Soil organic carbon determination as influenced by Ontario biomass crops

UNIVERSITY of GUELPH

Jordan Graham [a], Andrew Gordon [a], Bill Dean [b], Paul Voroney [a] and Naresh Thevathasan [a]

[a] School of Environmental Sciences, [b] Department of Plant Agriculture

Ontario Ministry of Agriculture, Food and Rural Affairs

Introduction

- Switchgrass (*Panicum virgatum)* and miscanthus (*Miscanthus giganteus*) are perennial crops grown on less productive soils for biomass production.
- Previous studies have reported increases in soil organic carbon (SOC) (0-30cm) in 10-20 yr switchgrass and miscanthus stands by rates of 1.1 Mg C ha^{-1} yr^{-1} [1] [2] from decaying root biomass and residual above-ground plant material. Since biomass crops are typically grown on less productive and marginal lands, the effects of adoption of this land-use change on food production should be minimal [3].
- Increases in SOC are also associated with improved soil chemical, physical and biological properties.
- Soil type and climate [1] affect both plant biomass production and formation of stabilized SOC.
- It is not known how biomass crops will influence SOC levels in the soils and climates of southern Ontario.

Figure 1. Switchgrass (left) and miscanthus (right) research plots located at the University of Guelph Elora Research Station.

Objectives

1. Create a GIS database of SOC content in fields growing switchgrass and miscanthus in Ontario.
2. Determine concentrations of SOC in biomass stands of varying species, stand age, soil type and location.
3. Compare levels of SOC between biomass, agricultural and forest land-uses to determine the potential influence of land-use change on the carbon sequestration potential of biomass crops.
4. Use the Century model to predict effects of biomass cropping systems on their potential to sequester SOC.

Hypothesis

- SOC content in fields growing switchgrass and miscanthus will be higher than in adjacent agricultural fields.
- SOC contents will increase with biomass stand age and with increases in soil clay content.
- Computer simulation will predict increased SOC storage in biomass fields.

Methodology

Study Locations

- In 2016, 19 Ontario farms containing biomass fields were sampled for SOC shown in Figure 2 below.
- Soil samples were collected from biomass fields as well as adjacent agricultural fields and woodlots for SOC comparison between different land-uses.

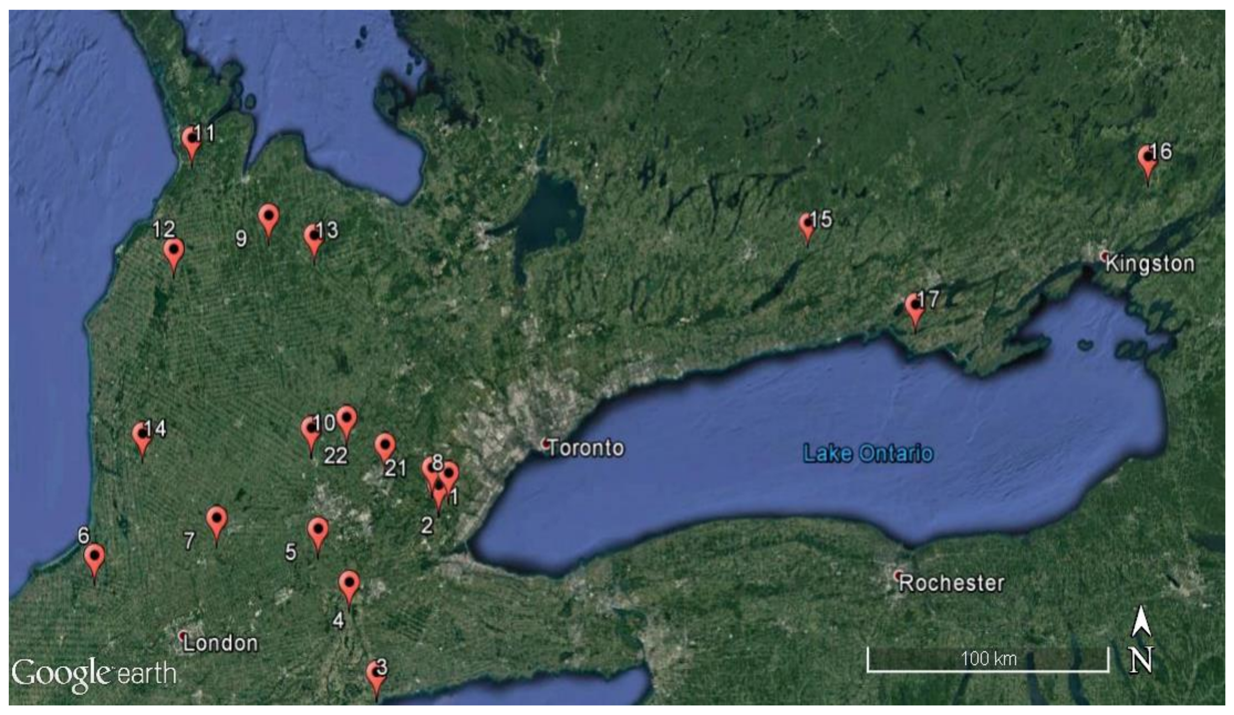

Figure 2. Selected biomass sites sampled for soil organic carbon in 2016

Sample Collection

- 15 soil samples were collected along a transect and their locations (to within 2m) marked using a GPS unit.
- For each sample, soil from 0-30cm was collected manually using a Dutch auger.

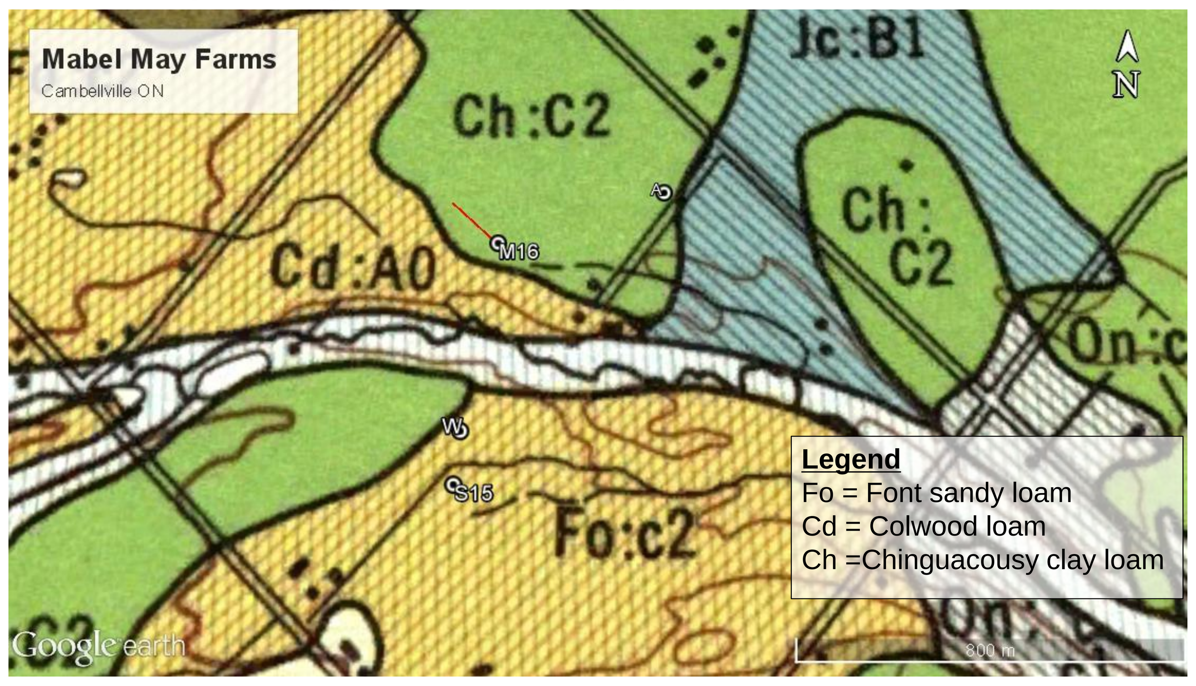

Figure 3. Locations for each of the four transects sampled in Cambellville ON, 2016 in relation to the soil type found in the Soils of Halton (1971) [4].

Laboratory Analysis

- In preparation for analysis soil samples were air dried, passed through a 2 mm sieve, and hand ground using a mortar and pestle prior.
- SOC was determined by the direct combustion method adapted from Wang and Anderson (1998) [5].

Figure 3. Biomass research plots located at the University of Guelph Turf Grass Institute.

Results

- SOC (%) increased with stand age (Table 1). This can be seen field soils in the Holland Center, ON.
- At Port Ryerse, soil texture appears to have had an influence on SOC levels. However, this could also be due to differences in SOC content of the soil prior to planting miscanthus.
- Comparison of field soils at a single location showed that agricultural fields had higher SOC contents than biomass fields. Soils in adjacent woodlots had the highest SOC (%).

Table 1. Average soil organic carbon (%) in the topsoil of six farms growing biomass crops in Ontario sampled in 2016.

Location	Field Type *	Textural Class	SOC (%)
Port Ryerse, ON	Miscanthus (2012)	Clay Loam	1.401
	Miscanthus (2012)	Sand	0.547
	Agricultural	Sandy Loam	3.092
Holland Center, ON	Switchgrass (2009)	Clay Loam	4.252
	Switchgrass (2011)	Clay Loam	3.582
	Switchgrass (2012)	Clay Loam	3.891
Guelph, ON	Switchgrass (2006)	Sandy Loam	1.900
	Miscanthus (2006)	Sandy Loam	1.840
	Agricultural	Sandy Loam	2.120
	Woodlot	Sandy Loam	3.350
Elora, ON	Switchgrass (2009)	Silt Loam	1.270
	Miscanthus (2009)	Silt Loam	1.420
	Agricultural	Silt Loam	1.610
Parkhill, ON	Switchgrass (2011)	Sandy Loam	1.958
	Agricultural	Sandy Loam	1.624
	Woodlot	Sandy Loam	3.137

**Agricultural fields represent adjacent fields growing common field crops and brackets indicated year of biomass crops establishment*

Future Work and Significance

- The use of $\Delta^{13}C$ isotope techniques to measure the direct contribution of biomass crops to the SOC pool.
- Parameterization of the CENTURY computer model to predict future changes in SOC.
- Data collected from this study can be used by members by the Ontario Biomass Producers Cooperative to claim carbon credits in the future within the context of Ontario's new cap and trade initiatives.
- The information gained by understanding SOC dynamics in biomass crops will also help to guide soil health and management policy.

References

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For More Information:
Jordan Graham
jgraha08@uoguelph.ca

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School of Environmental Science, University of Guelph, Guelph, Ontario, Canada, N1G 2W1

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