How effective are the *Ten Ways* for reducing nitrogen?

Research has been conducted throughout the Midwest to determine effectiveness of these practices. The average and a range that encompasses most of the studies is shown in the figure below. Reductions can vary widely, depending on the following factors:

Improved N Management reductions depends on the initial and revised practices and on weather and other management factors.

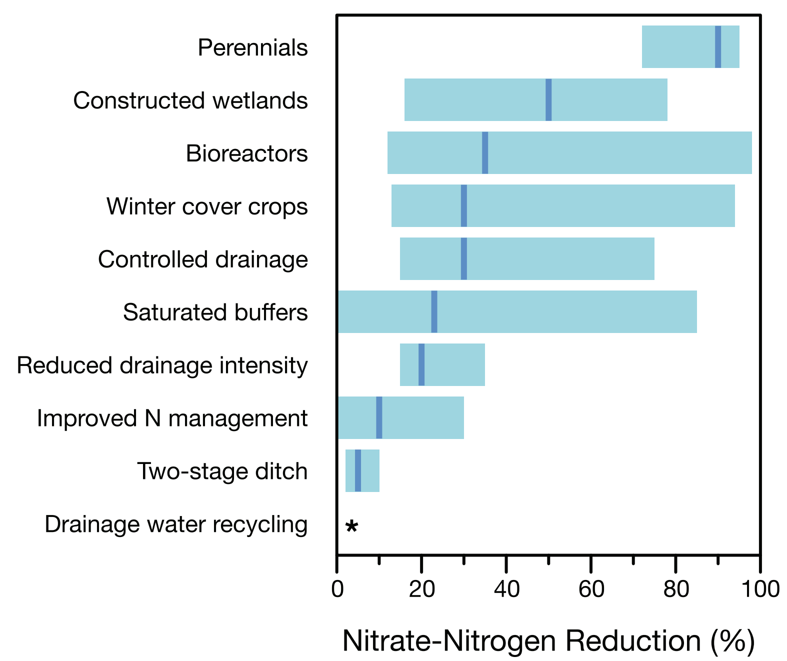
Winter cover crop effectiveness depends on their establishment which varies with weather and other conditions.

Controlled drainage reductions are higher when more drain flow occurs during the controlled period.

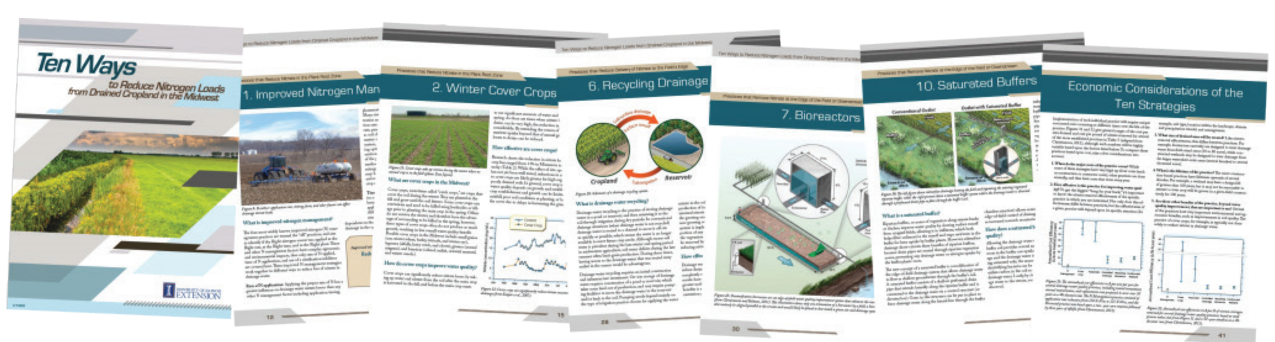
The effectiveness of **Drainage water recycling, Bioreactors,** and **Constructed wetlands** depends on the storage volume relative to the crop area being treated.

Two-stage ditches can remove thousands of pounds of nitrate, but the effectiveness percentage is limited because they usually only treat a fraction of the nitrate present.

Saturated buffer effectiveness depends on the portion of drainage water treated, and the organic matter content of the soils promoting denitrification.



*Drainage water recycling: Although research results have been promising, this is a new practice for which greater understanding of design and management is required before nitrogen reduction effectiveness can be calculated.



Visit http://go.aces.illinois.edu/TenWays to access the full *Ten Ways* booklet and get more for information on each practice.

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Ten Ways

to Reduce Nitrogen Loads from Drained Cropland in the Midwest

A SUMMARY FACTSHEET

Nitrogen losses from subsurface (tile) drained land can cause water quality problems downstream. Reducing these losses, while maintaining agricultural productivity, is possible.

Scientists and engineers have identified the ten most promising ways to reduce nitrogen loads.

The Nitrogen Cycle

There are four processes to reduce nitrogen loads from drained cropland, and various practices employ different combinations to reduce nitrogen losses. The nitrogen cycle is complex because nitrogen exists in many forms and can easily change from one form to another. The nitrogen processes that affect nitrogen loads in subsurface drains are the basis for how the ten strategies work to reduce nitrogen loads.

- **Reducing nitrogen sources:** If less nitrogen is available in the soil, less will be lost.
- **Increasing plant uptake:** If plants take up more nitrogen, particularly in the non-growing season, nitrate loads will decrease.
- **Increasing denitrification:** Denitrification is the process through which microbes naturally convert nitrate in the soil or water to nitrogen gas.
- **Reducing drain flow:** Practices that reduce the amount of water leaving the field will reduce nitrogen loads.

Finding the Solutions that Work for You

There is no universal approach for improving drainage water quality. Each of the *Ten Ways* provides unique features and characteristics that will be appropriate for some but not all field circumstances. Many of these practices can be used in combination, and several such combinations are very complementary (for example, use of an in-field and edge-of-field practice together).

A suite of water quality improvement approaches will be needed across the landscape to meet our water quality goals.

No one practice will be suitable on every acre, but every acre needs at least one practice.

More information on reducing nitrate is available through the full *Ten Ways* booklet

http://go.aces.illinois.edu/TenWays

PRACTICES THAT MODIFY THE CROPPING SYSTEM

1. Improved nitrogen management

Applying nitrogen at the rate needed by the crop and in spring or summer as close as possible to the time it is needed can reduce nitrate loads in subsurface drainage water. Nitrogen management is difficult to fine-tune, however, due to crop needs that change throughout the season and year to year. At least one improved N management practice is appropriate everywhere N is applied.

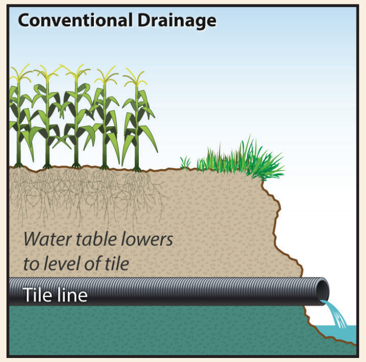
2. Winter cover crops

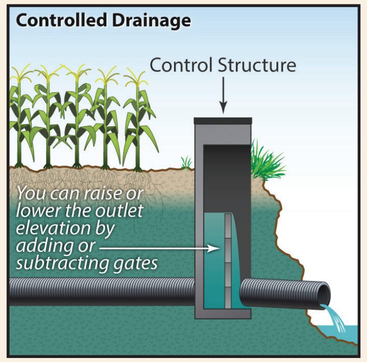
Cover crops are crops that are planted in the fall and cover the soil during the winter. Cover crops reduce nitrate losses by taking up water and nitrate from the soil after the main crop is harvested in the fall. Those that overwinter can also take up nitrate before the main crop starts growing in the spring. The greatest reduction of nitrate load generally occurs when the cover crop has good fall establishment and growth and in areas where drain flow occurs during periods when the cover crop is growing.

3. Perennials in the cropping system

Perennials are plants that can grow for two or more years without re-planting. Perennials reduce nitrate loads by extending the season during which water and nitrate are removed from the soil, and are the least "leaky" cropping system. Most perennial crops can be grown almost anywhere in the Midwest, but their adoption is limited by availability of on-farm utilization, markets, and infrastructure.

PRACTICES THAT MODIFY THE DRAINAGE SYSTEM





4. Controlled Drainage

(Drainage Water Management)

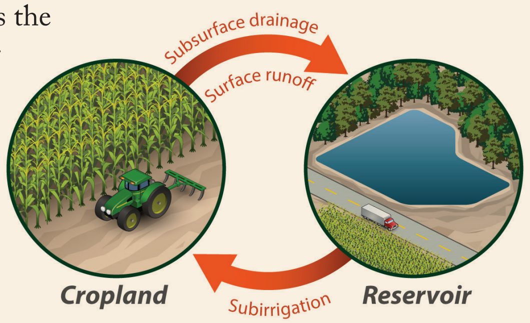
Drainage water can be managed through the use of adjustable water control structures placed in the drainage system that allow the outlet level (or water depth) to be adjusted. The water table must rise above the outlet level before drainage will occur, thus raising the outlet level when drainage is less critical reduces the overall amount of drainage and nitrogen that moves downstream. Controlled drainage is most practical and economical on fields with average slopes less than 0.5%, although there is no absolute limit on slope.

5. Reduced drainage intensity

Drainage intensity refers to the spacing and depth of the drainage pipes. Installing drainage pipes either with wider spacing or closer to the soil surface can reduce the total water drained, and thus, result in less nitrate transported from the field. No minimum/maximum slopes, soil types, or specific climates are required for this practice.

6. Drainage water recycling

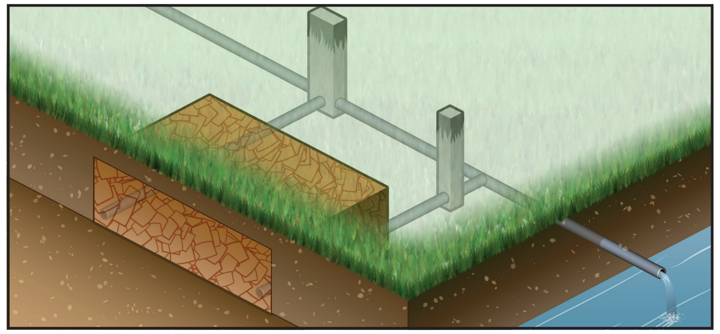
This is the practice of capturing and storing drainage water in a pond or reservoir and then returning it to the soil through irrigation during dry periods. Recycling drainage water can reduce or even potentially eliminate nitrate loss by reducing the water that leaves the site. Drainage water recycling has broad potential, but the size of the water storage reservoir will be the limiting factor in most situations.



PRACTICES THAT WORK AT THE EDGE OF THE FIELD

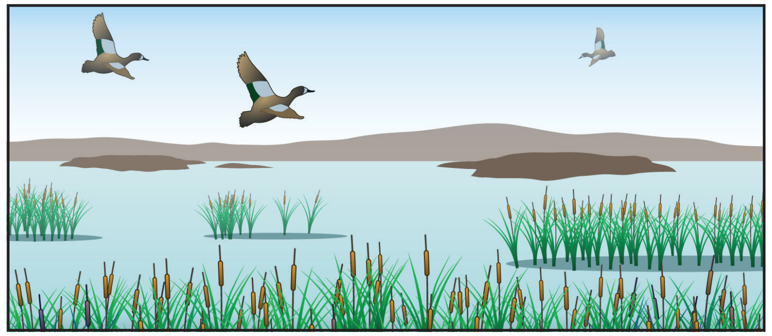
7. Bioreactors

Bioreactors are trenches filled with woodchips through which drainage water is routed. Control structures are used to allow for bypass flow during high flow events and control flow through the woodchips. Bioreactors treat the water by enhancing the natural, biological process of denitrification. Bioreactors are fairly adaptable but require space at the edge of the field.



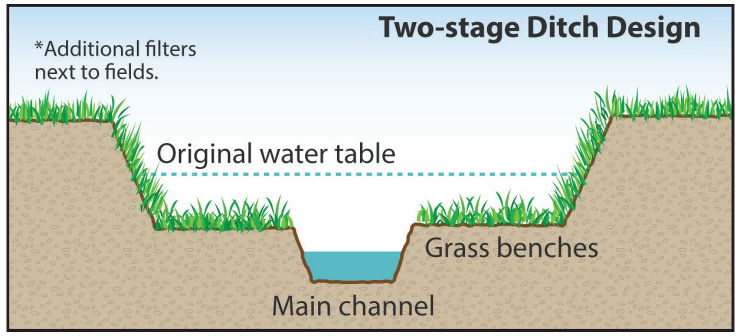
8. Constructed wetlands

Wetlands are dynamic ecosystems containing plants, soil, bacteria, and water. Constructed wetlands remove nitrate through denitrification, plant uptake, and reduction in flow due to seepage and evaporation. Nitrate-removal wetlands can be highly effective, but widespread implementation remains limited due, in part, to concerns about the cost of taking land out of agricultural production.



9. Two-Stage Ditches

This practice consists of a small main channel that accommodates low flow conditions and a second low, grassed floodplain that accommodates higher flows within the ditch. This creates a zone of plants and soil that absorbs part of the nitrate load through plant uptake and denitrification, and may also reduce flow. This type of alternative open-ditch design may help decrease periodic costs associated with ditch maintenance.



10. Saturated buffers

A saturated buffer is an edge-of-field practice that allows drainage water to be distributed through a riparian buffer via a shallow perforated drain pipe that extends laterally along the buffer. As the drainage water seeps through the buffer soil, denitrification is increased and the roots take up the drainage water and nitrate. Saturated buffers work where a drain outlets through a buffer that is at a lower elevation than the field. Soil must contain high organic matter content and not have layers of high permeability (sand or gravel layers).

Outlet with Saturated Buffer