Soil Health Protocols

Kiss the Ground Farmland Program

The Farmland program has been developed to support the transition to Regenerative Agriculture at a global scale, within the context of regionally appropriate practices. Through the education and training program, the scholarship fund supports farmers to be introduced to principles that with help them make context-specific decisions. Once the management practices change, we want to track the outcomes on the land to see how soil health is responding. Drawing upon the combined knowledge and advice from the leading agricultural research schools, soil scientists and agricultural professionals, we have compiled soil health protocol list to assess the baseline soil health on the landscapes being managed by our participating farmers.

pH

Soil pH is considered the other master variable of soil. The pH indicates the level of acidity or alkalinity in a given soil and determines what nutrients will be available for plant uptake. When the pH is too high certain nutrients, such as phosphorus, iron, manganese, copper, and boron may become unavailable to the crop. Alternatively, when the pH is too low, calcium, magnesium, phosphorus, potassium, and molybdenum may become unavailable and heavy metals and aluminum may become more available, presenting potential toxicity problems. Optimum soil pH ranges from 6.2-6.8 for most crops. Organic matter provides buffering capacity in soils, allowing crops to perform better at lower pH's than they would otherwise. Soil pH also is a major determinant of microbial community structure and thus, influences what organisms (beneficial or pathogenic) are able to colonize the roots and the surrounding area.

Soil Organic Matter (SOM)

Soil organic matter (SOM) consists of both decomposed and decaying plant and animal residues and while it is made up of nearly 50% carbon, contains all the plant essential nutrients in a slow-release form. Similarly, to clay, organic matter improves aggregation and increases the ability of a given soil to hold nutrients and water, as well as provide habitat and resources to soil organisms. In addition, organic matter is known to increase resistance to pests and disease; resilience against droughts and flood; yields; nutritional quality; and more. While the exact language and metrics for defining soil health are still hotly debated within the scientific community, there is a strong consensus that organic matter management is at the heart of soil health management.

Soluble Salts

Soluble salts is measured by electrical conductivity and indicates whether levels of salts, such as Mg^{+2}, Ca^{+2}, Na^{+}, K^{+}, Cl^{-}, SO_4^{-2}, HCO_3^{-} and CO_3^{-2}, could present problems with salinity (excessive salt levels) or sodicity (excessive sodium levels). While these conditions can occur naturally, they can also be exacerbated and/or introduced by the use of irrigation in semi-arid and arid regions. Salinity is problematic because it decreases the water potential in the soil, relative to the plant, reducing water flow from soil to plant. Furthermore, certain salts, such as chloride, can create toxicity problems for plants and microbes. Sodium can also create problems with aggregation, surface crusting, and compaction.

Texture

Texture is one of the master variables regarding soil function. It is a measure of the relative proportion of variously sized mineral particles: sand (0.05 to 2 mm), silt (0.002 to 0.05 mm), and clay (less than 0.002 mm). While it can not be significantly altered by management, it is important for understanding soil health and for identifying best management practices. Generally speaking, the greater the percent clay, the greater the ability of a given soil to store and exchange nutrients, hold water, and sequester/stabilize organic matter. However, too much clay can lead to compaction, reduced infiltration, and restricted root growth. On the other hand, too much sand can lead to poor aggregation, rapid drainage, and low nutrient holding capacity.

'Complete' Analysis

The complete nutrient analysis utilizes a variety of extracts to assess levels of plant available macro- and micronutrients. While this is often used in traditional soil tests and for determining nutrient management, it is an estimate, at best, of what will be available in the soil at any given time. Roots and microbes are constantly releasing acids and other compounds that alter the pH and thus, the availability of any given nutrient at any given time. This analysis covers the three macronutrients needed by all plants (nitrogen, phosphorus, and potassium), the secondary nutrients (calcium, magnesium, and sulfur), and the micronutrients (iron, manganese, zinc, and copper).

Infiltration

Infiltration is the velocity at which water enters the soil and is an indicator of how freely water is able to move through a soil profile. It is crucial to soil health because when infiltration is compromised, more water runs off the field and less is available for root uptake, plant growth, and the activity of microbes and other organisms.

PFLA

Soil microbial community testing at Ward Laboratories is conducted by analyzing phospholipid fatty acids or PLFA. These fatty acids are found in the cell membranes of living organisms, from bacteria to plants and animals. However, they degrade relatively quickly in the soil when an organism dies and the membrane begins to break down. These characteristics make extracting and quantifying PLFA from the soil a powerful tool for estimating living microbial biomass. In addition, PLFA biomarkers, or signature fatty acids, allow us to identify the presence or absence of various functional groups of interest such as different bacterial groups, actinomycetes, arbuscular mycorrhizal fungi, rhizobia, protozoa, etc. PLFA is a snapshot of community structure and abundance at the time of sampling. As environmental conditions such as pH, temperature, and moisture change so does the microbial community. These communities are also influenced by soil type, organic matter, intensity and type of tillage, crop rotations, cover crops, and herbicide or pesticide applications. The ability of microbial communities to change rapidly provides producers with a tool to compare agricultural management techniques with respect to overall better soil health and fertility.

Bulk Density

Bulk density is an indicator of soil compaction. It is calculated as the dry weight of soil divided by its volume. This volume includes the volume of soil particles and the volume of pores among soil particles. Bulk density is typically expressed in g/cm3.

Slake Test

Slaking is the breakdown of large, air-dry soil aggregates (>2-5 mm) into smaller sized microaggregates (<0.25 mm) when they are suddenly immersed in water. Slaking occurs when aggregates are not strong enough to withstand internal stresses caused by rapid water uptake. Internal stresses result from differential swelling of clay particles, trapped and escaping air in soil pores, rapid release of heat during wetting, and the mechanical action of moving water.

Haney Test

Designed to access soil health by utilizing “green chemistry. It can be used on any soil type and management scenario. The “green chemistry” includes water, soil microbial indicator, and a weak organic acid (H3A). Soil samples are taken at 0–6” depth* and submitted to Midwest for analysis. Samples are dried at 50oC and ground to pass through a 2 mm sieve. About 4 grams of dry soil is weighed into each of two tubes and a third sample of 40 grams is weighed into a perforated beaker that can allow infiltration of water. One of the tubes with the 4 gram sample has water added and the second tube has H3A added. The tubes are shaken for 10 minutes to ensure extraction, centrifuged, and then filtered. The extracts are analyzed for nitrate, ammonia, phosphate, and minerals including aluminum, iron, phosphorus, calcium, magnesium, and sodium. The perforated container is placed in a jar with water and a Solvita paddle, capped, and allowed to sit for 24 hours. After the 24 hour period, the Solvita paddle is read.