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Studying Stover Harvest Effects on Yield, Soil, Climate

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Abstract

Corn stover has been used for many years as bedding and food for livestock, as well as to nourish and protect soils. In recent years, the ubiquitous stalk, leaf and cob residue of corn plants left in fields after harvest has found a new market: as a potential source for cellulosic ethanol production.

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Studying Stover Harvest Effects on Yield, Soil, Climate

By Mahdi Al-Kaisi, John Sawyer and Antonio Mallarino, Department of Agronomy

Corn stover has been used for many years as bedding and food for livestock, as well as to nourish and protect soils. In recent years, the ubiquitous stalk, leaf and cob residue of corn plants left in fields after harvest has found a new market: as a potential source for cellulosic ethanol production.

But harvesting the stover – which, when left in place, halts erosion and supplies vital nutrients back to the soil – could have unintended consequences, from lowering the fertility of fields to affecting productivity, soil and water quality and even climate. A comprehensive new study by Iowa State University agronomy researchers may soon shed light on these questions.

Last fall, Mahdi Al-Kaisi, ISU Extension soil management specialist, and ISU Extension soil fertility colleagues John Sawyer and Antonio Mallarino, started a three-year study looking at how removing residue at different rates affects soil productivity, nutrient cycling and greenhouse gas emissions in no-till and chisel-plow fields. They also want to find the optimal nitrogen, phosphorus and potassium fertilization rates needed to supplement nutrients lost from residue removal. The research is funded by the ISU agronomy department.

“There’s not any research integrating these questions the way Iowa State is doing it,” Al-Kaisi said. “The impacts of large-scale corn stover removal on the soil, sustainability of crop production and environmental conservation are not well-known.

“A diverse research-based effort integrating these questions could provide information needed to successfully use biomass production for energy and livestock in Iowa.”

The study was set in motion after harvest last fall on continuous corn fields at ISU’s Armstrong Research and Demonstration Farm near Lewis, and the ISU Bruner Research Farm west of Ames. Residue was removed at three rates (0, 50 or 100 percent) on both the no-till and chisel-plowed plots.

Residue samples were analyzed for initial nutrient content and the fields were left to sit until this spring, when six nitrogen rates ranging from 0 to 250 pounds per acre were added to the plots after planting. A regular daily and weekly regimen of soil testing started soon after.

Soil productivity

For future viability of broad-scale stover harvest, fields need to remain productive. This fall, researchers will get initial yield results from the various treatments and measure nutrient uptake in the leftover residue.

Productivity is highly linked to available nutrients – which in turn can affect soil structure, another key factor in yields. “Corn stover residue is a good source of carbon into the soil organic matter. If you continue to harvest

residue, you are removing a significant portion of the carbon input to the soil,” Al-Kaisi said.

How stover removal alters nutrient cycling – the second major component of the research – is integral to the yield question.

Nutrient cycling

“The amount of nutrients in the residue will depend on the fertility program farmers use during the growing season,” Al-Kaisi said. “A well-managed field with optimum nutrient supply will have healthy plants – and good grain production. This would reflect in the amount of nutrients left in the stalks after harvest.”

Seeing how recycling of nutrients back to the soil is altered by stover removal is the broad aim of this angle.

Throughout the spring and summer, ISU agronomy graduate student Jose Guzman has been testing a range of soil indicators, from levels of organic carbon, nitrogen and other nutrients to water infiltration, microbial biomass and emissions of carbon dioxide (CO₂) and nitrous oxide (N₂O), two key greenhouse gases.

“Soil temperature and moisture are huge factors in the decomposition of stover,” Guzman said. “Every hour, in-field sensors capture soil temperature data, and every day someone tests soil moisture. We’ll capture these all year and might try to use this data to make a model to predict decomposition rates.”

Monitoring greenhouse gases

Determining environmental effects of stover harvest is the third key aim of the research. “We want to see how agricultural practices can sequester more CO₂ and minimize N₂O emissions,” Al-Kaisi said.

The interaction between corn residue removal, soil nutrient retention and greenhouse gas emissions is complex. But as Al-Kaisi explains, large-scale stover removal has the potential to change soil chemistry and dynamics so more gases are released to the atmosphere instead of locked within the soil.

Continuous corn fields also require more nitrogen, which can further skew the soil chemistry and increase the risk of N₂O emissions. “That’s why we’re using six nitrogen rates, to see what’s the optimum rate to minimize emissions yet have profitable corn production,” Al-Kaisi said.

To monitor these changes, Guzman tests emissions on a weekly basis. With the sun high overhead, he strides into a field of corn taller than his head toting a CO₂ sampling machine that looks part portable vacuum cleaner, part old transistor radio with a flexible suction hose.

Crouching in the sun-dappled shadows under the corn stalks, Guzman attaches the hose to a PVC pipe buried in the soil and explains the significance of the CO₂ reading.

“We’re keeping track of how much carbon we’re putting in and how much we’re losing,” he said. “Carbon helps retain other nutrients in the soil. If farmers manage for carbon, they will have very healthy soils – which will help productivity.”

Initial results of the research will be available later this fall. Researchers ultimately hope to use the data to help farmers, agronomists and policy-makers make sound economic and environmental decisions about stover use.

“We need to strike a balance between economic viability and the bottom line of farmers, and environmental consequences,” Al-Kaisi said. “We have good soil in Iowa, and we want to keep it this way if we want to keep our high productivity.”

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This article was written by Tamsyn Jones, ISU Corn and Soybean Initiative communications specialist and distributed by the College of Agriculture and Life Sciences.

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