

In 2017, the Soil Health Institute released its Tier 1 soil health measures, all of which are considered effective indicators of soil health:

- 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
- Micronutrients

All 19 of these indicators provide valuable insight into the health of the soil system. To learn more, visit www.soilhealthinstitute.org/2017-tier-measurements/

FIVE

SOIL SMELL

The fifth indicator isn't visual, but it depends on another one of our senses: smell. The earthy smell of a biologically healthy and active soil is the presence of an organic compound called geosmin.

In 1965, American scientists isolated the primary odor of soil to a single compound, which they called geosmin from the Greek, geo (earth) and osme (odor).

Geosmin is an organic product produced by active soil bacteria. Essentially, if your soils are cycling organic matter, they will have that fragrant earthy smell. Soils can have other smells, but they are not associated with soil health. Soils absent of oxygen can have a rotten egg or sulfur smell. This is often a sign of poor drainage.

FOUR

ROOTING RESISTANCE

When looking at a soil profile or even a shovel slice, we can often see evidence of layers of resistance. These resistance layers can be seen in the soil structure with the presence of platy structure or horizontal layers. A couple of common sources of this effect are the continuous compaction of a soil from the soil surface and previous tillage creating what is known as a plow pan. Both of these restrictive layers limit root penetration and water infiltration.

One common indicator of a resistance layer can be found in the plant roots themselves, specifically in taproot species. On these sites, taproot plants will show signs of "J" rooting, which means a plant root grows down to the resistance layer and turns 90 degrees because it cannot penetrate the resistance layer. In extreme cases, water infiltration is also halted at this layer, which limits the soil's water holding capacity and ultimately exacerbates the effects of drought.

THREE

BIOLOGICAL ACTIVITY

Healthy soils are biologically active soils. The presence of biological activity can give you insight into the soil's state of health. Essentially, we are referring to the presence of earthworms, earthworm castings, dung beetles, etc., or evidence of their activity.

Earthworms are not only major decomposers of organic material, they are underground engineers. Earthworms create burrows through the soil profile, which increases porosity, enables water to move down and creates channels for roots. Earthworm excrement, known as castings, help increase nutrient cycling because pound-for-pound they contain significant amounts of nitrogen, phosphorus and potassium.

Dung beetles are another indicator of biological activity. Dung beetles are found on every continent except Antarctica, and they provide tremendous ecological services. These beetles take dung from the soil surface, roll it into a ball, lay their eggs in it and bury it deep in the soil. This creates a food source for their young and brings nutrient-rich organic material into the soil profile, which increases nutrient cycling and availability.

TWO

SOIL STRUCTURE

Soil structure is the arrangement of soil particles in different sizes and shapes. Structure often determines the amount of pore space between particles. Pore space is the space between soil aggregates, which the USDA Natural Resources Conservation Service define as "groups of soil particles that bind to each other more strongly than to adjacent particles." More pore space allows for greater water infiltration.

The ability of a soil to hold its particles together and form soil structure is referred to as "aggregate stability." Soil aggregation can occur by physical processes, such as when positively charged cations bind with clay particles. Soil aggregation can also occur biologically by organic adhesives. The amount of organic matter in a soil is a primary driver of aggregate stability. Commonly, aggregate stability increases as the percentage of soil organic matter increases.

Soil texture, or the amount of sand, silt or clay content, also plays a large role. Generally, soils with higher clay content inherently have greater amounts of organic matter. It is more difficult for sandy soils to build soil structure largely due to lower organic matter concentrations.

ONE

SOIL COLOR

Soil color provides a tremendous amount of information. Soil color can tell us the amount and state of organic matter and iron oxide, age, and other physical processes. In general, the darker the soil, the higher the organic matter content. Soil is typically darkest in the uppermost layers of the soil profile, and it lightens as depth increases. Soil organic matter and soil organic carbon are primary drivers in biologically active soil systems. In some cases, the dark color can be due to the presence of reduced iron and manganese in our deep prairie soils.

Today, we use soil color to not only gain a general sense of organic matter but to classify soils across the globe with a standard soil color system. Albert H. Munsell first standardized the soil color system as we know it today based on a system with three components: hue, value and chroma. It was primarily standardized for use in industry as a way for companies to order standard, consistent colors for materials. The U.S. Department of Agriculture later adopted the Munsell system as its official classification of soil colors.

LOOK FOR THESE SOIL HEALTH INDICATORS IN THE FIELD



WHAT IS SOIL HEALTH?

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

For some, the Dust Bowl of the 1930s changed our perception of how we view soil. For instance in 1949, Aldo Leopold in *A Sand County Almanac* stated, “Land, then, is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants and animals.” Leopold went on to state,

“When we see land as a community to which we belong, we may begin to use it with love and respect.”

Fast forward to today and much has changed in how we view the soil. What has not changed is our responsibility as land stewards, and that process starts with how we see the soil.

SOIL HEALTH INDICATORS

In order to better see the soil, we need to know what we are looking for. You can use the following five indicators of soil health on any farm with just a shovel, your eyes and your nose. The next time you're out for a trip across the pasture, take some time to look beyond what's growing on the surface. Look down, dig a hole and see what your soil is telling you.



ONE

SOIL
COLOR

TWO

SOIL
STRUCTURE

THREE

BIOLOGICAL
ACTIVITY

FOUR

ROOTING
RESISTANCE

FIVE

SOIL
SMELL

CONNECT
WITH US



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