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Is Soil Health Real?

Sceptics of soil health abound in agriculture. After World War II, farmers became reliant on inorganic fertilizer to improve crop yields. Soil organic matter (SOM) levels were still high, so an investment in fertilizer gave big yields. Today, most soils have lost 50-80% SOM, so it takes more fertilizer and environmental problems are getting worse. With improved genetics, crop yields continue to climb but at a much slower rate than most scientist predict. Soil pests like weeds, insects, and diseases continue to persist. While yields have improved, the nutrient density or mineral and vitamin content of our food is much lower than it was in the 1950's. Fertilizer, genetics, and new technology (all man-made innovations) have a limited ability to improve our food supply without Mother nature's help from microbes recycling nutrients and sequestering soil carbon. Improving soil health is all about using all our resources (man-made and natural) to enhance crop productivity.

Farmers should want to optimize nutrient cycling, not maximize it. Most farmers are maximizing how much nitrogen and phosphorus they apply, hoping for maximum yields. The result is unfortunately a nutrient efficiency rate of about 30-50% on nitrogen (N) and 10-50% on phosphorus (P). Optimizing N and P and most other micro-nutrients requires healthy soils with diverse microbes and carbon sequestration (SOM). Soil erosion, water quality and inefficient nutrient cycling are biological problems related to unhealthy soils that lack microbial diversity and efficient carbon cycling. Modern agriculture has focused mainly on man-made innovations but future innovations will need to incorporate more natural solutions involving microbes and keeping green plants on the land year-round to improve carbon recycling and sequestration.

Keeping high levels of carbon and SOM in the soil is the key to improving soil and crop productivity while minimizing environmental problems related to soil erosion, water and air quality. Carbon is the most limiting soil element to maximizing photosynthesis and crop yields. Scientist estimate plants only have enough carbon dioxide (which comes from plant roots) for only 10-20% photosynthesis rate which occurs early in the morning. Without carbon, plants stop photosynthesizing. Carbon chelates or binds most minerals for crop production, so when the recycled carbon flow slows down, mineral release for crop production also slows down, limiting crop yields.

Most crop nutrients need to be in a reduced form not the oxidized form to be plant available. Reduced and soluble forms of nutrients tend to leach so for optimal nutrient cycling, the soil needs adequate carbon to bind the minerals with diverse soil microbes slowly releasing those nutrients just in time for plant roots to absorb them efficiently. Keeping carbon recycling and keeping diverse healthy microbial populations requires a change in farm management.

USDA-NRCS promotes these four soil health principles to optimize soil health, nutrient recycling and to minimizes environmental problems with soil, air, and water quality. Minimizing soil disturbance or tillage not only keeps soil from eroding, it optimizes soil carbon (SOM) and minimizes soil nutrient losses. Tillage changes soil structure, causing soil compaction and a loss of microbial diversity. Maximizing green plants and live roots in the soil year-round builds carbon (SOM) and keeps soluble and reduced forms of nutrients from leaching away. Live roots not only feed the microbes but they also absorb soluble nutrients (N & P) and reduced micro-nutrients needed to optimize crop yields.

Maximizing surface residues moderates soil temperature and maintains soil moisture allowing healthy plants and soil microbes to maximize photosynthesis while reducing rainfall impact and soil erosion. Enhancing biodiversity through crop rotation and planting a variety of cover crops, reduces many pests including weeds, insects, and diseases. Research shows that many pest problems are kept in check in healthy soils because healthy plants out compete weeds for sunlight and nutrients. Healthy microbial populations also keep insects and disease organisms at lower tolerable levels. All four principles are needed to maximize soil health.

Optimizing crop yields requires good soil health. New research now focuses on what biofertilizers may enhance soil health. Soil health genetic research is finding improved cover crop varieties but is also selecting for genes and/or traits that allow crops to flourish in a diverse healthy soil environment. Purdue University researchers estimate that most corn has the capability to produce 1100 bushels per acre but that requires a healthy soil environment. Modern agriculture needs to embrace soil health concepts in order to optimize future soil and crop productivity.