Plant Agriculture

Ag Biomass and Soil Health

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Ag Biomass Day - 2015

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Guelph, Ontario, Canada.

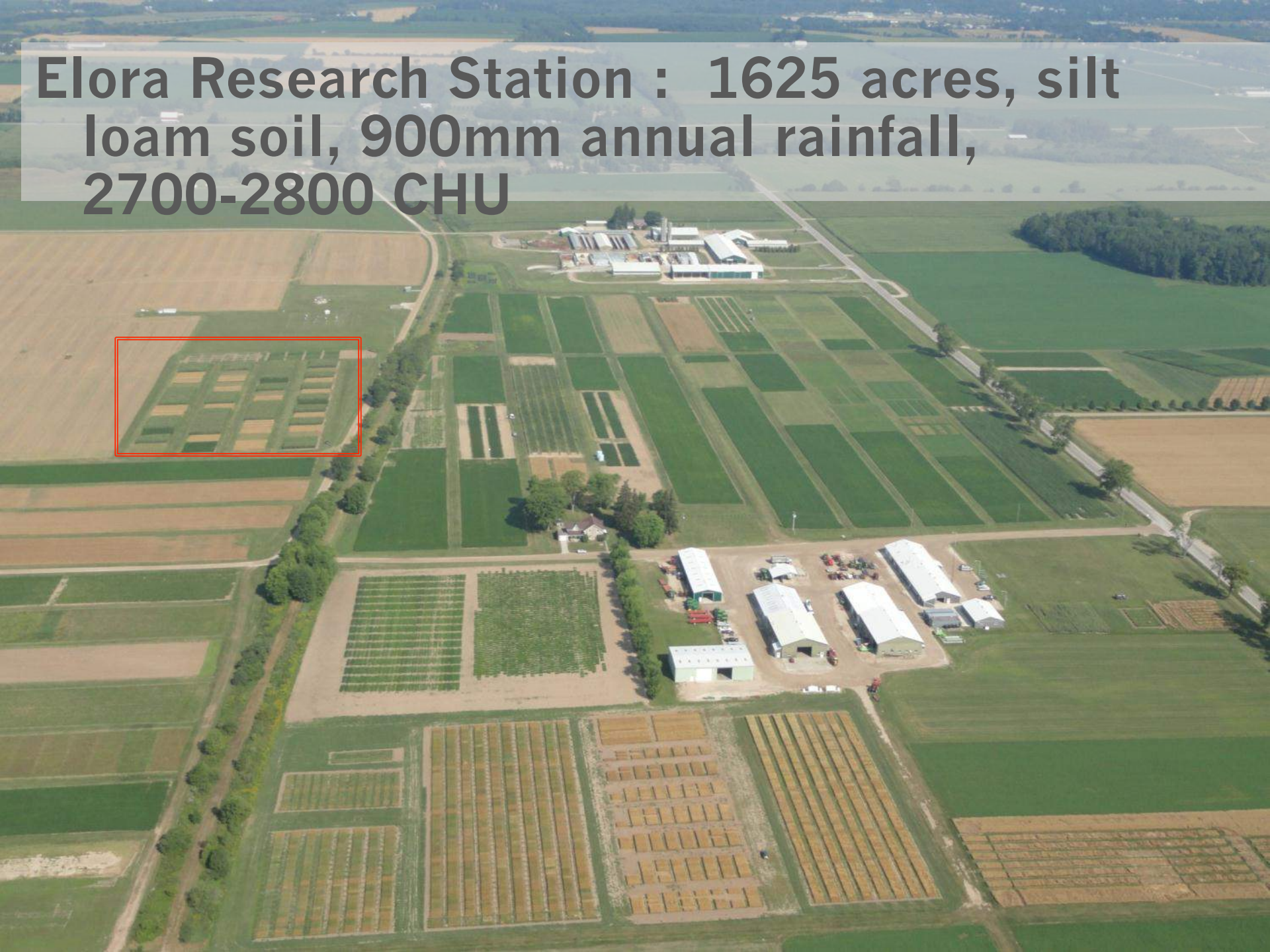
Changing Lives Improving Life

University of Guelph

Outline

- Regardless of your definition of soil health, organic matter is critical
- Crop residue removal and soil health – proceed with caution…
- Perennial grasses good for soil health BUT not all soil will benefit equally

Elora Research Station : 1625 acres, silt loam soil, 900mm annual rainfall, 2700-2800 CHU

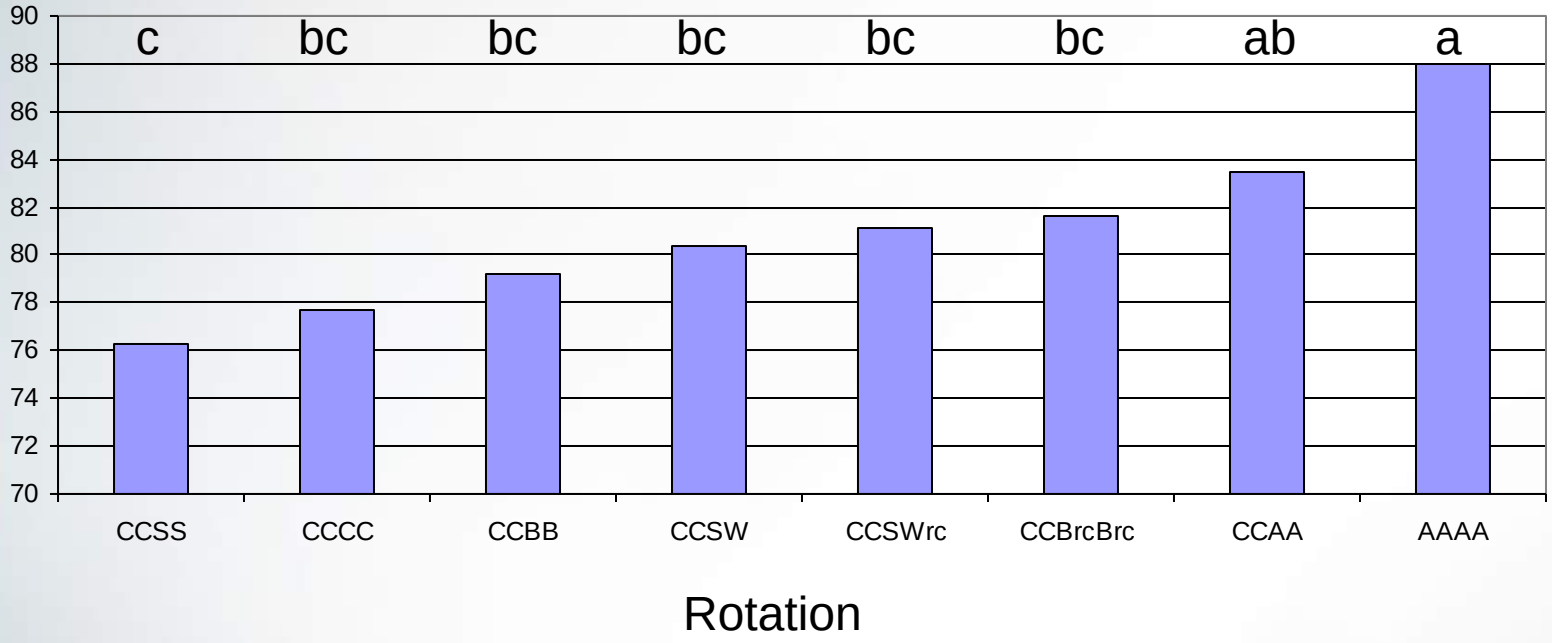


Corn soybean rotation is associated with

- Reduced yield
- Reduced system resiliency
- Lowest soil organic matter
- Increased input requirement (eg. nitrogen)
- Reduced input use efficiency
- Reduced probability of no-till success
- Reduced opportunity to incorporate cover crops
- Increased GHG emission

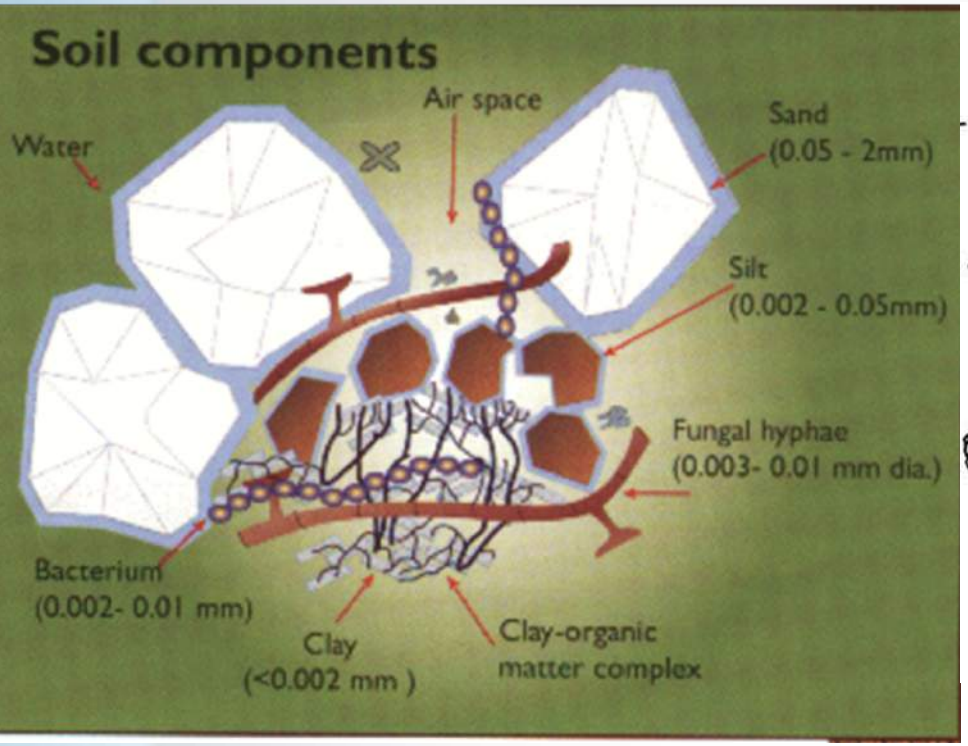
Meyers et al, 2006a; Meyers et al 2006b; Sanscartier et al, 2013; Munkholm et al, 2012; Munkholm et al, 2013; Muellera et al, 2009; Gaudin et al, 2013; Gaudin et al. 2014; Gaudin et al. 2015, Kludze et al. 2013.

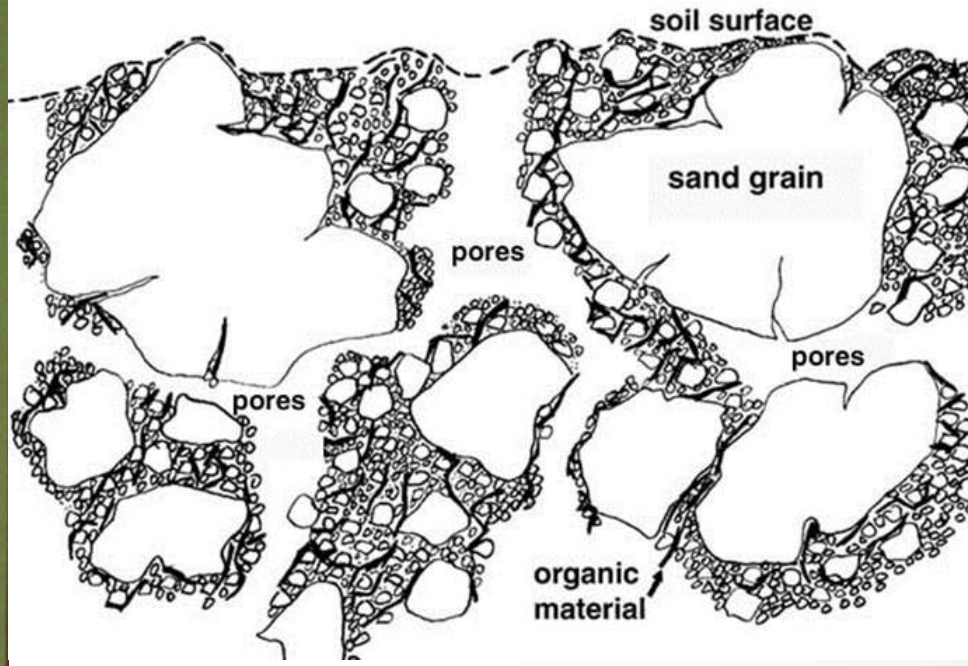
Carbon content on different long term rotation plots based on equivalent mass of 4800 Mg ha^{-1} (the average depth for this mass is 34 cm)



Meyers-Aurich et al., 2006

OM and Soil health





Corn soybean rotation is associated with

- Reduced yield
- Reduced system resiliency

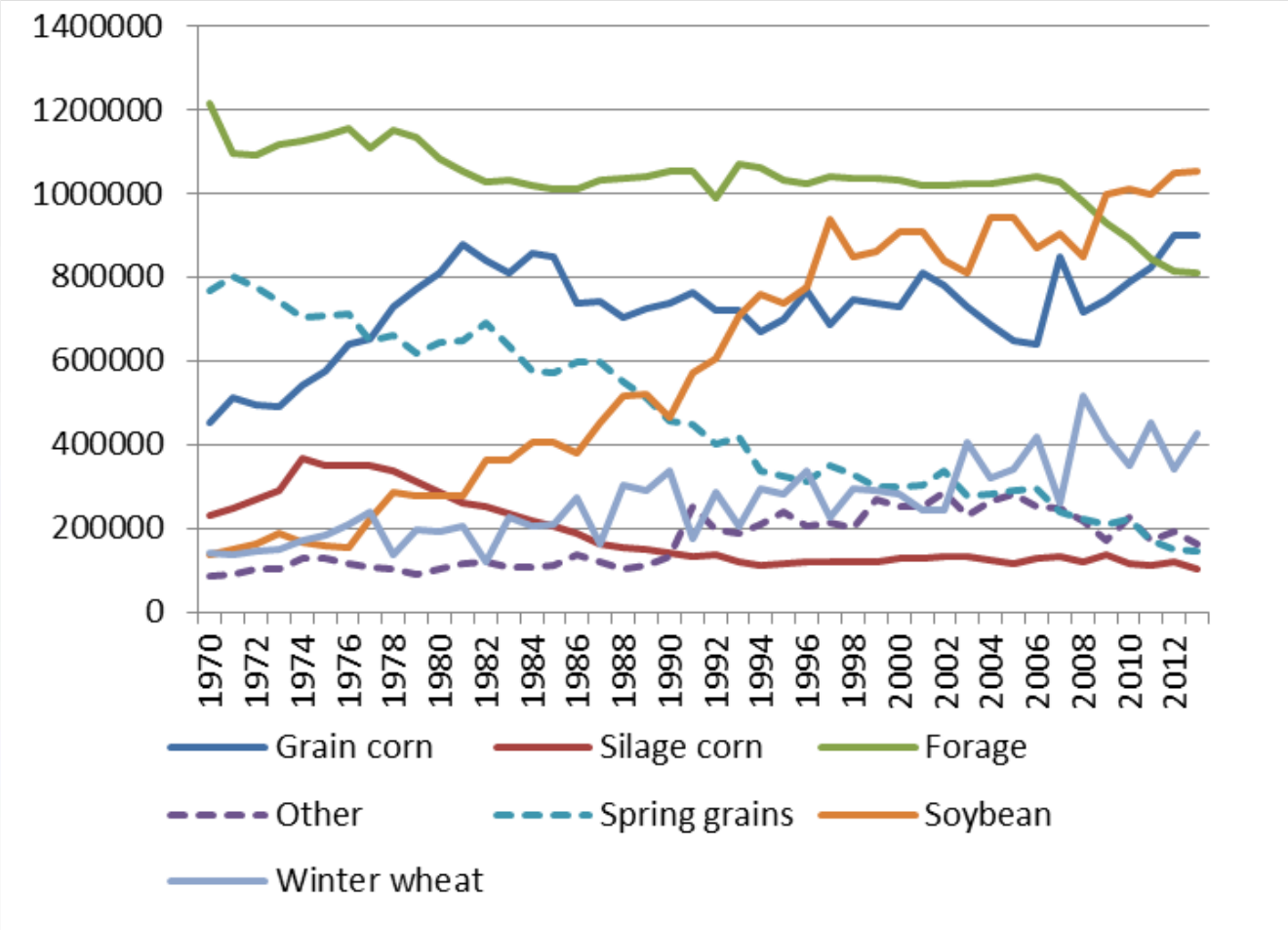
CS most common rotation and becoming more common!

crops

- Increased GHG emission

Meyers et al, 2006a; Meyers et al 2006b; Sanscartier et al, 2013; Munkholm et al, 2012; Munkholm et al, 2013; Muellera et al, 2009; Gaudin et al, 2013; Gaudin et al. 2014; Gaudin et al. 2015, Kludze et al. 2013.

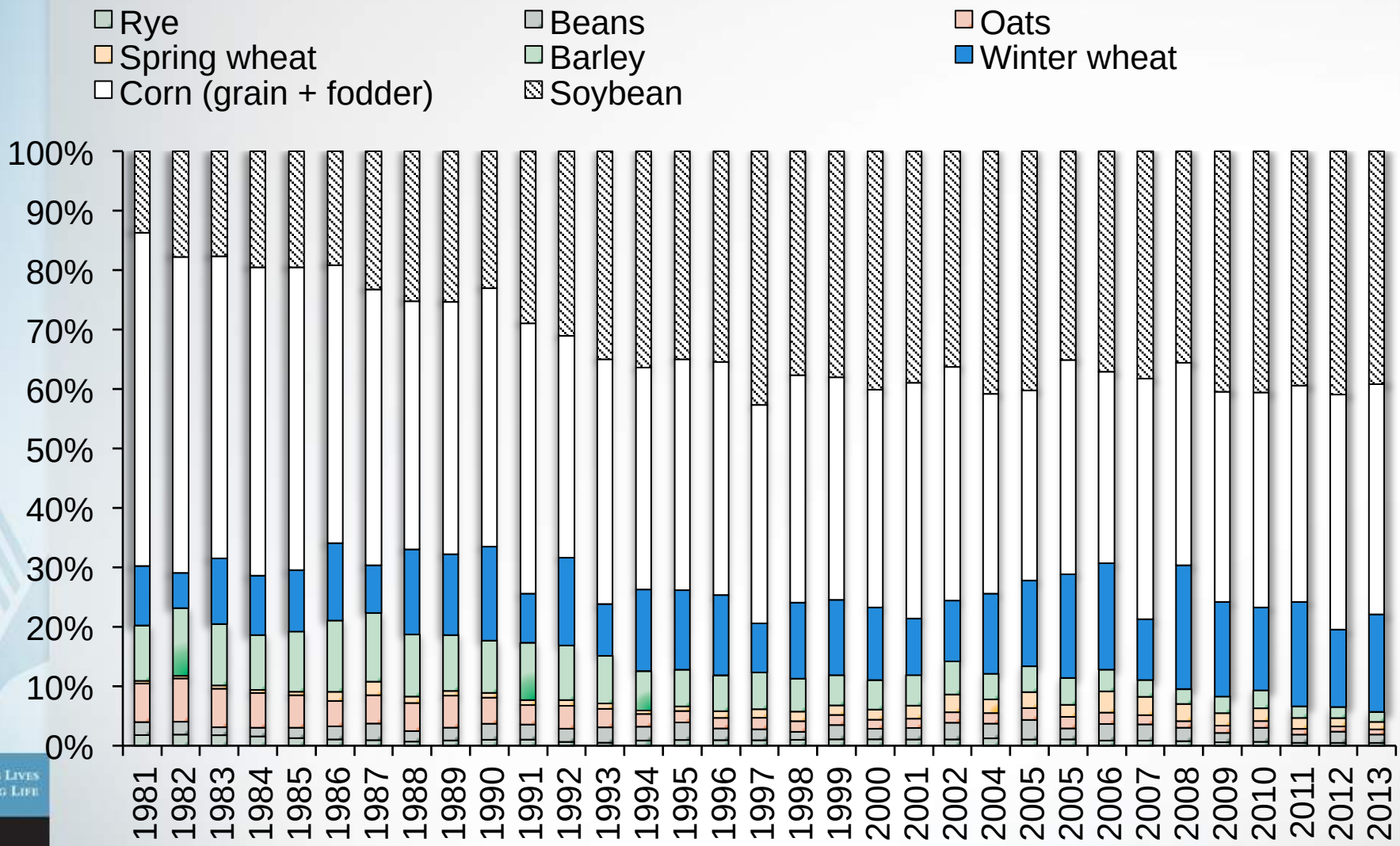
Seeded area by crop, 1970-2013



Source: Statistics Canada. Table 001-0010 - Estimated areas, yield, production and average farm price of principal field crops, in metric units, annual (accessed: November 08, 2014)

% harvested area 1981-2013

(OMAFRA, Field statistics 2014)



Gaudin A *et al.*, PLOS One (2014) DOI 10.1371/journal.pone.0113261

July 2014, somewhere near London, ON

Crop residue removal and soil health

- Proceed with caution… problems with simple rotations, in part, are caused by low OM… residue removal could exacerbate this problem.

- Recommended BMPs
  - Preferentially remove residue from complex rotations
  - Compensate for removal by using cover crops
  - Maintain/increase crop yield





C4 perennial grasses and soil health

Perennial grasses – good for soil health

- High soil OM: high yield, high root:shoot
- Good soil structure: aggregation, porosity
- High water infiltration/low erosion
- High water holding capacity
- Low nutrient losses

…. BUT not all soils will benefit equally




GLOBAL CHANGE BIOLOGY
BIOENERGY

GCB Bioenergy (2013), doi: 10.1111/gcbb.12062

Implications of land class and environmental factors on life cycle GHG emissions of Miscanthus as a bioenergy feedstock

" Yield and soil C of the displaced agricultural systems are key parameters affecting emissions. The systems with the highest potential to provide reductions in GHG emissions are those with high yields, or systems established on land with low soil carbon. "

sions for Miscanthus production varied greatly among scenarios (−90–170 kg CO_2eq per oven dry tonne of Miscanthus bales at the farm gate). In some cases, the carbon stock dynamics of the agricultural system offset the combined emissions of all other life cycle stages (i.e., production, harvest, transport, and processing of biomass). Yield and soil C of the displaced agricultural systems are key parameters affecting emissions. The systems with the highest potential to provide reductions in GHG emissions are those with high yields, or systems established on land with low soil carbon. All scenarios have substantially lower life cycle emissions (−20–190 g CO_2eq kWh $^{-1}$) compared with coal-generated electricity (1130 g CO_2eq kWh $^{-1}$). Policy development should consider the implication of land class, environmental factors, and current land use on Miscanthus production.

Keywords: GHG, LCA, Miscanthus spp., Perennial, Soil carbon

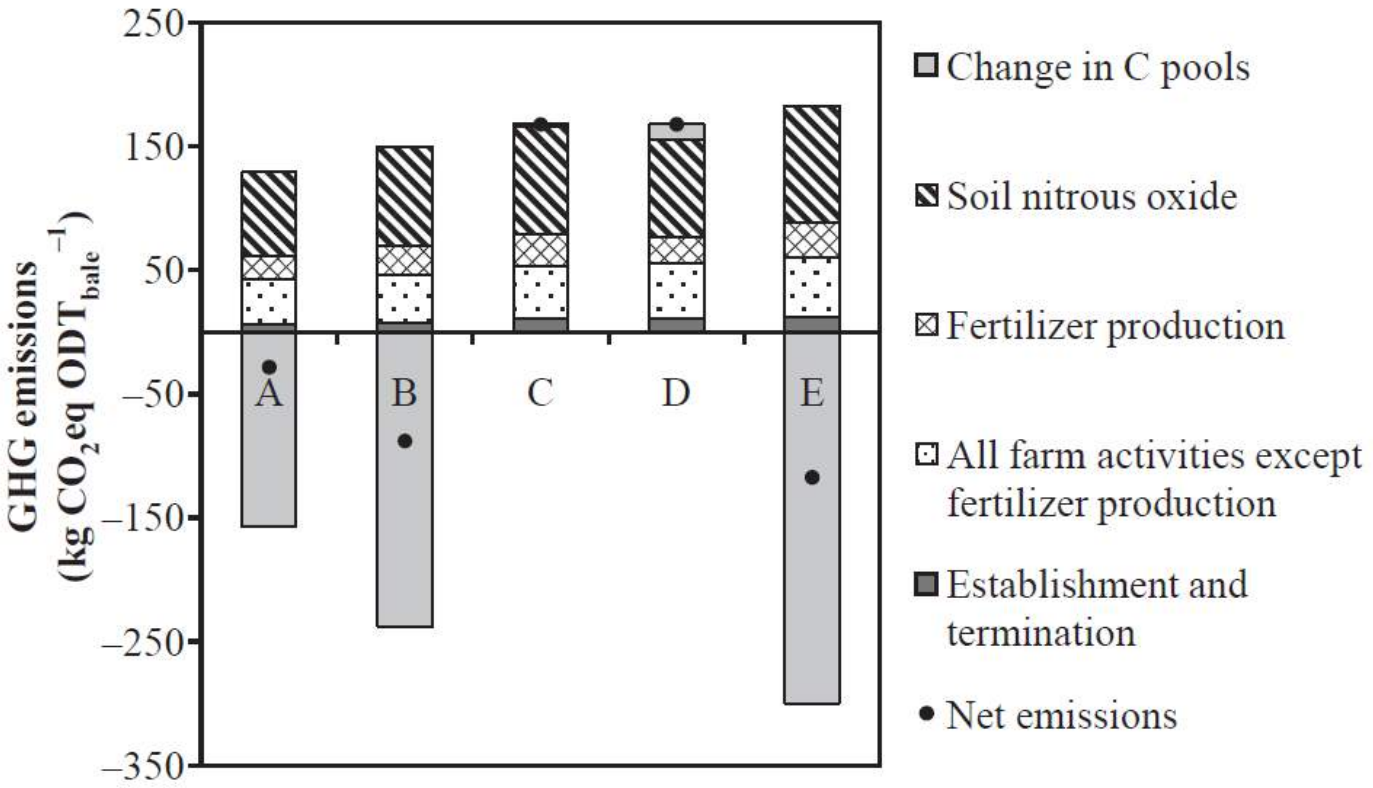
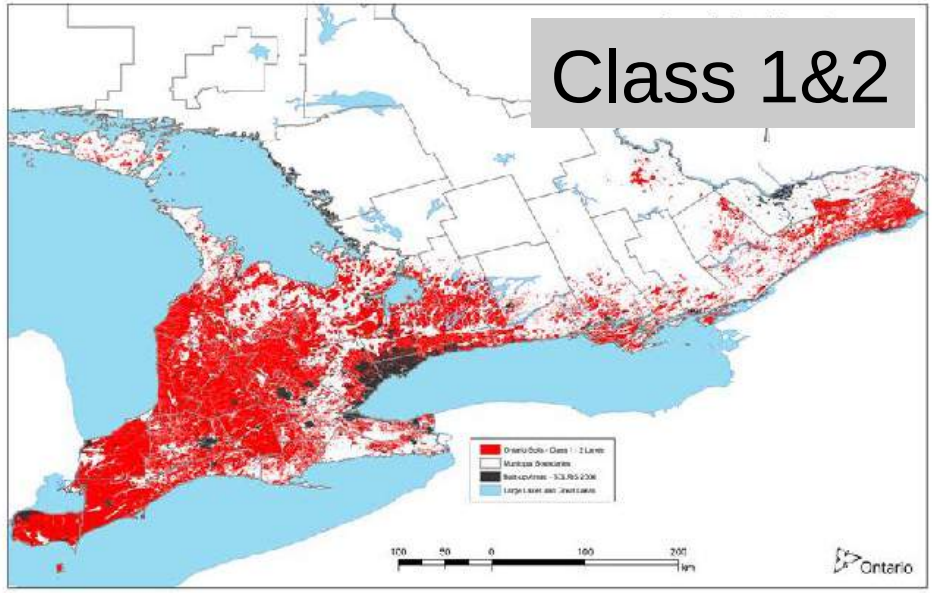


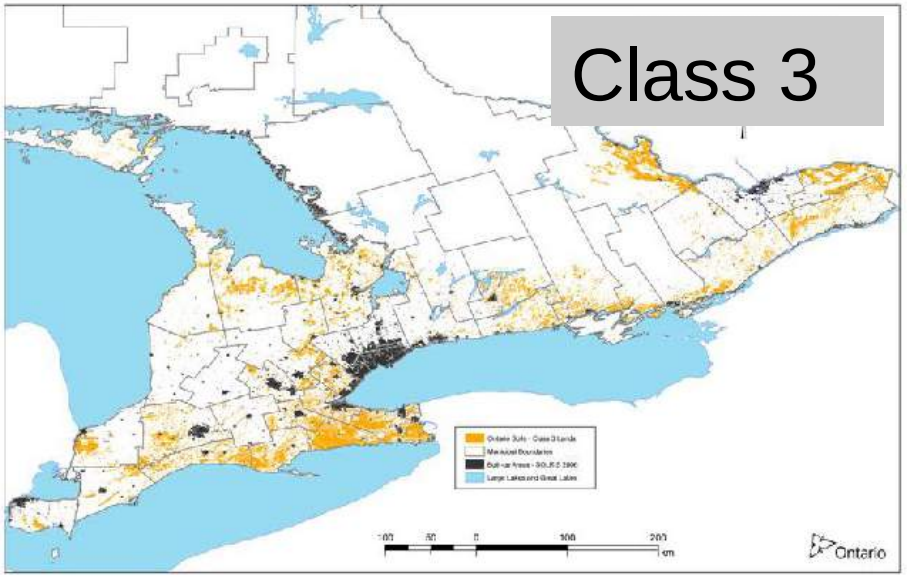
Fig. 3 Life cycle GHG emissions for the five Miscanthus scenarios per oven dry tonne of Miscanthus bale (ODT_{bale}) at the farm gate. Negative "Change in C pools" corresponds to a net uptake of C to the system.

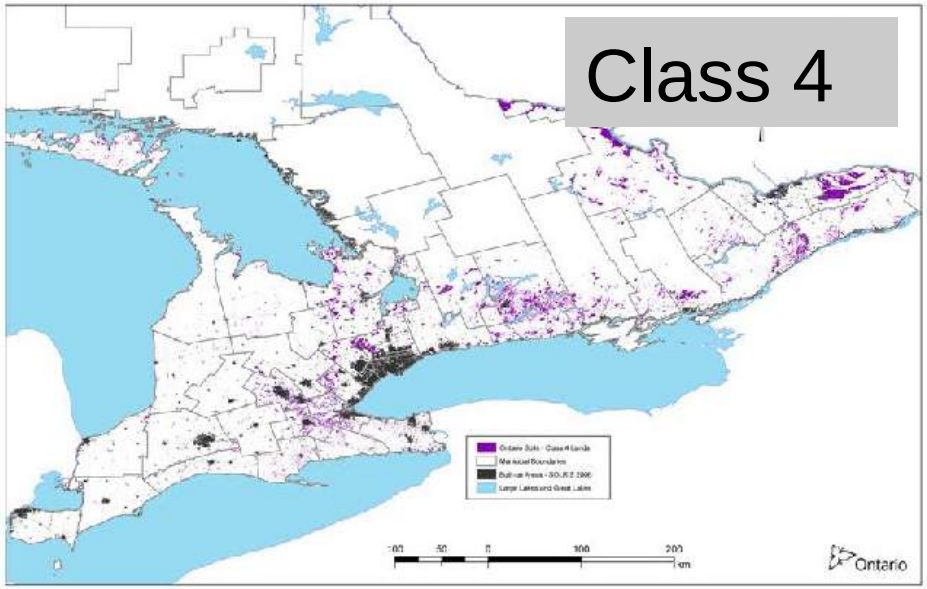
Scenarios: A) corn-soy, Class 1-2; B) soy-soy, Class 3; C) corn-forage, Class 3; D) pasture – Class 4-5; E) tobacco-cereal, Class 3-4

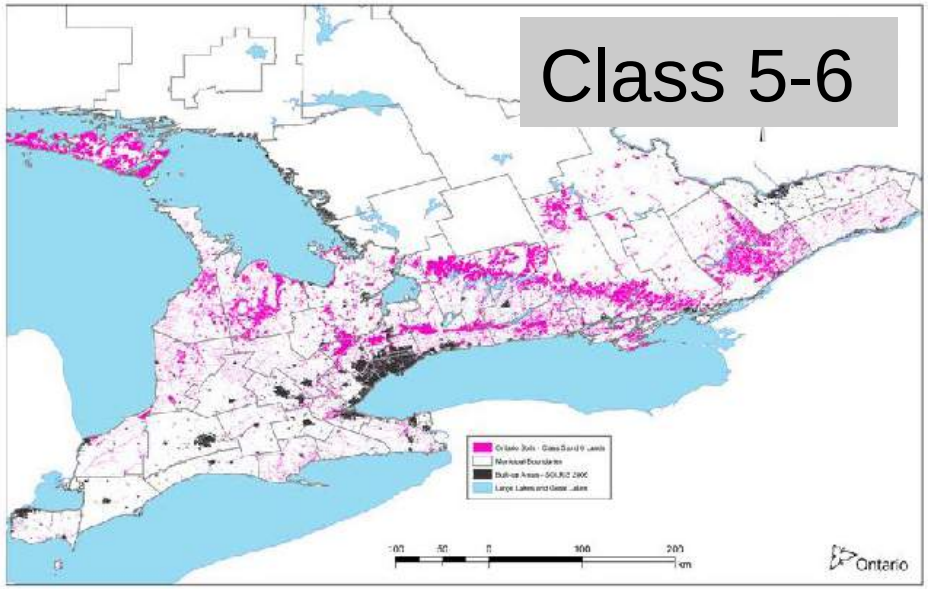
Sanscartier et al. GCBB, 2013

Ontario Land Class Distribution









Where to grow switchgrass & miscanthus?

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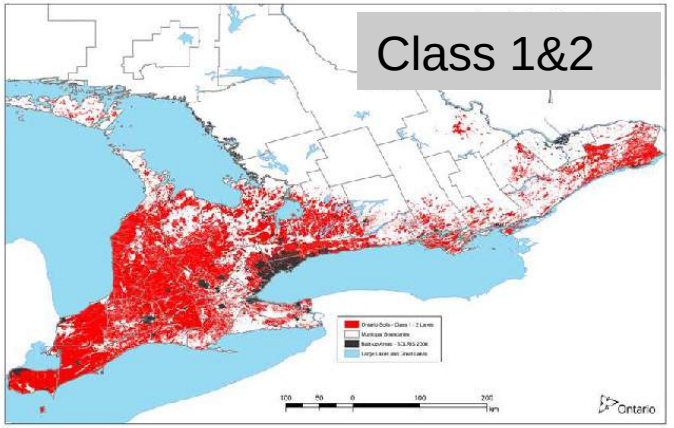
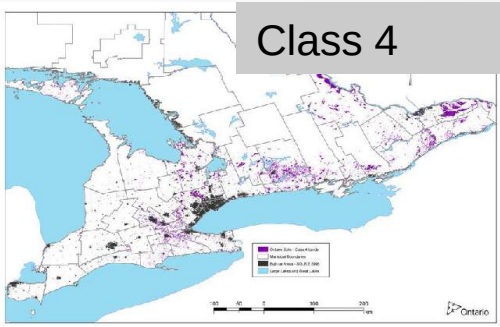
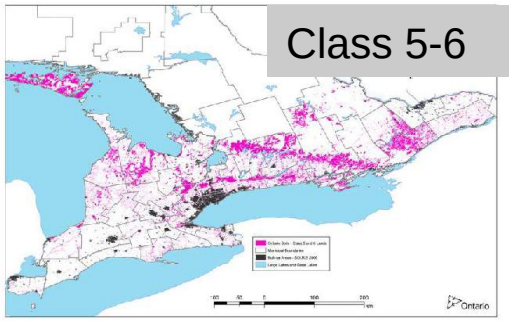
- Class 1,2 land – high yield potential, less establishment risk, more stable supply, large OM/soil health benefit (if displacing row crops)
- Can we target "environmentally sensitive" land?
- Can we fit switchgrass into rotation?



Where to grow switchgrass & miscanthus?

- Class 4,5 land – lower yield potential, greater establishment risk, less OM/soil health benefit (displacing forages/pasture)





Where to grow switchgrass & miscanthus?

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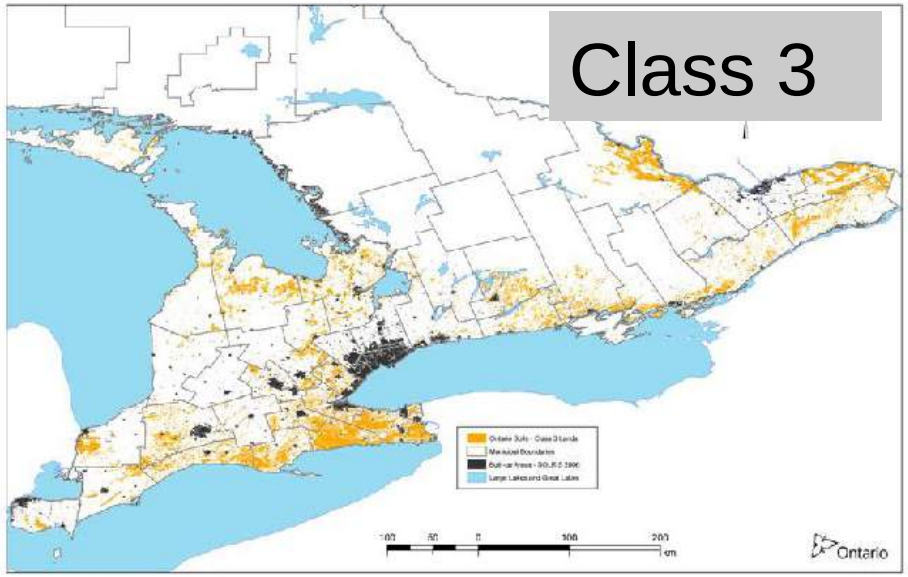
- Class 3 land – good yield potential, large OM/soil health benefit
  - Target Class 3 land currently in row crop production?



Conclusions

- Regardless of soil health definition, organic matter critical
- Crop residue removal and soil health – proceed with caution…
- Perennial grasses good for soil health BUT not all soils benefit equally