Soil Health: Jay Fuhrer, NRCS Soil Health Specialist

The Soil Health foundation consists of five principles which are: soil armor, minimizing soil disturbance, plant diversity, continual live plant/root, and livestock integration. This article will discuss the first principle; soil armor. In this first of five articles on soil health, Jay explains the concept of "soil armor" and why it is important for building soil health.

Principle 1 of 5 - Soil Armor

Soil armor or cover, provides numerous benefits for cropland, rangeland, hayland, gardens, orchards, road ditches, and more. Let's take a closer look at some of the soil armor benefits:

• Controlling Wind and Water Erosion – armor protects soil from wind and/or water as it moves across the soil surface. It holds the soil in place along with valuable soil organic matter and nutrients.

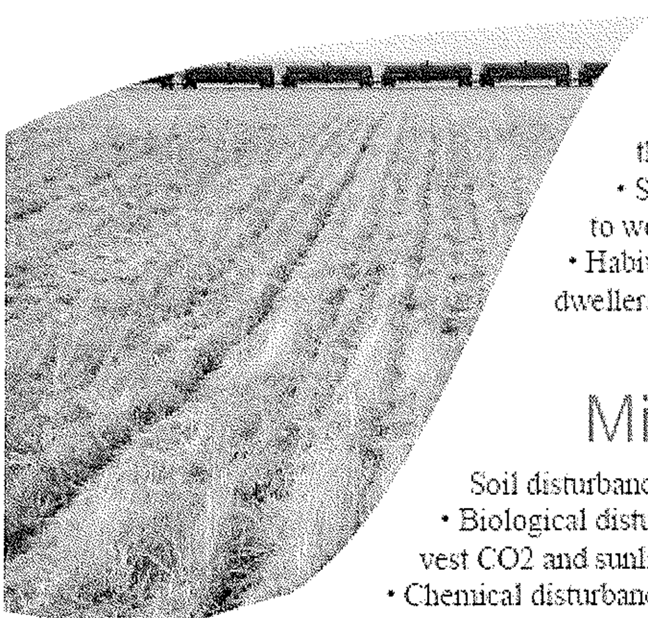
• Evaporation Rates – armor reduces the soil evaporation rates, keeping more moisture available for plant use.

• Soil Temperatures – armor helps soils maintain a more moderate range of soil temperatures, keeping soil warmer in cold weather, and cooler in hot weather. Like us, the soil food web functions best when soil temperatures are moderate.

• Compaction – rainfall on bare soils is one cause of soil compaction. When rainfall hits the armor instead of bare soil, much of the raindrop energy is dissipated.

• Suppresses Weed Growth – limits the amount of sunlight available to weed seedlings.

• Habitat – provides a protective habitat for the soil food web's surface dwellers.



The picture above shows the residual armor after corn planting was completed at the Menoken Farm, located just east of Bismarck, ND. At a minimum, the armor should last until the new crop is fully canopied. How quickly this residue decomposes depends on the carbon/nitrogen ratio of the residue. High carbon residue (eg: wheat at 80:1) decomposes much slower than low carbon residue (eg: pea at 29:1). When we supply the soil surface with a diversity of residues from one year to the next, we can achieve the benefits of soil armor and still maintain a fully functioning nutrient cycle.

Principle 2 of 5 - Minimize Soil Disturbance

Soil disturbance can generally occur in different forms:

• Biological disturbance, such as overgrazing, which limits the plants ability to harvest CO_2 and sunlight.

• Chemical disturbance, such as over application of nutrient and pesticide, can disrupt the soil food web functions.

• Physical disturbance, such as tillage, which we will focus on in this article.

A typical soil is approximately 45% mineral (sand, silt, and clay), 5% soil organic matter, 25% water, and 25% air. The water and air portions exist in the pore spaces between the soil aggregates. Over time, tillage implements reduce and remove the pore spaces from our soils; restricting infiltration and destroying the biological glues which hold our soils together.

Ultimately tillage results in one or more of the following:

• water erosion; transporting soil, nutrient, and water to offsite locations, which negatively impacts water quality and quantity.

• wind erosion; transporting soil, and nutrient to offsite locations, which negatively impacts air quality, human health, and animal health.

• ponding water; which stays saturated on the surface for long periods of time, a result of reduced infiltration and increased runoff.

• crusting easily, which restricts plant emergence.

• soil organic matter depletion.

Can we reverse the impacts from tillage and improve soil function? Yes, we can. Minimizing soil disturbance is a good start to rebuilding soil aggregates, pore spaces, soil glue, and soil organic matter. This is an essential step for long term soil productivity.

Principle 3 of 5 - Plant Diversity

The Journals of Lewis and Clark describe the northern plains landscape as having abundant plant diversity. Numerous species where observed, working together as a plant community to provide forage for large herbivore populations. Our soils where built over geological time in this environment.

However, settlement of the plains brought agriculture, which resulted in the polyculture perennial landscape being replaced by a monoculture annual landscape. Where the soil food web use to receive carbon exudates (food) from a diversity of perennial plants harvesting sunlight and carbon dioxide; it now receives carbon exudates from only one annual plant at a time.

We can start to mimic the original plant community by using crop rotations which include all four crop types. Diverse crop rotations provide more biodiversity, benefiting the soil food web; which in turn improves rainfall infiltration and nutrient cycling, while reducing disease and pests. Crop rotations can also be designed to include crops which are; high water users, low water users, tap root, fibrous root, high carbon crops, low carbon crops, legumes, and non-legumes to name a few.

The following lists the four crop types with a few common crop examples of each:

- Warm Season Grass – corn, sudan, and millet.
- Warm Season Broadleaf – sunflower, and soybean.
- Cool Season Grass – wheat, oat, barley, and rye.
- Cool Season Broadleaf – flax, pea, and lentil.

Diverse crop rotations mimic our original plant diversity landscapes. They are important to the long term sustainability of our soil resource and food security.

Principle 4 of 5 - Continual Live Plant/Root

Our perennial grasslands consist of cool season grasses, warm season grasses, and flowering forbs. Consequently, adaptable plants are able to grow during the cool spring and fall weather, as well as the summer heat. Allowing for a continual live plant feeding carbon exudates to the soil food web during the entire growing season.

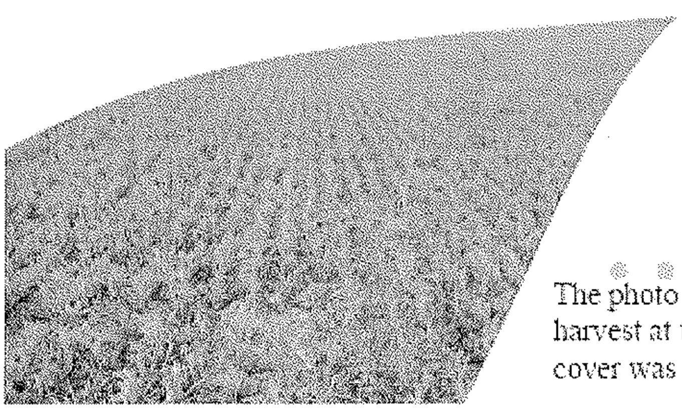
Our cropland systems typically grow cool or warm season annual cash crops, which have a dormant period before planting and/or after harvest. Cover crops are able to fill in the dormant period and provide the missing live root exudate, which is the primary food source for the soil food web. Cover crops may be incorporated into a cropping system as annuals, biennials, or perennials. Starting on a small acre scale will allow farmers and ranchers to find the best fit for their operation.

Cover crops can address a number of resource concerns:

- Harvest CO2 and sunlight, providing the carbon exudates to the soil food web.
- Building soil aggregates and pore spaces, which improves soil infiltration.
- Cover the soil, controlling wind and water erosion, soil temperature, and rainfall compaction.
- Catch and release of inorganic nutrients, improving water quality.
- Salinity management.
- Pollinator food and habitat.
- Weed suppression.
- Wildlife food, habitat and space.
- Livestock integration.
- Adding crop diversity
- Adjusting the cover crop combination's carbon/nitrogen ratio, to either accelerate or slow decomposition.

Principle 5 of 5 - Livestock Integration

Watch for it in our Next Newlsetter



The photo shows an 8-way cover crop combination seeded after spring wheat harvest at the Menoken Farm, benefiting numerous resource concerns. The cover was seeded immediately after harvest.