Using Soil Sensors to Monitor Soil Organic Matter Content in Western Newfoundland

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Background

The role of soil organic matter (SOM) in improving soil quality and soil health, while boosting agricultural productivity, is well recognized. SOM enhances soil microbial activity, improves the soil fertility by increasing nutrient availability, retains more water, and strengthens soil structure and stability. Additionally, its ability to capture atmospheric carbon (C) and store it as SOM, is pivotal for mitigating global environmental issues such as climate change. Agronomic practices significantly influence SOM content, leading to variability in and throughout agricultural fields. Identifying this variability using fast and cost-effective methods is important for understanding large-scale C sequestration potential. Proximal soil sensors, such as electromagnetic induction (EMI) sensors that measure soil electrical conductivity (EC_a), can rapidly collect extensive soil data while operating close to the soil surface. EC_a is influenced by several soil properties including texture, water content, bulk density, and ion/nutrient levels; however, the relationships between SOM, EC_a and other soil properties remain poorly understood. Developing a comprehensive model that explains these relationships will enable the implementation of effective methods to assess the variability of SOM content in agricultural fields.

Project Objectives

This project involves monitoring and assessing variability of SOM at different soil depths and times throughout the year under different soil moisture levels in forage and potato fields using an EMI sensor. The variability of EC_a maps will also be used to determine the effects of beneficial management practices (BMPs) on C sequestration capacity in boreal podzolic soils in western Newfoundland.

Methodology

An EMI-based proximal soil sensor is used to collect geo-referenced soil EC_a data for oil depth variability of SOM. Georeferenced soil EC_a data was generated by holding the sensor about 20 cm above the soil surface and moving at a constant speed along parallel lines across the field and maintaining a 1 - 2 m distance between survey lines. Four consecutive EC_a surveys were completed in the entire field before and after harvesting crops as well as in the area where experimental plots had been established during the growing season. Soil sampling for moisture content and organic matter was done at 0 - 10 cm and 10 - 20 cm depths on the same days as EC_a surveys. An existing relationship (model) between soil properties and EC_a will be modified to predict the variability of SOM at different soil depths and times throughout the year insoils in western Newfoundland.

Preliminary Results

Soil EC_a maps showed considerable variability across different depths (0 - 0.38 m, 0 - 0.75 m and 0 - 1.5 m) and time (spring and fall seasons, 2023) (Fig. 2 and Fig. 3). This is consistent with previous research which shows that soil properties such as water content, texture, bulk density, SOM, and pore water electrical conductivity are major contributors to variations in soil EC_a (Corwin and Lesch, 2005).

Agricultural Industry Benefits

Defining the relationship between SOM and EC_a using proximal sensor data can potentially reduce the need for destructive and tedious soil sampling and analysis procedures. The adaptation of a region-specific model and maps may allow for timely planning and support precision management practices such as drainage requirements, as well as fertilizer and amendment application.

Reference

Corwin, D.L. and Lesch, S.M., 2005. Apparent soil electrical conductivity measurements in agriculture. *Computers and electronics in agriculture*, *46*(1-3), pp.11-43.

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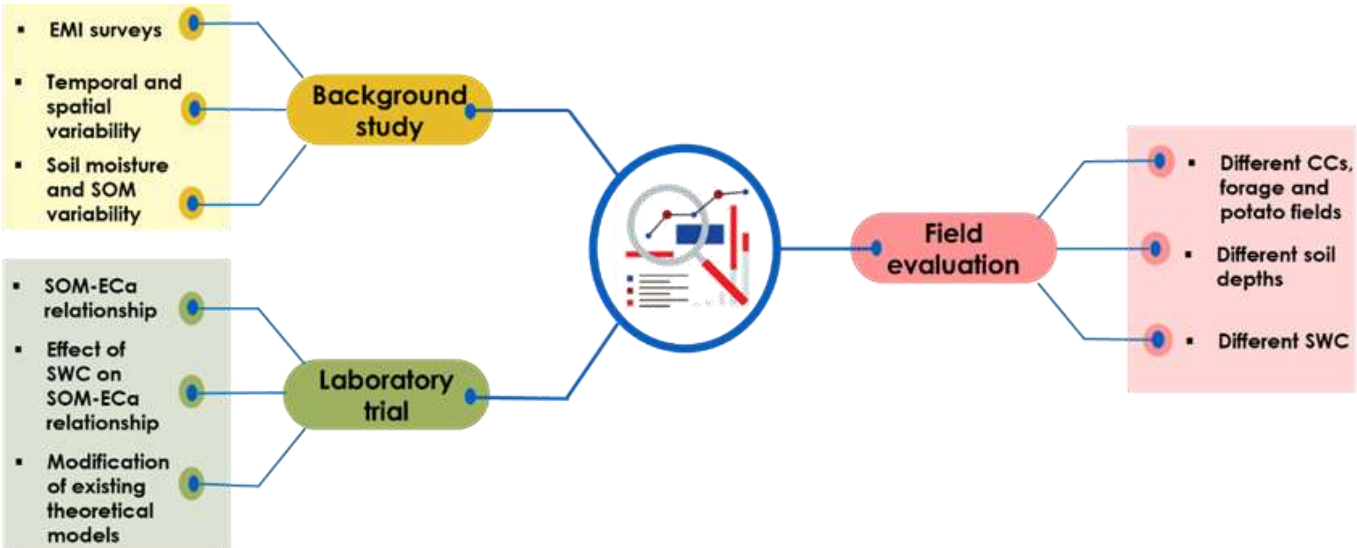

Figure 1. Flow diagram for the methodology of the research project

Abbreviations: EMI – Electromagnetic Induction, SOM – Soil organic matter, ECa – Apparent electrical conductivity, SWC – Soil water content, CC – Cover crops

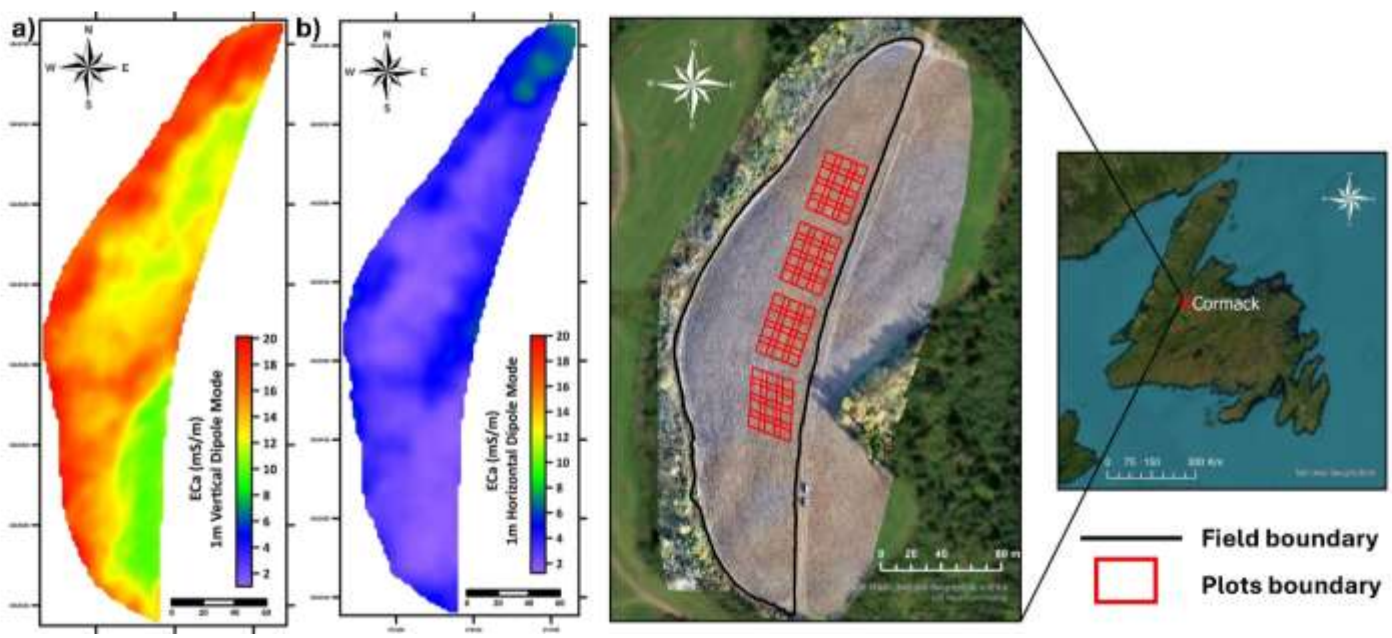

Figure 2. Spatial variability of soil apparent electrical conductivity before cultivation in forage field. Spatial variability of soil apparent electrical conductivity was shown two different effective soil depths of a) 0-1.5m and b) 0-0.75m.

Abbreviations: ECa – Apparent electrical conductivity

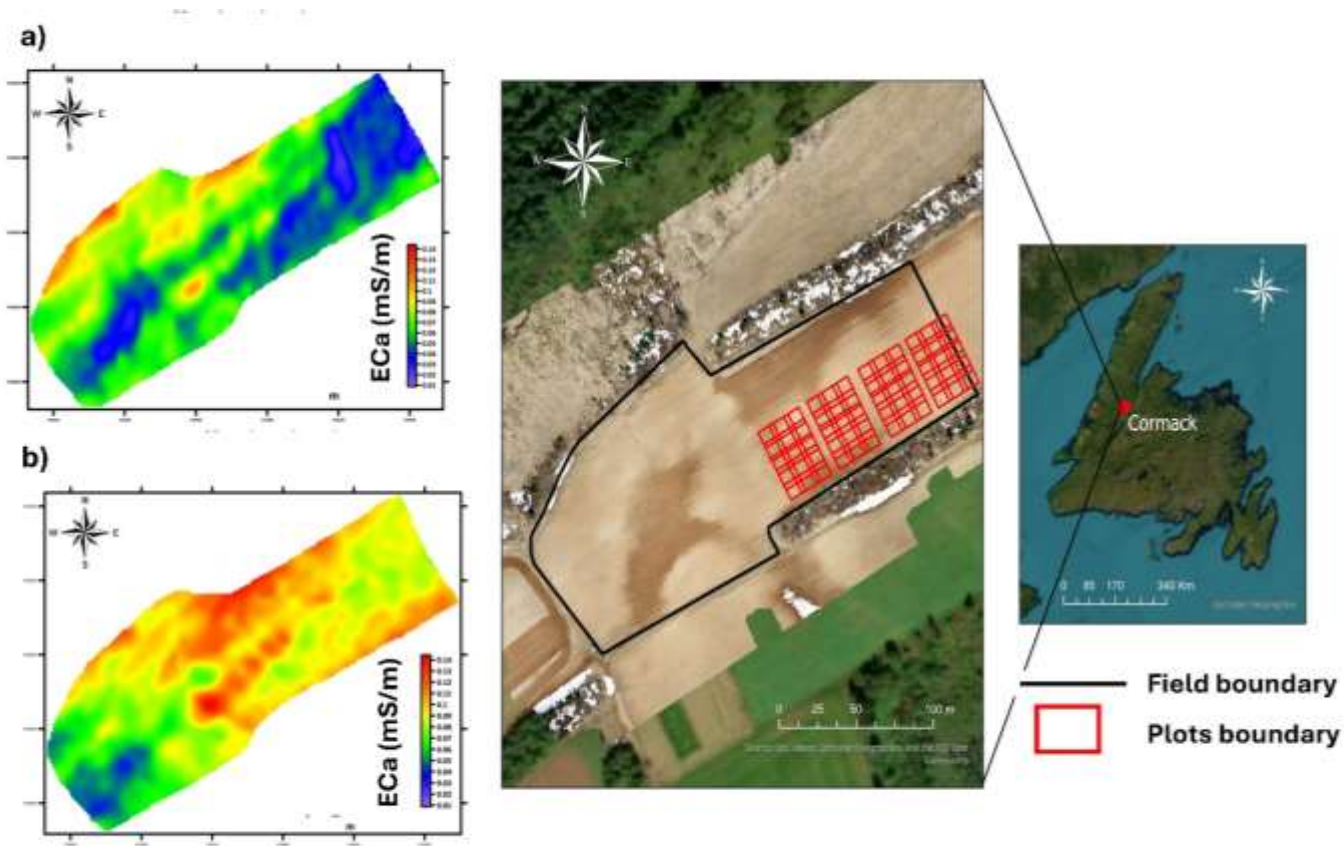

Figure 3. Spatial variability of soil apparent electrical conductivity before cultivation in potato field. Spatial variability of soil apparent electrical conductivity was shown two different effective soil depths of 0-1.5m and 0-0.75m.

Abbreviations: ECa – Apparent electrical conductivity