Soil Organic Matter Stratification as an Indicator of Soil Quality in Cropland

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Appreciation is noted for experiences gained through collaborations with:
Frank Hons, Dave Zuberer, Rick Haney (Texas A&M), Charlie Arshad (Agriculture Canada), Harry Schomberg, George Langdale (USDA-ARS)

Summary of presentation at the 15th Conference of the International Soil Tillage Research Organization in Fort Worth, TX held 1-7 July 2000.

Rationale

Soil is an essential natural resource
- Medium for plant growth
- Regulates and partitions water flow
- Environmental buffer in the formation, attenuation, and degradation of natural and xenobiotic compounds

Soil organic matter sustains many key soil functions
- Provides energy, substrates, and biological diversity to support biological activity, which affects
- Aggregation (soil erosion, habitat, oxygen supply)
- Infiltration (leaching, runoff, crop water uptake)
- Decomposition (nutrient cycling, detoxification)

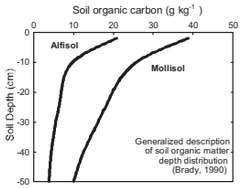
Lack of residue cover and exposure of soil to high-intensity rainfall leads to:
- Poor aggregation
- Reduced plant water availability
- Erosion
- Off-site impacts of sedimentation and poor water quality

Stratification of soil organic matter with depth is common in natural ecosystems, including
- Forests, grasslands, pastures, and conservation tillage

Hypothesis

Degree of stratification can be used as an indicator of "soil quality"

Because surface organic matter is essential to erosion control, water infiltration, and conservation of nutrients



Objectives

Develop hypothesis (i.e., Degree of stratification can be used as an indicator of "soil quality")

Test the capability of different soil organic matter pools to express this hypothesis

Illustrate the potential of soil organic matter stratification to detect management-induced changes in soil quality

Materials and Methods

Long-term experiments comparing
CT - conventional, inversion tillage
NT - no tillage

Texas
10 years, wheat, soybean, sorghum

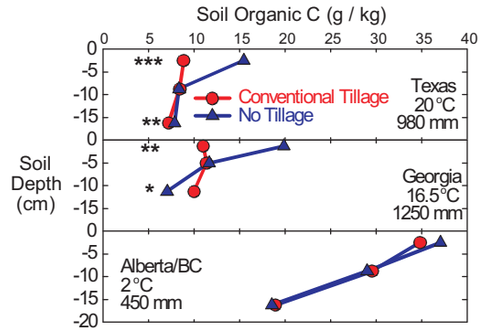
Georgia
4 years, millet, clover, cotton, rye

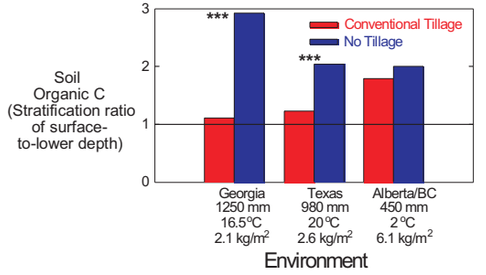
Alberta/British Columbia
4-16 years, wheat, barley, canola

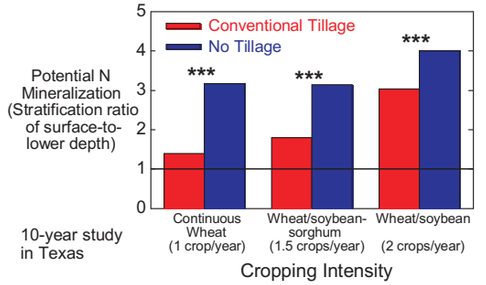
Stratification ratios calculated from soil properties:
at 0-5 and 12.5-20 cm in Texas and Alberta/BC
at 0-2.5 and 7.5-15 cm in Georgia

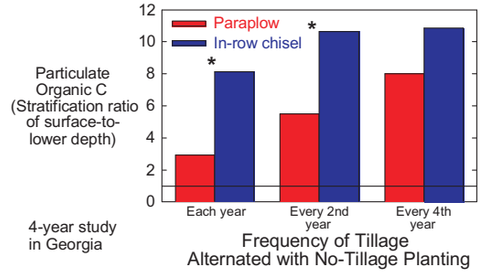
Soil properties measured:
soil organic C
particulate organic C
soil microbial biomass C
potential C and N mineralization
macroaggregation

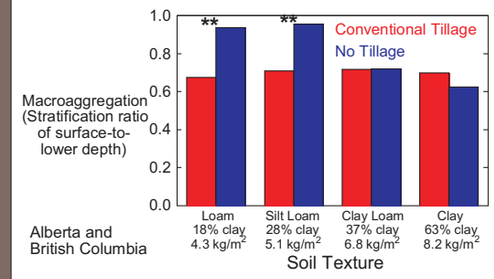
Results

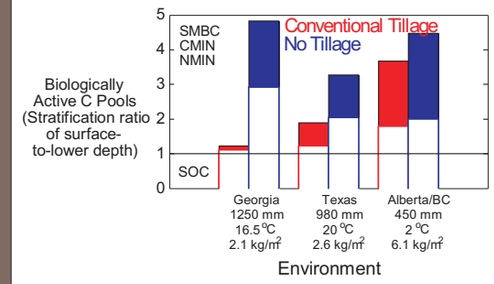












Summary and Conclusions

Stratification of most soil organic matter pools was greater under NT than under CT
- Greatest difference between tillage systems in Texas and Georgia (hot, wet, and low soil organic matter environments)
- Least difference in Alberta/BC (cold, dry, and high soil organic matter environments)
- Improvement in "soil quality" may be best achieved in environments with lowest native soil organic matter

Stratification ratios of soil organic C and N pools (i.e., SOC, POC, SMBC, CMIN, NMIN) under NT were always >2, while they were often <2 under CT
- Except in Alberta/BC, where ratios under CT were also >2, suggesting that soil quality may not have been greatly impaired under CT due to the cold, arid environment that limited degradative processes

Further research is needed to:
- Test the applicability of this soil quality indicator approach in different agroecological zones
- Determine the most appropriate sampling depths for calculating a stratification ratio in diverse environments
- Make quantitative relationships between changes in stratification ratios of soil C and N pools and the ability of the soil to function