Farmers are also being encouraged to plant trees and adopt a range of best management practices (see regenerative agriculture under Theme 2) to increase carbon sequestration on their lands. Collectively, these strategies have strong global buy-in, with the research community actively engaged, increasing the chances that the goals set can be achieved. By comparison, the leading edge of the beef industry, the Canadian Roundtable on Sustainable Beef (CRSB; comprised of a voluntary membership), has not committed to a long-term net zero objective. For now, they point to the positive biodiversity benefits of Canadian beef (i.e., by maintaining biodiverse rangeland) and have established a strong mid-term objective of committing to reducing the GHG emission intensity of Canadian beef by 33% by 2030, while noting in 2016 that “a carbon neutral goal was not realistic” because “any goal set must be achievable it was deemed inappropriate to pursue this goal at this time.”³⁹

What foundations can do

There are many environmental organizations dealing with climate change and many farm and industry organizations active on agricultural sustainability. However, few are working at the intersection of climate and agriculture in a way that highlights or fundamentally challenges

existing policies and power structures. These include Greenpeace (limited work on fertilizer companies), the National Farmers Union (challenging focus on yields versus profits), Farmers for Climate Solutions (advocating for climate-focused government programs including crop insurance), and media outlets like Corporate Knights and the National Observer.

Foundation resources would most usefully be spent supporting existing environmental groups, farm organizations and think tanks to dedicate efforts toward evidence-based work highlighting agriculture and climate issues. In particular:

- Communicating about the scale of the problem, the subsectors that are most directly responsible (beef, dairy and nitrogen fertilizers), and the extent to which those subsectors are engaging (or not) to address the challenge. An early contribution to this work could be a well-researched study on fossil fuel-based subsidies to agriculture by one of Canada's environmental think tanks, to inform eventual advocacy to eliminate such subsidies.
- Targeting manufacturers and fertilizer companies to demand stronger action on the GHG emissions associated with their products and supply chains.
- Advocating for governments to include the agricultural sector in emissions reductions plans and working with those sectors to establish and then meet emissions reduction targets aligned with Canada's net-zero commitments for 2050.
- For all of the above, using communications and engagement approaches that use recent opinion data to choose messages and messengers that resonate with target audiences (see Theme 3, Recommendation 7).

Recommendation 2:

Engage on biodiversity issues, especially the threat of urban encroachment on prime agricultural land; conversion of forests, wetlands and grasslands to cropland, and the environmental and human health impacts of agricultural pesticides.

Biodiversity loss is accelerating across the planet including Canada. This loss has been driven by the spread and intensification of agriculture. High-input agriculture practices have reduced the variety of existing habitats, threatening or destroying the nesting, feeding and breeding of mammals, birds, insects and microbial organisms and crowding out innumerable native plant species.⁴⁰ Biodiversity conservation in agriculture requires greater conservation of natural areas around and beyond farms as well as changing farming practices to reduce use of toxic chemicals and foster diversity in production.⁴¹ We are recommending bringing attention to agricultural biodiversity through focused work on land issues, notably urban encroachment on agricultural land, the conversion of high ecological-value land into croplands, and the use of toxic chemicals, particularly agricultural pesticides.

a) Protect agricultural land from urban encroachment

Only about five percent of Canada's land base is considered “dependable” for agriculture without severe constraints (i.e., Class 1, 2, and 3 farmland), but by 2016 over two-thirds of this land was located in rapidly growing urban and suburban areas.⁴² Agricultural land has been lost to stores, warehouses, highways, airports and oil, gas, mining, and alternative energy projects as well as through land fragmentation, short-term land rental, and suburban areas where conflicts with urban populations challenge agricultural production.

Existing protection from these pressures is limited in Canada. Agricultural zoning and protection tools (including urban growth boundaries and greenbelts, which protect land for recreation, nature conservation and agriculture) are strongest in BC, Quebec, and PEI. However, even in these jurisdictions these tools are regularly undermined by exemptions and municipal failure to implement provincial frameworks. Land protection mechanisms are under constant pressure from developers, land speculators, and governments being lobbied by these actors. This issue came to the fore in late 2022 when the Ontario government passed legislation intended to spur highway and housing development by opening Ontario Greenbelt land to development. This recent legislative move was just one piece of a much larger problem. Ontario was estimated to have lost 2.8 million acres (18% of its total farmland) to urbanization and aggregate mining between 1986 and 2021—which averaged to 319 acres/day.⁴³

One way to address this issue is through farmland trusts, which seek to provide permanent preservation for farms and ranches and prevent their subdivision, development, or sale to non-farmers/ranchers.⁴⁴ Such trusts purchase land, accepting land donations or benefit from compensation funds and provide long-term rentals to farmers, or put easements on lands to ensure protection. To date, however, farmland trusts appear to be only a small part of the solution, given the limited number of acres they protect. In Saskatchewan, [Farmland Legacies](#), Canada's longest-standing farmland trust organization, has protected some 2 600 acres out of the province's 41 million acres! The [Ontario Farmland Trust](#) has direct control over less than 1800 acres, with another 1800 acres under easement or other protections. In Quebec, the recently established charity [Fiducie agricole UPA-Fondaction](#) holds some 800 acres, out of the province's 15 million acres.

Beyond direct control of land however, farmland trusts and other organizations can play a critical advocacy role, pushing for greater formal protection of agricultural lands. In the Ontario case mentioned above, the Greenbelt Foundation, the Ontario Farmland Trusts and others have been important voices for maintaining the protections of the Greenbelt.⁴⁵ In Quebec, the UPA (farmers' union) regularly advocates for farmland protection, often in collaboration with other actors.⁴⁶ BC's Agricultural Land Reserve (created in 1973 to protect arable land from urban sprawl) is constantly under pressure for new development, with farmers, citizens and various non-profits working to maintain protection.⁴⁷

What foundations can do

- Support ‘watch dogs’ from civil society to prevent weakening and overturning of agricultural land policies.
- Support coalitions that include ‘unlikely allies,’ which can be highly effective in bringing the issue to the public eye. One example is [Alliance ARIANE](#) which works on territorial management including agricultural land protection: environmental organizations, heritage associations and the Quebec farmers’ union.
- Commission research to explore innovative, practicable solutions: for example, France has a system that requires people selling agricultural land to offer it first to a regional body that protects agricultural land, slowing speculation.

b) Protect natural and semi-natural ecosystems from commodity crop agriculture

As much as urban sprawl is encroaching on farmland, farmland is also encroaching on natural wetlands, forests, and grasslands, releasing carbon sequestered over millennia as farmers seek better revenues from the high prices of commodities like canola, soy, and corn. Saskatchewan lost some 3.3 million acres of native grassland between 1990 and 2015, and estimates are that less than 25% of Canada’s original native grasslands remain.⁴⁸ It is estimated that Canada is losing an average of 148,000 acres of native grasslands per year from conversion to cropland,⁴⁹ with tame pastures and hay lands cycling back and forth between crops and pastures.

Decisions by farmers and ranchers to convert grasslands to croplands are economically rational, but the carbon and biodiversity impacts are immense. One reason for high commodity prices is the adoption of clean fuel regulations in Canada (with most provinces requiring a percentage of biofuels)⁵⁰ and the US (which recently accepted canola oil as a biofuel feedstock, causing a major increase in canola production projections).⁵¹

Finding solutions to the trade-offs between reducing emissions from carbon-intensive beef production and consumption on the one hand and preserving native grasslands where much of the cattle is raised (rather than seeing it turned into canola fields, causing an initial “bump” in GHG emissions and then ongoing emissions associated with fertilizer use) on the other, will be neither simple nor easy. At least in part, it is likely to include conservation measures that make native grassland preservation a financially viable option.

There are currently a range of projects by conservation organizations being supported by philanthropy (e.g. the [Weston Foundation](#)) and the federal government (e.g. [Natural Climate Solutions program](#)). These include [Nature Conservancy of Canada](#), [Ducks Unlimited Canada](#), [Saskatchewan Stock Growers Foundation](#), [Grasslands National Park](#) (Parks Canada), [Meewasin Valley Authority](#) and the [Manitoba Habitat Heritage Corporation](#) for Prairie grassland work. Approaches include conservation easements, carbon sequestration markets, education, and knowledge mobilization. These programs aim to reach at least 4 million acres under stewardship or protection in the coming few years and it remains to be seen how effective the work will be in the face of high commodity prices.

Several projects are focused on biodiverse-rich grasslands controlled by Indigenous communities on the Prairies. As the [CCA report \(December 2022\)](#) highlights: “Engaging with Indigenous communities and recognizing Indigenous knowledge and management practices are essential for the long-term success of certain Nature Based Conservation Solutions (NBCSs), including the reintroduction of buffalo to grasslands as a component of grassland restoration and conservation. These NBCSs also foster reconciliation through the promotion of Indigenous self-determination.”⁵²

What foundations can do

- Seek to better understand and then support First Nations’ and conservation organizations’ efforts to conserve grasslands through Nature based climate solutions., and the impact of the work relative to the scale of the challenge.
- Support research to better understand the extent of the problem of land conversion in Canada, and the efforts being undertaken to address it (including where funding is coming from, and how much difference it is making). This should include engagement with existing industry groups like the [Canadian Roundtable on Sustainable Beef](#) and [Canadian Roundtable on Sustainable Crops](#), as well as conservation organizations, governments, foundations, companies and others who are engaging with this challenge.

c) Convene key actors to explore the development of a long-term campaign on the health and environmental impacts of pesticide usage in Canadian agriculture.

Pesticide use is on the rise in Canada and has seen a 30% increase over the past decade, largely due to the growth in area under no-till crops treated with glyphosate-based herbicides (GBHs).⁵³ GBHs are used for preparing no-till fields, controlling weeds and desiccating crops prior to harvest.⁵⁴ As a signatory to the Kunming-Montreal Global Biodiversity Framework, Canada has committed to reduce pesticide risk by 50 per cent by 2030, but there are numerous implementation failures and loopholes in the pesticide regulatory system.⁵⁵ While input companies (and many farmers who rely on them) frequently maintain that pesticides are essential tools of modern agriculture, approaches not dependent on pesticides do exist for most sectors and applications. One weed scientist stated candidly “we know enough to be able to reduce herbicide use, so that's not the issue. It's whether or not farmers have the opportunities [in terms of the economic pressures they face], and will take the opportunities, to implement the ways and means to reduce herbicide use.”

Progress in controlling use of pesticides can at best be described as having followed a zigzag path, with frequent reversals of gains in restrictions on use, on-going development and approval of new products which need to be researched to provide credible information,⁵⁶ and difficulty for scientists and non-profits to obtain timely data.⁵⁷ More generally, the current system of regulation for pesticides lacks an overarching vision based on environmental and health outcomes.

The approval of pesticides for use in agriculture is under federal jurisdiction. Experts note the federal legislation provides a relatively “strong” framework (in the sense that it sets clear goals and can be legally challenged) but has many implementation gaps. While the Pest Control Products Act allows pesticides to be registered only when there is a reasonable certainty that no harm will occur to human health and the environment, in practice regulators making these decisions do not wrestle with the full complexity of the problems that pesticides can cause. As one expert noted, “we have a system that is very much focused on addressing the toxicity of pest control products and not their ecological or total health impacts.” This was also highlighted in the June 2023 resignation letter of the co-chair of Health Canada’s scientific advisory committee on pest control products, Dr. Bruce Lanphear.⁵⁸ As a result, Canada is falling behind many of its OECD partners. It has only banned 32 “active” pesticide ingredients out of 531 banned in 168 countries, and in 2017 it reapproved glyphosate-based herbicides (GBHs) for use until 2032.⁵⁹

What foundations can do

The first goal of this recommendation is to increase public awareness of the issue and raise the level of discussion about pesticide use: both the ecological impacts (for example, declining populations of insects and amphibians with knock on effects on other species⁶⁰) and the human health impacts (contamination of food, chemical concentrations in human blood, links to cancer and neurological conditions) for workers⁶¹ and the general population.⁶² The broader goals are to encourage governments to adopt laws and policies to support changes to agricultural practices that will reduce pesticide use and mitigate the remaining environmental and health impacts, and to encourage large industry players to support these changes. Multiple policy instruments could be appropriate, but ultimately tighter regulatory standards will probably be necessary.

Such a campaign should be planned on a decade-long time frame, given the need to build expertise and the pace of policy change. It would be important to examine the ecosystem of efforts already ongoing in this area and explore lessons from previous decades of work as well as initiatives in other countries, particularly on mobilization of legal expertise.⁶³ Foundation funding could be used to support such a campaign, convene in this area, support policy-oriented research on appropriate government interventions, and so on.

There are at least two under-resourced networks currently working on toxics in Canada which could be supported in this area as a starting point:

- An informal network, the ‘federal pest control product reform network’ includes [EcoJustice](#), [Safe Food Matters](#), [David Suzuki Foundation](#), [Friends of the Earth](#), [Canadian Association of Physicians and the Environment](#), and others. The network has been coordinating work in this area with limited resources. Foundation support could build expertise and momentum.
- The [Coalition for Action on Toxics](#), which aims to significantly reduce toxics in the environment generally and reform how they are approved. It includes [the Canadian](#)

[Association of Physicians for the Environment](#), [Ecojustice](#), [Environmental Defense](#) and [Equiterre](#). Recent work has focused on the Canadian Environmental Protection Act reforms, rather than specifically on pesticides.

We recommend foundations assess existing initiatives to decide the best way to move forward on this issue, identifying which organizational forms and approaches are most appropriate, given experiences working to address pesticides in Canada and other countries. One approach could be to convene environmental NGOs, sympathetic farm organizations, as well as scientific and legal experts, together with experts on pesticide campaigning from other countries (especially Europe and the US) to develop a comprehensive strategic plan for expanding public understanding and debate on this issue, strengthening existing laws and extending protections to agricultural workers. Decisions would then need to be made about whether campaigning is best done through increased funding for existing organizations or the establishment of a new organization or coalition to work on this issue. For example, there may be utility in a coalition that links agricultural chemicals to other toxic usage (e.g. fire retardants in furniture, health care products, etc.), or it may make more sense to focus exclusively on agricultural pesticides as a class.

Theme 2

Promote the adoption of more environmentally sustainable agricultural approaches, practices, technologies, and systems across Canada

The recommendations under this theme focus primarily on furthering sustainability at the level of the farm and related production, manufacturing, and distribution activities. The first recommendation (Recommendation 3) focuses on the adoption of specific farm management practices, embedding these within systemic ways of thinking about farm-practice change (regenerative agriculture, organic agriculture, agroecology and Indigenous agriculture and food systems). The second (Recommendation 4) covers promoting sustainability through novel technologies. The third (Recommendation 5) deals with cross-cutting issues such as peer-to-peer learning networks, agricultural extension programs, research, and measurement and monitoring initiatives that can advance more sustainable agriculture in Canada. And the last (Recommendation 6) encourages cross-sectoral collaborations that use the power of local and regional relationships and scale out sustainable agricultural practices and systems.

A number of key sustainability challenges, including GHG emissions, soil degradation, biodiversity loss, and water pollution can be addressed by better farm management practices, and there is increasing understanding of the practices that make a difference.⁶⁴ These include reduced or no tillage (to minimize soil erosion and maximize carbon storage), year-round cover cropping (where possible) and intercropping, crop diversification (including increased adoption of perennial crops and legumes in rotations), reduced and/or better targeted synthetic nutrient inputs, and increased use of animal fertilizers and rotational grazing

of animals (to maximize feed uptake efficiencies while allowing for more complex pasture mixes).

Regenerative agriculture, organic agriculture, and agroecology each involve efforts to adopt various combinations of these practices at the farm level. However, each system emphasizes distinct priorities, considerations, and outcomes and needs support to continue experimentation and/or scaling out. Revitalized **Indigenous food systems** are about coming at these issues, first and foremost, from the perspective of Indigenous peoples contributing to the sustainable agriculture agenda in ways that align with their priorities, values, and approaches. We recognize that Indigenous-led farming programs are generally strongly aligned with the farm level sustainability practices (regenerative, organic and agroecological approaches) cited above, as well as the avoidance of grassland conversion described under theme 1.⁶⁵

These farm-practice recommendations are grounded in four premises. First, Canada's agri-food system is in the 'emergent' phase of transition, during which promising approaches are emerging—some at smaller scales, and some larger—and it is unclear exactly which approaches will be critical to the sustainability of the system decades from today. Second, the diversity of our agri-food system (as described above in section 2, Canada's agri-food system) will require a variety of solutions in terms of systems, principles, and practices that produce more sustainable outcomes (as explained in Part 1 on Transitions). Third, a range of activities are already taking place in the agri-food sector in Canada to develop and implement more sustainable approaches at the level of food production and harvesting practices. Farm organizations, governments, civil society organizations, researchers, investors, and food businesses are increasingly focusing on these questions, resulting in incremental sustainability improvements. It is important to build on existing initiatives grounded in partnerships with farmers. Fourth, both 'incumbent' and 'niche' producers and their organizations are working to bring about change, and both types deserve engagement and support. From the perspective of transition theory, innovations can come both from '*niche*' systems, such as organic farming, as well as the incorporation of '*niche*' technologies and practices within the dominant regime, such as adopting biodigesters⁶⁶ in conventional dairy barns to reduce their environmental footprint while producing renewable fuel and fertilizer.

Under this theme we also include a related recommendation to support sustainability-enhancing emerging technologies, promote regional agri-food collaborations, and support Indigenous agriculture and food systems. These elements are not about change at the farm level, per se, but each has the capacity to address core environmental sustainability challenges in their own way.

There is considerable promise in an array of **emerging technological innovations** derived particularly from the digital and bio-science realms. Supporting appropriate deployment of such technologies that include 'precision agriculture' (carefully tailoring inputs such as water, fertilizer, feed, and pesticides to crop or animal needs), improved plant and animal breeds, remote sensing and automation, and cellular agriculture can contribute to enhanced sustainability. Of course, there are risks that applied inappropriately novel technologies can

worsen environmental outcomes, and there are many social and economic factors that must also be included in technology assessment. But this simply emphasizes the need for third party evaluation to validate sustainability claims made on their behalf.

The final grouping under this theme deals with **cross cutting measures** that can enhance the innovation areas covered in the preceding two recommendations. **Peer-to-peer learning**—where farmers learn from their neighbors—has shown itself as an essential tool to scale up sustainable practices and systems. Also important is the development of networks of **technical advisors (extension services)** that can help farmers, breaking dependence on the advice of sales representatives of major input suppliers. Enhanced **research capacity** for sustainable agriculture is also important, as is further development of **tools for environmental measurement and monitoring** – both to better equip individual farmers to make choices about their production practices, and to allow a broader understanding of the environmental impacts of evolving agricultural practices.

Let us look at each of these areas in more detail.

Recommendation 3

Support the development and scale up of regenerative, organic, agroecological and Indigenous practices and systems.

a) Regenerative agriculture

There is currently a huge buzz around regenerative agriculture both in Canada and around the world. Regenerative agriculture⁶⁷ can be defined in different ways but is generally taken to refer to farming that regenerates—rather than degenerating—the soils it is based upon.⁶⁸ It is about improving soil health,⁶⁹ by growing crops that cover the soil year-round, keeping living roots in the ground.

Proponents of regenerative agriculture believe these practices have enormous potential to sequester carbon. However, estimates of the global carbon sequestration potential of regenerative agricultural practices vary considerably, from 1.5 to 15.6 Gt CO₂ (equivalent) per year.⁷⁰ Drever et al. have developed estimates for the sequestration potential of these practices in Canada, suggesting the greatest potential for sequestration (within agriculture) are from avoided grassland conversion, avoided peatland disturbance, and the adoption of cover crops. However, their data is highly variable with avoided grassland conversion, for example, representing the preservation of somewhere between 2.2. and 41.3 Tg CO₂ (equivalent) of existing soil carbon stocks per year. The key takeaway is that carbon sequestration through regenerative agricultural practices may have significant potential but, carbon sequestration is too variable (across soil types) and measurements are currently too costly or inaccurate, for scaled and credible estimates of how much sequestration is possible through the adoption of specific practices.⁷¹ Thus, more research is needed here. In addition, there is a broadly held view that regenerative agricultural practices can yield soil health and several other environmental benefits like biodiversity and water quality, while also reducing GHG emissions

through practices like reduced tillage (less tractor passes) and reduced application of nitrogen fertilizers.

The growing popularity of regenerative agriculture is an opportunity to bring change at scale, engaging investors, food manufacturers, farmers, citizens, and others across the food value chain. This opportunity is echoed in reports and recommendations, such as the recent [Agribusiness Task Force report on Accelerating Regenerative Agriculture](#), which identified areas for action including building farmers' income from environmental outcomes, creating mechanisms and sourcing models to share the cost of transition with farmers, and ensuring that government policy enables and rewards farmers for transition.

A handful of prominent food companies, responding to reputational, investor, and consumer pressure, have begun setting goals and encouraging the implementation of regenerative practices in their supply chains. For example, [General Mills](#) has committed to advancing regenerative agriculture on 1 million acres of farmland by 2030. [PepsiCo](#) has a 7 million acres regenerative agriculture goal for the same date. And [Maple Leaf Food](#) is looking to maintain their carbon neutral status partly through regenerative agriculture insetting projects.⁷² Several Canadian NGOs are beginning to work with agri-food companies to help implement projects to reach these goals and better support farmers in adopting regenerative practices. Companies include Cargill, General Mills, Loblaw, Maple Leaf, Nature's Path, Nutrien, and Pepsico; non-profits include [ALUS](#), [Canadian Organic Growers](#), [FoodBridge](#), [Nature United](#) and [Regeneration Canada](#). Other organizations are involved in measurement and reporting work; see Recommendation 5 on Expanding grounded knowledge sharing.

There is currently an ongoing discussion in Canada about how to define and implement regenerative agriculture. Some actors, such as the Canadian Organic Growers, see regenerative practices as something that can and should be adopted within the framework of certified organic production. The Rodale Institute has developed a regenerative organic certification with a dozen certified Canadian farms so far.⁷³ Broader standards are being developed by other organizations and governments; for example, British Columbia is developing a regenerative agriculture standard with a flexible and outcomes focused approach⁷⁴ and the Canadian Standards Association recently announced that it will develop indicators and performance metrics for circular, regenerative agriculture.⁷⁵

On the other hand, many regenerative agriculture proponents are advocating more flexible definitions amenable to wide scale adoption within mainstream agriculture, avoiding the cost and administrative work that certifications entail and which often represent a barrier to entry. Regeneration Canada promotes definitions and approaches including reduced tillage, agroforestry, integrated livestock, good water management practices, and social justice. Several companies have developed principles and frameworks, such as McCain Foods' [Regenerative agriculture framework](#) which includes a progress pathway for potato growers to improve practices over time. And in still other cases, work is referred to as soil health promotion or natural climate solutions, avoiding the term regenerative entirely because of perceptions that it ignores past and existing sustainability efforts by producers.

At present it is unclear whether there is long term value in developing a voluntary regenerative agriculture standard or certification. We note, however, that the effort to ‘go big’ can also result in a watered-down or overly flexible approach that is effectively meaningless (and can thus result in “greenwashing” (i.e., minimal changes to farm practices with no holistic vision of a sustainable farming system underpinning them), which several of our interviewees warned us about). As a result, we believe a variety of voices (both private and governmental) need to be engaged in any conversations that do take place about how to define standards in this space. The governance mechanisms of any standards produced (e.g. does it get reviewed periodically, and by whom) is also key. For example, the Canadian Organic Standard is renewed every five years by a multistakeholder committee established under the Standards Council of Canada and the Canadian General Standards Board.

Where and when regenerative agriculture standards are being developed, we encourage foundations to ensure that farm organizations with sustainability goals front of mind (such as the [Ecological Farmers Association of Ontario](#) or [Farmers for Climate Solutions](#)) or food systems organizations with a strong understanding of farming (such as [Farm Folk City Folk](#) in BC) are involved in these processes to keep discussions focused on achievable environmental benefits (public goods). Without these voices at the table, companies may simply establish standards internally, or only with the support of consultants and conversations with selected farm groups. Further, while mainstream farm organizations (commodity groups, provincial and national federations of agriculture) are also needed in regenerative agriculture standard-setting conversations to ensure outcomes take into consideration average farmer needs and are implementable, when these organizations dominate, outcomes can effectively reaffirm the status quo.

Core to the question of how to advance regenerative practices is payment to producers (see Brief and Focus group summary, below). Producers need to be fairly compensated for their work as stewards of the land and funding can clearly be an important lever for change. However, there are different possible approaches for making farm economics work for environmental outcomes, including:

- Promoting known, feasible practices that are cost neutral or cost saving. Reduced tillage is the classic example, since fewer tractor passes mean less time and less gas—although typically an increased use of herbicides. However, machinery adjustments may be needed, so that the practice isn’t immediately cost neutral, and subsidies can be needed to get over the adoption hump at the beginning.
- Experimenting with new practices (on research and experimental farms and by working with producers who are compensated for their efforts), selecting only cost-neutral, economically feasible practices for promotion. Several publicly and privately funded farms are doing this.⁷⁶ For example, nitrogen inhibitors, which release the fertilizer slowly and require less applications.

- Subsidizing (with private or public premiums, grants, reduced banking or insurance fees) practices during the transition period until it becomes cost neutral. Practices like cover cropping can take years of investment before soil quality improves and drought and flood resilience show up.
- Providing insurance tools to reduce financial risk of the sustainable practice. Many producers over apply nitrogen fertilizer knowing that a year of heavy rains will yield a bumper crop. Paying producers to reduce fertilizer use and/or compensate the opportunity cost of a low yield can avoid this.
- Paying for practices that the market won't (yet) pay for (witness the small percentage of consumers that purchase organic), when there is a public benefit (clean water, reduce GHG or other emissions, etc.).

It is important to support a range of practices to drive synergies and use a holistic and systemic versus a transactional approach. How payments are framed affects the amount farmers are willing to invest in practices – for example, describing farmers as heroes rather than as taking a government handout, or framing payments as a way to offset risk. Also, having simple, easy to use systems for payments and tracking is vital for producer engagement.

Relative to the scale of the problem, not much funding is currently being offered to producers, either from currently embryonic offsets, insetting programs, offset markets or government subsidies. Many companies are restricting their support to technical assistance. The cost of paying for changes, in many regions at least, is less than what carbon market buyers can afford.

What foundations can do:

There are several ways foundations can support producers to adopt regenerative practices and systems across a wide spectrum of farming approaches and scales in Canada:

- Support collaborative, pre-competitive projects that operationalize regenerative agriculture goals by companies and other buyers and support producers in a transition to more regenerative approaches with credible measurement, reporting and verification systems
- Engage with sustainability-oriented funder and investor networks
- Provide stacked payments: The scale of payments needed goes well beyond philanthropy's resources, but foundations can work to coordinate with, and top up payments for existing strong programs. Philanthropy can contribute to stacked payments from different sources (provincial, federal, market) to build an amount that is relevant for farmers.
- Undertake research and innovation on financing mechanisms with a focus on understanding the circumstances in which farmers can benefit alongside the environment (i.e. there are both economic and environmental benefits to changed practices) vs. those circumstances where financial incentives are needed to pay for

ecosystem outcomes that are primarily a public (rather than private) benefit. Thought is required about the different ways in which the public benefit can be secured (payments, regulation, etc.), the need for price transparency (on carbon pricing), perceptions of risk from stacking payments, or the question of standards. Support could be provided to explore other mechanisms, like taxation systems, multiple year basis funding, crop insurance, or ‘grid pricing’ (with pricing based on various attributes of sustainability in production).

- Supporting or convening targeted conversations on how to better align the many emerging incentive programs (e.g. from provincial and federal governments, food companies, etc.) for the adoption of regenerative agricultural practices.
- Support the development and maintenance of local and regional food infrastructure (see Recommendation 6) to ensure that farmers have markets for the diversity of products produced through regenerative farming.

b) Organic agriculture

Organic agriculture is an area of proven innovation that has been growing slowly but steadily in Canada for over five decades. It is a system grounded in principles of soil health (“feed the soil, not the plant”) and many regenerative practices come out of trials and developments in organic systems. However, its standards have ended up being focused on verification of what farmers are not permitted to use—notably synthetic fertilizers and pesticides—representing a significant difference from regenerative agriculture, which generally advocates for reduced use of these practices without a specific requirement for reduction, much less elimination. Organic systems generally produce a lower yield per acre, even after the initial transition period, which partially explains their higher costs. Nevertheless, it has been an important source of sustainability benefits and of innovative practices which can often be transferred to other types of agriculture. Organic farmers are often recognized as sustainability leaders within their sectors (e.g. horticulture, dairy).

“Organic agriculture is... an example of how you can knock some ecological sense into a production system because you don't have those easy to reach for tools like fertilizers and pesticides.”

– *soil scientist*

Despite four decades of growth, Canada’s total percentage of farmland used for organic agriculture was still only 2.4% in 2020.⁷⁷ This slow uptake, compared to nearly 10% in the EU, can be explained partly by the costs of conversion and a weak advisory system, but there has also been an ongoing bias against organic production in some parts of the agricultural industry as well as a lack of political support in most areas of the country. Further, while certified organic producers can benefit from a premium for their product, organic certification requires a minimum of three years of transition, during which farmers may not reap the benefits of premium prices for organic products, while bearing the increased cost of retooling.⁷⁸ The conversion from conventional to organic production is also knowledge-intensive, and there is a

need for better transition advisory capacity, whether from national or regional organic organizations, organic certification bodies, mentors, or peers.

Government support for organics varies considerably between provinces, and the federal government remains only lightly engaged with the sector. Québec leads Canada for provincially supported programming and financing of the burgeoning organic sector, targeting young farmers in particular, and PEI offers payments for conversion to organic farming; other provinces offer fewer supports. Meanwhile, Canada's major trading partners have recently adopted pro-organics policies: United States Department of Agriculture subsidizes the cost of converting farms from conventional to organic production⁷⁹ and the European Union has committed to 25% of all farming being certified organic by 2030 through its [Farm to Fork Strategy](#).⁸⁰ For more details, see Brief and Focus Group report in Supplemental Materials.

What foundations can do:

As a sector, organic is more mature than regenerative agriculture, with peak organizations ([COG](#), [Organic Federation of Canada](#), [COTA](#)) working in Ottawa (now with a unified voice, based on an MOU between them) to advocate on behalf of the sector for support similar to what is emerging in the US and EU. These organizations are developing a national organic action plan and are seeking increased engagement from federal and provincial governments. The federal government and most provincial governments, however, continue to view organic as a niche sector allocating funding proportionate to its current market share. Our perspective is that these governments are missing the larger potential within this sector from a transition perspective. The organic sector has the potential both for significant sustainability impacts as it gets to scale, and to influence conventional agriculture with the innovations that it can develop by being an external player. To achieve these impacts, it requires particular supports.

Foundations can:

- fund regional and provincial organizations that support peer-to-peer learning and uptake of organics among farmers.
- support organic farming conversion projects and national and provincial organizations engaged in that effort.
- support research in the (underfunded) organic sector by offering the 'matching' portion that must come from industry partners to support agricultural research.

c) Agroecology.

Regenerative agriculture and organic agriculture are both relatively well-known practices in the process of scaling in Canada. In contrast, agroecology is not yet widely discussed in the country. However, it is central to international discussions (e.g. at the FAO) as a way of thinking systematically about the challenge of transitioning our food systems to sustainability.⁸¹ It emphasizes environmental principles like input reduction and soil health, economic principles like the value of economic diversification and social principles such as knowledge co-creation, participation (e.g. in governance) and fairness including farmer agency and food sovereignty.

Agroecological transitions look beyond the farm to landscape, territory and food systems levels in ways that challenge the “history of policies, practices, and ideologies that have prioritized maximizing agricultural yields over other socioeconomic, environmental, and biocultural objectives.”⁸² From an agroecological perspective, themes such as food sovereignty and democratic control over thriving local food communities are seen as just as important components of a sustainable food system as ecologically safe practices.

What Foundations can do:

- support further agroecological experimentation. From a transition theory perspective, we see agroecology as a movement to watch and support in the spirit of experimentation. This can, for example, take the form of supporting efforts by farm organizations and allied academics to run agroecology field schools.⁸³
- support further conversations about agroecology in Canada, including between proponents of agroecology and allied movements (food justice, racial and gender justice, Indigenous and land reconciliation, food sovereignty, human rights) to build a big ‘tent’ with an intersectional approach that focuses on farmer and citizen power, rights, and food sovereignty.

d) Indigenous agriculture and food systems

The northern boreal forest and the prairie provinces receive very little philanthropic support, mirroring relatively little overall funding to Indigenous charities and qualified recipients (approximately half a percent of funds granted), and low support overall for environmental initiatives.

There are several collaboratives that support work in boreal and northern communities, which are predominantly First Nation, Métis, or Inuit populations. Their work focuses on community based solutions but also engage with the continued impacts of colonization within community structures, flow of resources, policies, laws, and programs that hold multiple technical barriers, notably in the application processes. Even where communities are able to navigate such barriers, issues of internal bias and systemic racism persist. Despite these barriers, interest in working with Northern and Indigenous communities and networks is growing, and views of funders and governments are slowly evolving to be more open.

Existing collaboratives include the (NMFCCC), [Northern Manitoba Food, Culture and Community Collaborative](#), [Gaagige Azzgibigaa](#) (northern Ontario) and the [On the Land Collaborative](#) (NWT). The National Circle for Indigenous Agriculture and Food is a new Indigenous-led non-profit being formed to create more inclusivity, accessibility, cultural awareness, and thematically responsive programs, services, and knowledge. With start-up support from Farm Credit Canada, it will focus on three main areas: Indigenous business, reconciliation in the industry, and capacity development.

What foundations can do

- Contact the National Circle for Indigenous Agriculture and Food to learn more about their work and as an entry point to Indigenous-led projects across the country.
- Participate in collaboratives like NMFCC and others listed above, provide grants in a culturally appropriate, community engaged manner and learn about Reconciliation.
- Building on work by the above collaboratives, support an Indigenous-led coaching team to support funding organizations, including governments, to use community-engaged approaches to food systems work in northern and Indigenous communities.

Recommendation 4

Support emerging technologies with the potential to enhance the sustainability and resilience of agri-food systems, including by supporting holistic technology assessments and lifecycle analyses

This recommendation focuses on engaging with a wider range of food *production* and *harvesting* practices that also have the potential to improve the sustainability of the agri-food system in specific ways.

Novel technologies include a range of emerging technological developments. There are important sustainability benefits expected from these developments, but it is notable that many align with ‘sustainable intensification’ and are thus already well supported by industry and/or government funders. We advocate for philanthropic donors to closely track these technological developments, and to offer support (for comprehensive life cycle assessments, for example) where important funding gaps are apparent.

Technological developments offer important prospects for significantly reducing the environmental footprint of agricultural activities. For example, efforts are ongoing to improve delivery mechanisms for nitrogen fertilizers (precision application, delayed release coatings) as is research to develop crop varieties which can fix their own nitrogen. Breeding has already vastly improved the efficiency with which cattle convert feed to body mass, and now attention is being paid to improving both animal and feed genomics to reduce enteric emissions.

Today the two largest contributors to this technological dynamism are digitalization and advances in biosciences. Digitalization is impacting all areas of farm management and has applications for remote monitoring of crops and livestock, semi-autonomous equipment (such as harvesters), precision application of inputs, tracking supply chains (for food safety, disease control, and sustainability certification) and exploiting large data sets (for improved crop and livestock management and breeding). The primary driver for most of these advances is economic—improving production efficiencies, but increasingly environmental concerns are shaping priorities: particularly the reduction of GHGs from farm operations. On the biosciences side, the rapid development of techniques for genetic modification (especially CRISPR) and the

dramatic fall in associated costs is expected to bring enormous changes in the form of novel food products and production processes. While some of these technologies have the potential to reduce the environmental footprint of agriculture, there are also potential negative effects. As such, it is vital to support the engagement of independent scientists, civil society and farm organizations to ensure adequate testing, regulation and labelling of new technologies.

Perhaps the most disruptive potential developments are in the area of cellular agriculture, a term we use to cover both precision fermentation (where genetically modified microorganisms are used to produce proteins or other bioactive products) and cultured meat (where animal cells are grown in a sterile medium to replicate animal tissue). Precision fermentation has already been used for several decades to produce insulin and other high value bioactive substances for the pharmaceutical industry. Advances and cost reduction of genetic engineering technologies mean precision fermentation is now entering the food industry. For example, ice cream made with casein (the main protein in milk) produced by microorganisms has been approved for sale in the United States. Growing animal tissues is the more challenging of the two approaches, so the large-scale impact of precision fermentation is likely to be felt first.

Enthusiasts for cellular agriculture suggest we are on the cusp of a significant shift in agriculture in which we will be able to sidestep the problems associated with raising animals (from land use and GHG emissions to cruelty and human diseases) and grow animal proteins (or ultimately entirely novel proteins) from plant-based feedstocks. Potential environmental benefits would include the release of land currently dedicated to animal agriculture (not just pasturage but most of the land currently devoted to growing crops to feed animals), reducing the GHGs associated with livestock (and feed), and so on. Critics of cellular agriculture see it as further industrialization of the agri-food industry. They question the health impacts of more highly processed foods in human diets, doubt the scale of hypothesized environmental benefits, and wonder about the potential acceptability to consumers.

In the short term, the impact of the development of this sector is likely to be small, but on the scale of several decades there could be more significant effects. Precision fermentation could provide inputs to food manufacture (potentially undercutting the market for dairy or beef derived inputs). While there is a tendency to see cellular agriculture in opposition to traditional agriculture, it is likely to initially prove more complementary—with ingredients derived from precision fermentation or cell culture being combined with others provided by animal and plant agriculture. Biological feedstocks are required for both processes, and if the sector grows there will be a demand for these crops.

Today there is considerable hype around the sector and hundreds of millions of dollars of venture capital funds have flowed into research and development. But large-scale deployments remain in the future and the sector (like other new technologies) is likely to experience several hype cycles. Yet this does not mean that it should be ignored. Change is coming. As one academic with knowledge in this space told us, the unsustainability (GHGs) and un-scalability (globally) of the existing animal agriculture system means that over the coming decades we will

be looking for alternatives, and so “cellular agriculture” is ultimately “either going to happen in Canada, or to Canada.” As a major agricultural producer, Canada needs to engage with this nascent sector which could (if deployed appropriately) provide opportunities for the production of novel food stuffs and the expansion of value added agri-food industries in Canada as well as sustainability gains.

What can foundations do?

Monitor and engage (as appropriate) with emerging technology developments of all kinds across the agri-food system, encouraging holistic assessment and lifecycle analysis of novel approaches.

For cellular agriculture: support self-organization of the sector, support studies of environmental risks and benefits, encourage dialogue between traditional farming communities and the emergent sector.

Recommendation 5

Expand grounded knowledge sharing by supporting peer-to-peer learning networks, revitalized extension programs, research and measuring and monitoring initiatives that support the development and adoption of sustainable agricultural practices.

Measures encouraged by this recommendation can enhance the impact of other food production practice changes discussed under this theme.

a) Peer-to-peer learning networks

Expansion of peer-to-peer learning networks is critical to the advance of more sustainable agricultural practices in Canada. Farmers pay attention to farm leaders in their sectors and their communities. Like all of us, they watch and learn from the experiences of peers they can relate to. Regardless of which specific sustainability practices or systems one wishes to encourage, supporting peer-to-peer learning is thus key. It is also a vital community-building mechanism, given that farmers often feel isolated in their work and mental health is a critical concern. Such exchanges are important within particular communities (localities), among those adopting particular cultivation systems (organic versus regenerative, etc.), around particular growing products (field crops, beef production) but also across these more defined categories.

What foundations can do:

Foundations can support peer-to-peer learning by funding farmer-serving organizations and projects that run webinars, local field days, farmer visits to similar farms in other regions or countries. Such organizations and projects include [Living Labs across the country](#), the [Ontario Soils Network](#) and [Innovative Farmers of Ontario](#), [Farmers for Climate Solutions](#), [Young](#)

[Agrarians](#), [Forage and Grassland associations](#), [Acadie Lab](#), farmers unions, etc. Foundations should also consider supporting dialogue and engagement across and between such peer-to-peer programs, thereby encouraging learning and the diffusion of innovation among adherents of different approaches (regenerative, no-till, organic, agroecological approaches, etc.).

b) Revitalized extension programs

When farmers turn to ‘experts’ today, they often have few choices outside agents employed by seed/agrichemical/machinery suppliers. Much of Canada lost provincial agricultural extension services through provincial government cutbacks in the 1990s, Quebec being a notable, if imperfect, exception. In some sectors, researchers at universities or working for federal government agencies have stepped in to fill this gap, but support is minimal and fractured, and researcher engagement with farmers is uneven. Some farm organizations have also helped to fill the extension gap, including when it comes to supporting niche systems (like organic agriculture). But these organizations are not strong enough to undertake extension across the farming landscape.⁸⁴ On the Prairies, a Trusted Advisor Partnership is being created at Assiniboine Community College to develop soil health knowledge among agronomists and crop advisors, with support from several food companies and in partnership with the [Sustainable Food Lab](#), the [Southeast research farm](#) in Saskatchewan and the University of Manitoba.

What foundations can do

Foundations can join with other stakeholders to advocate for and support the development of an agricultural extension ecosystem that provides services to farmers interested in increasing the sustainability of their operations, across a range of approaches (regenerative, organic, agroecological...). Models can vary across the country and include independent consultants, farm organizations, university-based researchers, and government-connected scientists. The goal should be an array of resources that is independent of suppliers (who are necessarily interested in marketing their products). The idea is for farm level advice where trusted relationships can be built over time to support sustainability transitions on individual farms. As much as possible these advisory networks should be connected to the peer-to-peer learning described above and to the research activities described below.

Foundations can support projects looking to fill the extension gap, including advocacy for increased government support for extension, and consider undertaking a national study to assess areas of greatest need to guide funding.

c) Research supporting the development and adoption of sustainable agricultural practices

Although there is a great deal of ongoing agricultural research in Canada, a large proportion of this is not yet geared to address issues of environmental sustainability or climate change.⁸⁵ There are also a number of gaps which were flagged to us by our interviewees, including the relative lack of attention given to organic, regenerative and agroecological production; funding for short term opportunistic projects (when an emerging situation presents a real time

opportunity to assess a particular issue); and very long term projects (for example, monitoring soils). All of these have struggled in various ways to secure research council and government funding. It would seem particularly valuable to link research activities to the peer-to-peer learning networks and extension activities described above as it allows researchers to engage directly with problems as they present themselves on the farm.

What foundations can do

Foundations cannot be in the business of providing core funding for agricultural research in Canada as the large pools of capital to be mobilized must come from government and the private sector. Research activities which foundations could consider—some of which are already mentioned elsewhere in this report—include:

- Providing “matching funds” for projects—being put forward by academic researchers and farm organizations to federal or provincial research funders—that have long-term potential for furthering sustainability but have difficulty identifying immediate industry support.
- Creating research chairs in under-funded (but promising) areas, such as organic agriculture, regenerative agriculture, and agroecology.
- Research that helps to identify sectors and geographies with the highest potential for economic and environmental benefits from the adoption of regenerative agricultural practices.
- Research that strengthens a more diverse and innovative agri-food policy ecosystem, by revealing imbalances in access to policy-makers, and demonstrating the value of more inclusive decision-making processes.
- Research on agricultural land issues (as discussed under theme 1), including corporate land ownership and avoided grassland, wetland, and forest conversion.

d) Measurement and monitoring

There is increasing demand from consumers, governments, and supply chain actors to demonstrate evidence of sustainable production practices in agriculture. Companies are being called upon to report progress toward Environment, Social and Governance (ESG) performance, and particularly on climate risks.

This has led to a growing number of sustainability programs and requirements that are often disconnected or overlapping, adding cost, complexity and risk to farmers, companies and investors. International initiatives including the [Science-based Target Initiative](#) and [Value Change Initiative](#) are developing guidance to set targets and implement credible programs that align with global carbon accounting standards, notably the [Greenhouse Gas Protocol](#).

In Canada, various pieces of software (often proprietary) allow farmers to estimate their GHG emissions and companies to aggregate data: these include the [Cool Farm Tool](#) and the [Fieldprint Calculator](#) (managed by Field to Market Canada). [Holos](#), an open-source software developed in partnership with Agriculture and Agri-Food Canada, is used by extension agents

and academics for estimating on-farm GHGs, but is often considered impractical and has low take-up among farmers. The Environmental Farm Plan tool is used by an estimated 40% of Canadian producers, but it is not yet available in an on-line version and is also considered unwieldy, although several provincial governments and a few companies use it to track change and as a requirement for producers to access subsidies.

In general, there is a need for more high-quality, globally comparable information on sustainability-related risks and opportunities. While much effort is focusing on carbon, we also need to consider practices that build soil health, ensure clean water, protect biodiversity and reduce other greenhouse gases, and the tools to measure such outcomes. Several initiatives including the, [National Index on Agri-Food Performance](#), [CASI](#), and [CANZA](#) (all described in Section 1, Recent efforts to strengthen agricultural sustainability in Canada) as well as various government initiatives are working to improve this situation, but more coordination and transparency is needed.⁸⁶

What foundations can do

- Support the engagement of farm and food organizations in the development of widely understood, user-friendly, low-cost and accessible, open-source tools which talk to each other while ensuring adequate protection of farmer's data and alignment with the public good. In the case of soil testing for example, these tools should integrate findings from remote sensing, computer models and soil samples.
- Support improved data integration, collection, management and quantification methodologies to ensure that policies and programs are informed by accurate and accessible data. Ensure transparency to improve producers' understanding of the impacts of a given practice and their contributions to improved outcomes.

Recommendation 6:

Encourage cross sectoral collaborations to advance more sustainable agri-food systems particularly at the local and regional levels.

Cross sectoral collaborations, that draw together participants from multiple societal domains (including farmers and farm organizations, manufacturers and retailers, researchers, not-for-profit groups, and government) are important for developing and scaling up sustainable agri-food practices and overcoming multiple 'lock-ins' that perpetuate existing arrangements. Such practically focused coalitions link the experience and perspectives of different constituencies and can facilitate experimentation and popularization of alternative approaches. International experience suggests the success of such coalitions, whether local, regional, or national depends both on their practical orientation and the existence of a shared commitment to meaningful change. Such initiatives struggle if they are not focused on securing a practical object (and instead just constitute 'talk shops') or if they include participants who are basically satisfied

with the status quo (and are just maintaining a ‘watching brief’, or worse have a direct interest in slowing down progress).

We have already referred to several recently established national industry-led coalitions that have pledged to promote sustainable agriculture in Canada and pointed to the potential role of foundations in engaging with these initiatives. There may be additional opportunities for philanthropic organizations to support or initiate national level initiatives, particularly in relation to regenerative agriculture where a great deal is happening, but activities remain nascent and fragmented. The key here would be to avoid duplication of existing efforts, and to find an approach to bringing together the most dynamic actors in a way that could accelerate change. Systematic interactions with those most active in this area would be required to co-develop this opportunity further.

Having said this, we do see clear opportunity and a transformative potential in local and regional agri-food collaborations.

There is substantial evidence internationally that strong local and regional agri-food collaborations can accelerate movement towards the sustainability of agricultural production. This coincides with one of the basic learnings of transition studies that networking innovators—drawing together those most interested in change from across multiple domains, fields of expertise, or organizations can accelerate the build out of transition pathways. In this case the focus for building networks is spatially grounded—in the local or regional area. Such collaborations can involve local agricultural producers (farmers and their organizations), food processors (manufacturers), retail outlets (shops, restaurants), local institutions (schools, libraries, colleges), not for profits (community organizations, environmental groups, youth groups), the tourist industry (local hoteliers, tour operators) and local governments (municipalities, regional development agencies).

The focus for these networks includes: promoting more sustainable production methods; marketing local sustainably produced, healthy, and tasty local produce; capturing more value-added activities in the local economy (though artisan production, local processing; farmer and craft markets); linking to community services and activities (healthy meals for hospitals, the elderly, disadvantaged communities); and encouraging tourism (to experience nature, visit sustainable farms, see local crafts, arts, culture, etc.). This often involves development of a local or regional sustainable (or healthy, green, organic, or regenerative) brand and participation from local agricultural organizations, chambers of commerce, and so on. The linking of the economic development opportunities with the encouragement of sustainable farm practices, and the establishment of direct local/regional links across sectors empowers a broader societal coalition for change and offers more ways for farmers to realize economic gain from investment in sustainable practices. Such local and regional strategies can tap into local traditions and identities which share similar history, ecological context, and economic opportunities.

One element of such initiatives is the (re)building of local food infrastructure. This includes local/regional processing facilities, distribution channels, and markets that can provide outlets

for diverse agricultural products that are being produced in regenerative, organic and agroecological farming systems. Local and regional food systems can offer ‘protected markets’ (niches) within which products can be developed, and that allow consumers and producers within regions to better connect. Accessible local processing facilities (for grains, meat, etc.) are often essential for the expansion of specialized, small scale and organic production that are not well served by large scale processors.

The development of such local and regional sustainable agri-food bridgeheads can allow these more advanced localities and regions to serve as examples for other communities. They can also provide steppingstones to gain wider influence in national conversations about the future of agri-food. Because the context for innovation varies across the country (with farming conditions and regional economic and political context) prioritizing local/regional initiatives and alliances allows a concentration of resources in areas where the possibility for movement is most ripe and where regional actors are already trying to come together to effect change.

What foundations can do

- Support regional and local initiatives that draw together different agri-food stakeholders intent on developing local/regional environmental and economic sustainability strategies, activities, branding and facilities.
- Consider focusing funding, convening, and other support activities in particular regions or localities and deliberately encourage cross connections among projects, groups, initiatives, etc. and, when conditions are right, encourage the emergence (and then support) of coalitions focused on developing local/regional agri-food sustainability initiatives.

Theme 3:

Build a more diverse and innovative agri-food policy ecosystem and a broader conversation about the future of agri-food

Transforming agri-food systems involves highlighting problems (Theme 1), developing and scaling up solutions (Theme 2), but also deliberately creating spaces to deepen collective conversations around the place of agriculture and agri-food systems in our societal arrangements. We also need to strengthen the voices championing environmental sustainability in the agri-food system and encourage longer-term dialogue about difficult issues associated with agri-food system reform.

In a context where issues are often polarized and farming communities can be alienated from what they perceive as ill-informed urban elites, and we can see other countries where agriculture has become a political flashpoint, it is important to find ways to encourage deeper

dialogue over challenging issues where effective and equitable solutions are sometimes far from obvious.

Our first recommendation under this theme (Recommendation 7) focuses on expanding the diversity, capacity, and expertise of the agri-food policy ecosystem, while the report's final recommendation (Recommendation 8), focuses on strengthening broader public discussions about agri-food system sustainability while deepening the knowledge base that inform these debates.

Canada's agricultural policy system has historically been dominated by key industry incumbents including major input providers, large producer organizations, and food processors, manufacturers, and retailers. Agriculture and Agri-Food Canada as well as provincial agriculture ministries were, and still largely are, positioned as promoters of the agri-food industry and its growth objective rather than as enablers of a sustainable agri-food system for all Canadians. While there have recently been some encouraging efforts to open up Canada's policy environment, established voices continue to dominate both the public discussion of agriculture and the relatively closed circle of decision-making around federal and provincial agriculture ministries. Policies, programs, and funding decisions tend to reproduce the existing agricultural development trajectory, perpetuating unsustainable practices, or furthering a narrow set of ideas consistent with the paradigm of sustainable intensification.

Several factors contribute to the relatively closed nature of the existing agri-food policy system, including ownership concentration among agrochemical, equipment and seed providers, food manufacturers and major retail companies, the well-established lobbying efforts and political influence of major producer organizations, and long-standing relationships between agri-food industry players and provincial and federal officials.

"One of the major barriers is what the government is hearing from whom... There is a lot of farm voice in Ottawa and in Queens Park.... Farmers are highly organized and have lots of long, long experience in being effective lobbyists."

- *agricultural scientist*

One interviewee who works in an agricultural college emphasized that the power of producer voices in national and provincial capitals encourages the adoption of policies that minimize risks to farmers, and so may inadvertently stifle innovation and change. An interviewee from a provincial farmers union pointed out that many farm organizations "get over half their revenue from input companies who want to improve their image by having producers support them," and that this funding inevitably influences the positions these farm organizations take.

International experience suggests that a more diverse policy ecosystem, which includes different kinds of voices, is likely to result in a more innovative system and accelerate movement towards more sustainable approaches. Opening up the policy system to new

perspectives can provide a counterpoint to deeply entrenched institutional interests, allowing alternative sustainable agriculture solutions to be considered in high level decision-making while also introducing perspectives of civil society organizations concerned with the broader sustainability conversation (including health, environment, workers' rights, equity, and so on).

Opening up the policy process also includes bringing in more independent science and research voices. Important moves are already afoot in Canada to strengthen science and social science research related to sustainable agriculture and agri-food policy, including recent research chairs and programs supported by philanthropic organizations such as the Arrell, Jarislowsky, and Weston foundations. Our recommendation for philanthropy therefore *focuses on civil society and farmer organizations for policy work*. It is important to note that encouraging foundations to support 'new' and diverse voices is not meant to diminish the efforts being made by more established (incumbent) agricultural voices such as the [Canadian Federation of Agriculture](#), [Dairy Farmers of Canada](#), or the [Canadian Roundtable on Sustainable Beef](#) to develop strong sustainability positions. We see each of these efforts and applaud them. From a transitions perspective, however, bringing additional diverse and informed perspectives into the conversations can accelerate movement across the whole agri-food policy ecosystem.

There are numerous agricultural policy engagement opportunities, including municipal, provincial, and national programs, policies, and budgets. The broadest policy opportunity occurs with the renewal of the federal-provincial Agricultural Policy Framework (AFP), with the next one due to be adopted in 2027. One pathway for foundations to advance sustainable agriculture policy in Canada generally as well as within the AFP window of opportunity would be to:

- Undertake an assessment of existing capacity and interest in public policy by farm and civil society organizations, as well as identifying who would be trusted as network coordinator(s).
- Provide support to a selection of those organizations most in need of policy capacity (
- Support public policy and communications training opportunities.
- Support networking and coordination with other organizations around key policy opportunities.

These elements are presented in Recommendation 7 below. Note that several European foundations supported a similar process in the lead-up to the Farm to Fork strategy. Inspiration and lessons could be taken from this experience (see Supplementary Materials for contact information).

Recommendation 7.

Expand policy and communications capacities of farmer and civil society organizations focused on the sustainability of agri-food systems and their ability to coordinate actions

We see two types of voices emerging in Canadian agri-food policy networks that deserve more space in governance conversations and need support to do so. First are farm organizations with

an active focus on sustainability issues. Some of these are active primarily at the local or regional levels, some at provincial and national levels. Some are partnerships or coalitions among existing farm organizations working together to deliberately address sustainability issues. Others are organizations dedicated to supporting specific approaches to sustainable agriculture, such as organic agriculture, best management practices that encourage soil health, or regenerative agriculture. Diversification of the agricultural policy ecosystem can be promoted by encouraging further self-organization and public policy and communications capacity-building for these types of farm organizations that represent different approaches to promoting more sustainable agriculture.

Local and regional farm organizations that ground agricultural sustainability in local conditions and identities include [ACORN](#) (Atlantic Canadian Organic Regional Network), [Cooperative pour l'agriculture to proximité écologique](#), [Ontario Soil Network](#), [Ecological Farmers Association of Ontario](#), [Manitoba Forage and Grasslands Association](#), [Sasksoil](#) (Saskatchewan), [Results Driven Agricultural Research](#) (Alberta) and [Young Agrarians](#) (BC and Prairies). Although many **national farm organizations** (and commodity groups) are well funded from member dues or agribusiness sponsorship agreements and well represented on the policy stage, others are less well-resourced but important voices (eg. National Farmers' Union, Farmers for Climate Solutions), and a case could be made for supporting their agricultural sustainability policy programs.

The second group of emerging voices in the Canadian agri-food policy space are civil society organizations, both rural and urban-based, with broad mandates focused on conservation or the sustainability and justice of food systems. Recent research shows that dozens if not hundreds of such organizations have emerged in Canada over the last two or three decades to respond to challenges with our food systems. While they are often created to address specific issues, their efforts have increasingly shifted to trying to influence policy and governance at multiple levels: from local/municipal (e.g. establishing new farmers markets or urban agriculture initiatives) and provincial/territorial (e.g. land-use planning) to national (e.g. pesticide regulation) and international (e.g. climate policy).⁸⁷

However, if either of these 'new' perspectives is to offer constructive input, *these organizations need the capacity to engage fully in governance processes*. Even when funded by philanthropy to undertake specific projects, such groups may lack capacity because sustained policy engagement does not contribute to an easy list of 'outcomes' that funders may like to see in end of project reports, and significant governance 'wins' often take years to achieve.⁸⁸ Practically speaking, this means these farmer and civil society organizations (both urban and rural) working on sustainable agriculture need staff who have the time and appropriate training to follow policy discussions, develop well-informed positions, engage with other policy actors, build coalitions, and influence outcomes. In some cases, these actors will build the capacity to convene their own governance spaces, thereby contributing to institutional innovation.⁸⁹ Our interviews suggest that this capacity needs to be spread widely in Canada, supporting engagement on issues that relate to sustainable agriculture at all levels, from local to international.

Civil society organizations work on the sustainability of the agri-food system from a wide diversity of perspectives. For example (approximate categorization of incomplete list):

- Migrant workers' organizations ([Justicia for Migrant Workers](#))
- Local/sustainable/just food organizations: [FarmFolk CityFolk](#), [The Bauta Family Initiative on Canadian Seed Security](#) (SeedChange), [Food Secure Canada](#), [Food Water Wellness Foundation](#)
- Indigenous food or agriculture organizations: [Plenty Canada](#), [Northern Manitoba Food Culture and Community Collaborative](#)
- Vegetarian, vegan, animal welfare organizations
- Public health associations ([Heart and Stroke Association](#), [Association pour la santé publique du Québec](#))
- Conservation organizations: ([Ducks Unlimited](#), [Nature United](#), [ALUS](#), [Nature Conservancy Canada](#))
- Environment-focused organizations: ([Equiterre](#), [Ecology North](#), [WWF](#))

Communications and narratives expertise

An expertise building effort relating to communications and narratives would further strengthen the intervention capability of all these organizations. This capacity is essential to allow effective communications with policy makers, the constituencies of each organization, and broader publics. We know that evidence and science on their own are not sufficient to change hearts and minds. People respond to messengers they trust and to messages and stories that resonate with their values and experience.⁹⁰ Understanding which stories are powerful and who are the credible messengers is essential to building the momentum needed to drive change.

In Canada there have been significant efforts, primarily funded by commodity groups, the food industry, and governments (AAFC and provincial) to build trust in food and farming. The initiatives are focused on telling a positive story about agriculture and reassuring consumers, with little recognition of a need for improvement.⁹¹ There has also been little work combining climate or environmental goals with communications about, or to, producers and agriculture – for example, the [2023 Re.Climate public opinion summary](#) contains no mention of agriculture.

We recommend funding narrative and public communications work, **such as**

- commissioning public polling research, in general and with farmers.⁹²
- Supporting communications training and support to farm and civil society organizations.
- engaging with groups and organizations farmers hear from and trust, e.g. industry organizations, industry supported media, and work with them to help frame sustainability messaging.

Organizations that do such work include [Re.Climate](#) (a centre for training, research and strategy on climate change communications and engagement)⁹³ and several public communications and engagement firms.

Collaborative policy engagement

Finally, under this recommendation we encourage support for collaboration among broad coalitions to advance work together and develop collective policy initiatives promoting sustainable agriculture and agri-food systems.

Two examples of existing collaborations are listed below; others may emerge organically or be prompted by a scoping study or call for proposals.

[Farmers for Climate Solutions](#) is a national coalition of 27 farmer-led and farmer-supporting organizations working to make agriculture part of the solution to climate change. They undertake both programming (peer-to-peer farmer practice adoption work) and advocacy, which among other impacts was very influential in the creation of the On Farm Climate Solutions funding program.

[Green Budget Coalition](#) brings together 22 leading Canadian environmental organizations to collaboratively develop, refine, and promote a comprehensive set of detailed, strategic recommendations for the annual federal budget. They have proven effective at influencing the budget, combining a complex coordination of recommendations with a strong advocacy work with federal officials and politicians, and recently began including agriculture-related recommendations in their budget proposals.

The globalized character of the agri-food system means coordination of policy work with other countries can be highly relevant, notably with the US and its [Farm Bill](#) (also renewed every five years, with the current bill expiring at the end of 2023) and the EU [Farm to Fork Strategy](#), part of the European Green Deal. Such coordination requires a sophisticated, trade-savvy set of actors working together and thus could be considered in a second phase in the lead up to the new agreements.

Recommendation 8:

Support opportunities to deepen research that foregrounds the environmental sustainability of agriculture, and collective conversations about agriculture and agri-food systems in Canada

This recommendation is focused on encouraging deeper societal reflection and constructive discussion about food, health, environment, social and economic dimensions, and the future of the Canadian agri-food system. Conversations about agri-food sustainability in Canada are heavily weighted towards incumbent industry voices. We see two pieces to “levelling” the playing field and building more inclusive conversations. First, stronger research capacity and coordination is needed among sustainable agriculture advocates within civil society and academia in Canada to present clear, evidence-based, analyses of the challenges facing agriculture in this country, how these challenges are being addressed (here and elsewhere) and what more can be done on these issues. For example, this report has identified a number of topics that require more research, combined with advocacy:

- incentives for sustainable production and subsidies for unsustainable practices.
- Conversion of agricultural land, and avoided grassland, wetland, and forest conversion
- the state of agri-environmental monitoring
- the role of industry influence in agricultural policy-making at federal and provincial levels, and the value of more diverse and inclusive governance mechanisms

Second, we see a need to build inclusive dialogue on a number of ‘sticky’ issues facing the agri-food system that don’t have easy answers, but on which the future hinges.

It is worth noting here that while previous recommendations most directly concerned production (environmental impacts, promising farming practices and related policy interventions), this one links to consumption—the demand for agricultural products and services from businesses and consumers—as well as to the wider place agriculture occupies in society. Over the long-term, building sustainable agri-food systems will inevitably involve choices not just about how we produce agricultural commodities (food, fibre, fuels), but also about what we produce, the ways these outputs are used by society, and the role of agriculture within the broader socio-economy. The following examples illustrate the kinds of issue on which we think broader public discussion can be productive.

Diets. The appropriate place of meat protein in human diets, and the role of animal agriculture in sustainable agri-food systems, are an area of ongoing discussion. Arguments relate to the rapidly rising demand for meat protein in developing countries, the difficulty of reconciling the scale of the global livestock industry with environmental limits, the importance of Canada meeting its 2050 climate target, as well as potential health benefits from reducing the proportion of calories derived from animal sources in the diet of the average Canadian. Although it is often assumed that diets are relatively stable, change over several decades can be quite dramatic: for example, the relative decline in beef and the rise in per capita chicken consumption in Canada, and the shift towards non-dairy milks, seen in recent years. A global shift towards a larger dietary role for plant-based proteins would significantly reduce the environmental footprint of the agri-food system. It is not just about direct emissions from livestock but the relative low protein conversion rate of beef (where internationally only about 4% of plant protein in feed is converted into animal protein). Yet many agronomists suggest that animal agriculture is an essential part of sustainable farming systems. How such debates will be resolved remains an open question. But the consideration and implications go far beyond what is happening on the farm. Diets can be an emotive question. Canadians are unlikely to look favorably on heavy handed attempts to alter what they eat. Farmers may perceive discussion of increasing the proportion of plant-based foods in diets as an attack on the nutritious quality of the food they produce or an attempt to undermine their way of life. Yet these conversations appear unavoidable over the longer term. Indeed, they are already happening. It behoves us to organize research, investigation, and discussion in a respectful manner.

Energy crops. Today a rising demand for bioenergy crops is already transforming the rural landscape. Food crop-derived ethanol for gasoline blending has long been promoted by Canadian governments and the demand for canola for biodiesel is today rapidly rising under the stimulus of US programs. Yet there are serious questions about the impacts of first generation biofuel production related to competing land uses, GHG emissions from nitrogen fertilizer used in their production, and other environmental pressures.⁹⁴ Should Canada really be encouraging biofuel production? If so, for which purposes—blending with gasoline for light duty vehicles, heavy duty freight, or aviation? Are other net zero fuels available or preferable for these uses? Are there potentially more important uses for this biomass (power generation, industrial feedstocks)? Answers to such questions go well beyond what is happening on the farm and relate to broader understandings of the transformation of energy systems, the role of agriculture as a foundation for social and economic development, and the type of society we want to build over the coming decades. But the way such discussions are managed, and their eventual outcomes, will have profound impacts on farmers and agricultural communities.

‘Conventional’ vs. ‘alternative’ agriculture. Throughout our interviews, we heard strong opinions on organic farming, both for and against, with proponents on each side of this divide often disparaging those on the other side. This division is emblematic of larger discussions about whether sustainable agriculture is to be achieved through large scale operations vs smaller ones, whether it should depend on fossil-fuel derived off-farm inputs vs. more circular approaches to farming systems, and debates between farming approaches that rely on synthetic pesticides, or genetically modified seeds vs. those that do not. Informed by transition theory, this report deliberately side-stepped these debates, focusing on the potential value of multiple approaches to sustainable agriculture. We note, however, that strong views against specific ‘alternative’ practices and approaches can create biases in public policy and result in missed opportunities. The lack of supportive policies for organic farming, both at the national level and in most provinces, despite the growing market share for organics both in Canada and abroad—and supportive policy interventions in both the US and EU (see theme 2)—is a case in point. It is important to have open conversations about both the possibilities and limitations of various approaches to sustainable farming, and to cultivate dialogue among these approaches in the context of wider public debate over the kinds of farming we want to see in our society, if we are to achieve public policies that encourage a full spectrum of solutions to the challenges we face.

The future of farming communities. The scale of Canadian agricultural enterprises has grown continuously over more than a century (while the number of farms and farmers has fallen) and the concentration of agricultural land in an ever-smaller number of hands appears set to continue in coming decades with increased corporate and investor-owned agricultural operations.⁹⁵ Consolidation can increase economic and environmental efficiencies and facilitate competition in global markets. On the other hand, some argue that there is value in mixed farming communities with small and medium scale farms under family ownership and that more support is needed for new farmers and farm transfers.⁹⁶ and to combat farmland consolidation and corporate ownership.⁹⁷ Some countries have introduced deliberate policies to preserve the character of rural communities and family-based agriculture (as has Canada

with policies like supply management). Should more measures along these lines be developed in Canada? Again, the answers concern society as a whole and conversations about these sorts of issue are of wide interest.

Temporary migrant labour. Under current conditions many forms of agricultural production are uneconomic in Canada without a steady supply of migrant labour, and current projections suggest this supply will continue to increase. These workers must be prepared to work long hours in difficult physical conditions for low wages and without all the same protections (medical benefits, the ability to shift from one employment opportunity to another, the right to collective bargaining, etc.) that Canadian workers receive. Is this dependence on foreign labour inevitable or desirable? Can mechanization or changes in cultivation practices provide solutions? Should migrant workers receive the same standards of protection that Canadian workers receive? Should Canada abandon production of items that cannot be grown competitively without temporary migrant labour? These are questions that concern not just farmers but relate to broader socio-economic issues about Canada's food systems.

Clearly these and many other related issues are of differing scope and might be addressed over different time scales. But to the extent that they are already entering the conversations around sustainable agriculture, often with quite polarized perspectives, and where clear solutions are not yet evident, foundations can contribute by encouraging further study and convening respectful and evidence-based discussions.

What foundations can do

Advancing constructive discussion to lay the ground for future action on the suite of issues described above and others requires action on two fronts: First we need coordinated research connected to sustainable agriculture advocacy. Second, we need a skillfully designed, inclusive dialogue process to move conversations forward on the 'sticky' issues. While it may be possible to have one organization undertake both types of initiatives, we believe these efforts should be undertaken separately, by different types of organizations, as they serve two distinct functions.

The **research element** would be closely connected with farm organizations, environmental civil society organizations, and researchers who bring a constructive but critical perspective to agri-food system issues in Canada. While avoiding duplication of existing academic, farm sector or civil society initiatives, but still drawing on each of these sectors to strengthen critique and bring new proposals forward. A careful survey of existing capacity, framing the remit of such a body, and identification of appropriate leadership would be necessary before investing the funds that would be required to make this a success.

A point of reference for this is [IPES-Food](#), an international panel of experts bringing together environmental scientists, development economists, nutritionists, agronomists, sociologists, farmers, indigenous peoples representatives, and experienced practitioners from civil society & social movements to international policy conversations over the future of the global food system. IPES-Food produces well-researched reports that bring fresh perspectives to debates about sustainability, diets, hunger, farm debt and more. An independent Canadian organization

along these lines, but with membership that includes many of the types of farm organizations and NGOs we encourage philanthropy to fund under Recommendation 7, could provide a useful complement to existing academic research centers or organizations like the [Canadian Agri-food Policy Institute \(CAPI\)](#).⁹⁸

Action on this recommendation would take on some of the ‘political’ work needed to expose and challenge power structures in the Canadian agri-food system, while advocating for diverse solutions, that many of our interviewees noted as critical for advancing sustainability. It should be networked with the work of existing think tanks doing agri-food work (for example, [IISD](#)) existing agri-food focused university research centers (for example, [Arrell Food Institute](#) at the University of Guelph, [Simpson Centre](#) at the University of Calgary, the [Sustainable and Just Food Systems Lab](#) at Lakehead University), but bring forward a distinct perspective by being informed (and partially governed) by a group of experts with deep experience as environmental NGO campaigners and representatives of farm organizations with a strong commitment to sustainability.

The **dialogue** component of this recommendation could be carried forward by an organization (possibly a new or existing research center connected with a university) with a mandate to convene public discussions over the future of the agri-food system: a ‘national dialogue on tough food issues.’ The convening role of this center could take multiple forms, including on-line and in-person workshops (using processes such as those used by the [Energy Futures Lab](#)) and citizen debates (for example, [The French Citizen Climate Debates](#)).

A point of reference which combines these two elements is the [TABLE Debates](#), a collaborative initiative between the University of Oxford, the Swedish University of Agricultural Sciences and Wageningen University in the Netherlands, a platform for knowledge synthesis, reflective, critical thinking, and inclusive dialogue about the future of food. The initiative aims to act as ‘an honest broker in global food systems debates, while acknowledging that the current food system is in need of major transitions’ and aims to bridge unhelpful divides with a process that brings people’s underlying values into the open and into the discussions.

Sector analysis: Dairy, Beef, Grains

When engaging in efforts to further agricultural sustainability in Canada, it can be important to think in sectoral terms. As illustrated in Part 1 of this report, the Canadian agri-food system is complex and diverse. Different sectors are at different stages in developing more sustainable approaches. Further, the characteristics of each sector (e.g. whether they are oriented to domestic or export markets, or the kinds of infrastructure they depend on) can be key determinants to where they are in that journey, as well as what kinds of interventions they may respond to.

The three sectors presented here are all important in different ways, and this is why we selected them. Together, cattle make up 62% of the GHG emissions from the agricultural sector in Canada, so we decided to focus on the two cattle sectors (dairy and beef). These cases also illustrate just how significant differences between two sectors can be, even though both work with cattle. The dairy sector is supply managed and thus domestically oriented and relatively small, with a herd of 1.4 million cattle. So, while dairy cows emit significantly more methane per cow than beef cows, Canada's dairy sector is only responsible for about 13% of agricultural GHGs. The beef sector, in comparison, is export oriented and much larger, with a herd of over 12 million beef cattle. Thus the beef sector is responsible for almost four times as many GHG emissions as dairy, with beef operations representing 49% of agricultural GHGs. The grain sector is important for Canada because of the breadth of its acreage, with some 34% of active farms growing grains, oilseed or field crops, and the potential for beneficial management practices (such as cover cropping and crop rotation) for protecting biodiversity, potentially sequestering carbon, and other environmental benefits.

These sectoral profiles are not meant to suggest that these are the sectors where philanthropic foundations should prioritize for investments. Rather, **they are intended to illustrate how our recommendations can be applied to specific sectors** – while recognizing that a sectoral approach is not always the most effective one. For example, strengthening local and regional food systems requires a cross-sectoral approach, and on the other extreme, an effective strategy may involve focusing on a single commodity such as canola or corn.

What we do not yet do here (because it would take considerably more time and research) is develop a detailed analysis of the supply chain dynamics within each sector, and how these could be leveraged to encourage substantive change towards sustainability. In dairy, for example, our analysis shows that Canadian consumers play a significant role in driving change because the sector is largely domestically oriented. What we have not yet ascertained is the role that specific domestic processors are or could play, in 'coalitions of the willing' (Recommendation 6), to drive change within the sector. We know that some processors (e.g. Danone and General Mills) are advocates for regenerative agriculture among the farmers they buy from, but how much change companies with small market shares can achieve, versus a larger player like Agropur, would be important to think through in developing strategic interventions in this sector. Similarly, while the beef sector is export-oriented, and thus less influenced by domestic consumer preferences, it would still be important to explore the dynamics within international markets for Canadian beef, such as the US, and to see how this can be built upon in campaigns targeting this industry in Canada (or North America more broadly).

Sector Profile and Engagement Opportunities: Dairy

Summary:

Canada's dairy sector has made important strides in becoming more sustainable in recent decades, mostly due to gains in production efficiencies, but also thanks to commitments by industry leaders as well as growing pressure from consumers (who are increasingly turning to non-dairy alternatives, especially for liquid milk). Progress is also a result of strong international cooperation, close internal relationships in the sector, the relative economic sustainability of dairy farming. The industry has also long been data-driven, thereby making it easier to collect and report on sustainability metrics. Many of these factors relate to the fact that dairy is a supply managed commodity. The latest demonstration of dairy farmers' efforts to become more sustainable was the 2022 release of the Dairy Farmers of Canada's net zero carbon target for 2050. Many things need to come together for this vision to be realized by 2050.

Engagement opportunities for this sector include affirming the progress the dairy sector and many of its farmers are making, while encouraging still greater adoption of more sustainable approaches across the sector (R1); supporting peer-to-peer learning to continue the roll out of regenerative and organic practices in the sector (R3; R5); supporting efforts of dairy sector organizations to trial measurement tools for carbon sequestration (R5); engaging with practical cross-sectoral initiatives like CANZA (which has a biodigester initiative focused on dairy farming) (R6); and including dairy sector organizations in discussions on the potential contributions of plant-based diets, animal welfare, etc. (R8).

1. Industry Portrait

- In 2021, there were 1.43 million dairy cows and heifers (93% Holstein breed) in Canada on 9,952 farms, which produced 9.5 billion liters of milk. Québec and Ontario dominate the industry with 36% and 33% of dairy cows, respectively.
- Herd size shrank 46% from 1981 to 2011, but milk production has increased 6% over the same period. From 2001 to 2011 production per animal increased 16%.
- Dairy is a supply managed product. The Canadian Milk Supply Management Committee sets the raw milk production quota annually and the Market Sharing Quota (MSQ) for each province. It also sets import quotas and price controls.
- In 2021, Canada imported over \$1 billion in dairy products (mainly cheese, butter, milk protein substances, and whey products from the USA, UK, New Zealand and Australia) and exported \$380 million (mainly skim milk powder, cheese, whey products to the US, Saudi Arabia, Australia, Kuwait). Both numbers have increased in the past 10 years.
- Provincial marketing boards regulate milk marketing, organize producers, administer quotas, and settle agreements between producers and processors. There are three regional milk pools – Newfoundland, Eastern (NS to ON), and Western (MB to BC) that pool milk revenues, costs, and harmonize pricing.
- While supply management is gradually being watered down by dairy import quotas included in trade deals, it is unlikely to disappear anytime soon given the disproportionate political influence of rural Ontario and Quebec in Canada.
- There are two supply chains for dairy cattle in Canada, conventional and organic (since 1994). In 2020-2021 organic milk represented 1.5% of total milk produced in Canada. To be certified, an organic dairy farm must feed their cows a minimum of 60% of their diet from pasture and dried forage. Cows are also required to have outdoor access year-

round. Grains used to supplement the cows' diet must come from 100% certified organic sources and typically come from the same farm.

- There is currently a pilot project by the DFC for the certification of grass-fed dairy in which 75% of the dry matter intake of the lactating herd must be from forage or grass at all times.
- Canada's dairy farmers are aging. Due to the high capital costs and the cost of purchasing quota, dairy remains a difficult sector for new entrants to succeed in.
- Dairy production and manufacturing employed 26,817 people in 2021 plus an additional 16,670 operators working on dairy farms across Canada. The number of dairy farm operators has declined 55% since 2006.

2. Consumer Demand

- Per capita milk consumption increased from 1960 to peak at 98 litres in 1979 and 1980. It has then gradually decreased to 58 litres per person per year in 2022⁹⁹.
- Consumption of yogurt has increased from 0.38kg/person in 1970 to 9.87 kg/person in 2018. Consumption of cheddar cheese has increased from 1.88kg/person in 1970 to 4.13kg/person in 2018. Sales of cottage cheese and processed cheese declined in this same period.
- Dairy alternatives, particularly milk alternatives including almond, soy, coconut, and oat are gaining popularity. In 2020, sales of milk alternatives were valued at over \$450 million. With increasing health and environmental concerns, milk alternatives have been marketed as environmentally sustainable and animal-free alternatives to conventional milk.
- Non-dairy alternatives to cheese, yogurt, and ice cream currently represent only a small percentage of total sales in Canada.

3. Environmental sustainability of the dairy cattle industry in Canada

Multiple issues are relevant for assessing the environmental sustainability of the dairy industry. These include *greenhouse gas emissions, water quality, soil health, soil erosion, and biodiversity* impacts, as well as factors such as animal health and wellbeing. The magnitude of these environmental impacts varies by region (due to differences in weather patterns, terrain, climate, etc.) and by on farm practices. The general picture for the sector can be summarized as follows:

- **Biodiversity and erosion:** Well-managed pasture provides key habitat as well as natural corridors and nesting habitat. Unfortunately pasture and forage lands are in decline, with more and more dairy cows relying on annual crop production for the majority of their diet. Annual crop systems used in feed production, especially those under intensive tillage, contribute to a decline in biodiversity and habitat. On the other hand, increasing adoption of conservation tillage and no-till systems mean crop production is less likely to lead to soil erosion than in the 1980s.
- **Water Quality:** This indicator has declined since the 1990s due primarily to increased application of fertilizers and pesticides, especially in no-till and conservation tillage production. As dairy operations have become more concentrated in Ontario and

Québec, these watersheds are at increased risk of contamination. However, this is balanced by a reduced risk of water quality contamination in other regions that had previously hosted a greater number of smaller operations. Further, improving manure management systems reduces risks to water quality.

- **Greenhouse Gas Production and Sequestration:** In 2018, dairy farming was responsible for about 13% of the agricultural sector's GHGs or 1.3% of Canada's GHGs. (Ageco, 2018). In 2018, 48% of dairy GHGs were caused by enteric fermentation. 28% from feed production, 18% from manure management, 6% from energy, infrastructure and transport. While not insignificant, the GHG intensity of each litre of milk produced in Canada is about 1/3 the global average. Dairy farms also sequester carbon in soils, but the actual balance of carbon dioxide from the air and the amount soils can capture remains contested.

4. Sustainability opportunities in this sector:

- Dairying and GHGs:
 - 2011 to 2016 saw decreases in the carbon footprint, water consumption and land use in the dairy sector by 7.3%, 5.6% and 10.9%, respectively.
 - The main driver for better environmental performance (2011-2016) is increased milk production per cow, achieved by adopting beneficial management practices (BMPs – most of which are considered 'regenerative' practices) including improved forage management, better composting or anaerobic digestion of manure, and more diversified crop rotations and the adoption of new technologies like Controlled Traffic Farming (designed to reduce soil damage from heavy machinery)
- This sector has a good track record of moving forward on sustainability issues because of:
 - Strong international cooperation within the dairy sector
 - Sustainability advocates within the sector, including organic farmers and proponents of regenerative practices.
 - Strong internal relationships between suppliers and distributors through supply management
 - Close relationships with Canadian consumers (who are sensitive to environmental messaging, and increasingly turning to dairy alternatives for fluid milk) and producers.
 - A long history of being data-driven, so new metrics (e.g. on environment or animal care) are easy to add in
 - The relative economic sustainability of dairy farmers (due to supply management), allowing farmers (and their networks) to invest in new technologies, research, etc.
- While supply management ensures strong coordination and buy-in, it also makes it difficult to differentiate 'more' sustainable products or allow farmers to charge a premium for these (with some exceptions including the organic supply chain and DFC's pilot 'grass-fed milk' system).

- It is also notable that the way milk is pooled locally and regionally in the dairy sector means that milk typically does not travel long distances. It is one of the few sectors that already has strong ‘local food’ infrastructure (as encouraged by R6) in Canada.
- A key mechanism for strengthening sustainability in the sector is the [ProAction](#) Quality assurance program (established sector-wide in 2016). This program is mandatory on all Canadian dairy farms. It requires farmers demonstrate excellence in six areas: milk quality, food safety, animal care, livestock traceability, biosecurity, and environment. The environment portion is the Environmental Farm Plan Program.
- In 2022, Dairy Farmers of Canada established a ‘net zero’ carbon target for 2050. Their plan includes a combination of emissions reductions (e.g. using BMPs more widely, breeding for lower emission cattle) and removals by increasing carbon sequestration on the farm. DFC will also be working to “leverage and enhance” measurement tools, including developing a biodiversity assessment as part of the LCA they undertake on all farms every five years, and participate in a carbon sequestration study. Finally, DFC has developed a [National Dairy Research Strategy](#) focused on dairy farm sustainability, animal health, care and welfare, and dairy in human nutrition and health.

5. Engagement opportunities (noting alignment with this report’s recommendations):

This sector is both highly networked and sensitive to shifts in Canadian consumer demand because of supply management. It would be fruitful to work with key network actors to move existing initiatives forward while encouraging the sector to move more quickly. Such efforts could include:

- Affirming the progress the dairy sector and many of its farmers are making, while encouraging still greater adoption of more sustainable approaches across the sector, in any efforts to intensify education and advocacy
- work around climate change impacts of current farming practices **(R1)**
- Encouraging further adoption of regenerative and organics in this sector by supporting peer-to-peer learning efforts by organizations like DFC, Regeneration Canada (which is working on a dairy pilot in Quebec) and enhancing extension **(R3; R5)**
- Strengthening the organic dairy sector **(R3)**, linking this goal to any campaigns developed to reduce pesticide dependence in Canadian agriculture **(R2)**
- Supporting efforts of organizations like DFC and their partners to trial and roll out measurement tools for carbon sequestration **(R5)**
- Engaging with practical cross-sectoral initiatives like CANZA (which has a biodigester initiative aligned with DFC goals) **(R6)**
- Including dairy sector organizations and farmers in discussions on the potential contributions of plant-based diets, animal welfare, etc. **(R8)**

Sector Profile and Engagement Opportunities: Beef

Summary:

Canada's beef sector is highly decentralized and continentally integrated. It may be vulnerable to shifts in international consumer demand (towards or away from beef) but is less sensitive to shifts in Canadian consumer demand. The main beef supply chain (85% of beef) in Canada serves both export markets and supermarkets and is dominated by Western producers. The smaller supply chain (15% of beef), which is more likely to produce grass (rather than grain) finished beef, relies on a shrinking network of provincial abattoirs. These facilities represent critical pieces of local and regional food infrastructure.

From an environmental point of view, this sector is both important and complicated. The beef sector is responsible for almost 50% of agriculture's GHG emissions. However, the cow-calf operations that serve the feedlot industry also protect biodiversity (on rangeland and pasture) and protect carbon in the ground that that could otherwise be released in a carbon 'bump' if land were converted into cropland – something our report documents as an ongoing problem. This poses a real conundrum for engaging with the beef sector, suggesting the need for a complex mix of policies and incentives to both reduce GHGs in this sector AND maintain biodiversity. Further, because beef farms come in so many sizes, and are found throughout Canada, the initiatives designed to encourage more sustainable practices are many and poorly coordinated.

Engagement opportunities for this sector including affirming the progress leaders in the beef sector (e.g. members of the Canadian Roundtable on Sustainable Beef) are making, while also noting gaps (like no net-zero commitments made) in efforts to intensify education and advocacy work around climate change impacts of current farming practices (R1); encouraging greater cooperation among the numerous initiatives in this sector designed to support sustainable beef production (R3; R6), working to minimize transaction costs and/or improving financial incentives (R3); supporting the development of better tools for methane measurement at the farm level (R6); strengthening the organic beef sector (R3), linking this goal to any campaigns developed to reduce pesticide dependence in Canadian agriculture (R2); and including beef sector organizations and farmers in discussions on the potential contributions of plant-based diets, animal welfare, etc. (R8)

1. Industry Portrait

- In 2021, there were 74,148 farms and ranches in Canada raising 12,640,089 beef cattle with farm cash receipts of \$10.2 billion.¹⁰⁰
- On average, Canadian cattle producers reported 163 animals in 2022. 52% of cows are found on medium-sized farms (farms with 48-249 head of cattle) which represents 33% of farms. 61% of farms have fewer than 47 head of cattle (representing only 16% of the beef cattle population).
- Most beef is produced in Western Canada, with Alberta accounting for 40%.¹⁰¹
- 69 million acres¹⁰² (or 43%) of Canada's farmland is used for beef cattle.¹⁰³ On average, beef cattle farms use 40.5% of their land for crops (not necessarily for feed), 38.1% as native pasture, and 13.6% as tame or seeded pasture.¹⁰⁴

- The beef industry grew steadily until 2006, when it began to decline due to major market disruptions beginning with the 2003 BSE (“mad cow disease”) outbreak which resulted in a lasting shift in consumer behaviours away from beef and towards other meat (namely pork and poultry).¹⁰⁵ Economic factors such as a higher Canadian dollar, which made exports to the US more expensive, increased feed costs, and country-of-origin labelling discouraging other nations from consuming Canadian beef also contributed to declines in the industry.
- From 1976-2021, the average carcass weight for beef increased 55% from 248 kg to 385 kg, which would in fact mean a 21% increase in kg of beef produced, which also helps explain the decline in the head of cattle.
- There are two main supply chains for beef in Canada: The main one (85% of beef) begins with calves born on cow-calf operations, which contain approximately 65% of beef cattle in the chain at a given time. Calves are weaned and then move onto feeder and stocker farms¹⁰⁶ (approximately 20% of beef cattle in the chain) where they are fed both grass and grains to prepare them for the feeding operations (or feedlots) (approximately 15% of beef cattle in the chain) where they are typically finished on grains. Animals are typically sold at auction between these stages.¹⁰⁷ These animals are transported to federally-inspected meat processing facilities and either sold domestically or internationally. There were 19 federally-inspected meat processing facilities in Canada in 2021 that processed more than 85% of Canadian beef.
- The smaller supply chain (15% of all beef) also begins with cow-calf operations where cattle are then *finished* on grass-fed operations. These animals are more likely to be processed at smaller, provincially-regulated slaughterhouses and sold either directly to consumers¹⁰⁸ or supplement the domestic beef supply. Meat processed at provincially regulated facilities cannot be exported across provincial or national borders.
- These provincially inspected facilities represent critical pieces of local and regional food infrastructure, and their number continues to shrink, with more closing than opening, threatening the ability of farmers to produce livestock for local markets in many parts of the country.
- Regardless of the pathway beef cattle take to market, inputs remain fairly consistent and include feed (or pasture, or land), labour (including veterinarians), and equipment. In 2018, approximately 65% of operating expenses were directly from livestock (including purchasing animals, feed, supplements, veterinary fees, medications and breeding fees.)¹⁰⁹
- According to the 2021 Agriculture Census, the entry of younger farmers in beef cattle farming is growing. The number of women in beef cattle continues to climb with women as sole operators representing 8.8% of all operators and women on multi-operator farms at 42.1%. Geographically, BC has the highest number of women operators, and they are found more often on cow-calf operators.¹¹⁰

2. Consumer Demand

- Almost half of Canadian beef is exported to the US.¹¹¹

- Due to growing demand for beef in Asia and the US, global beef demand is expected to keep rising.
- Canadian demand for beef has been declining for decades. Data from 1980, shows 28.7kg of beef available annually per person, while 2021 data has 17.0kg available,¹¹² a drop of 41%.
- However, beef remains the dominant meat consumed by Canadians. In 2019, Canadians spent \$399 annually on beef per household, accounting for 42.5% of household meat consumption with most supply coming from domestic sources.¹¹³

3. Environmental sustainability of the beef cattle industry in Canada

- The environmental sustainability of the beef cattle industry is multifaceted with impacts from greenhouse gas emissions, water quality, soil health, erosion, air pollutants, and biodiversity as well as factors such as animal health and wellbeing and the health and wellbeing of workers in the industry (including those in meat processing facilities). These impacts vary significantly by region (due to differences in weather patterns, terrain, climate, etc.) and by on farm practices. For example, grass-fed beef has impacts through pasture and manure management, while grain-finished beef has impacts through field crop production for feed, transportation of feed, and manure management.
- Beef production can contribute to **biodiversity** protection since well-managed pastures (found on both grass-fed and cow-calf operations in Canada) provide key habitat for species while also providing natural corridors and nesting habitat. Pastures, forages, and perennial hay lands also have reduced risk of **soil erosion and salinization**, and improved **soil organic matter**. Further, when grain fed to animals comes from no-till, conservation or organic systems, the soil quality impacts of feedlot systems improves.
- Large-scale feedlot production can have an impact on **water quality**. As feedlots have become more concentrated in Ontario and Alberta, these watersheds are at increased risk of coliform (and to a lesser extent nitrogen and phosphorus) contamination. However, this is balanced by a reduced risk of water quality contamination in other regions that had previously hosted several, smaller operations. By comparison, smaller systems including cow-calf operations and those using rotational grazing have less impact on water quality as manure quantity is lower and distribution 'built-in' as the heavy hoof 'traffic' of animals integrates manure constantly.¹¹⁴ In both cases, protecting water sources from overuse can reduce contamination risks from manure.
- The most significant environmental issue facing the beef industry is the **GHGs** associated with beef production, primarily methane from enteric fermentation and manure management. Agriculture represents 10-12% of Canada's total GHG emissions and¹¹⁵ of these emissions, just under half come from beef cattle production. In 2018, beef cattle were responsible for 42% of manure-management related emissions in Canada (30% methane and 70% nitrous oxide).^{116 117} On a per animal basis, grass-fed beef has higher

lifetime emissions than feedlot cattle since the animals take longer to reach their full size. It is also notable that, on a per weight basis, emissions from beef cattle are decreasing. The intensity of GHG emissions reduced 18-20%/Kg of beef from 1990 to 2022.¹¹⁸

4. Sustainability opportunities in this sector:

- The 2021 Agriculture Census asked farmers to identify different technologies and sustainability practices used on their farms. It found that these practices (including shelterbelts and windbreaks, rotational grazing, and in-field winter grazing) were more commonly used on cow-calf operations than on finishing (feedlot) operations.
- Regionally, in-field winter grazing or feeding is highest in Western Canada (35-55%). The application of rotational grazing is fairly consistent across the country (44-60%).¹¹⁹
- This sector has many initiatives encouraging farmers to adopt more sustainable practices (see list below), but there is a lot of overlap (and insufficient coordination) among them
- Some existing initiatives involve high transaction costs for farmers (i.e. filling out forms and data gathering)
- Most initiatives support specific on-farm activities, but few effectively monitor outcomes
- There are competing tools for measuring GHGs at the farm level, but they are not always compatible with one another, nor are they easily accessible to all farmers.
- Financial incentives for sustainability programs are important, but ‘early adopters’ are seldom rewarded.
- Farmers recognize they need support to implement specific initiatives on their farms, but often lack access to appropriate extension services to do this.
- The growth in new entrants in beef farming represents an opportunity for sector renewal and sustainability
- Beef producers are engaged in a wide range of governments, private, and non-profit programs that support greater sustainability in the beef cattle sector, including Environmental Farm Plans, Living Labs ([Eastern Prairies](#), [Saskatchewan](#)), projects funded by the On Farm Climate Action Fund, ALUS, Ducks Unlimited and Nature Conservancy Canada programs.
- A few initiatives are also specific to beef, notably: the Canadian Roundtable for Sustainable Beef (CSRB) and the Forage and Grassland Initiatives (Canadian and provincial organizations). In our focus group on sustainable beef as well as interviews, we heard about challenges associated with such a diverse landscape of programs and a need for greater coordination.

5. Engagement Opportunities (noting alignment with report’s recommendations)

This sector is highly decentralized and continentally integrated. It may be vulnerable to shifts in international consumer demand (towards or away from beef) but is less sensitive to shifts in Canadian consumer demand. Efforts to strengthen the sustainability of beef production in Canada could include:

- Affirming the progress leaders in the beef sector (e.g. CRSB) are making, while also noting gaps (like no net-zero commitments made) in any efforts to intensify education and advocacy work around climate change impacts of current farming practices **(R1)**
- Encouraging greater cooperation among the numerous initiatives in this sector designed to support sustainable beef production, including reducing overlap among programs and better monitoring of outcomes **(R5; R6)**
- Encourage initiatives that support outcomes (e.g. lower GHGs, or more carbon sequestration), allowing farmers to choose which changes are appropriate to their farm **(R5)**
- Minimizing the transaction costs, or improving financial incentives, for such initiatives **(R3)**
- Supporting the development of better tools for methane measurement at the farm level, working with initiatives like the Canadian Agri-Food Index and CRSB **(R5)**.
- Strengthening the organic beef sector **(R3)**, linking this goal to any campaigns developed to reduce pesticide dependence in Canadian agriculture **(R2)**
- Support efforts by civil society, farm organizations, working with private businesses, to maintain or re-establish local food infrastructure for the livestock sector (e.g. abattoirs) **(R6)**
- Including beef sector organizations and farmers in discussions on the potential contributions of plant-based diets, animal welfare, etc. **(R8)**

Sector Profile and Engagement Opportunities: Grain

Summary

The grain sector is highly export oriented, with 76% of total agricultural exports (wheat and canola) grown on the Prairies. Crops used for animal feed (corn, wheat, barley...) and biofuels (canola, soy, corn..) drive much of purchases and incentivize the conversion of grasslands to croplands, and recent biofuel policies in the US have raised demand (with commensurate environmental impacts) even further. Nitrogen use per hectare has grown significantly since the 1980s with negative impacts on soil, water and air; nitrogen fertilizer emissions make up about 27% of total agricultural emissions. Concerted efforts will be required to meet Canada's 30% fertilizer emissions reduction target. A few sustainability improvements such as adoption of conservation tillage have been significant, others such as cover crops and crop rotation have been more limited.

Several recent government, corporate and philanthropic programs aim to support adoption of more sustainable cropping practices including for grains, and/or stem the conversion of ecologically important lands to croplands but larger investments, better coordination, and careful consideration of lessons learned to date is needed. Many recommendations from this report are relevant to the grain sector; see Engagement Opportunities below.

1. Grain: an industry portrait

- Of 189,870 active farms in Canada, 65,135 (34%) produce grain, oilseeds, or field crops¹²⁰
- The majority of wheat, oats, barley, rye, flax, canola, mustard, and sunflowers are grown on the Prairies. Almost all of Canada's canola (99%), spring wheat (98%), and barley crops (96%) comes

from Manitoba, Saskatchewan, and Alberta with 89% of Canada's lentil production in Saskatchewan¹²¹

- Ontario led the nation in total farm area for soybeans (54%), corn for grain (67%), and winter wheat (76.1%). Quebec produced most of the remaining grain corn (24%) and soybeans (18%)¹²²
- The grain sector is highly export oriented, particularly on the Prairies; 76% of total agricultural exports were wheat and canola grown on the Prairies¹²³
- Total grain production has generally been on an upward trend over the past two decades with significant yearly fluctuations; annual wheat production has varied from 20 to 37 million metric tonnes and canola (with a steeper growth) varying from 5 to 21 million metric tonnes.¹²⁴ Yield increases primarily come from increased use of fertilizers and improved varieties, while declines are largely attributed to poor subsoil conditions and insufficient rain levels which have led to widespread pockets of drought throughout the Prairie regions.
- Trade is a strong driver for Canadian grain producers and the trading sector is highly concentrated with three companies (Viterra, Cargill and Pioneer) dominating Canada's primary grain elevation, as well as terminal elevation in the port of Vancouver.
- Because the majority of grain production is concentrated in the Prairies, distances from processing plants (concentrated in Ontario and Quebec) and exporting facilities (on the coasts) are long, necessitating a reliance upon rail transport with 94% of Canadian grain shipped by rail.¹²⁵ Canadian National and Canadian Pacific are highly integrated players in the rail infrastructure, with several hubs throughout the country that facilitate cross-Canada transportation. However, labour shortages and extreme weather events increasingly disrupt this system.
- Key national industry stakeholders are Canada Grain Council, Cereals Canada, and Grain Growers of Canada.

2. Consumer demand:

- Demand for Canadian grain is strong and growing, notably in the face of global economic and environmental crises (most recently the war in Ukraine) and global population growth
- While historically dominated by wheat, oats and barley crops, soy and canola have taken an increasingly large share of grain production, with animal feed and biofuels driving purchases
- A global innovation cluster, Protein Industries Canada, was established in 2018 to build collaborations for companies and researchers to develop plant-based protein products, particularly from canola and pulses.

3. Environmental sustainability of grain production in Canada

- Crop production is very GHG heavy, accounting for 35% of the total emissions profile in the Prairies. Nitrogen use per hectare of crops on the Prairies has increased nearly threefold since the 1980s, with only half of it reaching crops and the remainder contributing to degraded soils, wetlands, water, and the atmosphere. Prairie canola growers now spend about \$1 to \$1.15 billion annually on nitrogen fertilizer. GHG emissions have continued to increase, with emissions from nitrogen fertiliser production and use making up about 27% of total agricultural emissions.¹²⁶
- Much of Canada's grain goes to animal feed, with 80% of barley, 60% of corn and 30% of wheat produced used in Canadian feed manufacturing¹²⁷
- The Prairies are warming more quickly than any other region in Canada outside of the Arctic. Summer precipitation has increasingly led to greater flooding, resulting in loss of fertility and

increased erosion. Drought and wildfires pose serious issues for canola production in particular¹²⁸

- As winters continue to become warmer, there is greater potential for an influx of pests such as beetles and ticks, and diseases such as cereal rust. Pesticide use has more than doubled in the past two decades¹²⁹
- Biofuels (fuels derived from plant or algae material or animal waste) have been touted as an answer to the problem of GHG emissions caused by transportation¹³⁰. Two major biofuels, ethanol and biodiesel, have dominated the biofuel landscape.¹³¹ Biofuel markets have increased prices for eligible commodities (notably canola and corn) and helped drive conversion of sensitive and biodiverse lands to cropping, reduced opportunities for crop diversification, and competing for food production.
- The vast majority of biofuel produced in Canada comes from first-generation feedstocks, namely corn and canola. Increasing production of these feedstocks means upward pressure on food prices, considerable risk of increased GHG emissions through direct and indirect land-use change such as the conversion of Prairie grasslands for canola production, the degradation of land, water resources, ecosystems, and overall loss of biodiversity through an increasing usage of freshwater, fertilizers, and pesticides.¹³²
- The US Environmental Protection Agency approved canola oil as an eligible feedstock for the biofuel sector in December 2022; a year later, US canola consumption had increased 42%, and represented 16.4% of all biofuel production¹³³. Production of first-generation biofuel feedstocks is set to increase further, with crop production becoming even more concentrated on a few crops, managed by a few companies.¹³⁴
- Second and third-generation biofuels could help to address the problems associated with conventional biofuel production, but these fuels are not currently economically viable relative to the cost of production, and the prices of oil more generally. Production of micro algae is very energy intensive, making its long-term viability questionable; it also presently involves a higher GHG emissions profile than traditional fossil fuels¹³⁵
- Numerous life-cycle analysis studies point toward a potential for biofuels to achieve meaningful reductions in GHG emissions for fuels, but the estimated impact on climate change mitigation is often highly variable.¹³⁶

4. Sustainability opportunities in this sector

- No-till or reduced tillage farming (planting seeds and applying fertilizer or manure with the least amount of soil disturbance possible) has been adopted in recent decades to address problems of soil erosion, soil water leakage, soil quality while reducing costs.¹³⁷ Up to 65% of arable land on the Prairies employs some degree of tillage reduction.¹³⁸ Drawbacks and limitations to no-till include increased difficulty controlling weeds leading to greater herbicide use and weed resistance¹³⁹
- Summer fallowing, in which some cropland is kept out of production for a growing season to promote moisture retention, was historically heavily used in cereal-based production and led to significant soil degradation and loss of production¹⁴⁰, but decreased significantly between 1970 and 2000.¹⁴¹
- Pulses like lentils, dry beans and chickpeas include lower needs for water due to shallow root systems and reduced need for synthetic nitrogen fertilizer when placed in a rotation; pulse crops like lentils have replaced summer fallowing in a few pockets of the Prairies¹⁴²
- Organic grain production has been found to reduce the risk of soil erosion and increase biodiversity, through greater use of crop rotation and cover crops and use of insect and weed control measures.¹⁴³ Organic crops are a lucrative investment with a heightened return, but certification can

be prohibitively expensive in both money and time, especially where subsidy programs are underfunded or entirely absent¹⁴⁴

- Cover crops, which are grown to cover the soil when it would otherwise be left bare, have been gaining in popularity although only about 10% of Canadian farms currently use the practice with adoption higher in eastern Canada¹⁴⁵. In the Prairies, limited soil moisture and the very short window of time between harvest and winter has reduced uptake of cover cropping; intercropping (planting a secondary crop between the rows of the main crop) is also being explored by many grain producers. Drawbacks include reduced soil moisture and additional costs for planting and terminating¹⁴⁶
- Grains planted in the fall (notably wheat and rye) and overwintering before an earlier harvest promote soil health because of the root system that promotes biodiversity and prevents erosion; Ducks Unlimited and several industry organizations created a [Habitat Friendly Winter Wheat eco-label](#). Some 75% of Canada's winter wheat is currently grown in Ontario¹⁴⁷
- Crop diversity in grain producing regions is important for biodiversity and other environmental benefits, but is difficult to achieve given the economic interest of primary commodities for export human food and animal feed markets as well as biofuels.
- The Canadian Roundtable for Sustainable Crops (CRSC) released a voluntary code of practice for grain production entitled "Responsible Grain" in 2021, but this report was met with considerable backlash from producers, due in large part to the prescriptive tone of the original report. The CRSC's efforts have been refocused to a metrics site with information and a potential second version of the Code aims to focus on the existing accomplishments, regulations, and practices taking place within the sector and focus on four key "modules": soil and nutrient management, water and biodiversity, seed varieties and crop health, and health and wellness¹⁴⁸
- Agriculture Canada set a target to reduce fertilizer emissions by 30% below 2020 levels by 2030. A set of measures to help get there include more widespread soil testing, 4R fertilizer practices (right source, rate, timing and placement), conservation tillage (reduced or no-till), cover crops, diverse crop rotations, precision management of nitrogen and variable-rate application technologies. The fertilizer industry has simultaneously promoted the 4Rs and resisted ambitious targets¹⁴⁹
- Several recent government (On Farm Climate Action Fund, Sustainable Canadian Agricultural Partnership, Resilient Agricultural Landscape Program), corporate (see Recommendation 3 on Regenerative and Organic) and philanthropic programs are aimed at both support adoption of more sustainable practices including for grains, and stemming the conversion of ecologically important lands (forests, wetlands, grasslands) to croplands (see Recommendation 2), although investments pale in comparison to US and European programs¹⁵⁰
- Sustainability-focused technologies hold promise, including precision agriculture such as laserweeding and fertilizer applications targeted to soil needs, improved crop genetics and protection of soil microbiomes, although more investment in research and oversight to ensure public good is needed.

5. Engagement Opportunities (noting alignment with report's recommendations)

Efforts to strengthen the sustainability of grain production in Canada could include:

- Highlight the increased use of nitrogen fertilizers produced from fossil fuel and pesticide use and the need to move from yield focus to net income (**R1, R2**), using sensitive and savvy communications (**R7**).
- Undertake study on fossil fuel-based subsidies to agriculture (**R1; R8**)
- Promoting requirements and follow up on acres being claimed for GHG or regenerative agriculture to prevent grassland conversion (**R2**)

- Assess impact of current efforts to address land conversion being undertaken and where further work is needed (**R2; R8**)
- Support initiatives that accelerate the adoption of regenerative, organic, agroecological and Indigenous practices and systems (**R3**) including local and regional supply chain collaborations (**R6**)
- Promote peer-to-peer learning programs and rebuilding of extension capacity for grain producers (**R5**)
- Support the development of open source, accessible and interoperable metrics to enable grain farmers to better understand the source of their emissions and enable outcome-based programs (**R5**)
- Bring together net exporting countries of certain grains (canola, soybean) to set sustainability standards, including with engagement of largest customers (**R6**)
- Support non-profit capacity (staff time, policy and communications training, networking) to advocate for expanded and improved cost-share and crop share programs (**R7**)

Conclusion

This report has assessed strategic opportunities for philanthropy to contribute to advancing more sustainable agricultural systems in Canada. After a brief review of the agri-food system in Canada, and discussion of a transition framework that can help us think about change in large scale systems of production and consumption, it presented **eight recommendations** for foundation activity organized under three broad themes. Taken together, and implemented over a decade or more, these activities could do much to advance movement to a more sustainable agrifood system in Canada.

A summary of our recommendations is presented in the table on the next page (Figure 1). This is followed by a graphic that show how these recommendations relate to the broader agri-food system (Figure 2).

We have also highlighted **four core priority opportunities** which foundations can take up right now to scale up their activities and deepen their engagement with this the agri-food sector. The justification for the choice of these four opportunities is discussed in the second half of Part A of this report (entitled ‘Strategic recommendations for philanthropy to contribute to advancing more sustainable agricultural systems in Canada’).

In thinking about these opportunities, we considered the areas where there is currently some *momentum*: where there is an openness to change and actors within the sector have begun to initiate reform. The political conjuncture matters here as does engagement by incumbents. We have also favoured areas where foundations have *advantages* compared to other funders. They can be systematic and strategic, flexible, and collaborative, and engage over the long term. We have also considered areas where foundations may have some *prior experience* with funding and convening, such as supporting civil society actors to constructively influence government policy. A *potential for early wins* is also desirable, all the while keeping in mind the need to build steadily towards longer term goals

The four core priority opportunities we have identified are:

- **Zooming in on net zero:** Take advantage of increased concern with climate change to advocate for increased action to reduce greenhouse gas emissions from agriculture, develop more sustainable agricultural practices, and broader discussion around the sustainability of the current agrifood system.
- **Amplifying the regenerative wave:** Build the movement to promote regenerative approaches and enhance the sustainability and resilience of agricultural systems.
- **Mobilizing grounded knowledge for sustainability:** Facilitate farmer peer-to-peer learning network and revitalize agricultural extension in order to scale up more sustainable farming practices.
- **Strengthening farm and civil society voices for sustainability and local and regional coalitions for change:** Empower farmer and civil society organizations to contribute to policy debate and formulation, and build local and regional alliances to accelerate change.

By sizing on these priorities and working with a wide range of partners from across the agri-food system and Canadian society more generally, we believe that foundations can play a very positive role in agrifood system transformation in the years ahead. We encourage foundations to act collaboratively, and to add finesse to the strategy adopted through collective learning.

Table 1: Summary of Recommendations

Note: Green highlighting in this table refer to the Priority Opportunities explained in the section below.

Theme 1

Highlight critical challenges to the environmental sustainability of the existing agri-food system in Canada, and advocate for action by government and industry to address these issues.

R1 : Intensify education and advocacy work around the greenhouse gas emissions associated with farming practices	
R2 : Engage on biodiversity issues, including :	(a) Threat of urban encroachment on prime agricultural land
	(b) Conversion of forests, wetlands, and grasslands to cropland
	(c) Human health and environmental impacts of pesticide use

Theme 2

Promote the adoption of more environmentally sustainable agricultural practices, technologies, and systems across Canada.

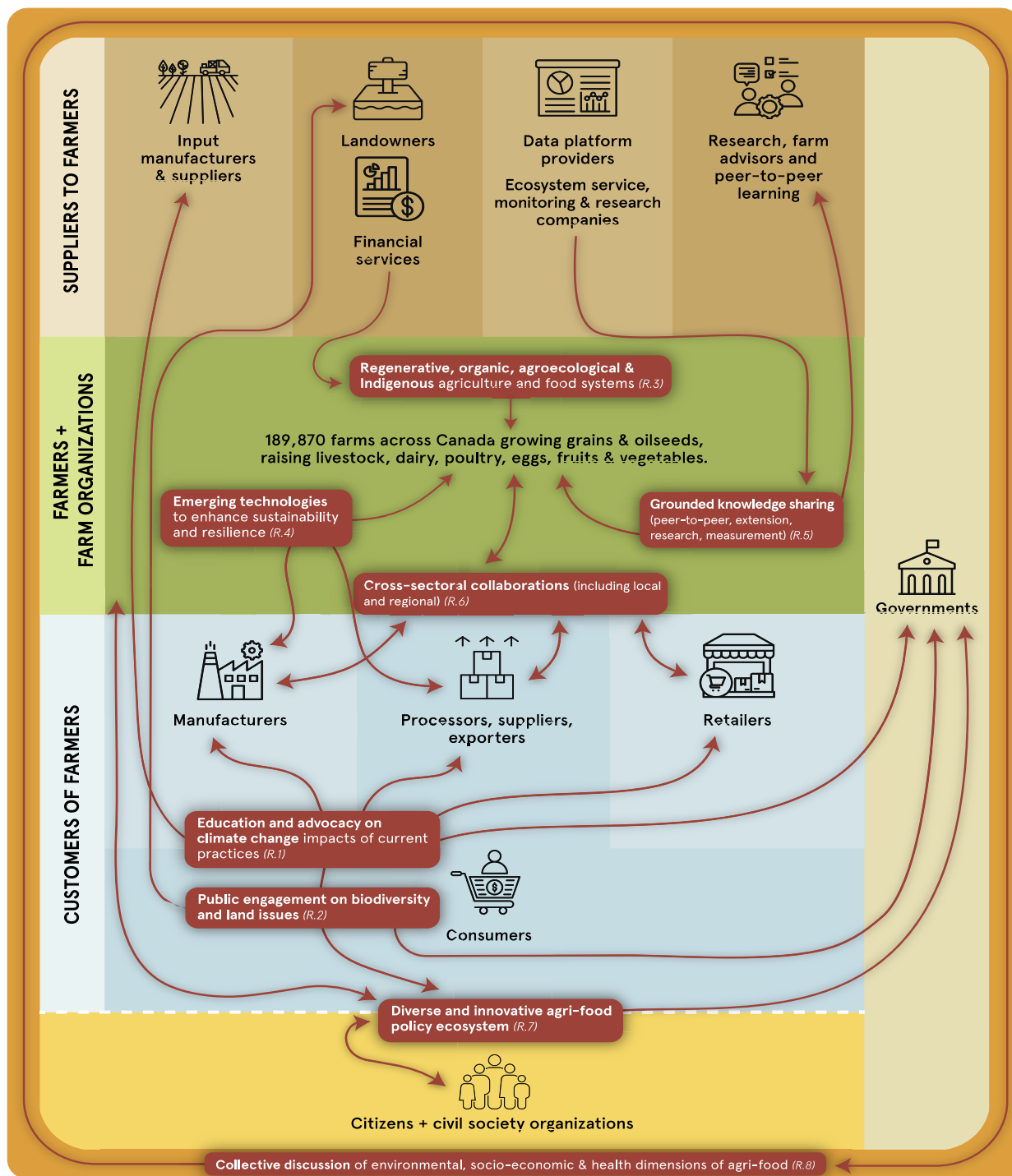
R3 : Support the development and scale up of sustainable agricultural practices and systems, including :	(a) Regenerative agriculture
	(b) Organic agriculture
	(c) Agroecological systems
	(d) Indigenous agriculture and food systems
R4 : Support emerging technologies with the potential to enhance the sustainability and resilience of agri-food systems (including through holistic technology assessments and life cycle analyses)	
R5 : Expand grounded knowledge sharing, by supporting :	(a) Peer-to-peer learning networks
	(b) Revitalized extension programs
	(c) Research
	(d) Measurement and monitoring initiatives
R6 : Encourage cross sectoral collaborations to advance more sustainable agri-food systems, particularly at the local and regional levels	

Theme 3

Build a more diverse and innovative agri-food policy ecosystem and a broader conversation about the future of agri-food

R7 : Expand policy and communications capacities of farmer and civil society organizations focused on the sustainability of agri-food systems and their ability to coordinate actions	
R8 : Support opportunities to deepen research that foregrounds the environmental sustainability of agriculture , and collective conversations about agriculture and agri-food systems in Canada	

Figure 2: Mapping of recommendations on Canada’s agri-food system



Endnotes

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- ²⁸ Dorith A. Vermunt et al., “Sustainability transitions in the agri-food sector: How ecology affects transition dynamics,” *Environmental Innovation and Societal Transitions* 36, (August 2020): 247, <https://doi.org/10.1016/j.eist.2020.06.003>.
- ²⁹ Hamid El Bilali, “The Multi-Level Perspective in Research on Sustainability Transitions in Agriculture and Food Systems: A Systematic Review” *Agriculture* 2019, 9(4), 74; <https://doi.org/10.3390/agriculture9040074>
- ³⁰ Kerry Stewart et al., “Changes in greenhouse gas emissions from food supply in the United Kingdom,” *Journal of Cleaner Production*, 410, (July 2023): 137273, <https://doi.org/10.1016/j.jclepro.2023.137273>.
- ³¹ The Ceres Investor Network brings together over 220 institutional investors managing more than \$60 trillion in assets.
- ³² Ceres’ Food Emissions 50 is an investor-led initiative to accelerate progress towards a net zero future in the food sector.
- ³³ Global network of over 350 investors in support of building a more transparent, resilient and sustainable global food system: faiir.org
- ³⁴ The term pesticides includes herbicides, insecticides, fungicides, soil fumigants, and chemical seed coatings.
- ³⁵ For example, the Canadian Alliance for Net Zero Agriculture is working to develop a low cost, scalable, and nationally relevant measurement reporting, verification system and create a carbon credit platform to help producers develop and monetize high quality carbon assets [Mohamad Yaghi, “Championing climate-smart agriculture: Building a road map for low emissions agriculture,” Royal Bank of Canada, May 5, 2023, <https://thoughtleadership.rbc.com/championing-climate-smart-agriculture-building-a-road-map-for-low-emissions-agriculture/>], and the National Farmers’ Union has produced a report on 18 Reasons Why Agricultural Soil Carbon Offsets are the Wrong Approach to the Climate Crisis, and What We Should Do Instead [National Farmers Union, “18 Reasons Why Agricultural Soil Carbon Offsets are the Wrong Approach to the Climate Crisis And What We Should Do Instead,” National Farmers Union, July 2023, 1-17, <https://www.nfu.ca/publications/reasons-why-offsets-wrong-approach/>].
- ³⁶ Science Based Targets, “Companies Taking Action,” accessed September 1, 2023, <https://sciencebasedtargets.org/companies-taking-action#dashboard>.
- ³⁷ Agriculture represents 10% of Canada’s total GHG emissions [Environment and Climate Change Canada, National Inventory Report 1990-2018: Greenhouse Gas Sources and Sinks in Canada, 2020]. Of these emissions, approximately 62% is from livestock production, primarily beef and dairy cattle [Zong Jia Chen, “Comparing Canada’s Agriculture with Other Developed Nations: Japan, the United Kingdom, and the United States,” 2022.].
- ³⁸ Between 1990 and 2019 the carbon footprint of Canadian milk decreased by 24%/litre. In the case of beef, carbon emissions reduced about 18-20%/Kg of beef over roughly the same period (McAllister, T. pers comm. December 2022).

The dairy figure comes from DFC. [“How We’re Reducing Emissions,” Dairy Farmers of Canada, accessed September 22, 2023, <https://dairyfarmersofcanada.ca/en/sustainability/emissions/>.]

³⁹ Canadian Cattle’s Association, “Canadian Beef Advisors – Industry Goals to 2030,” 2016, p3, https://cattle.ca/wp-content/uploads/2022/03/GHG_Goal_Fact_Sheet-Sept-3-1.pdf.

⁴⁰ Tim G. Benton et al., “Food system impacts on biodiversity loss Three levers for food system transformation in support of nature” Chatham House, February 2021, https://www.chathamhouse.org/sites/default/files/2021-02/2021-02-03-food-system-biodiversity-loss-benton-et-al_0.pdf.

⁴¹ David Tilman and David R. Williams, “Preserving global biodiversity requires rapid agricultural improvements” The Royal Society, accessed September 17, 2023, <https://royalsociety.org/topics-policy/projects/biodiversity/preserving-global-biodiversity-agricultural-improvements/>.

⁴² Nancy Hofmann, Giuseppe Filoso, Mike Schofield, and Statistics Canada, “The loss of dependable agricultural land in Canada,” *Rural and Small Town Canada Analysis Bulletin*, 6, no.1 (January 2005): <https://www150.statcan.gc.ca/n1/en/pub/21-006-x/21-006-x2005001-eng.pdf?st=U5dP5d6h> ; Alexandra Pope, “Mapping 40 years of Canadian urban expansion,” *Canadian Geographic*, March 23, 2006, <https://canadiangeographic.ca/articles/mapping-40-years-of-canadian-urban-expansion/>.

⁴³ Ontario Farmland Trust, “2021 Donor Impact Report,” Ontario: University of Guelph and Ontario Farmland Trust, 2021, <https://ontariofarmlandtrust.ca/wp-content/uploads/2022/09/2021-OFT-Donor-Impact-Report.pdf>.

⁴⁴ Ibid.

⁴⁵ Mark Pare, “Guelph-based farmland trust says protection needed,” *Guelph Today*, December 1, 2022, <https://www.guelphtoday.com/local-news/guelph-based-farmland-trust-says-protection-needed-6179755>.

⁴⁶ Équiterre, “Dossier: Agricultural rezoning in Quebec,” Équiterre, January 8, 2021, <https://www.equiterre.org/en/articles/news-dossier-agricultural-rezoning-in-quebec>.

⁴⁷ Justine Hunter, “Fifty years later, B.C.’s farms and cities reap the benefits from a scheme to spare land from development,” *The Globe and Mail*, April 28, 2023, <https://www.theglobeandmail.com/canada/british-columbia/article-fifty-years-later-bcs-farms-and-cities-reap-the-benefits-from-a-scheme/>.

⁴⁸ Prairie Commons, “The state of native prairie in Saskatchewan,” July 30, 2020, https://www.prairiecommons.ca/?page_id=300.

⁴⁹ Karen Briere, “Grassland loss called major environmental issue,” *The Western Producers*, May 12, 2022, <https://www.producer.com/news/grassland-loss-called-major-environmental-issue/>.

⁵⁰ Government of Canada, “What are the Clean Fuel Regulations?” last modified July 7, 2022, <https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/about.html>.

⁵¹ Sean Pratt, “Emerging canola processing at home will affect exports,” *The Western Producer*, June 1, 2023, <https://www.producer.com/markets/emerging-canola-processing-at-home-will-affect-exports/>.

⁵² Council of Canadian Academies, “4 Agriculture and Grasslands,” In *Nature-Based Climate Solutions*, (December 2022), 79. https://cca-reports.ca/wp-content/uploads/2022/12/Carbon-Sinks_EN_Final.pdf.

⁵³ Herbicides accounted for 77% of pesticide sales in agriculture in Canada in 2019, while GBHs accounted for 58% of pesticides used in the agriculture sector in Canada in 2017. PMRA. Pest Control Products Sales Report for 2019. Pest Management Regulatory Agency (PMRA), Health Canada; Ottawa, ON, Canada: 2021.

⁵⁴ See Clapp, 2021, “Explaining Growing Glyphosate Use: The Political Economy of Herbicide-Dependent Agriculture.” *Global Environmental Change* 67, no. January (2021): 102239. <https://doi.org/10.1016/j.gloenvcha.2021.102239>.

⁵⁵ David Suzuki Foundation, “Federal government signals its willingness to get serious on pesticides,” last modified June 20, 2023, <https://david Suzuki.org/press/federal-government-signals-its-willingness-to-get-serious-on-pesticides/#:~:text=Laura%20Bowman%2C%20Ecojustice%20lawyer%2C%20said,no%20pest%20or%20weed%20ou,tbreaks>.

⁵⁶ For example, in 2021, pesticide companies proposed an increase to the levels of glyphosate allowed on imported foods in Canada. Public outcry followed, and, in June 2023, the Canadian government announced that it would not immediately make a decision on that proposal.

⁵⁷ For example, recent reduction in tracking of pesticide use in the US: Virginia Gewin, “Move to change how U.S. tracks pesticide use sparks protest: Scientists oppose U.S. Geological Survey plan to reduce scope and frequency of chemical database,” *Science*, May 30, 2023, <https://www.science.org/content/article/move-change-how-u-s-tracks-pesticide-use-sparks-protests>.

⁵⁸ Laura Osman, “Pesticide regulation 'obsolete,' protects industry: Canadian scientific adviser's resignation,” *The Canadian Press*, July 18, 2023, <https://www.cp24.com/news/pesticide-regulation-obsolete-protects-industry-canadian-scientific-adviser-s-resignation-1.6483815>.

⁵⁹ Marie-Hélène Bacon, Louise Vandelac, Marc-André Gagnon, Lise Parent, “Poisoning Regulation, Research, Health, and the Environment: The Glyphosate-Based Herbicides Case in Canada,” *Toxics* 11 no. 2 (January 2023): 121, <https://doi.org/10.3390/toxics11020121>.

⁶⁰ Kenneth V. Rosenberg et al. “Decline of the North American avifauna.” *Science* 366, no. 6461 (September 2019): 120-124, DOI: 10.1126/science.aaw13.

⁶¹ Kayo Togawa et al., “Cancer incidence in agricultural workers: Findings from an international consortium of agricultural cohort studies (AGRICOH),” *Environment International* 157 (December 2021): 106825, <https://doi.org/10.1016/j.envint.2021.106825>.

⁶² Pauline Rebouillat et al., “Prospective association between dietary pesticide exposure profiles and type 2 diabetes risk in the NutriNet-Santé cohort,” *Environmental Health* 21, no. 57 (May 2022), <https://doi.org/10.1186/s12940-022-00862-y>.

⁶³ For example, an informal group of lawyers has played a major role in inciting government action to implement environmental laws protecting nature on agricultural land in the Netherlands. While the environmental damage from toxic agricultural chemicals is more extreme in the Netherlands than in Canada, given its small land mass and intensive livestock production, the example is instructive. See Ciara Nugent, “Farmer Protests in the Netherlands Show Just How Messy the Climate Transition Will Be,” *Time*, July 29, 2022. <https://time.com/6201951/dutch-farmers-protests-climate-action/>.

⁶⁴ Groupe Agéco, Équiterre, and Green Belt, “The Power of Soil: An Assessment of Best Approaches to Improving Agricultural Soil Health in Canada,” Metcalf Foundation, December 2020, <https://cms.equiterre.org/uploads/finalagecoreport.pdf>. ; Ronnie C. Drever et al., “Natural climate solutions for Canada.” *Applied Ecology* 7. (June 2021): eabd6034.

<https://www.natureunited.ca/content/dam/tnc/nature/en/documents/canada/natural-climate-solutions-for-canada-science-advances.pdf>. ; Council of Canadian Academies, “4 Agriculture and Grasslands,” In *Nature-Based Climate Solutions*, (December 2022), https://cca-reports.ca/wp-content/uploads/2021/03/Carbon-Sinks_EN_CH-4_Agriculture-Grasslands.pdf. ; Nature United, Viresco Solutions, “Beneficial Management Practices (BMPs) for Reducing Greenhouse Gas (GHG) Emissions in Prairie Agriculture,” (Nature United, February 2022), <https://www.natureunited.ca/content/dam/tnc/nature/en/documents/BMPs-for-Reducing-GHG-Emissions-in-Prairie-Agriculture.pdf>.

⁶⁵ Council of Canadian Academies, “4 Agriculture and Grasslands,” In *Nature-Based Climate Solutions*, (December 2022), https://cca-reports.ca/wp-content/uploads/2021/03/Carbon-Sinks_EN_CH-4_Agriculture-Grasslands.pdf.

⁶⁶ In the case of an expensive technology like biodigesters, it is notable that these can have the inadvertent effect of favoring larger farms unless they are developed through policies and programs that encourage collective use, hence the need for careful oversight about the technologies that are encouraged to facilitate the transition.

⁶⁷ Regenerative agricultural systems are defined variously, with some emphasizing specific practices, others principles, and others outcomes. For example, one regenerative agriculture advisor we spoke with defined regenerative agriculture in broad terms as an “innovative, integrated, intensive dynamic systems approach to agricultural production.” Part of this diversity reflects the ethos in the emerging regenerative agriculture community that what “regenerative” means on any specific farm is contextual. It is about the approach(es) that can work on that soil, and in that socio-economic environment.

⁶⁸ Loekie Schreefel et al., “Regenerative agriculture – the soil is the base,” *Global Food Security*, 26, (August 2020): 100404, <https://doi.org/10.1016/j.gfs.2020.100404>.

⁶⁹ Christopher J. Rhodes, “The Imperative for Regenerative Agriculture,” *Science Progress*, 100, no. 1, (March 2017): 80–12, <https://doi.org/10.3184/003685017X14876775256165>.

⁷⁰ Betsy Taylor et al., “Healthy Soils to Cool the Planet: A Philanthropic Action Guide,” Breakthrough Strategies and Solutions, February 2019, 9, <https://www.breakthroughstrategiesandsolutions.com/soilguide>.

⁷¹ Ronnie C. Drever et al, “Natural climate solutions for Canada,” *Science Advances*, 7 no. 23 (June 2021): eabd6034, DOI: 10.1126/sciadv.abd6034.

⁷² Insetting refers to actions taken by companies within their supply chains to reduce their ‘Scope 3’ emissions, both upstream and downstream from their direct activities.

⁷³ Regenerative Organic Alliance, “Farm like the world depends on it,” accessed September 22, 2023, <https://regenorganic.org>.

⁷⁴ It frames regenerative agriculture primarily in terms of outcomes rather than specific practices. For the BC government, RA seeks “continuous improvement of ecosystems...through improving soil health and the welfare of all species involved in the agricultural ecosystem, including farmers and ranchers, farm workers, livestock, and pollinators. Regenerative practices create healthy ecosystems that are self-renewing and resilient.” This definition is purposefully flexible and outcome focused, acknowledging that the agricultural practices employed will depend upon the needs of the soil and climate of the farmland in question and that the concept “continues to evolve” under the influence of multiple actors. [Minister’s Advisory Group on Regenerative Agriculture and Agritech, BC Agriculture Council Working Group on Regenerative Agriculture and Agritech, Indigenous Farmers and Food Sovereignty Champions, Government of British Columbia, “Can Help B.C. Achieve its Sustainable Agriculture Goals: Final Report and Recommendations,” Government of British Columbia, May 2023, 17, https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/regenerative-agriculture/regenerative_agriculture_and_agritech_can_help_bc_achieve_its_sustainable_agriculture_goals.pdf.]

⁷⁵ “Circular Regenerative Agriculture: Indicators and Performance Metrics,” Standards Council of Canada, accessed September 17, 2023, <https://www.scc.ca/en/standards/notices-of-intent/csa/circular-regenerative-agriculture-indicators-and-performance-metrics-0>.

⁷⁶ For example, Nature’s Path, McCain, Sollio and government or university experimental farms.

⁷⁷ FiBL & IFOAM. (2020). *The World of Organic Agriculture: Statistics and Emerging Trends 2020*.

⁷⁸ David W. Crowder and John P. Reganold, “Financial competitiveness of organic agriculture on a global scale,” 112, no. 24, (June 2015): 7611-7616, <https://doi.org/10.1073/pnas.1423674112>. ; Sean Pratt, “Demand booms for organics,” *The Western Producer*, September 23, 2021, <https://www.producer.com/news/demand-booms-for-organics/>.

⁷⁹ United States Department of Agriculture, “Economic Research Service: Overview,” retrieved January 30, 2023, <https://www.ers.usda.gov/topics/natural-resources-environment/organic-agriculture.aspx>. ; United States Department of Agriculture, “USDA to Invest up to \$300 million in New Organic Transition Initiative,” published August 22, 2022, <https://www.usda.gov/media/press-releases/2022/08/22/usda-invest-300-million-new-organic-transition-initiative>.

⁸⁰ European Commission, “Farm to Fork Strategy For a fair, healthy and environmentally-friendly food system,” 2021, https://food.ec.europa.eu/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf.

⁸¹ Agroecology Europe, “The 13 Principles of Agroecology,” accessed September 1, 2023, <https://www.agroecology-europe.org/the-13-principles-of-agroecology/>.

⁸² Marney E. Isaac et al., “Agroecology in Canada: Towards an Integration of Agroecological Practice, Movement, and Science,” *Sustainability* 10, no. 9, (2018): 3299. <https://doi.org/10.3390/su10093299>.

⁸³ Bryan Dale, Julia LaForge, and Charles Z. Levkoe. “Building an Agroecological Movement in Canada: Report from the 2018 Agroecology Field School and Research Summit,” (Ontario, Canada, 2019): 1-22, <https://fledgerezsearch.ca/wp-content/uploads/2021/07/AgroecFieldSchoolReport.pdf>.

⁸⁴ Julia Laforge et al., “The future of agroecology in Canada: Embracing the politics of food sovereignty,” *Journal of Rural Studies* 81 (January 2021): 194-202. <https://doi.org/10.1016/j.jrurstud.2020.10.025>. ; Julia Laforge, Vanessa Corkal and Aaron Cosbey, “Farming the Future: Agriculture and climate change on the Canadian Prairies,” Manitoba: International Institute for Sustainable Development, November 18, 2021, <https://www.iisd.org/publications/report/farming-future-agriculture-and-climate-change-canadian-prairies>.

⁸⁵ Promising exceptions include recent (2023) NSERC and SSHRC calls for research proposals focused on sustainable agriculture.

⁸⁶ In New Zealand, as a comparative example, an active effort to get farmers to “know your numbers” over the last ten years has been critical for moving forward the discussion of how the farm sector should mitigate its GHGs.

⁸⁷ Charles Z. Levkoe et al., “Civil society engagement in food systems governance in Canada Experiences, gaps, and possibilities,” *Journal of Agriculture, Food Systems, and Community Development* 12, no. 2 (February 2022): 267–286, <https://doi.org/10.5304/jafscd.2023.122.005>.

⁸⁸ Levkoe et al., “Civil society engagement in food systems governance in Canada Experiences, gaps, and possibilities.”

⁸⁹ Jill K. Clark et al. “The power to convene: making sense of the power of food movement organizations in governance processes in the Global North,” *Agriculture and Human Values*, 38 (February 2021): 175–191, <https://doi.org/10.1007/s10460-020-10146-1>.

⁹⁰ For example, research about Alberta farmers, *Just don’t call it climate change: climate-skeptic farmer adoption of climate-mitigative practices* Davidson concludes that climate change beliefs have no bearing on decisions by farmers to adopt new practices. The strongest reported motivations were instead expectations of economic benefits, soil quality improvement, and biodiversity protection. [Debra Davidson, “Just Don’t Call It Climate Change: Climate-Skeptic Farmer Adoption of Climate-Mitigative Practices,” *Environmental Research Letters*, 14, no. 3 (March 2019): 034015, <https://doi.org/10.1088/1748-9326/aafa30>.]

⁹¹ For example, [Farm and Food Care](#) and the [Canadian Centre for Food Integrity](#).

⁹² For example, RealAgriculture News Team, “RealAgriculture and Agri Studies launch RealAgristudies — giving today’s farmer a voice,” *realagriculture*, February 3, 2020, <https://www.realagriculture.com/2020/02/realagriculture-and-agri-studies-launch-realagrystudies-giving-todays-farmer-a-voice/>. ; Justin Funk, “Farm Vision 2020 Farmer Behaviour Research Study,” *LinkedIn*, January 28, 2021, https://www.linkedin.com/pulse/farm-vision-2020-farmer-behaviour-research-study-justin-funk/?trk=public_profile_article_view.

⁹³ Note that the Carasso Foundation in France and Spain is planning to undertake climate communications work about food and agriculture which may provide an opportunity to collaborate.

⁹⁴ Harish K. Jeswani, Andrew Chilvers, and Adisa Azapagic, “Environmental sustainability of biofuels: a review,” *Proceeding of the Royal Society Publishing* 476 no. 20200351 (October 2020): 20200351, <https://doi.org/10.1098/rspa.2020.0351>.

⁹⁵ See for example, on Canada’s largest farmland owner: Jason Kirby. “Farmland Inc,” *The Globe and Mail*, September 10, 2022, <https://www.theglobeandmail.com/business/article-farmland-ownership-canada-andjelic/> and Yasmine Ghania and Sam Samson, “Sask. farmers, researchers worry investor-bought land ‘empties out the countryside’,” CBC News, November 26, 2022, <https://www.cbc.ca/news/canada/saskatchewan/farmers-researchers-worry-investor-bought-land-1.6664976>.

⁹⁶ A few programs are looking to address this issue, albeit with limited resources. Quebec has a program that helps young farmers access land; Nova Scotia runs a farmland investment fund to support new farmers and various NGOs (e.g. Young Agrarians in BC, L’ARTERRE in Quebec) also have programs to encourage land matching between new farmers and those who own land. There are also several farmland investment funds in Canada that primarily purchase land and rent to producers, although most do not help farmers to acquire land in the long term. Area 1 Farms is an exception, aiming to expand farms while also supporting farmers to purchase the land when the fund exits; however, its growth model is based on converting forests or pasture to farmland and investing in tile drainage and irrigation projects.

⁹⁷ The National Farmers Union has a suite of recommendations on this issue, including that the federal government and provinces work together to develop a “unified set of land ownership restrictions wherein farmland can be owned only by individuals who reside in the province in which the land is located, or by incorporated farming operations (including co-operatives) owned by such individuals,” restrictions on land transfers to non-agricultural users, as well as differential taxation rates for farmers vs. land investors and corporations. [National Farmers Union, “Campaigns: Protecting farmland for today and tomorrow,” September 1, 2023, <https://www.nfu.ca/campaigns/farmland-ownership/>.]

⁹⁸ CAPI is an important voice in Canadian agri-food policy circles, but its board composition shows that it is one strongly rooted in industry and government experience and perspectives.

⁹⁹ Michelle St. Pierre, “VISTA on the Agri-food Industry and the Farm Community Changes in Canadians’ preferences for milk and dairy products,” Statistics Canada, released April 21, 2017, <https://www150.statcan.gc.ca/n1/pub/21-004-x/2017001/article/14786-eng.htm>. ; Mahsa Shahbandeh, “Consumption of milk per capita in Canada from 2015 to 2022 (in liters),” Statista, published Aug 17, 2023, <https://www.statista.com/statistics/438584/consumption-of-milk-per-capita-canada/#:~:text=The%20consumption%20of%20milk%20has,liters%20per%20capita%20since%202015.>

¹⁰⁰ Statistics Canada, “Cattle inventory on farms, Census of Agriculture, 2021,” published May 11, 2022, <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210037001>. ; “Cattle inventory on farms, Census of Agriculture, 2021,” Statistics Canada, released May 11, 2022, <https://doi.org/10.25318/3210037001-eng>.

¹⁰¹ “Cattle/Beef and Veal,” Agriculture and Agri-Food Canada, Government of Canada, last modified June 15, 2021, <https://agriculture.canada.ca/en/sector/animal-industry/red-meat-and-livestock-market-information/cattlebeef-and-veal>

¹⁰² This value combines the acreage for livestock and croplands on farms with beef cattle. It is important to note that feed may come from off farm sources and that not all cropland on these farms is necessarily used for feed. As such, this estimate is approximate.

¹⁰³ Canfax Research Services, “Canadian Beef Industry 2021 Census of Agriculture,” Canfax Research Services, July 15, 2022.

¹⁰⁴ Canfax Research Services, “Canadian Beef Industry 2021 Census of Agriculture.”

¹⁰⁵ R. L. Clearwater, T. Martin, and T. Hoppe, “Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series - Report #4” (Ottawa: Agriculture and Agri-Food Canada, 2016), https://publications.gc.ca/collections/collection_2016/aac-aafc/A22-201-2016-eng.pdf.

¹⁰⁶ This is also called backgrounding. Not all cattle make this intermediate stop. Some of these young cattle remain on cow-calf operations past the weaning stage and then go to the feedlot for finishing at a later date.

¹⁰⁷ Kiran Toor and Mahamat Hamit-Haggar, “Analysis of the Beef Supply Chain: Reports on Special Business Projects,” Statistics Canada, last modified November 10, 2021, <https://www150.statcan.gc.ca/n1/pub/18-001-x/18-001-x2021002-eng.htm>.

¹⁰⁸ In 2020, 12.5% of beef cattle farms reported direct sales to consumers, largely as a response to the COVID-19 pandemic. 2% of all beef cattle farms rely on direct marketing for 100% of farm revenues. [Canfax Research Services, “Canadian Beef Industry 2021 Census of Agriculture.”]

¹⁰⁹ Toor and Hamit-Haggar, “Analysis of the Beef Supply Chain: Reports on Special Business Projects.”

¹¹⁰ Canfax Research Services, “Canadian Beef Industry 2021 Census of Agriculture.”

¹¹¹ Toor and Hamit-Haggar, “Analysis of the Beef Supply Chain: Reports on Special Business Projects.”

¹¹² Protein availability is a proxy measurement for the amount consumed, but the actual amounts consumed are unknown since consumption patterns within the home are difficult to track.

¹¹³ Tyler Patrice, “From Slaughter to Supermarket: How Supply-Chains Inform Beef Prices,” (Ottawa: Statistics Canada, 2022), <https://www150.statcan.gc.ca/n1/pub/62f0014m/62f0014m2022010-eng.htm>.

¹¹⁴ Deborah H. Stinner, Benjamin R. Stinner, and Edward Martsof, “Biodiversity as an Organizing Principle in Agroecosystem Management: Case Studies of Holistic Resource Management Practitioners in the USA,” *Agriculture, Ecosystems & Environment* 62, no. 2–3 (April 1997): 199–213, [https://doi.org/10.1016/S0167-8809\(96\)01135-8](https://doi.org/10.1016/S0167-8809(96)01135-8).

¹¹⁵ Environment and Climate Change Canada, “National Inventory Report 1990-2018: Greenhouse Gas Sources and Sinks in Canada,” Government of Canada, 2020, https://publications.gc.ca/collections/collection_2020/eccc/En81-4-2018-1-eng.pdf

¹¹⁶ In general, manure management systems that are poorly aerated produce high methane, while nitrous oxide is more commonly the result of aerobic decomposition.

¹¹⁷ Environment and Climate Change Canada, “National inventory report : greenhouse gas sources and sinks in Canada,” (Ottawa : Environment Canada, c2006), publications.gc.ca/pub?id=9.506002&sl=0

¹¹⁹ Canfax Research Services, “Canadian Beef Industry 2021 Census of Agriculture.”

¹²⁰ Statistics Canada. (2023a, January 9). Canada’s 2021 Census of Agriculture: A story about the transformation of the agriculture industry and adaptiveness of Canadian farmers. <https://www150.statcan.gc.ca/n1/daily-quotidien/220511/dq220511a-eng.htm>

¹²¹ Statistics Canada. (2022, June 15). Canada’s 2021 Census of Agriculture: A closer look at farming across the regions. <https://www150.statcan.gc.ca/n1/daily-quotidien/220615/dq220615a-eng.htm>;

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Lentils.org. (2019, September 17). *Lentil production*. Lentils.org. <https://www.lentils.org/about-lentils/lentil-production/#:~:text=Canada%20is%20the%20world's%20leading,produces%2095%25%20of%20Canada's%20lentil>

¹²² StatsCan 2022 Ibid; StatsCan 2023 *Estimated areas, yield, production, average farm price and total farm value of principal field crops* <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210035901>

¹²³ Brewin, D., Nolan, J., Gray, R., Schmitz, T., & Schmitz, A. (2017). The Canadian Grain Handling Supply Chain in the Post Canadian Wheat Board Era.

¹²⁴ StatsCan 2023, Ibid.

¹²⁵ Brewin et al. 2017 Ibid; Grain Growers of Canada (2023, January 31). *Transportation*. Grain Growers of Canada. <https://graingrowersofcanada.ca/policy/transportation/>

¹²⁶ Laforge, J., Corkal, V., & Cosbey, A. (2021, November). *Farming the future: Agriculture and climate change on the Canadian prairies*. International Institute for Sustainable Development.

<https://www.iisd.org/publications/report/farming-future-agriculture-and-climate-change-canadian-prairies>

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<https://www.producer.com/news/raising-the-bar-on-nitrogen-efficiency/>; Darrin Qualman and the National Farmers Union, *Nitrogen Fertilizer: Critical Nutrient, Key Farm Input, and Major Environmental Problem* (Saskatoon: NFU, 2022)

¹²⁷ <https://www.anacan.org/feed-industry/public-resources/fundamentals-of-the-commercial-feed-industry/>

¹²⁸ Drever, C. R., Cook-Patton, S. C., Akhter, F., Badiou, P. H., Chmura, G. L., Davidson, S. J., Desjardins, R. L., Dyk, A., Fargione, J. E., Fellows, M., Filewod, B., Hessing-Lewis, M., Jayasundara, S., Keeton, W. S., Kroeger, T., Lark, T. J., Le, E., Leavitt, S. M., LeClerc, M.-E., ... Kurz, W. A. (2021). Natural climate solutions for Canada. *Science Advances*, 7(23). <https://doi.org/10.1126/sciadv.abd6034>; Pratt, S. (2023c, July 26). *It’s Crop Insurance Territory*. Western Producer.

<https://www.producer.com/crops/its-crop-insurance-territory/>

¹²⁹ Laforge et al. 2021 Ibid; Drever et al. 2021 Ibid.

¹³⁰ Government of Canada. (2023, April 14). Greenhouse gas sources and sinks in Canada: executive summary 2023. <https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/sources-sinks-executive-summary-2023.html#toc8>;

Jeswani, H. K., Chilvers, A., & Azapagic, A. (2020). Environmental Sustainability of Biofuels: A Review. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 476(2243). <https://doi.org/10.1098/rspa.2020.0351>

¹³¹ Sparling, B., Martin, L., & Bucknell, D. (2007). *The importance of fertilizer to biofuels in Canada: discussion paper*. George Morris Centre; Jeswani et al., 2020 Ibid). Three types of feedstock are **Conventional/first-generation biofuels** that are produced from food or animal feed crops and have very well-established technologies and processes, making them the largest contributor to the biofuel industry; **Second-generation biofuels** from non-food feedstocks like miscanthus, switchgrass, forest and agricultural residues including corn stover and straw and **Third-generation biofuels** that produce biodiesel from microalgae through the treatment of algal oil; still in the research and development stage and not yet economically viable, but they hold promise.

¹³² Jeswani et al., 2020; Sparling et al., 2007

¹³³ Pratt, 2023a.

¹³⁴ Pratt, S. (2023b, June 1). *Emerging Canola processing at home will affect exports*. Western Producer. <https://www.producer.com/markets/emerging-canola-processing-at-home-will-affect-exports/>

Canada had projected to yield about 8.8 million tonnes of canola oilseed between 2023-2024, and new expansions by Richardson International, Viterra, and Cargill are projected to increase refinement capacity by another 7.8 million tonnes along the same time horizon.

¹³⁵ Jeswani et al., 2020

¹³⁶ Jeswani et al., 2020

¹³⁷ Dang, Y. P., Dalal, R. C., & Menzies, N. W. (2020). No-till Farming Systems for Sustainable Agriculture Challenges and Opportunities (Y. P. Dang, R. C. Dalal, & N. W. Menzies, Eds.; 1st ed. 2020.). Springer International Publishing. <https://doi.org/10.1007/978-3-030-46409-7>; May, W. E., St. Luce, M., & Gan, Y. (2020). No-Till Farming Systems in the Canadian Prairies. In Y. P. Dang, R. C. Dalal, & N. W. Menzies (Eds.), *No-till farming systems for sustainable agriculture: Challenges and opportunities* (pp. 601–618). essay, Springer Nature.

¹³⁸ May et al., 2020 Ibid; Clearwater, R. L., Martin, T. & Hoppe, T. (2016). Environmental sustainability of Canadian agriculture (R. L. Clearwater, Ed.). Agriculture and Agri-Food Canada

¹³⁹ May et al., 2020 Ibid

¹⁴⁰ Dang et al., 2020 Ibid

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<https://doi.org/10.1016/j.agrformet.2006.03.026>

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<https://doi.org/10.1016/j.fcr.2019.03.020>

¹⁴³ Snyder, C., & Spaner, D. (2010). The sustainability of organic grain production on the Canadian prairies—a review. *Sustainability*, 2(4), 1016–1034. <https://doi.org/10.3390/su2041016>

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¹⁴⁵ Stats Can 2023: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210036901>,

¹⁴⁶ CAPI Callum Morrison report <https://capi-icpa.ca/wp-content/uploads/2021/06/2021-06-10-Callum-Morrison-Individual-Report-1-2.pdf>

¹⁴⁷ Stats Can 2023: <https://www.statcan.gc.ca/o1/en/plus/3107-winter-wheat-grain-grows-beneath-snow>.

¹⁴⁸ Heppner, K. (2023, March 21). *Consultations underway on “code 2.0” for Canadian crop sector*.

RealAgriculture.com. <https://www.realagriculture.com/2023/03/consultations-underway-on-code-2-0-for-canadian-crop-sector/>, <http://metrics.sustainablecrops.ca/>).

¹⁴⁹ Fertilizer Canada, 2023, <https://fertilizercanada.ca/wp-content/uploads/2021/09/Press-Release-MNP-Report-Final-1.pdf>, <https://leaderpost.com/opinion/white-paper-math-dubious-but-expected>)

¹⁵⁰ Compared to Canada, the [EU and US invest over ten times more per acre](#) in climate programming in agriculture. Arounb, Youssef. 2023.

<https://thoughtleadership.rbc.com/fertile-ground-how-soil-carbon-can-be-a-cash-crop-for-the-climate-age/>

C. Appendix 1: List of interviewees, focus group participants and strategy workshop participants

We are grateful to the following individuals for sharing their time, knowledge, and perspectives through interviews, focus groups and/or the strategy workshop. Note that affiliations are listed are from the time of participation in interviews, focus groups or the workshop, and may have subsequently changed. The contents of this report (including potential errors and omissions) are the exclusive responsibility of the authors, and participants were not asked to endorse its conclusions or recommendations.

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Betsy Taylor, Breakthrough Strategies and Solutions
Bob Lowe, Canadian Cattlemen's Association
Brent Preston, Farmers for Climate Solutions
Brian Innes, Soy Canada
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Jennifer Cote, Opalia
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Jim Thomas, ETC Group
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Karen Ross, Farmers for Climate Solutions
Kat Lorimer, Smart Prosperity Institute
Kevin Boon, BC Cattleman's Association
Kim Ominski, University of Manitoba
Kim Ong, Vereo Advisors
Kimberly Cornish, Food, Water, Wellness Foundation
Korb Whale, dairy farmer
Kris Nichols, MyLand Company
Kristine Tapley, cow-calf producer, Ducks Unlimited Canada

Laura Bowman, EcoJustice
Laura Telford, Manitoba Agriculture
Lauren Baker, Global Alliance for the Future of Food
Lejgy Gafour, CULT Food Science
Lenore Newman,
Lenore Newman, University of the Fraser Valley
Liesel Carlsson, Acadia University
Lorne Johnson, Ivey Foundation
Marie-Eve Levert, Transition Accelerator
Martin Entz, University of Manitoba
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Stacy Cushenbery, Oatley
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