Modeling nutrient loss from Midwestern crop fields

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ARS scientists used a simulation model to see if winter rye crops seeded into no-till corn-soybean fields in the Midwest could lower nitrate subsurface drainage, and they found that it was successful. Above is a winter rye crop in a no-till corn field in Iowa in the spring. Credit: Tom Kasper

In many Midwestern crop fields, excess water laden with nitrates drains into subsurface tile pipes and then flows into surface streams and rivers in the Mississippi River watershed. When the nutrient-rich field drainage reaches the Gulf of Mexico, it supports algal blooms that lower water

oxygen levels and contribute to the development of the economically and environmentally devastating "dead zone."

Upriver in Iowa, Agricultural Research Service scientists Rob Malone, Tom Kaspar, and Dan Jaynes are using the Root Zone Water Quality Model (RZWQM) to assess how using winter rye cover crops in corn-soybean rotations could mitigate nitrate loads in field drainage water. RZWQM is a field-scale computer model developed by the Agricultural Systems Research Unit in Fort Collins to simulate plant growth and the movement of water, nutrients, and chemicals within and around the root zones of agricultural crops.

In one study, the researchers ran the RZWQM simulation for several different planting scenarios at 41 sites across the Midwest from 1961 to 2005. Their results indicate that winter rye crops seeded in no-till corn/soybean systems when the cash crops were mature have the potential to reduce annual nitrate loss in field drainage by about 43 percent, or by 18 pounds per acre.

The model results also suggested that cover cropping is more effective in reducing nitrate losses in subsurface drainage in the southern part of the region. Overall, however, Malone notes, "The model underestimates the benefit of cover crops in reducing nitrate discharge because the nitrate losses simulated by the RZWQM were about 30 percent less than field observations in Iowa."

Malone and his colleagues, including Purdue University scientist Eileen Kladivko, used their findings in a larger regional simulation of nitrate losses from tile-drained fields in Indiana, Illinois, Iowa, Minnesota, and Ohio, located within the Mississippi River Watershed. Most of this farmland is in corn and soybean production and contributes around 46 percent of the nitrate load carried by the Mississippi River to the Gulf of Mexico.

In this study, two agricultural counties were selected in each state, and the potential for winter rye cover crop adoption was estimated based on cash crop rotation and tillage systems. Results indicated that producers could introduce winter rye cover cropping on around 30 to 80 percent of the land used for corn and soybean production, and that the cover crop systems could potentially reduce nitrate loadings to the Mississippi River by approximately 20 percent.

"Now we need to study the effects of cover cropping on land that is not drained by subsurface tiles, as well as how cover cropping affects phosphorus loss, erosion, soil organic matter, and soil quality," Malone says. "But our results so far indicate that using cover crops such as winter rye in Midwest corn and soybean crop production could significantly reduce nitrate load runoff via subsurface tile drains. And this reduction could substantially help mitigate hypoxia and support larger national efforts to reduce nitrate loads and protect water quality in the Gulf of Mexico."

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