To Plow or Not To Plow?

Balancing Slug Populations With Environmental Concerns and Soil Health

Plowing a field once causes hardly any carbon loss from the plow layer. Though previous studies indicated significant losses, an ARS study at Coshocton, Ohio, has shown that it may take 3 to 5 consecutive years of plowing before those significant losses show up.

But even a year of tillage greatly damages soil structure, which increases erosion and impairs water infiltration and soil health. Also, plowing mixes carbon throughout the plow layer, removing some of it from the surface, where it is important for holding plant nutrients and water.

The plowing experiment was one of several at the ARS North Appalachian Experimental Watershed Research Unit in Coshocton that have cast light on exactly how much—or how little—soil carbon is lost by moldboard plowing. Soil carbon losses are a concern because buildup of carbon dioxide in the atmosphere traps heat on Earth, contributing to global warming.

The experiments tracked carbon escaping as carbon dioxide from soil into the air, carbon lost in eroded soil particles carried off fields in water runoff, and carbon lost by leaching into groundwater.

ARS soil scientist Lloyd Owens has plowed a half-acre plot near the ridge of a hill each spring for the past 20 years and another plot for 6. Each time, he measured the amount of carbon in soil samples before plowing.

"For the first few years, you couldn't notice any loss in soil carbon," Owens says. "The upper foot of newly plowed soil held about 19 tons of carbon per acre—the same amount as was in soil we sampled from no-till fields and meadows. But eventually, there was a significant loss of carbon in the plowed field. The level went down to 15 tons per acre."

Forty Years of No-Till Research

No-till is a method of planting crops in the residue of previous crops, without any kind of tillage before or after planting. The Coshocton unit began experimenting with the practice long ago. Their 40-year no-till experiment on two hillside watersheds is the oldest such continuously running experiment in the country. "It enables us to compare results of new experiments, like our plowing study, with long-term no-till data on similar land," Owens says.

Over the past four decades, no-till has done more to reduce soil erosion on more acres than any other single conservation practice. It improves soil structure and increases infiltration. Several years without tillage are needed to maximize these benefits.

But there are places—like northern Ohio, where the weather and soils can be cool and wet during the early part of the growing season—where no-till may cause serious problems for certain crops. For example, Owens says, "Heavy slug infestations occur with no-till in this area every 5 years or so. The crop residue, especially from corn, provides food and a moist habitat for slugs. No-till corn is on the decline in northern Ohio, and one of the reasons is the periodic slug problem."

In a bad slug year, some no-till farmers plow to decrease the infestation. "Knowing this, we wanted to see how much carbon loss one plowing might cause," Owens says. He concluded from that study that a one-time plowing did not cause great losses of carbon in the soil profile.

The Coshocton work is part of a long-standing national research effort by ARS to solve problems like this one—and others. ARS does the research in response to needs identified by USDA's Natural Resources Conservation Service, which works directly with farmers to reduce soil erosion through voluntary efforts.

A 2000 survey done by the Conservation Technology Information Center in West Lafayette, Indiana, showed that conservation tillage is used on 37 percent of U.S. planted acres. The practice is responsible for U.S. farmland storing more carbon than it loses.

PEGGY GREB (K11400-1)

Soil scientist Lloyd Owens collects a water sample for carbon analysis from a spring in a pasture.

PEGGY GREB (K11401-1)

Technician Joyce Alloway weighs sections of dried soil cores before grinding and analysis for total carbon.

PEGGY GREB (K11392-1)

Soil scientist Lloyd Owens (left) and technician Don Lightell section a soil core from a conventionally tilled cornfield in preparation for determining total carbon with soil depth.

Carbon Loss From Erosion or Leaching

In a second study related to plowing and carbon losses, Owens and colleagues checked the effects of tillage on the amount of carbon lost with soil in erosive runoff. They found that different tillage practices make no difference in the concentrations of soil carbon attached to eroding soil particles. But tillage still causes more carbon to be lost by water erosion than no-till does, simply because erosion losses are higher and each particle of soil carries more carbon away.

"This tells us that farmers who want to conserve carbon should choose a practice with a focus on how erosive it is, rather than on how much carbon it leaves in the soil," Owens says.

The third Coshocton study measured the effects of chisel-plowing and grazing on carbon losses in soil water as it leaches down to groundwater. That route has rarely been studied. Owens was able to confirm that the loss is as small as suspected—averaging 3 to 5 pounds of carbon a year from each of these two diverse farming practices.

"Knowing where significant carbon losses occur helps farmers focus on those areas," he says. "Our experiments show that plowing every year will cause significant soil carbon losses over time, but that leaching is not a significant route for carbon losses. We've also shown that farmers can plow once without causing significant soil carbon losses. But they need to be aware that this tillage benefit is heavily offset by increased soil loss and decreased soil health and quality.

"Basically, we've found that farmers don't have to consider the effects on carbon when they choose a tillage method," says Owens. "They just have to choose the least erosive method that will solve their problem and have the best long-term soil benefit. We hope that these findings will encourage more farmers to return to no-till corn."—By **Don Comis,** ARS.

This research is part of Soil Resource Management, an ARS National Program (#202) described on the World Wide Web at www.nps.ars.usda.gov.

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PEGGY GREB (K11388-1)

Technician Don Lightell analyzes water samples collected from surface runoff and groundwater springs for total carbon.