



Methods of Assessing Soil Quality

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Soil quality is the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to sustain plant and animal productivity, to maintain or enhance water and air quality and to support human health and habitation

What is soil quality assessment?

The art and science of creating decision tools for sustainable land management. The process of quantifying “fitness for use” or “capacity of a soil to function”

Assessment Requirements

Tools must be accurate, simple to use, meaningful, provide site-specific standards & guidelines for interpreting soil quality indicators.

Methods of Soil Quality Assessment (Friedman *et al.*, 2001)

A variety of methods or approaches are used to measure and assess soil quality. It range from primarily qualitative to purely quantitative. The major soil quality assessment methods are:

1. Soil Health Card
2. NRCS Soil Health Card Template
3. Soil quality test kit
4. Laboratory analysis

1. Soil Health Card

A qualitative tool designed by and for farmers. The cards contain farmer-selected soil quality indicators and associated ranking descriptions typical of local producers. Generally, indicators listed, such as soil tilth, abundance of earthworms, or water infiltration, can be assessed without the aid of technical or laboratory equipment. All cards have a scoring system, which usually includes either a range of poor to good or a numerical scale from 1 to 10 for each indicator. Cards are obtained from the local NRCS, Conservation District, or Cooperative Extension Service office in those states that have produced cards. They can also be accessed at the Soil Quality Institute Web site at <http://soils.usda.gov/sqi>. Health cards integrate physical, biological, and chemical properties in ways that are familiar to producers. For example, the cards use terms like tilth, which refers to the physical structure of soil and which also depends on biological properties. Soil health cards are producer friendly, quick, and require only basic tools such as a shovel and wire flag. Directions for use are found on each card. To use the card, simply pick an area that is representative of the field. Qualitatively score each of the indicators using your best judgement. Record the information with other important data, including management practices, fertilizer rates, pest management, manure application, etc. Soil quality changes are best interpreted by having the same person assess the field under approximately the same conditions (time of the year).

2. NRCS Soil Health Card Template (NRCS Template)

If qualitative soil quality assessment information is desired for an NRCS conservation plan, adapt for local use. Although technically this template can be used as is, the indicators and rankings it uses have been collated from various parts of the United States and are very general. When



adapting the template, select only locally relevant indicators and descriptive terms, and be sure to add others that are needed for local soil and agricultural systems. Generally, not more than 10 indicators should be used on a template, as too many questions make the process cumbersome. As with the farmer-developed health cards, assessments should be done by the same person over time, under similar conditions, and during the same time of year for each sampling. Suggested guidelines for sampling times are included with the NRCS Template. Check carefully that this information is locally relevant, and modify any suggestions which are not appropriate to local conditions.

3. Soil Quality Test Kit

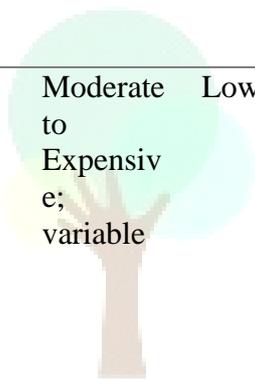
The Soil Quality Test Kit, is an on-farm soil quality assessment tool. The kit is used as a screening tool to give a general direction or trend of soil quality; e.g., whether current management systems are maintaining, enhancing, or degrading the soils. It can also be used to troubleshoot problem areas in the field. Included in the kit are tools to measure standard soil quality indicators such as respiration, water infiltration, bulk density, electrical conductivity, pH, aggregate stability, slaking, and earthworms. The kit is accompanied by the Soil Quality Test Kit Guide, which provides a list of supplies and instructions for the tests as well as background and interpretive information for evaluating the results from each test. The Instruction Section describes the procedures for 12 soil quality diagnostic tests and includes worksheets for gathering data. The guide also lists sources of supplies needed to build a field test kit. The kit provides a soil quality assessment method that quickly provides quantitative, reliable data. Most of the tests can be conducted in the field and/or in the office. Some users have found that completing a whole set of measurements in the Soil Quality Test Kit may take as long as 4-6 hrs. Thus, it may be unrealistic to expect a farmer to use the kit independently. However, the results can be determined immediately after conducting the tests. Be sure to allow time to assist with, or do, many of the measurements. Also, a few of the morphology estimations are considered difficult for the untrained professional to perform, so be prepared to have a soil scientist or specialist help with this part of the analysis. The kit can be used by people with little experience. To reduce error, first-time users should practice with people who have more experience. Guidelines for the number of samples and detailed steps for data collection and processing are listed in the Kit guide and should be followed carefully. Although sampling should be conducted in similar spots and at similar times of year, it does not have to be conducted by the same person each time since the measurements are quantitative.

Table: Comparison of soil quality assessment methods

Assessment Tool	Speed of use/ Results	Ease of use	Cost	Farmer interaction with advisor	Advantages	Disadvantages
Soil Health Card	Use: Fast (15-30 min.) Results: Immediate	Easy	None	Low to high	Land owners can use independently and are more involved, results easy to interpret, locally adapted	Reliability of information, requires specific conditions for sampling, subjectivity in interpretation of results



NRCS Soil Health Card Template	Use: Fast (15-30 min.) Results: Immediate	Easy	None	High	Results easy to interpret, locally adapted, can be included in conservation plan	Reliability of information, requires specific conditions for sampling, subjectivity in interpretation of results
Soil Quality Test Kit	Use: Moderate (4-6 hours for comprehensive evaluation) Results: Immediate	Intermediate-hard	Low to moderate	High	Reliable information, data can be collected by various users, interpretation of tests available in guide	Some tests difficult to interpret, not locally adapted, requires specific conditions for sampling, labor intensive
Lab Analysis	Use: Fast (15-30 min.) Results: 2-3 weeks	Easy	Moderate to Expensive; variable	Low	High reliability and precision, professional recommendations accompany results for some tests.	Need help to interpret, need outside lab, all tests not available, potential high costs for repeated tests



1. Laboratory Analysis

It is a quantitative soil assessment tool. Although the sampling time (field portion) is shorter when using a soil testing lab, getting results may take from 3 days to 2 weeks. Health Card and Kit results can be determined on the same day that sampling occurs. Advantage of a lab analysis is assurance that the results are obtained with quality control and that they are numerically reliable for long-term comparisons. Also, results from fertility related tests are often returned with interpretations and with specific recommendations to help make management decisions. The most standard tests performed by soil testing labs are for chemical properties and for micronutrients and macronutrients. Chemical tests include pH, EC, cation exchange capacity, nitrate, and ammonium. Macronutrients and micronutrients include sulfate, P, K, Ca, Mg, Zn and Cu. Labs can also test for elements, such as aluminum and boron, which may be considered yield limiting in high levels. Most labs can also test for soil organic matter, total organic carbon, and total soil nitrogen. Some will also conduct physical tests such as bulk density, water release curves, and soil water content. Laboratories differ in their procedures for some tests. Try to use the same lab, or be aware of any differences in methodology. Use in-state labs when possible, since they are familiar with local and regional soils. Request information about the methodology and units used by the lab, so that lab results may be compared with results from the Test Kit. Some specialized labs do very specific tests for biological properties,



including microbial respiration and activity or direct counts of bacteria, fungi, protozoa, and nematodes. A few also identify arthropods and soil fauna. In locations with a university or research station nearby, it may be possible to take advantage of specialized equipment such as cone index penetrometers for measuring soil strength or neutron probes for measuring soil water. Sampling requirements are similar to those described for the Soil Quality Test Kit. Generally, local labs have specific instructions on the number of samples needed and on sample preparation. Samples for biological analysis generally must be refrigerated (not frozen) and shipped within 24 hours.

Choosing a method

The most important criteria is that the results are practical and consistent with the information needs of the producer. Before proceeding with the soil quality evaluation, talk with the producer about the type of information desired. For eg. Some producers may want as much information as possible, in which case a full set of indicators could be used. Others might identify only one or two very specific problems, such as erosion and water infiltration. In this case, a whole data set does not need to be used; only those specific indicators can be assessed. Some producers may only want numerical results from an accredited soil testing laboratory. Other producers may want to collect the information themselves and use a tool such as the soil health card or kit. It is important to clarify this information before beginning the evaluation process so that unnecessary or irrelevant data is not collected.

Selecting a Soil Quality Assessment Approach

Select those methods and indicators that will match the information needs of the farmer and provide practical information. Be sure that the person conducting the evaluation (farmer and/or specialist) has the resources to successfully complete the method. Check that the method can be repeated with ease over time. Ensure a realistic time frame for completion of the assessment.

Reference

Friedman, D., Hubbs, M., Tugel, A., Seybold, C., & Sucik, M. 2001. USDA- Guidelines for Soil Quality Assessment in Conservation Planning. United States Department of Agriculture.