Bay Journal

Saturated buffers reduce nitrates in runoff from farms' tile drains

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Technique uses microbes to turn nutrients into gas that is released into the air, much like a wetland would

Rona Kobell | December 17, 2015

3

Nick Meier and Shane Wulf, who works for the Natural Resources Conservation Service, examine the control box of the saturated buffer. For this practice to make a difference, Wulf said, you'd need many more of them across the Corn Belt. (Rona Kobell)

A new technique to reduce nitrates flowing off farm fields, now being tested in the Midwest, holds promise for Chesapeake Bay watershed farmers.

Called a saturated buffer, the practice focuses on reducing the amount of nitrate that can enter streams via tile drains. Tile drains, ubiquitous in the Midwest and quite common in

parts of the Chesapeake Bay's watershed as well, are a system of trenches and below-ground pipes that improve drainage so crops can grow. Farmers may plant riparian buffers and grass waterways to slow down surface water and reduce pollutants, but the runoff that moves through tile drains bypasses those practices. There is no opportunity for any excess nitrogen and phosphorus that may drain off the field in that water to be absorbed.

So, researchers at the National Laboratory for Agriculture and the Environment in Ames, IA, developed a mechanism to divert part of the flow from the tile drain into a buffer that absorbs nitrogen and some of the phosphorus before it enters nearby streams.

A regular buffer strip catches surface water and some shallow groundwater that flows off a field. But a saturated buffer does more than that. It operates more like a wetland.

A diverter in a control box channels water collected by the tile drains into the buffer, saturating the soil. Using the control box, a farmer can modulate the levels of water in the drain, on the field and in the saturated buffer.

Plants in the buffer absorb a portion of the nitrate, using the nutrient for growth. But the wet soils provide the right environment for anaerobic microbes that digest, or denitrify, much of the remaining nitrate. Through a series of steps, the microbes convert nitrate into a harmless nitrogen gas that will dissipate into the air.

The biggest difference between the saturated buffer and a regular riparian buffer is that the saturated one treats surface water and tile water and, because of its soggy soils, is better at denitrification.

So far, researchers said, the saturated buffers are reducing nitrate 20–80 percent, with the higher numbers coming with more experience in properly siting the buffers and the control box that goes with them to divert the water.

It's an inexpensive practice — about $3,000 (control box, perforated tile and tile drain field) for farmers who already have a buffer strip in place — and it could be an important one. Nitrate — leftover from the fertilizers farmers put on crops — is soluble in water. It can be harmful to babies and cause stomach problems in adults. The federal standard is 10 milligrams per liter, so anytime a water treatment plant, or rural home's well, exceeds that it must treat the water. Water plants must also disclose nitrate levels to an understandably nervous public.

Nitrate in drinking water supplies has become an issue in Iowa. In the spring of 2015, the Des Moines Water Works sued three rural Iowa counties, alleging that drainage tiles were leaching nitrates into the rivers that feed the Des Moines and Raccoon rivers.

Iowa occupies only 5 percent of the Mississippi River drainage basin, but it is responsible for 25 percent of the nitrate that the Mississippi River delivers to the Gulf of Mexico. The gulf struggles with a huge dead zone each summer because of low-oxygen conditions that are fueled by increasing amounts of nitrate. The Des Moines waterworks built a $4.1 million facility to extract nitrate from its finished water, but concentrations still exceed allowable levels about a quarter of the time. Des Moines water officials have said they would need up to $183 million to treat the water for 500,000 customers, which would mean raising rates for urban consumers.

"There's no single practice that we have that's going to solve this nitrate problem," said Dan Jaynes, a research soil scientist at the National Laboratory for Agriculture and the Environment who worked on developing the saturated buffer. "There are practices we can use, but we know they are not going to get us all the way to where we need to be."

Tile drains made farming the Midwest possible, Jaynes said. Before farmers figured out how to drain land, Iowa resembled a prairie wetland, unsuitable for growing much more than the occasional hay crop. That changed in the late 1880s, and the practice of tile draining soil continues — even with the increased knowledge that the drains are a conduit for nitrate to enter streams, groundwater and ultimately the drinking water systems.

Farmers in Iowa and elsewhere have come a long way using best management practices to reduce runoff and improve soil health. Sprouts of rye and rapeseed cover crops dot the autumn landscape of La Porte City and Waterloo, where the federal government recently announced a $4.3 million project between Cedar Rapids and various conservation districts to reduce nitrate in the waterways.

With the funds, scientists and field agents are trying to cultivate farmers like Nick Meier, a conservation-minded 61-year-old who has long practiced no-till farming and has buffer strips and a bioreactor to "digest" some of the nitrogen that flows off his fields before it enters the small tributary that leads to Miller Creek. Meier farms 800 acres he inherited from his father. He grows corn and soybeans for consumption as well as corn for ethanol. He also planted cover crops and grass waterways. But when Jaynes discovered that Meier's conservation practices were only partially addressing nitrate coming from tile drains, Meier added the buffer. Initial results are promising.

Meier said farmers are part of the pollution problem in the Chesapeake Bay and the Gulf of Mexico, and they need to show they can be part of the solution.

"We've got to try to do something because of the hypoxia thing down in the Gulf," he said. "I'm concerned about the regulation that's getting one step closer to us. I'm trying to get ahead of the curve, to show farms what can be done, and that it's a good thing."

Agriculture scientists don't doubt that it's a good thing, but to be an effective one, Iowa and the rest of the Corn Belt need many more Nick Meiers.

"Look around," said Shane Wulf, the watershed coordinator for the Blackhawk Soil and Water Conservation District in Waterloo, which works with Meier on his drainage practices. "Look how much we would have to do."

Experts agree they would need thousands of saturated buffers to make a difference. They are trying to convince Iowa farmers of the benefits. Meier has already hosted Agriculture Secretary Tom Vilsack, former Iowa governor, on his farm; neighbors have stopped by; and Meier has shared his expertise at regional Field Days.

The $4.3 million from the federal project will help. Called the Middle Cedar Partnership Project, the goal is to implement practices like the saturated buffer so that Cedar Rapids can avoid the situation in Des Moines.

Whereas the bustling capital is home to insurance and financial companies, the more rural Cedar Rapids employs hundreds of people who work for the companies that turn northern Iowa's crops into commodities. The town processes 1 million bushels of corn and 100,000 bushels of soybeans each day.

"We just have a different connection to the landscape," said Cedar Rapids Utilities Director Steve Hershner. "We want to do everything we can to work with those producers and landowners."

Hershner acknowledges that the nitrate levels have been increasing. If Cedar Rapids needed a nitrate treatment facility, Hershner said, "it's safe to say it would be a tens of millions of dollars project."

Cedar Rapids' water comes from alluvial wells in the Cedar River. In 2010 and 2012, Cedar Rapids' water was voted the best tasting in the state.

Peter Kleinman, who works for the U.S. Department of Agriculture's Agricultural Research Service in State College, PA, predicts that saturated buffers will catch on in the Chesapeake Bay watershed, just as bioreactors have. They, too, began life in the Midwest at a time when the federal government was developing a renewed interest in drainage.

"There is applicability to the Chesapeake Bay," Kleinman said. "You need drainage for good agriculture. This is a good way of trying to treat the water."

In La Porte City, IA, Meier agreed. He may be farming differently — corn for ethanol instead of the livestock his father raised — but his commitment to soil and water health remains.

"I'm doing this for the next generation," he said. "I want to pass it on and let people know that litigation is not the way."

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About Rona Kobell

Rona Kobell is a former writer for the Baltimore Sun. Send Rona an e-mail .

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Comments

Kristen Saacke Blunk on December 15, 2015:

Really great article Rona. Enhancing buffers to function as wetlands could have ecological benefits in addition to enhancing dentrification - including potential habitat for birds, amphibians, and other beneficial invertebrates and vertebrates that do not pose any risk to the producer who is willing to implement this practice. There could be some hydrology-based benefits under flood conditions as well. It's exciting to hear from producers who are specifically looking for opportunities to diminish the loss of N from their systems. That's good business.

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vern latwesen on December 17, 2015:

What is the best guess as to the ratio of buffer to tilled land? The farmers I know are reaping crops on every square foot of land they can(ie in and out of ditches, along water ways, between telephone poles, highly erodible land,etc. Unless Uncle Sam pays them for crop acres lost by this plan(like CRP for example) it will take another 100 years to make a difference. I hate to be so negative but I live in this environment and I can only go by what I see every day. Good article.

David Lobb on December 27, 2015:

Interesting article. Ironic that I received it via the SWCS's newsletter, in which climate change mitigation was also highlighted. I presume that readers may not know that N2O gas (280-320 times stronger than CO2 as a greenhouse gas) is one of the major products of the denitrification that is being encouraged. This highlights one of our major environmental challenges: do we save soil health, protect water quality or deal with climate change?

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