CONSERVATION EVALUATION AND MONITORING ACTIVITY

Soil Health Testing

DEFINITION

Quantitative testing for physical, biological, or chemical characteristics of soil and constraints of soil using approved laboratory methods.

CRITERIA

General Requirements

A Conservation Evaluation and Monitoring Activity (CEMA) is the assessment, monitoring, or recordkeeping activities required to plan, implement, or determine the effectiveness of conservation practices as described herein.

The CEMA includes the performance of work and documentation of the tasks, results, interpretations, and other activities described herein.

This CEMA includes details to collect and analyze soil based on soil health resource concerns and planning objective. Soil samples will be submitted to laboratories for analysis using standardized methods.

Plans and specifications for soil testing shall be consistent with this standard and the referenced technical notes.

Technical Requirements Applicable to All Soil Tests

Individuals collecting soil should demonstrate the knowledge, level of skill, and experience associated with soil sampling and collection for soil health testing.

Record the purpose and strategy for testing the soil. Design the soil sampling strategy based on goals and available tools. Analyze the soil type, topography, and management information to determine appropriate sampling locations within a management unit. Use the following sampling strategies, or combination of strategies, when applicable:

- **Random:** Soil in management unit is homogeneous and there are few problem areas. Sampling locations are chosen by assigning random numbers to areas on a grid overlay.
- **Stratified:** Soil in management unit is heterogenous and contains different soil types across different landscape positions. Sampling locations are chosen randomly within delineated subareas (or strata) in proportion to the size of the subarea in relation to the management unit.
- **Composite:** Soil is subsampled from many locations in a larger management unit and combined into one homogenous sample.
- **Grid or Systematic:** Deliberate sampling at regularly spaced intervals or patterns.
- **Problem:** Distinct areas with uneven crop performance are strategically sampled.

- **Judgment:** Expert opinion based on visual observation.

Ensure all equipment is relatively clean and free from residue prior to collection. Remove vegetation or debris from the soil surface.

Collect soil prior to beginning growing season activities, throughout the growing season or after harvest, providing it is done when soil moisture and temperature are not extreme and there have not been any recent physical disturbances, additions of soil amendments, or other chemical inputs.

Avoid collecting or combining soil samples under the following conditions, unless a sampling strategy is used to specifically address the variability (*e.g.* stratified sampling):

- Wheel tracks or drive lanes, field borders, depressions, or other odd areas within the field
- Areas with historically lower or higher productivity
- Different landscape positions
- Fields with different crops or rotations, or the same crops with a different management
- Row versus inter-row areas
- Eroded versus non-eroded areas
- Saturated soil

Use the same georeferenced locations and sampling strategy under similar soil conditions, and if possible, the same time of year in the future to monitor practice effects.

Break up any clods, and remove stones, roots, or debris from the soil. Thoroughly mix the sample and air-dry unless specific tests require different handling.

Follow all USDA-APHIS regulations for prohibited, regulated, or quarantined soils.

Use laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program under the auspices of the Soil Science Society of America or use an alternative State-approved certification program that considers laboratory performance and proficiency to assure accuracy of soil test results.

Additional Requirements for Soil Health Testing

Collect soil in the same locations where resource concern assessments for the appropriate land use were already completed.

Use a tile spade, sharpshooter, or straight shovel to collect soil, when practical. Dig a hole 8 inches deep and remove a 2-inch thick vertical, rectangular slice of soil 6-8 inches in depth. Sampling a soil slice in this way preserves the structure and aggregates better than sampling with a probe. If it is impractical to sample a slice of soil, then a soil probe that is 1-inch or more in diameter may be used.

Soil samples should be composited based on the appropriate sampling strategy. Store soil for soil health testing in a cooler or refrigerator if samples are not immediately sent to the laboratory. Follow all laboratory recommendations (soil temperature, storage, shipping times, etc.) for the indicator(s) being analyzed.

Test soil for indicators referenced in Soil Health Technical Note No. 450-03, Recommended Soil Health Indicators and Associated Laboratory Procedures.

Basic Soil Health Test

The basic soil health test includes all five of the following indicators by the methods below:

- Soil organic carbon content measured by dry combustion
- Wet macro-aggregate stability measured using ARS or NRCS methods or by sprinkle infiltrometer
- Respiration using 1, 2, 3 or 4-day incubation
- Active carbon measured by permanganate oxidation
- Bioavailable nitrogen measured by ACE Protein method

Single Indicator Test

Use any recommended indicator or method listed in Table 1 of Soil Health Technical Note No. 450-03, or other tests approved at the State level. In addition to the tests included in the basic soil health test, other acceptable examples include:

- Microbial diversity using phospholipid fatty acid (PLFA)
- Enzyme activity of β-glucosidase, N-acetyl-β-D-glucosaminidase (NAG), arylsulfatase, protease, or acid or alkaline phosphatase.

Post Analysis Scoring and Interpretation

Scoring is currently available for soil organic carbon, respiration, active carbon, and bioavailable nitrogen. Scoring for aggregate stability and other soil health indicators will be available soon.

All participants in the NRCS Soil Health Testing CEMA must have their raw data scored prior to delivering results to producers. Scores (from 0 to 100) will be reported using the Soil Health Assessment Protocol and Evaluation (SHAPE) procedure, which compares results of similar soils and climates. Scores can also be used to monitor changes over time.

The responsible party (laboratories, planners, TSPs) should submit raw data and sampling location(s) coordinates to SoilHealthTest@usda.gov. Copy all partners on the email who should receive the final scores and report. A summary report will be generated with the scores and returned to the parties who submitted the raw data.

Additional Requirements for Fertility Testing

If soil fertility testing is not completed under another activity (for example, as part of a Nutrient Management Plan) then fertility testing may be included to provide information on soil nutrient content as it relates to healthy soil function and nutrient cycling.

Follow Land Grant University (LGU) or industry guidance to collect, prepare, store and ship soil samples. Ensure sampling and nutrient extraction methods are the same as those required by the State-adapted NRCS Nutrient Management Code 590 practice standard.

Basic Fertility Testing

At a minimum, include the following tests:

- Soil organic matter, phosphorus, potassium, calcium, magnesium, and pH

Comprehensive Chemical Analysis

Include all analytes in the general fertility test, as well as:

- Sulfur, iron, manganese, copper, zinc, boron, cation exchange capacity, and total nitrogen

Supplemental Testing

Test for the following additional analytes when applicable to local conditions:

- Molybdenum, aluminum, sodium, and soluble salts (electrical conductivity)

Documentation

Include the following records:

- Aerial imagery with GPS point data for sampling locations and GPS polygon data for the management unit,
- Sample identification code and other sampling observations
- Laboratory test results
- Schedule of additional testing or monitoring at recommended frequency

Definitions

ACE Protein (Autoclaved Citrate Extractable Protein) is a soil health indicator method that measures the amount of protein-like substances in soil organic materials, which indicates the amount of nitrogen potentially available for plants and microorganisms.

Active Carbon, also known as POXC when measured by permanganate oxidation, is a soil health indicator that indicates available carbon and represents the amount of microbial food available.

Respiration is analyzed as a soil health indicator of microbial activity and measured by the amount of carbon dioxide gas released from a soil sample over a period of 1 to 4 days.

Soil health is the continued capacity for soil to function as a vital living ecosystem to support plants, animals, and humans.

Soil Health Management System (SHMS) is a collection of NRCS conservation practices that focuses on maintaining or enhancing soil health by addressing soil health management principles: minimize disturbance, maximize soil cover, maximize biodiversity and maximize the presence of living roots.

Soil Health Management Unit (SHMU) is one or more planning land units with similar soil type, land use, and management that can vary in size or acreage depending on soil texture, topography, and cropping system. SHMU is like a conservation management unit but designed to assess soil health status and potential limitations on soil health indicators.

Soil Organic Carbon is a soil health indicator that indicates the carbon storage and soil organic matter cycling and is analyzed by high-temperature, dry combustion of soil.

Wet aggregate stability is a method of testing how well soil aggregates resist breaking apart under water pressure, which indicates the size and amount of water-stable aggregates.

DELIVERABLES

These deliverables apply to Conservation Evaluation and Monitoring Activity (CEMA) 216.

Two copies (hardcopy or electronic) of the plan must be developed—one for the client and one for the NRCS field office. At the client's request, Technical Service Provider (TSP) or agricultural professional can deliver NRCS's copy to the NRCS Field Office. The client's copy must include all sections unless the client requests other documents from this section. The NRCS copy must include all items identified herein. An additional electronic copy of the plan should also be uploaded on NRCS Registry.

1. **Cover Page**
    a) Client Identification:
        1) Operation name, owner name, street address and county/state.
        2) Primary phone number of client.
    b) TSP or agricultural professional identification, as applicable:
        1) Name, address, phone number, email, TSP number.
        2) Names and credentials of all persons that performed substantive work.
        3) TSP certification statement with signature and date.
        4) A statement that the TSP or agricultural services provided:
            i. Comply with all applicable Federal, State, Tribal, and local laws and requirements.
            ii. Meet applicable NRCS program requirements.
            iii. Are consistent with the conservation program goals and objectives for which the program contract was entered into by the client.
            iv. Incorporate alternatives or interpretations that are both cost effective and appropriate.
    c) Client acceptance statement:
        1) A statement that the information represents existing conditions.
        2) Signature of the client and date the client received the plans.
    d) Block for NRCS reviewer acceptance (to be completed by NRCS), as applicable.

2. **Correspondence**
    a) Document the client's objectives.
    b) Document each interaction with the client, include notes and results of that interaction, date, and initials of the TSP, planner, or agricultural professional.
    c) Document each site visit, activity in the field, results of each site visit, all parties present, date, and initials of the TSP, planner, or agricultural professional.
    d) Any correspondence between the TSP, planner, or agricultural professional and the client relating to the development of the CEMA.

3. **Maps**
    a) Maps to include, but not be limited to:
        1) General location map of the implementation areas showing access roads to the location.
        2) Conservation Plan map (this may consist of several maps to account for the entire implementation area). This map may be obtained from the

client.
3) Sampling map.
4) Other maps, as needed, with appropriate interpretations.

b) At a minimum, all maps developed for the CEMA will include:
1) Title block showing:
i. Map title.
ii. Client's name (individual or business).
iii. Prepared with assistance from USDA – NRCS.
iv. Assisted By [TSP, planner, agricultural professional's name].
v. Name of applicable conservation district, county, and State.
vi. Date prepared.
2) Map scale.
3) Information needed to locate the assessment or monitoring area, such as geographic coordinates, public land survey coordinates, etc.
4) North arrow.
5) Appropriate map unit symbols and a map symbol legend on the map or as an attachment.

4. Documentation

Include the documentation listed in the Technical Requirements section. At a minimum, the following is required:

a) Soil test purpose and sampling strategy.
b) Applicable tests as described in the "Additional Requirements" sections.
c) Records as noted in the Technical Requirements section under "documentation."

REFERENCES

USDA Natural Resources Conservation Service. 2019. Soil Health Technical Note No. 450-03. Recommended Soil Health Indicators and Associated Laboratory Procedures. https://go.usa.gov/xpxqQ

USDA Natural Resources Conservation Service. 2019. Soil Health Technical Note No. 450-04. The Basics of Addressing Resource Concerns with Conservation Practices within Integrated Soil Health Management Systems on Cropland. In Press. Found in Directives at Technical Notes, Title 450 - Technology.

USDA Natural Resources Conservation Service. 2014. Kellogg Soil Survey Laboratory Methods Manual. Soil Survey Investigations Report No. 42. Version 5.0.

US Environmental Protection Agency. 2002. Guidance on Choosing a Sampling Design for Environmental Data Collection. EPA QA/G-5S.

Nunes, M.R., K.S. Veum, P.A. Parker, S.H. Holan, D.L. Karlen, J.P. Amsili, H.M van Es, S.A. Wills, C.A. Seybold, and T.B. Moorman. 2021. The soil health assessment protocol and evaluation applied to soil organic carbon Soil Science Society of America Journal 85:1196-1213.

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