Rapid Soil Carbon Assessment of the U.S. for Conservation Planning and Model Validation

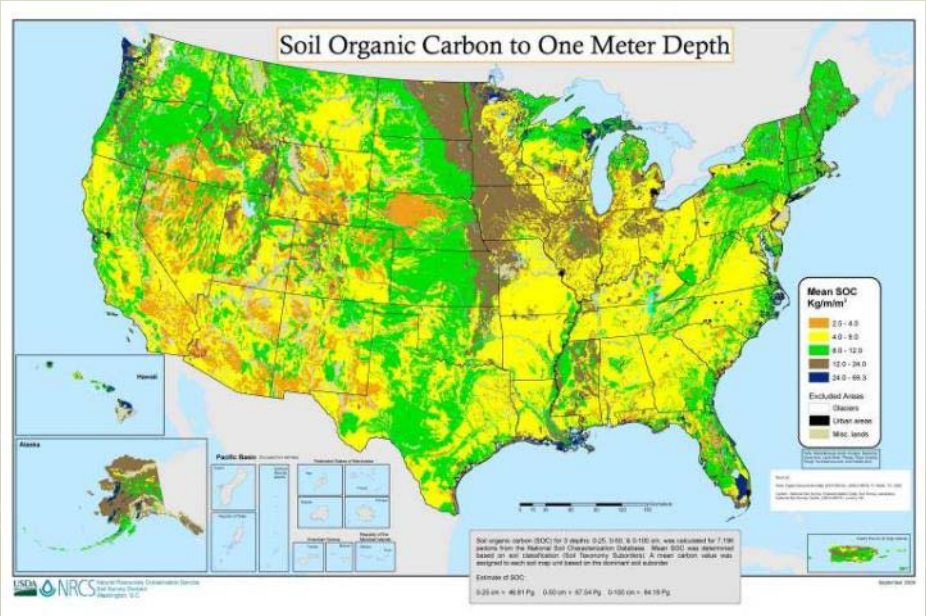
USDA-NRCS Soil Survey Division

Why Carbon Data?/Project Goals

- Reliable estimates of the amount of carbon that can be practically stored in soil
  - Soil
  - Agricultural management/ecological site and state
- Quantitative data
  - Decision support tools such as COMET-VR
  - Carbon cap and trade programs
  - Global carbon accounting
  - Model validation

Objectives

- Evaluate US soil carbon stocks as affected by
  - Soil
  - Land cover
  - Agricultural management
  - Ecosystem state



- Inventory soil carbon stocks for U.S.

2 Phase Program

1. National soil carbon inventory developed from SSURGO

2. Collection of soil carbon and other data for evaluation of carbon stocks for Benchmark and other important soils

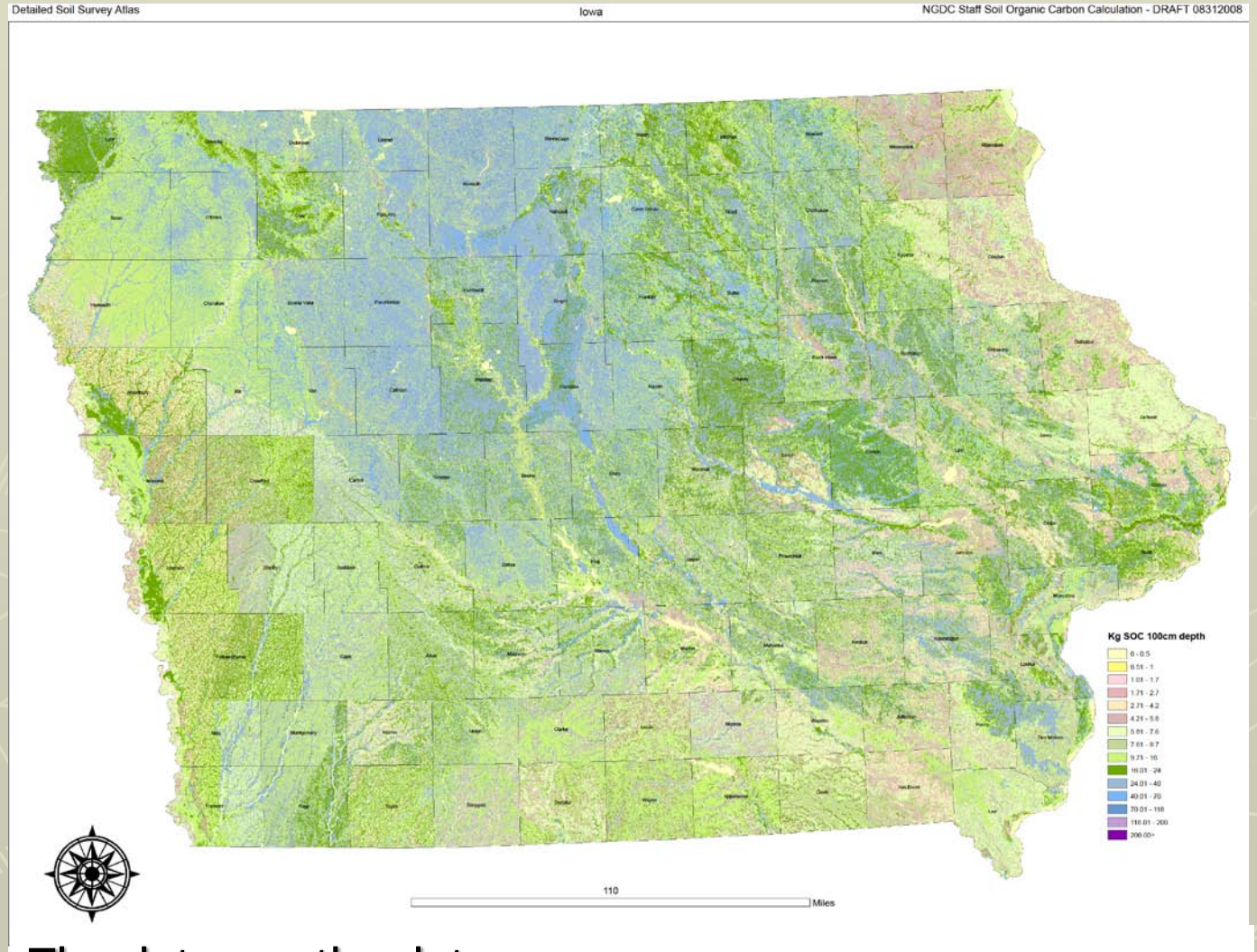
Phase 1

National Soil Carbon Inventory Developed from SSURGO

SSURGO SC Estimates to 1 m

- Organic
- Inorganic ($CaCO_3$)
- Carbon concentration adjustments based on land cover
  - Dominant cropland; pasture = high OM
  - Dominant forest; cropland = low OM
- State Soil Scientist review

SSURGO SC Estimates to 1 m



The data are the data

Validation

- NCSS pedon data
  - 27,000+ pedons with measured soil carbon and other data for carbon stock calculations
  - Additional data being incorporated from university laboratories
  - Stratified by land cover to enhance accuracy and validation
- Overlay appropriate pedons on SSURGO map units to compare point measurements to aggregated data

Phase 2

Collection of soil carbon and other data for evaluation of carbon stocks

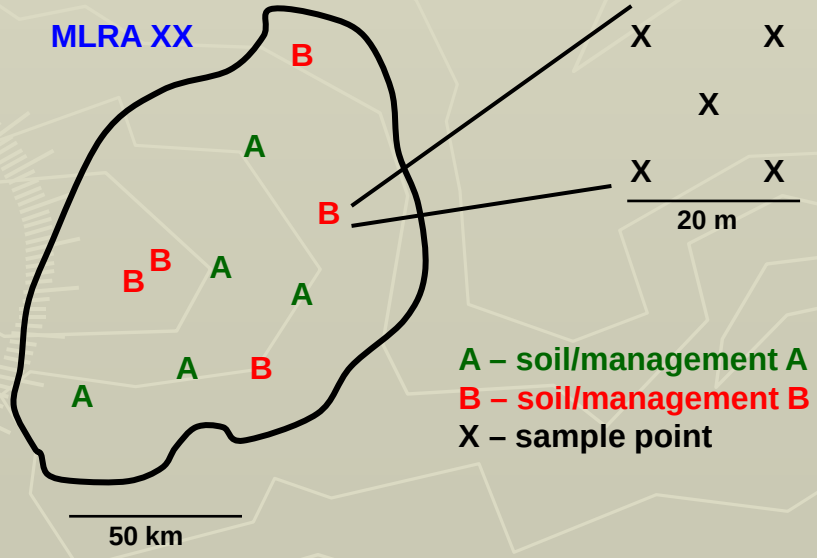
For benchmark and other important soils

Nationwide Effort

- Soil
- All land uses and ecosystems
  - Cropland
    - Agricultural management systems
  - Pasture
  - Range
  - Forest
  - Wetlands
  - Floodplains
- Ecological site and state

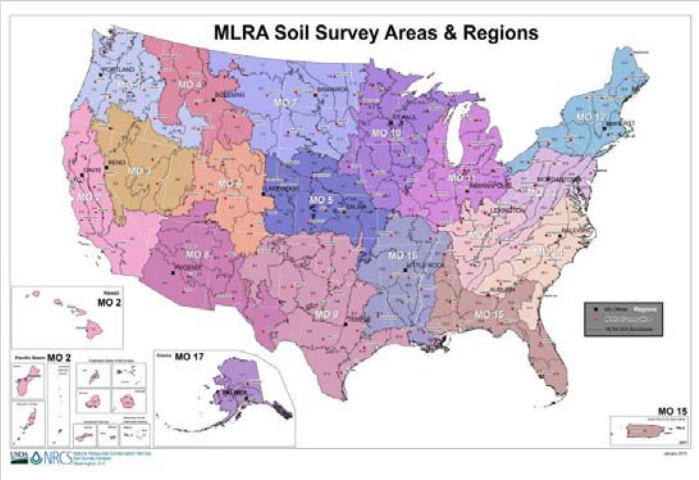
Replication for Statistical Confidence

- NCSS pedon data suggests need about 25 replicates (sample points) per soil-ecosystem combination for 80% confidence in mean
- Clustered sample design



How much data can we collect?

- Dispersed analysis
  - 18 MO regions
  - 400 sites/MO
  - ~7,000 sites
  - 35,000 sample points
- ~1,400 soil-land cover combinations
  - 80 per MO region
  - 7 land covers
    - 3 tillage systems, 2 pasture conditions, 2 forest ecological states
  - 11 soil groups



Sites – 1st stratification = soil

- Benchmark and other important soils
  - Grouping of similar soils based on properties that influence carbon dynamics
    - Texture, drainage, mineralogy, etc.
- Additional groups to ensure all important ecosystems are included and to maximize spatial coverage
- Limited number of groups per MLRA region (13-20)
  - Issue for diverse MO regions

Stratification within Soil Groups

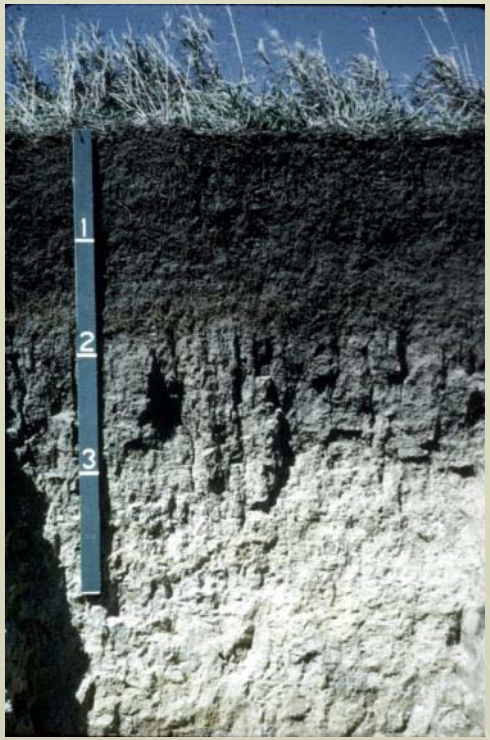
- Land use – management – ecosystems expected to have similar influence on carbon dynamics
  - Steady state conditions
    - End result not rate
- Evaluate end member conditions
  - Broad groups
  - “Minor” permutations not addressed

Sites

- Randomized NRI points within appropriate map units
  - Site must meet acceptance criteria confirmed on site
    - Soil group
    - Steady-state ecological state/ management
- Other available data as appropriate
  - ARS GRACEnet sites
  - University research sites
  - Existing pedon data (NCSS database)

Data Collection

- By horizon to 1 m
  - 0-5 cm depth sampled separately
- Landscape properties
- Soil morphology
  - Series identification
- Total and inorganic C
- Bulk density
  - Core, compliant cavity, model
- Dispersed data collection
  - 150,000 hoizons
  - VNIR spectroscopy

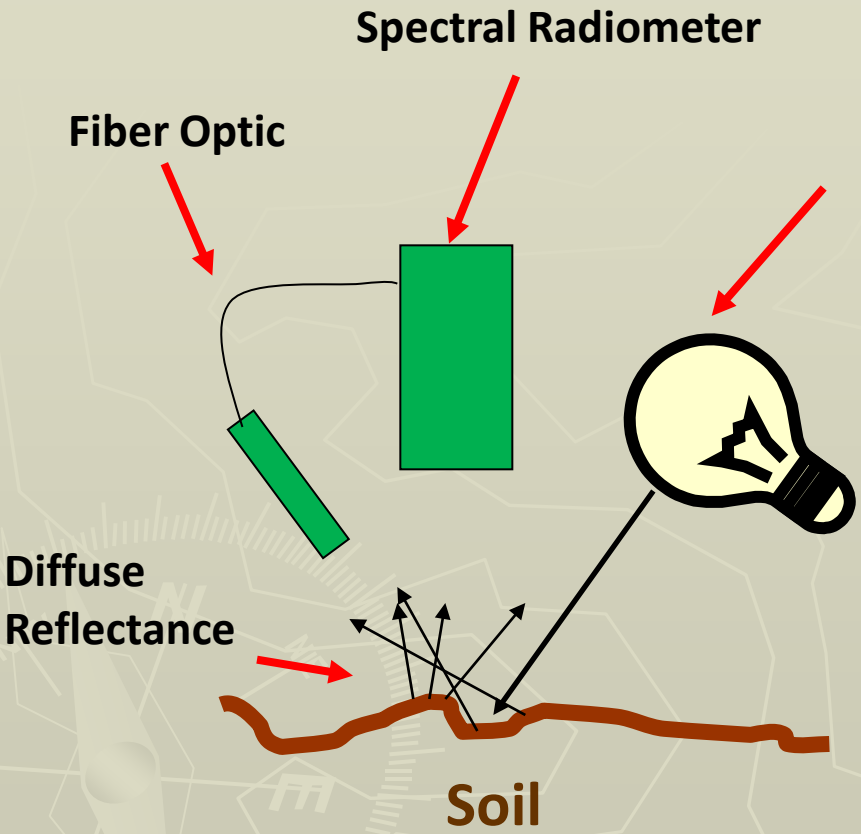


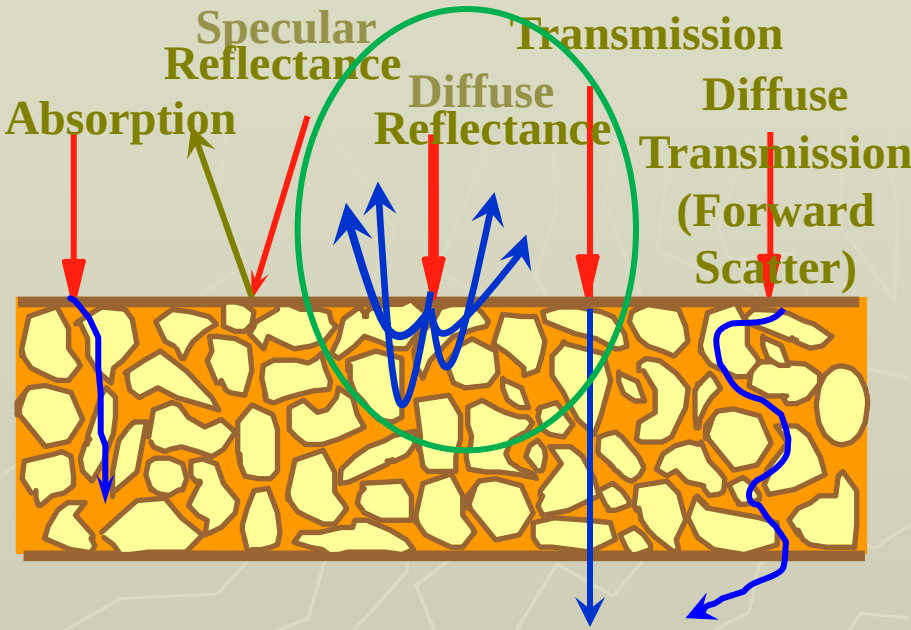
Visible Near IfraRed Spectroscopy

Rapid technique to evaluate certain soil properties

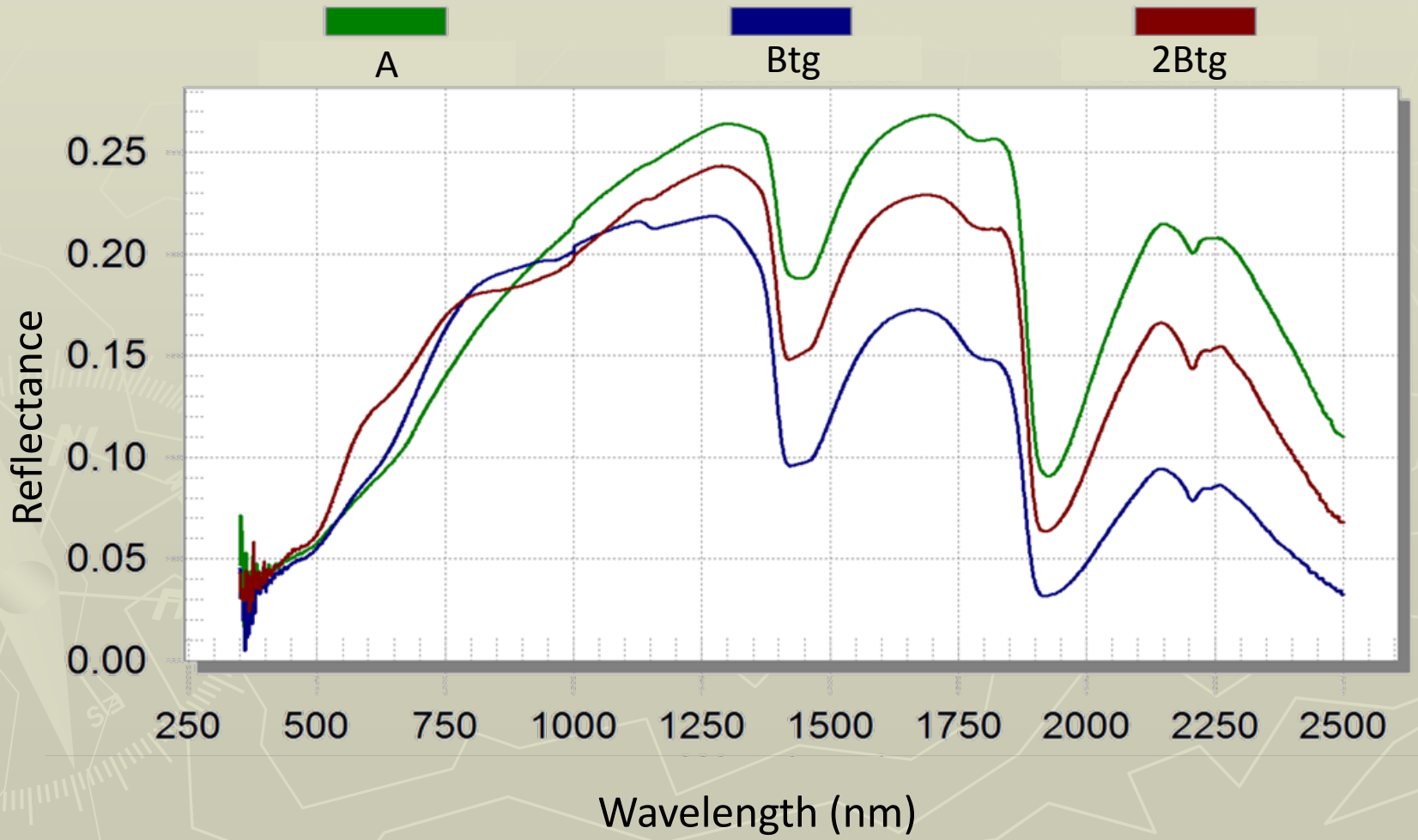
Applications in field and/or laboratory

VNIR and Light Interaction with Matter





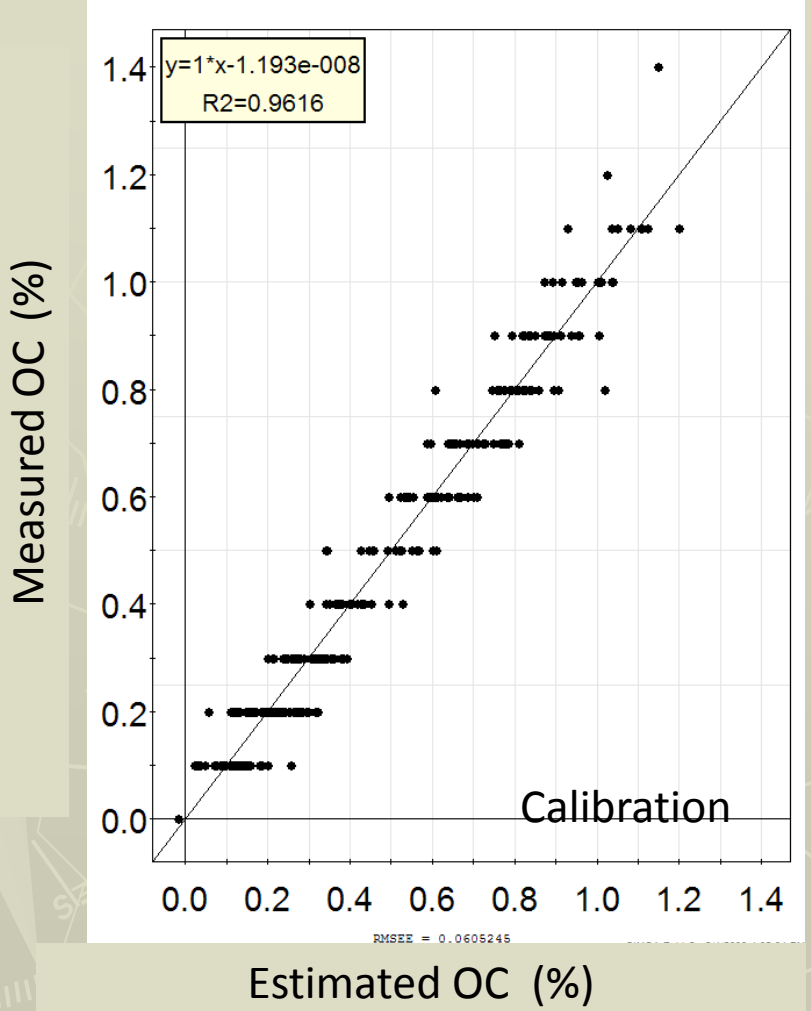
Data collected are VNIR Spectra

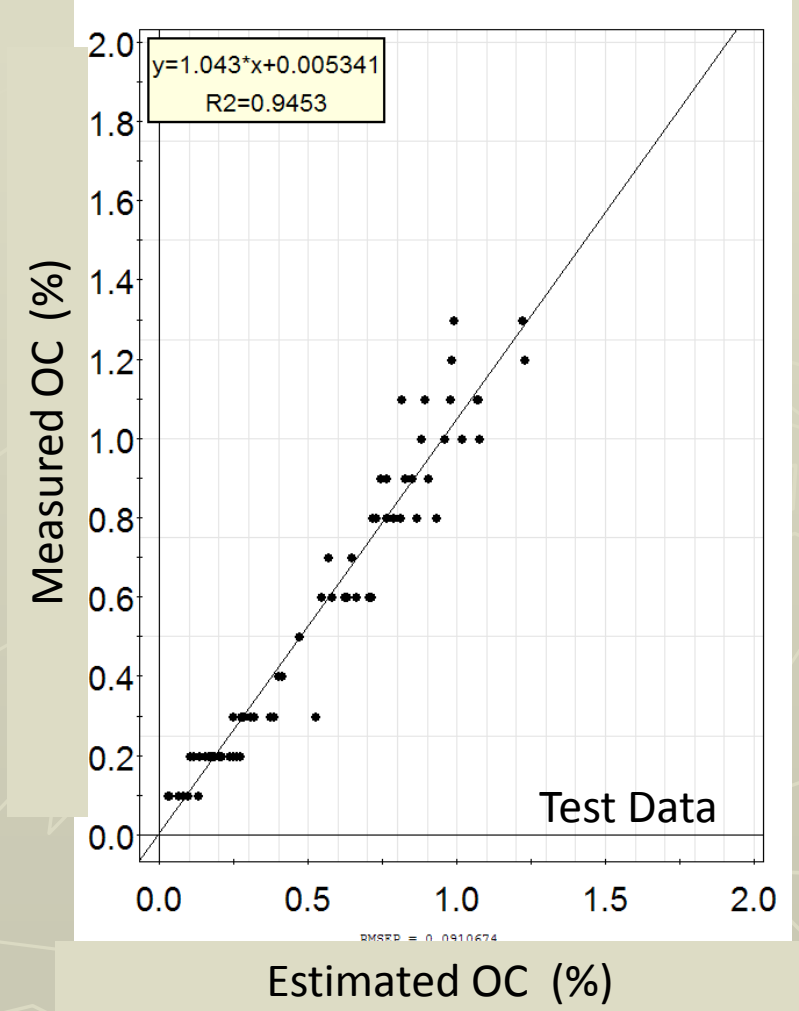


Quantitative Soil Analysis with VNIR

- Quantity of property predicted from calibration models developed from VNIR spectra and laboratory measurements
- Large spectral library needed
- Global models?
- Family of models
  - Parent material
  - MLRA or other regional stratification
  - Taxonomy

Organic Carbon





Who will Do the Work?

- MO rapid carbon leads
  - Field data collection and sampling
  - 1 VNIR spectrometer per MO
- MLRA Soil Survey Offices
  - 5-6 weeks assistance during data collection in MLRA area
- NSSC staff
  - VNIR model development
  - Data storage and analysis
  - Training
  - QA

Questions?

Comments?