Ten Ways to Reduce Nitrogen Loads from Drained Cropland in the Midwest

1. Improved Nitrogen Management

2. Winter Cover Crops

3. Recycling Drainage

4. Bioreactors

5. Floating cover systems

6. Wetland cover systems

7. Woodchip drains
THIS WORK BROUGHT TO YOU BY

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ARTIFICIAL DRAINAGE IS INTEGRAL TO CROP PRODUCTIVITY.

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Are you interested in practices that...

...are cropping or management strategies?
  - Improved Nitrogen Management
  - Winter Cover Crops
  - Perennials in the Cropping System
  - Drainage Water Management (Controlled Drainage)
  - Reduced Drainage Intensity
  - Recycling Drainage Water
  - Bioreactors
  - Wetlands
  - Alternative Open-Ditch Design
  - Saturated Buffers

...are in the field and that...

...modify the drainage system?

This practice improves water quality by...
  - reducing the nitrogen source
  - increasing plant uptake
  - reducing the amount of drainage or flow entering the stream
  - increasing denitrification
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are at the edge of the field or offsite?
Are you interested in practices that...

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IN-FIELD MANAGEMENT PRACTICE: IMPROVED N MANAGEMENT (4RS)

What is it? Applying “the right source of nutrient, at the right rate, at the right time, and in the right place”
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How does it reduce N loss in drainage? Reduces the source of N (rate) or increasing plant uptake (timing, nitrification inhibitor)
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What is it? Applying “the right source of nutrient, at the right rate, at the right time, and in the right place”

How does it reduce N loss in drainage? Reduces the source of N (rate) or increasing plant uptake (timing, nitrification inhibitor)

How effective is it? Generally 6-20% annual N loss reduction

Where does it work? Everywhere N is applied

https://www.youtube.com/watch?v=3Qja938T5e0
What is it? A crop planted in late fall to cover the soil over the winter

Winter wheat drilled into soybeans following harvest.
IN-FIELD MANAGEMENT PRACTICE: WINTER COVER CROPS

What is it? A crop planted in late fall to cover the soil over the winter.

How does it reduce N loss in drainage? It takes up water and nitrate from the soil after the main crop is harvested and before the next crop starts growing.
IN-FIELD MANAGEMENT PRACTICE: WINTER COVER CROPS

**What is it?** A crop planted in late fall to cover the soil over the winter

**How does it reduce N loss in drainage?** Takes up water and nitrate from the soil over winter

**How effective is it?** Approximately 30% N loss reduction in the IA and IL Strategies

**Where does it work?** Robust establishment is the most important for water quality benefits
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Where does it work? Robust establishment is the most important for water quality benefits

Lots of additional benefits! Slows erosion, improves soil health, smothers weeds, increases biodiversity...
IN-FIELD MANAGEMENT PRACTICE:
PERENNIALS IN THE ROTATION

**What is it?** Inclusion of perennials within an extended rotation or at critical locations within a field
IN-FIELD MANAGEMENT PRACTICE:
PERENNIALS IN THE ROTATION

What is it? Inclusion of perennials within an extended rotation or at critical locations within a field.

How does it reduce N loss in drainage? Takes up water and nitrate from the soil during periods when annual crops are not growing.

Based on a recent meta-analysis of drainage studies:

Annual Rotations: >28 lb N lost per ac

Perennials: <7 lb N lost per ac

Source: Christianson and Harmel, 2015 (Ag. Water Management)
IN-FIELD MANAGEMENT PRACTICE: PERENNIALS IN THE ROTATION

What is it? Inclusion of perennials within an extended rotation or at critical locations within a field

How does it reduce N loss in drainage? Takes up water and nitrate from the soil during periods when annual crops are not growing

How effective is it? 72-95% annual N loss reduction in the IA, MN, and IL Nutrient Strategies

Where does it work? Most perennial crops can be widely grown, but their adoption is limited by availability of on-farm utilization, markets, and infrastructure
IN-FIELD DRAINAGE SYSTEM PRACTICE:
DRAINAGE WATER MANAGEMENT

Conventional Drainage

Water table lowers to level of tile
Tile line

Controlled Drainage

Control Structure
You can raise or lower the outlet elevation by adding or subtracting gates
What is it? Adjustable structures to manage the level of the drainage outlet

Controlled Drainage

You can raise or lower the outlet elevation by adding or subtracting gates
IN-FIELD DRAINAGE SYSTEM PRACTICE:
DRAINAGE WATER MANAGEMENT

What is it? Adjustable structures

How does it reduce N loss in drainage? Holds back water and nitrate in the soil during periods when drainage isn’t critical

Source: Frankenberger et al. (Purdue Extension publication WQ-44)
IN-FIELD DRAINAGE SYSTEM PRACTICE:
DRAINAGE WATER MANAGEMENT

What is it? Adjustable structures

How does it reduce N loss in drainage? Holds back water and nitrate in the water

How effective is it? Generally a 30% N loss reduction (15-75%)

Where does it work? Most practical on slopes of <0.5% because more structures are needed with steeper slopes
What is it? Installation of subsurface drains either closer to the surface or with wider spacing than conventionally done.
IN-FIELD DRAINAGE SYSTEM PRACTICE:
REDUCED DRAINAGE INTENSITY

What is it? Installation of either wider or shallower subsurface drains

How does it reduce N loss in drainage? Less water leaves the field as drainage, thus less N leaves the field

How effective is it? Approximately a 20-30% annual N loss reduction

Where does it work? Anywhere subsurface drainage is installed
What is it? Drainage water is stored in a pond or reservoir and then returned it to the soil through irrigation during dry periods.

How does it reduce N loss in drainage?
Recycling the drainage water can reduce or even potentially eliminate nitrate loss by reducing or eliminating the water that leaves the site.
What is it? Store drainage water for later crop application.

How does it reduce N loss in drainage? Reduces drain flow leaving the site.

How effective is it? Shows good potential, but is very new.

Where does it work? Wide applicability, but the available space for the pond and the cost are usually limiting factors.
EDGE-OF-FIELD OR OFF-SITE PRACTICE:
WOODCHIP BIOREACTORS

What is it?
Woodchip-filled trench where good microbes “eat” the carbon in the woodchips to fuel their work removing nitrate from the drainage water.
EDGE-OF-FIELD OR OFF-SITE PRACTICE: WOODCHIP BIOREACTORS

**What is it?**
Woodchip-filled trench

**How does it reduce N loss in drainage?**
Additional carbon “super-powers” the natural process of denitrification

*From Christianson and Helmers (2011)*
EDGE-OF-FIELD OR OFF-SITE PRACTICE:
WOODCHIP BIOREACTORS

What is it? Woodchip-filled trench
How does it reduce N loss in drainage? Enhances the natural process of denitrification
How effective is it? 25-45% annual N loss reduction
Where does it work? Anywhere subsurface drainage is installed and room is available for this narrow construction
EDGE-OF-FIELD OR OFF-SITE PRACTICE:
WETLANDS

What is it? Constructed wetlands are dynamic ecosystems of plants, soil, bacteria, and water.

How does it reduce N loss in drainage? Wetlands primarily enhance the natural process of denitrification, but also provide some plant uptake of N and reduced downstream flow.
EDGE-OF-FIELD OR OFF-SITE PRACTICE: WETLANDS

What is it? Constructed wetlands are dynamic ecosystems.

How does it reduce N loss in drainage? Denitrification, plant uptake, and reduced flow.

How effective is it? 40-50% annual N loss reduction.

Where does it work? Concerns about the cost of taking land out of production limits widespread implementation.

Lots of additional benefits! Flood retention, wildlife habitat…

Photo: https://iowalearningfarms.wordpress.com/2014/06/26/incredible-wetlands/
EDGE-OF-FIELD OR OFF-SITE PRACTICE:
ALTERNATIVE DITCH DESIGN
(TWO-STAGE DITCH)

What is it?
Retrofit an existing ditch to contain a small “main” channel and low, grassed floodplains

How does it reduce N loss in drainage?
Denitrification, plant uptake, and reduced flow via infiltration to the mini-floodplains
EDGE-OF-FIELD OR OFF-SITE PRACTICE:
ALTERNATIVE DITCH DESIGN
(TWO-STAGE DITCH)

What is it? Ditch retrofit into 2-stages

How does it reduce N loss in drainage? Denitrification, plant uptake, and reduced flow

How effective is it? Nitrate removal data is forthcoming

Where does it work? Where there are existing ditches; ditch may need to be widened, but may reduce cleanout costs
What is it? A modification of the edge-of-field drainage system that allows drainage water to flow as shallow groundwater through the buffer’s soil.
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How does it reduce N loss in drainage? As water moves through the buffer’s soil, nitrate is denitrified, plants uptake water and N, and flow is reduced.
EDGE-OF-FIELD OR OFF-SITE PRACTICE: SATURATED BUFFERS

What is it? Drainage treatment under a vegetated buffer

How does it reduce N loss in drainage? Denitrification, plant uptake, and flow reduction

How effective is it? 20-50% annual N loss reduction, but more research is needed

Where does it work? Where there is a buffer or room for one; Organic rich soil

Photo: courtesy Dr. Dan Jaynes, USDA ARS
SUMMARY

Practices to reduce N loads in drainage vary in:
- Effectiveness
- Cost
- Suitability
- Additional environmental and agronomic benefits

No one practice will be suitable on every acre, but every acre needs at least one practice.
TEN WAYS TO REDUCE NITROGEN LOADS FROM DRAINED CROPLAND IN THE MIDWEST

1. 44 page booklet
2. PowerPoint slide sets
3. Short summary factsheet (In development)
4. Online module (In development)
WHERE CAN I GET THESE MATERIALS?

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

Or Google: “ten ways drainage”
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