SYNTHESIS REPORT

CARBON OFFSETS AND PATHWAYS TO A MORE CIRCULAR FOOD ECONOMY IN GUELPH-WELLINGTON

ACKNOWLEDGEMENTS

THIS REPORT was authored by Clarissa Samson and Tara Campbell from the David Suzuki Foundation. Expertise from carbon economics specialist Aldyen Donnelly was instrumental in providing theoretical estimates of the carbon sequestration potential in Guelph-Wellington and two surrounding counties. Yannick Beaudoin, director of innovation at the David Suzuki Foundation, oversaw the work and provided direction and commentary. The David Suzuki Foundation, County of Wellington and the City of Guelph would like to thank the interviewees and workshop participants for their time and the invaluable perspectives.

EXECUTIVE SUMMARY

BACKGROUND AND SCOPE

Our Food Future is a program in partnership with the City of Guelph and the County of Wellington that aims to circularize their local food system. The team at Our Food Future and over 150 collaborator organizations have been carrying out a suite of projects in line with this ambition. As part of this, in 2022, Our Food Future plans to begin a new stream of work that would endeavour to provide incentives to farmers, producers, and food businesses that are carrying out sustainable practices that would contribute to a more circular economy. There was a particular interest in encouraging farmers and producers in Guelph-Wellington to adopt farm management practices that are understood to sequester carbon in soils and promote soil health.

Our Food Future was initially interested in the possibility of carbon credits as a way of incentivizing farmers and producers to adopt regenerative agriculture practices. With limited familiarity with carbon credits and carbon markets, the team at Our Food Future approached the David Suzuki Foundation (DSF) with a request to conduct initial exploratory research that would support them in framing next steps for their new stream of work. They wanted to know about the potential benefits and pitfalls of participating in carbon offset markets, and the steps needed to establish carbon crediting for soil carbon sequestration in Guelph-Wellington. They were also curious about other initiatives that could be pursued alternatively or in addition to carbon markets that would encourage the adoption and spread of carbon-sequestering farm management practices.

METHODOLOGY

To prepare a scan of perspectives on carbon markets and other initiatives to encourage carbon-sequestering agricultural practices, DSF conducted semi-structured interviews with 19 soil, agriculture and carbon accounting experts as well as program managers involved in initiatives at different points in the food supply chain. These interviews were complemented by a selective literature review to better understand stakeholder perspective and elicit key factors that might inform next steps for Our Food Future as they pursue this new stream of work. Following the initial drafting of a report synthesizing these perspectives, DSF led two workshops with the Our Food Future team and potential advisors for this work to validate findings and discuss their envisioned priorities for Guelph-Wellington investment planning and programmatic design. Theoretical carbon estimates were also calculated to understand the potential incremental increase of carbon storage in Wellington and two surrounding counties.

HIGH LEVEL FINDINGS

Theoretical carbon estimates revealed that there is potential to sequester carbon in Guelph-Wellington soils that could be leveraged to generate carbon credits. However, several critical perspectives on ecosystem and carbon offset markets arose during interviews that demonstrated the complexity of using carbon markets as an incentive mechanism and to guarantee certain quantities of carbon sequestration:

- Current technology to quantify carbon stored in soils is expensive and would require cost-effective approaches to ensure that the measurement and transaction costs still make it feasible for a farmer to be paid and so that costs do not outweigh the benefits.
- Carbon offsets are often not resulting in real greenhouse gas emissions reductions.
- People responsible for the "on the ground change" are not the ones being compensated in carbon markets.
- Farmers who are already practicing sustainable agriculture and/or have already adopted some of the processes that would not qualify for carbon offset credits.
- Nature-based carbon offsets will always face issues of uncertainty around permanence, additionality and leakage.

In addition to carbon markets, interviewees raised several other considerations and questions for the Our Food Future team as they move forward with this stream of work:

- Paying for changes in farm management practice may be more straightforward than paying for the amount of carbon sequestered. However, there is also a need to respect the knowledge and autonomy of farmers as they determine how best to manage their farms.

- Adopting new farm management practices can require learning and reskilling. *How might farmers/producers in Guelph-Wellington best learn about and develop interest in different management practices?*
- The transition to a circular food economy will require policy, regulation, and programs that could relieve some pressure/risk from the farmers. *What other supports may be needed to support farmers and producers to shift their practices?*
- Soil carbon sequestration may not be the highest leverage point intervention for reducing emissions from the food system. *Based on current emissions, what other opportunities exist for reducing emissions from the food system in Guelph-Wellington that may have higher benefits than solely focusing on soil carbon?*

These findings were presented to Our Food Future through a draft version of this report, as well as through two workshops with potential advisors to shape next steps for this new stream of work.

NEXT STEPS

The goal of Our Food Future has always been to build a circular economy for the food system starting in the testbed of Guelph-Wellington. Carbon markets were seen as a potential mechanism to release financial value from beneficial farm management practices and food waste reduction, thereby supporting the good work of farmers and food businesses. However, through the David Suzuki Foundation's research and workshops with potential advisors, Our Food Future learned more about the inherent and complex challenges of carbon offset markets. With this context in mind, Our Food Future will use their next phase of work to develop and prototype an idea adjacent to the regulated carbon markets.

They are currently working on a concept for an assessment framework that can grow into a certification program, one in which participants could receive a certification level for their farm, business or organization based on a matrix built from a series of best practices. As with the Sustainable Development Goals, they aim to capture the full connectedness of circular economy values by including metrics to assess biodiversity, food security and social justice in addition to specific climate impact measures.

By prototyping this kind of assessment framework, Our Food Future hopes to champion the actions of early adopters, and to demonstrate that the circular economy serves the climate economy. If successful, it should make good works visible and contain enough rigour to act as a pre-qualifier for any system or funder seeking to encourage this work. A robust framework for this prototype is expected in fall 2022.

LIST OF ACRONYMS			
Acronym	**Definition**	**Acronym**	**Definition**
AAFC	Agriculture and Agri-Food Canada	GHG	Greenhouse gas
BMPs	Best management practices	SOC	Soil organic carbon
CDM	Clean development mechanism	SOM	Soil organic matter
DSF	David Suzuki Foundation	RA	Regenerative agriculture

TABLE OF CONTENTS

1. INTRODUCTION

Like other municipal and regional governments in Canada, the County of Wellington and the City of Guelph (hereafter referred to as Guelph-Wellington) is grappling with climate change. Wellington County is an agricultural centre in Southwestern Ontario with over 2,500 farms and food businesses covering 466,400 acres. [1]The agricultural sector has the highest emissions in Wellington County (not including city emissions) of any sector. [2]Transformation of the agricultural and food sector in efforts to mitigate climate change does not only mean looking to reduce emissions through manure management, reduced use of fossil fuels throughout the supply chain for transport and machinery, food waste reduction, but also realizing the potential for soils to sequester carbon through changes in farming practices and land management, particularly regenerative agricultural practices.

OVERVIEW OF OUR FOOD FUTURE PROGRAM

Our Food Future is an initiative co-led by the City of Guelph and Wellington County and involves over 150 collaborator organizations. Funded through Infrastructure Canada's Smart Cities Challenge, Our Food Future is reimagining local food systems and working toward achieving circular food economy. Our Food Future would like to initiate a new program of investigation and experimentation in 2022 that examines carbon markets, and how they could incentivize the adoption of regenerative agriculture, and carbon-sequestering agricultural practices.

To determine next steps for this work, Our Food Future engaged the David Suzuki Foundation to undertake research to better understand the national and global landscape of the carbon offset market and how it might be used a tool to increase adoption of more sustainable management practices for agricultural production. This research involved identifying potential risks as well as opportunities in the Guelph-Wellington context. This report provides a summary of the preliminary research that has been used to inform the opportunities and questions Guelph-Wellington might pursue in the full scope of work. The report provides a summary of the carbon offset market in relation to soil organic carbon, as well as existing perspectives of the carbon offset landscape to inform Guelph-Wellington's investment planning.

METHODS

This exploratory piece was intended to inform next steps in regards to programmatic planning for Guelph-Wellington. Table 1 below summarizes the key areas of interest that would support Guelph-Wellington to understand both the carbon offset landscape as well as other ongoing initiatives that have similar objectives.

---

2 See FUTURE FOCUSED: A climate change mitigation plan for the County of Wellington for more detailed emissions breakdowns

Table 1 Key questions and methods that scaffolded the exploratory research encapsulated in this report

KEY QUESTIONS	POTENTIAL AREAS OF INQUIRY	METHODS
What are the key considerations for entry into the carbon offset market (both voluntary and compliance) to support adoption of regenerative agriculture practices?	• Factors that might influence an enabling environment (e.g. policy frameworks, market, political will and key actors) for soil carbon to enter the voluntary/compliance carbon offset market • Verification, monitoring, and reporting measures exist and would be required • Existing aggregating models and who is involved in running them • Existing processes and protocols in place that might support agricultural sector and soil carbon markets • Shortfalls that exist around carbon offset markets in general, and more specifically for soil carbon • Potential value of carbon given current prices and the project future value	Literature review Interviews Carbon sequestration and carbon pricing analysis
What can be learned from other global and national initiatives for the Guelph and Wellington County vision?	• Contributing factors that lead to successful outcomes • Potential next steps for Guelph/Wellington County to consider • Lessons learned from processes currently being undertaken (including areas where this has not been don't well and criticisms) • Risks and limitations of using carbon offsets crediting systems as a mechanism for incentivizes low carbon agricultural transformational change • Benefits of ecological services that offer sustained value	Literature review Interviews
What other innovative practices might be employed to encourage carbon reduction and more circular food economies in Guelph and Wellington County?	• Opportunities and challenges for other innovations to support a more circular economy • Recommendations for potential programs Our Food Future could pursue	Literature review Interviews

SEMI-STRUCTURED INTERVIEWS AND LITERATURE REVIEW

To prepare this report, DSF conducted semi-structured interviews with 19 soil, agriculture and carbon accounting experts as well as program managers involved in initiatives at different points in the food supply chain. Interviewees were largely based in Canada (with a particular concentration in Guelph), with a few projects and experts internationally. Soil scientists, nature-based solutions–related project leads, carbon credit issuers, farmers and farmer advocates who were available during the period of this study were consulted for recommendations on current literature. Farmers provided their perspectives on carbon markets and carbon-sequestering agricultural practices. These interviews were complemented by a selective literature review to better understand stakeholder perspective and elicit key factors that might inform Guelph-Wellington decision-making.

Interviewees were also asked to speak about their experience of initiatives that worked well, and opportunities for regional and municipal level government engagement. Section 6 of the report summarizes a number of relevant initiatives applicable for Guelph-Wellington where lessons learned might apply to future programming in the region.

THEORETICAL CARBON SEQUESTRATION AND CARBON PRICING ANALYSIS

Theoretical carbon estimates were calculated to understand the potential incremental increase of carbon storage in Wellington and two surrounding counties (Bruce and Grey). This was based on conservative incremental changes using recent soil science literature, to understand possible increase in soil organic carbon storage and CO2 sequestration potential of soil following agricultural practice change. Census data was used as the baseline measurement of SOC,[3] [4] and it was assumed that the maximum incremental increase was between 0.2 and 0.6 per cent a year upon adoption of best management practices. This value was agreed on based the accepted rate of increase by soil scientists who were consulted for this analysis. The calculations were quantified on a 20-year timeframe, assuming that adoption rates could increase to 75 per cent over that period. The incremental increase per acre was calculated and the economic value of carbon was calculated based on current and projected carbon credit prices per tonne. [5] It is a general estimate based on a theoretical incremental potential increase in carbon storage, given current adoption rates, SOC storage and assuming proven practices are adopted in a context-specific way. For example, some plots have already adopted certain practices that could increase SOC content, while other plots will have a higher incremental potential if management practices that enhanced SOC storage were all adopted at the same time. These calculations and a discussion can be found in Annex A.

WORKSHOPS

Following the initial drafting of the report, DSF led two workshops to validate findings and discuss envisioned priorities for Guelph-Wellington investment planning and programmatic design. Each workshop consisted of 4-5 participants from relevant fields, to draw on expertise from a wide range of stakeholders. Ideas and key themes were grouped together and presented to Guelph-Wellington using Mural, a web-based platform, to note what the participants felt were top priorities for Guelph-Wellington. During the workshop, participants also had the opportunity to provide feedback to initial ideas for proposed programs through the Our Food Future work. Links to the notes from the workshop can be found in Annex B of the report.

3 Available here: http://54.229.242.119/GSOCmap/

4 Source: https://search.open.canada.ca/openmap/5931f6f0-0008-4b0c-94d7-a1ff596182c5)

5 These calculations do not prescribe a specific practice, nor should these quantifications be used as a predictive measure for potential carbon credit revenue.

REPORT STRUCTURE AND AUDIENCE

This report is a synthesis of the perspectives people share around the carbon offset market, how to incentivize good practice, and factors to consider for deciding next steps for Guelph-Wellington programmatic and investment planning. The intended audience is program-level leads and relevant project managers within the City of Guelph and the County of Wellington as well as project partners and advisors who may be supporting this stream of work.

The report aims to provide:

- An overview of carbon offset markets, how they work and the actors involved
- A discussion of carbon market challenges and further lines of inquiry
- Highlights of relevant cases around the world that have similar objectives
- Implications of these findings for Our Food Future's investment and programmatic planning
- Estimates of carbon sequestration potential in Guelph-Wellington

2. REGENERATIVE AGRICULTURE AND SOIL CARBON

Challenges for humanity to produce healthy food for a growing population have led to farming approaches such as organic agriculture, climate-smart agriculture, sustainable intensification and, more recently, regenerative agriculture.[6] The global food system is releasing about 25 per cent of annual anthropogenic greenhouse gas emissions due to heavy use of pesticides and fertilizers and fossil fuels and large proportions of food waste. Contrary to Canada's national targets under the Paris Agreement, GHG emissions from Canadian agriculture are projected to increase to 2030.[7]

Regenerative agriculture is a concept that has recently emerged as a way of addressing the need for a holistic approach to farming. It does not have a comprehensive scientific definition, but most literature focuses on the process-based definitions of RA, which assume a few main agricultural practices: the integration of crops and animals, the use of no-till agriculture and the use of cover crops.[8] Overall, there is a focus on soil health and improvement of nutrient cycling through increase in soil organic matter, as well as the overall quality and health of the land. RA has also taken on a principles-based definition that promotes an adaptive management approach where specific practices or processes will depend on the ecological dynamics of the particular region or even a particular square metre of land. RA has a strong focus on enhancing soil functions to increase soil carbon sinks to impart climate and economic resilience. Different from "sustainable," the term "regenerative" focuses on the improvement of ecosystem functions and capabilities rather than maintaining ecosystem functions.[9]

6 Schreefel, L., Schulte, R. P. O., de Boer, I. J. M., Schrijver, A. P., & van Zanten, H. H. E. (2020). Regenerative agriculture – the soil is the base. Global Food Security, 26(August), 100404. https://doi.org/10.1016/j.gfs.2020.100404

7 De Laporte, A., Schuurman, D., & Weersink, A. (2021). Costs and Benefits of Effective and Implementable On-Farm Beneficial Management Practices that Reduce Greenhouse Gases (Issue February).

8 Newton, P., Civita, N., Frankel-Goldwater, L., Bartel, K., & Johns, C. (2020). What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes. Frontiers in Sustainable Food Systems, 4(October), 1–11. https://doi.org/10.3389/fsufs.2020.577723

9 Sanyal, D., & Wolthuizen, J. (2021). Regenerative Agriculture: Beyond Sustainability. International Journal on Agriculture Research and Environmental Sciences, 2(1), 1–2. https://doi.org/10.51626/ijares.2021.02.00007

WHAT ENHANCES SOIL ORGANIC CARBON CONTENT?

Soil organic carbon represents a pool of carbon larger than terrestrial biomass and atmospheric carbon combined.[10] Understanding sequestration potential for natural climate solutions involves understanding how climate, land use and the various soil properties affect the maximum storage potential of SOC. Several factors make up the potential soil organic carbon storage in soil, whereby each property shares a relationship with the other (e.g., increased moisture leads to increase porosity). Carbon stocks over a given period are dependent on the soil's maximum capacity to hold carbon, often termed as the saturation level, as well as the average annual rate at which carbon stock gains can be achieved. This means that very healthy and well-tended soils could be close to their carbon stock saturation point, and incremental gains that are associated with change of practice would likely be small. Soils, however, that are dehydrated and have faced long histories of "extractive" management practices could reach larger incremental gains in carbon stocks under improved management practices and/or with changes in land use (e.g., tree planting in unproductive crop or grasslands). SOC concentrations in soil are also dependent on depth of measurement (i.e., there variations in soil concentration deeper into the ground). Below is a list of physical soil properties that affect the SOC content, as the loss of soil carbon is often linked to the deterioration of soil physical properties.[11]

- **Moisture retention (soil water content):** Soil's capacity to hold water will also determine SOM. Alternatively, an increase in SOM also increases the porosity of soil and enhances water storage capacity. It is estimated that a one per cent increase in organic matter can add as much as 16,000 gallons (approximately 60 566 litres) of water storage capacity per acre (or 144,000 litres per hectare).[12]
- **Microbial activity:** Interactions between plants and microbes at the plant-soil interface. This is important for nutrient acquisition.[13]
- **Clay content:** Major portions of SOC are retained through clay-organic matter interactions. Clay is the inorganic part of the soil that binds to organic carbon.[14]
- **Bulk density:** How compact the soil is, which is calculated as the dry weight of soil divided by its volume. Generally speaking, soils with rich organic matter will have a lower bulk density.[15]
- **Soil depths:** Typical soil surveys will account for a soil depth of about one metre when quantifying SOC. There is evidence that SOC can increase with depth if SOM is transferred to deeper soil levels via subsoil microorganisms.[16]
- **Porosity:** The fraction of soil volume that is taken up by pore space, which facilitates the movement of air and water in the soil. For example, pores are necessary to ensure space for microorganisms in the soil environment, and affect soil carbon sequestration.[17]

10 Janzen, H.H., 2015. Beyond carbon sequestration: soil as conduit of solar energy. European Journal of Soil Science 66, 19–32. https://doi.org/10.1111/ejss.12194

11 Jiao, S., Li, J., Li, Y., Xu, Z., Kong, B., Li, Y., & Shen, Y. (2020). Variation of soil organic carbon and physical properties in relation to land uses in the Yellow River. 1–12. https://doi.org/10.1038/s41598-020-77303-8

12 White, C. (2020). Why Regenerative Agriculture? American Journal of Economics and Sociology, 79(3), 799–812. https://doi.org/10.1111/ajes.12334

13 Zhao, M., Zhao, J, Yuan, J., Hale, L., Wen,T., Huang, Q., Vivanco, J.M., Zhou, J., Kowalchuk, G.A., & Shen, Q. (2020). Root exudates drive soil-microbe-nutrient feedbacks in response to plant growth. Plant, Cell, and Environment 44:613-628. https://doi.org/10.1111/pce.13928

14 Matus, F. J. (2021). Fine silt and clay content is the main factor defining maximal C and N accumulations in soils : a meta - analysis. Scientific Reports, 1–17. https://doi.org/10.1038/s41598-021-84821-6

15 https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053256.pdf

16 The Depth Distribution of Soil Organic Carbon in Relation to Land Use and Management and the Potential of Carbon Sequestration in Subsoil Horizons. https://doi.org/10.1016/S0065-2113(05)88002-2

17 Chapter One - Soil organic carbon dynamics: Impact of land use changes and management practices: A review. https://www.sciencedirect.com/science/article/abs/pii/S0065211319300343

Other contributing factors:

- **Land use type:** Cropland, grassland and/or forest landscapes will affect the SOC concentrations in the soils.
- **Climate type:** Tropical, temperate and/or Mediterranean climates.

Extreme climate events have major impacts on agriculture, and various regions of the Canada are being affected in different ways. Some areas are experiencing longer periods of drought, while other areas are experiencing an increased frequency and intensity of flooding events. However, soil has the capacity to recover its quality following natural or anthropogenic perturbations, which implies that soil can regain its quality following physical or chemical soil degradation. This includes unsustainable, more conventional agricultural practices that deplete SOC.[18]

3. CARBON OFFSET MARKETS

Carbon offsets were first introduced in 1995 as a market mechanism for the Kyoto Protocol that could serve as a cost-effective approach to climate change mitigation. The Clean Development Mechanism was developed as part of Article 12, which allowed the implementation of emissions-reduction projects to earn a saleable certified emissions-reduction credit.[19] These emissions reductions could then be counted toward meeting a country's climate target. Nature-based carbon offsets rely on natural ecosystems to sequester carbon from the atmosphere, primarily forest management and/or restoration projects. More recently, agricultural soils are gaining more attention for their ability to store and sequester carbon.

Carbon offsets involve paying others to reduce emissions. However, carbon offsets do not result in direct emissions reductions from the investor, but trade where emissions reductions occur, which is why it is so important for each offset credit to actually achieve the claimed reduction each credit represents (i.e., 1 credit = 1 metric tonne of CO2 equivalent emissions reduced or removed from the atmosphere). Carbon offset systems is different from emissions trading where the exchange between two entities is covered by an emissions cap, with one entity reducing more of their emissions and selling the excess to another. This is the trade part of the cap and trading between countries under the Paris Agreement.[20] Offsets, in contrast, support specific emissions projects that are permitted by an offset program and the project is required to prove additionality (i.e., evidence that emissions reductions would not have otherwise occurred without the offset credit).

Compliance offset programs are generally regional or national cap-and-trade schemes. These are mandatory systems regulated by national, regional or provincial law that require certain emissions sources to achieve compliance with regulations on GHG emissions reductions. Examples include California's cap-and-trade program[21] and Regional Greenhouse Gas Initiative,[22] and the European Union Emissions Trading Scheme.[23]

18 Lal, R. (2015). Restoring Soil Quality to Mitigate Soil Degradation. 5875–5895. https://doi.org/10.3390/su7055875

19 https://unfccc.int/process-and-meetings/the-kyoto-protocol/mechanisms-under-the-kyoto-protocol/the-clean-development-mechanism

20 https://unfccc.int/topics/what-are-market-and-non-market-mechanisms

21 https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program

22 https://www.rggi.org/

23 https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets_en

Voluntary offset programs allow for offsets outside of a regulatory regime. This might include businesses, governments, NGOs, academic institutions and/or individuals that purchase offsets via voluntary offset markets.

In 2016, Canada adopted the Pan-Canadian Framework[24] on Clean Growth and Climate Change to deliver commitments under the Paris Agreement. The Greenhouse Gas Pollution Pricing Act[23] came into force in June 2018, which required all provinces and territories to implement carbon pricing systems that met federal benchmarking criteria established by Environment and Climate Change Canada or would be subject to the federal pricing system. Pricing carbon is one measure in Canada that is being used to reduce emissions as part of the implementation of the Pan-Canadian Framework. As an alternative to paying the full carbon price for emissions above the threshold, some provinces will allow emitters to purchase offset credits.

Under the Greenhouse Gas Pollution Pricing Act, Canada published a draft Greenhouse Gas Offset Credit System Regulations in March 2021.[26] Canada's Federal Greenhouse Gas Offset System is under development in order to better regulate the use of offsets through voluntary emissions reductions as a way of incentivizing offset credit generation. The system is being set up to encourage more cost-effective GHG emissions reductions and removals from activities that are not covered by the carbon pollution pricing and ones that go beyond legal requirements.[27] Environment Canada published draft protocols, that have undergone recent public consultation periods. The federal offset protocol will set out a consistent approach for quantifying emissions for a given project, including rules for establishing a baseline for approved offset project activities. This is intended to clarify which approved project activities will generate credits under the federal GHG offset system. A set of recognized and accepted offset programs and protocols under provincial authorities could qualify as recognized units under the federal OBPS. Guidance is available here.[28]

CARBON MARKET PROCESSES, AGRICULTURE

Below is a summary of the processes and key actors involved in carbon offset transactions. Requirements will depend on whether offsets are purchased through the compliance or voluntary offset market. Most enthusiasm for crediting soil carbon centres on agricultural practices involving reduced tillage intensity, planting cover crops and improving grazing management. While these all have the potential to increase soil health and reduce emissions, the specific practices that can sequester the most carbon is difficult to determine as it varies based on the soil properties and interactions with SOM. This also implies that adoption of a practice doesn't not necessarily equate to additionality, but often times is used as a proxy for estimating carbon sequestration.

24 https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html

25 https://laws-lois.justice.gc.ca/eng/acts/G-11.55/

26 https://canadagazette.gc.ca/rp-pr/p1/2021/2021-03-06/html/reg1-eng.html

27 https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system.html

28 https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/list-recognized-offset-programs-protocols.html

PROJECT DESIGN AND CARBON OFFSET REGISTRIES

Various project registries involve project developers or farmers to enlist carbon removal projects that would enable them to sell the carbon offsets to a potential buyer (i.e., corporations and/or industries). Registries track offset projects and issue offset credits to each unit of emission reduction or removal that is verified and certified.[29] A serial number is assigned to each verified offset credit. However, if carbon offsets are purchased given regulated GHG emissions obligations, certain carbon offsets will need to be regulated from project design to implementation in accordance with the registry's protocols. For example, Gold Standard's (voluntary market project registry) process includes a preliminary check phase early in the process to see if the project is likely to succeed and the project idea is viable. The certification process could take several months and/or years from project design to carbon offset issuance. The process typically involves a stakeholder consultation phase, requiring an audit process to review project design, and a monitoring plan to demonstrate compliance with registry rules, which also includes the need for an independent third-party verification process. Farmers have typically sought out support from project developers to help navigate this process.

ISSUANCE AND PROTOCOLS

Offset credits are issued for reductions achieved by a particular project, whereby the project must demonstrate that it has achieved reductions by following predefined rules and procedures. Certain protocols will include soil sampling requirements, how to prove additionality and other safeguard measures on project activities (e.g., data protection measures and environmental and social safeguards). At present there are over a dozen protocols for soil carbon that exist to specify requirements projects must abide by in order to claim credits that can be sold to buyers. Commentary on the quality and robustness of each protocol, or the number of purchases made through different registries, is beyond the scope of this research piece. However, all carbon offset programs require the application of rigorous quantification, verification and enforcement criteria to provide evidence that the integrity of GHG emissions reductions is not compromised.[30]

Given the lag time between project implementation and issuance of offsets by registries, projects are typically financed through emission-reduction purchase agreements, which can be front-loaded payments or payments made once activities have achieved GHG reductions. The latter option is often referred to as "results-based climate finance." Given the risk of the former option, carbon offsets are usually much lower than the issued carbon offsets on the market.

ONGOING MONITORING AND MEASUREMENT

As noted above, in order to earn credits for incremental soil and above-ground carbon stock realized from adopting regenerative agricultural technology practices, the initial requirement would be to begin collecting and storing appropriate data. Under most carbon credit protocols, the operators would need to be able to share verifiable data for three- to five-year periods. However, this varies between protocols,

29 https://www.offsetguide.org/understanding-carbon-offsets/carbon-offset-programs/registries-enforcement/

30 Broekhoff, D., & Zyla, K. (2008). Outside the Cap: Opportunities and Limitations of Greenhouse Gas Offsets. World Resources Institute, Climate and Energy Policy Series, December, 12.

31 Piñeiro, V., Arias, J., Dürr, J., Elverdin, P., Ibáñez, A. M., Kinengyere, A., Opazo, C. M., Owoo, N., Page, J. R., Prager, S. D., & Torero, M. (2020). A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes. Nature Sustainability, 3(10), 809–820. https://doi.org/10.1038/s41893-020-00617-y

32 Cesar, R., Paustian, K., Collier, S., Baldock, J., Burgess, R., Creque, J., Delonge, M., Dungait, J., Ellert, B., Frank, S., Goddard, T., Govaerts, B., Grundy, M., Henning, M., Izaurralde, R. C., Mcconkey, B., Porzig, E., Rice, C., Searle, R., … Jahn, M. (2019). Quantifying carbon for agricultural soil management: from the current status toward a global soil information system. Carbon Management, 0(0), 1–21. https://doi.org/10.1080/17583004.2019.1633231

and with the case of SOC projects, outcomes might have a substantial lag time between uptake of new practices and expected results. Given variability in weather and climate from year to year, practice change may even result in negative consequences for the farmer over the short-term.[31]

With the increase in appetite to incentivize soil carbon sequestration, ways to reliably and cost-effectively quantify carbon is an important undertaking for offset projects and carbon trading mechanisms. More importantly, increasing SOC stocks would enhance the performance of soils under high-stress conditions such as a drought.[32] Biotic carbon stocks like SOC exist as dynamic and continual inflows and outflows of carbon from soil. Therefore, the most important metric is the net CO2 that is sequestered from the atmosphere, which is difficult to measure accurately and routinely given the fluxes of CO2 uptake from plants and the respiration from plants and soil biota. There is also a high degree of spatial variability and issues regarding costs and difficulty of standardizing measurement. Below are accepted methods of quantifying SOC. Typically, a combination of multiple methods is applied as part of the requirement for credible and creditable assessments of SOC.

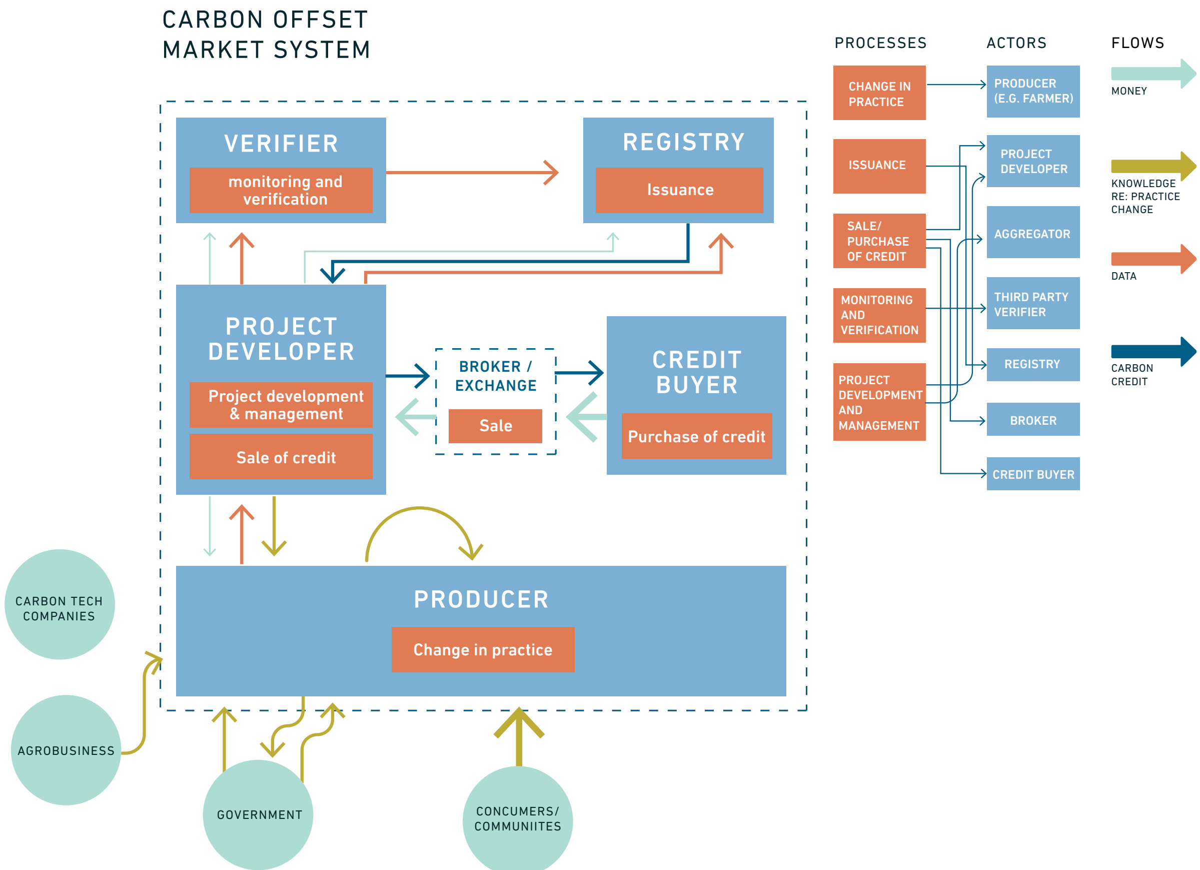
Model-based systems consider the integrated effects of different soil management practices, their impacts on soil and the climate conditions to produce mathematical calculations. These are more based on theoretical, experimental relationships to model soil carbon dynamics. Generally speaking, soil measurements from long-term observations from field experiments are the main source of information that would form the basis of the model.

- **Statistical models** are based on field data that represent the basis of estimated SOC that is quantified statistically. For example, the IPCC's national GHG inventory to help countries with national-scale SOC stocks as a function of land-use changes and management practices is a statistical model. The field data would be applied to represent land-use or management impacts on SOC stock changes over a given period of time. These models are constrained by the available field data and cannot extrapolate soil carbon accurately for a wide range of climates, types and management combinations where observational data gaps exist. The IPCC model aggregates global data sets, which makes it difficult to understand carbon stocks at a more local scale.
- **Process-based models** typically involve computer simulations that employ a set of equations to describe the dynamics of soil carbon. These models integrate various factors, such as different management conditions (e.g., crop rotation, tillage, nutrient management, irrigation) but are more complex and difficult to use compared to statistical models. However, they are attractive because they are able to make predictions at multiple scales. The main difference is that process-based models do not make inferences based solely on observational data, and are more suited for extrapolation when field data does not represent the same or similar soil conditions of a given area.

More laborious methods to obtain direct measurements of SOC at a given site require the application of soil sampling methods, to get highly accurate results of bulk density and carbon concentration. Soil samples are dried and processed in representative samples. These techniques are typically completed in a research setting and require expensive instruments and technical knowledge, which does not make them practical for routine measurements. More particularly, carbon offset projects need more cost-effective approaches to quantifying carbon over time that would reduce time and effort on sampling and analyzing carbon stock changes.

Carbon offset market systems can be set up in many ways. The figure below represents a general market organization. Different actors are represented in blue, and the processes they are involved in are listed in orange. Different pieces of information and resources flow between actors. These are represented with different coloured arrows in Figure 1.

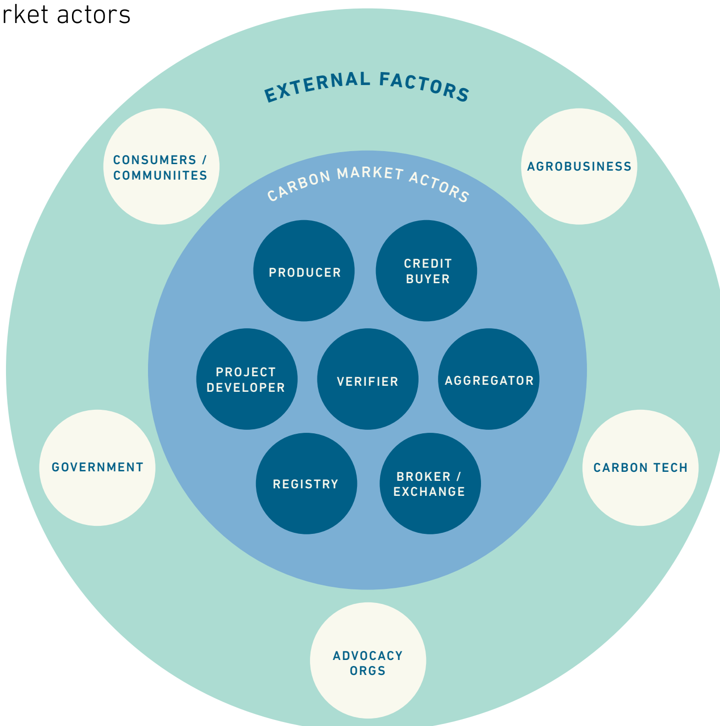
Figure 1 Carbon market system



CARBON MARKET ACTORS

Voluntary carbon markets are made up of a variety of actors that play distinct roles and are involved in different processes. Not all voluntary markets look alike, so you will not necessarily always see the same actors, and some actors assume multiple roles. See Figure 2.

Figure 2 Carbon market actors



The interior circle represents actors that are directly involved in a carbon market system. Not all these actors may be a part of a specific voluntary scheme. The exterior ring represents actors generally external to the carbon market but who may exert an influential force on the market.

Producers
For agriculture-related carbon credits, producers are farmers or land managers who manage soil or other natural areas. These producers can implement practices that avoid emissions or sequester carbon in soils.

Project developers
Project developers oversee carbon credit projects. This can include activities from assessing the potential of projects before they begin; selecting standards and protocols; supporting the implementation of the project; working with an independent auditor/verifier; supporting ongoing monitoring, reporting and verification; and the sale of carbon credits.

Aggregator
Aggregators pool together carbon projects across several farms. They are not a necessary actor in a carbon market system, although many buyers are looking to purchase large quantities of offsets and may prefer to deal with an aggregator. Aggregators often act as project developers as well.

Verifier
A verifier is generally a third party that, through assessments, determines the quantity of emissions that a carbon project has removed or reduced.

Registry
Carbon offset registries issue carbon credits for units of emissions removal/reduction that have been verified. Credits are assigned unique serial numbers, and registries keep a record of ownership for the credit. If the credit is being used as an offset, the registry will "retire" it so that the credit cannot be offered for sale again.

Broker/Exchange
Project developers may sell their credits directly to a buyer, or may sell to a broker or exchange that acts as an intermediary and facilitates the sale to credit buyers. Brokers/exchanges are not necessarily involved in a carbon offset market.

Credit buyer
Credit buyers purchase offsets. These may be corporations with footprint-reduction ambitions, individuals, investors, government, etc.

EVOLVING PERSPECTIVES AND MAJOR TENSIONS ON ECOSYSTEM AND CARBON MARKETS

While the improvement of soil health and ecosystems would be undeniably positive, stakeholder interviews suggested that carbon offsets should not be the priority mechanism for reducing emissions in the agricultural sector given the complexities of SOC. Alternative options would involve investing in encouraging adoption of more sustainable management practices via education and/or funding support to reduce financial risks for farmers shifting their agricultural practice. However, despite the skepticism, there are still strong advocates for improving measurement and market mechanisms, to ensure that credits result in real greater soil carbon storage and sequestration potential. A number of protocols have emerged to address the complexities in determining carbon stocks, and while there will always be a degree of risk and uncertainty, detailed rules are being developed for investors interested in soil carbon credits. There has yet to be an agreed-upon level of uncertainty that is acceptable in the scientific community, that would serve as a buffer from the fluxes in carbon and the variability of actual versus predictive carbon accounting. More particularly, third-party offset registries like Verra, Climate Action Reserve and Gold Standard, and companies like Nori and the Regen Network, have established protocols. Some of the more common concerns or unresolved issues with soil carbon offsets raised during interviews are described below.

Current technology to quantify carbon stored in soils is expensive and would require cost-effective approaches to measure to ensure that the measurement and transaction costs still make it feasible for a farmer to be paid and that costs do not outweigh the benefits. There is an unresolved issue that projects are consistently facing, which is that soil carbon projects cannot be credited with a sufficient rigour. The soil will need to be sampled and measured at regular intervals, requiring investment in technology and human capital to ensure that reliable data can be presented to a third-party verifier. Much of the issue translates into a data issue, the aggregation costs associated, and guarantee that farmers are still completing a certain practice so that the same net carbon maintains stored in the soil.

Advocates of a process-based models like the U.S. COMET Farms model, for example, suggested that Wellington County could mimic this information system and use set of locally sampled plots to predict the value and carbon sequestration potential from a given practice change.[34] This way the data collected from the sites can be used a proxy for how much the farmer can be credited. In theory, the main benefits are that if it were to be publicly available and could be a reliably replicated approach in Wellington County, this would potentially reduce the costs of involving intermediaries to support carbon crediting and transactions. However, this approach assumes that regenerative agriculture and other sustainable land measures are standardized practice, but given the large variations in soil storage practices cannot be standardized. The California Air Resources Board and the California Department of Food and Agriculture, for example, used COMET-Planner to inform the allocation of the state's Healthy Soils Initiative subsidy program.[35] However, process-based modelling will most often create significant discount factors that will not deliver maximum benefits back to the farm, as they would rely on a conservative estimate based on the model's prediction of the practice change and associated SOC potential.

In Alberta, the Food Water Wellness Foundation is supporting work on using satellite imagery throughout the entire growing season to continuously build data layers into a carbon map that would allow it to aggregate carbon credits for the entire province. Verification costs for this method would come down considerably over time, relative to process-based models that would still regular site sampling.

34 http://comet-planner.com/

35 https://www.cdfa.ca.gov/oefi/healthysoils/

Carbon offsets are not resulting in real GHG emissions reductions. Historically, soil carbon offsets have overestimated soil carbon storage and resulted in the trading of carbon credits that did not result in real emissions reductions. Nature-based (e.g. forests or soil ecosystems) offsets received attention because of their tremendous potential benefits directing private climate funds into mitigation and conservation but also received attention for high risk and over-crediting so far. A study of U.S.-based forest offset projects issued by the California Air Resources Board found that out of the 36 forestry projects, which represented 80 per cent of total offset credits, 82 per cent did not represent true emissions reductions due to the protocol's lenient leakage accounting methods.[36]

In May, 2021 the National Farmer's Union made a submission during the public comment period for the federal government's Draft Greenhouse Gas Offset Credit System Regulations. In response to the draft regulations, the NFU recommended that for at least the next two decades, the federal government remove its focus on offset credit systems and emissions trading and instead focus on actually reducing fuel combustion and emissions. In addition, the submission made a recommendation to stop using projects to offset fossil fuels, but rather rapidly reduce emissions using mature and affordable technology, while retaining a strong commitment to the principle of additionality. In addition, protocols tend to use lower percentage leakage rates despite available published research studies that support percentages approximatively three times greater. Using such low and unsupported rates have therefore resulted in over-crediting.

People responsible for the "on the ground change" are not ones being compensated. Stakeholders who are working in the carbon market space also pointed to the fact that too many existing carbon market models prescribe specific practice changes, and tend to deliver massive new revenues to consultants and auditors. Often times this has delivered next to no incremental financial reward to the actual farmers and ranchers who do the work.

Farmers who are already practicing "sustainable agriculture" and/or have already adopted some of the processes that would qualify for carbon credits will not be compensated. Farmers in the County of Wellington who have voluntarily agreed to bear the costs of practice changes will not qualify for carbon credits since carbon offsets require proof of additionality. At this time, the AAFC is stipulating that early adopters of best soil management practices and land use should not qualify for carbon credits. This position is also consistent with rules of existing voluntary carbon credit registry–approved protocols. However, Canada's federal offset regulation is in development and this could change. There are U.S. regulating bodies that are not comfortable with the current issuance criteria that deliver no benefits to early adopters.

Nature-based carbon offsets will always face issues of uncertainty around leakage, additionality and permanence. More particularly, SOC projects are constantly facing the issue of guaranteeing permanence given complexes of the natural processes of ecosystems. Climate change may pose additional risks regarding permanence as the soil carbon saturation point may decrease as the climate warms.

36 https://gspp.berkeley.edu/assets/uploads/research/pdf/Policy_Brief-US_Forest_Projects-Leakage-Haya_2.pdf

INHERENT CHALLENGES TO NATURE-BASED CARBON OFFSETS

A large reason why there is so much skepticism in the use of carbon offsets concerns the uncertainties that are inherent in offset projects and programs. The larger the project the higher the risks of impermanence and carbon being emitted back in the atmosphere. Three inherent challenges are listed below.

1. **Risk of reversal and permanence:** CO2 storage in soils is volatile and subject to re-emission in the atmosphere due to natural carbon fluxes or a farmer's decision to switch back to conventional methods.
2. **Additionality:** A critical challenge for offsets from the start. Offsets credits should only be generated from reductions caused by the offset program. A U.S. study completed to assess 80 per cent of total offset credits issued by CARB So found the offsets should never have been claimed by the offset credit buyers. High rates of non-additional offsets persist today, including forest offsets.
3. **Leakage:** Occurs when a project reduces emissions in one place but causes emissions elsewhere, such as logging — for example, reduction of logging in one place and increased logging elsewhere to meet timber demand.

Ways of mitigating these challenges have been to ensure quality assurance in monitoring, verification and reporting processes, as well as certification of methodologies that can support the integrity of the carbon credit. For example, Gold Standard has developed a framework for soil carbon from cropland.

FACTORS TO CONSIDER FOR ENTERING OFFSET MARKET. TRYING TO GET IT RIGHT

Below are the main factors that stakeholders felt were important for the context of Guelph-Wellington to consider if they were to proceed with investment in an offset credit system.

1. **Policy approach and policy robustness when it comes to setting appropriate conditions for offsets need to be carefully considered.**

   Policies that can complement GHG emission reduction mechanisms can support the effectiveness and efficiency of ensuring that guiding principles act as a directive toward a particular outcome. According to interviews, current policies are incentivizing farmers to increase yield, which has resulted in the adoption of unsustainable practices to meet quantitative production targets. Several interviewees felt that policy juxtaposes sustainability goals and delaying the potential shift toward regenerative agriculture. Policy should serve the purpose of incentivizing behaviour toward more meaningful change in the agricultural sector that encourages producers to adhere to science-based targets in a timely manner. Despite more recent efforts from Canada to allocate greater funds toward support for more sustainable, climate-related funding for agriculture, we are still well behind global peers when it comes to tackling GHG emissions and building resilience through more regenerative agricultural systems.[38]

   It was believed that local and regional governments had a role in countering the implicit narrative that conventional farming practices are still permissible under current policies at the provincial and federal level. Regional governments should instead invest in education for farmers on ways of enhancing soil health and ecological sustainability of their land. Furthermore, policy should also be grounded in a clear understanding of best practice and complexities of natural systems. At present, effective measurement and greater understanding of soil ecosystems in Wellington County and Guelph are needed to validate practices that enhance soil health while reducing emissions along the supply chain.

38 Farmers for Climate Solutions. (2021). Climate Action in Agriculture Policy Around the World How does Canada stack up when it comes to climate policy in agriculture?

When it comes to the purchase of offset credits, some corporations that have set science-based targets to achieve net-zero emissions have implemented policies that allow them to track which offset projects that would offset emissions along their supply chain. For example, a large-sized food production corporation reported that in order to ensure offsets were achieving real reductions, they would purchase from a select few trusted offset credit registries, and avoid the purchase of vintage credits older than 24 months. Projects would therefore reduce emissions where the business was emitting.

2. **Both economic and environmental viability of practice changes should be considered to understand public versus private benefits within the context of Wellington County.**

Farmers will face economic barriers to adopting new agricultural practices that lead to pollution abatement. Interviews noted that programs that can facilitate access to government funding to support adoption could be beneficial to farmers. Furthermore, it was expressed that local governments should consider the promotion of practices with lower abatement costs. Regarding the offset market, crediting farmers would be most effective in incentivizing practice changes if the upfront costs to adoption were outweighed by the benefits (i.e., the price of carbon) and if farmers had the capacity to absorb the risk related to change practice.

Farmers for Climate Solutions published a report titled, "Costs and Benefits of Effective and Implementable On-Farm Beneficial Management Practices that Reduce Greenhouse Gases."[39] The report listed the costs associated with the adoption of each of the management practices per hectare. Therefore, inability to absorb costs could act as a barrier to adoption despite proven benefits. Given the current and projected prices of carbon in the future, further analysis within the context of Guelph and Wellington County should be done to better understand the financial risks associated with adoption of different management practices versus the benefits and distribution of benefits.

Annex A provides theoretical estimates of the potential increase carbon storage and potential revenue benefits based on the increasing price of carbon. However, Guelph-Wellington should explore ways in which the financial rewards are delivered directly to the farmers, without large portions of the potential revenues dispersed heavily amongst aggregators and other intermediaries. On the other hand, changing practice to more sustainable methods of farming will produce more longer-term benefits in terms of land productivity. According to some carbon and agricultural economic specialists, farmers would likely realize a positive return on the upfront costs associated with adopting those changes after seven to 12 years.

3. **Question of scale and whether a certain level of scale is required for carbon credits to make sense.**

There is skepticism around whether carbon markets would be well-suited in the context of Ontario and other eastern provinces of Canada (i.e., outside the prairies). Given the nature of production in Wellington County, with regard to the variations of crops, size of plots and current farming practices, from a soil science perspective, the carbon sequestration potential is highly complex. Despite technological advances in the different ways of aggregating SOC across the county, the increased carbon storage potential in relation to current carbon price might not be enough to incentivize practice change, when weighed against upfront costs and investments required to adopt new agricultural technologies such as regenerative agriculture. According to the report published by Farmers for Climate Solutions, negative impacts on net revenue would be greater outside the prairies for most practices (e.g., increasing legumes in pasture).[40] Answers to this question will require enhanced monitoring and more robust measurements of soil carbon sequestration potential.

39 De Laporte, A., Schuurman, D., Weersink, A. (2021). Costs and Benefits of Effective and Implementable On-Farm Beneficial Management Practices that Reduce Greenhouse Gases (Issue February 2021).

40 Ibid.

4. **Need for setting up a localized measurement system that is rigorous and consistent to maintain the integrity of the carbon offset credit (i.e., evidencing additionality).**

   Data requirements and monitoring will be required to understand the soil properties and conditions. This will also support tracking for pilot projects to better understand the results on soil health and the initiatives that demonstrate their contribution to a more circular food economy and substantial reductions of GHG emissions. At the same time, a database is required for understanding what enhances the ability for soil to sequester carbon. There are a number of field sites being sampled in and around Guelph-Wellington (primarily by researchers at the University of Guelph) to better understand the variables that contribute to higher soil carbon content and the carbon sequestration potential of soil if BMPs were adopted. AAFC recently launch a carbon potential map at the national-level, using census data. A snapshot of the map zoomed in on Guelph-Wellington is available in Annex A to illustrate the high carbon sequestration potential. Satellite imagery and GIS has been useful for quantifying spatial patterns in SOC and can be used to predict SOC concentrations in soils.

   Based on a high-level scan of the existing soil protocols for offset projects, long-term data storage and monitoring systems will be required to understand soil carbon and demonstrate additionality. Data will need to be georeferenced and adopted approaches to farming will need to be carefully documented alongside carbon measurement. Paustian et al. (2019) identified core elements that could form the basis of a global soil information system, which could be considered when planning for a regional soil data platform or system. The involves long-term field experiments that would inform, validate and parametrize a predictive model complemented with a monitoring network to reduce uncertainty through remote sensing and GIS techniques and fed into a process-based model.

5. **Technical assistance requirements around project decision-making, registries and protocols as well as necessary actors to consult.**

   Technical assistance for both project planners and farmers should be incorporated into project planning to anticipate risks and apply learning from other areas. For example, ALUS is presently leading the New Acre program which is organizing and providing important technical support to farmers and ranchers to advise on the “right” path given the current context and assessed readiness of the country and farmers. The key would be to make sure that farmers and ranchers make decisions based on how best to increase carbon stocks and reduce nutrient runoff and water pollution in response to a transparent and predictable financial incentive and with the appropriate technical and advisory support necessary.

4. CONSIDERING FARMERS AND PRODUCERS

Farmers and producers are integral to any agricultural emissions reduction innovations as they are the ones implementing carbon-sequestering or emissions reduction practices.

Adopting regenerative agriculture practices may require learning and reskilling. In various carbon market schemes, a project developer is responsible for determining and encouraging the shifts in practice need to sequester SOC. This involves the transfer of knowledge and methods from the project developer to producers. The importance of education methods that farmers are receptive to was brought up frequently in interviews. Several people spoke to the importance of peer-to-peer learning and demonstration sites. There were mixed feelings around government extension programs as farmers may feel less interested in government messaging. Additionally, not all farmers will be interested in participating in regenerative agricultural practices or the carbon market. It was suggested that factors linked to land ownership versus tenancy; the age of the producer; the size and type of farm;

etc. may be important to consider when targeting farmers to participate in pilot projects. Distinct types of farms and farmers may have different ideal learning methods as well.

Carbon markets need to respect the knowledge and autonomy of farmers. Several interviewees stressed the importance of acknowledging and respecting farmers' autonomy over their own practices and data. Simply prescribing and monitoring practices denies farmers the opportunity to use their knowledge and respond to measurements and innovate as they see fit. Additionally, farmers and producers should not be seen solely as receivers of a carbon market scheme or other systemic innovations meant to broadly encourage the uptake of regenerative agriculture but should be actively involved in the design of such systems.

SUMMARY OF FURTHER AREAS OF INQUIRY

- How might farmers/producers in Guelph-Wellington best learn about and develop interest in different management practices?
- What other supports may be needed to support farmers and producers to shift their practices?
- What type of farmers/producers should be targeted to be encouraged to participate in regenerative agriculture or carbon market practices?
- What issues may arise for farmers/producers around data use and data ownership by their participation in carbon markets? How might they use their data to support their knowledge of the land and their ability to innovate?
- How might farmers and other food systems actors be involved in the planning and design of initiatives like carbon markets?

5. ALTERNATIVE WAYS TO REDUCE GHG EMISSIONS THROUGH AGRICULTURE

Many stakeholders interviewed, whether skeptical of carbon markets or not, spoke about alternative measures that could be taken to achieve similar aims (i.e., decarbonization of the food system, with a particular emphasis on production). A lot of these conversations came down to other ways to incentivize practice change outside of compensation through carbon markets. Some, however, spoke to the importance of focusing on ways of reducing agricultural emissions.

Paying for practice may be more straightforward than paying for quantity of carbon sequestered. Given the technical complexities of estimating and measuring SOC, and the administration of carbon credit projects, some interviewees said that compensating farmers for regenerative agricultural practices is the simpler route to go. However, they also cautioned that practices cannot be prescribed in a blanket fashion. Practices may need to be combined to be effective, which will likely require a series of pilot projects and monitoring to understand how best to respond to the local needs of Guelph-Wellington food producers. Some practices may actually be detrimental (e.g., one interviewee mentioned that no-till can reduce SOC and yields in Eastern Canada). Related to this, prescribing and paying for certain practices in a blanket fashion can deny farmers' agency and ability to innovate.

Beyond carbon sequestration, there are many co-benefits to regenerative practices: they can increase soil health, resiliency against flood or drought, food security, provide pollination services, etc. Appropriate practices should be encouraged regardless of the exact amount of carbon they sequester.

There was consensus from interviewed stakeholders that the transition to a circular food economy will require policy, regulation and programs that could relieve some pressure/risk from the farmers. Some additional suggested measures that could incentivize practice change include:

- Tax credits for property taxes, or land-based taxation and crediting systems to reward good practice. This would partially address the issues of additionality for farmers who are already practising reduced tillage and crop rotation, for example, and would not qualify for federal credits.
- Technology companies could lend equipment to farmers to make it easier to facilitate practice change.
- Education/demonstration/peer-to-peer learning showing that changes in practice can be good for the farming bottom line.
- Financial and practical support for farmers transitioning to regenerative practices.

There may be higher impact areas to consider for reducing emissions from the food system. Some interviewees were skeptical of carbon credits as the primary vehicle for incentivizing emissions reductions from the food system. A detailed emissions breakdown for the agricultural sector in Guelph-Wellington would be needed to understand where the highest leverage areas to target may be. Interviewees mentioned the following potential alternative areas of focus: reduction of fertilizer, reduction of land base, lower-emissions farm equipment and reduction of animal herds and alternative herd management. Reductions in these could also be considered for a crediting system, although none interviewees were aware of any precedents. They did speak to these kinds of change being incentivized through insetting and Scope 3 emissions reductions where corporations work to reduce emissions through their value chains. You can see a brief overview of different emissions scopes in the diagram below.

Figure 3 Overview of GHG protocol scopes and emissions across the value chain
Diagram originally published in Greenhouse Gas Protocol Report.

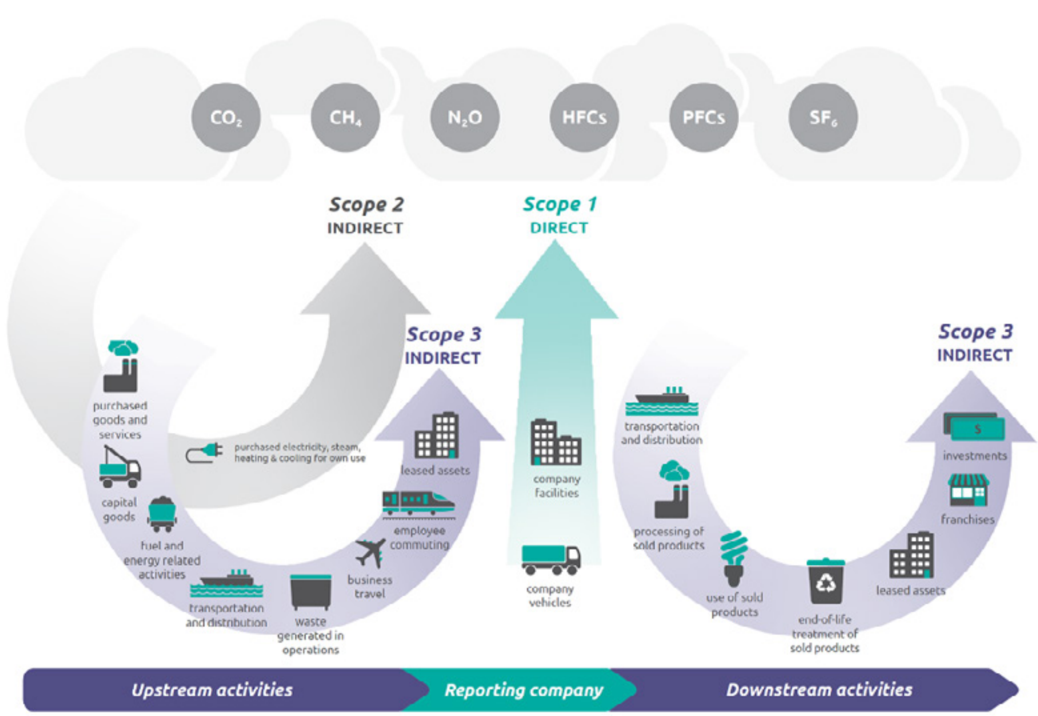
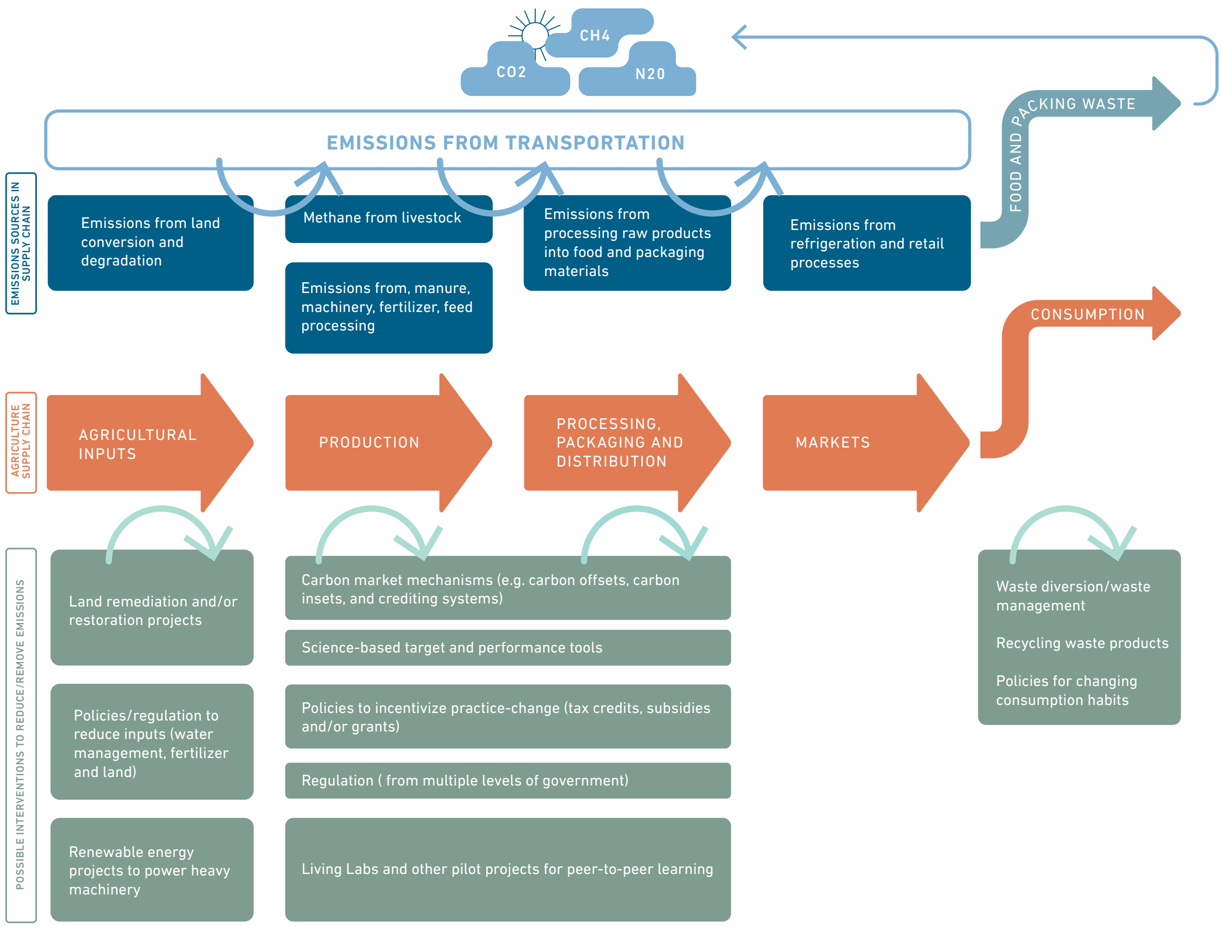


Figure 4 Possible interventions and opportunities to reduce/remove emissions from the food system



SUMMARY OF FURTHER AREAS OF INQUIRY

- What initiatives might need to be considered alongside carbon market projects in order to support the projects or to achieve the aims of Guelph-Wellington around food system circularity?
- What other opportunities exist for reducing emissions from the food system that may have higher benefits than a carbon market based on current emissions in Guelph-Wellington?
- How might "insetting" or corporate emissions reductions practices regarding Scope 3 emissions be leveraged to incentivize agricultural decarbonization in Guelph-Wellington?

6. CONSIDERING MUNICIPAL AND REGIONAL GOVERNMENTS

As Our Food Future is an initiative of the City of Guelph (municipal government) and the County of Wellington (regional government), stakeholders interviewed were asked about what roles local governments may play in establishing local carbon markets or otherwise encouraging decarbonization of food system production. They had several suggestions, some tied directly to carbon markets and others more peripheral for food system decarbonization.

LOCAL GOVERNMENT ROLES IN ESTABLISHING CARBON MARKETS

- **Innovate with local carbon market systems.** A few stakeholder interviews suggested that there was an opportunity for Guelph-Wellington to innovate with local carbon markets (i.e., that are not offsetting emissions from somewhere outside the municipality or county).
- **Develop local soil data.** Local government could organize a pilot project for soil mapping and develop a county-sized map that could be used to support carbon market projects.
- **Develop the project with care.** Those who will be implicated in the eventual innovation should be involved in its design so there is buy-in from the start and a shared sense of ownership.

ADDITIONAL LOCAL GOVERNMENT INNOVATIONS TO ENCOURAGE REGENERATIVE AGRICULTURE

- **Support a local foodshed by acquiring land.** Municipalities and regional governments can buy up land around a city and use it for innovative practices and to support young people, new Canadians, etc. to get involved in regenerative food systems. This can also secure more food security and higher nutritional value for the residents in their community.
- **Develop consumer demand for regenerative practices.** Several interviews spoke on the power of consumer demand to push for changes to agricultural practices and food system decarbonization. Local governments could play a role in developing consumer demand through campaigns, programs at local markets, etc.
- **Consider local tax incentives.** Farm taxes (which are collected at a municipal/county level) could be tied to changes in practice or reductions in emissions.
- **Support food and fibre producers to decarbonize their value chains.** Encourage and incentivize businesses with activities in Guelph to reduce their Scope 3 emissions.

SUMMARY OF FURTHER AREAS OF INQUIRY

- What might a local, place-based carbon market system look like?
- What role might watershed authorities play in the establishment of a local carbon market?
- How might local government develop consumer demand for local products from regenerative farms and producers?
- How might local government work with local food and fiber businesses to reduce emissions across their value chain?

7. RELEVANT EXAMPLES TO DRAW LEARNING FROM

Throughout the data collection process, case studies and pilot projects were identified as examples that are similar in nature to what Guelph-Wellington is looking to experiment with. The list below was developed based on discussions held during the span of this study, and have the potential to produce learning outcomes that can be useful for Guelph-Wellington planning.

CARBON CREDITING AND CRYPTOCURRENCIES

Carbon credits, and more broadly, ecosystem markets stream from the recognition that benefits from nature to society could amount to more than the global gross domestic product and that there is a relative cost to sustain them. Generally speaking, carbon credit systems typically involve payments from governments or businesses for the protection or enhancement of these benefits from nature. Reasons for this might include the need to mitigate climate risks for the business, reduce costs, secure social licence to operate or to contribute to corporate climate targets or sustainable goals.

- Ecosystem Service Market Consortium | U.S.
  - "ESMC is a non-profit that works to compensate farmers and ranchers who improve the environment through their agricultural practices." ESMC is creating an ecosystem services market that supports farmers and producers who are improving soil health. In May 2022, they are launching a credit program for greenhouse gas reductions.
  - Relevance for Guelph-Wellington: The initiative is organized around outcomes, not practices, so farmers and producers maintain autonomy over the management of their land; they look at the benefits of regenerative practices broadly and not simply as emissions reductions/removal. They are interested in multiple markets, such as water quality, biodiversity, etc.
- Nori US Croplands Pilot | U.S.
  - Nori is a marketplace that connects carbon removal projects to individuals and businesses looking to reduce their carbon footprints.
  - Relevance for Guelph-Wellington: Farmers maintain autonomy over their practice change; a Nori Carbon Removal Token (mainly directed for sale to businesses looking to negate their carbon footprint) represents one tonne of carbon being stored for 10 years — very different take on "permanence"; now launching a cryptocurrency called NORI Token.[41]
- Soil Capital | France, Belgium, U.K.
  - Program that allows farmers to be paid for carbon sequestration through carbon certificates.
  - Relevance for Guelph-Wellington: No prescribed practices so farmers maintain agency to do what they think is best with the land they steward; issues something called carbon certificates mostly sold to food companies but cannot be used to offset its emissions and declare itself carbon-neutral as with carbon credits.

41 https://nori.com/token

- Coin4Planet | Global
  - Nature Token by Coin4Planet is a natural asset investment system that allows investors to earn interest from tree planting and regenerative use of natural resources. Yield is generated from forestry, CO2 storage, soil restoration and biomass production.
  - Relevance for Guelph-Wellington: Given the interest in developing a local currency within the region to ensure that adoption of sustainable practices was monitored within jurisdictional boundaries. However, the ambitions of this initiatives are not necessarily aligned with what Guelph-Wellington is looking to achieve, but could be good to observe to understand the processes behind the development of a local currency that is intended to resource adoption of good practice.
- Regen Network | Global
  - A registry for regenerative agriculture projects and acts as a knowledge hub/platform for guidance on purchasing, selling, validating and/or developing a project related to carbon accounting and regenerative agriculture. The network is in the process of integrating the use of blockchain.
  - Relevance for Guelph-Wellington: Not recommended approach for Guelph-Wellington, given the level of preparedness and interest in the carbon market space at present. However, it's an initiative that shares common themes, and might be worth following for a general sense of the carbon market landscape and the role private entities are playing to ensure there is more accounting and monitoring rigour in the crediting system.

INSETTING AND CORPORATE SUSTAINABILITY

Insetting relies on investment from organizations to promote sustainable practices and reduce company footprint within its supply chain. Carbon offsetting and insetting differ based on where the reduction is taking place. Carbon offset are project-based and reductions do not necessarily occur within a corporation's supply chain. The benefit of insetting is the value it can serve directly to farmers or producers, and support the reduction of a company's Scope 3 emissions. However, similarly to carbon offsetting, it doesn't lead to Scope 1 and 2 emissions reductions, as the company is not directly reducing its emissions. Other initiatives relate to partnerships with corporations to provide technical assistance and project implementation to support sustainable objectives through alternative mechanisms.

- Nutrien and Maple Leaf Pilot Project | Canada and U.S.
  - Through a partnership with Nutrien, a Canadian crop input company, Maple Leaf Foods is incentivizing and educating farmers and producers within their supply shed to adopt regenerative practices and reduce emissions from fertilizer use.
  - Relevance for Guelph-Wellington: Carbon insetting has recently emerged as another mechanism for supporting and incentivizing adoption of sustainable practice by directly funding actors along the supply chain to reduce emissions.
- Value Change Initiative | Global
  - Value Change Initiative is driven by SustainCERT and Gold Standard to investigate and develop best practices for Scope 3 emissions reductions. The initiatives look to support the reduction of Scope 3 emissions through assistance around carbon accounting and capacity building to reduce emissions. Value Change provides a multi-stakeholders forum to develop a governance framework.
  - Relevance for Guelph-Wellington: Takes a carbon focus, which was of interest to Guelph-Wellington during initial planning phases. The initiative can provide some guidance on value chain interventions and quantifying carbon and help understanding of where Scope 3 emissions can be reduced.

- ALUS New Acre | Canada
  - New Acre is a project of ALUS that helps corporations meet their sustainability goals. Through corporate partnerships, ALUS can fund and support farmers and producers to establish and maintain or restore nature on the land they manage (i.e., supporting the implementation of nature-based solutions on their land).
  - Relevance for Guelph-Wellington: Represents a way of bridging farming and natural infrastructure (i.e., wetlands, grasslands and woodlands) restoration and protection alongside lands that are used for agricultural production. This supports a wider systemic view of sustainable ecosystems that contribute to healthy soil and sustainable agricultural inputs.

GOVERNMENT PROGRAMS

These interventions can vary a bit more widely, and are not the only ways regional and local governments can support GHG emission reductions and incentivize change. Almost all interviewees mentioned that the role of policy and government support was important for creating strong policy directives to change, and to promote adoption by removing certain barriers to practice changes.

- California Healthy Soils Program / COMET Planner | California, U.S.
  - The Healthy Soils program was established in 2015 and provides financial support for farmers implementing healthy soil practices. The program also funds demonstration projects that showcase best practices for soil health and encourage peer-to-peer learning. The program uses COMET-Planner, a tool that can estimate emissions reductions and program payments.
  - Relevance for Guelph-Wellington: This was mentioned as a way of monitoring carbon fluxes in sampled fields, as a process-based model system to predict SOC.
- U.K. Gov – Environmental land management schemes | U.K.
  - The Sustainable Farming Incentive from the U.K. is a pilot financial incentive provided by the government for farmers to manage their land in an environmentally sustainable fashion. The incentive has a set of standards for best practice for different types of land that may be present on a farm.
  - Relevance for Guelph-Wellington: Generally applicable from a policy lens and to show how top-down approaches have supported adoption of better management practices.

EDUCATION AND ADVOCACY

Several stakeholders noted that peer-to-peer learning and relationship-building were key factors to change. It was important to get the messaging and communication strategy right, which would result in more productive working relationships with farmers and producers. It was important to educate farmers on the significance of adopting certain practices, and to understand local farmers' needs to ensure sustainably of positive results. All initiatives listed below would be relevant for the City of Guelph and the County of Wellington to explore, based on feedback from interviewees.

the County of Wellington to explore, based on feedback from interviewees.

- Baltic Sea Action Program | Finland
    - Carbon Action Pilot is a collection of soil carbon sequestration projects and a platform that connects researchers, farmers, funders, businesses and advisers.
- Commonland | Netherlands, Spain, South Africa, Australia
    - Commonland undertakes landscape restoration projects and has also created an online learning community called 4Returns where practitioners can connect and learn from each other.
    - This initiative has developed a framework for change management and applying a TheoryU approach to bring stakeholders together in a more meaningful way. The aim is to better connect initiatives for more effective transition to circular and more equitable economies. The general focus is about building relationships to understand challenges and address them more effectively when the network is stronger and more consolidated.
- Farmers for Climate Solutions | Canada
    - Farmers for Climate Solutions is a coalition of farmer-centred organizations advocating for agriculture to be leveraged in the fight against climate change. They have released policy-level resources here.

8. NEXT STEPS AND RECOMMENDATIONS

SYNTHESIS OF PERSPECTIVES ON WELLINGTON COUNTY AND OFFSET MARKETS

- **Soil carbon is highly variable and expensive to measure, and why incentives should be placed on practice change and not the measure of carbon.** There is sufficient evidence that would support the idea that certain management approaches lead to increases in SOC, but how much SOC remains difficult to quantify at a given point in time. The approach to measuring carbon frequently and rigorously has high costs, whereby it is difficult to guarantee permanence to a system that will always have a constant inward and outward flow of carbon. At present there is no cost-effective approach to measurement that will guarantee both methodological rigour and timeliness, and that will ensure the integrity of the offset credits available on project registries, while at the same time providing farmers with a source of revenue to incentivize adoption. It is likely that incentivizing practice change would be the more practical option and would avoid the technical challenges of appropriate carbon accounting.
- **Carbon markets should not be the only mechanism for supporting emissions reductions in the food supply chain, but they can be part of a resilient funding stream.**

  Offsets present a potential for private financing to be directed toward mitigation and conservation efforts; however, offsets are not the sole space for achieving this outcome and other opportunities will support ecosystem health effectively. Initiatives should be carefully framed to ensure that carbon storage and sequestration for carbon credits do not take away from the need to create a diverse and ecological resilient system that looks deeper into reducing GHG emissions across food supply chains.

- **Regenerative agriculture is about looking at an entire regenerative system, and not just the agricultural practice.**

  Regenerative agriculture should be viewed as a systemic change alongside the main tenets that dictate rotation, tillage, livestock and cover cropping. The goal is to achieve a regenerative system and not just a series of options to adopt. Soil health is dependent on complex structures and properties that require consideration of the landscape and the environment as a whole. Climate change will also impact the relationships of the different components of soil ecosystems.

- **Crediting soil carbon should not depend on a prescribed practice change.** Soils in different areas and different types will have a wide array of different outcomes even if the same set of practices is prescribed. Soil carbon can vary annually depending on the climate, the depth from which the soil is sampled and interactions of SOM.

- **Practitioners and regional governments should seek to further understand the local conditions that will contribute to the successful food economy.** This would entail understanding the costs and risks that may need to be absorbed by farmers, and where government funding or intervention can help support this or ease the burden, particularly for those with low-risk capacity and/or resources to support.

RECOMMENDATIONS

1. **Develop a data management and monitoring and evaluation system for measuring and tracking outcomes of the different regenerative agricultural practices.** The system should track and measure outcomes across large landscapes to reduce uncertainty and improve accuracy of predictive mapping. Boxes throughout this report note areas for further exploration, particularly around what sort of investments will contribute most to overarching objectives.

2. **Identify a set of mechanisms and/or initiatives that can be piloted with available resources.** Carbon offsets may serve as a complementary mechanism, but should not be the only focus. While it is important to align programmatic planning with national priorities, current carbon offset protocols, particularly for soil ecosystems, may not serve the purpose that the County of Wellington and the City of Guelph have set out to achieve with available funding sources. It is recommended that local and regional level governments strategically assess where offsets can act as a contributory mechanism alongside other policies and initiatives, and when offsets would no longer be the best approach.

3. **Develop a robust climate mitigation and adaptation strategy and approach the vision of a circular food economy from a portfolio or food-systems perspective to ensure sustained co-ordination and learning throughout the implementation of programs.** Concepts in strategy and design documents remain relatively high-level and could benefit by having a detailed pathway to change. This may require assessing specific risks at the project or investment level and equip practitioners and planners with clear understanding of the pathway at early project planning phases. This might include integrated farmer perspectives and messaging to ensure that there is effective relationship management and knowledge-sharing across stakeholders or tools that ensure consistency across projects.

4. **Integrate learning from other initiatives in the planning and piloting of a carbon credit system at a regional scale.** Incentivize emitters to reduce emissions directly as a priority or ensure that they are offset locally where the project can be rigorously traced to maintain the integrity of each carbon credit. This can mean drawing on alternative measures beyond offset crediting systems (e.g., carbon insetting) that will contribute to circular economy objectives within the supply chain and explore

how to make the adoption of best practice more viable for local farmers. Partnerships and multi-stakeholder perspectives should be involved in decision-making to support greater relationship-building across all agricultural actors.

5. **Identify a group of relevant stakeholders who are already involved in the space to provide technical assistance and advisory support for farmers and regional and municipal governments in order to establish buy-in from multiple actors.** Investments can become more transformational if a full range of barriers are addressed. The best way to anticipate risks and challenges is to share a clear understanding of the change pathways required to reduce emissions and promote a more stable and circular economy.

AN EMERGING NEXT STEP

The goal of Our Food Future has always been to build a circular economy for the food system starting in the testbed of Guelph-Wellington. Carbon markets were seen as a potential mechanism to release financial value from regenerative agriculture and food waste reduction, thereby supporting the good work of farmers and food businesses. However, through the David Suzuki Foundation's research and workshops with potential advisors, we learned that the inherent and complex challenges of carbon offset markets set punishingly high barriers to entry for small- and medium-scale farms and food businesses, and the intended aims were not always achieved. With this context in mind, Our Food Future will use their next phase of work to develop and prototype an idea adjacent to the regulated carbon markets.

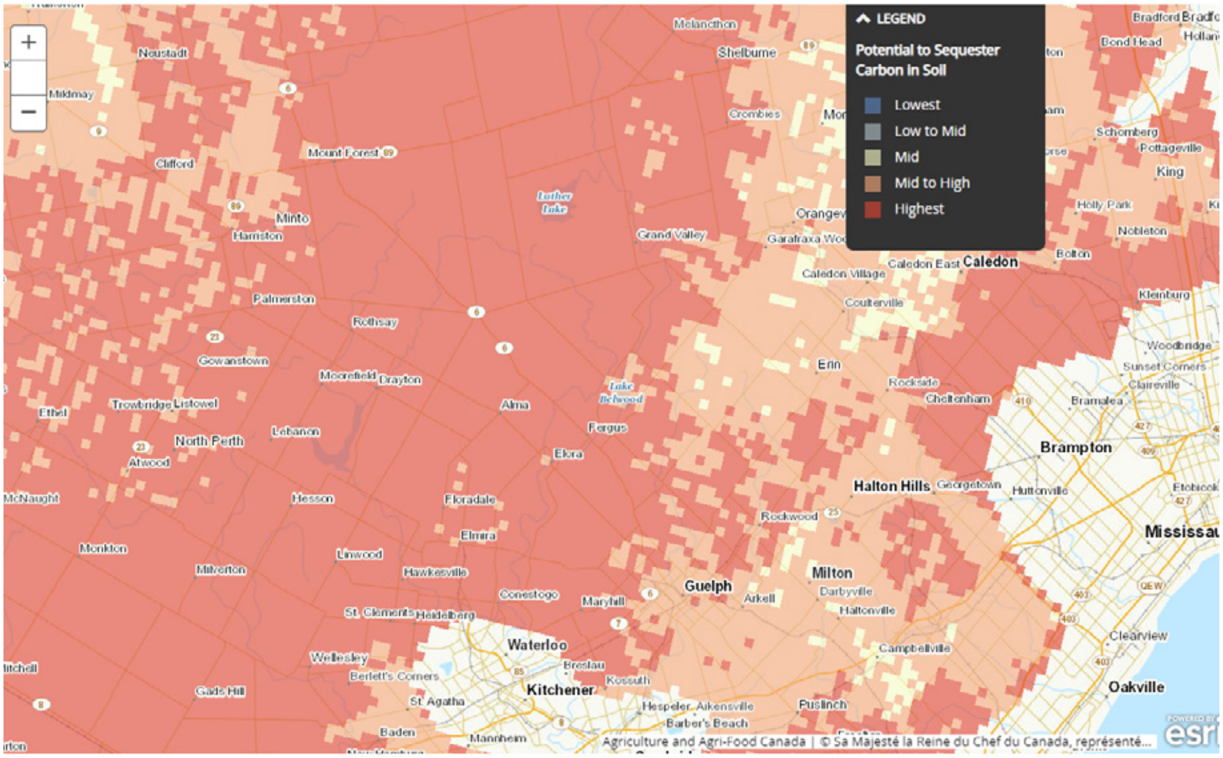
They are currently working on a concept for an assessment framework that can grow into a certification program, one in which participants could receive a certification level for their farm, business or organization based on a matrix built from a series of best practices. As with the Sustainable Development Goals, they aim to capture the full connectedness of circular economy values by including metrics to assess biodiversity, food security and social justice in addition to specific climate impact measures.

This kind of program could be compared to LEED, the Leadership in Energy and Environmental Design green building certification program. What LEED did successfully was to create a clear and accessible starting place for assessing a particular set of qualities (energy or water efficiency, green materials, etc.). The front-end checklist looks simple, but it is the result of multiple committees of expertise translating complex best practices into recommended actions.

By prototyping this kind of assessment framework, Our Food Future hopes to champion the actions of early adopters, and to demonstrate that the circular economy serves the climate economy. If successful, it should make good works visible and contain enough rigour to act as a pre-qualifier for any system or funder seeking to encourage this work. A robust framework for this prototype is expected in fall 2022.

ANNEX A: CARBON SEQUESTRATION POTENTIAL IN WELLINGTON COUNTY

Figure 5. Map of carbon sequestration potential in Wellington County (AAFC map found here)



CARBON SEQUESTRATION ESTIMATES IN WELLINGTON COUNTY

Theoretical quantification of potential incremental carbon was modelled using available public data sets and SOC studies to support assumptions made. The approach used to quantify carbon sequestration potential in Wellington County draws on Statistics Canada's Agriculture Census data, which provides cropped and managed pasture acreage breakdowns at a county-level resolution. The data tables below have also considered Bruce and Grey Counties, as many of the families who own and manage acres in Wellington also own and operate acres in these counties. Unfortunately, due to data availability, estimates could not be further broken down to the district subdivision level.

Table 2 below presents a summary of the potential incremental soil carbon sequestration potential averaged over a 20-year period after assumed adoption of management practices that improve soil health, reduce water pollution and sequester incremental carbon in soils. The numbers presented below show estimates of incremental soil carbon sequestration range for croplands and managed grazing lands in Wellington County and two other neighbouring counties. The table outlines the annual averages of tonnes of CO_2 emissions per acre per year given a 75 per cent adoption rate of improved management and with a series of estimates in line with current scientific understanding of more realistic incremental changes to carbon storage.

The set of tables below also show what the ability to sell carbon credits might generate for landowners and operators who adopt best management practices. These estimates define a range for the theoretical incremental carbon sequestration potential of soils and root systems only. This does not include the additional carbon that can be drawn into and stored in above-ground perennial plants (which might include trees that produce nuts, fruit and syrup). There are many acres of wetland pockets in the arable land mass of these three counties. However, given data limitations at present, total incremental carbon sequestration estimates for wetlands recovery potential for the counties cannot be properly quantified as they depend on how many acres of land this would capture. However, research does support the improvement in soil carbon when these interventions are implemented. A current inventory or records of what percentage of the total wetlands in the county are protected or in their natural state and what percentage represents the area available for rehabilitation is lacking at present.

POTENTIAL GAIN FROM CARBON CREDITS AT HIGHER CARBON PRICES

As shown in Table 2 if the carbon price were C$100/CO2e, for example, using representation of the lower expected AAFC estimate as a proxy indicator would represent a potential to increase farmer and rancher revenues by C$18.48/acre/per year. However, current prices of carbon are around C$50 this year, which is approximately C$9.24 CAD per acre each year. This would not, however, represent the reality, because only a portion of this dollar value would go directly to the farmer under typical carbon market setup.

At higher carbon prices, a greater proportion of the carbon credit revenue (e.g., C$18.48/acre/year) could go to the farmer's bottom line, and this would represent a significant increase in the farm's profitability and the farming family's financial stability. At these estimates, this would suggest that a payment system could reap financial incentives for the farmers and even more so if the farmers adopted management practices that would further increase SOC. For example, at C$100 per tonne of carbon, the farmer's revenue could increase to about $37.67 to $57.60 per acre per year. This would rely heavily, however, on policy and potentially government-led incentives that ensure farmers received a greater proportion of this credit rather than market intermediaries. This also assumes that farmers have the capital to make upfront investments in technology change and have the knowledge to adopt more sustainable management practices and/or have access to loans with reasonable interest rates. Farmers would also need to have the capacity to absorb some risks associated with practice change, which might include experimenting and choosing most appropriate suites of practices for their land.

In addition, census data also shows that Wellington County has experience a decreasing SOC trend, whereby soil organic carbon is decreasing. Based on the soybean and corn crop yield increases over the past 10 years, this could be attributed to the increase in land transfer from smaller plots to more industrial farmers who practise monoculture and mass tillage. Based on farmer feedback from interviews, some farmers experience difficulties adapting to challenges from adopting new technologies. Those who have generally been open to innovation for reasons beyond interest in sustainability are often the ones who face the steepest learning curve and bear the greater risk. Thus, despite the profitability from carbon markets, government intervention will be required to support measures and policies we introduce to encourage the adoption of location-tailored best practices, reflecting an awareness that the challenge is to get to years seven to 12.

Given the estimates provided in this report, the potential revenue from 75 per cent of Wellington's arable acres practising better management would amount to a figure close to $6 million per year, at approximately C$38 per acre per year.

Table 2 Theoretical incremental soil carbon sequestration potential for Wellington County

		WELLINGTON COUNTY			BRUCE COUNTY			GREY COUNTY			ALL 3 COUNTIES		
		AAFC	Low	Moderate-to-High	AAFC	Low	Moderate-to-High	AAFC	Low	Moderate-to-High	AAFC	Low	Moderate-to-High
		20-yr cumulative			20-yr cumulative			20-yr cumulative			20-yr cumulative		
Incremental Net CO2 Sequestration Potential	TCO2e	1,478,920	2,972,192	4,544,875	1,837,146	3,745,302	5,727,063	1,420,400	2,895,702	4,427,912	1,715,466	9,613,196	14,699,850
	TCO2e per hectare per year	9.13	18.62	28.47	10.32	21.03	32.16	10.05	20.49	31.33	9.84	20.07	30.68
	Average TCO2e per acre per year	0.18	0.38	0.58	0.21	0.43	0.65	0.20	0.41	0.63	0.20	0.41	0.62
	Price of carbon credit (CAD) per ton of CO2e	AAFC	Low	Moderate-to-High	AAFC	Low	Moderate-to-High	AAFC	Low	Moderate-to-High	AAFC	Low	Moderate-to-High
Gross New Revenue Potential (per acre per year)	**$20**	$3.70	$7.53	$11.52	$4.17	$8.51	$13.01	$4.07	$8.29	$12.68	$3.98	$8.12	$12.42
	$30	$5.54	$11.30	$17.28	$6.26	$12.77	$19.52	$6.10	$12.44	$19.02	$5.98	$12.18	$18.63
	$50	$9.24	$18.84	$28.80	$10.44	$21.28	$32.52	$10.17	$20.73	$31.70	$9.96	$20.30	$31.04
	$75	$13.86	$28.25	$43.20	$15.66	$31.92	$48.80	$15.25	$31.09	$47.54	$14.94	$30.45	$46.57
	$100	$18.48	$37.67	$57.60	$20.87	$42.55	$65.07	$20.34	$41.46	$63.39	$19.92	$40.60	$62.09
	$170	$31.41	$64.04	$97.93	$35.49	$72.34	$110.62	$34.57	$70.48	$107.77	$33.86	$69.03	$105.55

AAFC ASSUMPTIONS ON CARBON CREDITING SYSTEMS

The estimated value was based on AAFC census data, which provided some context on of soil class, historical land use, weather and climate and the limits to the soil's capacity to absorb and retain incremental atmospheric CO2e, given those conditions. The value ranges defined by low and high are not tied to any specific practice changes, but reflect comparable datasets that were able to provide a proxy of possible incremental changes to carbon content given practice changes, and accounting for maximum saturation levels given soil properties. The initial column estimates were drawn from Agriculture and Agri-Food Canada's best assessment of the mean background carbon stocks, which looks at the potential incremental increase as a result of adoption of three main practices: cover cropping, intercropping and variable rate fertilizer.[42 43] The lower and moderate to high estimates were based on the potential and more realistic rates at which the soils in Wellington could build up the carbon stocks. Given the selected practice changes, AAFC data assumes approximately 0.2 per cent rate of increase of carbon each year to estimate potential 20-year accumulation period, whereas the low estimates are based on a 0.4 per cent rate of increase each year, and the moderate to high estimates are based on a 0.6 per cent increase.

42 Variable rate fertilizer involves testing soil throughout the field to vary the rates of fertilizer applied as needed for a section of land depending on field measurements of nitrogen and other micronutrient content.

43 Source: AAFC soil sequestration potential map

The AAFC estimate is lower than both the low- and higher-end estimates because AAFC approaches this question from a different perspective. AAFC starts with a shortlist of changes in land management practices, and then uses the average rate of the national and regional soil carbon stock gain that would be expected when those practices are widely adopted. AAFC estimates are likely lower given that they are starting the analysis with a shortlist of practice prescriptions at a baseline using nationally averaged data. The analysis that was completed started by assessing the difference between the state reported in 2016 census data and an assessment of what healthy soil looks like given current research available on the soil properties found in Wellington County. Estimated rates were then benchmarked against COMET planner data sampled across various U.S. sample sites, and matched with comparable soils to Wellington County

ANNEX B: WORKSHOP NOTES FROM PARTICIPANTS

You can see notes from the first workshop here, and the second workshop here.