Challenges of Measuring and Managing Soil C Sink for Mitigating Climate Change

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MEASUREMENT OF SOC FOR AGRONOMIC PURPOSES

**Quantity:** Concentration (%, g/kg)

**Depth:** Plow depth (0-20 cm)

**Frequency:** Rotation cycle (1 to 3 yrs)

**Precision:** One decimal place when expressed as %

**Scale:** Plot scale, pedon scale
**SOC MEASUREMENT FOR TRADING CARBON CREDITS**

**Quantity:** SOC pool (Mg C/ha)  
**Depth:** 1-m or more  
**Frequency:** 2-5 yrs depending on land use  
**Precision:** Whole # in Mg/ha  
**Scale:** Landscape or farm scale
Scaling Issues in SOC Stock Assessment

- Size (m)

- Molecules
- Clay
- Microaggregate
- Macroaggregate
- Clod
- Soil Profile
- Soil Scape
- Watershed
- Landscape
- River Basin
- Continent
- World
Recent Advance in Soil Carbon Analyses

- Accelerator Mass Spectrometry (AMS)
- Pyrolysis Molecular Beam Mass Spectrometry (Py-MBMS)
- Laser Induced Breakdown Spectroscopy (LIBS)
- Mid and near-infrared diffuse reflectance spectroscopy
- Inelastic neutron scattering
CRITERIA FOR GOOD METHODS

1. Economic and cost-effective
2. Field and laboratory based
3. Rapid
4. Routine and simple
5. Standardizable
6. Adaptable in a wide range of soils (wetlands, tropical, Vertisol, gravelly, Andisols, etc.)
7. Assess total system C
8. Precision of at least 0.5 g/kg
9. Assess pool rather than concentration alone
10. Differentiate between SOC and SIC
Managing Carbon Sequestration in Soils and Terrestrial Ecosystems

\[ \text{C Sequestration} = \text{C}_{\text{input}} > \text{C}_{\text{output}} \]

\[ \text{C Depletion} = \text{C}_{\text{input}} < \text{C}_{\text{output}} \]

\[ \text{C}_{\text{output}} = \text{Erosion, Decomposition, leaching, Harvest} \]

\[ \text{C}_{\text{input}} = \text{Residues, Mulch, Compost, Amendment, Deposition} \]
Creating a Positive Carbon Budget

Gains by:
• NPK
• Manure
• Residues
• Cover crop

Losses by:
• Erosion
• Leaching
• Decomposition

“You can manage what you can measure”
So, what part of SOM should we measure or model?
DEPTH OF MEASUREMENT

SOC Concentration

MANAGEMENT A

MANAGEMENT B
Atmospheric concentration of CO$_2$ (ppmv)

Year:
- 1990
- 2010
- 2030
- 2050
- 2070
- 2090
- 2100
- 2110

Carbon Sequestration
Can Soil C Sequestration Mitigate Climate Change?

• No, C sink capacity of soils of agro-ecosystems is finite (~1 PgC/yr for 50-100 years).

• But, it has numerous co-benefits and is the more cost-effective option.

• Restoring soil quality, of which SOC pool is the important determinant, is essential to human wellbeing and nature conservancy.
**Capacity of Soil Carbon Sink**

- Total SOC pool to 2-m depth = 2400 Pg
- Increasing SOC pool by 1% = 24 Pg
- 1 Pg = 0.47 ppm

C sink capacity for every 1% increment ≈ 11 ppm