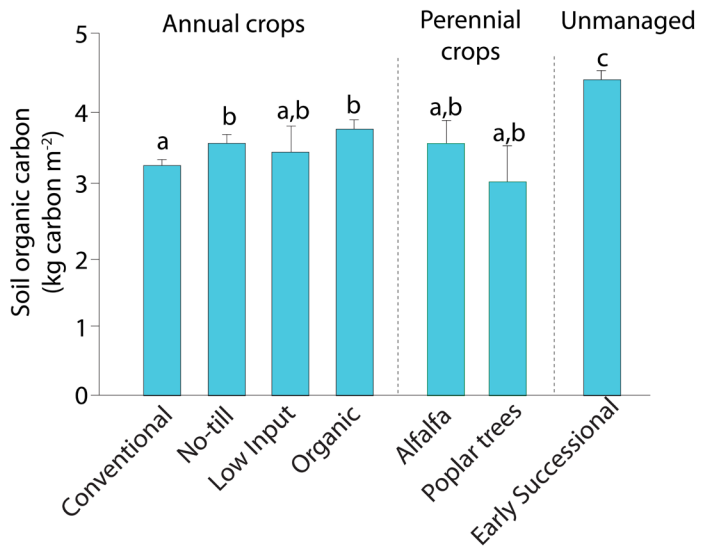
Research Highlights

Soil Carbon

NO-TILL FARMING CAN HELP TO MITIGATE CLIMATE CHANGE

Soil organic matter, also called soil carbon, is very important to farmers because it contributes to good soil quality and crop productivity. It provides plants and soil organisms with the nutrients and food they need to grow. Soil organic matter also influences many soil physical properties such as drainage and structure which help create a good environment for crop roots and boost crop yields. Soil organic matter levels in crop fields are also linked to global climate change, an issue that extends far beyond the farm field and affects all humans. Agricultural lands have the potential to mitigate—reduce the severity of—global climate change by increasing soil organic matter levels. By increasing soil organic matter, carbon is stored in the soil and kept out of the atmosphere. This is commonly referred to as *soil carbon sequestration*.



This graph shows how various farming methods affect soil carbon amounts in surface soils levels (~8 inches deep). Soil samples were collected in 2001, 12 years after treatments were established. Before treatments were established, there were no differences in soil carbon levels across the experimental plots. Annual field crops were a rotation of corn, soybeans, and wheat. Treatments with different lower case letters above them are statistically significantly different ($p \leq 0.05$). Adapted from Syswerda et al. 2011.

This graph shows how various farming methods affected soil carbon amounts in surface soils levels at the Kellogg Biological Station Long-term Ecological Research site. As this data shows, there are ways of farming the land that promote soil carbon sequestration. For annual cropping systems that include crops such as corn, soybean, or wheat, one of these farming methods is no-tillage technology. No-tillage technology (also called no-till or zero tillage) does not use machinery that disturbs the soil or crop residue. When soil is disturbed by tillage, the soil layers mix with air, resulting in a great deal of soil microbial activity. This microbial activity causes soil organic matter (crop residue) to be broken down quickly and carbon to be converted from organic carbon to carbon dioxide, which escapes to the atmosphere. Under no-till farming, the soil remains undisturbed and organic matter can accumulate faster than it decomposes, resulting in soil carbon gain.

Because changes in soil carbon occur slowly, scientists track soil carbon levels in a given area over many years to document changes. To date, most estimates of how much carbon sequestration could occur from agricultural lands have been based on studies of soil carbon change in surface soils—that is, soils approximately one foot deep or shallower. Researchers have recently reported concerns that no-till soils deeper than one foot may not be gaining carbon. Even worse, they think these soils could be losing carbon. If true, this has very important management and policy ramifications. If no-till soils are gaining carbon in surface soils but losing carbon at deeper levels, then no-till farming loses much of its value as a climate change mitigation strategy.

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Research Highlights

Collecting deep soil core samples on the KBS LTER; Photo Credit: K.Stepnitz, Michigan State University

Why haven't many researchers measured if soils are gaining or losing carbon at deep levels? Because it takes a great deal of time and money to do so. Soil carbon amounts vary a great deal over a farm field, making it is hard to detect changes in soil carbon over time. This is especially true when deeper soil layers are included in the analysis. Therefore, to detect soil carbon change many soil samples from many replicated experimental plots are needed. For years, KBS LTER scientists have documented soil carbon gains in surface soils under no-till management. More recently, they wanted to know if farm fields under no-till management were actually losing carbon at the deeper levels. Because of the replicated, long-term nature of the KBS LTER experiment they were able to do so.

In 2001, KBS researchers collected many soil samples to depths of three feet from plots that had been under different types of farm management for 12 years. The researchers discovered that surface soil carbon amounts were greater under no-till management compared to the conventional cropping treatment that included tillage. Furthermore, they could not detect any differences in soil carbon at depths greater than one foot, showing that at KBS, soils under no-till are not losing carbon at deeper levels. These findings demonstrate that no-till farming can be a genuine strategy for climate change mitigation—good news for both farmers and society. But, KBS researchers have also learned that if land that has been under no-till farming is eventually plowed up, it loses all of the carbon it had gained. The researchers are gearing up for another round of intensive soil sampling from the LTER plots in the fall of 2013. These new findings will continue to help farmers and policymakers manage and develop agricultural landscapes that provide high crop yields and environmental protection.

For Further Reading

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Grandy, A. S. and G. P. Robertson. 2007. Land-use intensity effects on soil organic carbon accumulation rates and mechanisms. *Ecosystems* 10:58-73.

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