Healthy soil leads to better crops

By Benjamin Letourneau

Recently the Natural Resources Conservation Service (NRCS) has been promoting a nationwide Soil Health Initiative through programs and outreach. Soil health can be defined as "the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans." To put it simply, it is how well the soil does what it is supposed to do. For a soil to be healthy, all the processes—physical, chemical, and biological—are working as they should. A healthy soil has good soil structure, high infiltration rates, and high water-holding capacity. It resists erosion, cycles nutrients, and supports healthy plants and animals. Most people know a healthy soil when they see it—by its color, its structure, and even its smell.

So how does a healthy soil accomplish all these things? What does it have that a degraded soil does not? One of the first things is organic matter. The more organic matter in a soil, the more nutrients are available and the more water it can hold. For every 1 percent of extra organic matter, a soil can hold an additional 19,000 gallons of water per acre. That 1 percent soil organic matter also contains an estimated $900 worth of nutrients in nitrogen, phosphorus, potassium, sulfur, and carbon. Healthy soil has better structure; it is not compacted. Stable soil aggregates and larger pore spaces increase water infiltration and make it easier for roots to grow. The biology of a healthy soil is thriving. Active organisms such as earthworms, fungi, and bacteria cycle nutrients, break down plant residues, and open up pores in the soil. The soil fungi (or mycorrhizal fungi) produce the biotic glues that hold soil aggregates together.

Mycorrhizal fungi also make nutrients and water more available to the plant roots.

The health of our soils can be improved in serval ways as discussed below. Initially, disturb the soil less. No-till is an important key to improving the quality of the soil. Tillage buries residue and creates bare ground. This leaves the soil more prone to erosion and also increases the soil temperature in the summer, leading to higher evaporation rates. Opening up the soil through tillage interrupts the biological processes. Tillage causes the bacteria that cycle nutrients to start mineralizing these nutrients faster than they can be used by the plants. The nutrients are then volatilized or leached. Beneficial fungi and earthworms are destroyed.

Another way to improve soil health is to increase the diversity of the plants growing on the soil. Soil organisms thrive in diverse habitats. Diversity in crop fields can be achieved through crop rotations, growing as many different crops and crop types as possible. For example, a wheat/milo/soybean rotation has three crop types or functional groups: a cool-season grass (wheat), a warm-season grass (milo), and a warm-season legume (soybean). Rotations can be enhanced by using perennials such as alfalfa. There is also great potential to increase crop diversity by including cover crops, such as turnips, radishes, oats, Austrian winter peas, barley, sunn hemp, canola, annual ryegrass, and many others. Cover crops can be included in most crop rotations.

Along with low disturbance and high diversity, it is important to keep living roots in the soil as much of the year as possible. As with all food chains (or food webs), the soil food chain starts with plants. Plants form the base of a food chain by converting sunlight to food energy through photosynthesis. In the soil food chain, the plant component is the root. The root is where the mycorrhizal fungi is found, feeding on the carbohydrates released by the roots. Soil bacteria feed on sugars released by the fungi. The plant roots then utilize the nutrients that are mineralized by the bacteria. As with any chain, it takes all the links in the soil food chain working to make it function as it should.

It is also important to have the plants above ground as well. Keep the soil covered through growing plants (cash crops or cover crops) and residue. Plants and residue intercept raindrops to reduce erosion.

The USDA Service Center located off of highway 56 west of Lyons.

(photo by Ryan Carlson)

They also keep soil temperatures down, reducing the evaporation rate. When the soil temperature is at 70°F, 100 percent of the soil moisture is used for plant growth. When it reaches 100°F, 15 percent is used for growth and 85 percent is lost through evaporation or transpiration. At 130°F, 100 percent is lost to evaporation and transpiration, and at 140°F, soil bacteria starts to die. On summer days when the air temperature is over 100°F, it doesn't take long for the soil to reach over 130°F if it is left uncovered.

The ultimate goal of improving soil health is not about having more bacteria, fungi, or earthworms. It is not about no-till or cover crops. What it all comes down to is our simplified definition of soil health: How well does the soil do what it is supposed to do? For agricultural producers, this means a soil that supports sustained or increased yields, even in drought years. It means maximized profits and soils that are still in place for future generations. For consumers, healthy soil provides plentiful, healthy, and affordable food. For everyone it means clean water and stable landscapes. Working together to improve soil health, all these things can be achieved.