

# CLIMATE-SMART SOILS TRAINING AND EDUCATION

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 @UoGAgMet

**Summit on Canadian Soil Health**  
**Soil Conservation Council**  
**November 17, 2021**

UNIVERSITY  
of GUELPH

ONTARIO  
AGRICULTURAL COLLEGE

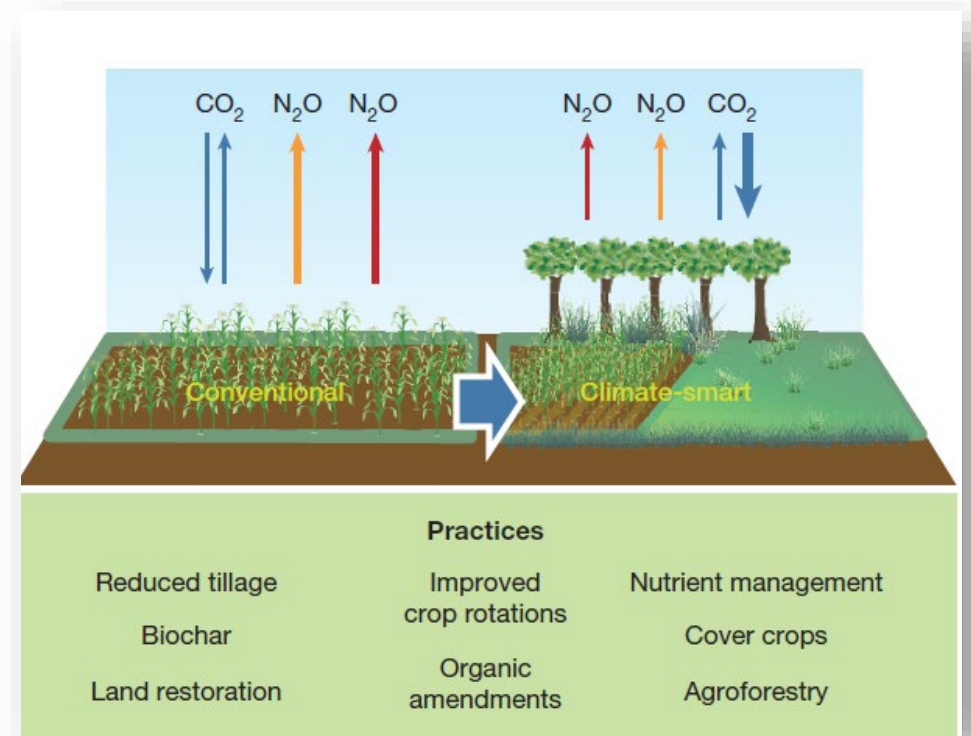
SCHOOL OF ENVIRONMENTAL SCIENCES

# THE CASE FOR SOIL HEALTH

- 95% of the global food supply derived from soils
- Soil degradation is estimated to cause losses in crop productivity of \$3 billion/year in Canada
- This estimate does not consider impact on other services such as water security, biodiversity and climate change mitigation
- Globally 24 bill tons of fertile soil are lost every year and soil degradation is estimated to reduce GDP in developing countries by up to 8%
- Soils could play a pivotal role in limiting global temperature increase to less than 2°C

# THREE OBJECTIVES OF CLIMATE-SMART AGRICULTURE...

# ...AND CLIMATE-SMART SOILS



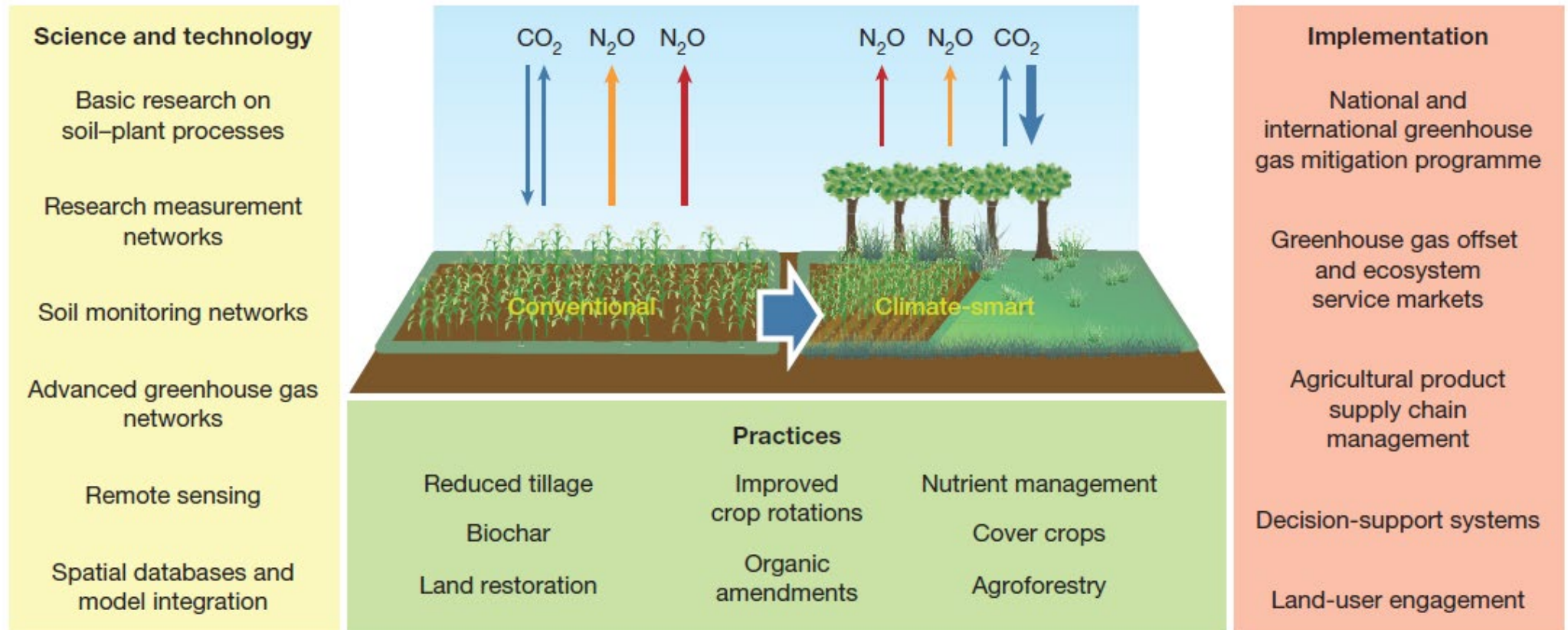
*Adapted from Paustian et al. (2016)*

<https://www.fao.org/climate-smart-agriculture/en/>

Co-benefits:

↑ soil health, ↓ soil erosion, ↑ food security  
 ↑ water quality, ↑ biodiversity

# TO GET THERE: NEED TO INTEGRATE RESEARCH AND IMPLEMENTATION

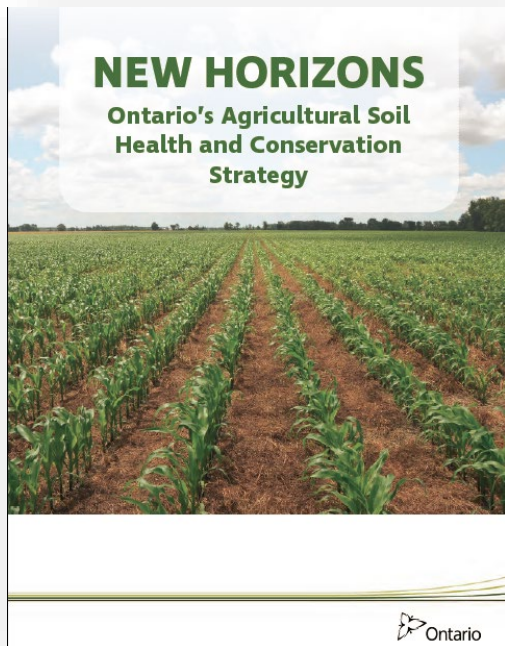


*Paustian et al. (2016)*

“... there needs to be a **greater level of engagement with the land users** themselves, who will be the ones implementing practices that abate GHG emissions and sequester C.”



# SOIL HEALTH STRATEGIES: NEED FOR TRAINING AND EDUCATION



Second Session, Forty-third Parliament,  
69-70 Elizabeth II, 2020-2021

HOUSE OF COMMONS OF CANADA

## BILL C-290

An Act respecting soil conservation and soil  
health

FIRST READING, APRIL 26, 2021

(d) support and encourage farmers and other land users in the use of best management practices that allow soil systems to be managed in ways that promote soil health and sustainability, including by

(i) supporting research programs that provide evidence to guide the development and implementation of regenerative soil management,

(ii) providing education and training in soil health and conservation for producers and agricultural professionals,

(iii) enhancing knowledge transfer and the availability of technical assistance to producers and soil managers who work in soil health, and

(iv) promoting Indigenous stewardship and conservation practices and the sharing of Indigenous knowledge of the soil;

- **Diversify learning approaches** available to farmers
- Build understanding of farmers' **learning styles and motivation**
- Build capacity for **peer-to-peer** learning and innovation
- Build soil knowledge among **service providers**
- Build provision of key soil-related skills in **post-secondary education**
- **Elementary and secondary education** provides sound basic soils knowledge
- Build **general understanding** of soil health



# Training the next generation of scientists



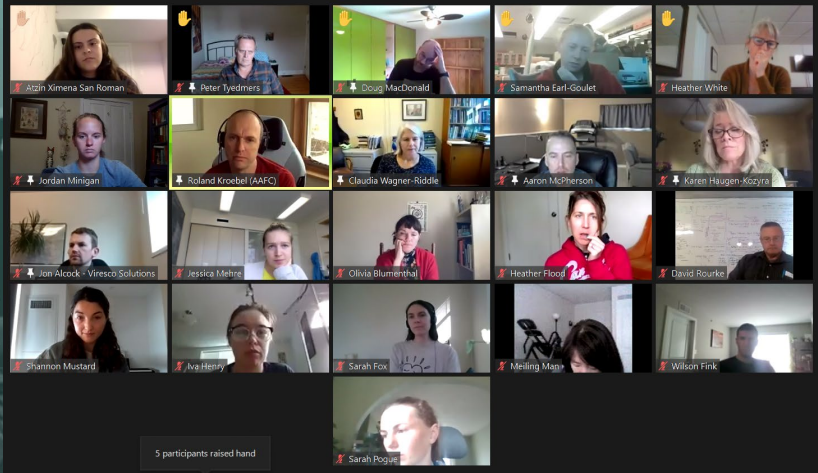
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## Addressing climate change through soil science training

The CREATE in **Climate-Smart Soils** (CREATE-CSS) is the first **multi-institutional soil-centered program** to address the need for highly qualified personnel training to sustainably lead Canada's agri-food sector.

[FIND OUT MORE](#)





# Climate-Smart Soils Training Program

- Funding: NSERC Collaborative Research and Training Experience Program
- 6-year value-added training program started in 2019
- \$1.65 mill total: 80% for stipends, 20% for training activities
- 6 Universities (Dalhousie, McGill, Toronto, Guelph, MB, SK)
- 21 original and 9 new collaborators: industry and farming org., NGOs, private sector, federal and provincial dept.



# Who is involved?

SK



**Kate Congreves**  
Soil Biogeochemistry



**Melissa Arcand**  
Soil Biogeochemistry

MB



**Mario Tenuta**  
Soil Ecology



**Martin Entz**  
Agronomy

McGill



**Cynthia Kallenbach**  
Soil Ecology

Toronto



**Myrna Simpson**  
Environmental Chemistry

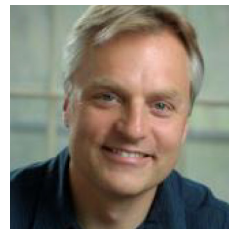
Guelph



**Claudia Wagner-Riddle**  
PI, Agrometeorology



**Kari Dunfield**  
Env. microbiology



**Alfons Weersink**  
Agric. & Resource  
Economics



**Helen Hambly**  
Capacity Dev. & Extension

Dal



**David Burton**  
Soil Science



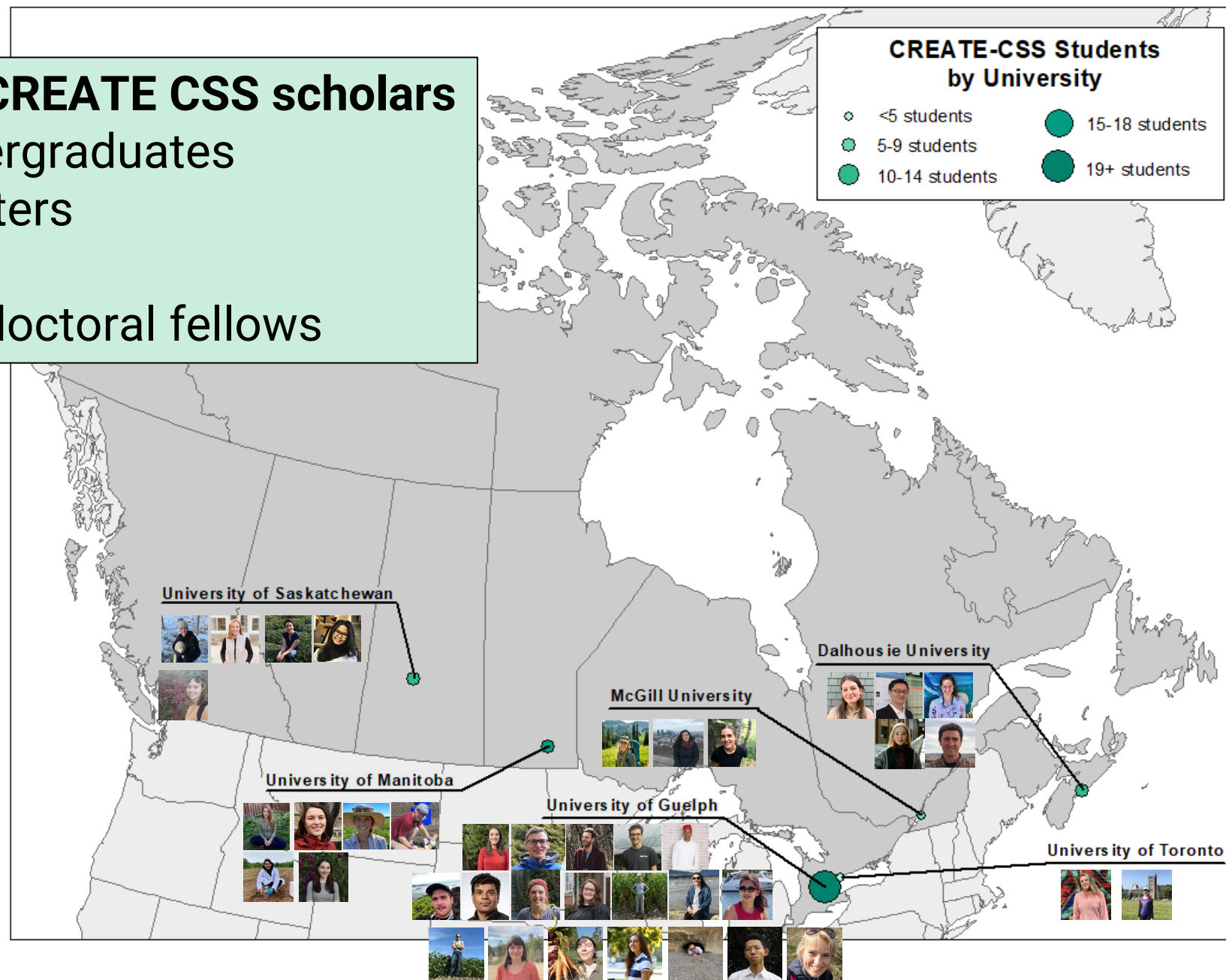
**Peter Tyedmers**  
Food Systems Sustainability



## Goal: 62 CREATE CSS scholars

- 21 undergraduates
- 30 Masters
- 8 PhD
- 3 post-doctoral fellows

### CREATE-CSS Students by University



# Program Objectives

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- train HQP to have a deep **understanding** of soil GHG emissions and C sequestration mechanisms by using novel techniques, and to establish Canada as a leader in CSS science;
- provide **systems-based** training for HQP to conceptualize and create more durable and resilient future solutions for CSS nationally and globally;
- equip HQP with **knowledge** in C protocol development, GHG inventory analysis, implementation metrics and policy development for climate change reduction target achievements;
- provide training in the use of CSS knowledge from **gender and diversity perspectives**;
- equip HQP with effective **professional skills** to enable implementation of CSS practices in the agri-food sector.

# Program Components

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- Research projects (all)
- **Core course**\*: “Principles and Assessment of Climate-Smart Soils” (graduate students and post-doc)
- **Internships**\* (graduate students)
- Professional skills:
  - Individual Development Plan/**Mentorship**\* (graduate students)
  - Adaptive Project Management & Leadership Short Course (graduate students)
  - Workshop on Gender & Diversity Leadership, **Science Communication**\* (all)

\*collaborator involvement



# Core Course: Principles & Assessment of Climate-Smart Soils

## Principles

- Soil Ecosystems Overview
- Climate-Smart Soils and Agriculture
- Socio-economics of Climate-Smart Soils
- Social Dimensions of Climate-Smart Soils
- Stakeholder's Perspective: Regenerative Agriculture at General Mills
- Communicating with Farmers and Ontario Soil Health Strategy



**Mechanisms for soil carbon storage**

Least protected from disturbance → Most protected from disturbance

**Chemical recalcitrance**

Phase 1 Phase 2

Carbon and Nitrogen

Chapin Ecosystem Ecology (vol. 01: 7)

**Physical protection**

Management

Soil matrix

Microaggregates

Controls: Soil structure, pores, aggregation, water, anything that impacts decomposer physical access

**Chemical/physio protection**

Electrostatic interactions

Protein and organic surface charge from microorganisms

Soil matrix

Layer Silicate Clays + 2 water

Controls: Soil matrix (clay), Chemical environment (change in pH can dissolve and release C)

CREATE

Wipondok et al., Appl. Environ. Microbiol. 2015; Jilings et al., 2018, Biogeochem.

Video conference grid showing participants: Khondra, Raj, Tiffan MMS, Cynthia Kater, Claudia Wöhl, Dan Schumm, Ryan Meyer, Emily Layton, Carole Hovith, Stephen Zhang, Christopher G., Samantha G., Victor Valdez, Paige Kennedy.

# Core Course: Principles & Assessment of Climate-Smart Soils

## Assessment

- Canada's National GHG Inventory
- Holos GHG Calculator
- Life Cycle Assessment
- Quantifying & Monetizing GHG Emissions
- Environmental Farm Plan
- Group assignment: apply Holos to 3 farms (SK, ON, PEI)
- Farm visits and panel discussion between farmers and students


**Mull na Beinne Farms, PEI**  
 Owners & Operators:  
 • Vernon & Bertha Campbell

**Special Achievements:**  
 • Members of the Soil Conservation Hall of Fame!

**Commodities Produced:**  
 • Potatoes  
 • Beef (160-180 heads)  
 • Dairy (85 milking cattle)  
 • Cereals  
 • Forages for feed

**Carbon Foot-print from HOLOS:**  
 • Majority of GHG emissions from enteric methane  
 • Remainder of emissions from manure and fertilizers

**Climate Smart Soil Practices:**  
 • Minimal Tillage  
 • Crop Rotations  
 • 4R Nutrient Management  
 • Cover cropping



**Axten Farms**  
 "Loyal to the Soil"

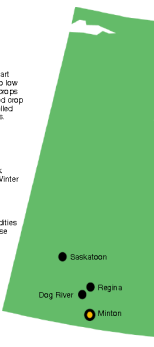
In the early 1990s, the farm began their soil-smart practices with no-till drilling. They progressed to low disturbance no-till and growing higher residue crops to reduce erosion. The farm no longer uses diversified deep cultivars, intercropping, cover cropping, controlled traffic farming, and home-brewed compost teas.

**Location:** Minton, Saskatchewan

**Crops:** Lentil, Oat, Spelt, Flax, Forage Barley, Canola, Maple Pea, Mustard, Red Fife, Black, Brome, Spring Wheat, Sorghum, Buckwheat, Winter Pea, Chickpea, Triticale, and Fye

**Acres:** 6000 acres as 31 fields

**Future:** Developing more value-added commodities with an intent to build a mill to sell nutrient-dense grains directly to consumers.



**BUIS BEEF**  
 Beef, Corn, Crops, and Dairy




**BUIS BEEF**  
 Chatham, ON  
 650 acres

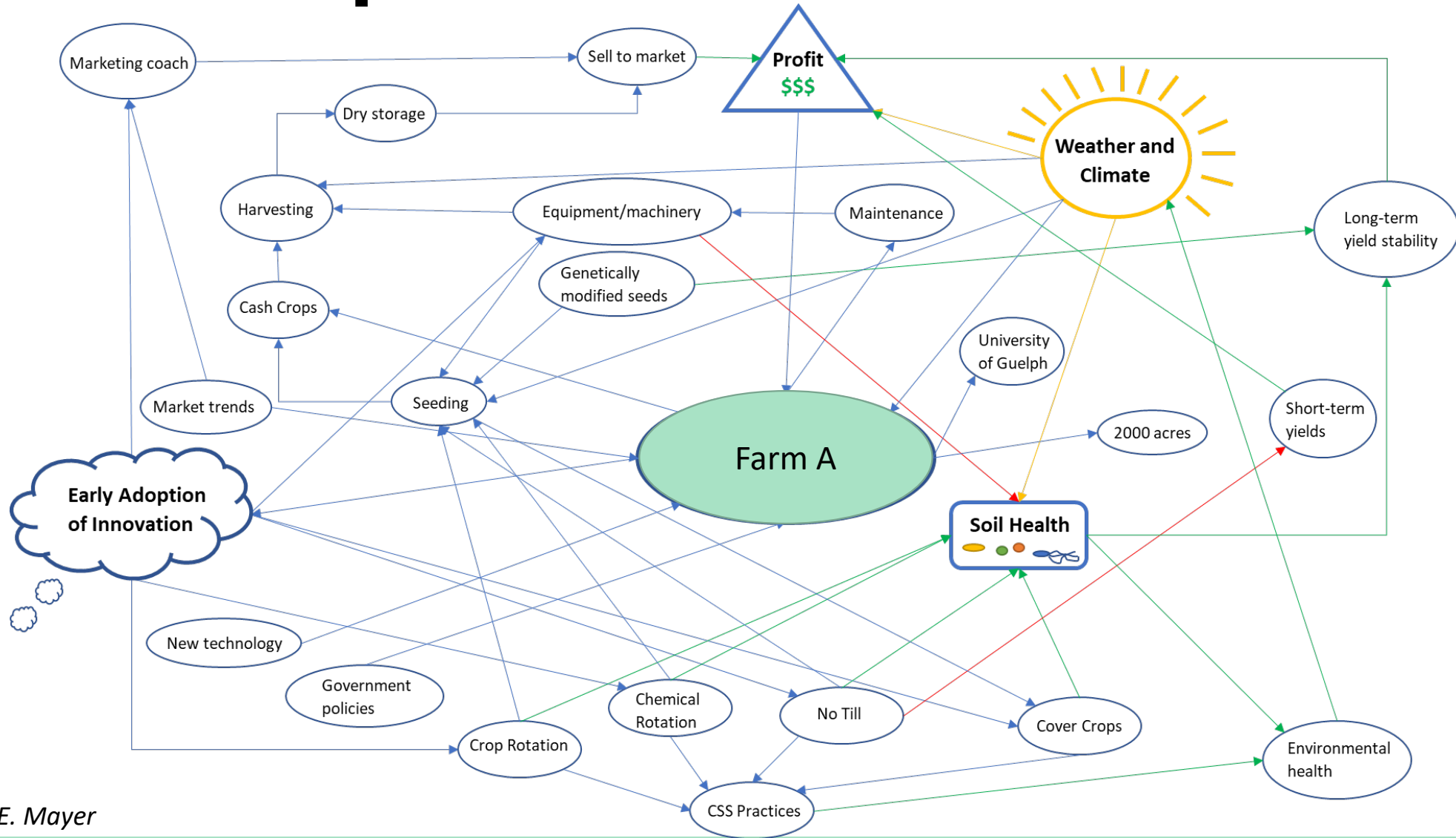
Crops Grown	Cattle operation
<ul style="list-style-type: none"> <li>• Sweet corn</li> <li>• Grain corn</li> <li>• Winter wheat</li> <li>• Soybeans</li> <li>• Grass hay</li> </ul>	<ul style="list-style-type: none"> <li>• Beef Cow-Calf: 300 cows, 12 bulls, 262 calves</li> <li>• Backgrounding: 130 Heifers, 130 Steers</li> <li>• Finishing: 128 Heifers, 128 steers</li> </ul>

**Climate-Smart Practices**

<ul style="list-style-type: none"> <li>• No/Low till</li> <li>• Crop rotations</li> <li>• Cover crops</li> </ul>	<ul style="list-style-type: none"> <li>• Manure application</li> <li>• Grazing on cover crops</li> <li>• Ultrasound technology at finishing</li> </ul>
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**CREATE**  
 Climate-Smart Soils

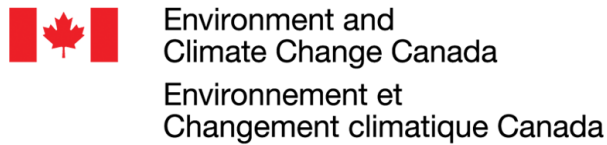
# Mind map from one of the Farm-Visits



Source: E. Mayer



# Mentorships



# Internships



Study of long-term climate trends across the Canadian Prairies



Creation of Health Training modules on the role of soil microbes in soil health



Ministry of Agriculture, Food & Rural Affairs

Creation and delivery of materials for the 2020 Midwest Cover Crop Council Conference



Environment and Climate Change Canada  
Environnement et Changement climatique Canada

Quantifying manure carbon addition to soils in the National GHG Inventory Report



Ag-related emissions in financial portfolio through a life cycle assessment



Developing communication materials on cover crop research



SOIL CONSERVATION COUNCIL OF CANADA  
CONSEIL CANADIEN DE CONSERVATION DES SOLS



FERTILIZER CANADA  
FERTILISANTS CANADA

Development of 4R Nutrient Stewardship BMP guidance documents



FARMERS FOR CLIMATE SOLUTIONS

Research on Canada's Business Risk Management programs and the role of crop insurance on adoption of cover crops



iresco Solutions  
End-to-end sustainability

Grassland carbon offset pilot project



Advising producers in on soil health and nutrient management



IAPO  
First Nations Farm & Business Financing

Developing a soil health program for client education



Scaling Up Conservation Agriculture program in Kenya

# Science Communication and Outreach



CREATE Climate-Smart Soils @SmartSoils · Apr 23, 2020

Remembering a time when we could learn & share in person...

Jess had a very successful display at the Prairie Organics Conference in March, talking about amendments to nutrient cycling w/ farmers. #Scicomm is so important when sharing research w/ those who can use the results!



Display by Jess Nicksy at the Prairie Organics Conference March 2020

From ONFARM's First Year

## Soil Microbial Health Modules

- Module 1**
  - General Soil Microbiology
  - Ecosystem Services
  - Managing your microbes
- Module 2**
  - Cropping Systems
  - Tillage
- Module 3**
  - Organic vs. Inorganic Fertilizers
  - Biofertilizers
- Module 4**
  - Soil Biological Health Testing

Soil Microbial Health Module #1: Introduction to Soil Microbiology

Soil Microbial Health Module #2: Cropping Systems

Soil Microbial Health Module #3: Organic vs. Inorganic Fertilizers

Soil Microbial Health Module #4: Soil Microbial Health Testing

42:17 / 42:50 | Scroll for details

Presentation by Linsey Van Koppen at the 2021 ONFARM FORUM organized by Ontario Soil Crop Improvement Association February 2021



## CLIMATE-SMART CONNECTIONS

### Virtual Annual Conference

Join us to meet students and collaborators & discuss the future of sustainable ag in a changing climate

**February  
18-19, 2021**

**12:00-4:30 pm EST**

### Join here:

<https://zoom.us/j/97226951315?pwd=NFlwUDRBUD093UTdaMUY2RDhkVjpwUT09>

### Event at a Glance

(all times in EST; detailed schedule on next page)

DAY 1		DAY 2	
12:00 pm	<b>Welcome &amp; Collaborator Updates</b>	12:00 pm	<b>Welcome</b>
1:00 pm	<b>Presentations &amp; Discussion</b> <i>Management Practices</i>	12:15 pm	<b>Presentations &amp; Discussion</b> <i>Nutrient Management 1</i>
1:50 pm	<b>Presentation &amp; Discussion</b> <i>Genes &amp; Microbes</i>	1:00 pm	<b>Presentation &amp; Discussion</b> <i>Nutrient Management 2</i>
2:35 pm	<b>Presentations &amp; Discussion</b> <i>Cover Crops &amp; Crop Rotation</i>	1:45 pm	<b>Presentations &amp; Discussion</b> <i>Life Cycle Analysis &amp; Economics</i>
3:30 pm	<b>Presentation &amp; Discussion</b> <i>Nutrient Cycling &amp; Management</i>	2:30 pm	<b>Presentation &amp; Discussion</b> <i>Maps &amp; Measurements</i>
4:15 pm	<b>Closing Remarks</b>	3:10 pm	<b>Career Panel</b>
		4:15 pm	<b>Closing Remarks</b>

Join us for an optional & interactive **Climate-Smart Social** Friday evening after the event 4:45 pm!

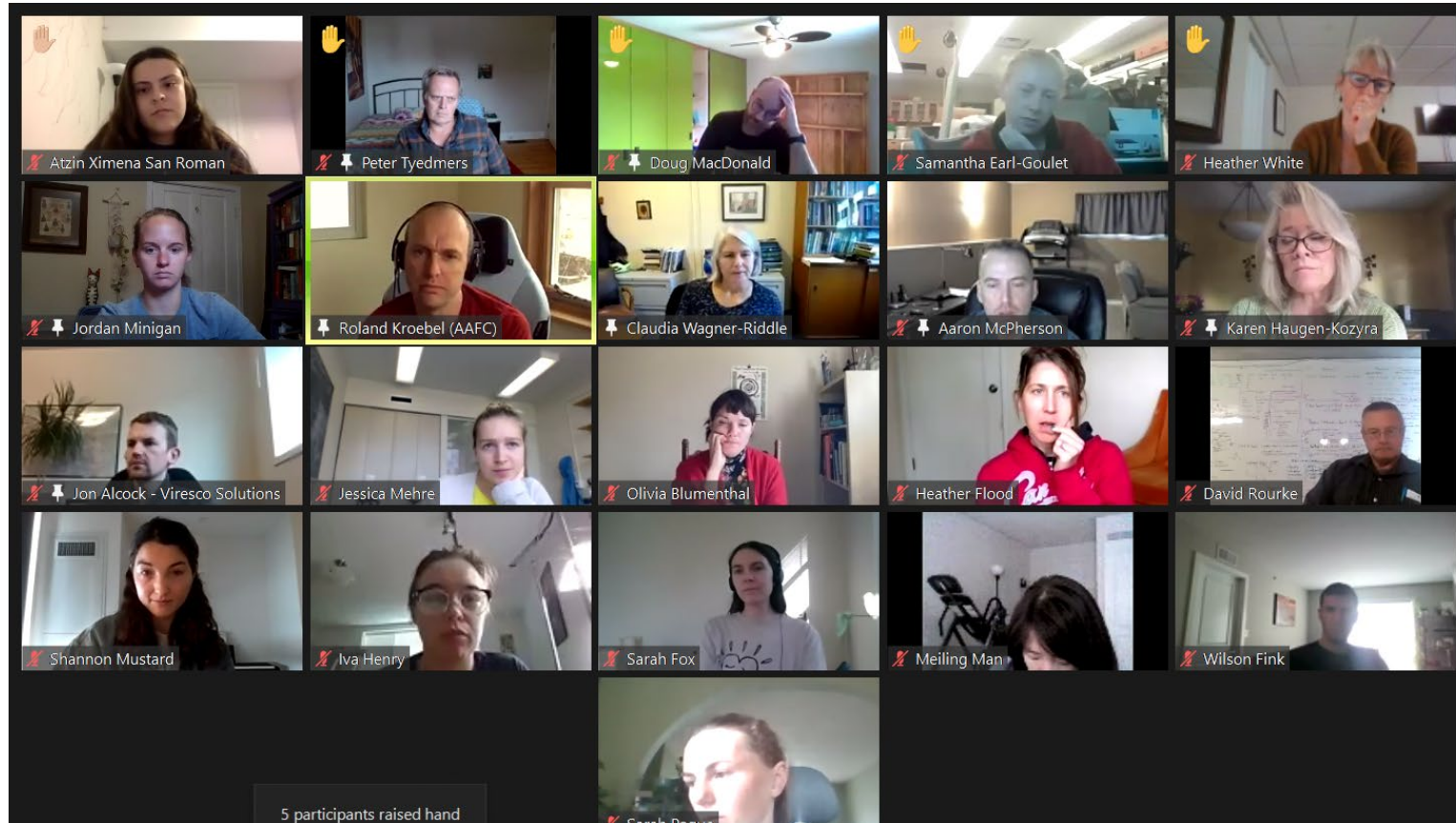
# Annual Conference Organizing Committee



# CONCLUDING REMARKS

- Highly qualified personnel with workplace experiences, technical (e.g. carbon reduction verification) and non-technical skills (e.g. communication with non-technical audiences) are needed to implement soil health strategies
- The CREATE-CSS program was designed with these needs in mind and involves collaboration with 6 Universities in 5 provinces and 20+ collaborators from industry, farming organizations, government and NGOs
- The program aims to provide increased understanding of the agricultural industry, access to mentoring and leadership opportunities, career development options, creation of an inclusive environment and building awareness of potential career paths





## Thank you!

Claudia Wagner-Riddle: [cwagnerr@uoguelph.ca](mailto:cwagnerr@uoguelph.ca)

Jordan Minigan (program coordinator): [info@smartsoils.ca](mailto:info@smartsoils.ca)

*“Hearing the opinions and getting to talk to experts in the field on a conversation level I felt was eye-opening to our strengths and weaknesses in a field of GHG Assessment. I also felt like it was a great opportunity to utilize professional social skills in a time where we can't meet to discuss in person. Very rewarding experience overall.”*