W 998

What Does Soil Health Mean for Tennessee Farmers?

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Soil health is one of the most popular and widely discussed terms among the agricultural community in recent years. The soil health concept has been around for decades, along with similar concepts such as soil tilth, soil fertility and soil quality. Following the Dust Bowl in the 1930s, soil management practices were primarily targeted at controlling soil erosion and increasing soil fertility. These early efforts mainly focused on improving the physical and chemical properties of soil and largely overlooked soil biology. There is an abundance of microscopic life in the soil and it is recognized that soil microbes play a critical role in regulating soil functions. Soil health is "the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals and humans" (USDA-NRCS). This definition underscores that soil is living and that soil life sustains life above ground. Beyond this broader definition, what does soil health mean for farmers when it comes to attaining, maintaining and improving the health of their farms?

Farmers in Tennessee are recognizing the importance of soil management to their operations and are engaged in management practices that promote soil health. By putting 96 percent of the planted area under conservation tillage in 2018 (NRCS-Tennessee Field Office, 2018), which helps reduce erosion and build soil organic matter, Tennessee farmers are already contributing to improving soil health. A survey conducted in 2020 by the University of Tennessee Extension that covered 30 counties showed that nearly five out of every 10 row crop farmers in Tennessee are using cover crops for soil conservation purposes (Figure 1). Farmers are clearly interested in understanding how cover cropping and other management practices can be used to promote healthy soils.

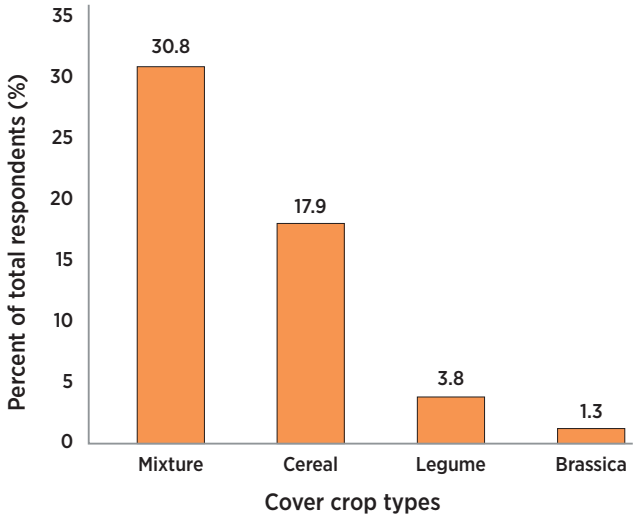

Figure 1: *Cover crop adoption by Tennessee farmers. (Total number of respondents: 78)*

Characteristics of healthy soils

Healthy soils have several desirable physical, chemical and biological properties (Figure 2). Healthy soils show good structure or tilth, with the soil particles forming

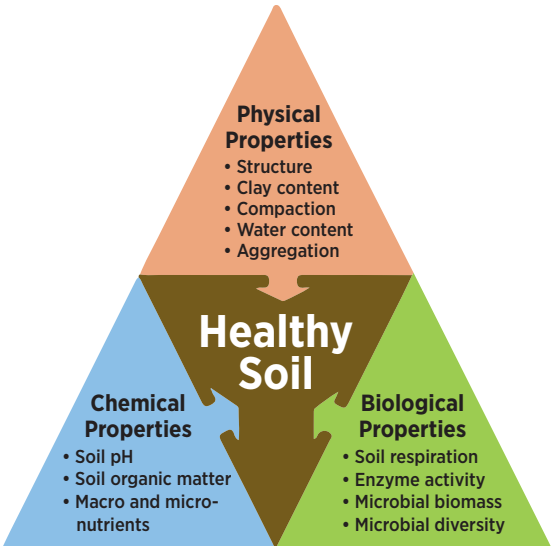

Figure 2: *Major soil properties influencing soil health.*

aggregates with pore spaces in between aggregates. Good pore structure facilitates root growth, drainage, better water and air exchange, less compaction, resistance to erosion and serves as habitat for soil organisms. Healthy soils maintain a nutrient balance to provide sufficient nutrients for crop production while minimizing potential losses from leaching and surface runoff. Healthy soils accumulate soil organic matter over time, which not only serves as a nutrient reserve but also helps regulate soil moisture, allowing soils to thrive under adverse weather conditions such as drought and heavy rainfall. Healthy soils are also home to billions of organisms, most of them microscopic (Figure 3). These organisms include microorganisms (bacteria, fungi, viruses), microfauna (nematodes, amoeba, flagellates, tardigrades, etc.), and macrofauna (arthropods,

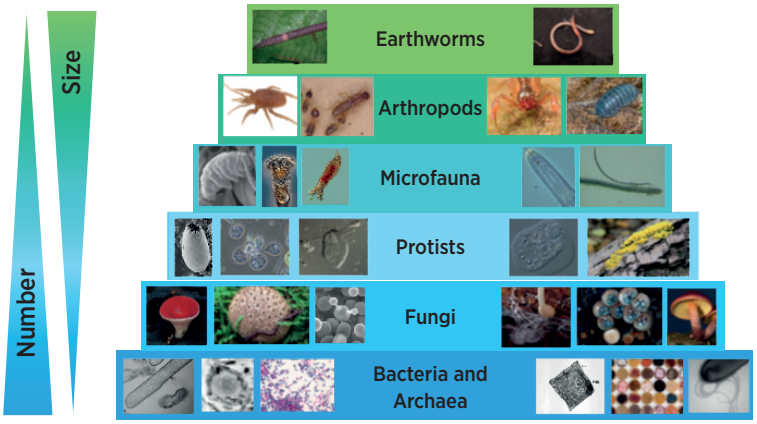

Figure 3: *Major soil organisms organized by number and size.*

earthworms, rodents, etc.), all of which are assembled in complex food webs. Microorganisms in particular, which number in the millions per teaspoon of soil, carry out many of the critical functions of soil, including residue decomposition, carbon storage, nutrient cycling, nitrogen fixation, pesticide biodegradation and pathogen control.

Benefits of healthy soils

Healthy soils can offer multiple benefits to society by positively impacting agricultural production, environmental health and human health (Figure 4).

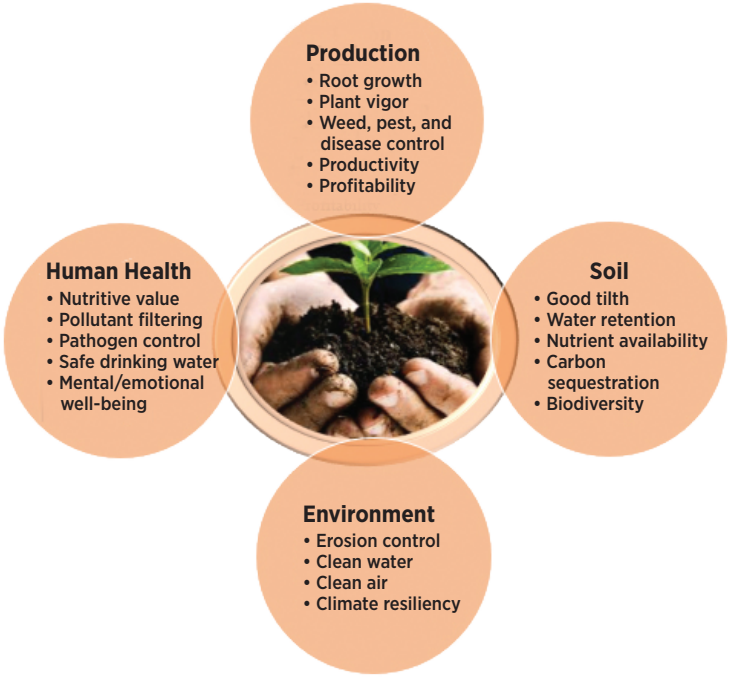

Figure 4: *Ecosystem and societal benefits from healthy soils.*

Farmers may experience near-term benefits such as weed suppression (Sabbagh et al., 2020), erosion control and soil moisture retention from covering the bare ground with cover crops and/or crop residues, as well as long-term benefits such as increased organic matter accumulation, crop yield, biodiversity and resistance of our production systems to extreme drought and other weather anomalies. Healthy soils are efficient in converting organic and complex forms of soil nutrients to plant-available forms, potentially reducing the need for some inputs and reducing the crop production costs. These near-term and long-term benefits can offer multiple far-reaching services to our society, including sustained plant and animal productivity, cleaner air and water and fewer soil contaminants and pathogens, ultimately supporting human health and well-being.

Building soil health

Soil health can be improved and maintained by following conservation agricultural practices such as reduced tillage or no-tillage, growing cover crops, rotating cash crops, applying organic amendments such as manure or poultry litter and, where practical, integrating grazing. These soil building practices are broadly grouped under four management principles by USDA-NRCS:

i. Minimize soil disturbance
ii. Maximize soil cover
iii. Maximize biodiversity
iv. Maintain year-round living roots in the soil

Reducing soil disturbance by decreasing the frequency and intensity of tillage can help improve soil structure, reduce soil erosion and increase soil organic matter accumulation. Decades ago, intensive tillage practices had caused high erosion rates of agricultural soils. Since the 1980s Tennessee farmers have widely adopted no-till methods, and with a 78.6 percent adoption rate, Tennessee is now leading the nation in no-till farming (Soil Health Institute Progress Report, 2019). Providing ground cover with winter cover crops is an additional conservation strategy for further reducing soil erosion and improving soil health. One recent study showed that 39 years of continuous no-till practices and a winter cover crop accumulated the greatest amount of soil organic matter in a soybean production system in West Tennessee (Figure 5). The study also found that soil organic matter accumulation increased with decreasing tillage intensity from moldboard tillage to no-tillage (Figure 5).

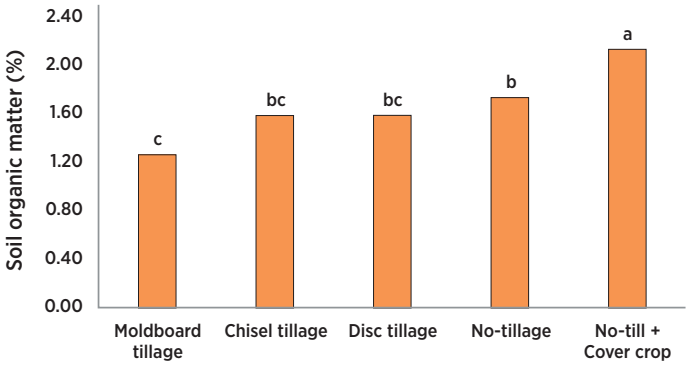

Figure 5: *Effect of different intensities of long-term tillage and combination of no-tillage and cover cropping on soil organic matter content (Adapted from Singh et al., 2020). Different letters above the bars indicate statistical significance.*

Diversifying production systems is another conservation agricultural practice for maintaining soil health. Some

options to potentially diversify the production systems include rotating cash crops, growing cover crop mixtures and promoting livestock grazing, when and where appropriate. Grass cover crops that grow and cover the ground well can store excess nutrients from the soil in their biomass, legumes can convert atmospheric nitrogen to plant-available forms, and deep-rooted brassicas such as turnips, radishes and cabbage can break through some compacted soil layers like the fragipan common in Tennessee. A cover crop mixture of grasses, legumes and brassicas can potentially improve soil properties compared to individual species if all the species in the mixture establish successfully. The year-round presence of diverse plants and living roots in soil supports diverse soil microorganisms that are responsible for maintaining soil health by increasing nutrient cycling and availability, organic matter accumulation and soil's resilience to stress.

Scientists at the University of Tennessee Institute of Agriculture have been and will continue to invest effort in unbiased research trials to identify best management practices for our region to attain, maintain and improve soil health to support profitable farming and environmental benefits.

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Additional Resources on Cover Crops in Tennessee

Cover Crop Variety Tests in Tennessee 2020 W 953

Cover Crops Quick Facts W 417

Additional questions can be sent to Sindhu Jagadamma, assistant professor in the Department of Biosystems Engineering and Soil Science, by emailing sjagada1@utk.edu.

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