Brian Hicks is testing controlled drainage on his farm near Tracy, MN. He adjusts one of two tile outlet control structures that control the water table in this flat 100-acre field.

PHOTOS: LIZ MORRISON

GAIN FROM A BETTER DRAIN

DRAINAGE WATER MANAGEMENT REDUCES NITRATE AND MOISTURE LOSS.

BY LIZ MORRISON

It was the drought of 1988 that got John Wilken thinking about the wisdom of draining his "liquid assets."

Wilken, who farms in east-central Illinois, had partly tiled a field before the season started. That dry summer, the undrained portion of his field produced significantly better corn than the drained portion. "That tripped a trigger in my mind, that we should be conserving some of our water for when it's needed," he says.

Today, Wilken does just that. He controls how much – and when – tile drainage water leaves 340 acres of flat cropland in Iroquois County.

Using eight outlet control structures in his main tile lines, Wilken can raise and lower the water table depth in two fields. He holds back water in the soil all winter, when drainage isn't needed for crop production, then releases it about two weeks before field operations begin in the spring.

After planting, he raises the outlet height above the tile depth in order to capture some of the rainfall that would ordinarily drain out. Just before harvest, he drops the outlet back down to the tile depth. In November, after fall strip-tillage and fertilizer application, Wilken raises the outlet height once more, lifting the water table almost to the surface.

This practice – known as drainage water management, or controlled drainage – cuts nitrate loads flowing into surface waters through the tile system, especially during the fallow period, says Don Pitts, a drainage expert for the Natural Resource Conservation Service in Illinois. And during the growing season, controlled drainage stores moisture and nutrients for the crop, offering the potential for higher yields in dry years, he says.

RESEARCHERS ALL AROUND the Midwest are looking for ways to cut pollutants in subsurface drainage water without lowering drainage efficiency. As public concern over water quality intensifies, there is "more interest in what we can do to minimize drainage water volumes and nitrate losses," says

Matt Helmers, an Iowa State University agricultural engineer. Many new methods are now being tested on Midwest farms, including shallow drainage, constructed wetlands, woodchip biofilters and controlled drainage.

Controlled drainage is widely used on the sandy-soiled eastern and southern coastal plains, often in combination with subsurface irrigation. In Midwest corn and soybean country, though, it's a new practice that is still being tested.

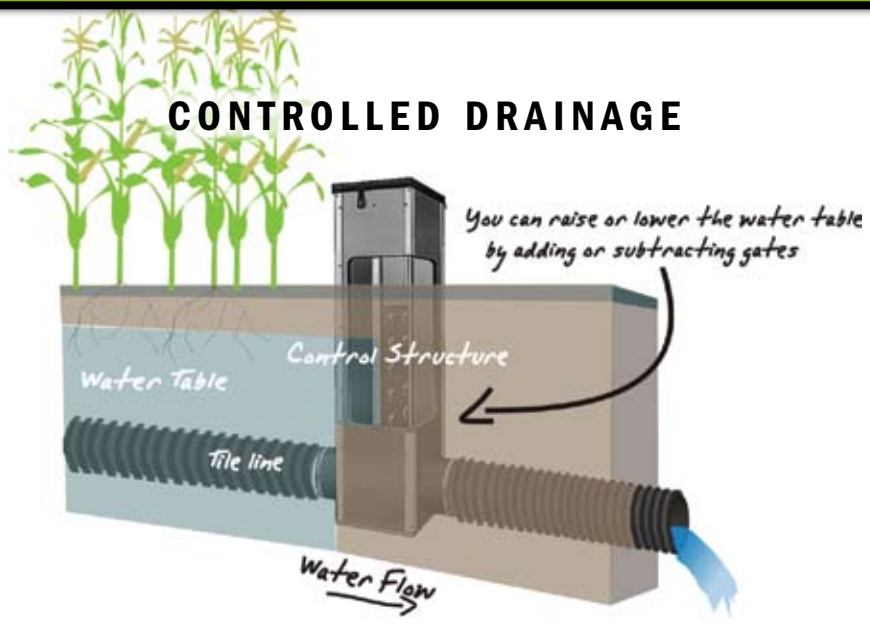
In 2007, the five-state Agricultural Drainage Management Coalition began side-by-side comparisons of conventional and controlled drainage on 20 farms in Ohio, Indiana, Illinois, Iowa and Minnesota. These demonstrations "will really accelerate our understanding" of the practice, and how it performs across a variety of climates and soils, Helmers says.

In Illinois, where more than 50 on-farm demonstration systems have been installed, drainage water management has cut tile outflow by 40%, Pitts says. As tile water volume drops, so does nitrate loss – especially during the winter, when half of annual drainage flow occurs in the eastern Corn Belt.

IN THE NORTHERN Corn Belt, the benefits will probably be more modest, says Gary Sands, a University of Minnesota Extension engineer. There, about 70% of annual tile flow occurs from April to June, when growers need drainage most. "So we have a smaller window of opportunity to manage drainage water here," he says.

Still, northern states could see "20-40% reductions in the volume of drainage water" and corresponding nitrate loads, Helmers says.

John Wilken grows corn and soybeans on 1,900 acres near Onarga, IL. In 2002, he installed controlled drainage in a 160-acre field and a 180-acre field. The improvements were cost-shared under the Environmental Quality Incentives Program (EQIP).



▲ In drainage water management, water control structures are installed in main tile lines, allowing raising and lowering of a field's water table. The aim is to cut nitrate losses through the drainage system and conserve water. The outlet is raised after harvest to reduce nitrate delivery; and then lowered a few weeks before planting and harvest to drain the field more fully. After planting, the outlet is raised to store water for crops.

SOURCE: AGRICULTURAL DRAINAGE MANAGEMENT COALITION

Both fields are pattern-tiled with 5-in. laterals every 100 ft. to a depth of about 3.5 ft. The ground is very flat, averaging 1 in. of vertical fall per 100 ft., "which makes the system work better," Wilken says.

The 160-acre field has three outlet-control structures, and the 180-acre field has five. These consist of stacked flashboard risers in the main lines. Wilken adjusts the tile outlet height by manually adding or removing risers. He raises the outlets in mid-June, "or even earlier if it's a dry spring," and leaves them up all summer, "unless we get a 4- or 5-in. rain." By saving moisture in the soil, "I'm confident there's a 5-6 bu./acre yield increase for corn" in dry years, he says.

Maintaining the water table 2 ft. below the surface, rather than the typical 4 ft., retains up to 1.5 in. of additional water in the soil, Pitts says. "This equals about six days' water supply for a corn crop in July, and thus, could have a significant crop production benefit."

WHERE DOES THE RETAINED WATER GO?

What happens to water that is held back in the field through drainage water management?

Good question, says Matt Helmers, an Iowa State University agricultural engineer. Researchers don't yet have a clear picture.

Besides subsurface drains, water leaves the field along several pathways. It can return to the air through evaporation and transpiration by plants. It can run off the surface, percolate down into the aquifer or flow laterally below the tile depth. But these movements are very hard to measure, Helmers says.

Still, "It is generally thought that these pathways tend to have water lower in nitrate concentration than tile flow water," says Don Pitts, a water quality and drainage expert at the Illinois Natural Resource Conservation Service. That helps explain why curbing tile flow also reduces nitrate losses. ◀◀

The cost of controlled drainage depends mainly on the steepness of the field and the size of the tile mains. Retrofitting 81 outlet structures on existing tile systems in Illinois ranged from about $25/acre on flat sites to more than $250/acre on sloping fields, Pitts says.

Managed drainage is most economical on land that slopes less than 0.5%, or 5 ft. of vertical fall/1,000 ft., says Kevin Ellingson, of Ellingson Drainage, based in West Concord, MN, and Fargo, ND. Ellingson Drainage has installed half a dozen controlled drainage systems in Minnesota and North Dakota. "For every 1.5 ft. of elevation change, you need an outlet structure to control the water in that zone," he says.

Dan Jaynes at the National Soil Tilth Laboratory in Ames, IA, estimates that about 8.3 million drained acres in Ohio, Indiana, Illinois, Iowa and Minnesota are flat enough to make controlled drainage practical.

On suitable land, a drainage management system amortized over 15 years at 6% interest would cost $7-9/acre, according to Leonard Binstock, executive director of the Agricultural Drainage Management Coalition. Yield increases of just 2 or 3% could pay for the system. Controlled drainage is also eligible for EQIP grants, and additional incentives were included in the new farm bill.

Pitts contends that drainage management "is arguably the conservation practice with the highest benefit-to-cost ratio for reducing nitrate loss." Wilken agrees: "I feel my yield increases have paid for the investment. And we're doing our part to keep nitrates from ending up in the Gulf of Mexico."

If you're planning to upgrade your drainage system or install a new one, think about designing it "with drainage water management in mind," Sands suggests.

WATERPROOFING

Brian Hicks could see the problem on his yield monitor.

In a fertile, low-lying cornfield, there was an area that lagged the rest of the field by 25-30 bu./acre, year after year. "That portion of the field always dried out in July," says Hicks, who raises corn, soybeans and grass hay near Tracy, in southwest Minnesota.

The flat bottomland near the Cottonwood River was also slow to dry out in the spring. Hicks wished he could "get the water drained out in the spring, and then save the water later in the season when it got dry."

He had been reading about controlled drainage and thought it might fit the bill. The method uses outlet controls installed in tile lines to raise and lower the field's water table. Water can be held back

in the winter and released before planting and harvesting. During the growing season the water table can be raised and lowered according to crop needs. The practice reduces nitrate losses and also conserves water during dry spells.

Hicks connected with Jeff Strock and Gary Sands, University of Minnesota researchers who are doing drainage water design and management research throughout Minnesota. Strock says Hicks' field was ideal for controlled drainage. It has very productive but poorly drained soil and little slope. The drainage water ends up in the Cottonwood River, classified as an impaired waterway by the Minnesota Pollution Control Agency.

Hicks pattern-tiled the 100-acre field in late 2005, with laterals on 50-ft. spacings and two main lines: one 15-in. and one 10-in. In the course of tiling, "we discovered a good streak of sand about 3 ft. down," which explained the low-yielding area. "The soil wasn't able to hold the moisture."

Hicks paid for the tiling. The field has two outlet control structures, which each manage the water table in a 45-acre zone of the field. The cost of the two water control structures – about $3,000 – was shared with the Redwood Cottonwood River Control Area, a conservation group.

For the last three years, Hicks has raised the tile outlet after fall tillage and lowered it the first week of April. Within seven or eight days, the water table drops enough for fieldwork, Hicks says. This fall, he applied 4,000 gal./acre of hog manure and then raised the outlet again, bringing the water table up to about 6 in. from the surface.

It's not much different from how he manages another low-lying field, which has a pumped tile outlet. In the spring, after planting and spraying, he shuts off the pump and lets the water table rise. "Why send that water to the river?" he says. "So we've been thinking about managing our drainage water for a long time."

Now, Hicks is cooperating with Strock and Sands on side-by-side comparisons of controlled and free-flowing drainage. The multi-year trials will look at how drainage water management affects corn and soybean yields, tile flow and discharges of nitrates, pesticides and other pollutants. Researchers will also be tracking fecal coliform in the drainage water, and even greenhouse gas emissions from denitrification in the soil.

Similar drainage management systems are being tested on farms throughout the Midwest. Demonstrations like this are important for agriculture, Hicks says. "We, as farmers, need to be proactive in telling our story and showing that what we're doing isn't detrimental to the environment." CSD