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Canadian Agriculture: The Challenge of Achieving Authentic Sustainability

Initial input into Agriculture and Agri-Food Canada's Sustainable Agriculture Strategy consultation process

From the National Farmers Union

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The NFU has benefited from the rich resource of publicly funded science from Canadian and international researchers published in peer-reviewed journals.

Canada's NFU is a direct-membership national organization. Founded in 1969, and with roots going back more than a century, the NFU represents thousands of Canadian farm families, farm units, and farm workers from coast to coast, and also enjoys the support of many non-farmer Associate Members. The NFU embodies the principle that all farmers share common problems and that all farmers must come together, and work with non-farmer allies, in order to address those problems. Our organization believes that agriculture should be economically, socially, and environmentally sustainable. Food production should lead to enriched soils, clean water, a more beautiful countryside, adequate and stable farm incomes, livelihoods for non-farmers, thriving rural communities, healthy natural ecosystems, and Canadian tables arrayed with diverse, delicious, nutritious foods.

The NFU's governance structures are democratic, participatory, and progressive. A farm unit membership gives equal participation rights to all family members over the age of 14. The NFU has leadership positions for youth, women, men, and BIPOC (black, indigenous, and people of colour) representatives. It was the first major farm organization in Canada to elect a woman as President and the first to establish the position of BIPOC President.

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Preface

On December 12, 2022, the Honourable Marie-Claude Bibeau, federal Minister of Agriculture and Agri-Food, announced the beginning of a process to create a Sustainable Agriculture Strategy (SAS).[1] Agriculture and Agri-Food Canada (AAFC) states that the "25 year Sustainable Agriculture Strategy" will "serve as a guide to support the livelihoods of farmers while growing a sustainable sector."

As part of that December 2022 announcement, AAFC published a 29-page *Sustainable Agriculture Strategy Discussion Document*.[2] That Document explains the need for the Strategy: "To provide an integrated and coordinated approach to improving the agriculture sector's environmental performance and supporting its long-term vitality." The Document proposes the following goals for the SAS:

1. *The agriculture sector is resilient to short and long-term climate impacts while growing productive capacity, and has adapted to changing contexts due to climate change.*
2. *Environmental performance is improved in Canada's agriculture sector, contributing to the environmental, economic, and social benefit of all Canadians.*
3. *The agriculture sector plays an important role in contributing to Canada's national 2030 GHG emission reduction and net-zero by 2050 targets while remaining competitive and supporting farmers.*
4. *A more comprehensive and integrated approach is taken in addressing agri-environmental issues in the agriculture sector....*
5. *Canada has addressed data gaps and improved capacity to measure, report on, and track the environmental performance of the agriculture and agri-food sector.*

As part of the process of crafting its SAS, AAFC initiated a consultation process that closes March 31st, 2023. The report you have in-hand is the NFU's initial written contribution to AAFC's SAS consultation.

This report has three parts: First, it looks briefly at macro-trends within global human economic systems as a way of understanding the context for analyses of sustainability; next, it focuses in on Canadian agriculture and details the challenge of achieving durable, authentic sustainability in that sector; finally, it includes an Appendix that is structured according to AAFC's SAS questionnaire and provides the NFU's answers to those questions.

The thousands of farmers and farm families that make up the NFU congratulate AAFC for catalyzing this important process and look forward to working with all involved to measure up to the magnitude of this historic challenge. Nothing is more important than succeeding in restoring our food system, and all other human systems, to sustainable alignment within planetary boundaries and biospheric limits. This must be the ultimate goal of the Sustainable Agriculture Strategy process.

1 Agriculture and Agri-Food Canada, "Government Launches Consultations for a Sustainable Agriculture Strategy," news releases, December 12, 2022, https://www.canada.ca/en/agriculture-agri-food/news/2022/12/government-launches-consultations-for-a-sustainable-agriculture-strategy.html.

2 Agriculture and Agri-Food Canada, "Sustainable Agriculture Strategy: Discussion Document" (Ottawa: AAFC, December 12, 2022), https://agriculture.canada.ca/en/about-our-department/transparency-and-corporate-reporting/public-opinion-research-and-consultations/sustainable-agriculture-strategy-discussion-paper.

1. Human systems are unsustainable and in collision with planetary limits

Canadian agriculture exists within a context of the larger economy and an increasingly interlinked and powerful global civilization. Similarly, the concept of sustainability exists within a context of human energy and material flows, biospheric cycles and processes, and cultures and histories. Before turning our attention directly to Canadian agriculture, it is important to take a few pages to examine those framing contexts of agriculture and sustainability. Thus, we begin with the big picture in order to better understand what "sustainable agriculture" truly requires. Here is a wide-angle look at what humans are doing.

Doubling and redoubling the size and pace of human systems

We have normalized something profoundly abnormal: the explosive exponential growth of nearly every attribute of human societies and economies. Nearly all metrics—human populations, economic flows, energy and material flows, consumer spending, automobile numbers, aggregate air travel distances, microchip production, plastic tonnage, etc.—are doubling and redoubling on timescales ranging from 20 to 50 years. Figure 1 shows the relentless redoubling—the exponential growth—of the global economy, energy use, and GHG emissions. The graph covers the past 2,020 years.

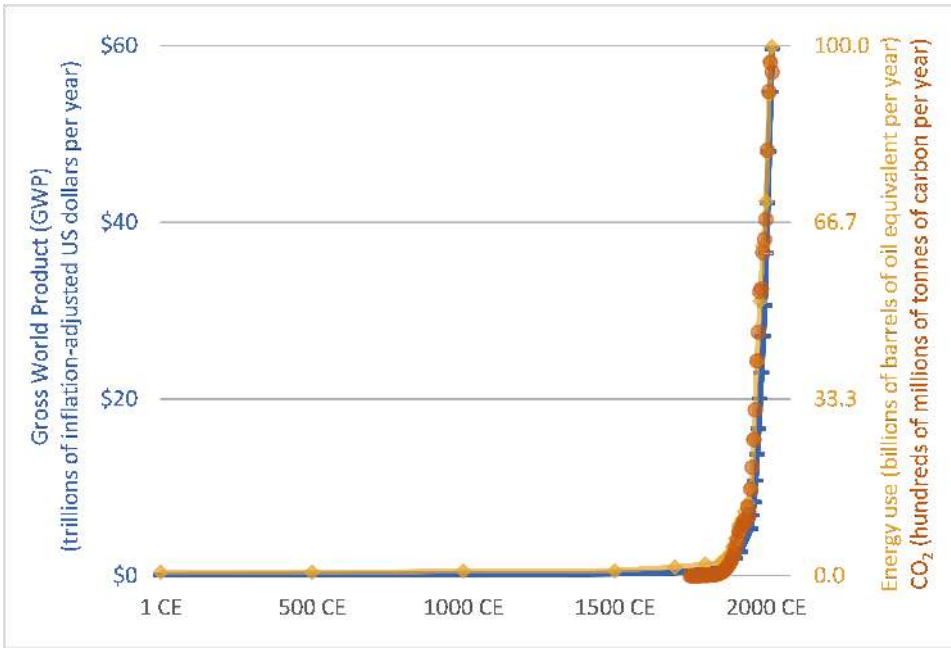

Figure 1. The magnitudes of the global economy, energy use, and GHG emissions, 1 CE – 2020 CE.
Sources: Vaclav Smil, Angus Maddison, British Petroleum, World Bank, US Department of Energy, etc.[3]

Adjusted for inflation, the global economy grew more than sixteenfold during the 20th century. That is to say, it doubled in size four times: 2, 4, 8, 16. Its average doubling time was 25 years and its average

3 Energy: Vaclav Smil, *Energy in Nature and Society: General Energetics of Complex Systems* (Cambridge, MA: MIT Press, 2008); British Petroleum, *BP Statistical Review of World Energy 2022*, 71st ed. (London: BP, 2022); British Petroleum, *BP Statistical Review of World Energy*, various years; pre-1500 energy levels are estimates based on data in Smil and on population numbers; Gross World Product: Angus Maddison, *The World Economy, Volume 1: A Millennial Perspective* (Paris: OECD, 2001); Angus Maddison, *Contours of the World Economy, 1–2030 AD: Essays in Macro-Economic History* (Oxford: Oxford University Press, 2007); World Bank, World Databank, http://databank.worldbank.org/data/reports.aspx?source=2&series=NY.GDP.MKTP.KD&country=WLD#; Emissions: T. Boden, G. Marland, & R. Andres, "Global, Regional, and National Fossil-Fuel CO_2 Emissions," Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge Laboratory, US DOE, 2010, https://cdiac.ess-dive.lbl.gov/ftp/ndp030/global.1751_2010.ems.

annual rate of growth was 2.8 percent—a growth rate we continue to encourage today; one seen as normal and desirable in most economies. Seldom raised are the obvious questions: can we maintain such growth rates and, thus, can we double the size of the current global economy and its impacts on the natural environment? ...and then double it again? ...and again? ...and again? This century, is an eight- or sixteenfold increase in the size of the global economy *sustainable*?

As the global economy grows, energy use increases. Figure 1 shows the tight correlation—indeed, the reciprocal *causation*—between energy use and the size of the economy. A continuing commitment to redoubling the size of the global economy (i.e., a commitment to "normal" levels of economic growth) entails a continuing commitment to redoubling energy production and use.

It is not just energy use that will continue upward if our economies continue doubling in size; material use, too, must increase apace. The economy is not merely dollar tokens: it is made of *materials*: steel, aluminum, lithium, gold, glass, plastic, concrete, gravel, wood, grain, coal, oil, etc. Despite vague talk of "efficiency" and "decoupling," global material use tonnage (water excluded) is doubling every 30 years[4]—it increased more than eightfold during the 20th century. Our economy is now using nearly 100 billion tonnes of material per year—about a trillion tonnes per decade. Many of our environmental problems are caused by the waste-product outflows from those trillions of tonnes of material inflows.

Nearly every metric of our global economy is doubling on timescales of 20 to 50 years—two to five doublings per century (increases ranging from fourfold to thirty-two-fold). Here is a selected overview:

- Plastic tonnage is doubling approximately every 20 years.[5]
- Global automobile manufacturing doubled twice between 1967 and 2017[6]—a fourfold increase and a doubling time of 25 years. COVID intervened, but that downturn may soon be reversed.
- Global air travel utilization ("revenue passenger kilometres") increased eightyfold between 1960 and 2019—just over six doublings, and a doubling time of 9 years.[7]
- Global freight movement (tonne-kilometres) is doubling approximately every 25 years.[8]
- The average size of a newly constructed house in Canada has doubled since the 1960s (from about 1,000 square feet to about 2,000[9]) and in the US nearly tripled since the 1950s.[10]

4 Christian Lutz and Stefan Giljum, "Global Resource Use in a Business-as-Usual World: Updated Results from the GINFORS Model," in *Sustainable Growth and Resource Productivity: Economic and Global Policy Issues* (Sheffield, UK: Greenleaf Publishing, 2009); Fridolin Krausmann et al., "Growth in Global Materials Use, GDP, and Population during the 20th Century," *Ecological Economics* 68, no. 10 (2009); Fridolin Krausmann et al., "Long-Term Trends in Global Material and Energy Use," in *Social Ecology: Society-Nature Relations across Time and Space* (Springer, 2016); UN Environment Programme and Stefan Bringezu et al., *Assessing Global Resource Use: A Systems Approach to Resource Efficiency and Pollution Reduction* (Nairobi: UNEP, 2017); Organization for Economic Cooperation and Development, *Global Material Resources Outlook to 2060: Economic Drivers and Environmental Consequences*, (Paris: OECD Publishing, 2019).

5 Roland Geyer, Jenna Jambeck, and Kara Lavender Law, "Production, Use, and Fate of All Plastics Ever Made," *Science Advances* 3, no. 7 (July 19, 2017); Organisation for Economic Co-operation and Development, *Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options* (Paris: OECD, 2022), https://doi.org/10.1787/de747aef-en.

6 Motor Vehicle Manufacturers Association of the United States, *World Motor Vehicle Data*, 1981 Edition; Ward's Communications, *Ward's World Motor Vehicle Data 2002*; United States Department of Transportation, Bureau of Transportation Statistics, "National Transportation Statistics," Table 1-23; International Organization of Motor Vehicle Manufacturers (OICA), "Production Statistics." See https://www.darrinqualman.com/global-automobile-production/ .

7 Airlines for America, "World Airlines Traffic and Capacity," Traffic and Operations: 1929-Present, accessed January 22, 2023, https://www.airlines.org/dataset/world-airlines-traffic-and-capacity/.

8 Darrin Qualman, "Fraught Freight: Trade Agreements, Globalization, and Rising Global Freight Transport," *Darrin Qualman* (blog), March 14, 2017, https://www.darrinqualman.com/global-freight-transport/.

9 Preet Banerjee, "Our Love Affair with Home Ownership Might Be Doomed," *The Globe and Mail*, January 18, 2012, https://www.theglobeandmail.com/real-estate/mortgages-and-rates/our-love-affair-with-home-ownership-might-be-doomed/article4179012/.

10 Evan Comen, "The Size of a Home the Year You Were Born," 24/7 Wall St, n.d., https://247wallst.com/special-report/2019/04/05/the-size-of-a-home-the-year-you-were-born-5/.

One could go on listing doubling times, e.g., for freshwater use, forest cutting, cellphone or refrigerator manufacturing, internet traffic, etc. It is now wholly normal for everything to double. And it is normal to look at this doubling and redoubling and pretend that, with a few tweaks and a bit of "innovation," it can be made sustainable. That is not rational thinking. Almost all human systems are now massively unsustainable, even before the next planned doubling. ...or the next.

As human systems expand, natural systems are damaged and displaced

As human systems redouble in size, speed, resource consumption, and waste output, they damage the biosphere. Here is a whirlwind tour of some of the impacts, depletion, and extinctions:

- Earth will warm several degrees this century (2 to 4° C, or more).[11] Northerly latitudes and continental interiors (i.e., most of Canada) will continue to warm at twice the global rate.
- Half the planet's glaciers (excluding the Antarctic and Greenland ice sheets) will disappear this century[12] with consequent impacts on river flows, river ecosystems, and water supplies.
- We have blocked and fragmented Earth's rivers with 57,000 large dams,[13] and to facilitate shipping, we have channelized 500,000 kms of rivers.[14]
- Human appropriation of net primary productivity (HANPP) (i.e., the portion of green-plant photosynthesis biomass captured by humans) has reached 25 percent.[15] Until recent centuries, it is unlikely that any one of the Earth's millions of animal species captured even 1 percent of global NPP. Our outsized capture of plant productivity is both a reflection of our spread across Earth's land area and a driver of the extinction pulse now underway.
- Humans removed much of the native flora and fauna from North America and replaced those with Eurasian species, e.g., our ancestors slaughtered 99.99% of North American bison.[16]
- Wild animal numbers are falling rapidly. A 2022 report that synthesized data on 32,000 populations of 5,320 species found that those populations had declined by an average of 69 percent between 1970 and 2018.[17]

11 United Nations Environment Programme, "Emissions Gap Report 2022" (Nairobi: UNEP, 2022); James Hansen et al., "Global Warming in the Pipeline," *Pre-Print ArXiv*, December 12, 2022; Kevin Anderson, John Broderick, and Isak Stoddard, "A Factor of Two: How the Mitigation Plans of 'Climate Progressive' Nations Fall Far Short of Paris-Compliant Pathways," *Climate Policy* 20, no. 10 (2020); Jeff Tollefson, "How Hot Will Earth Get by 2100?," *Nature* 580, no. 7804 (April 22, 2020); Adrian Raftery et al., "Less than 2 °C Warming by 2100 Unlikely," *Nature Climate Change* 7, no. 9 (September 2017).

12 David Rounce et al., "Global Glacier Change in the 21st Century: Every Increase in Temperature Matters," *Science* 379, no. 6627 (January 6, 2023): Fig. 1.

13 The International Commission on Large Dams (ICOLD), "Number of Dams by Country Members," n.d., https://www.icold-cigb.org/article/GB/world_register/general_synthesis/number-of-dams-by-country-members.

14 Mark L'Vonich and Gilbert White, "Use and Transformation of Terrestrial Water Systems," in *The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere over the Past 300 Years*, ed. B.L. Turner (Cambridge and New York: Cambridge University Press, 1990).

15 Helmut Haberl, Karl-Heinz Erb, and Fridolin Krausmann, "Human Appropriation of Net Primary Production: Patterns, Trends, and Planetary Boundaries," *Annual Review of Environment and Resources* 39, no. 1 (2014); Fridolin Krausmann et al., "Global Human Appropriation of Net Primary Production Doubled in the 20th Century," *Proceedings of the National Academy of Sciences of the United States of America* 110, no. 25 (2013); Helmut Haberl et al., "Quantifying and Mapping the Human Appropriation of Net Primary Production in Earth's Terrestrial Ecosystems," *Proceedings of the National Academy of Sciences of the United States of America* 104, no. 31 (2007); Peter Vitousek et al., "Human Appropriation of the Products of Photosynthesis," *BioScience* 36, no. 6 (1986).

16 Andrew Isenberg, *The Destruction of the Bison: An Environmental History, 1750–1920* (Cambridge: Cambridge University Press, 2000); Geoff Cunfer and Bill Waiser, eds., *Bison and People on the North American Great Plains: A Deep Environmental History* (College Station, TX: Texas A&M University Press, 2016).

17 Worldwide Fund for Nature, "Living Planet Report 2022: Building a Nature Positive Society" (Gland, Switzerland: WWF, 2022).

- Insect biomass is being reduced by 1 to 2 percent per year[18]—an "insect apocalypse"[19] caused by plant biodiversity loss, climate change, and the annual application of a half-million tonnes of insecticides.[20]

- Bird numbers in North America fell 29 percent (a loss of 3 billion birds) over the past 50 years, with grassland species declining the most.[21] A comparable decline was documented in Europe: 17 to 19 percent over 40 years.[22] Declines are related to habitat loss and insecticide use.

- In the oceans, human predation has cut whale numbers by 60 to 80 percent;[23] destroyed the world's greatest fishery: the Atlantic cod;[24] reduced Atlantic salmon stocks by 50 to 90 percent[25] and Pacific salmon by a lesser but still significant percentage; and reduced the biomass of large fish (i.e., the fish humans prefer to eat) by two-thirds over the past century[26] (e.g., Bluefin tuna numbers are down more than 90 percent[27]).

- Coral reefs will be nearly eliminated this century—cut by as much as 90%[28]—largely as a result of fossil fuel combustion which is raising the temperature and acidity of the oceans. Reef ecosystems provide habitat for over a million species.[29]

- Ocean dead zones (low-oxygen areas caused largely by fertilizer run-off) are doubling in number and area every 10 to 20 years.[30]

- Rainforests are being rapidly destroyed. It may be that already one-third of original tropical rainforest area is gone and another third is degraded.[31] But even if such assessments

18 David Wagner et al., "Insect Decline in the Anthropocene: Death by a Thousand Cuts," *Proceedings of the National Academy of Sciences* 118, no. 2 (2021); David Wagner, "Insect Declines in the Anthropocene," *Annual Review of Entomology* 65 (2020); Francisco Sánchez-Bayo and Kris Wyckhuys, "Worldwide Decline of the Entomofauna: A Review of Its Drivers," *Biological Conservation* 232 (April 1, 2019).

19 Brooke Jarvis, "The Insect Apocalypse Is Here," *The New York Times*, November 27, 2018.

20 Food and Agriculture Organization of the United Nations, "FAOSTAT: Pesticides Use," n.d., https://www.fao.org/faostat/en/#data/RP.

21 Kenneth Rosenberg et al., "Decline of the North American Avifauna," *Science* 366, no. 6461 (October 4, 2019).

22 Fiona Burns et al., "Abundance Decline in the Avifauna of the European Union Reveals Cross-Continental Similarities in Biodiversity Change," *Ecology and Evolution* 11, no. 23 (2021).

23 Line Bang Christensen, "Marine Mammal Populations: Reconstructing Historical Abundances at the Global Scale" (Vancouver: Fisheries Centre, University of British Columbia, 2006); Robert Rocha, Jr., Phillip Clapham, and Yulia Ivashchenko, "Emptying the Oceans: A Summary of Industrial Whaling Catches in the 20th Century," *Marine Fisheries Review* 76, no. 4 (March 3, 2015).

24 Michael Harris, *Lament for an Ocean: The Collapse of the Atlantic Cod Fishery* (Toronto: McClelland & Stewart, 2013); Dean Bavington, *Managed Annihilation: An Unnatural History of the Newfoundland Cod Collapse* (Vancouver: UBC Press, 2010); Mark Kurlansky, *Cod: A Biography of the Fish That Changed the World* (London: Jonathon Cape, 1997).

25 Michael Dadswell et al., "The Decline and Impending Collapse of the Atlantic Salmon (Salmo Salar) Population in the North Atlantic Ocean: A Review of Possible Causes," *Reviews in Fisheries Science & Aquaculture* 30, no. 2 (April 3, 2022); North Atlantic Salmon Conservation Organization, "State of North Atlantic Salmon" (Edinburgh: NASCO, 2019), https://nasco.int/wp-content/uploads/2020/05/SoS-final-online.pdf; Atlantic Salmon Federation, "2020 State of Wild Atlantic Salmon Report" (St. Andrews, NB: ASF, 2020), https://www.asf.ca/assets/files/asf-2020-state-of-population-v2.pdf.

26 Villy Christensen et al., "A Century of Fish Biomass Decline in the Ocean," *Marine Ecology Progress Series* 512 (October 9, 2014); Boris Worm et al., "Impacts of Biodiversity Loss on Ocean Ecosystem Services," *Science* 314, no. 5800 (November 3, 2006).

27 The Pew Charitable Trusts, "Pacific Bluefin Tuna Stock Remains Highly Depleted, New Science Shows," accessed January 19, 2023, https://pew.org/2s4LhJd; International Seafood Sustainability Foundation, "Status of the World Fisheries for Tuna: November 2022," ISSF Technical Report 2022-15 (Pittsburgh: ISSF, 2022).

28 Katja Frieler et al., "Limiting Global Warming to 2 °C Is Unlikely to Save Most Coral Reefs," *Nature Climate Change* 3, no. 2 (February 2013).

29 Frieler et al., "Limiting Global Warming to 2 °C Is Unlikely to Save Most Coral Reefs."

30 Robert Diaz, Rutger Rosenberg, and Kersey Sturdivant, "Hypoxia in Estuaries and Semi-Enclosed Seas," in *Ocean Deoxygenation: Everyone's Problem*, ed. D. Laffoley and J.M. Baxter (Gland, Switzerland: IUCN, 2019), 20; Robert Diaz and Rutger Rosenberg, "Spreading Dead Zones and Consequences for Marine Ecosystems," *Science* 321, no. 5891 (2008); Andrew Altieri and Robert Diaz, "Dead Zones: Oxygen Depletion in Coastal Ecosystems (Ch. 24)," in *World Seas: An Environmental Evaluation*, ed. Charles Sheppard, Second Edition (Academic Press, 2019).

31 Rainforest Foundation Norway, "State of the Tropical Rainforest: The Complete Overview of the Tropical Rainforest, Past and Present." (Oslo: Rainforest Foundation Norway, 2020), https://d5i6is0eze552.cloudfront.net/documents/Publikasjoner/Andre-rapporter/RF_StateOfTheRainforest_2020.pdf?mtime=20210505115205.

overestimate the damage, current rates of loss—about 10 million acres per year[32]—will soon make those pessimistic assessments a reality.

- Poaching, habitat annexation, and other human impacts are slashing the number of African "big game" animals: the tigers, elephants, rhinos, gorillas, etc. of our childhood picture-books. For example, African elephant numbers are down roughly 90 percent—from several million a century ago[33] to about half a million today. Poachers and land appropriators are doing to elephants in the 20th and 21st centuries what North Americans did to bison in the 18th and 19th.
- Global wetland area has been reduced by 87 percent over the past three centuries[34] with drainage continuing to proceed rapidly in Canada and around the world.

The preceding is merely a selection from a vast catalogue of ecosystem impacts, losses, and damage. A full listing would continue for many pages. As we remove animal population after population, species after species, ecosystem after ecosystem, we are, in effect, playing biospheric Jenga®.

Atop these potentially future-curdling environmental impacts and extinctions come other dimensions of the intensifying global polycrisis: pandemics; resource depletion; rising nationalism and negative forms of populism; racism and xenophobia; disinformation; growing inequality; the failure to deliver on the "development" agenda for much of the world; increasing supply chain complexity and distance; and, as noted above, the impossibility of continuing the exponential economic growth rates that businesses, governments, investors, and markets have come to rely upon. As we move deeper into the polycrisis, we will be forced to critically examine our outdated notions of sustainability. It will become harder and harder to sustain basic human systems and supports. Indeed, our default assumption must be that adaptation, resilience, and the continuation of complex human systems is now very much an open question—one for which there are no ready answers or easy "solutions"; a predicament that may only be eased by massive transformation, revised goals and aspirations, and near-wartime levels of action.

It is no surprise if citizens, public servants, and elected officials are inadequately aware of the unsustainability of human systems. Leading scientists studying these issues note that "the scale of the threats to the biosphere and all its lifeforms—including humanity—is in fact so great that it is difficult to grasp for even well-informed experts." They go on to note "the lack of appreciation of the enormous challenges to creating a sustainable future" and underscore that "*without fully appreciating and broadcasting the scale of the problems and the enormity of the solutions required, society will fail to achieve even modest sustainability goals*" [italics added].[35]

Human social and economic systems are already colliding with planetary limits, and continuing to expand and accelerate the global human enterprise will make these collisions increasingly violent. We have massively damaged and depleted the Earth systems upon which we depend and which have supported and enriched our societies for hundreds of generations. And we continue to inflict damage at an *increasing* rate. *This* is the context and the "common understanding" that must form the foundation of all efforts to move toward authentic sustainability. **Key is to understand we are very, very far from sustainability, and that we are currently moving away from it, not toward it**.

32 United Nations Food And Agriculture Organization, "FRA 2020 Remote Sensing Survey" (Rome: FAO, May 1, 2022), https://doi.org/10.4060/cb9970en; Mikaela Weisse and Elizabeth Dow Goldman, "The World Lost a Belgium-Sized Area of Primary Rainforests Last Year," April 25, 2019, https://www.wri.org/insights/world-lost-belgium-sized-area-primary-rainforests-last-year.

33 World Wildlife Fund, "The Status of African Elephants," *World Wildlife Magazine*, Winter 2018, https://www.worldwildlife.org/magazine/issues/winter-2018/articles/the-status-of-african-elephants; E.J. Milner-Gulland and J.R. Beddington, "The Exploitation of Elephants for the Ivory Trade: An Historical Perspective," *Proceedings of the Royal Society of London. Series B: Biological Sciences* 252, no. 1333 (April 22, 1993).

34 Nick Davidson, "How Much Wetland Has the World Lost? Long-Term and Recent Trends in Global Wetland Area," *Marine and Freshwater Research* 65, no. 10 (2014).

35 Corey Bradshaw et al., "Underestimating the Challenges of Avoiding a Ghastly Future," *Frontiers in Conservation Science* 1 (2021).

2. Agriculture, like other human systems, may be similarly unsustainable

Now let us turn from the larger context of global human economic and production systems to focus in on Canadian agriculture. In light of the preceding chapter, we should consider the idea that human food systems—core parts of the global economy and human civilizations—may be similarly unsustainable. Indeed, agriculture contributes to most of the environmental crises we are now facing: GHG emissions, ocean dead zones, loss of insects and birds, deforestation, loss of wetlands, etc. Like all human systems, agriculture is colliding with planetary limits. Such statements are not indictments; rather, they are acknowledgements of what we should expect: agriculture is not an exception—not uniquely sustainable or benign.

Scientists Will Steffen, Johan Rockström, and others have developed and refined the concepts of "planetary boundaries" and "the safe operating space for humanity."[36] Their peer-reviewed academic papers have been published in top journals such as *Nature* and *Science*. In these articles, Steffen, Rockström, and others conclude that there are three domains in which humans have pushed furthest past Earth's safe operating limits. One is biodiversity loss—humans are driving the fastest extinction rates in 65 million years, with species disappearing a hundred times faster than the long-term, background rate.[37] But few people will guess the second or third domains where we have pushed furthest past planetary boundaries: the nitrogen and phosphorus cycles (see Figure 2).

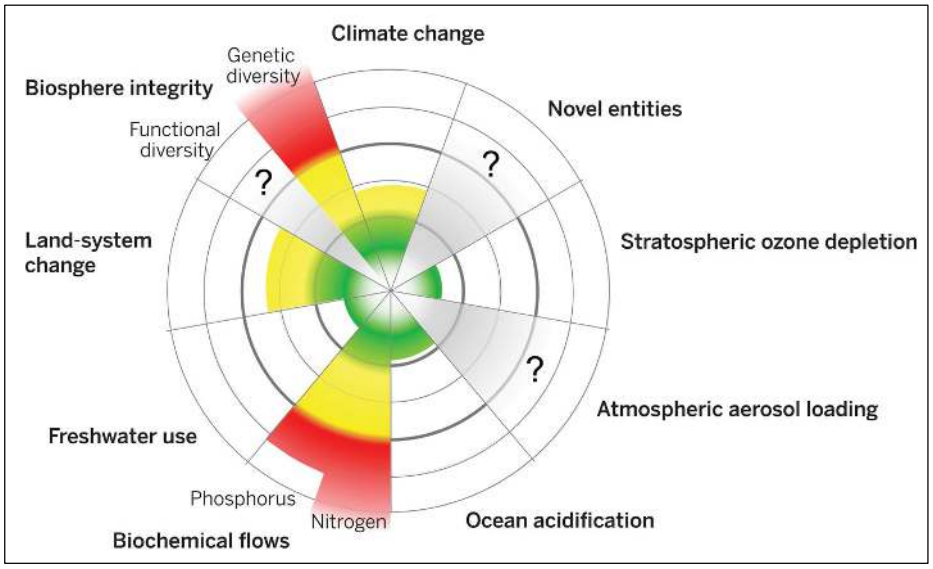

Figure 2. A diagram of human transgressions of planetary boundaries.
Source: Reproduced from Will Steffen et al., "Planetary Boundaries...," 2015. See footnote at bottom of page.

Dr. Bruce Campbell and his coauthors write that "of the nine [planetary boundaries (PBs)], five are in the high risk or increasing risk zones, with agriculture the major driver of four of them and a significant driver of the remaining one.... There are numerous possible intervention points to reduce the impact of agriculture.... However, nothing less than a radically transformed system will be required..."[38]

36 Johan Rockström et al., "Planetary Boundaries: Exploring the Safe Operating Space for Humanity," *Ecology and Society* 14, no. 2 (2009); Johan Rockström et al., "A Safe Operating Space for Humanity," *Nature* 461, no. 7263 (2009); Wim de Vries et al., "Assessing Planetary and Regional Nitrogen Boundaries Related to Food Security and Adverse Environmental Impacts," *Current Opinion in Environmental Sustainability* 5, no. 3 (2013); Will Steffen et al., "Planetary Boundaries: Guiding Human Development on a Changing Planet," *Science* 347, no. 6223 (2015).

37 Millennium Ecosystem Assessment, *Ecosystems and Human Well-Being: Synthesis* (Washington: Island Press, 2005), 5; Gerardo Ceballos et al., "Accelerated Modern Human-Induced Species Losses: Entering the Sixth Mass Extinction," *Science Advances* 1, no. 5 (2015).

38 Bruce Campbell et al., "Agriculture Production as a Major Driver of the Earth System Exceeding Planetary Boundaries," *Ecology and Society* 22, no. 4 (2017): 14.

Globally, nitrogen fertilizer use has doubled since 1979 and quadrupled since 1969.[39] In Canada, the increase is even more rapid, with tonnage here almost double that applied in 2006.[40] Similarly, Canadian phosphorus tonnage has doubled since 2009. Again, we see most metrics are doubling and redoubling on timescales of 20 to 50 years—four- eight- or sixteenfold increases every century.

We are redoubling use of many agricultural inputs even though we face supply limits and other constraints. There are no substitutes for phosphorus, but supplies are limited and humanity will face shortages in coming centuries, perhaps decades.[41] Similarly, fossil aquifers such as the Ogallala will be depleted this century.[42] Though agriculture is millennia old, it faces severe constraints in coming decades and centuries. Sustaining agriculture will be a challenge forever—an intensifying challenge.

Beyond the very important work of sustaining human food supplies, a key aspect of agricultural sustainability is the impact of these systems on ecosystems, other species, and the natural environment. It is easy to grasp how the relentless redoubling of crop output tonnage drives attendant increases in nitrogen fertilizer inputs and subsequent environmental impacts,[43] but less apparent may be agriculture's role in driving up extinction rates. Figure 3 illuminates that connection.

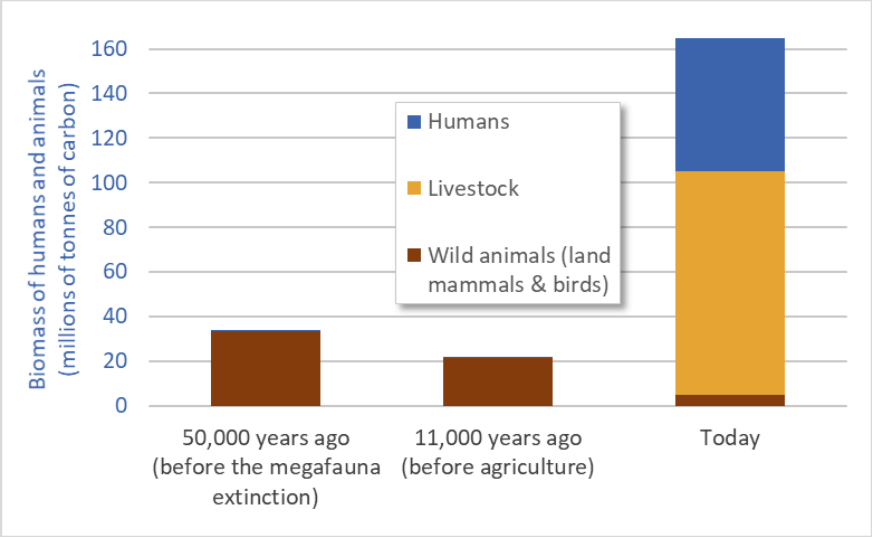

Figure 3. Mass of humans, livestock, and terrestrial wild animals, selected periods.
Sources: Bar-On, Phillips, and Milo; Barnosky; and Smil.[44]

Figure 3 shows the mass of humans, our livestock, and terrestrial wild animals (mammals and birds). Three periods are shown. On the left is the period 50,000 years ago: before humans were significant factors in most of Earth's ecosystems. In the middle is the period around 11,000 years ago: after humans had spread over most of the Earth but before we began practicing agriculture. (On both the

39 International Fertilizer Industry Association, "IFADATA," n.d., http://ifadata.fertilizer.org/ucSearch.aspx.

40 Statistics Canada Tables 32-10-0039-01 and 32-10-0274-01.

41 Martin Blackwell, Tegan Darch, and Richard Haslam, "Phosphorus Use Efficiency and Fertilizers: Future Opportunities for Improvements," *Frontiers of Agricultural Science and Engineering* 6, no. 4 (December 15, 2019).

42 David Steward et al., "Tapping Unsustainable Groundwater Stores for Agricultural Production in the High Plains Aquifer of Kansas, Projections to 2110," *Proceedings of the National Academy of Sciences* 110, no. 37 (2013).

43 Darrin Qualman and National Farmers Union, "Nitrogen Fertilizer: Critical Nutrient, Key Farm Input, and Major Environmental Problem," A Discussion Paper (Saskatoon: NFU, August 30, 2022).

44 Yinon Bar-On, Rob Phillips, and Ron Milo, "The Biomass Distribution on Earth," *Proceedings of the National Academy of Sciences* 115 (2018); Anthony Barnosky, "Megafauna Biomass Tradeoff as a Driver of Quaternary and Future Extinctions," *Proceedings of the National Academy of Sciences* 105 (2008); Vaclav Smil, *Harvesting the Biosphere* (Cambridge, MA: MIT Press, 2013).

left-hand side and in the centre, the mass of humans is so small as to not be visible on the graph.) On the right is the situation today: We and our livestock dominate the Earth.

The mass of livestock animals on Earth today is three or four times the mass of wild animals in previous eras—the number of animals today is *unnaturally* large. Current numbers include about 1.5 billion cattle; 3.3 billion sheep, goats, and hogs; and tens-of-billions of chickens, turkeys, and ducks.[45]

The mass of livestock animals today dwarfs the mass of wild animals in past eras, but even more so, it dwarfs the mass of wild animals *today*. Our livestock outweighs remaining wild animals 20-to-1. Add the biomass of humans to that of livestock, and we find that we and our pigs, cows, chickens, etc. outweigh remaining wild animals 32-to-1, with wild animals making up *just 3 percent of terrestrial animal biomass*. This unprecedented mass of humans and livestock upon the Earth (and the resulting human seizure of land for grazing, feedgrain production, and food-crop production) is the main reason why the Earth is undergoing the most rapid extinction event in 65 million years.[46]

When analyzing global fertilizer and farm input use, crop production increases, and livestock numbers, we should be clear as to what humanity is doing:

1. We are extracting massive and climate-destabilizing quantities of fossil fuels;
2. We are turning a portion of those fossil fuels into fertilizers, especially nitrogen;
3. We are injecting those fertilizers into our cropping systems to increase the size of our harvests;
4. We are feeding large parts of that fertilizer-expanded harvest to livestock, such that the numbers of those animals are now unprecedented upon the Earth;
5. And we are turning those fossil-fuel- and fertilizer-expanded quantities of crops and livestock products into unprecedented numbers of humans (we have doubled our population since 1974);
6. In all of this, we are claiming more and more of the Earth's surface and photosynthetic biomass, leaving less for wild animals and thus accelerating a spasm of extinctions;
7. We are doing all the above at accelerating rates (increasing our annual impacts);
8. And even as we do this, we hope to find ways to label such actions and systems "sustainable."

The graphs above will lead many to conclude that current human food systems are unsustainable. But what are we planning to do? As in the rest of the economy, the plan for Canadian and global agriculture is to redouble output, redouble input tonnage, redouble exports, etc. In terms of input use, Canadian nitrogen and phosphorus fertilizer tonnage are doubling about every 20 to 30 years (see Figure 4).

45 United Nations Food and Agriculture Organization (UN FAO), FAOSTAT website, "Production: Live animals."

46 Millennium Ecosystem Assessment, Ecosystems and Human Well-being: Synthesis, 2005, (Island Press, Washington), 5, 36, & 38.

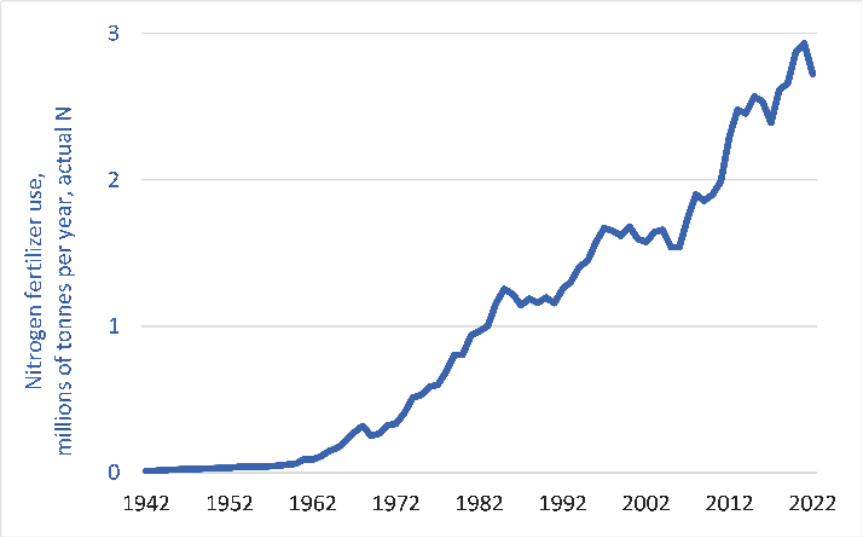

Figure 4. Canadian nitrogen fertilizer consumption, actual N, 1942 – 2022.
Sources: Statistics Canada; Korol and Rattray; and Dominion Bureau of Statistics.[47]

Canadian herbicide use is doubling approximately every 20 years.[48] Diesel fuel use is stable, but as nitrogen fertilizer represents the largest energy input into the sector, overall fossil fuel use is rising.

With fertilizer and energy inputs rising, GHG emissions are rising, too. AAFC notes that emissions from Canadian crop production doubled between 1990 and 2020[49]—a doubling time of 30 years. For a detailed look at emissions, please see the NFU's report *Agricultural Greenhouse Gas Emissions in Canada*.[50]

As input tonnages double and redouble, so does output. Canadian production of major grains and oilseeds doubled between 1980 and 2022 (see Figure 5)—a doubling time of 42 years. (Production also doubled between the 1940s and 1980 and between 1900 and the 1940s.) Canadian grain production displays a consistent 40-year doubling time. It is possible that this will continue and output will again double in the next four or five decades. Though this seems hard to imagine, it is merely the result of applying to the 21st century the rates of yield and output increase consistent and "normal" in the 20th. Increases in yield and output are so large and rapid that production tonnage in the severe drought year of 2021 exceeded the bumper crops of the 1990s (see Figure 5).

47 Statistics Canada Table 32-10-0274-01 & 32-10-0039-01; Maurice Korol and Gina Rattray, "Canadian Fertilizer Consumption, Shipments and Trade: 1999/2000" (Ottawa: AAFC, 2001), http://www5.agr.gc.ca/resources/prod/doc/pol/pub/canfert/pdf/canfert99_00_e.pdf; Statistics Canada and Dominion Bureau of Statistics, "The Fertilizer Trade," various years from 1926 to 1948, accessed June 29, 2022, https://publications.gc.ca/site/eng/9.853796/publication.html.

48 Health Canada, Pest Management Regulatory Agency, "Pest Control Products Sales Report," various years (Ottawa: PMRA).

49 Agriculture and Agri-Food Canada, "Sustainable Agriculture Strategy," 14.

50 Darrin Qualman and National Farmers Union, "Agricultural Greenhouse Gas Emissions in Canada: A New, Comprehensive Assessment," Second Edition (Saskatoon: NFU, 2022), https://www.nfu.ca/wp-content/uploads/2022/06/Comprehensive-Ag-GHG-Emissions-EN-2nd-Ed.pdf.

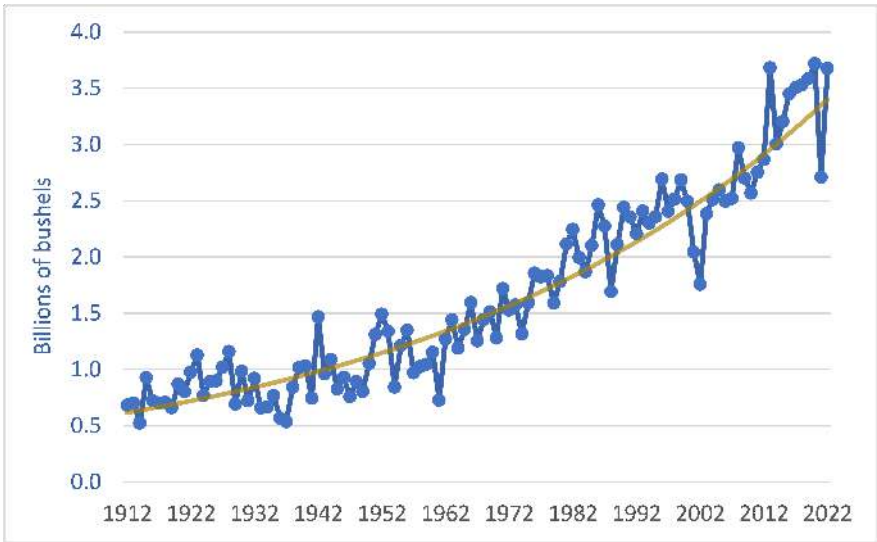

Figure 5. Canadian production of major grains and oilseeds, 1912 – 2022.
Sources: Statistics Canada Table 32-10-0359-01.

Canadian production of other agricultural products is similarly increasing. Figure 6 shows the situation for chicken production and Figure 7 shows the same for pork.

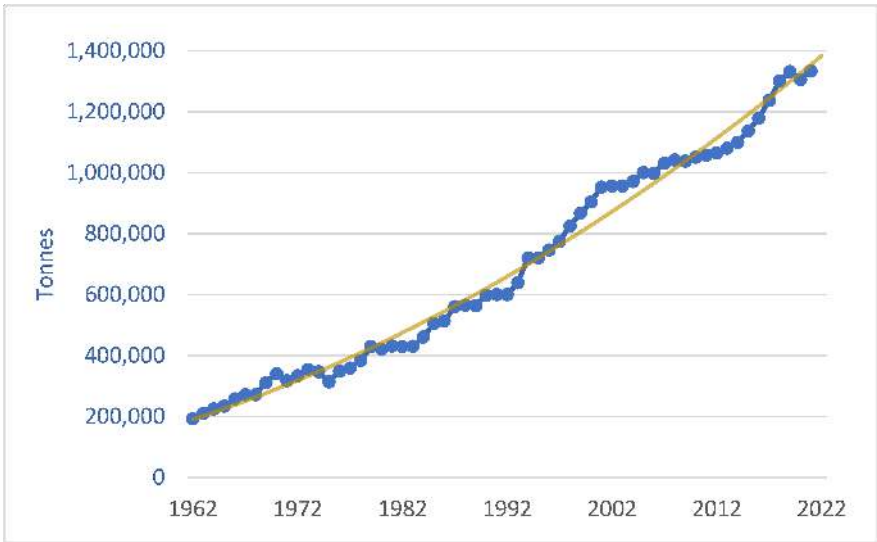

Figure 6. Canadian production of chicken meat, 1962 – 2021.
Sources: Statistics Canada Table 32-10-0118-01.

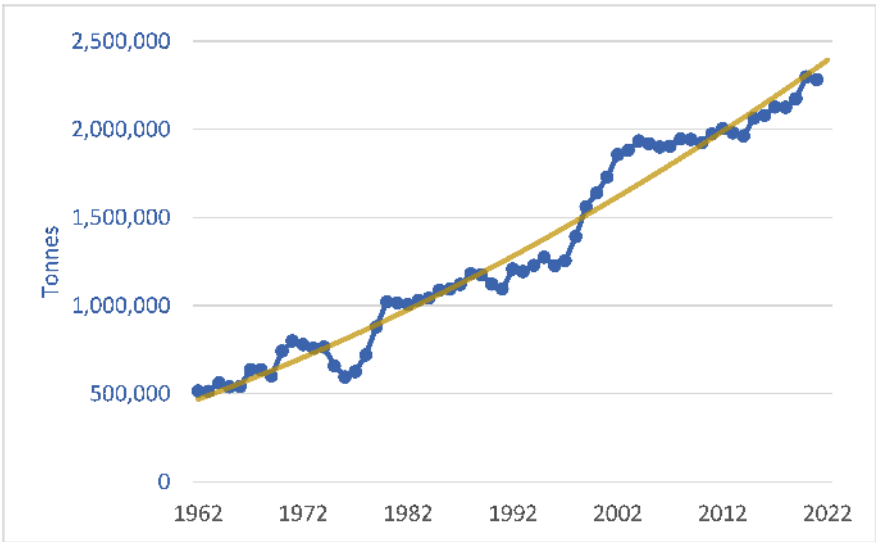

Figure 7. Canadian production of pork meat (cold, trimmed weight), 1962 – 2021.
Sources: Statistics Canada Table 32-10-0126-01.

While grain and oilseed production is doubling every 40 years, chicken and pork production output are doubling every 30. If continued, and the trendlines appear strong, this will lead to an eightfold increase this century: three doublings.

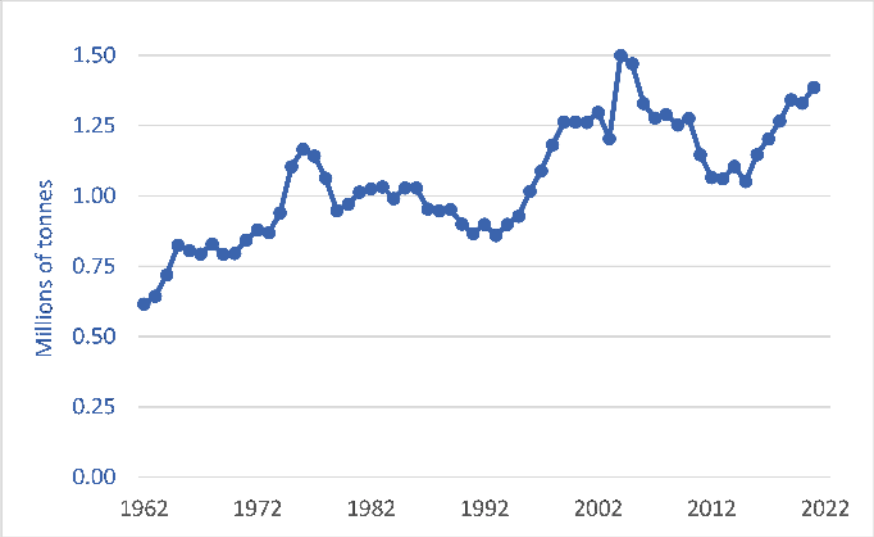

Figure 8. Canadian production of beef, 1962 – 2021.
Sources: Statistics Canada Table 32-10-0125-01.

Canadian beef production (Figure 8) is not increasing as fast or as consistently as output of other meats, but an increase is evident. It appears that production may be doubling approximately every 60 years, though the trend in recent years is ambiguous (for that reason, this graph includes no trendline).

Canadian potato production (Figure 9) is doubling approximately every 40 years.

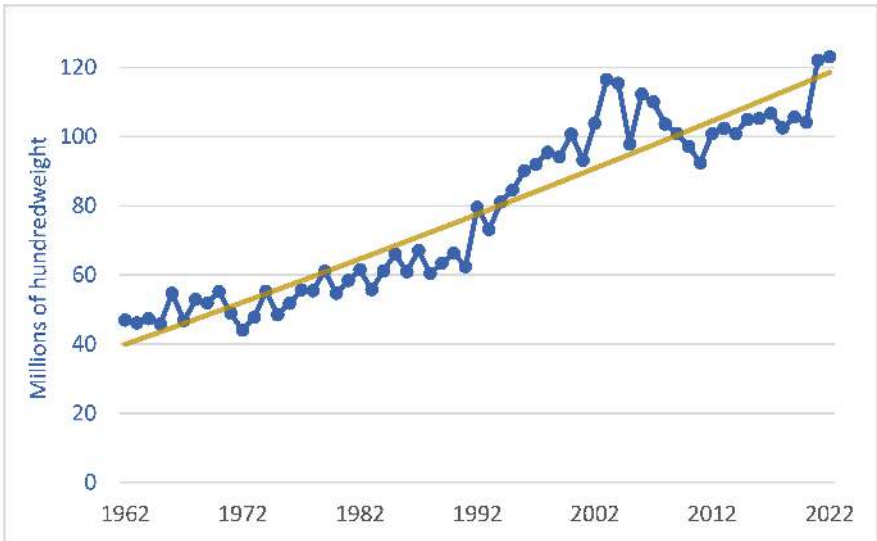

Figure 9. Canadian production of potatoes (one-hundred-pound units), 1962 – 2022.
Sources: Statistics Canada Table 32-10-0358-01.

The many increases detailed above are partly related to efforts to increase agri-food exports. Governments have repeatedly set ever-higher targets. 2021 agri-food exports of $82 billion represents a doubling since 2006 (all figures adjusted for inflation). Indeed, there have been two doublings in the past 30 years, yielding an average doubling time of 15 years (see Figure 10). Such rates of growth, if continued for a century, would lead to a hundredfold increase in agri-food exports (nearly seven doublings). The point is not that such a huge multiple in exports will occur, but rather to highlight the *extreme* nature of government targets and policies. Such extreme policies move us away from sustainability. Among governments, there is a lack of policy coherence.

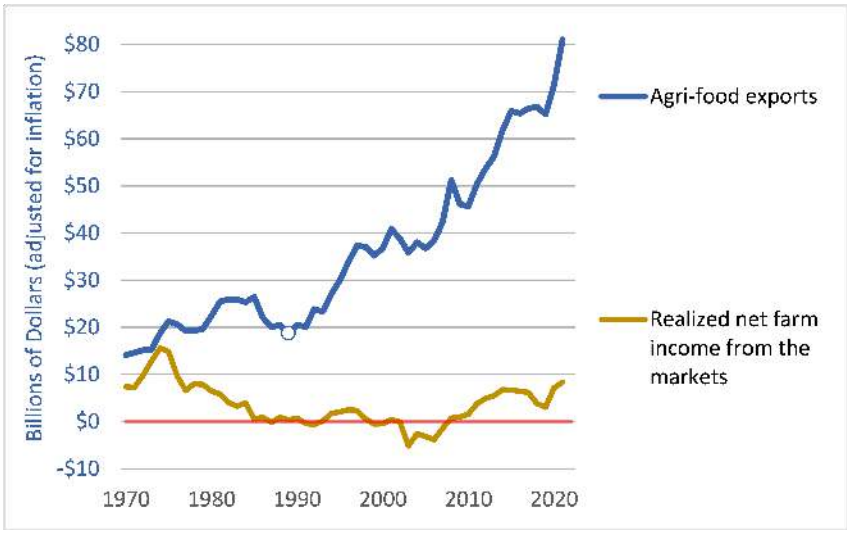

Figure 10. Canadian agri-food exports and realized net farm income from the markets, 1970 – 2021.
Sources: Statistics Canada and Agriculture and Agri-Food Canada.[51]

51 Realized net farm income from the markets (i.e., with farm-support payments subtracted out): Statistics Canada Tables 32-10-0045-01, 32-10-0052-01, and 32-10-0106-01; Agri-food exports: Data from AAFC upon request (from aafc.infoservice.aac@canada.ca) and 2021 value from Agriculture and Agri-Food Canada, "Government of Canada Invests Over $2.7 Million to Grow Agri-Food Exports," news release, June 9, 2022, https://www.canada.ca/en/agriculture-agri-food/news/2022/06/government-of-canada-invests-over-27-million-to-grow-agri-food-exports.html.

When evaluating upward trends in crop and livestock output and even exports, it is too simplistic to think that we are "feeding the world." Reality is more complex. Much of our production is turned into nutritionally disfigured foods: colas, sugary cereals, and salty snacks. Another portion is thrown away uneaten—as much as 40 percent in Canada[52] And we turn an increasing portion of crop tonnage into biofuels to power our growing fleet of cars and trucks and, perhaps soon, vacation jets and cargo ships (Figure 11).

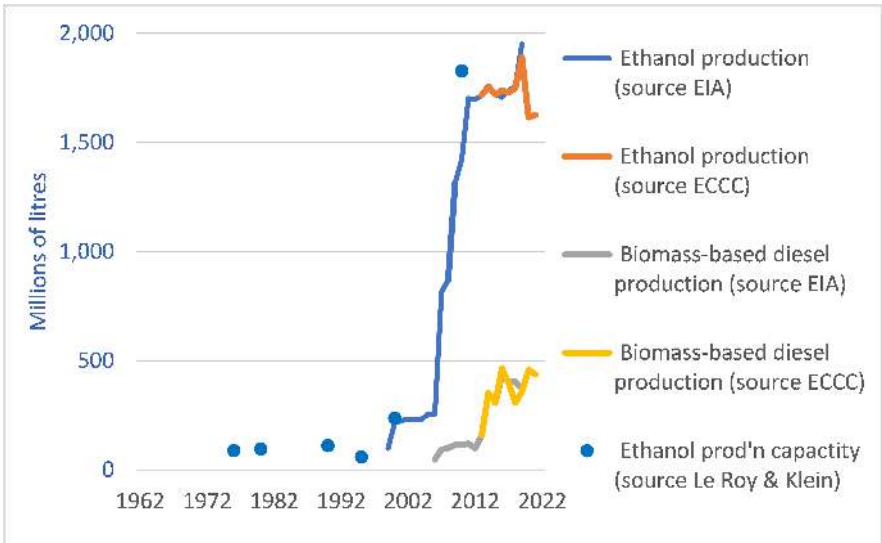

Figure 11. Canadian production of biofuels, 1962 – 2021.
Sources: US Energy Information Agency, Environment and Climate Change Canada, and Le Roy and Klein.[53]

Government and industry commitments to exponential growth in farm input and output tonnage formed the foundations of Canadian agriculture policies and practices in the 20th century. Continuing such upward trends (2x, 4x, 8x) deeper into the 21st century vetoes sustainability. We must find another way, because we cannot continue down the current path. We must find ways to provide sustainable, family supporting livelihoods for Canadian farmers even as we support them in stepping off the output and input-use treadmills.

Indeed, because the GHGs coming out of our farming systems are, to a large extent, a direct reflection of the input tonnage we push in, a move to lower-input systems is inevitable. To move toward sustainability, we need to support farmers in moving through a transformative process in which we get more of what we need from the Earth's biological systems and less from industrial facilities.

52 Martin Gooch, Abdel Felfel, and Nicole Marenick, "Food Waste in Canada," *Value Chain Management Centre, George Morris Centre*, 2010, 2, http://vcm-international.com/wp-content/uploads/2014/01/Food-Waste-in-Canada-November-2010.pdf.

53 U.S. Energy Information Administration (EIA), "International," Biofuels, accessed March 10, 2023, https://www.eia.gov/international/data/country/CAN/biofuels/biofuels-production; Government of Canada, "Data Collected under the Renewable Fuels Regulations - Open Government Portal," accessed March 10, 2023, https://open.canada.ca/data/en/dataset/d9ed24bd-82d9-406a-801c-585c28e6edb1; Danny Le Roy and Kurt Klein, "The Policy Objectives of a Biofuel Industry in Canada: An Assessment," *Agriculture* 2, no. 4 (December 2012): 436–51.

3. Conclusions

The default assumptions—namely, that Canadian agriculture is close to being sustainable and can be made fully so by relatively modest tweaks, efficiencies, incentive programs, and technology add-ons—are not supported by the evidence and should not be trusted or adopted. To the contrary, the magnitude of humanity's sustainability predicament—in all our systems, including food production—may now be so large that we cannot yet fully articulate adequate responses and thus we must take all steps we can, as fast as we can, *while simultaneously setting the stage for even more ambitious actions in the future*.

Normally, such deep and difficult considerations are avoided by policymakers and farmers alike. But we have been brought face-to-face with these questions; AAFC has initiated a once-in-a-generation process of creating a twenty-five-year Sustainable Agriculture Strategy—a plan that will affect Canadian legislation and landscapes to mid-century; perhaps our last chance to change course before 2050. The long-term nature of this Sustainable Agriculture Strategy raises the stakes and creates a need for exceptional rigour, candor, and courage.

The NFU is an organization of farmers. It is not in our interests to unnecessarily impugn agriculture, overstate any environmental harms it may be causing, or needlessly question its sustainability. Nonetheless, the combination of current human impacts on biospheric systems coupled with wholly-taken-for-granted plans to redouble the size (and impacts) of those human systems, including agriculture, leads us to raise an alarm regarding the future that may be in store for all humanity, and most especially for farmers. Because it is farmers who will be among those most damaged by climate change, among the most affected if an "insect apocalypse" collapses wild pollinator populations, among those left to lament an emptier and lonelier countryside if birds and other wild animals continue to disappear, and among those who experience most intensely the lash of storms or the withering effects of droughts.

We must speak out, underscore the excruciating nature of humanity's predicament, and call attention to the risks of attempting to continue along our current path. We do this in order to lay the foundations for a *truly effective* Sustainable Agriculture Strategy. We do this so that this process may make evidence-rooted, meaningful steps toward *authentic* and *durable* sustainability. We do this so that by fully understanding the enormity of our challenges, we may make plans that are their equal—so that we may succeed rather than fail.

Note: the preceding is just one small part of the NFU's ongoing analysis of climate change, agricultural emissions, and sustainability. The NFU has detailed the problems and challenges in reports such as *Nitrogen Fertilizer: Critical Nutrient, Key Farm Input, and Major Environmental Problem*. And we have detailed paths to a better future in reports such as *Imagine If: A Vision of a Near-Zero-Emission Farm and Food System for Canada* and *Tackling the Farm Crisis and the Climate Crisis: A Transformative Strategy for Canadian Farms and Food Systems*. Please find those reports at www.nfu.ca .

Please see the Appendix that follows, in which we provide the NFU's specific answers to the questions contained in AAFC's Sustainable Agriculture Strategy Discussion Document (these are the same questions as in its online questionnaire).

Appendix: Answering the questions in AAFC's questionnaire

AAFC questions are in black; NFU answers are in *green italic*.

Proposed Goals for a Sustainable Agriculture Strategy:

1. The agriculture sector is resilient to short and long-term climate impacts while growing productive capacity, and has adapted to changing contexts due to climate change.
2. Environmental performance is improved in Canada's agriculture sector, contributing to the environmental, economic, and social benefit of all Canadians.
3. The agriculture sector plays an important role in contributing to Canada's national 2030 GHG emission reduction and net-zero by 2050 targets while remaining competitive and supporting farmers.
4. A more comprehensive and integrated approach is taken in addressing agri-environmental issues in the agriculture sector, across policy, programming, and partners in the value chain.
5. Canada has addressed data gaps and improved capacity to measure, report on, and track the environmental performance of the agriculture and agri-food sector.

➢ Which of the proposed goals ... do you agree with most? What would you add or change?

The five goals above are vague and in a state of flux as the SAS process continues. Increasingly, it is the outcomes and targets that define the SAS. That said, it is important that any high-level goals incorporate and communicate several key ideas, including:

i. We need a holistic, systems approach, therefore progress is needed toward all goals equally.

ii. We need authentic sustainability, not half-measures or sustainability-as-a-marketing-tool.

iii. We need transformative change, not just modest adjustments to business as usual. Because we are so far from sustainability—and moving away from that goal, not toward it—we need bold, transformative changes. Tweaks, incremental changes, and techno-add-ons will fail.

iv. Key is AAFC capacity. Farmers need independent, public-servant extension agrologists who can focus on increasing sustainability and reducing emissions. (Currently, many agrologists end up acting like input-company salespeople—focusing on maximizing production and, thus, input use). AAFC should provide free soil testing—a step toward universal annual testing to optimize input use and maximize soil carbon gains. AAFC staff could run demonstration farms where low-emission, sustainable practices could be refined and showcased. When the climate turned against farmers in the 1930s, governments responded with the PFRA (Prairie Farm Rehabilitation Administration), to help farmers protect soils, manage water, deal with drought, plant trees, find grazing for cattle, etc. Similar coordinated, well-resourced actions are needed today. AAFC will fail if it continues its withdrawal from the countryside and tries to create sustainability through "action at a distance" from offices in urban centres and using programs delivered by third-parties and private companies. The NFU has detailed this expanded role for governments under the proposed label of Canadian Farm Resilience Agency (CFRA). Please see https://www.nfu.ca/wp-content/uploads/2022/12/CFRA-two-summary-EN.pdf

v. Adaptation is not a one-and-done process, rather, adaptation will be ongoing for this entire century, and beyond, as the climate continues to respond to increasing GHG concentrations; indeed, the pace of dangerous climate change will accelerate due to human activity, so adaptation measures must also accelerate as we move through coming decades.

➢ What should a Sustainable Agriculture Strategy aim to achieve in the agriculture sector in terms of:

- Climate change mitigation

1. *Emissions from fertilizer use (absolute, not intensity based) are cut by half, or more, by 2050.*
2. *Overall, agricultural emissions are 20% lower (absolute) by 2030 and 50% lower by 2050 (with every-five-year sub-targets between those years to ensure near-term and steady progress).*
3. *Agricultural-area sequestration (in cropland soils and also in grasslands and additional treed areas on riparian zones and marginal lands, etc.) in 2050 has a rate roughly double that of today (again, with five-year sub-targets).*
4. *Achieving the above, the sector is net-zero by 2050, i.e., emissions are roughly half as high and sequestration twice as high and thus the two are approximately equal.*
5. *All new agricultural machinery sold is zero-emission by 2040.*
6. *Our electricity generation and distribution systems supply low-emission renewable energy to farms, and decentralized on-farm generation of clean electricity is incentivized and maximized.*
7. *Farm building retrofits cut energy use by half by 2030 (spurred by financing and incentives) and in the 2030s there are ambitious programs to transition to electric heating systems, including air-source and ground-source ("geothermal") heat pumps.*
8. *Maximal efforts are made to reduce emissions from manure, incl. lagoon covers, etc. (That said, complex high-cost solutions that only work at large scales, e.g., biodigesters, should be critically evaluated to ensure that we do not spur concentration and farm giantism.)*
9. *Livestock enteric methane emissions are minimized, but within a context that recognizes the benefits of biodiverse grassland ecosystems and good grazing. As much as possible, grazing systems should be prioritized over feedgrain-based and confinement livestock systems.*
10. *Transport of agricultural products, especially grain, is mainly accomplished by rail, which is far more energy efficient than trucking and can more easily be electrified, reducing transport emissions to near zero.*
11. *Fertilizer-production facilities reduce their emissions to near zero by using renewable energy and CO_2 capture.*
12. *Wetlands loss is stopped, and reversed.*
13. *Removal of trees is stopped, and reversed, and tree-planting maximized on marginal lands, etc.*
14. *Grasslands are protected and grassland conversion to cropland is stopped, and reversed.*
15. *Ambitious targets are in place for increased adoption of alternative approaches: agroecology, regenerative agriculture, organic production, intercropping, and low-input methods.*
16. *Efficacy testing and data reporting for non-fertilizer supplements is reinstated so that farmers can evaluate and adopt alternatives to conventional fertilizers and thus reduce emissions.*

- Adaptation

17. *As noted, adaptation has no endpoint. To the contrary, multi-century, intensifying climate impacts require very-long-term, expanding, and accelerating adaptation measures.*
18. *Very ambitious measures to maximize the rate of soil organic matter (SOM) gain are in place by 2030. Maximizing SOM is one of the most powerful ways to capture and hold water.*
19. *Because agronomic resilience options are limited, <u>financial</u> resilience is crucial. We must increase farmers' margins and reduce debt. Curtailing overdependence on costly inputs is key.*
20. *Many proposed agri-technologies will increase farmers' costs. Thus, while such technologies might increase agronomic resilience, they may simultaneously reduce financial resilience, leaving farmers more vulnerable to climate-induced losses. Evaluate technologies critically. Smaller-scale, farmer-repairable, decentralized technologies are best for resilience.*

21. *Support mixed farms, integrated systems, more complex rotations, and other practices to hedge risks and boost resilience.*
22. *Adaptation cannot be limited to investments in productive acres alone. Resilient landscapes make resilient farms and, thus, the protection and restoration of wetlands; grasslands; treed areas, hedgerows, and fencerows; riparian areas; and other sensitive areas must be a priority.*

- Biodiversity

23. *The destruction of wetlands is stopped by 2030 and reversed thereafter, with number and area increasing.*
24. *Tree removal is stopped then reversed with very significant gains in treed area (on marginal land, etc.) by 2030 and accelerated plantings throughout the 2030s, 2040s, and beyond.*
25. *The destruction of grassland is stopped and biodiverse grassland area is increasing.*
26. *Insecticide and herbicide tonnage, currently increasing, are decreased by 10% by 2030 and 25% by 2040. Integrated systems and more complex rotations reduce chemical dependence.*
27. *Biodiversity, on a broad set of metrics (e.g., insects, birds, other animals, trees and other plants, soil biota, etc.), is increasing by the 2030s.*
28. *Both in-field biodiversity (e.g., more complex rotations, more legumes, intercropping) and whole-landscape biodiversity (i.e., outside of fields, too) are increasing.*
29. *Northern forests are protected and the agricultural land area is not allowed to creep northward at the expense of forests as climate warming advances.*

- Water

30. *Fertilizer run-off to rivers and lakes is reduced and continues a downward trend.*
31. *Nitrate leaching to groundwater is continuously decreasing.*
32. *Manure run-off to rivers and lakes is reduced and continues a downward trend.*
33. *Pesticide run-off to rivers and lakes is reduced and continues a downward trend.*
34. *Soil erosion, especially losses to waterways, is all but eliminated.*
35. *Wetlands destruction, drainage, and diversions are stopped and wetlands area is increasing.*
36. *Biodiversity in on-farm wetlands is increasing.*
37. *We understand that the damage done by irrigation megaprojects is antithetical to the goals of sustainability and so do not advance such projects.*

- Soil health

38. *Soil is highly valued and extremely ambitious steps are taken to eliminate soil loss. Data collection is increased, as are research and extension programs.*
39. *We take a holistic, ecological, multi-faceted approach to soil health, i.e., we do not just focus on carbon or primary nutrients: N, P, and K.*
40. *Soil organic matter (aka soil carbon) gain rates are maximized via very rapid and ambitious adoption of all beneficial management practices (BMPs) including reduced tillage, cover crops, enhanced rotations, etc.*
41. *A more diverse suite of farming practices is fostered, including regenerative, organic, agroecological, and low-input systems, and acreage targets are created for these approaches.*
42. *Regenerative practices (keep the soil covered, keep green plants growing and living roots in the soil, diversify crops, intercropping, etc.) and agroecological systems are encouraged and incentivized and adopted on an increasing number of farms and expanding acreage.*

43. *Because increases in pasture and grasslands are important ways to keep the soil covered, rotational grazing and related BMPs are maximized.*

➢ How can a Sustainable Agriculture Strategy support an environmentally, socially, and economically sustainable agriculture sector?

44. *Farmers' margins are key. Overdependence on purchased inputs has simultaneously increased emissions, reduced margins, and contributed to record-high farm debt. Low-input systems can reduce input use and related emissions while expanding margins, benefiting a farm's financial resilience to climate impacts. Highly indebted, low-margin, input-overdependent farms are highly vulnerable to the multi-year climate impacts that will occur in the 21st century.*
45. *A socially and economically sustainable agricultural sector requires avenues for entry and this means access to affordable land. High and rising land prices create barriers to entry and incentives to exit. This is contributing to accelerating concentration in ownership—with the largest owners or operators controlling tens-of-thousands of acres. Continuing to allocate farmland solely according to ability-to-pay will cause a reversion to long-term historically normal patterns of land ownership, i.e., massive concentration of ownership in the hands of neo-Lords, with the vast majority of citizens effectively barred from owning farmland.*
46. *Government intervention is needed to advance equity, inclusion, and justice. All actions toward sustainability must prioritize and deliver upon our goals of reconciliation and also our support for excluded, marginalized, or vulnerable populations. Just as the larger society is divided by growing inequality, so too is the case regarding those who can access land and those who cannot, and between smaller farms and larger. The problems of inequality in society in general are mirrored by inequalities in our food system. Corporate control, expanding farm sizes, and a focus on high-tech, high-cost production systems are exacerbating inequalities.*
47. *Again, AAFC capacity must increase. We need public-interest, public-sector extension services; universal soil testing; comprehensive data collection and sharing; demonstration farms; and a return to a system where government is again a trusted provider of valued services to farmers.*

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

➢ What success stories can you share ...?

48. *NFU members are among the most innovative and sustainability focused farmers in the country, employing a range of practices including intercropping; cover cropping; using advanced technologies to selectively apply fertilizers in order to minimize nitrous oxide emissions; rotational grazing; farm building retrofits and heat pumps; even electric tractors. And our members are doing this while at the same time employing farm-supporting, resilient business plans. But while success stories are important, we need to understand that such stories and practices are the exceptions: the dominant agribusiness corporations continue to push farmers to use more and more inputs and to produce higher emissions. I.e., despite some farmers moving toward sustainability, the sector as-a-whole is being pushed in the opposite direction.*

➢ What suggestions do you have for additional approaches that could be part of a Sustainable Agriculture Strategy to:

- Support environment and climate outcomes in the agriculture sector in general?

49. *Again, we need ambitious, courageous, <u>coordinated</u> steps toward durable, authentic sustainability. Government capacity and action are key.*
50. *AAFC should look critically at vague, in-the-future technology solutions. Such technologies can entangle farmers in webs of corporate control and thereby reduce margins and, thus, resilience.*

51. *Low-input approaches are key. Many of agriculture's environmental harms (e.g., GHGs, toxicity, resource depletion, etc.) are a direct function of the quantity of farm inputs we push in. I.e., low-emission systems will be low-input systems.*
52. *Endless growth vetoes sustainability. Most agricultural metrics (e.g., grain and oilseed output tonnage, pork and chicken production, fertilizer use, emissions, etc.) are doubling every 20 to 40 years. If input use and output are continuously driven upward sustainability will diminish. An agricultural sector with double the output and double the input use will have more adverse impacts. And we are on track to double the size of the sector in the coming 30 to 40 years.*

- Support the agriculture sector in reaching net-zero by 2050?

53. *Key is government capacity. Farmers need independent advice and extension agrologist support to help farmers understand their operations' GHG emissions, take steps to reduce those emissions, and access a complex and growing array of government programs and incentives.*
54. *Maximize progress on expanding availability of a clean, near-zero-emission electricity grid to support decarbonization of buildings and machinery and even fertilizer production.*
55. *Support and incentivize the maximum in decentralized, on-farm clean electricity production.*
56. *Work with designers and builders of powertrains for long-haul trucks to transfer near-zero-emission powertrain technologies to agricultural equipment as quickly as possible.*

➢ Given the pace of change needed, in which areas could regulatory approaches or changes to existing ones be used to accelerate environment and climate action?

57. *AAFC should consider regulations/restrictions in the context of a three-part approach:*
    i. *Incentives and cost-sharing programs (i.e., remove affordability obstacles);*
    ii. *Supports and knowledge transfer (provide very extensive agronomic support, assistance in filling out forms and accessing programs, demonstration farms, etc.);*
    iii. *Regulations and prohibitions.*

    Number iii should only come after numbers i and ii are fully in place. It would be inappropriate and counterproductive to rely significantly on regulation and prohibitions at this time because government has not yet done what it must do in terms of ensuring farmers have extensive supports in the forms of agronomic advice, etc. Stated another way, before requiring farmers to do the maximum, governments must do <u>their</u> maximum.
58. *While the preceding should be the general approach, there are some near-term exceptions where strong government regulation should be introduced immediately. One example is wetlands destruction. Farmers who want to continue receiving a portion of publicly funded support (such as business-risk management programs, esp. AgriInvest) should be prohibited from destroying wetlands. Another regulation needed immediately would bar foreign and investor ownership of farmland.*

➢ What type of research should be prioritized to advance environment and climate outcomes...?

59. *Research and development are needed toward the following goals:*
    a. *Widespread availability of non-fossil-fuelled, near-zero-emission farm machinery;*
    b. *Low-input production systems that maintain yields while minimizing inputs;*
    c. *Alternatives to purchased inputs, including circular flows of nutrients, biological nitrogen fixation, integrated pest management, etc.;*
    d. *Low-emission grazing systems as alternatives to grain feeding and finishing;*
    e. *Zero-emission fertilizer production (i.e., renewable energy and carbon capture);*

f. *Strategies for cover cropping on the dry Prairies (e.g., time-release coatings for cover crop seeds);*

g. *Perennial cereals; and*

h. *Intercropping practices.*

60. *But research is not a panacea. Too often, when faced with the challenges of the climate crisis, industry and government leaders default to vague talk of future technologies. For the most part, crucial 2023–2050 emissions reductions will be accomplished by existing technologies. We can make ambitious progress now; we need not wait on research or innovations.*

Issue 3: Targets and data on environmental performance

➢ What kind of data are most important for measuring environmental and climate outcomes in the sector?

61. *We need additional data collection on virtually every front, including: adoption rates of on-farm BMPs; emissions; wetlands loss; energy use; etc.*
62. *That said, government staff in ECCC and elsewhere know what needs to be collected, but they lack the mandate/funds to undertake such collection. Government staff need to be empowered, funded, and directed to fill the many already-well-known data gaps.*
63. *Data collection needs to be done by governments, not private entities. Only governments can provide integrated, comprehensive, long-term, publicly accessible data. Anyone doubting this should try to access and publish the mountains of data currently held by Deere, Nutrien, etc.*
64. *On-farm energy use is an area where data collection needs to be dramatically increased. Almost no detailed data exists for these metrics.*

➢ What suggestions do you have for improving how environmental data is collected and shared...?

65. *Expanded AAFC and ECCC capacity is needed. There must be a federal presence in the countryside. Governments can be of service to farmers by collecting and publishing data.*
66. *Tools such as the Environmental Farm Plan (EFP) could be updated biannually by farmers (with AAFC staff support) to provide needed data on on-farm adoption of BMPs, energy use, emissions, land use, etc.*

➢ What qualitative or quantitative targets do you feel would be realistic, ambitious, and measurable to generate the most action in the following:

- Reducing GHG emissions or storing carbon

67. *See points 1–7, above.*
68. *Net-zero emission agriculture by 2050, with intermediate goals to ensure continual movement in the right direction, e.g., 20% reduction in absolute emissions by 2030.*
69. *To attain net-zero by 2050, attempt to achieve a 10% increase in the rate of sequestration (cropland, grazing land, trees on marginal land, etc.) every 5 years and a doubling by 2050.*
70. *50% absolute reduction in fertilizer-related emissions by 2050 (building on 2030 target of 30%).*
71. *100% reduction in emissions from new machinery sold in 2040 and beyond.*
72. *50% reduction in emissions from farm buildings by 2030 (spurred by incentives and financing).*
73. *0% rate of wetlands loss by 2030.*
74. *10% increase in treed area on marginal land every five years.*

- Making the sector more resilient

75. *Soil organic matter in every province is increasing by several percent per decade.*
76. *Farm debt is cut by 50% by 2040, to support financial resilience to climate impacts.*
77. *Financial margins in all agricultural sectors 50% larger by 2040 (via reduced dependence on purchased inputs, etc.).*
78. *90% of farms complete (expanded and comprehensive) Environmental Farm Plans (EFPs) by 2030; these could include emission-reduction plans and nutrient/fertilizer-management plans.*
79. *We are no longer reducing the number of farmers (crucial managers of land, water, soil, and biodiversity) and we see an upward trend in farm numbers in coming decades. There must be a target to reduce the rate of farmer loss to zero and then to increase numbers. Removing farmers from the land will thwart adaptation and erode resilience.*

- Supporting biodiversity

80. *0% rate of wetlands loss by 2030.*
81. *10% increase in treed area on marginal land every five years.*
82. *By 2040, 10% of Canadian agricultural land in set-aside programs that prioritize rewilding, biodiversity, and strategic grazing reserves.*
83. *Insecticide and herbicide tonnage are decreased by 10% by 2030 and 25% by 2040.*
84. *Biodiversity on a broad set of measures (insects, birds, plants, animals, soil biota, etc.) is increasing by 2040.*
85. *Biodiversity is increasing, both in-field (crop rotations and diversity) and whole-landscape (outside of fields, too).*

- Supporting water quality and availability

86. *Wetlands loss falls to zero by 2030 and thereafter area and number are increasing.*
87. *Losses of nitrate to groundwater are cut by half by 2040.*
88. *Pesticide contamination of surface waters is cut by half by 2040.*
89. *Fertilizer run-off to surface water is cut by half by 2040.*

- Improving soil health

90. *A 10% increase in soil carbon sequestration rate every 5 years.*
91. *Area planted to cover crops is doubled every 5 years.*
92. *Intercropping is encouraged and research supports expanded adoption.*
93. *Farmers add one additional crop to their rotations in order to improve soil building and biodiversity. Governments support farmers in finding markets for the products from diversified rotations.*

Final Questions:

➢ Do you have any other ideas, comments, feedback or suggestions to share...?

94. *Overall, to support sustainability in all sectors, a top priority is that we stop developing new fossil fuel projects and infrastructure (e.g., Bay du Nord and Trans Mountain Expansion pipeline) and that we reduce fossil fuel combustion by 90 percent well before 2050.*

95. *Avoid technologies that are not in farmers' interests, such as gene editing. Also, ensure that farmers' rights to their seeds are expanded, not reduced.*
96. *Governments and farmers must look very critically at corporate-centered "market-based mechanisms" such as emissions offsets and carbon trading that enable a continuation of business-as-usual while giving a false sense of moving toward solutions.*
97. *Control within the system is an ignored factor. Corporate control needs to be restrained and concentration reduced. To begin to rebalance market power, farmers need more control in the system via collective marketing agencies. Governments need to counter "market forces" pushing for more output and more input use and, hence, higher emissions and lower sustainability. In general, understand that a key barrier to sustainability is corporate control within the system and the push to have farmers purchase ever-larger quantities of inputs.*
98. *Integrate crucial considerations of the public good; the value of common lands; reconciliation with, and justice for, the Indigenous peoples who are the original (and often current) owners of this land; and a renewed and much more ambitious commitment to democracy, equity, inclusion, and social justice.*
99. *We need a multiplication of effort and speed—near-wartime levels of ambition and action as we struggle to fend off the intensely damaging impacts of accelerating climate change and to slow catastrophic rates of species loss. In our efforts toward sustainability, we are moving far too slowly; we are losing; we risk losing everything; we must act faster.* ***We need a government-led mobilization for food-system transformation.***
100. *Finally, we must take into account that our exponentially expanding global mega-civilization is very far from sustainability (see Chapter 1) and that we are moving away from, not toward, that goal. Thus, a Sustainable Agriculture Strategy with modest ambition and a Strategy that advances only small changes will prove inadequate. Worse, such a strategy will serve to greenlight a continued move away from sustainability. Frank and unflinching assessments coupled with courageous and very rapid action are all urgently needed at this moment of planetary crisis. To do less is to risk everything.*

Thank you,

National Farmers Union