Laws, L. "Scientists Explore Crop Management Options for Storing Soil Carbon." *Resilient Agriculture.* Aug. 2014: 27-29. Print.

^ Lori Abendroth and Martin Shipitalo examine soil aggregation and color at a Sustainable Corn Project research site in Coshocton, Ohio. Abendroth is the project manager and Shipitalo is a soil scientist with the National Laboratory for Agriculture and Environment in Ames, Iowa, and was a principal investigator with the Sustainable Corn Project in 2011.

# Scientists Explore Crop Management Options for Storing Soil Carbon

BY LYNN LAWS

Sustainable Corn Project scientists are exploring agricultural practices, which are known to build soil organic matter, to assess their capacity to increase carbon retention and sequestration (i.e. storage). If the practices show increased long-term carbon storage in field tests, they could provide farmers with options for increasing the fertility of their fields, while, at the same time, contributing to reductions in greenhouse gas emissions.

Sasha Kravchenko is a principal investigator with the Sustainable Corn Project and a professor of crop and soil sciences at Michigan State University, specializing in statistical analysis tools as applied to soil properties and soil organic matter. She and other researchers on the team are conducting studies at 10 sites in six Corn Belt states to explain the mechanisms by which cover crops increase the amount of carbon stored in the soil and to what extent that affects greenhouse gas emissions.

"In short-term experiments we might not necessarily be able to detect a change in the total soil organic matter (SOM)," says Kravchenko. "At least five to seven years are needed to start detecting increases in SOM. But some SOM components react

continue on page 28 >

more quickly to changes in management, such as particulate organic matter. We know if we start to see positive differences in those components, it is a sign that the management system is going in the right direction of increasing SOM and has greater potential for carbon sequestration," Kravchenko says.

Indeed project investigators are seeing those differences.

"In our Michigan sites, after just three years, we are starting to observe greater particulate matter levels in plots with cover crops than in conventional plots," says Kravchenko. Soil properties are measured and compared at depths of 0–10 and 10–20 cm.

"… use of cover crops may counteract some of the carbon losses due to tillage."

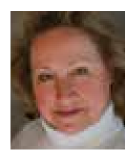
Emerson Nafziger, a professor of crop sciences at the University of Illinois, is a principal investigator with the Sustainable Corn Project who is examining the effects of various crop rotations and tillage on soil carbon. He says crop residue on or incorporated into the soil can take a long time to decay, but much of it eventually returns back to the atmosphere as carbon dioxide. One form of carbon that remains sequestered, however, is the carbon in the stable fraction of soil organic matter. Organic matter is said to be stable only after it is in a chemical form that does not break down any further.

"Indications are that soil organic matter at some point reaches a steady state in farmed soils, with additions about equal to losses over years," says Nafziger. "But it may be possible, depending on what crops are grown and how they and soils are managed, for some soils to begin to regain, ever so slowly, stable soil organic carbon."

Kravchenko says studies have shown that SOM increases in at least the top two inches of soil in a no-till system. "But what studies have also shown is that to continue that increase or keep that higher level of SOM it would have to remain in no-till. Even one tillage event will do a lot of damage to that freshly accumulated soil organic matter. A lot of it will disappear. So that restricts how useful no-till can be for carbon sequestration."

"So, with cover crops, the carbon appears to stay there despite the tillage. In my opinion, cover crops provide more flexibility for the farmer, when choosing tillage options," Kravchenko says.

"We also are observing that cover crop effects are different in various topographies. We hypothesize, and are now seeing first signs of support to this hypothesis, that we will reap greater benefits from cover crops, in terms of improvement of soil structure and increase in SOM, in parts of the terrain with poorer soil — areas that are more eroded, low in SOM, or have inadequate aggregation."



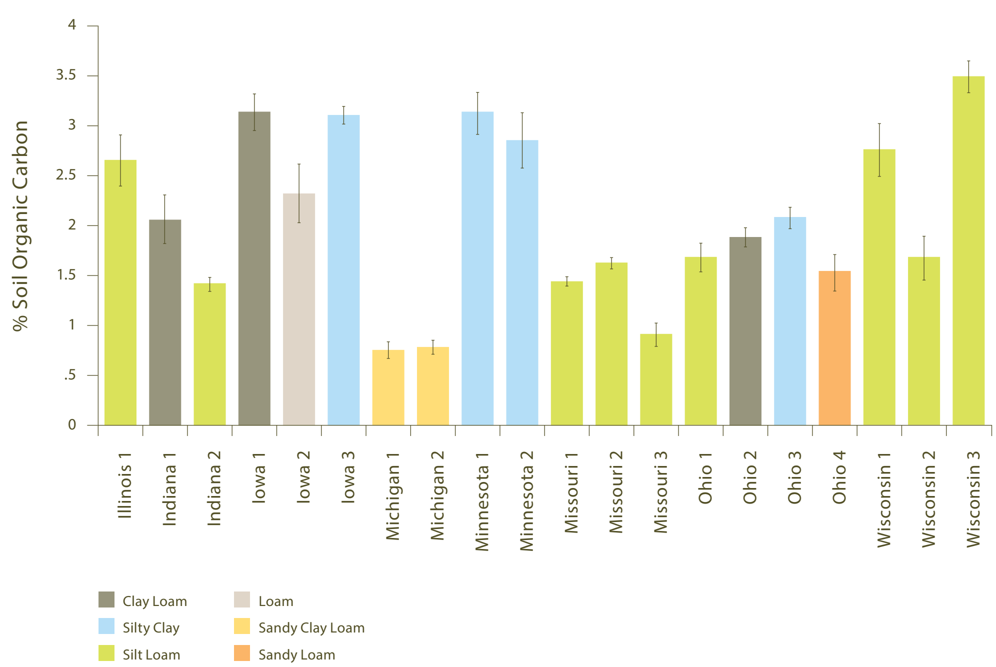
Lynn Laws is a communications specialist for the Sustainable Corn Project and for Iowa State University, College of Agriculture and Life Sciences.

## FIGURE 1 | SOIL ORGANIC CARBON

Increasing a soil's level of organic matter can make your crops less susceptible to drought. In fact, a one percent increase in soil organic matter (SOM) can result in an additional water holding capacity of 25,000 gallons per acre. This figure shows the variation in Soil Organic Carbon (SOC) across the Sustainable Corn Project sites. SOC is an indirect way to measure SOM. SOC comprises roughly 58% of SOM.

Sustainable Corn Researchers are collecting a suite of agronomic, soil, water, and greenhouse gas datasets to better determine the nitrogen, carbon, and water footprints of our Midwest corn-based cropping systems. Data are collected spanning 2011 to 2016 from across our teams' 35 site research network (see page 3) and encompasses 45 treatments and 115 types of measured data. An example of this unique data set is shown in the figure to the right, which showcases the range in soil carbon of some of the team's research sites.

Data interpreted and compiled by Landon Bunderson, Sustainable Corn Project data manager.



^ Soil organic carbon is part of soil organic matter (SOM). Mollisols (left), which are 5-15% carbon, and alfisols (right), which are 1-5% carbon, are the two dominant soil orders farmed in the North Central Region. Photos courtesy USDA Natural Resource Conservation Service.

## SOIL CRITICAL TO GLOBAL CARBON BALANCE

While soil carbon comprises only one to six percent of total soil mass, it plays a key part in the earth's carbon cycle. In fact, the organic matter currently in the world's soil contains 1500 petagrams (or 1,000,000,000,000,000 grams) of carbon, more than twice the carbon in living vegetation (560 petagrams). These facts draw interest from policy makers and scientists seeking ways to retain carbon in soil and reduce carbon dioxide emissions. Soil carbon is most highly concentrated in the top 8 inches and decreases with soil depth down to approximately 3 feet. Thus, soil carbon contained within the tillage layer is more likely to be affected by management practices than carbon in the deeper rooting zone.

## SOIL ORGANIC MATTER AND CARBON'S ROLE IN SOIL HEALTH

Soil organic matter (SOM), a key component of healthy fertile soil, is made up of previously living plant and animal residues that are in different stages of decomposition. SOM has important nutrients needed for plant growth and development, such as nitrogen, phosphorus, sulfur, and micronutrients.

SOM is one of the major binding agents of soil aggregation. It holds particles together and creates soil pores within and between aggregates to provide air and moisture to the roots and drain excess water. About 58% of SOM is carbon. Soil organic carbon (SOC) is the main source of food for soil microorganisms. Soil aggregates can be disrupted by tillage thereby increasing the availability of carbon to microorganisms which can result in release of carbon dioxide back to the atmosphere.

> In addition to other physical characteristics, like aggregation, one can tell if soil has high carbon content by its color. Darker soil has high carbon content; light soil is low in carbon. Photos by J. Simmons, Michigan State University.