LEOPOLD CENTER
FOR SUSTAINABLE AGRICULTURE

Understanding soil organic matter change: Modeling root and soil interactions across soil landscapes

Abstract: The project looked at bioenergy feedstocks and how they might be employed to improve soil properties, specifically soil structure and soil carbon in the form of organic matter content. In this study, switchgrass showed the greatest promise for improving soil qualities.

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The results showed that despite no change in total soil carbon, all three bioenergy cropping systems studied improved soil structure and increased the protected forms of soil carbon that result in storage of soil carbon. The greatest improvement to soil structure and organic matter levels occurred under switchgrass—likely due to the large amount of root biomass associated with this crop—while continuous corn showed the smallest changes. Additional analyses revealed that soil properties influenced shifts in protected forms of soil carbon through impacts to soil structure and root biomass.

ECOLOGY

What was done and why?

Soil organic matter (SOM) is critical for healthy agricultural lands that provide clean water, clean air and fertile soils. However, decades of intensive use of many agricultural areas have reduced SOM levels and significantly decreased these vital benefits, including soil carbon (C) storage that helps mitigate rising atmospheric CO2 levels. Emerging markets for cellulosic bioenergy feedstocks provide opportunities for implementing soil conservation practices that restore soil C storage within agricultural landscapes. Soil conservation strategies—including conversion to no-till, use of cover crops, and establishing perennial vegetation—alter belowground C cycling processes and increase soil C storage through protection of SOM. In particular, marginal sites less suited for conventionally tilled annual row-crops are being targeted as appropriate locations for conversion to perennial bioenergy crops. However, the effects of topography and variations in soil properties on belowground C cycling processes remain largely unknown.

The goal of this research was to quantify impacts of variation in topography and soil conditions on short-term changes to soil C under bioenergy crops. Specifically, the researchers sought to understand how plant roots and soil interact to improve the physical structure of the soil through the formation of soil aggregates that protect SOM from further decomposition, ultimately storing more C within soils.

What did we learn?

The objectives of this project were fully achieved to the extent possible within the Landscape Biomass Project experimental design. Results indicate that stored soil C pools changed in just three years, despite no overall changes in soil C stocks. These changes were shown to be related to increases in soil aggregation, which the model suggested was impacted by soil properties such as texture and by root biomass of the various cropping systems included in the study.