Soil Quality in Action Tour

Sponsored by:
Divivion S-6
(Soil & Water Conservation & Management)
and
Division S-3
(Soil Biology & Biochemistry)
of the
Soil Science Society of America

21 October 2001

Beecher Grose Dairy Farm
in Iredell County, North Carolina

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Soil Quality and the Stratification of Organic Matter

What is soil quality?

Soil quality is a concept that recognizes the need to understand the + / - impacts of management on the capability of soil to function

- as a medium for plant growth
- to regulate and partition water flow in the environment
- to buffer the flux of natural and xenobiotic compounds through decomposition and fixation

What is the role of organic matter in soil quality?

Organic components of soil are important in providing
- energy
- substrates
- biological diversity

necessary to sustain many soil functions.

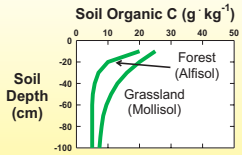
Of what significance is stratification?

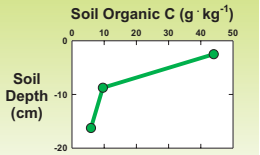
The soil surface is the vital interface that
- receives external production inputs
- receives the intense impact of rainfall
- partitions the flux of gases to/from soil

Where and why does stratification of organic matter occur?

Stratification of soil organic matter with depth is common in

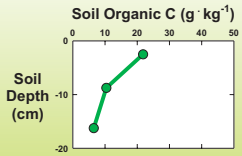
Natural ecosystems

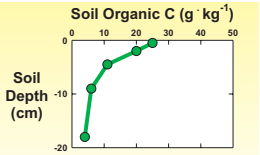




Managed grasslands

Managed forests





Cropland under conservation tillage

Hypothesis

Greater stratification of soil organic matter with depth will lead to improved soil functioning as a result of

- more efficient nutrient cycling by slowing the rate of mineralization–immobilization turnover
- more efficient utilization of water by
  - ⇑ water-stable aggregation
  - ⇑ surface-soil porosity
  - ⇑ water infiltration
  - ⇑ water retention
- creation of a substrate-rich, biologically active soil layer that enhances diversity

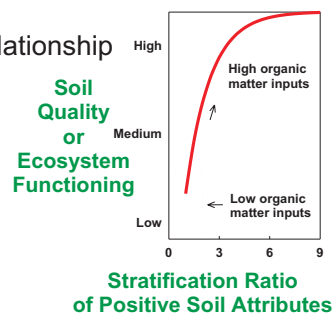
Objectives

Locally

Assess the changes in depth distribution of soil properties in response to a gradient in silage intensity
- **LR** - low residue (2 silage / yr)
- **MR** - medium residue (1 silage / yr)
- **HR** - high residue (0.5 silage / yr)

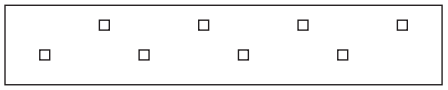
Globally

Define the relationship between stratification ratio of soil properties and ecosystem functioning

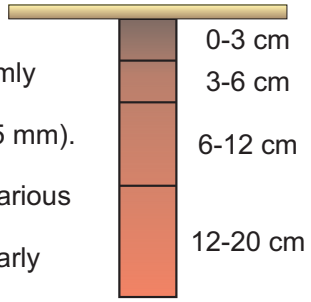


How is soil sampled?

Eight soil cores composited to represent treatment area.



Surface residue removed and quantified.
Soil cores sectioned into depths.
Soil dried uniformly at 55 C.
Soil sieved (4.75 mm).
Soil processed according to various methods.
Soil sampled yearly in autumn.



What have we found in this on-farm study?

Soil bulk density ($Mg \cdot m^{-3}$; Dec 2000)

Soil depth (cm)	Residue returned		
	Low	Medium	High
0–3	1.02	0.95	0.96
3–6	1.35	1.36	1.30
6–12	1.46	1.47	1.41
12–20	1.53	1.54	1.52
Stratification ratio $\frac{BD_{(0\text{-}6\ cm)}}{BD_{(12\text{-}20\ cm)}}$	0.78	0.76	0.74

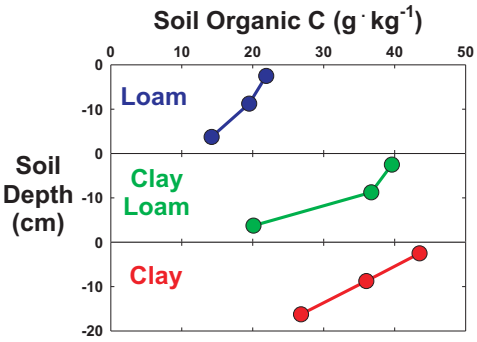
What have we found in this on-farm study?

Soil organic C ($g \cdot kg^{-1}$; Dec 2000)

Soil depth (cm)	Residue returned		
	Low	Medium	High
0–3	30	33	38
3–6	16	15	17
6–12	11	10	10
12–20	7	6	8
Stratification ratio $\frac{SOC_{(0\text{-}6\ cm)}}{SOC_{(12\text{-}20\ cm)}}$	3.2	3.5	3.4

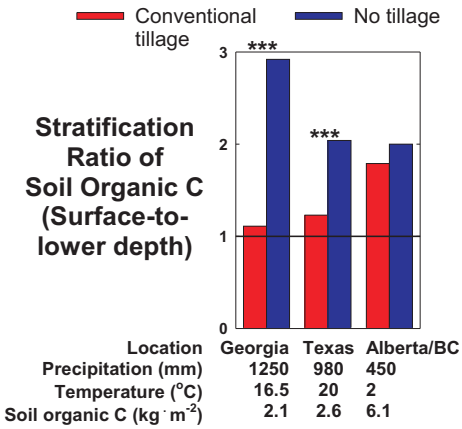
Why determine stratification ratios?

1 Soils vary in inherent properties.
2 Absolute values of organic C at the surface can vary, but a reference is needed to separate inherent from management-induced changes.
3 Soil organic C near the bottom of the plow layer should reflect an inherent characteristic that normalizes each soil.



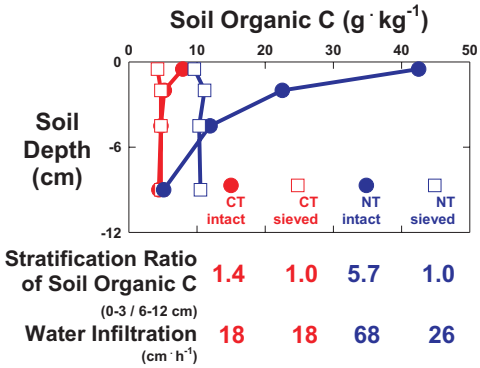
Why determine stratification ratios?

Soils inherently low in organic C may respond dramatically to conservation management, yet evaluation of organic C on absolute basis may not detect change.



Does stratification of organic matter really affect soil function?

Doubling of SOC with NT compared with CT increased infiltration 44% when uniformly distributed, but increased infiltration nearly 3-fold when stratified.



Summary and Outlook

It is relatively early in this study, but available data suggest an improvement in surface soil properties with higher residue returned (i.e. lower silage intensity).

With time, it is expected that soil organic C pools will increase more with greater organic inputs.

The relatively high stratification ratio of soil organic C, even with high silage intensity, implies that conservation tillage and manure application can compensate to some degree for the removal of above-ground plant residues.

Guiding principles to improve soil organic matter

Reduce soil disturbance

Conservation tillage
Permanent vegetation

Fix more C in plants and manage surface residues

Double-, inter-, and relay-cropping
Plant both cool- and warm-season forages

Apply animal manures when possible

Valuable C and nutrient sources
Base on nutrient requirement as a whole

Increase diversity

Crop rotations
Mixed-stand pastures