# A Protocol for Monitoring Changes in Soil Carbon Sequestration

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## Introduction

Recent interest in using the soil to remove $CO_2$ from the atmosphere by sequestering it through plant uptake and subsequent incorporation into the soil organic matter (SOM) pool requires monitoring changes in soil organic carbon (SOC) (or SOM) content. The major perceived drawback to utilizing the soil for carbon (C) sequestration and developing this into an economic asset for farmers has been and accurate measurement of C in the soil.

Soil organic matter (SOM/SOC) has been routinely measured as a soil testing parameter for over 50 years in the U. S. SOM is often used to characterize a soil because of the influence that it has on other chemical, physical and biological properties as well as plant growth. For this purpose, SOM is usually measured on a percent of soil volume basis.

The availability of a C measuring instruments provides a capability for highly accurate measurement of soil C content with a high level of precision. This capability along with measurement of C on a percent of soil mass basis allows for a means of monitoring changes in soil C with a higher degree of sensitivity than when measured on a percent of soil volume basis.

## Objective

To develop a procedure to minimize measurement error that provides the greatest amount of accuracy, consistency, and reproducibility over time.

## Sampling Criteria and Procedures

- Sampling Site Selection
  - –Geological features
  - –Landscape
  - –Vegetation
  - –Past/current management
  - –Soil series/texture
- Mark location with GPS techniques

## Soil Sampling Procedure

- 2-steps for baseline and end sampling.
  - –0-6 inches
  - –6-12 inches
- 5 to 7 cores.
- Composite like depths.
- Crush and mix soil

- Critical steps
  - –Determine soil volume sampled.
  - –Determine soil weight.
  - –Determine soil moisture
  - –Subsample for analysis.
  - –Process samples for analysis.

## Analytical Procedures

- C analysis by high-temperature combustion.
  - –Mill subsample to <0.15 mm.
  - –Determine both total C and inorganic C.
  - –Calculate organic C
- Determine soil bulk density.
- Calculate C mass per unit area.
- Resample every 3-5 years till end of contract period.

## Archiving Samples for Future Reference

- Rigid glass or plastic containers.
- Temperatures below 80 F

## Laboratory Selection and QA/QC

- Must have soil analysis as a major part of business.
- Participate in North American Proficiency Program (NAPT).
- Must be state-certified to conduct soil analysis (in states with requirement).
- Or, must be able to perform C analysis to 1 MAD as per NAPT.

## Summary

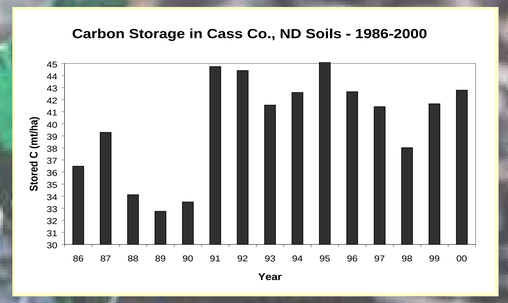
- Sequestered soil C can be measured with accuracy.
- Use of a consistent protocol is necessary.
- Protocol must be standardized relative to:
  - –Sampling
  - –Processing
  - –Analysis
  - –Laboratory
- Samples from baseline sampling should be archived and available for future analysis if questions arise.

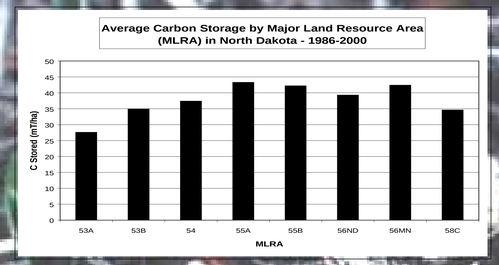
## Scientific Considerations

- Soil bulk density is affected by soil texture.
- Examples:
  - –Coarse (sand) 1.37 g/cm$^3$
  - –Medium (loamy) 1.22 g/cm$^3$
  - –Fine (clay) 1.10 g/cm$^3$

- Soil bulk density is affected by tillage.
- Example:
  - –Cultivated soil 1.23 0.11 g/cm$^3$
  - –Native (grassland) soil 0.95 0.16 g/cm$^3$
  - –Change +0.28 g/cm$^3$

## North Dakota Soil C Storage

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NDSU
North Dakota State University, Fargo, ND
ND Agricultural Experiment Station

PCOR Partnership

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