TENNESSEE STATE UNIVERSITY
College of Agriculture
Cooperative Extension
ANR-AGRO-02-2026

Agronomy and Soil

Soil health assessment in annual crop fields and perennial hay fields in Tennessee

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Current dominant annual cropping systems typically need annual replanting, which exposes soil to erosion (Paustian et al., 2016). Perennial forages persist for multiple years without the need for annual replanting, providing continuous ground cover and reducing soil disturbance (Glover et al., 2012). Including perennial forages in the annual cropping systems can improve soil health. Healthy soil builds soil organic matter, which improves retention of water and nutrients. Healthy soil can also sustain diverse microbial groups. This study aimed to conduct on-farm comparisons of soil health indicators between annual crop fields and perennial hay fields located close together with similar soil types.

Soil sample collection

Soil samples were collected from farmers' fields at 0–6-inch depth during fall 2024. Samples were collected from Giles County near Pulaski, Franklin County near Winchester, and Trousdale County near Dixon Springs in central Tennessee (**Fig. 1**). In western Tennessee, soil samples were collected in Madison County near Jackson (**Fig. 1**). Soils represented an Armour silt loam (Giles and Trousdale), Dickson silt loam (Franklin), and Feliciana silt loam (Madison) with >46% silt and 2 to 5 percent slopes.

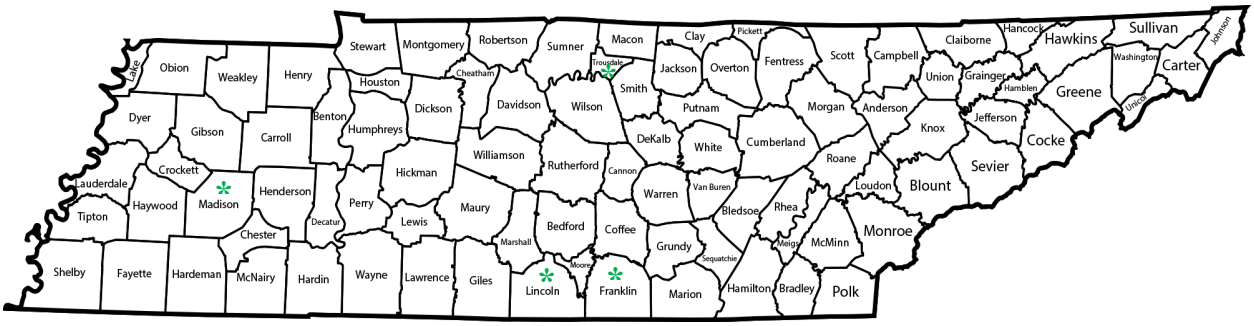

Figure 1. County map of Tennessee with asterisk (*) mark showing the counties sampled for soil health assessment.

A total of 20 annual crop fields and 20 perennial hay fields in four counties were used for the study. Annual cropping systems were sampled in corn and soybean (Pulaski and Winchester), corn (Dixon Springs), and corn, soybean, and cotton (Jackson) fields, whereas perennial forage systems were sampled in nearby orchardgrass, orchardgrass-alfalfa, and alfalfa (Pulaski), tall fescue, crabgrass-alfalfa, and alfalfa (Winchester), orchardgrass (Dixson Springs), and alfalfa and bermudagrass (Jackson) fields. For example, annual crop fields and perennial hay fields used in Winchester are presented in **Fig. 2**.

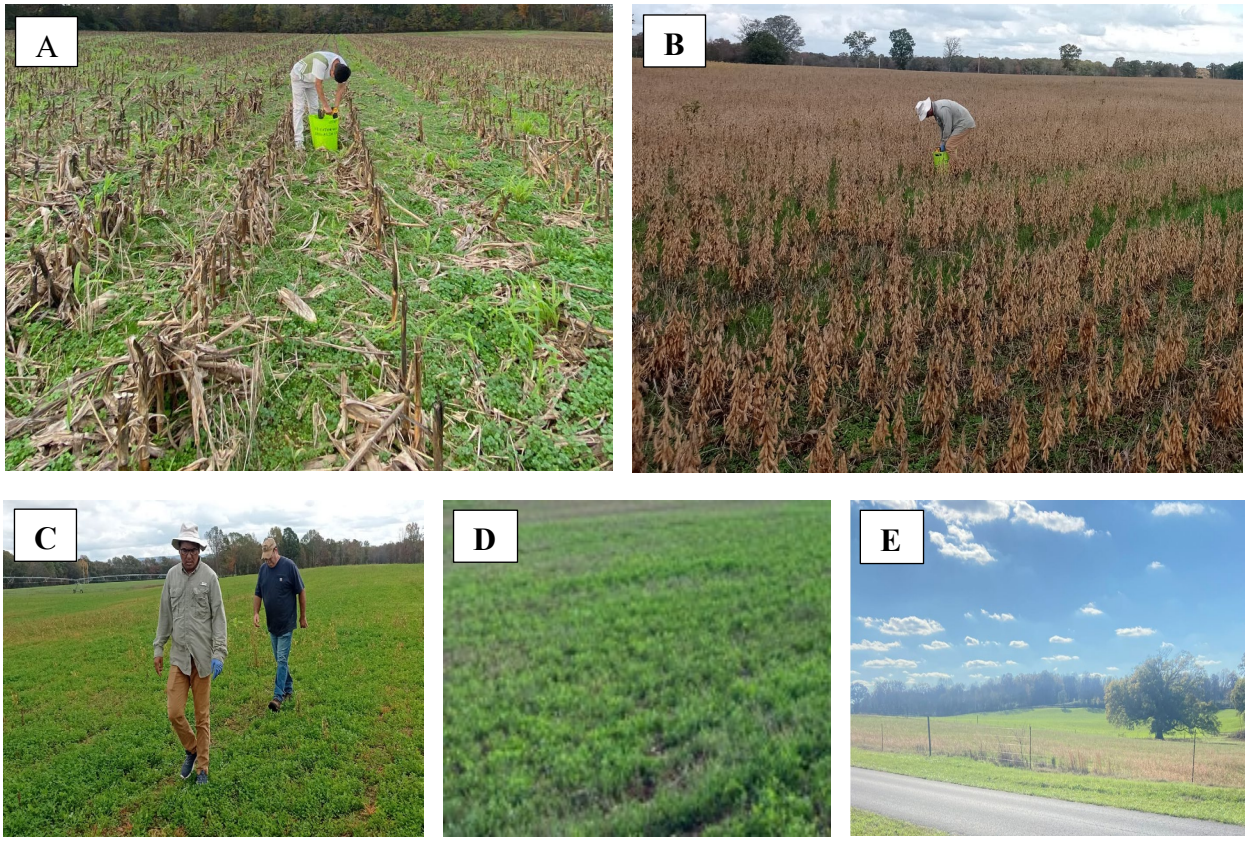

Figure 2. Annual crop fields (**A**-corn and **B**-soybean) and perennial hay fields (**C**-alfalfa, **D**-crabgrass-alfalfa, and **E**-tall fescue) sampled in Fall 2024 in Winchester, TN in Franklin County.

Measurement of soil health indicators

Soil physical (aggregate stability), chemical (soil organic matter and permanganate oxidizable carbon), and biological (total living microbial biomass) parameters were measured at Ward Laboratory in Nebraska.

Soil aggregate stability measures how easily a soil aggregate breaks down when exposed to water and wind, which provides information on the soil's resistance to water and wind erosion (Amézketa, 1999). *Soil organic matter* (SOM) includes both living and dead plant and animal matter, as well as microorganisms. It is crucial for soil fertility, water retention, and nutrient availability. *Permanganate oxidizable carbon* (POXC) quantifies the unstable carbon in the soil and is an early indicator of changes in soil organic carbon (Weil et al., 2003). *Total living microbial biomass* primarily represents the bacterial and fungal communities that break down the soil organic matter (Acosta-Martinez et al., 2010).

Results

The mean values of soil aggregate stability were higher in perennial fields compared to annual fields except that in Giles County where annual fields had higher aggregate stability (**Fig. 3**). Soil organic matter was higher in perennial hay fields compared to annual crop fields in all four counties (**Fig. 3**). The soil organic matter of each field is also given in **Figure 4**.

Permanganate oxidizable carbon (POXC) was higher in perennial forage systems than annual cropping systems in Franklin County while it was similar between both systems in the other three counties (**Fig. 3**). Total living microbial biomass was higher in perennial forage systems than annual cropping systems except in Giles County where there was higher total living microbial biomass in annual systems (**Fig. 3**).

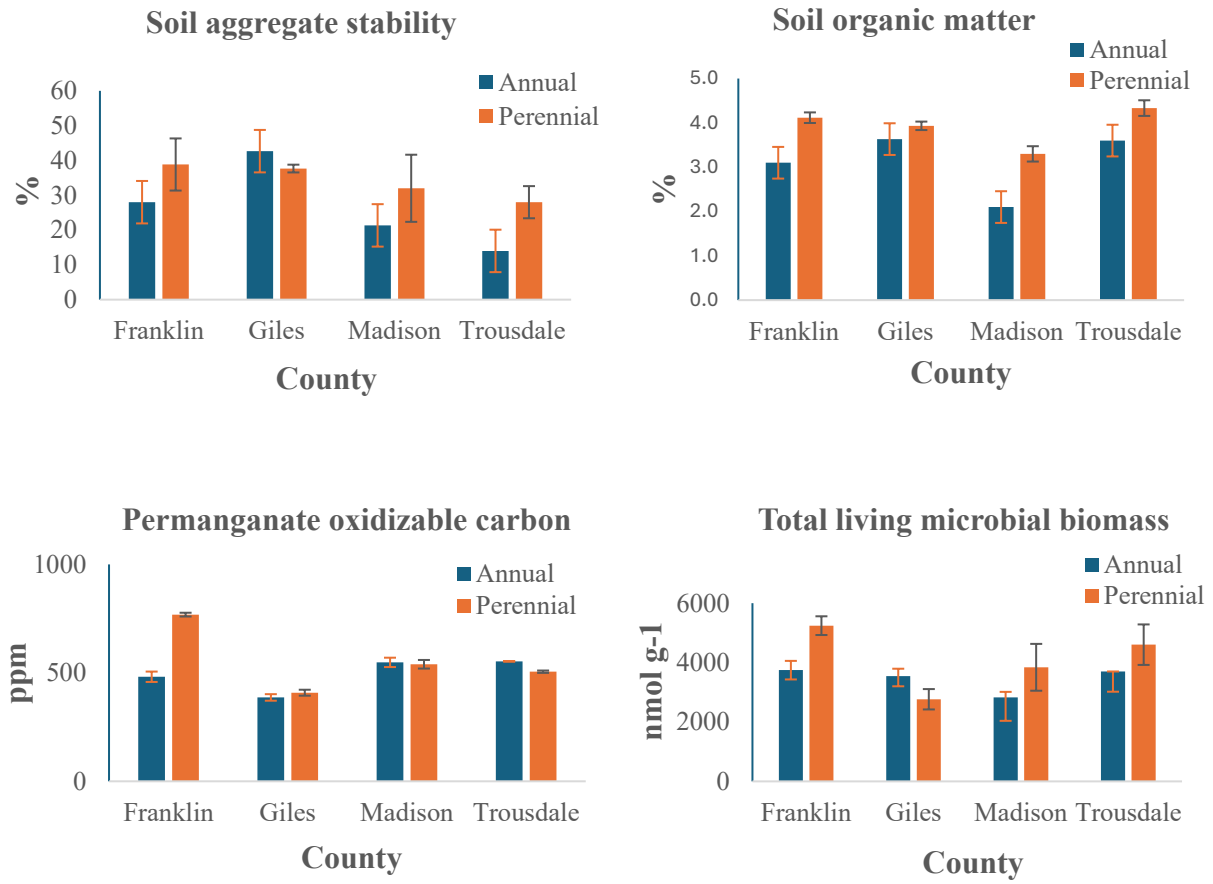

Figure 3. Bar graphs of soil aggregate stability (**top left**), soil organic matter (**top right**), permanganate oxidizable carbon (**bottom left**), and total living microbial biomass (**bottom right**).

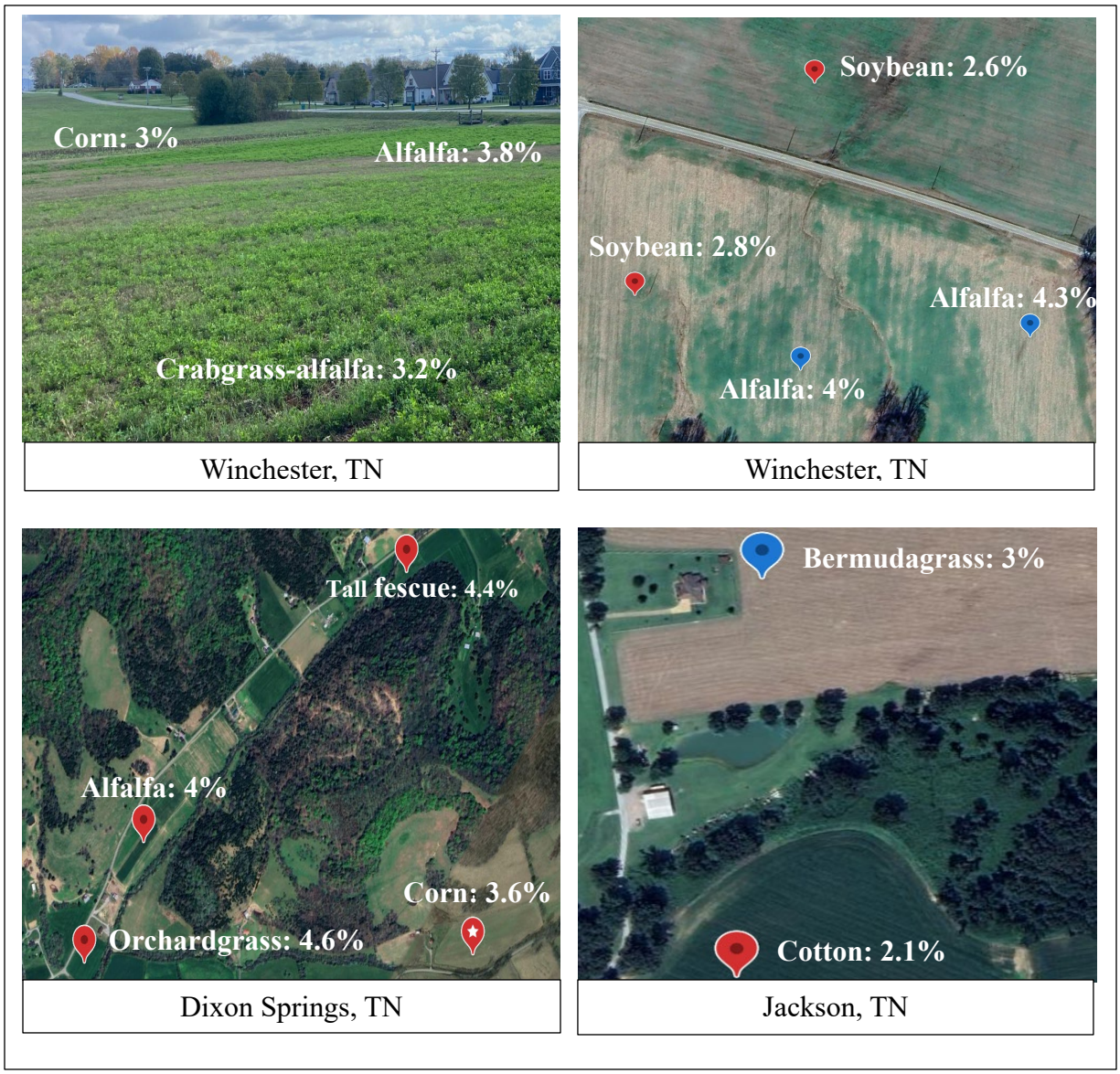

Figure 4. Soil organic matter (SOM) in different annual and perennial fields.

Conclusions

This study compared farm pairs (annual crop and perennial forage) in several sites in Tennessee by selected soil health indicators. Enhanced soil organic matter and total living soil microbial biomass in perennial forage systems indicate that such systems are promising for soil health. Including perennial forages in rotation with annual crops could potentially be a future strategy that farmers can use to improve soil health and overall agroecosystem resiliency.

References

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Funding support is partially provided by Tennessee Corn Promotion Board (TCPB). Tennessee State University is an EEO employer. TSU-26-433(C)-11i-83043