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EU-CANADA AGRICULTURE DIALOGUE WORKSHOPS

SOIL HEALTH FOR OUR FUTURE

OUTCOMES REPORT

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EXECUTIVE SUMMARY

This outcome paper is an outgrowth of the first in a series of five "joint events to promote sustainability, environmental stewardship and climate action in agriculture, within the framework of the Agriculture Dialogue" under the Canada-EU Comprehensive Economic Trade Agreement (CETA).[1] This workshop, titled Soil Health for our Future, brought together over 120 stakeholders from across Canada and the EU to explore the policy context and discuss good practices, research and innovation in the field of soil health. A final wrap-up conference will summarize the reports from the various workshops (i.e. soil health; greenhouse gas reduction in livestock production; fertilizer use in agriculture; pesticide use in agriculture; and organic agriculture).

In addition to relevant Canadian and EU policies, stakeholder discussions centred on the topics of agricultural soil carbon sequestration and soil biodiversity. Stakeholders identified key issues and challenges to resolution of soil health problems:

Agricultural soil carbon sequestration

- Limitations in current measuring and modelling systems
- The need to maintain beneficial management practices (BMPs) to avoid the depletion of soil carbon
- The effect of climate on our ability to store carbon in the soil
- The need to maintain stoichiometric balance in soils, and the resource or environmental challenges associated with increasing other nutrient levels in fields

Soil biodiversity

- Limitations in measuring soil biological health
- Lack of a clear definition of soil biodiversity
- The public and farmers typically lack awareness of the importance of soil biodiversity; farmers also sometimes receive insufficient and mixed messaging from various agricultural industry stakeholders
- Risk of short-term economic losses for farmers adopting new practices to support soil biodiversity

Shared challenges

- Still much to learn about soil carbon sequestration and soil biodiversity
- Soil health issues span multiple government departments, such as research, agriculture, and environment
- No one-size-fits all solution to soil health challenges is practical, given differences in socioeconomic contexts and soil management decisions across various geographic locations
- Several barriers to on-farm adoption of BMPs, including insufficient knowledge transfer, economic and policy barriers, etc.

1 Canada-European Union. (June 2021). European Union-Canada Summit – Joint Statement, pp. 3-4. Retrieved from https://pm.gc.ca/en/news/backgrounders/2021/06/15/canada-european-union-summit-joint-statement.

However, despite this broad range of challenges, stakeholders were optimistic about the opportunities to improve agricultural soil health by increasing soil carbon sequestration and soil biodiversity. Workshop participants underscored the need for increased collaboration between Canadian and EU stakeholders. Given the centrality of soil health to life on earth, workshop participants also highlighted the need for the scientific community, the agricultural community, policymakers, and the public all to play a role in the efforts to protect and improve soil health.

As the EU and Canada continue their work in this field, they can consider the following thirteen recommendations.

RECOMMENDATIONS FOR THE SCIENTIFIC COMMUNITY

Recommendation 1

Strengthen the scientific networking between the EU and Canada to address the gaps in knowledge about soil biodiversity and soil carbon sequestration.

Recommendation 2

Develop a shared model and framework for monitoring and measuring agricultural soil carbon sequestration that is realistic and holistic. This model and framework must consider both the range of factors that affect soil carbon sequestration and how soil carbon levels fit into the broader context of soil health and agricultural emissions.

Recommendation 3

Collaborate to identify indicators for soil carbon sequestration, based on shared understandings of agricultural BMPs or other visible markers. These indicators must be calibrated against actual carbon measures to ensure their usefulness.

Recommendation 4

Develop a shared definition of soil biodiversity that is flexible to accommodate the differences in systems and soils around the world.

Recommendation 5

Establish collaborative long-term field experiments in Canada and the EU for monitoring soil biodiversity and soil carbon levels.

Recommendation 6

Leverage the expertise of social and behavioural scientists to facilitate communication with farmers. Learn how to best support them in adopting soil health BMPs and how to incorporate farmers' grounded knowledge into scientific research.

Recommendation 7

Strengthen networks and two-way lines of communication between soil health researchers and farmers.

RECOMMENDATIONS FOR POLICYMAKERS

Recommendation 8

Take a holistic approach to environmental policies (i.e. develop and review policies related to air quality, soil health and water quality together) and a systems approach to policies and programs to support soil health (i.e. consider policies and programs related to soil carbon sequestration and soil biodiversity together).

Recommendation 9

In policy and programming design, balance the desire for given soil health outcomes at a regional or national scale with flexibility to accommodate local conditions and BMPs.

Recommendation 10

Develop farm support programs that are accessible for farm operations of varying sizes and that consider how farmers manage their systems holistically.

Recommendation 11

Exchange best practices on evidence-based soil health policy and program mechanisms between Canada and the EU so each government can apply lessons learned to their initiatives.

RECOMMENDATIONS FOR ALL SOIL HEALTH STAKEHOLDERS

Recommendation 12

Leverage opportunities to embed lessons on soil health (e.g. how it relates to our food, how healthy soils contribute to climate change mitigation, etc.) in the public-school curriculum.

Recommendation 13

Develop public awareness campaigns to showcase the relationships between agriculture, our food, consumer choices, and healthy soils.

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INTRODUCTION

1 · INTRODUCTION

1.1 · EVENT AND REPORT CONTEXT

In June 2021, at the Canada-European Union Leader's Summit, the leaders committed to "launch a series of joint events to promote sustainability, environmental stewardship and climate action in agriculture, within the framework of the Agriculture Dialogue" under the Canada-EU Comprehensive Economic Trade Agreement (CETA)[2]. This series of five events and wrap-up conference, planned for 2021/22, are aimed at exploring the policy context, and showcasing good practices, research and innovation taking place in Canada and the EU when it comes to sustainability and environmental topics in agriculture.

The first workshop, titled Soil Health for Our Future, took place on October 26, 2021, from 9 a.m. until noon ET (15:00 until 18:00 CET). Over 120 soil health stakeholders in Canada and the EU attended the event, including:

- Researchers and academics;
- Government officials;
- Not-for-profit representatives;
- Farmers.

The event was attended by soil health stakeholders from across Canada and the EU, including Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Hungary, Italy, Luxembourg, the Netherlands, Poland, Portugal, Spain, as well as the United Kingdom.

The objectives of the Soil Health for Our Future event were two-fold:

- To enhance collaboration on soil health between EU and Canadian stakeholders representing government, civil society and academia;
- To reinforce mutual learning on soil health, with a focus on biodiversity, carbon sequestration and data collection.

To accomplish these objectives, the Soil Health for Our Future event began with a discussion amongst a panel of EU and Canadian policy experts on the relevant policy context. The event also included collaborative breakout group discussions moderated, and attended, by soil science experts. These breakout groups focused on challenges related to defining and measuring soil carbon sequestration and soil biodiversity, and on ways to enhance understanding and adoption of soil health practices at both the policy and farm levels. (Please see Annex 7.1 for the full agenda.)

The discussions and outcomes from the Soil Health for Our Future event were synthesized to develop this outcome paper. It starts with an overview of the importance of soil health and the global challenges related to soil health. The paper then outlines the relevant soil health policy context in the EU and Canada, as well as joint initiatives and efforts. This section is followed by a deeper dive into the topics of agricultural soil carbon sequestration and biodiversity, first exploring the issues and challenges to resolution before outlining potential solutions. As the restoration and preservation of soil health necessitates a concerted effort involving multiple stakeholders, the paper outlines opportunities to engage citizens in this work. The paper concludes with a set of recommendations for soil health stakeholders in Canada and the EU to collaborate to enhance knowledge and adoption of practices that improve soil carbon sequestration and biodiversity on agricultural soils.

2 Canada-European Union. (June 2021). Canada-European Union Summit – Joint Statement, pp. 3-4. Retrieved from https://pm.gc.ca/en/news/backgrounders/2021/06/15/canada-european-union-summit-joint-statement.

1.2 · SOIL HEALTH: SETTING THE CONTEXT

No matter where you live in the world, life is fundamentally tied to healthy soils[3]. They are needed to produce food, feed and other raw materials, ensure clean water, recycle wastes, and support climate resilience.

Soil health encompasses physical, biological and chemical aspects. Beginning with the physical aspects, healthy soils have an absence of compaction, erosion, sealing and crusting[4]. Turning to the biological and chemical aspects, healthy soils have their nutrients in balance and are not polluted by toxic substances.[5] Healthy soils also contain a diversity of soil biota, including bacteria, fungi, other microorganisms, invertebrate and some vertebrate animals. Healthy soils continuously provide ecosystem services, such as "provid[ing] food and biomass production, including in agriculture and forestry; and absorb[ing], stor[ing] and filter[ing] water and transform[ing] nutrients and substances, thus protecting groundwater bodies."[6]

For the purposes of this paper, the discussion of soil health focuses on soil carbon levels and soil biodiversity, with the recognition that multiple factors influence overarching understandings of soil health.

Soils serve as "a major reservoir of global biodiversity".[7] Soil biota play important roles in such services as decomposition, nitrogen fixation and regulation of greenhouse gas emissions.[8] Soils also serve as a vast reserve for carbon, contributing to climate change mitigation.[9] Agricultural soil carbon sequestration also contributes "to improved soil quality, agricultural productivity, biodiversity and water protection and thus increased resilience against climate change."[10]

Notably, soil health stakeholders recognize that the various components of soil health, such as soil carbon levels and soil biodiversity, are interconnected. The microbes in the soil and other biota are vital for organic carbon cycling in the soil. The microbes use the carbon and other nutrients present in the soil as food. Soils with higher carbon levels usually have more microbes and (in)vertebrate animals, which leads to better functioning soils. Soils with higher carbon levels are typically more effective in terms of water management. So, a change in management practice to address one component of soil health can have ripple effects in other components of soil health. Soil health stakeholders stress we must take an all-inclusive approach to understanding and protecting soil health. We must focus on populations, community interactions and the resulting ecosystem processes and functions.

3 Mission Board for Soil Health and Food. (September 2020). Caring for Soil is Caring for Life, p. 5.

4 Food and Agriculture Organization of the United Nations. (2021). Management and Natural Processes Affecting the Physical Aspects of Soils. Retrieved from: https://www.fao.org/soils-portal/soil-degradation-restoration/global-soil-health-indicators-and-assessment/soil-heath-physical/en/.

5 Food and Agriculture Organization of the United Nations. (2021). Management and Natural Processes Affecting the Biological and Chemical Aspects of Soils. Retrieved from: https://www.fao.org/soils-portal/soil-degradation-restoration/global-soil-health-indicators-and-assessment/soil-heath-biological-and-chemical/en/.

6 European Commission. (2021). EU Soil Strategy for 2030: Reaping the Benefits of Healthy Soils for People, Food, Nature and Climate, p. 4.

7 Food and Agriculture Organization of the United Nations. (2015). Status of the World's Soil Resources: Main Report, p. 10.

8 Food and Agriculture Organization of the United Nations. (2015). Status of the World's Soil Resources: Main Report, p. 127.

9 Coordination of International Research on Soil Carbon Sequestration in Agriculture. (2020). "Get to know more about CIRCASA project". Retrieved from https://www.circasa-project.eu/Home/News-and-events/CIRCASA.

10 Coordination of International Research on Soil Carbon Sequestration in Agriculture. (2020). "Get to know more about CIRCASA project". Retrieved from https://www.circasa-project.eu/Home/News-and-events/CIRCASA.

When our soils are unhealthy, they cannot effectively provide the full range of ecosystem services. Around the world, soil health is threatened by factors such as erosion, declining soil organic matter, compaction, salinization, landslides, sealing for urban development, and contamination.[11]

Agricultural production practices, such as crop rotations, nutrient amendments and tillage, influence soil health. More intense agricultural management systems can result in a decline in soil biodiversity and an increase in diseases and pests.[12] Degradation makes soil less able to withstand extreme weather events and threatens food security and safety.[13]

Our growing global population, expected to be 9.7 billion in 2050,[14] puts more pressure on our soils. We must feed the growing population, while meeting their needs for housing and a host of other goods and services to ensure quality of life. As a result, lands are being converted into annual cropland and urban developments, which affects the health of our soils.

Climate change, too, jeopardizes the health of our soils. For example, rising temperatures and more extreme weather events, such as excessive rainfall or drought, affect the amount of moisture in the soil, which threatens soil biodiversity and, therefore, soil functioning.[15] Rising temperatures may accelerate decay, reducing levels of soil carbon.

Globally, we have cause for concern about soil health. In Europe, for example, between 60 to 70 per cent of soils are unhealthy because of current management practices. Even the most productive soils can be unhealthy, as they have lost multi-functionality (or the capacity to perform a variety of ecosystem functions other than crop production).[16] Other European soils are "unhealthy due to the [direct and] indirect effects of air pollution and climate change."[17]

In Canada, while adopting better practices has already improved soil health in some areas, many opportunities remain to minimize threats or to enhance continuing improvements in indices such as soil organic matter, biodiversity, and soil structure. Pressures from urban development are also leading to decreases in total farmland acreage and soil sealing.[18] In the province of Ontario, for example, which has over half of the country's highest-quality (Class 1) farmland,[19] 175 acres of farmland are lost daily due to urban development.[20]

11 Food and Agriculture Organization of the United Nations. (2015). Status of the World's Soil Resources: Main Report, p. 8.

12 Food and Agriculture Organization of the United Nations. (2015). Status of the World's Soil Resources: Main Report, p. 128.

13 Mission Board for Soil Health and Food. (September 2020). Caring for Soil is Caring for Life, p. 9.

14 United Nations. (n.d.) "Shifting Demographics". Retrieved from https://www.un.org/en/un75/shifting-demographics.

15 Food and Agriculture Organization of the United Nations. (2015). Status of the World's Soil Resources: Main Report, p. 200.

16 For more information on soils' multi-functionality, see European Academies Science Advisory Council. (September 2018). Opportunities for Soil Sustainability in Europe, p. 30.

17 Mission Board for Soil Health and Food. (September 2020). Caring for Soil is Caring for Life, p. 6.

18 Statistics Canada. Table 32-10-0153-01. "Total area of farms and use of farm land, historical data". Retrieved from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210015301.

19 Government of Ontario. (n.d.). "About Ontario". Retrieved from https://www.ontario.ca/page/about-ontario#section-1.

20 Ontario Federation of Agriculture. (2021). Home Grown. Retrieved from https://homegrown.ofa.on.ca/.

2

POLICY CONTEXT

2 · POLICY CONTEXT

2.1 · EU POLICIES

The EU's Common Agricultural Policy (CAP) was established in 1962 as a common policy across all EU countries. The CAP's key focus points are improving agricultural productivity, supporting the economic viability of EU farms, sustainably managing natural resources and managing climate change, and maintaining rural economic resilience. The Common Agricultural Policy facilitates three main activities:

- Income support for farmers that recognizes the non-marketable benefits of farming for communities;
- Market measures to help recover from unforeseeable changes in the market for agricultural goods;
- Rural development programmes to address challenges in rural areas across the EU.

For example, the CAP has mandatory conditions for farmers receiving support that include practices related to preserving soil and enhancing biodiversity.

In 2012, the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) was launched. It "works to foster competitive and sustainable farming and forestry that 'achieves more and better from less'."[21] The EIP-AGRI integrates various funding streams to better leverage resources to reach desired goals. The partnership fosters collaboration between researchers, farmers, businesses, NGOs, advisors, and others.

The European Green Deal charts a path to "make Europe the first climate-neutral continent by 2050",[22] and the Farm to Fork Strategy, released in May 2020, outlines how the agri-food industry will help attain this goal. Through the strategy, the European Commission seeks to reduce the use of pesticides and fertilizers, reduce soil nutrient losses, and increase the amount of farmland under organic production, among other sustainable agriculture goals.[23]

The Horizon Europe Mission "A Soil Deal for Europe" is part of various Green Deal strategies and is a flagship initiative of the long-term vision for the EU's rural areas. The eight objectives of "A Soil Deal for Europe" are as follows:

21 European Commission. (n.d.) "European Innovation Partnership 'Agricultural Productivity and Sustainability'". Retrieved from https://ec.europa.eu/eip/agriculture/en/european-innovation-partnership-agricultural.

22 European Commission. (December 2019). "The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050, boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind". Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/IP_19_6691.

23 European Commission. (May 2020). Factsheet: A Farm to Fork Strategy, p. 1.

1. Reduce land degradation relating to desertification;
2. Conserve and increase soil organic carbon stocks;
3. Stop soil sealing and increase the reuse of urban soils;
4. Reduce soil pollution and enhance restoration;
5. Prevent erosion;
6. Improve soil structure to enhance habitat quality for soil biota and crops;
7. Reduce the EU global footprint on soils;
8. Increase soil literacy in society across the EU.

The mission's overall goal is to establish 100 living labs and lighthouses to lead the transition towards healthy soils. Living labs are "spaces for co-innovation through participatory, transdisciplinary and systemic research".[24] Living labs bring together landowners and managers, as well as several other public and private sector stakeholders to test soil health research questions in real-world conditions. Lighthouses are selected from the living labs as exemplary spaces to showcase solutions, training and communication around the living labs approach and soil health more broadly. A Soil Deal for Europe will apply research and innovation in real-world conditions and grow the adoption of management practices that improve soil health and increase soil literacy amongst the public.

Living labs are

"spaces for co-innovation through participatory, transdisciplinary and systemic research"

To meet the overall goal, the mission has identified actions to be carried out through the Soil Deal for Europe Implementation Plan.

The EU Soil Strategy for 2030, released in November 2021, is another initiative aimed at meeting "climate and biodiversity goals under the European Green Deal".[25] This initiative "sets out a framework and concrete measures for protecting, restoring and sustainably using soils and mobilises the necessary societal engagement and financial resources, shared knowledge, sustainable practices and monitoring to reach common objectives."[26] The strategy provides a policy framework for soil protection in the EU, helping to align the various policy areas related to soil, such as research, agriculture, and pollution prevention.[27] This initiative addresses the main challenges of soil degradation by providing a roadmap to restore soil health and ultimately meet targets related to climate change, food security, biodiversity and food safety. Elements of the EU Soil Strategy will be legally binding, further reinforcing the commitment of EU partners in protecting agricultural soils and improving soil health. This legislative proposal will be tabled by 2023.[28]

24 European Commission. (2020). Proposed Mission: Caring for soil is caring for life, p. 17.

25 European Commission. (n.d.) "Healthy Soils – New EU Soil Strategy". Retrieved from https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12634-Healthy-soils-new-EU-soil-strategy_en.

26 European Commission. (2021). EU Soil Strategy for 2030: Reaping the Benefits of Healthy Soils for People, Food, Nature and Climate, p. 2.

27 European Commission. (2020). New EU Soil Strategy Roadmap, p. 3.

28 European Commission. (2021). EU Soil Strategy for 2030: Reaping the Benefits of Healthy Soils for People, Food, Nature and Climate, p. 4.

Another initiative under the European Green Deal is the Zero Pollution Action Plan. It outlines actions to reach key milestones by 2030 to meet the goal of zero pollution by 2050. The target for soil health is to improve "soil quality by reducing nutrient losses and chemical pesticides' use by 50%".[29]

EU stakeholders also contribute to international initiatives. For example, the International Research Consortium (IRC) in soil carbon seeks to advance research and innovation, and soil carbon monitoring and reporting.[30] The EU is also a partner and the main donor of the Food and Agriculture Organization of the United Nations (FAO) Global Soil Partnership that promotes sustainable soil management.

2.2 · CANADIAN POLICIES

In June 2021, Canada's Net-Zero Emissions Accountability Act (the Accountability Act) received royal assent. The act formalized a commitment to achieve net-zero emissions by 2050, along with associated five-year emissions reduction targets.

In July 2021, Canada submitted its enhanced Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change. The NDC commits Canada to reduce greenhouse gas (GHG) emissions by 40 to 45 per cent below 2005 levels by 2030 under the Accountability Act.

The Canadian Agricultural Partnership (CAP) is a five-year (2018-2023) federal-provincial-territorial initiative to strengthen the agricultural sector. The CAP includes regionally specific cost-shared programs between the federal, provincial and territorial governments. Most programs include initiatives dedicated to environmental sustainability. For example, most provinces and territories have an Environmental Farm Plan program, which helps farmers identify environmental risks on the farm, develop action plans to reduce these risks, and implement management practices to improve environmental outcomes. Consultations are underway for Canada's next five-year Agricultural Policy Framework.

The Government of Canada is also committed to supporting sustainable development through the 2020-2023 Federal Sustainable Development Strategy, and this is reflected in Departmental Sustainability Strategies. Agriculture and Agri-Food Canada's (AAFC's) Departmental Sustainable Development Strategy (DSDS) recognizes CAP and the living labs initiatives as activities that support effective action on climate change. The DSDS outlines commitments to supporting and conducting research related to agriculture and climate change.

Finally, the publication *A Healthy Environment and a Healthy Economy – Canada's strengthened climate plan to create jobs and support people, communities and the planet* sets out measures to achieve environmental and economic goals. The climate plan recognizes the initiatives and programs described above as tangible actions towards economic and environmental progress. The plan reflects the scale and urgency of the climate crisis and points to the power of nature to support resilient communities and healthy families; the health of the environment is strongly tied to economic health.

29 European Commission. (n.d.) "Zero Pollution Action Plan". Retrieved from https://ec.europa.eu/environment/strategy/zero-pollution-action-plan_en.

30 Coordination of International Research on Soil Carbon Sequestration in Agriculture. (February 2021). "CIRCASA - Towards an International Research Consortium". Retrieved from https://www.circasa-project.eu/Home/News-and-events/CIRCASA-Towards-an-International-Research-Consortium.

As part of Canada's strengthened climate plan, the new Agricultural Clean Technology Program enables the development and adoption of clean technologies that support efforts to reduce emissions and improve carbon sequestration in Canada's agriculture and agri-food sector. The program includes two streams:

An adoption stream

which provides funding for purchasing and installing clean technologies (e.g. green energy technologies, precision agriculture, and bioeconomy-based solutions) that reduce greenhouse gas emissions;

A research and innovation stream

which supports pre-market innovation to enable research and development of clean agricultural technologies.

The Agricultural Climate Solutions (ACS) program will help meet the 2030 emissions reduction target. The ACS program is a partnership between AAFC, Natural Resources Canada and Environment and Climate Change Canada to develop projects that fund natural climate solutions.

Two streams exist under the ACS – the Living Labs Initiative (discussed in further detail below) and the On-Farm Climate Action Fund. The latter is a three-year initiative that will provide direct funding for farmers to adopt management practices (nitrogen management, cover cropping and rotational grazing practices) that contribute to emissions reductions and increase carbon storage.

The Living Labs Initiative and On-Farm Climate Action Fund are two streams under the Agricultural Climate Solutions program to help meet the 2030 emissions reduction target.

2.3 · EU AND CANADA JOINT INITIATIVES AND EFFORTS

At the local level, Canadian and EU farmers are stewards of the land. They help to support soil health by using such beneficial management practices (BMPs) as:

- Cover cropping;
- Reducing tillage;
- Growing perennial crops;
- Applying organic amendments, such as manure or municipal compost.

Canada and the EU cooperate on the living labs initiative to advance knowledge on agrology and soil health.

The protection and improvement of soil health necessitates the involvement of a diversity of stakeholders at various geographic levels. Living laboratories bring together multidisciplinary teams of farmers, scientists, and other stakeholders to co-develop, test, and monitor BMPs and new technologies in a real-life context. Since 2018, Canada and the EU have cooperated on the living laboratories initiative on the topics of agrology and soil health.

As global challenges require joint solutions with international partnerships, Canadian and EU partners discussed how to best collaborate to support soil health. Their suggestions were as follows:

Build international collaboration into regional and national soil initiatives

Building international collaboration components into soil initiatives from the outset will ensure an intentional approach to partnering to improve soil health across Canada and the EU.

Consider climate data from international regions

Tapping into existing multi-lateral relationships, soil health initiatives in Canada and the EU should consider regions with similar climatic conditions to inform soil health indicators.

Collaboration should occur on micro and macro levels

At the micro level, researchers and policymakers can share best practices and successes for adopting management practices that improve soil health. Peer networks between Canada and the EU can serve as a soil health policy and programming community of practice. At the macro level, Canada and EU partners can work together to lead global efforts to address soil degradation.

3

ISSUES AND CHALLENGES TO RESOLUTION

3 · ISSUES AND CHALLENGES TO RESOLUTION

3.1 · AGRICULTURAL SOIL CARBON SEQUESTRATION

When BMPs are employed, agricultural soils can serve as carbon sinks "through formation of soil organic matter".[31] These BMPs include the application of organic amendments (e.g. manure), the use of cover crops and the growing of diverse crop rotations. It takes time to build soil organic matter and soil carbon levels, so it can be challenging for farmers to "see" the differences in their fields and to reap the longer-term benefits that increased soil carbon levels bring for their operations.

MEASURING SOIL CARBON

Our current systems for measuring soil carbon sequestration are limited. We cannot measure small changes in soil carbon levels. Our current methods of extracting and preparing samples for analysis is extremely laborious; as soil carbon varies widely over short distances in an agricultural landscape, many measures need to be taken to arrive at a meaningful understanding. We have commercial verification systems, some of which rely heavily on remote sensing (e.g. of vegetation health) and often lack sufficient ground truthing to ensure accuracy. Carbon levels often also vary with soil depth, so remote-sensing approaches are likely not applicable to understanding the amount of soil carbon in deeper soil layers.

Given our limitations in our modeling and measurement systems, we risk overestimating soil's ability to store additional carbon, as it takes many years before we can "see" if the modeling systems accurately predicted the increased soil carbon levels. We must ensure we make plausible, realistic estimates, recognizing that, while increased agricultural soil carbon sequestration will help to address atmospheric carbon dioxide levels, this approach must be used alongside other BMPs to address the issue of climate change. We need to implement proactive measures to reduce greenhouse gas emissions, rather than simply relying on reactive measures.

Limitations to measuring soil carbon:

- Cannot measure small, incremental changes.
- It takes time for farmers to "see" results of increased carbon capture.
- Current methods of measurement are costly and time-consuming.

RELATIONSHIPS BETWEEN SOIL CARBON AND OTHER NUTRIENTS AND FARM MANAGEMENT PRACTICES

Our soil carbon levels are not static; just as BMPs can help to build soil carbon, so too can the cessation of BMPs lead to the depletion of soil carbon. For example, carbon will be released into the atmosphere if a farmer decides to plow grasslands to grow arable crops. Climate change (e.g. rising temperatures and

31 Jarecki, M. K. and Lal, R. (2003). "Crop Management for Soil Carbon Sequestration." Critical Reviews in Plant Sciences, 22(6), p. 471. Retrieved from: https://doi.org/10.1080/713608318.

drought) also affects our ability to store carbon in soils, both because it may reduce the amount of carbon entering the soil as plant biomass, and because higher temperatures may accelerate decay (loss) of carbon already stored. So, any measurement and verification systems must be able to monitor changes in soil carbon levels over time.

Soils must maintain stoichiometric balance; we cannot build and maintain carbon in soils if other nutrients are at insufficient levels. In some countries, for example, nitrogen and or phosphorous can be limiting factors; farmers must add these nutrients to their soils to maintain and/or build desired carbon levels. Farmers must understand the stoichiometric balance of soils and have the resources to access the necessary nutrients for their fields. However, adding nitrogen to soils may result in the release of N_2O, a potent greenhouse gas, which may offset some of the benefits of the soil carbon gain.

3.2 · SOIL BIODIVERSITY

Our soils contain a diversity of organisms, including:[32]

- Micro-organisms (e.g. bacteria and fungi);
- Micro-fauna (e.g. nematodes and protozoa);
- Meso-fauna (e.g. acari and springtails);
- Macro-fauna (e.g. earthworms and termites).

These organisms interact within the soils, as well as "with the various plants and animals in the ecosystem".[33]

The "community" of organisms varies by the soil, but they are crucial to support the functioning of ecosystems, contributing to such important processes as soil carbon sequestration and nutrient cycling.

MEASURING SOIL BIODIVERSITY

As the "community" of organisms in our soils is so complex and varied, our ability to measure and compare soil biological health between systems is still effectively in its infancy. Given these measurement challenges, we do not yet have a clear definition of soil biodiversity. The lack of definition hinders this field of research. The public and farmers typically do not have a clear understanding of soil biodiversity and its importance, and governments generally do not yet have strong policies to support soil biodiversity.

Key challenges:

- Methods to measure soil biological health in their infancy;
- No clear definition of soil biodiversity;
- Lack of awareness of importance of soil biodiversity to overall soil health.

32 Food and Agriculture Organization of the United Nations. (2021). "Soil Biodiversity." FAO Soils Portal. Retrieved from: https://www.fao.org/soils-portal/soil-biodiversity/en/.

33 Food and Agriculture Organization of the United Nations. (2021). "Soil Biodiversity." FAO Soils Portal. Retrieved from: https://www.fao.org/soils-portal/soil-biodiversity/en/.

FARMERS AND SOIL BIODIVERSITY

As with soil carbon levels, it takes time for farmers to see the differences in their soil and the changes resulting from improved soil biodiversity. This situation makes it difficult to demonstrate the value to farmers for adopting new practices. If farmers face risks of economic losses, even if only in the short-term, they may be unlikely to invest in new equipment, training, or time spent on new practices.

This challenge is exacerbated by the fact that farmers typically do not receive enough information about the importance of soil biodiversity in supporting sustainable agricultural soils. Farmers also may receive mixed messaging from different stakeholders. The decline in government extension services contributes to the knowledge gap; while private industry stakeholders may recognize the importance of soil biodiversity, they may lack the resources to advance farmer education, particularly if this education is tangential to the products and services the companies sell. For example, crop input companies might not see soil biodiversity as fundamentally correlated with seed or crop protection products.

3.3 · SOIL CARBON AND SOIL BIODIVERSITY: SHARED CHALLENGES

As our discussions of agricultural soil carbon sequestration and soil biodiversity have shown, we still have much to learn about the intricacies of soil health.

Soil health issues span multiple government departments, such as research, agriculture, and environment. Given the range of players involved and the differing priorities between departments, it can be difficult to develop a "comprehensive and coherent policy framework to protect land and soil".[34] Relatedly, we lack sufficient coordination between various organizations and jurisdictions, which results in inconsistencies and duplication in efforts in soil health research.

Socioeconomic contexts and soil management decisions vary by geographic location,[35] and the parameters of soil health vary between natural and agricultural soils. So, a single, overarching solution to soil health challenges is not practical.

> *"Many of the challenges facing agriculture today are really beyond the capacity of one nation; [we] need collaboration."*
>
> Quote from a workshop participant

BARRIERS TO ON-FARM ADOPTION

We lack sufficient knowledge transfer from the scientific community to the public and agricultural communities. As a result, farmers may not know the latest scientific advances in soil health that can benefit their operations.

Even if farmers have this knowledge, they can face barriers in applying it in their operations. Farmers can face economic and policy barriers when adhering to BMPs or trying innovative soil health practices. For example,

34 European Commission. (2020). New EU Soil Strategy Roadmap, p. 2.

35 Food and Agriculture Organization of the United Nations. (2015). Status of the World's Soil Resources: Main Report, p. 5.

the switch from conventional tillage to conservation tillage or no-till can necessitate capital expenditures for new equipment. The use of cover crops involves additional costs for seed and more time needed to plant and perhaps terminate the cover crop. Notably, too, while these BMPs will improve soil health, farmers will typically see the benefits in the longer term, rather than in the short term. Management practices that help to increase carbon levels can even lead to short-term decreases in yields, although the yields should increase again in the longer term. It can be difficult for farmers to cashflow these short-term implications. The challenge may feel even more acute for farmers who cultivate rented land without the security of a longer-term tenancy. Thus, it is important for landowners to also learn about soil carbon sequestration, soil biodiversity, etc. to understand the investments and efforts necessary to preserve and improve the health of soils.

The size of farm operations can also play a role in management decisions. For example, farms in the Canadian Prairies are much larger than in many parts of the EU and in other parts of Canada, which influences the type of equipment that can be used. These larger farms can benefit from the economy of scale for equipment purchases. In Canada, operators of these larger farms tend to apply for Canadian Agricultural Partnership funding, as they can afford the farmer contribution for the cost-share component, and are more likely to have dedicated resources to complete the application.

Finally, farmers face challenges reconciling often competing demands. On the one hand, society demands readily available and cheap food. On the other, public opinion can be critical of modern agricultural practices, such as the application of some crop protection products. Policymakers should be mindful of these conflicting demands on the agricultural industry as governments chart the path forward regarding the protection and improvement of soil health.

4
SOLUTIONS

4 · SOLUTIONS

4.1 · AGRICULTURAL SOIL CARBON SEQUESTRATION

We must develop more accurate models and frameworks for monitoring and measuring agricultural soil carbon sequestration. These models and frameworks must span national, regional and local scales and reflect the real-world context. For example, Canadian farms likely need remote sensing because of the scale of the operations, but our remote-sensing technologies must be refined and ground-truthed to ensure accuracy. The models and frameworks must be holistic, considering the range of factors (e.g. wind, water and tillage erosion) that affect soil carbon sequestration and situating these factors in the broader context of soil health and agricultural emissions, such as methane and nitrous oxide. The models and frameworks must be dynamic so they can be updated as our knowledge about soil carbon sequestration evolves. Workshop participants identified AAFC's Holos, which "estimates greenhouse gas emissions based on information entered for individual farms"[36] as a good example of a holistic, farm-scale tool.

In the development of these modeling systems and frameworks, we must move beyond data collection at benchmark sites located at research centres and encompass actively farmed fields in a real-world context to ensure we have a broad and realistic range of data.

It may be helpful to explore the use of coupled models like what has been developed in climate change science. New technologies, such as soil spectroscopy (i.e. "the study of the interaction between matter and electromagnetic radiation"[37]), also offer potential.

We can advance our collective knowledge if we bring together the research underway in Canada and the EU to share lessons learned. We have shared problems in measuring soil carbon; we can collaborate to seek shared solutions.

As we continue to refine our knowledge and as agricultural management practices continue to evolve, we must establish baseline measurements of agricultural soil carbon sequestration and track how these measurements change over time. Only by accurately verifying the amount of soil carbon stored can we credibly demonstrate its contribution to climate mitigation.

We must move beyond data collection at benchmark sites located at research centres and encompass actively farmed fields in a real-world context to ensure we have a broad and realistic range of data.

Not all countries use the same methodologies for agricultural soil carbon sequestration and it will therefore be important to use common approaches as our work advances; these approaches would include more standardized and transparent methodologies and terminology. For example, it would be beneficial to reach a consensus on how to properly express carbon sequestration in biophysical, technical, and economical terms or units (i.e. increased soil carbon per unit area, per unit yield, etc.).

36 Agriculture and Agri-Food Canada. (January 24, 2020). "Holos software program". Retrieved from https://agriculture.canada.ca/en/scientific-collaboration-and-research-agriculture/agricultural-research-results/holos-software-program.

37 Food and Agriculture Organization of the United Nations. (2021). "Spectroscopy". Retrieved from: https://www.fao.org/global-soil-partnership/glosolan/soil-analysis/dry-chemistry-spectroscopy/en/.

Given the limitations of our current modeling systems for soil carbon, it may be helpful to identify indicators for maintaining or increasing soil carbon levels. If farmers and other land managers are implementing BMPs for carbon sequestration, we should see an increase in soil carbon over time. Scientists could collaborate on identifying applicable indicator(s) for soil carbon sequestration through the identification of BMPs or other visible markers. This approach has precedents in other aspects of the agricultural industry. For example, the presence of farmland birds is a well-accepted indicator for biodiversity in the EU. Farm management data may serve as a proxy for measuring progress in soil carbon sequestration. These proxies must be properly calibrated against actual carbon measurements to ensure they are useful indicators.

We must continue to advance research efforts to address knowledge gaps, such as how to improve carbon stocks in dryland systems. This research will be particularly important for understanding carbon sequestration in these systems under a changing climate.

In terms of which lands to target for carbon sequestration, soil health stakeholders emphasized the importance of a two-pronged approach. First, we must preserve the existing high-carbon soils, such as forests and native grasslands, to avoid releasing more carbon into the atmosphere. We must also minimize the loss of carbon stores in remaining "natural" ecosystems, such as forests, grasslands, and wetlands by minimizing conversion to cropland and other uses. To increase carbon sequestration, we should first work with degraded lands, such as eroded, crusted or compacted lands, or soils with salinity. The soils that have lost the most carbon are the ones that have the most to gain.

At the farm level, cover cropping, diverse crop rotations, and organic amendments can increase the amount of carbon in degraded soils. The planting of trees and hedgerows are also good practices for increasing carbon sequestration and other agroforestry practices, such as tree intercropping and silvopasture, show promise. When implementing practices to improve soil carbon levels, farmers must take a systems approach and remain mindful of the broader ramifications. For example, manure as a source of carbon must be managed carefully to avoid unintended impacts on water quality or GHG emissions.

4.2 · SOIL BIODIVERSITY

Given the importance of soil biodiversity to soil health, it is critical that we continue to conduct research in this area. We must strive to develop a clear definition of soil biodiversity to support knowledge transfer and policy development.

Relatedly, we should seek opportunities to standardize approaches to measuring soil biodiversity while recognizing the differences in systems and soils around the world. For example, every soil will have a slightly different carrying capacity for soil biodiversity, and earthworms are not relevant indicators of soil health in all ecosystems. Indeed, analysing the whole soil biota is not necessarily the solution to measuring soil biodiversity, as biotas will vary between geographic areas.

Scientists agree it is important to measure the soil biodiversity network complexity as well as keystone species (i.e. species that have significant impacts on their ecosystems). This work should be done in combination with studying soil chemical properties, enzyme activities, microbial biomass, and aggregate stability. This work involves characterizing how the soil microbiome is structured and understanding what types of multitrophic networks are formed; in essence, this approach involves applying network theory to soil biology. Applying this theory to soil biodiversity would necessitate a reliance on sophisticated, and potentially costly, research methods such as next generation sequencing (NGS) and a range of bioinformatic techniques including metagenomics, transcriptomics, and targeted gene sequencing. Another approach to measuring biodiversity is studying specific bioindicators based on soil invertebrates, such as earthworms. These bioindicators are easier to interpret and cheaper to perform compared to next-generation sequencing.

Scientists also look at the functioning of the entire system. To support this approach, we must conduct more research on the diversity and functions of soil organisms. Another pathway to measuring soil health could be considering proportions of different organisms (e.g. bacteria and fungi) in the soil. Focusing on farm management practices may be another way to “measure” soil biodiversity, since we know some BMPs (e.g. diverse crop rotations, keeping the soil covered, etc.) have benefits for protecting and improving biodiversity. If farmers and other land managers implement BMPs for soil biodiversity, we should see an increase in this diversity over time. Regardless of the final approach to this measurement system, the development of a such a standardized measurement system will enable soil biodiversity to enter policy agendas more easily.

Scientists must conduct long-term monitoring of soil biodiversity to develop baselines. If scientists can communicate changes over time (i.e. compared to the baseline), they can attract media attention to the topic. To strengthen the significance of this messaging for the agricultural community, scientists should also link soil biodiversity data with other informations, such as productivity and yield. Scientists should conduct parallel studies to consider different aspects of the soil, such as biodiversity and physics.

Scientists should conduct long-term monitoring of soil biodiversity to develop baselines so that, if changes over time are detected, these findings can bring more attention to the topic of soil biodiversity.

As the scientific community continues its work, it must strengthen its messaging. Scientists must be able to clearly communicate why soil biodiversity matters. Scientists also need to be able to share their research with the agricultural community in an approachable manner. For example, scientists can begin conversations about soil health with a focus on topics, such as soil structure and nematodes, that farmers can easily envision. While farmers are dedicated to the sustainability of their farm operations, they typically do not understand all the soil health science. For example, farmers can benefit from learning how their soil functions from a biodiversity perspective. Communication efforts must by dynamic and ongoing as the scientific understanding of soil biodiversity evolves.

4.3 · SOIL CARBON AND SOIL BIODIVERSITY: SHARED SOLUTIONS

EXCHANGING KNOWLEDGE

Stakeholders in the EU and Canada recognize they have shared aims, face similar obstacles to implementation and see similar proposed solutions to protecting and improving soil health. Canada and the EU, however, operate on different scales because of their geographic reach. As a result, we have the opportunity for synergies in learning from our cross-Atlantic colleagues. Canada and the EU should increase networking and knowledge exchange about soil biodiversity and function, soil carbon sequestration, and evidence-based policies. This knowledge exchange will enable Canada and the EU to further leverage resources to support soil health.

STRUCTURING RESEARCH STUDIES

Scientists should continue to develop and refine long-term studies to demonstrate the long-term benefits of management practices to support soil health. In both the EU and Canada, farmers' adoption of reduced tillage and cover crops is a success story from this approach.

Increased interaction and collaboration among EU and Canadian scientists will improve the science on soil biodiversity and soil carbon sequestration. Sharing knowledge, skills and techniques among scientists in different countries will encourage new breakthroughs and advances in these research domains. For example, scientists from different countries could consult on experimental design and develop collaborative field experiments on soil biodiversity and soil carbon sequestration in their respective countries.

In our ongoing efforts to protect and improve soil health, we must draw on the expertise of a broad range of scientists. Soil scientists, of course, are key players in this work, but social and behavioural scientists should also be involved. As farmers must implement BMPs in their farm operations, the issues of agricultural soil carbon sequestration and soil biodiversity are not simply technical in nature. To increase the uptake of BMPs, we must understand the human responses to the issues to recognize the societal and behavioural considerations. We must also understand that change takes time, and support farmers as they implement new practices.

Scientific knowledge transfer to, and within, the farm community is crucial to protecting and restoring soil health. A multi-pronged approach to this work should include:

- Leveraging farmer-to-farmer connections;
- Strengthening connections between farmers and researchers (e.g. with farm visits);
- Offering free, independent and accredited (i.e. government-funded) advices for farmers.

Scientists must share the latest research and findings on BMPs in an approachable manner. Communication materials should explain the linkages between soil carbon, soil biodiversity, and soil health. Communication materials should enable farmers to make evidence-based decisions. These materials should make the business case for soil health BMPs by communicating the linkages between soil health and economic (i.e. yields) and environmental (i.e. ecosystem services) benefits. As the scientific knowledge in this field is constantly evolving, we must keep the channels of communication open so farmers can gain information in real time.

Scientists, and other stakeholders communicating about soil health, must be mindful of the framing of their outreach. Sometimes, messaging focuses on the limitations of some modern agricultural practices. The more effective approach, however, focuses on empowering farmers by emphasizing how they can be part of the solution to soil health challenges. Of course, scientists must clearly identify the underlying causes of the problems, as we cannot solve problems without knowing the causes.

And information sharing should not be simply a linear transfer from scientists to farmers; rather, we need to foster strong ties between farmers and researchers and create opportunities for both groups of stakeholders to learn from one another. Scientists must leverage farmers' knowledge of soils and how BMPs affect their crops to advance research.

Living laboratories are a great example of how to effectively build connections between the scientific and farm communities; living labs take a circular, dynamic approach to research, involving the end users (i.e. farmers) in the design of practices that can be implemented in real-life settings. In Canada, for example, the living labs have begun to create a wide network of regional collaborations that co-develop, test and implement management practices that best store carbon, mitigate climate change and reduce greenhouse gases.

The living laboratories and lighthouses can be better leveraged to advance knowledge across Canada and the EU, and around the world more broadly. It would be helpful to develop a network of these living labs and lighthouse farms, perhaps modeled after such global research networks as the Nutrient Network (NutNet) and Drought Network (Drought-Net).[38] The more formalized network could enable the sharing of knowledge. However, any joint initiatives must recognize and respond to the local challenges and solutions. For example, some regions might be grappling with too much nitrogen in their soils, while others might suffer from nitrogen deficiencies.

BUILDING ON GLOBAL NETWORKS

Scientists around the world collect data on soil biodiversity and soil carbon sequestration. But this data is often only accessible at local, national or regional levels. For example, the EU has its Land Use/Cover Area frame statistical Survey Soil (LUCAS Soil), which looks at physio-chemical properties of topsoil across the EU.[39] In Canada, AAFC has its SeqDB, which "tracks the complete workflow and provenance chain from source specimen information through DNA extractions, PCR reactions, and sequencing leading to binary DNA sequence files."[40]

Researchers are striving to move to more of a global scale. The global Soil Biodiversity Observation Network (Soil BON), for example, collaborates "with the Global Soil Biodiversity Initiative and other global and regional partners to make available the soil biological and ecosystem observation needed to ensure living soil resources are sustainably conserved and managed and can support essential human needs."[41] And the FAO is preparing to launch a global soil biodiversity network.

We need to build on these local, regional, and developing global efforts to create systems that can "cross talk" to enable data integration and the combining of datasets. Shared global access to data will help to accelerate knowledge and research. While it may be logical to begin this work by sharing data about soil biodiversity within relevant circles and data about soil carbon sequestration within other circles, it would ultimately be most beneficial to twin efforts and interweave these types of data. Some stakeholders suggested that an understanding of soil health should be based on three pillars: carbon, water infiltration, and soil biodiversity. These three pillars should provide a foundational approach to soil health monitoring.

THE ROLE OF POLICYMAKERS

Policymakers also have key roles to play in protecting and improving soil health. As with scientists, policymakers should consider soil health within a broader context. For example, air quality and emissions standards have had a significant secondary impact on soil health by reducing the deposition of sulfur and metals. So, policymakers should take a more holistic approach to environmental policies. Relatedly, policymakers across all government departments, not just environmental and agricultural departments, should understand the importance of soil health and consider how this issue relates to their portfolios.

38 Nutrient Network. (n.d.). "Nutrient Network: A Global Research Cooperative". Retrieved from: https://nutnet.org/; Drought-Net. (n.d.) "Welcome to Drought-Net!" Retrieved from: https://drought-net.colostate.edu/.

39 Orgiazzi, A., Ballabio, C., Panagos, P., Jones, A. and Fernández-Ugalde, O. (November 23, 2017). "LUCAS Soil, the largest expandable soil dataset for Europe: A Review." European Journal of Soil Science. Retrieved from: https://onlinelibrary.wiley.com/doi/full/10.1111/ejss.12499.

40 Bilkhu, S. et al. (August 26, 2017). "SeqDB: Biological Collection Management with Integrated DNA Sequence Tracking". Biodiversity Information and Science Standards. Retrieved from: https://biss.pensoft.net/articles.php?id=20608.

41 Group on Earth Observations. (n.d.). "Soil BON". Retrieved from: https://geobon.org/bons/thematic-bon/soil-bon/.

Relatedly, we must take a holistic and "all inclusive" approach to soil health; our compartmentalizing of efforts can be limiting. If we break soil health challenges and solutions down into too small of pieces, the overarching solutions might not be as sustainable as desired. For example, an increase in organic production systems might offer benefits for soil health, but some farmers use copper as a pesticide in organic operations. This heavy metal can build up in the soil over time, which can cause further complications. So, policy efforts to support soil health must consider the "bigger picture".

Policymakers must also mindful that farming practices, including BMPs, can vary by geographic region, so policies must balance the desire for a given outcome at a regional or national scale with the local considerations.

Policymakers should continue to explore options to support farmers in their work; these supports can include subsidies, tax incentives, and cost-share programs. Policymakers should consider options to support farms of all sizes, as it will take a diversity of operations to meet our needs for food, feed and other raw materials. Government supports should include a system of checks and balances to ensure farmers continue to adhere to the BMPs.

Two points of view emerged related to the early adopters, or those farmers who already adhere to BMPs. One approach is to simply see these BMPs as the norm, while another approach is to reward these early adopters alongside those farmers who make changes in their operations thanks to government supports. Some stakeholders suggested examining how farmers manage their systems holistically, rather than focusing on individual practices, as a way to support early adopters.

Government supports may be a short-term solution; over time, farmers should see the benefits in their operations from the improved soil health and increased resiliency to climate change. Significantly, too, government supports should be viewed as only one tool in the toolbox; it simply is not feasible to fully fund climate change mitigation work through the government. Government supports should work alongside industry incentives, carbon offset programs, etc.

Indeed, the whole food chain should help to support farmers, and some companies are already contributing to these efforts. For example, General Mills aims to "advance regenerative agriculture on 1 million acres of farmland by 2030."[42] The company launched pilot programs to support farmers in implementing regenerative agricultural practices. Many companies are committing to science-based targets, which can help to support and enhance soil health.

Current and new certification programs for agricultural products could be another contributor to soil health efforts. Some processors use these programs to discourage poor practices by setting strict requirements that farmers must meet to secure contracts. Alternatively, processors can offer farmers premiums for sustainably produced or "climate-friendly" agricultural products.

And, of course, farmers are central to efforts to protect and improve soil carbon levels and soil biodiversity. Farmers should continue to use and adopt such BMPs as cover crops, reduced tillage or no till, diverse rotations, agroforestry, and the application of organic amendments. Farmers should, when possible, retain existing trees, grasslands and wetlands on their farms.

42 General Mills. (2021). "Regenerative Agriculture". Retrieved from: https://www.generalmills.com/en/Responsibility/Sustainability/Regenerative-agriculture.

5

ENGAGING CITIZENS TO PROTECT AND RESTORE SOIL HEALTH

5 · ENGAGING CITIZENS TO PROTECT AND RESTORE SOIL HEALTH

Given the fundamentality of soil health for life on earth, the question of preserving and protecting soil health should not be relegated simply to the purview of farmers, scientists and policymakers; rather, this work must be undertaken by society at large. Public-facing communications and engagement around the importance of soil health should:

- Speak to the relationship between agriculture, our food, consumer choices, and healthy soils;
- Speak to the broad array of ecosystem services provided by healthy soils;
- Use accessible, plain language;
- Leverage lessons learned from other successful public engagement initiatives (e.g. communications around plastics in oceans).

Public awareness campaigns can highlight how interconnected ecosystems are through soils. Soils influence our air and water quality, and air and water quality affect our soils and food production. These campaigns can also demonstrate how food production, consumer choices, and food production are interconnected. Farm management practices affect our soils and the food we eat, and consumers' choices and levels of food waste also profoundly affect our agricultural soil health. We are all intertwined through the flows of energy, carbon, and nutrients. Highlighting these connections may help to strengthen relationships and understanding between urban and rural populations.

Public awareness campaigns should begin engaging citizens at a young age. We should embed lessons on soil health as it relates to the food we eat and the soil's role in climate change mitigation in public education. Public outreach should also occur through mainstream media campaigns. Enhanced public awareness can lead to soil health becoming part of mainstream thinking and could lead to more informed consumer choices. For example, if consumers understand how the food they eat is connected to the land, they might be more willing to purchase sustainably produced or "climate-friendly" products.

6

CONCLUSIONS WITH RECOMMENTATIONS

6 · CONCLUSIONS WITH RECOMMENDATIONS

As healthy soil fundamentally supports life on earth, a diversity of stakeholders must collaborate to protect and improve soil health. Farmers, of course, are vital to this work as stewards of the land. Many farmers already employ soil health BMPs and are dedicated to continual learning and improvement. Scientists continue to advance our knowledge of such soil health topics as soil carbon sequestration and soil biodiversity, and policymakers strive to support soil health through their work. The public also has a role to play by better understanding the ties between agriculture, our food, consumer choices, and healthy soils, and making informed decisions regarding consumption practices and food waste.

Through a concerted effort – involving farmers, scientists, policymakers, and the public across Canada and the EU – we can make tangible advances in protecting and improving our soil health. The following recommendations will help the scientific community, policymakers, and all soil health stakeholders chart an action-oriented path ahead in this vital field.

RECOMMENDATIONS FOR THE SCIENTIFIC COMMUNITY

1. **Strengthen the scientific networking between the EU and Canada to address the gaps in knowledge about soil biodiversity and soil carbon sequestration.**
   - 1.1. Invite Canadian soil biodiversity and soil carbon stakeholders to join EU Soil Observatory technical working groups.
   - 1.2. Reduce barriers to the sharing of soil health data between Canada, the EU and other global partners, building on efforts such as the global Soil Biodiversity Observation Network and the Worldsoils project.
   - 1.3. Develop a global network of living laboratories and lighthouse farms, modeled after such initiatives as the Nutrient Network and Drought Network.
     - 1.3.1. Inspired by twin towns or sister cities, "twin" living labs in the EU and Canada that have similar climatic and growing conditions to undertake joint research projects.
2. **Develop a shared model and framework for monitoring and measuring agricultural soil carbon sequestration that is realistic and holistic.**

   This model and framework must consider both the range of factors that affect soil carbon sequestration and how soil carbon levels fit into the broader context of soil health and agricultural emissions.
3. **Collaborate to identify indicators for soil carbon sequestration, based on shared understandings of agricultural BMPs or other visible markers.**

   These indicators must be calibrated against actual carbon measures to ensure their usefulness.
4. **Develop a shared definition of soil biodiversity that is flexible to accommodate the differences in systems and soils around the world.**
5. **Establish collaborative long-term field experiments in Canada and the EU for monitoring soil biodiversity and soil carbon levels.**
   - 5.1. Use living labs as sampling sites.
   - 5.2. Conduct baseline measurements to enable the tracking of change over time.
   - 5.3. Commit to conducting regular testing (e.g. every five years) at these sites to track changes in soil biodiversity and soil carbon levels. This information will enable researchers to see if and to what extent soil carbon levels and biodiversity are improving.
   - 5.4. Explore opportunities to leverage and twin existing funding programs to support this long-term joint research.

6. **Leverage the expertise of social and behavioural scientists to facilitate communication with farmers.**

   Learn how to best support them in adopting soil health BMPs and how to incorporate farmers' grounded knowledge into scientific research.

7. **Strengthen networks and two-way lines of communication between soil health researchers and farmers.**

   7.1. In collaboration with social scientists, conduct more direct outreach to farmers, such as through farm visits and hands-on demonstrations (e.g. soil cores or pit digs). Explore how farmers can contribute to scientific advancements and emphasize how farmers are key to the protection and improvement of soil health.

   7.2. Collaborate to identify locally relevant and accessible indicators for use in discussions with the farm community about the importance of soil biodiversity.

   7.3. Leverage research and farm networks to conduct studies and disseminate findings that help to make the business case for soil health BMPs. For example, studies can highlight and verify the links between soil health and yields.

RECOMMENDATIONS FOR POLICYMAKERS

8. **Take a holistic approach to environmental policies (i.e. develop and review policies related to air quality, soil health and water quality together) and a systems approach to policies and programs to support soil health (i.e. consider policies and programs related to soil carbon sequestration and soil biodiversity together).**
9. **In policy and programming design, balance the desire for given soil health outcomes at a regional or national scale with flexibility to accommodate local conditions and BMPs.**
10. **Develop farm support programs that are accessible for farm operations of varying sizes and that consider how farmers manage their systems holistically.**
11. **Exchange best practices on evidence-based soil health policy and program mechanisms between Canada and the EU so each government can apply lessons learned to their initiatives.**

RECOMMENDATIONS FOR ALL SOIL HEALTH STAKEHOLDERS

12. **Leverage opportunities to embed lessons on soil health (e.g. how it relates to our food, how healthy soil contributes to climate change mitigation, etc.) in the public-school curriculum.**
13. **Develop public awareness campaigns to showcase the relationships between agriculture, our food, consumer choices, and healthy soils.**

    13.1. Demonstrate how farmers and consumers are entwined through the flows of energy, carbon and nutrients throughout our environments.

    13.2. Showcase the two-way flow of influence between agriculture and consumers: demonstrate how farmers' management practices and consumer choices (e.g. product selection and food waste) both profoundly affect our agricultural soil health.

    13.3. Highlight success stories about the good work underway on farms (e.g. reduced tillage, cover cropping).

7

ANNEXES

7 · ANNEXES

7.1 · WORKSHOP AGENDA

Plenary session I

SOIL HEALTH FOR OUR FUTURE: POLICY CONTEXT

09:00-09:45/15:00-15:45

Moderator

BRONWYNNE WILTON

PhD

- Andrea Vettori, DG ENV, European Commission: Policy overview and EU soil strategy
- Alexandre Lefebvre, Agriculture and Agri-food Canada: Climate smart Canadian agriculture
- Gaelle Marion, DG AGRI, European Commission: Supporting farmers for soil protection
- Kevin Norris, Agriculture and Agri-food Canada: Canada’s strengthened climate plan
- Kerstin Rosenow, DG AGRI, European Commission: Horizon Europe Mission “A soil deal for Europe”

Break – 5 minutes (transition to parallel sessions)

Parallel sessions

AGRICULTURAL SOIL CARBON SEQUESTRATION – SOIL BIODIVERSITY

09:50-10:50/15:50-16:50

Agricultural soil carbon sequestration

1A

Session in English

Possibility to express oneself in French

Moderator

HENRY JANZEN

Honorary research associate, Agriculture and Agri-Food Canada

Rapporteur

EDWARD GREGORICH

Agriculture and Agri-Food Canada

Soil biodiversity

2A

Session in English

Possibility to express oneself in French

Moderator

LORI PHILLIPS

Research scientist, Agriculture and Agri-Food Canada

Rapporteur

CLAUDIA GOYER

Research scientist, Agriculture and Agri-Food Canada

1B	2B
Session in English	Session in English
Moderator **WIM VAN DER PUTTEN** Research scientist, Netherlands Institute of Ecology	**Moderator** **ARWYN JONES** Joint Research Centre of the European Commission
Rapporteur **EMILIA HANNULA** Assistant professor, Leiden University Institute of Environmental Sciences	**Rapporteur** **ALBERTO ORGIAZZI** Joint Research Centre of the European Commission

Break – 10 minutes (transition back to Zoom webinar)

Plenary session II

REPORTING BACK FROM THE BREAKOUT SESSIONS

11:00-12:00/17:00-18:00

Moderator

Bronwynne Wilton

PhD

Rapporteur

Emilia Hannula

Leiden University Institute of Environmental Sciences

Edward Gregorich

Agriculture and Agri-Food Canada (AAFC)

Alberto Orgiazzi

Joint Research Centre of the European Commission

Claudia Goyer

AAFC

Reactions

Kevin Norris

Agriculture and Agri-Food Canada

Gaelle Marion

DG AGRI, European Commission

Alexandre Lefebvre

Agriculture and Agri-Food Canada

Andrea Vettori

DG ENV, European Commission

7.2 · BIOGRAPHIES OF PANELLISTS, MODERATORS AND RAPPORTEURS

SENIOR EXPERT AND WORKSHOP MODERATOR

Dr Bronwynne Wilton is the principal and lead consultant at Wilton Consulting Group in Fergus, Ontario. Bronwynne holds a PhD in rural studies and is experienced in managing comprehensive, full value-chain research and stakeholder engagement processes related to sustainability, innovation, strategic planning, regional agriculture and food strategies. Bronwynne is currently the project lead for the development of the Canadian Agri-Food Sustainability Initiative (CASI).

PLENARY SESSION I PANELLISTS

Andrea Vettori is deputy head of the Land Use and Management unit in the Directorate-General (DG) for the environment of the European Commission. Before that, he was part of the team who prepared and conducted the negotiations on the 7th EU Environment Action Programme. In the same DG, he also worked on strategic planning and policy coordination, on resource efficiency, and on an environmental program for small and medium-sized enterprises.

Alex Lefebvre is the associate director of environment and climate change science and policy integration in Agriculture and Agri-Food Canada's (AAFC's) Science and Technology Branch (STB). Alex joined STB after over 20 years spent in the department's Strategic Policy Branch working on environmental issues related to agriculture.

Gaëlle Marion is the head of unit for Conception and Consistency of Rural Development in the Directorate-General for Agriculture and Rural Development of the European Commission. She has been involved in the development of the Common Agricultural Policy since 2007, both on rural development and farm income support, and horizontal aspects such as governance, delivery models and networking. Her past career as secretary general of an European association for the development of mountain areas gave her in-depth expertise on territorial challenges and local development.

Kevin Norris. Since late 2019, Kevin has been the acting director of the Environment Policy team within the Strategic Policy Branch at AAFC. During this time, the Environment Policy team advanced several agri-environmental policies related to natural climate solutions, agricultural clean technologies, and increasing on-farm adoption of beneficial management practices, including as part of Canada's strengthened climate plan.

Kerstin Rosenow is the head of the Research and Innovation unit in the Directorate-General for Agriculture and Rural Development (DG AGRI) of the European Commission, where she is responsible for programming, managing and monitoring agricultural research under Horizon Europe and the European Innovation Partnership for Agricultural Productivity and Sustainability. Previously, she was head of unit in the EC Research Executive Agency, managing the implementation of the project portfolio for Horizon 2020 Societal Challenge 2. This initiative spanned food security, sustainable agriculture and forestry, marine, maritime, and inland water research and the bioeconomy.

PARALLEL SESSION MODERATORS

Arwyn Jones conducts research to support policies for sustainable soil management in the European Commission. With a background in quaternary geology and a PhD in remote sensing of semi-arid soils, Arwyn has spent almost the last 30 years in land surface research. Since 1998, he has specifically dealt with soil-related issues at EU and global levels.

Henry Janzen is an honorary research associate with AAFC, based in Lethbridge, Alberta. He has studied the flows of carbon through land, seeking ways of managing those flows to enhance soil health and withhold carbon from the atmosphere.

Dr Lori Phillips is a research scientist in microbial ecology with AAFC, based in Harrow, Ontario. Her research program investigates the soil biological processes that maintain and enhance agro-ecosystem productivity and sustainability.

Wim van der Putten is head of the department Terrestrial Ecology at the Netherlands Institute of Ecology and special professor in functional biodiversity at Wageningen University and Research. He studies vegetation-soil-aboveground interactions and their feedbacks with consequences for biodiversity and ecosystem functioning.

PLENARY SESSION II RAPPORTEURS

Alberto Orgiazzi is a soil biotechnologist by education. He curated the publication, by the European Commission's Joint Research Centre, of the first Global Soil Biodiversity Atlas. Since 2016, Alberto is working on the largest assessment of soil biodiversity in EU by means of DNA-based techniques.

Dr Claudia Goyer is a soil microbiologist at AAFC in Fredericton, New Brunswick. Her research program focuses on understanding the importance of diversity of microbial communities on plant disease, and soil ecosystem functioning including nitrogen cycling and greenhouse gases.

Edward Gregorich is a soil scientist with Agriculture and Agri-Food Canada based at the Ottawa Research and Development Centre. His research focuses on carbon cycling in soil and characterization of soil organic matter. He is also involved in research to support local food systems in the Inuit community of Makkovik.

Dr Emilia Hannula is an assistant professor at the Leiden University Institute of Environmental Sciences working on soil ecology and carbon cycling. She is tightly linked with Netherlands Institute of Ecology and is a guest researcher there. She has special expertise in soil microbial analyses and her research focuses on tracking the fate of carbon – and the role of soil life in carbon cycling – in grasslands, forest soils and arable soils using for example stable isotopes.

7.3 · PARALLEL SESSION SPEAKERS AND NOTETAKERS

CARBON SEQUESTRATION 1A

NAME	AFFILIATION	ROLE
Sebastian Belliard	OMAFRA	Speaker
Harm Brinks	DEPLHY	Speaker
Claire Chenu	INRAE (France)	Speaker
David Lobb	University of Manitoba	Speaker
Emanuele Lugato	European Commission	Speaker
Brent Preston	Farmers for Climate Solutions	Speaker
Marie-Élise Samson	University Laval	Speaker
Birgitta Vainio-Mattila	Ministry of Agriculture and Forestry	Speaker
Lucy Clearwater	Agriculture and Agri-Food Canada	Notetaker

CARBON SEQUESTRATION 1B

NAME	AFFILIATION	ROLE
Kirsten Hannam	Agriculture and Agri-Food Canada	Speaker
Trevor Harris	Coilltroim Biodynamic Farm	Speaker
Yvonne Lawley	University of Manitoba	Speaker
Eliisa Malin	Baltic Sea Action Group	Speaker
Marla Riekman	Manitoba Agriculture and Resource Development	Speaker
Jean-François Soussana	INRAE	Speaker
Christian Steiner	Authority of Land Reform, Lower Austria	Speaker
Laurent Van Arkel	Van Arkel Farms	Speaker
Bert VandenBygaart	Agriculture and Agri-Food Canada	Speaker
Benjamin Vallin	DG AGRI, European Commission	Notetaker

SOIL BIODIVERSITY 2A

NAME	AFFILIATION	ROLE
Edmundo Barrios	FAO	Speaker
Margot de Cleen	Ministry of Infrastructure and Water Management, Netherlands	Speaker
Kari Dunfield	University of Guelph	Speaker
Stefano Mocali	CREA, Italy	Speaker
Franck Stefani	Agriculture and Agri-Food Canada	Speaker
Joann Whalen	McGill University	Speaker
Mary-Cathrin Leewis	Agriculture and Agri-Food Canada	Notetaker

SOIL BIODIVERSITY 2B

NAME	AFFILIATION	ROLE
Gordon Bell	University of Guelph	Speaker
Michael Berger	WWF	Speaker
Ananda Fitzsimmons	Regeneration Canada	Speaker
Tandra Fraser	Agriculture and Agri-Food Canada	Speaker
Alfred Grand	Farmer	Speaker
Mellany Klompe	Soil Heroes Foundation	Speaker
Annette Vibeke Vestergaard	SEGES	Speaker
Betty Lee	DG AGRI, European Commission	Notetaker

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