Has farming become a soil-forming factor?

by Madeline Fisher

From erosion to acidification to loss of organic matter, the impacts of agriculture on topsoil are well known. But new research in the July–August 2015 issue of the Soil Science Society of America Journal now suggests that farming’s effects on soil actually go much deeper.

In a study that examined how soils across Iowa have evolved during 50 years of agricultural use, Iowa State University scientists Jessica Veenstra and Lee Burras uncovered the usual changes in surface soils that come with plowing and fertilizing, including acidification and damaged soil structure. But by sampling down to 150 cm, or 5 ft, they unearthed a host of additional impacts, including a curious buildup of organic carbon deep in the soil profile.

The depth of the transformation supports the notion that human activities, such as farming, don’t just make use of soil, but have joined climate, soil organisms, and other natural factors in forming soil, as well. It also suggests that agriculture affects soil more profoundly than previously thought.

“I think most soil scientists are comfortable with the idea that the surface 30 cm (1 ft) of soil is changing drastically with agricultural practices,” says Veenstra, now an assistant professor at Flagler College in Florida. “But our work shows that soils are changing in ways that perhaps we wouldn’t have expected if we didn’t look as deep as we did.”

She explains that most studies focus on the uppermost soil horizons for two important reasons: They’re the critical layers for cultivating crops, and sampling deeper takes much more time and labor. But her and Burras’ objective was different. “Our interest was looking at the whole pedon [all the horizons in each soil type],” Veenstra says, “to get at this idea of how everything we do as humans is influencing how soil changes over time.”

To address this, the scientists resampled 82 sites across Iowa, representing 46 soil series initially described in the U.S. Soil Survey between 1943 and 1963. At the time of the survey, most of Iowa’s soils were no longer under tallgrass prairie but were already being farmed—a point that’s key to the study goal.

“We didn’t specify the ‘native’ condition and then see what agriculture has done to it,” Veenstra says. “Our initial conditions were agricultural because we were asking, how have these soils changed under agriculture during the last 50 years and as we keep using the soil?”

When the scientists compared the properties of their present day samples with baseline data from the original survey, they found evidence that agriculture is speeding up soil
change to depths of 3 ft or more. Not surprisingly, for example, they documented soil loss in most landscape positions. They also observed declines in nitrogen and organic carbon levels in surface soils.

Unexpectedly, though, losses of soil organic matter were confined to the top 50 cm (1.6 ft). In deeper layers, the researchers actually saw an accumulation of organic carbon. Why this deep soil carbon exists they aren’t exactly sure. But their data also indicate that soils throughout Iowa are acidifying, with many sites now registering a pH below 5.5. The acidity may be causing organic matter near the surface to dissolve in water and move down into the profile, Veenstra explains, where it then precipitates out again.

Other changes included lowered water tables and a shift in soil structure from granular to blocky. But by far the most interesting finding was how deep the changes go, Veenstra says. And most of them aren’t good, she adds. “Accelerated erosion, accelerated acidification, loss of organic matter in surface horizons—those all can have pretty negative effects on crop growth.”

But if the evidence suggests that people are now a primary soil-forming factor, this means we can be a constructive force, as well. “There are all sorts of practices we can do that could have very positive effects on these soils to deep depths,” Veenstra says.