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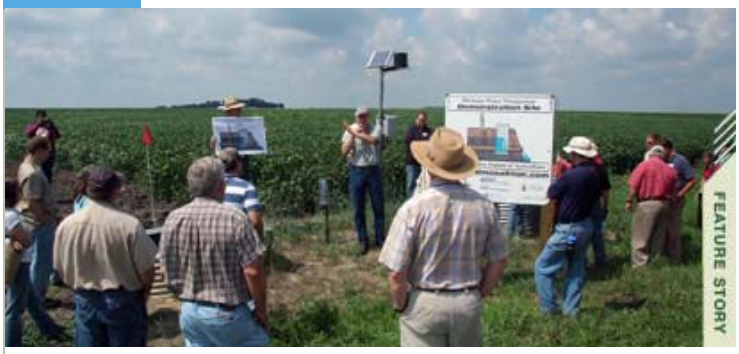


The Agricultural Drainage Management Coalition conducted demonstration field days in five states last year to give farmers, advisors and regulators an up-close look at field-scale drainage management plots side-by-side with free-flowing tile drainage.

Photo courtesy of Steve Werblow

//DRAINAGE WATER MANAGEMENT //

# Agricultural Drainage Management: Benefits Could Range from the Bin to the Gulf

By **Steve Werblow**

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Managing agricultural drainage water in the Midwest could represent the next great step forward in agriculture, with benefits that reach from conserving subsoil moisture on individual tile-drained fields to reducing nutrient loading all the way down in the Gulf of Mexico. Control structures with movable weirs, or "stop logs," allow growers to hold water in their soil or release it depending on the needs of their crop, their fieldwork schedule and the environment.

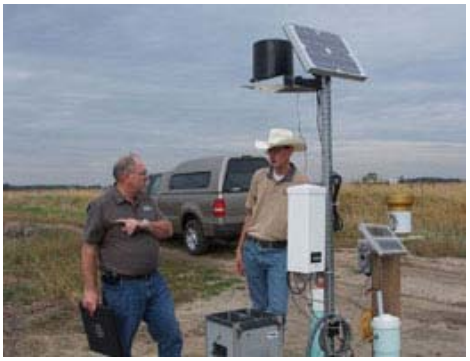
"The first step was to drain the land so it was farmable," notes Don Pitts, state water and air quality specialist with the USDA Natural Resources Conservation Service (NRCS) in Champaign, Ill. "Now it's time to manage that drainage."

Drainage water management systems can be most readily established on fields with slopes of 0.5 percent or less and patterned tile drainage systems. The cost of establishing a drainage water management system increases with the amount of re-plumbing necessary.

Photo courtesy of Steve Werblow

Pitts points out that most tile systems are designed to drain water as quickly as possible, combining tile line diameter, depth and spacing to achieve a drainage coefficient of 3/8 inch or more — the ability to remove 3/8 of an inch or more from the soil in a 24-hour period. That's important for drying out the soil during wet springs to accommodate fieldwork and planting, or to avoid crop damage from heavy rains or flooding. But in the drier months of summer, long-awaited rainwater can just flow down the drain.

Worse, drainage water can carry nitrates and phosphorous downstream, helping nurture blooms of algae that eventually die by the billions. Those dying algae cells tie up oxygen from the water as they decompose, creating an oxygen-starved hypoxic "dead zone" in the Gulf of Mexico that can be hundreds of miles across.



Leonard Binstock of the Agricultural Drainage Management Coalition and Nathan Utt of Purdue University check a monitoring station beside a drainage control structure. Data from 20 demonstration sites in

Research shows that drainage water management can reduce annual nitrate losses from tile-drained fields by 15 to 75 percent, depending on location, climate, soil type and cropping system. Most of the reduction in nitrate results from the reduction in water flow from the field through the tile. However, there is some indication that a portion of the nitrate may be

seeping deep into the ground or be denitrified by soil microbes.

No matter what the mechanism, trapping nitrates during the fall and winter fits well into the Midwestern crop cycle, notes Pitts.

"In Illinois, half the nitrate load comes during the wintertime, the part of the year where there's no need for drainage," he says, noting that most growers have traditionally focused on the water-storing benefits of in-season drainage management. " At a certain time of year, they let that water go but they would like to have it back."

## Grower Appeal

Many progressive growers across the Midwest and the South — where drainage management was first practiced — are exploring drainage water management to see if they can achieve higher yields by saving subsurface moisture while also benefiting water quality locally and downstream.

"If we could improve water quality on discharge, it's important to us," says grower Nathan Rettig of Napoleon, Ohio. "We all have to manage our environment. From a pure business standpoint, we're at least optimistic about yield potential."

If a thirsty crop responded to captured subsurface moisture during a dry season and delivered more yield, says Rettig, "you could gain back in a year the additional cost [of the control system], or many times over if it's managed right in a particular year."

Though studies in North Carolina show a yield benefit of five percent from drainage water management and models of Midwestern cropping systems estimate a similar return, quantifying a yield advantage in the field from drainage water management has been frustrating.

One challenge is that yields are likely to be impacted only in years when subsurface soil moisture is scarce in fields without drainage water management systems. Another is that there are so many variables involved in yield on field-scale plots that statistical significance is difficult to establish.

"I've seen a 20-bushel-per-acre difference in corn from shallow systems, but two years ago there was a one-bushel difference [on the same field] and last year there was no difference," notes Richard Cooke, an agricultural engineer at the University of Illinois. "On most sites, there's no significant difference between free and managed drainage. One of the problems, even in our fields, is yield is highly variable. Even if we look at a yield difference between two plots, standard deviation is on the order of 10 bushels per acre."

Rettig is hosting a demonstration plot on one of his fields, pitting a 38-acre parcel with a drainage control system against an adjacent 36-acre parcel with no control system on the tile lines. His plot is part of a five-state drainage water management demonstration program that includes 20 sites across Ohio, Indiana, Illinois, Iowa and Minnesota. The program is funded by a Conservation Innovation Grant from NRCS.

five states — coordinated by the Agricultural Drainage Management Coalition — will soon be available at www.admcoalition.com.

Photo courtesy of Steve Werblow

### Costing Out a Drainage Water Management System

The expression "that's very site-specific" could well have been coined by engineers estimating the cost of installing or modifying tile drainage systems on farm fields. Variables such as field dimensions, topography, soil type, tile depth, spacing between lines, direction of existing drainage lines, where mains may already be running — all can have a major impact on a drainage system price tag.

That makes the cost for installing or retrofitting drainage water management systems very difficult to estimate without an on-site inspection of the field. Drainage control structures cost between $500 and $2,000 apiece. Don Pitts of the USDA Natural Resources Conservation Service state office in Champaign, Ill., says retrofitting existing pattern tile drainage systems on an ideal slope can run $50 to $150 per acre. If extensive re-plumbing is required — for instance, to run laterals along the contours and make mains and control structures accessible along the field edge — costs can go up significantly, he says.

### Bioreactor Grabs Nitrates From Drainage Water

Some drainage water management systems, including the demonstration plot on Tony Thompson's farm near Windom, Minn., are being augmented by experimental bioreactors, which use wood chips to capture nitrates before drainage water is released from the farm.

Thompson's bioreactor is a long, plastic-lined trench that contains 80 cubic yards of walnut chips. Water from an 80-acre portion of his field flows into the bioreactor through a four-tube manifold and contacts the wood chips. Naturally occurring bacteria on the wood chips denitrify nitrates in the water — based on bioreactor experiments on other sites, he can expect to halve the nitrate load in his tailwater. A second manifold picks up treated water and allows it to flow through a drainage control structure to an outlet.

In all, his system cost about $5,000, including materials, excavation and installation. Research from the University of Illinois indicates that the bioreactor should be effective for at least 20 years.

"The demonstration plots are helping growers see these systems at work in a variety of real-world conditions, under real crops, side by side with traditional unmanaged drainage," says Leonard Binstock, executive director of the Agricultural Drainage Management Coalition (ADMC) in Owatonna, Minn. ADMC is coordinating the three-year project and hosting annual field days to share the latest data on the systems' performance, as well as insight

on drainage water management strategies. The organization's web site, www.admcoalition.com, is a treasure trove of articles and papers on drainage water management, and will ultimately feature data from each demonstration plot.

## Managing Drainage Water

Managing drainage water does not have to be particularly complicated, notes Jeff Strock, a soil scientist at the University of Minnesota's Southwest Research and Outreach Center near Lamberton, Minn.

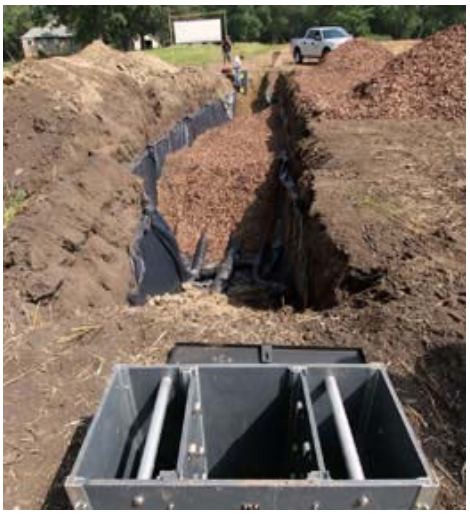
Removing stop logs in the control structures to dry out the top four feet of soil before spring and fall fieldwork provides adequate protection from soil compaction for most soils in Minnesota, he says. Once the crop is planted, growers can set the stop logs and generally let the crop do the rest.

"During the growing season, we probably don't have to do any manipulation of the water table because the crop is doing it for us through evapotranspiration and consumption," he adds. Strock points out that maintaining the water table two feet below the soil surface during the growing season keeps moisture within reach of crop roots and minimizes the risk of saturation from summer rains.

If a series of summer storms delivered excess rain, he explains, most Minnesota growers would be able to drop their water tables quickly enough to accommodate the rain without saturating the soil or setting the stage for runoff. His research shows that most fields with completely full water profiles can drain back to a two-foot-deep water table in less than 48 hours.

Minnesota grower Tony Thompson sees drainage water management as a natural complement to other best management practices that protect his soils and the environment.

Photo courtesy of Steve Werblow



The 80 cubic yards of wood chips in this bioreactor can treat drainage water from 80 acres of Tony Thompson's cropland. Bioreactors have been shown to cut nitrate levels in tile drain water by half.

Photo courtesy of Steve Werblow

## Candidate Fields

Drainage water management works most effectively on flat or very gently sloped fields, with slopes of 0.5 percent or less.

Ideally, the field is pattern tiled with the lines running along the contour of the slope, notes Pitts, which allows contractors to install control structures along the sloping main to manage the most possible acreage at increments of about two feet of elevation. (Laterals running perpendicular to the contour may be controlled by creating collector headers above hydraulic breaks, he notes.)

For cost-efficiency's sake, Pitts likes to see each control structure manage a zone of the field of at least 20 acres. It's most convenient if the main runs along a road or similarly accessible path to make it easier to set and maintain the structures.

The latest generation of control structure technology — such as automated control structures that can be buried deep in the root zone — may also expand the number of acres that could be effectively managed.

"We're getting lower-cost control structures manufactured, with more automation," he notes. "Low-cost automated control structures change the ball game." Even now, Pitts notes that some growers are willing to put in the extra structures to manage smaller zones, and to put in the extra time to adjust more stop logs.

Minnesota grower Tony Thompson is one of those

growers. He installed 16 control structures on a 140-acre field near Windom, Minn., to control drainage water. Thompson's slope is about one percent, so each structure manages a zone of about nine acres. At $500 to $2,000 per structure, the drainage water management structures only added about five to 15 percent to the cost of upgrading the field's century-old drainage system.

Though he hasn't measured a yield bump from the system yet, Thompson thinks drainage water management could be a good investment on his operation.

"If we as farmers don't take aggressive action ourselves to make sure our runoff water is of the best quality possible, there will be a more regulatory approach," he predicts. "I'd rather be part of a preemptive movement."

**Drainage Water Management Is Part of the Conservation Agriculture Continuum**

Grower Tony Thompson of Windom, Minn., sees his drainage water management system as an integral part of his broad approach to conservation agriculture, which includes ridge-till, cover cropping, closed tile intakes and other best management practices.

"The farmer has to think about water before the rain droplets strike the soil," Thompson notes. "The first thought is how to try to prevent the raindrop from striking bare soil. Once it's on the soil surface, we want it seeping into the ground and not running off the field, so we're working on tillage systems and buffering riparian areas.

"We've accomplished all those goals and had a big positive response in our surface waters and wetlands," he adds. "But the water passing through the drainage systems still needed some sort of treatment and is still very energy-charged when it comes out the outlet."

As a result, drainage water management continues the work that begins with crop residue management.

**FOR MORE INFORMATION**

Visit the Agricultural Drainage Management Coalition (ADMC) web site at www.admcoalition.com for details on drainage water management systems, the science and regulations surrounding drainage water management, and — soon — data from each of the 20 demonstration sites in the Midwest.

***About the Writer:*** *Steve Werblow is a freelance agricultural writer based in Ashland, Ore.*

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