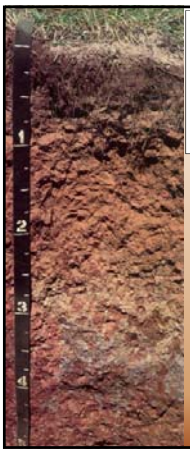


Soil Health Assessment Center
University of Missouri

Considerations in Analyzing Soil Health

Donna Brandt – Research Specialist

Service in the Land Grant Tradition

Goal

To provide

- a perspective on soil health testing
- to present some considerations in selecting analyses
- to provide resources to aid in decision making

Soil Health—USDA-NRCS

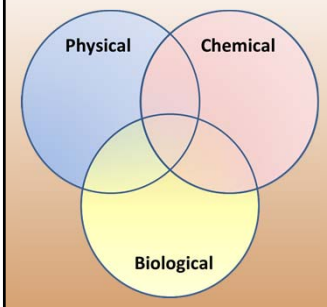
Soil health, also referred to as soil quality, is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

Soil Health

Soil …
- covers the earth's surface
- can support plant life
- is unconsolidated material containing
  - water,
  - air space,
  - organic matter,
  - plant roots and
  - myriad living organisms.
- Parent materials,
- climate,
- related organisms,
- relief
- act together through
  - time
  - space
- to produce a continuum of different soils within the soil

Health…
a condition in which vital functions are performed normally or properly.

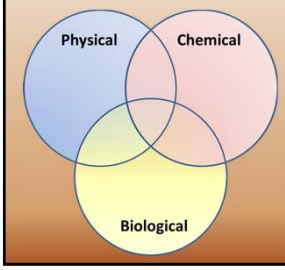
Soil Functions
- Produce biomass (food, fiber, energy)
- Regulate water flow and storage
- Filter, buffer, and transform matter
- Store/house minerals, organic matter and myriad organisms
- Support for plants and structures
- Provide raw materials (sand, silt and clay)
- Provide clues to past climates, vegetation, ecology and civilizations



Soil health testing involves identifying indicators of soil functions that can be measured.

Soil Health Institute

Tier 1 --accepted as soil health indicators, considered reliable; consistent in testing
Tier 2 --indicators considered beneficial ; need further testing
Tier 3--show significant promise ; require more extensive research



Specific Tier 1 measures endorsed include:
- organic carbon,
- pH,
- water-stable aggregation,
- crop yield,
- texture,
- penetration resistance,
- cation exchange capacity,
- electrical conductivity,
- nitrogen,
- phosphorus,
- potassium,
- carbon mineralization,
- nitrogen mineralization,
- erosion rating,
- base saturation,
- bulk density,
- available water holding capacity,
- infiltration rate, and
- micronutrients

Perspective

History and Development of Soil Testing

M. S. ANDERSON
Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Md.

The history and development of soil testing are considered in three approximate periods: 1845 to 1906, 1906 to 1925, and 1925 to 1952. Phosphorus and potassium are emphasized, but other elements are considered. Data of the second period provide background information for interpretation of soil tests. More recently many new methods have been developed, some for universal application and others for specific problems.

For a little more than a century soil and plant scientists have sought chemical and biological methods for determining the fertility of a soil. These procedures have often in recent years been related to recommendations issued by governmental agencies for fertilizer practice. The composition of crops has also had an important place in diagnosing the capacity of a soil to deliver nutrients to plants, particularly to crops to be grown subsequently in a field.

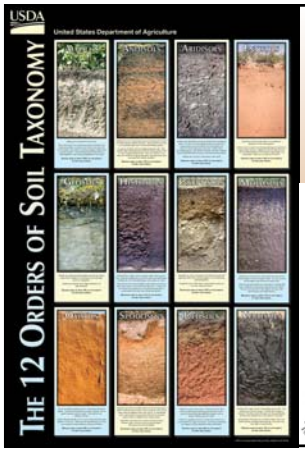
The present discussion divides history and development into three imperfectly defined periods. The first is from 1845 to 1906. Review here deals essentially with the work of four authors: Daubeny, Liebig, Hilgard, and Dyer. During the second period, roughly 1906 to 1925, emphasis was placed on the fundamental chemical composition of soils as related to crop production. A third period includes essentially 1925 to 1952, with ramifications extending to the present. This was a period of struggle for methods that could be universally applicable, and of efforts to adapt chemical procedures to specific soil conditions.

Early Work

One of the first records of quick soil tests for an assay of soil fertility is that of Daubeny in England in 1845 (6). He suggested the terms "active" and "dormant" to express the more and less soluble nutrient constituents of a soil, respectively. The solvent used for extracting the active portion was carbonated water. Analytical methods in use more than a century ago imposed difficulties in carrying out the suggestions of Daubeny; and the subject of soil testing appears to have been essentially laid aside until revived by Liebig about a quarter century later (*14*).

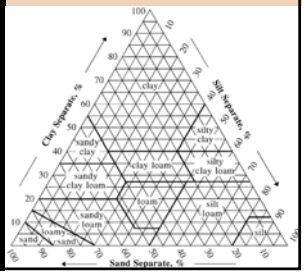
The procedure used by Liebig in-

An early criticism of soil health was the lack of quantitative measurements.



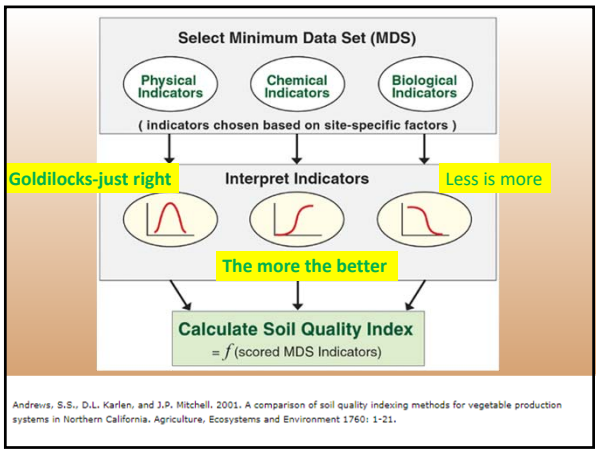
Soil Variability

What may be healthy for one soil may not be healthy for another



Comparisons are Important

- **Compare to:**
  - Long term grassland on similar soil
  - Different management or cropping systems
- **Soil Management Assessment Framework**
- **Cornell--Comprehensive Assessment of Soil Health**
  - Northeast
  - Midwest
- **MU Soil Health Assessment Center**
- **Others**



Andrews, S.S., D.L. Karlen, and J.P. Mitchell. 2001. A comparison of soil quality indexing methods for vegetable production systems in Northern California. Agriculture, Ecosystems and Environment 1760: 1-21.

How good is good enough?

- Some scores are based on a standard curve of accumulated samples; are we grading "on the curve"?
- How do the indicator scores match up with how well that measurement predicts a soil function?
- Crop yields may give us an indication on the "Produce biomass" soil function

How good is good enough? (Part 2)

Other soil functions may be more difficult

- Is the infiltration rate, soil porosity, and water holding capacity sufficient to provide water through the next drought?
- Is there sufficient infiltration to replenish the groundwater supply?
- Are soil microbial populations sufficient to break down herbicides to
  - Prevent carry-over?
  - Keep them out of groundwater?

Beginning Decision Making

- What is your budget?
- What are you most interested in?
- Who is your audience?
- What is the best use of your money?
- Which laboratories have the most experience with soils similar to soils you want tested?

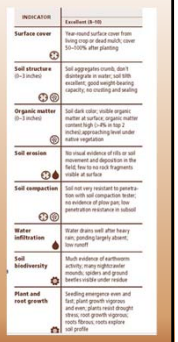
Field or Laboratory

- Some can only be done in the field
  - Get people looking at their soil
  - Can gather a lot of qualitative information
- Some are best conducted in the laboratory
- Some may be conducted both ways
  - Field Day or other demonstration–colorful tests
  - Laboratory test may be less expensive

In-field Soil Health Assessment

Lab tests are quantitative. Can measure properties you can't measure in the field

In field tests you can observe field and soil properties that can't be observed in the lab.



Research, Demonstration, or Farmer Use

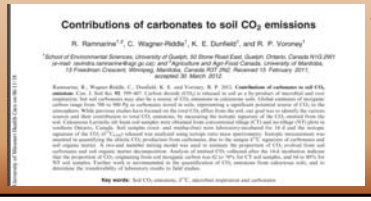
- A test may be too expensive for some uses
- But may be cost effective for research.
- PLFA is a prime example. Researchers get a lot of "bang" for their buck.

Different Regions Different Needs

- SAR—Sodium absorption ratio
- EC—electrical conductivity
- Micronutrients

Different Soils Different Laboratory Methods

- Bray P1, other analyses involving weak acid extractants
- Soil Organic Matter—different drying and combustion temperatures
- Inorganic carbon—soil respiration


Contributions of carbonates to soil CO_2 emissions

- **Be sure lab analysis is appropriate for your soil**
- **For comparison and consistency, use the same laboratory**

Tests for special interests or needs

- Micronutrients
- Phospholipid fatty acid analysis
- Bulk density
- Nutrient ratios

More Information on Soil Health Assessments

- https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/
- https://soilhealthinstitute.org/north-american-project-to-evaluate-soil-health-measurements/
- Soil Health Nexus Project