Constructed wetland will ease farm nitrate runoff

URBANA, Ill. — As methods of reducing nitrate runoff go, a constructed wetland is one of the best ways. But it's also one of the hardest sells.

A University of Illinois research project may make it a little easier to convince farmers – at least those whose land abuts a river, stream or drainage ditch – that turning some of their frontage into a wetland would be a worthwhile stewardship step.

By Mark Butzow

Associate Editor, Farm World

The new data come from measurements collected in the past two years at wetlands along the Embarras River in southern Champaign County, Ill.

Biogeochemist Mark David was involved when the wetlands were created in the 1990s to "scrub" runoff water as it left a farmer's 190 acres of crop land. More recently, graduate student Tyler Groh joined David and faculty researcher Lowell Gentry to revisit the Embarras wetlands to measure their effectiveness.

What they found is an overall 62 percent nitrate removal rate. In addition, they documented that little nitrous oxide, a potent greenhouse gas, is being released into the air. "Slowing down the rate of flow of the water by intercepting it in the wetland is what helps to remove the nitrate," said Professor David, a faculty member in the College of Agricultural, Consumer and Environmental Sciences.

"It's just about slowing the water down and allowing the microbes in the sediment to eliminate the nitrate. It goes back into the air as harmless nitrogen gas."

Groh is lead author, along with David and Gentry, of *Nitrogen removal and greenhouse gas emissions from constructed wetlands receiving tile drainage water*, which was published in the May/June issue of *Journal of Environmental Quality*. The research was partially funded by the USDA National Institute of Food and Agriculture.

Wetlands do work, but again, getting people to put them on their farm is a different story.

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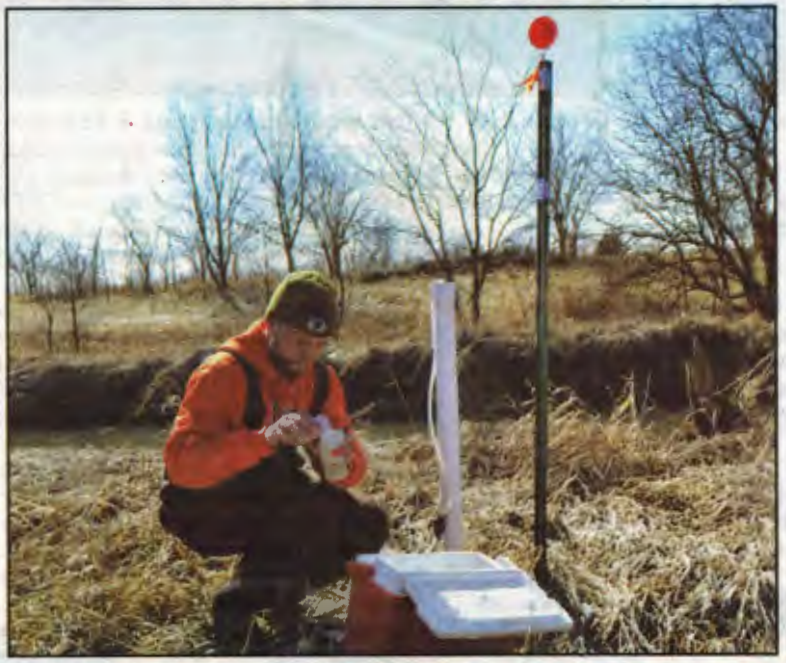


UNIVERSITY OF ILLINOIS graduate student Tyler Groh marks greenhouse gas sampling sites in a wetland on the Embarras River in Illinois. At right, Groh collects samples for nitrate analysis in wetlands.

(University of Illinois photos)

Constructed wetland ...

(continued from page 4)

The government will share the cost of a lot of nitrate-removal projects, but the farmer still may be losing some tillable ground for the long haul and the revenue that would have come from crops on that land going forward.

"We found people willing to add bioreactors, but no one wanted wetlands. And we were paying for it," David said.

Water quality issues

Agricultural applications of fertilizers and pesticides have increased dramatically since the middle 1960s, and the impact of agrochemicals on water quality has become a serious environmental concern, according to information from the Iowa Conservation Reserve Enhancement Program. Nitrate is a particular concern:

- Because of the potential adverse impacts on both public health and ecosystem function
- Because of the high mobility of nitrate in surface and groundwater
- Because of the widespread use of nitrogen in modern agriculture

Annual application of fertilizer-N in the United States has grown from a negligible amount prior to World War II to approximately 10 million metric tons of N per year.

Agricultural nutrient losses to streams are a special concern in the Corn Belt, a region characterized by intensive row-crop agriculture and by correspondingly intensive use of commercial fertilizer. Corn and soybeans are the two largest acreage crops in the region and account for the vast majority of fertilizer use.

Since 1950, total acreage of these two crops has increased by about 50 percent, primarily because of increases in soybean acreage. Over this same period, commercial fertilizer use has increased dramatically to approximately 10 million metric tons per year.

Nutrient loads to Corn Belt streams are among the highest in the country and are reflected by significantly elevated stream nutrient concentrations.

Nitrate nitrogen concentrations in agricultural streams frequently exceed the drinking water standard of 10 mg N L-1, and concentrations in tile drainage water are commonly more than double the drinking water.

In addition to impacts on water quality within the region, agricultural nutrient loads to Corn Belt streams are considered a major cause of the hypoxia in the Gulf of Mexico.

Nutrient reduction strategy

The EPA in 2011 directed 12 Midwest, Plains and Delta states to create "nutrient reduction strategies," but most have not developed those goals and action steps. The 12 states (Arkansas, Illinois, Indiana, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Ohio, Tennessee and Wisconsin) together are referred to as the Hypoxia Task Force.

"The USDA requested proposals on the effectiveness of wetlands and woodchip bioreactors to reduce nitrate losses from fields, but was also concerned about greenhouse gas emissions. On the Embarras River wetlands, we found the greenhouse gas emissions were really quite low. Nitrous oxide was not a problem."

Along with fertilizer management, cover crops and bioreactors, David said wetlands will be an integral part of the Illinois Nutrient Reduction Strategy. A September 2014 progress report on federal efforts to improve the Gulf of Mexico hypoxic zone concluded that state nutrient reduction strategies "have been slow to develop and are missing essential components."

Only two states, Iowa and Ohio, have a final strategy. To date, only three states – Iowa, Minnesota and Wisconsin – had set nutrient reduction goals. Of these three states, only Minnesota has a timeframe for meeting these goals.

The report also said those state strategies' "emphasis on local waterways needs to be augmented with a focus on the larger (Mississippi-Atchafalaya) watershed."

As a result, the EPA's Office of Water will work with the states to put more emphasis on monitoring results. "We recommend that the Assistant Administrator for Water work with state and federal Task Force members in the Mississippi River Watershed to develop and enhance monitoring and assessment systems that will track the environmental results of state nutrient reduction activities, including their contribution to reducing the size of the Gulf of Mexico hypoxic zone," said the EPA report.

(continued on page 6)

Constructed wetland will ease farm nitrate runoff ...

(continued from page 5)

The full report is available online at *www.epa.gov/oig/reports/2014/20140902-14-P-0348.pdf*

Bioreactor or wetland?

One advantage of a bioreactor is that it takes up very little land. A water control structure is installed near the outlet of a field's tile drainage system, and an area about 70 feet long and 10 to feet wide is excavated to a depth of 3 or 4 feet, then filled with a source of carbon, usually woodchips. A short length of drainage tile collects the denitrified water at the other end and carries it to a nearby ditch or stream.

To see a step-by-step construction of a bioreactor, visit *http://biogeochemistry.nres.illinois.edu/Embarras/bioreactor.html*

The cost of adding a bioreactor is similar to creating a wetland, although little or no land is taken from production as is the case for most constructed wetlands.

The process of converting drainage-tiled land into wetlands is relatively low-tech.

"It basically takes a bulldozer to break the tile at the (field's) edge and to dig a berm, and the scooped out area is where the water collects," David explained. That wetlands area must be lower elevation than the field delivering the water, but it is best when it is 2 or 3 feet deep, not 6 feet deep. "Shallow water increases success," he said.

David said there has been a push from environmental groups for years to build more wetlands. In Illinois, he said the Nature Conservancy built several in the Lake Bloomington watershed, but since no one wants to mandate a certain practice, there have been few built overall.

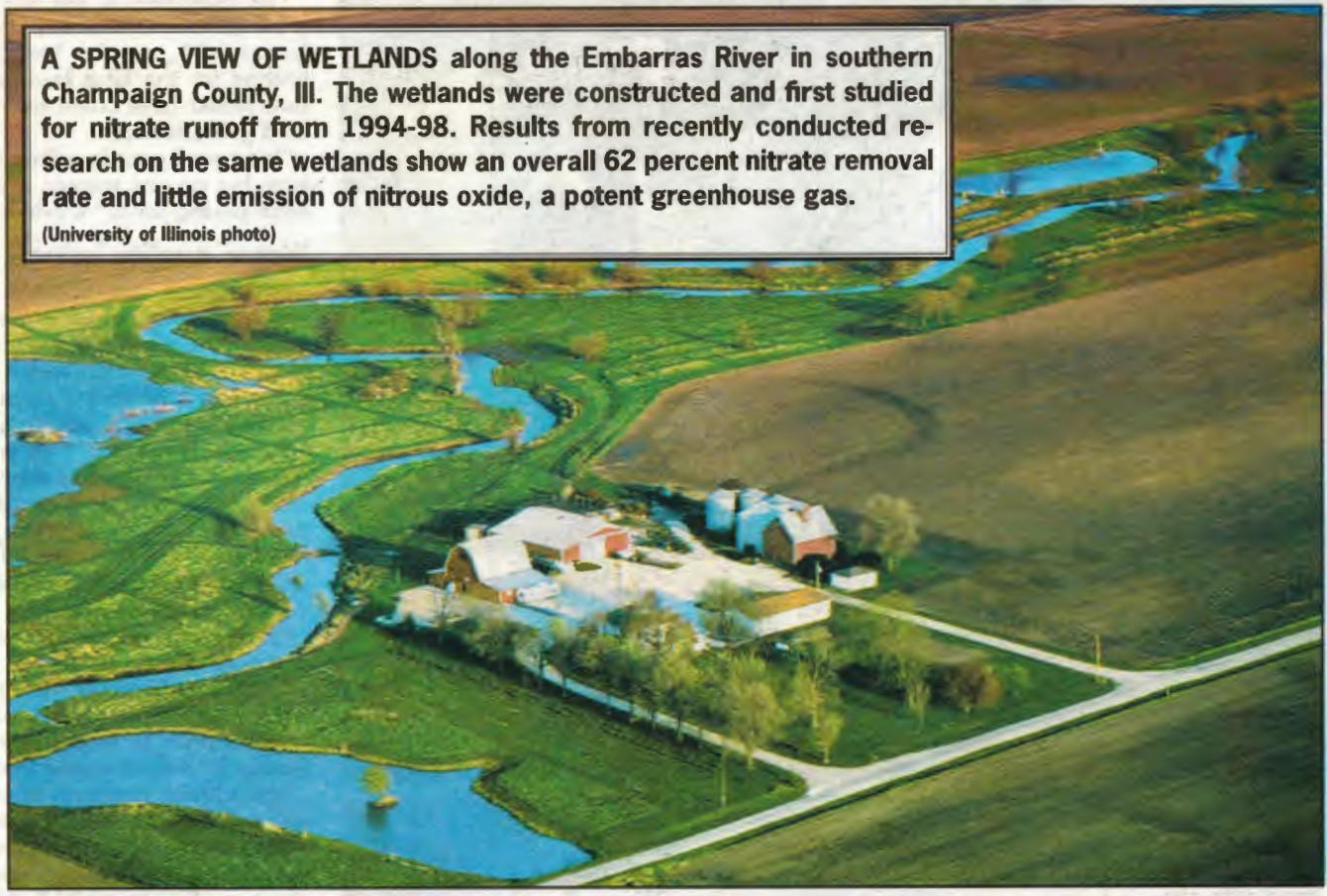
The drawback, says fellow researcher Lowell Gentry, is obvious. "Farmland along the river may be flood prone, but depending upon the landscape, it could be farmable land. In this case (the Embarras River project built in the 1990s), it was pasture so the wetlands didn't reduce the row-crop acreage, and the landowner was able to use it as hunting grounds.

"Our project included funds to build new wetlands, but we couldn't convince anyone to do it," Gentry said. "Wetlands have been a hard sell."

Building a wetland costs about the same as installing a bioreactor. One of the reasons David prefers wetlands to help solve the nitrogen pollution problem is that they work reasonably well in the winter when the water temperatures are low.

"These things are temperature dependent," he said. "Bioreactors try to speed up nitrate removal by pushing the water through woodchips."

The wood provides the carbon that microbes feed on, which drives denitrification. But it's cold water in January inhibits that microbial process. "You get a better removal rate in June," David said, suggesting northern areas such as Iowa and Minnesota would get less effectiveness from bioreactors than from wetlands.



A SPRING VIEW OF WETLANDS along the Embarras River in southern Champaign County, Ill. The wetlands were constructed and first studied for nitrate runoff from 1994-98. Results from recently conducted research on the same wetlands show an overall 62 percent nitrate removal rate and little emission of nitrous oxide, a potent greenhouse gas.

(University of Illinois photo)

David said wetlands have caught on more in Iowa than in Illinois.

"Iowa has taken a different approach. They have these big mains – handling 9,000 to 10,000 acres – and they're paying for the land's loss in crop production."

Iowa example

Through the Conservation Reserve Enhancement Program (CREP), the Iowa Department of Agriculture and Land Stewardship (IDALS) has worked with USDA, local soil and water conservation districts, and local drainage districts to construct 72 targeted wetlands in north central Iowa counties since 2001.

Targeting and designing for maximum water quality and other benefits includes a number of considerations. To respect upstream drainage rights, the permanent wetland pool is at least one foot below any incoming drainage tile. Pool depth is designed to be shallow, with no more than 25 percent of the pool area deeper than 3 feet to encourage rooted wetland vegetation and a mix of deep and shallow water wetland habitat.

This program has good landowner interest, and more sites continue to be developed as funding is available. The number of potential sites dramatically outweighs current funding resources, according to CREP. Many more sites could be established if additional or alternative funding resources are developed to meet demand.

To date, 640 acres of wetland pool and 2160 acres of buffer areas surrounding these targeted wetlands are in place. These 72 sites remove 1 million pounds of nitrogen annually that would otherwise continue downstream, making them some of the hardest working features of the landscape in terms of reducing Iowa's nutrient load into the Mississippi River basin. Along with these water quality benefits, wetlands provide wildlife habitat and aesthetic values.

This practice is only one approach to the enormous task of reducing nitrogen in Midwest waterways. But it demonstrates how an undervalued landscape feature largely removed from the landscape more than 100 years ago can play a role in reducing nutrient export from tile-drained cropland.

UNIVERSITY of ILLINOIS graduate student Tyler Groh walks in a wetland on the Embarras River in Illinois, so that he can collect greenhouse gas measurements.
(University of Illinois photo)

Programs help in restoring wetlands

The following programs play a role in restoring wetlands:

Wetlands Reserve Program

The USDA Natural Resources Conservation Service (NRCS) manages and provides technical support for the Wetlands Reserve Program (WRP). It is a voluntary program that offers landowners the means and the opportunity to protect, restore, and enhance wetlands on their property.

WRP details:

A nationwide voluntary program

Offers payment, based on the agricultural value, for restored wetlands that have previously been drained and converted to agricultural uses

Pays up to 100 percent reimbursement for restoration costs

Lets landowners retain control of access – no public access is required

Lets landowners maintain ownership of land – they have the right to lease the land for undeveloped uses, including hunting and fishing

For WRP information on landowner use and responsibility, eligibility, landowner options and how to enroll, contact your local NRCS office. General information on WRP is available online at *www.nrcs.usda.gov/programs/wrp*

Conservation Reserve Program

Administered by the USDA Farm Service Agency (FSA), the Conservation Reserve Program (CRP) is a voluntary program that offers landowners, operators and tenants the opportunity to voluntarily convert land with high erosion rates and other environmentally sensitive land to permanent vegetative cover.

Annual rental payments are made based on the agriculture rental value of the land, providing cost-share assistance for up to 50 percent of the participant's costs in establishing approved conservation practices. Participants enroll in CRP for 10-15 years.

CRP program support is provided by NRCS, soil and water conservation districts, Extension Service and state forestry agencies. For additional information, contact a local FSA office and go online to *www.fsa.usda.gov*

Conservation Reserve Enhancement Program

The Conservation Reserve Enhancement Program (CREP) is a partnership between the USDA and states to address water quality issues related to excess nitrogen.

CREP provides rental payments and other financial incentives to encourage producers to voluntarily enroll in long-term CRP contracts.

For more information on CREP, contact your local FSA office and go online to *www.fsa.usda.gov*

Farmable Wetlands Program

The Farmable Wetlands Program (FWP) is a voluntary program to restore acres of farmable wetlands and associated buffers by improving the land's hydrology and vegetation. Producers in all states can enroll eligible land in the FWP through the Conservation Reserve Program. FWP is limited to no more than 1 million acres, and no more than 100,000 acres in any one state.

For land to be eligible for this program, it must have been cropland or considered cropped in at least three of the past 10 years and physically and legally capable of being cropped. The wetland area must be five acres or less in size and not located in the floodplain of a perennial stream.

FWP contracts run from 10-15 years in exchange for annual rental payments, incentive payments, and cost-share for installing necessary practices.

Conservation practices authorized under FWP are:

CP27 – Farmable Wetlands Pilot Wetland

CP28 – Farmable Wetlands Pilot Buffer

FWP is administered by FSA with assistance from NRCS, Extension Service, state agencies, and local soil and water conservation districts. Producers can find out more about FWP by visiting their local FSA or NRCS office.

Source: USDA Natural Resources Conservation Service