Agronomic Spotlight

Drainage Water Management

To help enhance water removal and reduce nutrient and sediment loads new technologies and practices are being incorporated into conventional drainage systems. Drainage water management control structures can be used to maintain crop productivity and reduce nitrate loads in tile drainage systems. Management practices to improve drainage systems include woodchip bioreactors, rock inlets, and other management practices outlined in this update.

WHAT TO CONSIDER

Drainage systems developed during the 20th century have increased the productivity of croplands, but many systems have reached a point where updating or replacement is needed to manage water removal. Incorporating new designs and practices into systems can help maintain crop productivity and improve water quality. Controlled drainage, shallow drainage, rock inlets, woodchip bioreactors, alternative ditch design, saturated buffers, and various storage basins represent several of the approaches suited to adoption into drainage systems, based on local conditions and recommendations.

YIELD IMPACT

Drainage water management is a practice that can be used to reduce nitrate loads on tile-drained soils. A water control structure in the main, submain, or lateral drain is used to vary the depth of drainage outlet to manage the depth of the water table. The outlet depth is raised after harvest to limit drainage outflow and reduce nitrate delivery to ditches and streams; the outlet depth is lowered in spring and fall so the drain can flow freely; and raised again after planting and spring field operations to store water for crop use in midsummer. Research has shown that reductions in nitrates in tile drain flow range from 15 to 75%, depending on location, climate, soil type, and cropping practices.[1] Drainage water management reduces flow volumes in the system and may help reduce nitrate loss.[2]

Most conventional drainage systems can be retrofitted with control structures, particularly pattern drainage systems with laterals with less than 0.2% grade.[4] Drainage water management should be one of a suite of practices in an overall conservation management plan. Go to http://www.nrcs.usda.gov for information on cost-share programs.

MANAGEMENT OPTIONS

Woodchip Bioreactors are subsurface trenches filled with wood chips and capped with topsoil that receive water from the drainage system before water leaves the field to enter a body of surface water. The wood chips serve as a substrate for denitrifying bacteria to convert nitrate into nitrogen. Bioreactor advantages include:

- No modification of current practices
- No land is taken out of production
- No decrease in drainage effectiveness
- Little to no maintenance with a 20-year life span

Based on research from Iowa, Illinois, and Minnesota, bioreactors typically remove about 15 to 60% of the nitrate load in a system per year.[5] Woodchip bioreactors may also help dissipate herbicides, such as atrazine and acetochlor, and reduce phosphorous and coliform bacteria loads.[6]

Rock Inlets are an alternative to older open inlets and can be used to replace open inlets to reduce water flow to drainage inlets. Rock inlets remove water as effectively as open inlets, can hinder sediment and nutrients from entering the tile drainage system, allow planting and tillage across rock inlets, and allow drainage to occur

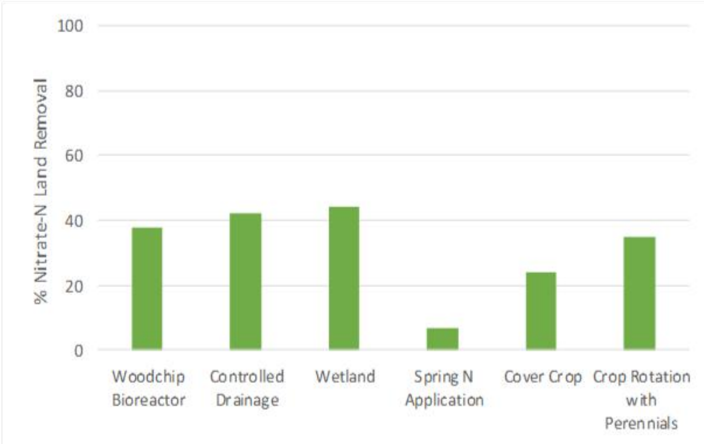

Figure 1. Comparison of different practices for average nitrate removal in soil. Adapted from Christianson, L. and Helmers, M. Woodchip bioreactors for nitrate in agricultural drainage PMR 1008. Iowa State University.

during late fall, early winter, and early spring.

Two-stage Ditches are drainage ditches that have been modified by adding benches that serve as floodplains within the overall channel. The two-stage design mimics a more natural stream channel that leads to greater channel stability. Recent evidence has shown that the two-stage ditch has great potential to improve nutrient processing compared to conventional ditches by creating an in-ditch bench that facilitates denitrification and nutrient uptake while enhancing the stability of the channel and reducing sediment movement.[7]

Other Management Practices. There are several other practices that can help manage the quality of drainage systems to maintain productivity and improve the quality of drainage water. Nitrate losses can potentially be reduced by up to 30% using nutrient best management practices.[3] States in the Mississippi River Basin are working in concert with a broad base of stakeholder groups and federal agencies to implement local nutrient reduction strategies to support agricultural output and improve water quality.[8] An important part of the program is the 4R philosophy that relies on an innovative and science-based approach to offer environmental protections, increased production, increased farmer profitability, and improved sustainability through the use of the right fertilizer source, at the right rate, at the right time, with the right placement to help agricultural retailers and crop advisors promote improved nutrient utilization to reduce nutrient losses.

For some farm operations, lengthening crop rotations with perennial broadleaf or grass crops can potentially decrease nitrate losses, but this may not be an economically viable solution for other operations. Increasing the diversity of crop rotations is a research objective for many programs, in addition to drainage programs, to improve productivity, break pest cycles, introduce new crop options, and identify the feasibility of using cover crops to maintain the sustainability of farming operations.

Restored, natural, and constructed wetlands have the potential to mitigate sediment nutrient losses. Constructed wetlands can improve the quality of subsurface drainage flow by sediment filtration to remove, transform, or stabilize contaminants that are within agricultural runoff.[9] Perennial crops that are adapted to wet soil conditions, or planted along the fringe of wetlands, have the capability to remove excess phosphorus from wetlands. Aquatic plants can result in higher treatment efficiency of constructed wetlands. Removing or harvesting aboveground vegetative growth can contribute to nutrient removal.

There are a number of viable practices that can be used to improve tile drainage systems and maintain crop productivity summarized in this document. For more information, contact local Extension, USDA representatives, and other local experts.

Sources
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[4] Frankenberger, J., Klavivko, E., Sands, G., Jaynes, D., Fausey, N., Helmers, M., Cooke, R., Strock, J., Nelson, K., and Brown, L. 2006. Drainage water management for the Midwest. WQ-44. Purdue University.
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[9] Lenhart, C, Sheaffer, C, Wyse, D., and Meschke, L. 2012. On-farm evaluation of treatment methods for excess nutrients in agricultural subsurface tile drainage. University of Minnesota. All web sources verified 10/2/2017.