Agricultural Drainage Water Management

Shows Promise For Economic & Environmental Benefits

Two back-to-back wet years have frustrated farmers, scientists and drainage contractors eager to put agricultural drainage water management systems through their paces, but they haven't dampened Doug Mills' enthusiasm for the technology. Mills, who farms near Crawfordsville, IN, is impressed enough by a side-by-side comparison of managed and free drainage on his farm – part of a regional demonstration program – that he is in the process of installing another set of drainage control structures on his own.

Mills believes managed drainage will help him fine-tune water management in drier years. The system also provides him with a bonus – as researchers from Purdue University analyze samples of water collected at his tile outlet for their nutrient concentrations, Mills is using their data to fine-tune his fertilizer practices.

Drainage contractor Rob Wood points out that installing a controlled drainage system requires careful planning before the first foot of tile is laid.

Managing the Water Table

At the edges of his managed-drainage field, Mills has installed gated control structures just before his tile outlets. Each control structure contains a set of removable weirs, or stop-logs. When he wants to retain water in his field – for instance, to minimize the flow of water and nutrients in the winter, or to hold onto summer rainfall during the growing season – Mills adds weirs and raises the water table. When he wants to lower the water table to permit spring fieldwork or fall harvest, he removes some of the weirs to allow the field to drain to the desired level.

The practice is designed to deliver two key benefits – one local and one national. On the farm level, controlling drainage has the potential to boost yields. Research from North Carolina, where drainage water management has been practiced for years, shows a five-percent improvement in yield, and researchers in the Midwest are gathering data to determine if such a boost could occur in the soils and climate of the Corn Belt.

Mills is convinced of drainage water management's promise on the farm level. "Water is one of those things where if there's too much of it or not enough, you've got a problem," he says. "I think drainage is worth about 50 bushels per acre, and irrigation is worth about 50 bushels per acre." Managing drainage, he explains, gives him the best of both worlds – removing or retaining water as needed.

Reducing Nutrient Load

Looking at the bigger picture, researchers have established that as agricultural drainage water management reduces the discharge of water from farm fields, it proportionally lowers the amount of nitrates released from those farms through tile outlets. Research by Dr. Norm Fausey of the U.S. Department of Agriculture Agricultural Research Service (USDA-ARS) in Columbus, Ohio, shows that managing drainage in the winter can reduce water flows by 40 percent and lower nitrate loads by 45 percent.

Nitrates drained from farms contribute to the hypoxic zone in the Gulf of Mexico, a nutrient-enriched area whose low oxygen levels threaten aquatic life. Reducing the flow of nutrients into the Gulf can help reduce the size of the hypoxic zone. As a result, agricultural drainage water management has captured the attention of conservationists and policymakers, who are seeking ways to include drainage water management in environmental programs aimed at improving water quality. Data from demonstration plots like Mills' will help quantify the effects of drainage water management on nitrates as well as phosphorus.

Two Projects

For his demonstration project, Mills split a 60-acre field in two to allow a side-by-side comparison between managed

Doug Mills (yellow hat) hosts a tour of his drainage water management demonstration site on his Indiana farm. His tour was one of a series of demonstration days coordinated by the Agricultural Drainage Management Coalition in 5 Midwestern states.

drainage and conventional free drainage. In 2005, the field had been tiled on 70-foot centers at a depth of 2.5 to 3.5 feet to drain the heavy Ragsdale silty clay loam, Reeseville silt loam, and Reeseville-Fincastle silt loam that characterize the project.

The 26.5-acre managed drainage side of the field has a four-foot elevation drop from the end of the laterals to the lowest point along the main; the 33.75-acre free drainage side has a maximum elevation change of 8.5 feet. Mills' 1,000-foot-long laterals drop one foot on their way to the main.

In 2006, with the help of the Agricultural Drainage Management Coalition (ADMC), Mills added electronic data collection equipment at the control structures to facilitate outflow monitoring. ADMC included the field in its 20-site demonstration project, funded by a Conservation Innovation Grant (CIG) from NRCS. Through the three-year CIG project, ADMC and its cooperators at USDA and the land grant university system have been observing side-by-side comparisons in Illinois, Indiana, Iowa, Ohio and Michigan. Data is available on ADMC's web site (www.admcoalition.com), and the project's final report will be released later this year.

"Doug Mills has been extremely important in helping us understand, study and share results from his demonstration field," says Leonard Binstock, executive director of ADMC in Owatonna, MN. "He's generous with his time, and he brings great insight and an eye for detail to the project. He's looking at drainage water management as a long-term proposition, both as a tool to improve yields and as a tool to help the environment. And he's shared that perspective as host of an on-farm demonstration day last fall for farmers, drainage contractors and agency people."

In fact, Mills is also looking forward to comparing managed vs. free drainage on another 60-acre parcel on his own. As with the first project, his tile contractor, Rob Wood of Wood Water Management in North Salem, IN, laid laterals on a 70-foot spacing at a cost of $450 to $500 per acre. Mills points out that Purdue recommends 66-foot spacing as optimal for the site, but 70-foot centers are easier to keep track of, and give him the option to easily split the distance to 35 feet if he decides to tighten up the spacing later. He is planning to add control structures – which cost between $500 and $2,000 per unit, depending on size and spec – to the second project upon approval of his plans by the USDA Natural Resources Conservation Service (NRCS).

As it stands, Mills says the tile system is very effective. When he removes weirs in his control structure to prepare for spring fieldwork, he says, "It will drain just like a rainstorm. We can lower the water table in a week."

Intriguing Questions

Rainy summers in 2008 and 2009 obscured any effect of in-season drainage

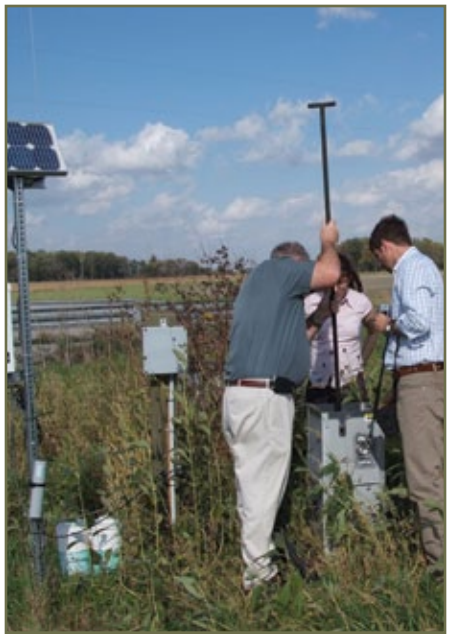
management, notes Mills. But the 2007 season, with its pretty typical rainfall pattern, gave him the best opportunity to observe the benefits of raising the water table during the growing season on his personal project. Watching the yield monitor in his combine during harvest, he observed that the free-drainage side of the field peaked at about 230 bushels of corn per acre, while the area of the managed-drainage side nearest the control structure peaked close to 280 bushels. The middle of the managed-drainage side peaked at 230 bushels, equivalent to the free-drainage side, he says.

A knoll with lighter soil texture and about 10 feet of elevation over the rest of the field – which Mills did not tile – turned out to be the wettest spot in the field, and yielded roughly 40 bushels per acre less than the drained portions.

The 2007 harvest raised several questions about the behavior of subsurface moisture that still intrigue Mills. "Is the upper half [the managed area] feeding the lower half?" he asks. "Our peak yield was in a low spot. Did controlling drainage add moisture in that low spot?"

Lessons to Learn

Questions like those highlight the dynamic world of managed drainage. Wood, a board member of the Indiana Land Improvement Contractors Association (LICA), installed his first drainage water management system with his father-in-law, John Guernsey, back in the early 1980s. He has been learning more about managed drainage with every job he's done since.



Leonard Binstock of the Agricultural Drainage Management Coalition adjusts stop-logs in one of Doug Mills' control structures.

"There's a lot of forethought that has to go into it," Wood notes. "You have to know what tile is coming onto the farm and what tile is going off the farm. You need to know where the water table is in the soil – whether it's a high water table, or if you're on sand and there's no water table at all. If there's no water table, you can't stack water in it."

If a field is a good candidate for a drainage water management system, the next step is strategic design, he adds.

"The field has to lay out right or you have to put in too many control stands, which becomes cost-prohibitive," Wood explains. "Another key is knowing where to put the control stands so you make sure they're easy to get to. If they are difficult to lay out, the grower is not apt to check them."

Demand is growing for drainage water management systems, Wood says. Growers are turning to drainage contractors for a management tool with the possibility of a good return on investment, while society values the environmental advantages of water conservation and improved water quality.

"We're going to help out in the long run on water quality, and we're going to have to make the good ground better," he says. "We're losing ground to development all the time. We're going to have to improve the yields on the ground we still have, and to save the water we have. Someday, this water is going to become a precious resource to have, like it is out in the West."

Tools like RTK and a growing body of knowledge being shared by ADMC, university drainage experts and LICA will help contractors step up and meet the need.

"There is much opportunity out here and there is a lot to be accomplished, and it must be done correctly by qualified people," says Wood.

Nitrogen Knowledge

Having a team of university researchers collecting nitrate data from the tile outlets on his demonstration field has been a luxury for Mills. The Purdue team is eager to quantify the effect of drainage water management on nutrient flows to the environment. Mills is using their data to check on the efficiency of his fertilizer program.

"It's a roundabout way to check our nitrogen efficiency, to see if we're really optimizing our nitrogen rate," he says. "Our nitrates out of the system are pretty low, which means we're probably maximizing our yield. You're going to have a certain amount of nitrate even if you have grass in the field. But our losses were low, so we're doing a fairly good job of nitrogen management."

Mills has invested a great deal of effort in optimizing his fertilizer rates. In 2004, he invested in an Exactrix applicator, which precisely manages the pressure and rate of anhydrous ammonia injection and blends fertilizers at application to form a stable nutrient source called tri-ammonium polyphosphate sulfate. The added control he received from his application allowed him to reduce his nitrogen rates by 30 to 40 pounds per acre without sacrificing yield, he says, leaving little available to travel with drainage water.

High Hopes

Mills is optimistic about drainage water management, and eager to learn its nuances in the drier summers in which it can really shine.

"This is not a cure-all – it's not going to be an instant money-maker," he says. But there's a yield increase in the right situation. We may end up using it to manage bigger fields. Like say you have an 80-acre field, and we can use the water from the upper 40 to improve yields on the lower 40 even more – get some improvement on the upper part and a bigger improvement on the lower part. We're still trying to figure out what is the best way to manage these systems."

He also believes in the larger mission of drainage water management – the chance to reduce the off-farm flow of nutrients that affect water quality all the way down to the Gulf of Mexico. "Being proactive isn't something agriculture is always good at," he says, "but this is something we ought to be thinking about." **L&W**

by Steve Werblow

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