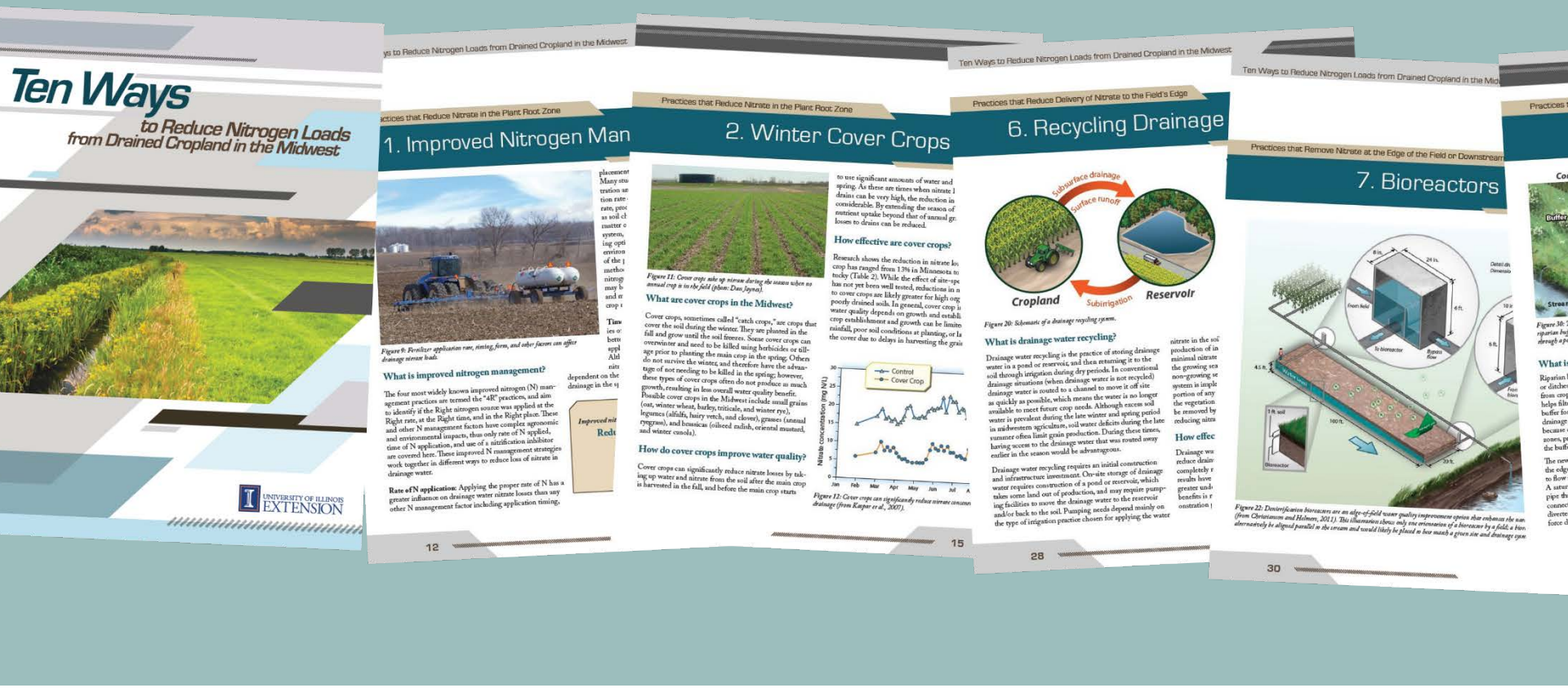

TEN WAYS

TO REDUCE NITROGEN LOADS FROM DRAINED CROPLAND IN THE MIDWEST

THIS WORK BROUGHT TO YOU BY

Editors:

Laura Christianson, Crop Sciences, University of Illinois

Jane Frankenberger, Agricultural and Biological Engineering, Purdue University

Chris Hay, Agricultural and Biosystems Engineering, South Dakota State University (former); Iowa Soybean Association (current)

Matthew Helmers, Agricultural and Biosystems Engineering, Iowa State University

Gary Sands, Bioproducts and Biosystems Engineering, University of Minnesota

Funders:

NORTH CENTRAL REGION WATER NETWORK

USDA NIFA (Agreement No. 2008-51130-04751),

East Dakota Water Development District

ARTIFICIAL DRAINAGE IS INTEGRAL TO CROP PRODUCTIVITY.

The US Midwest has a long history of drainage because it improves crop growth and trafficability.

http://www.nejohnston.org/wej/120%20Years%20of%20Johnston%20Farming/120%20years%20of%20Johnston%20Farming.html; http://mrbdc.mnsu.edu/sites/mrbdc.mnsu.edu/files/public/major/midminn/subshed/sevenmi/vtour/images/trench_crew_l.jpg; The Wetland Initiative

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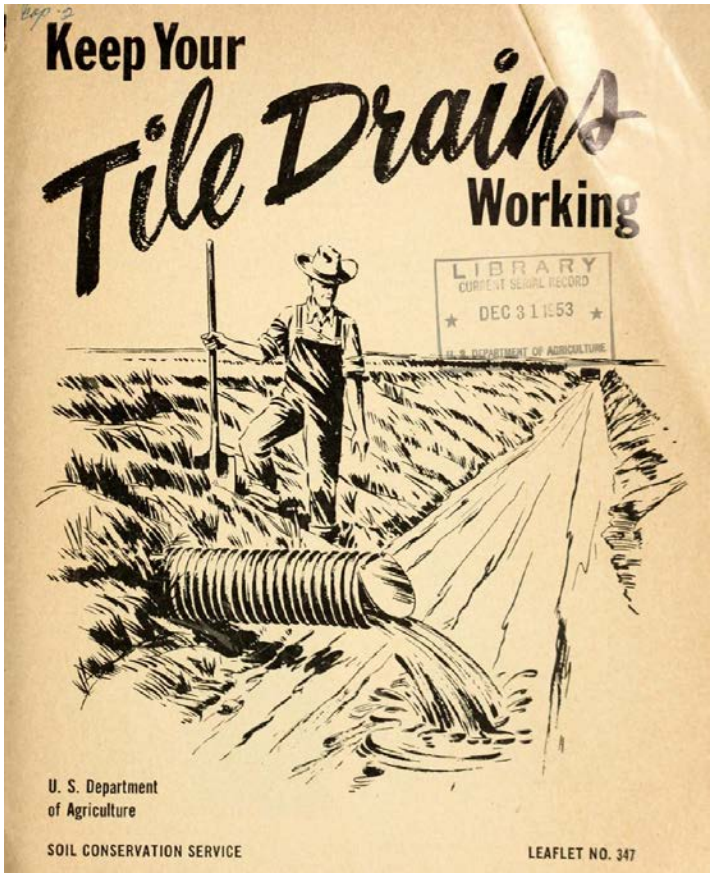

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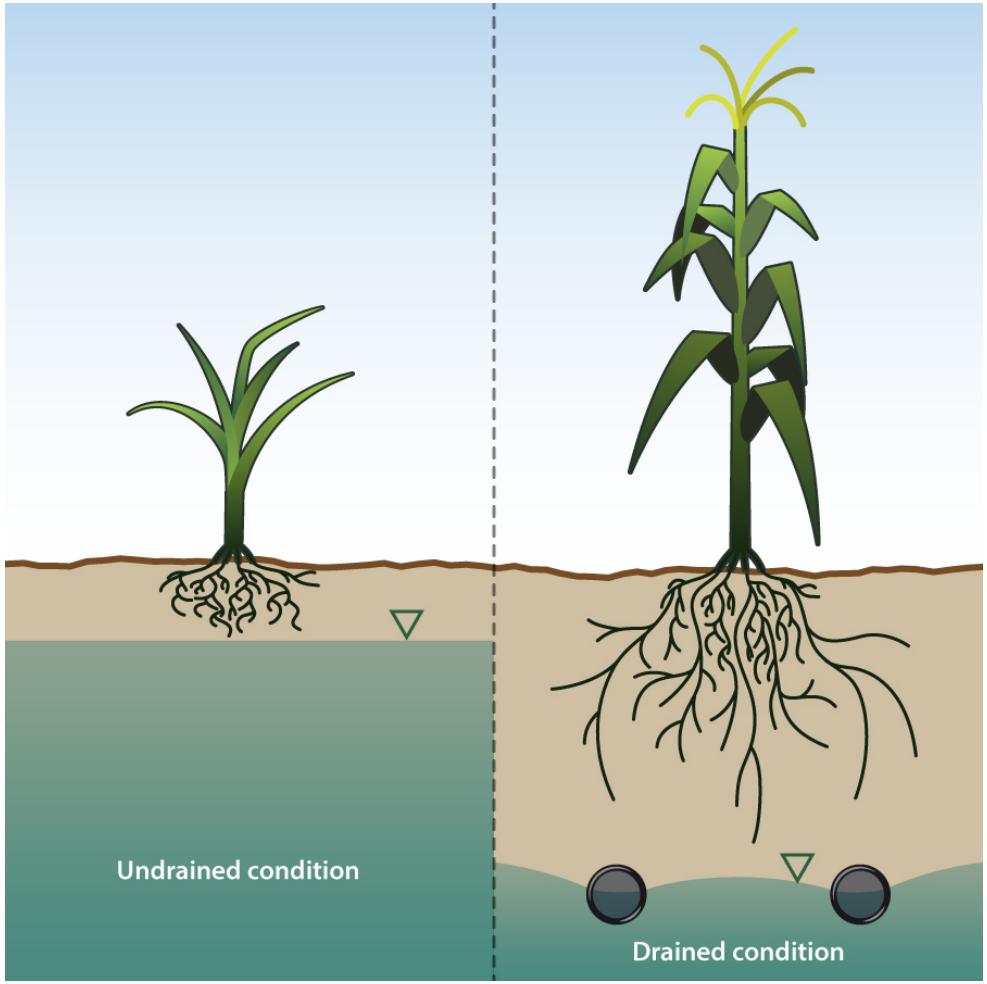
Tile drainage changes the natural hydrology and is a pathway for nutrients to move from our fields.



Not to scale

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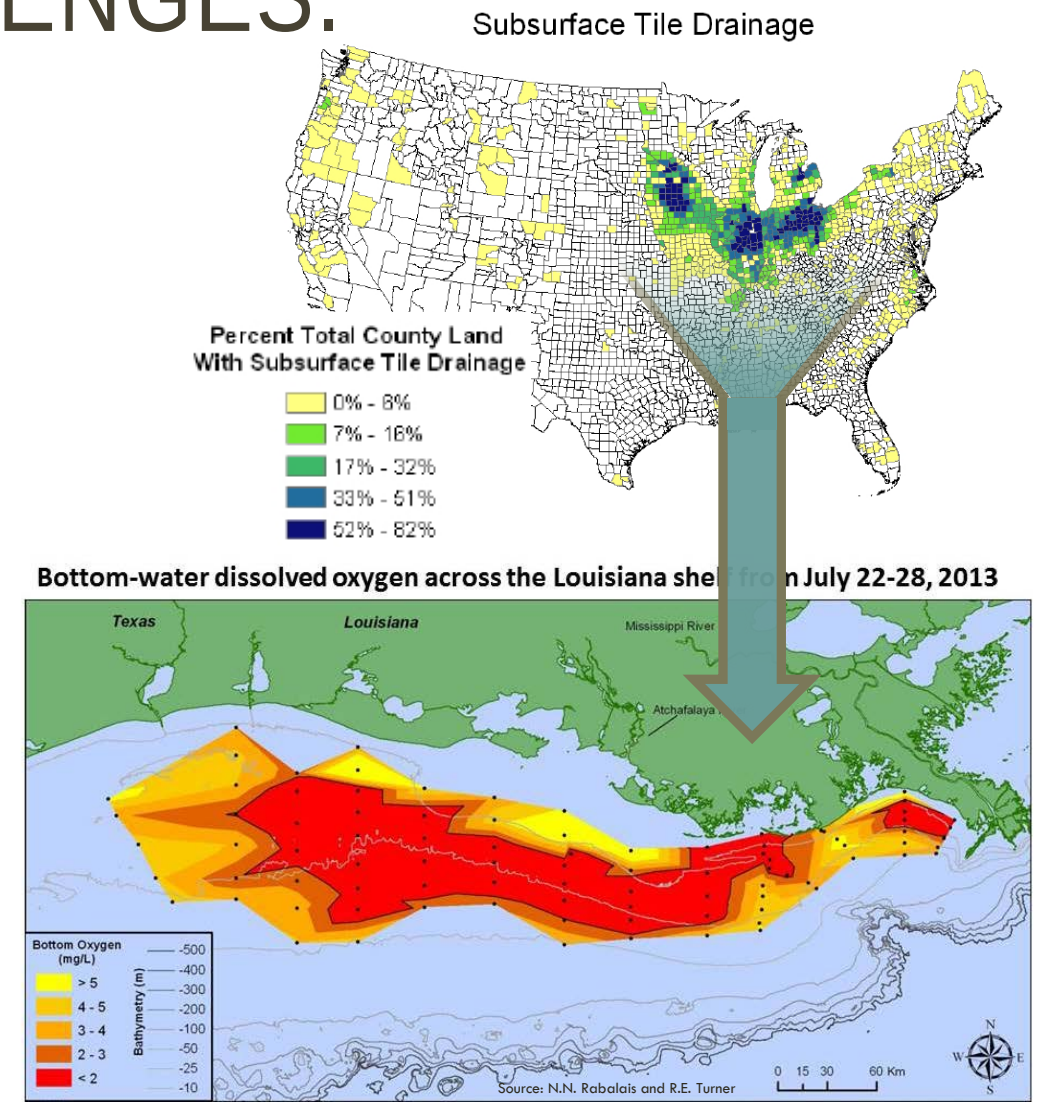

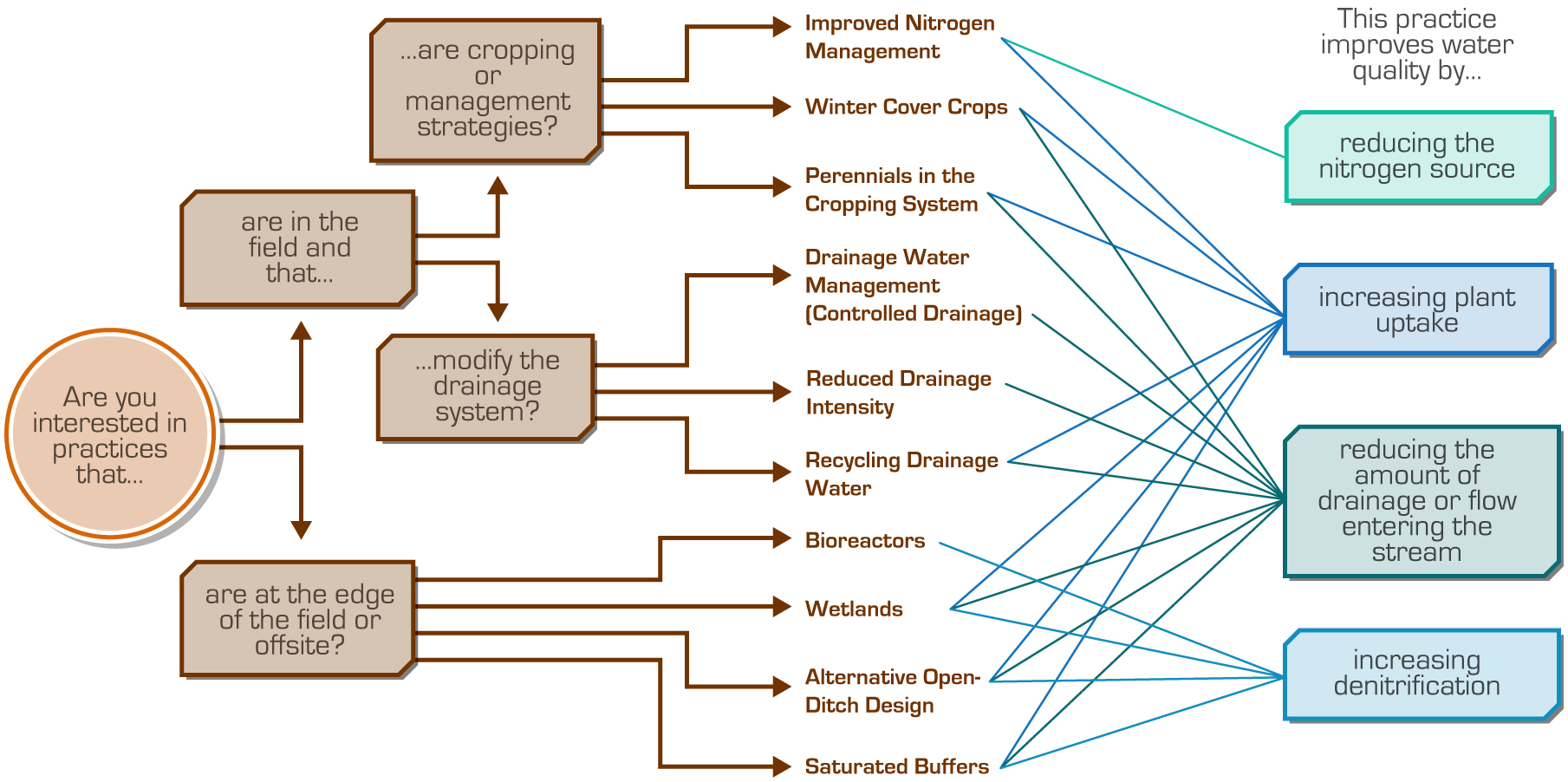
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Saturated Buffers
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reducing the nitrogen source
increasing plant uptake
reducing the amount of drainage or flow entering the stream
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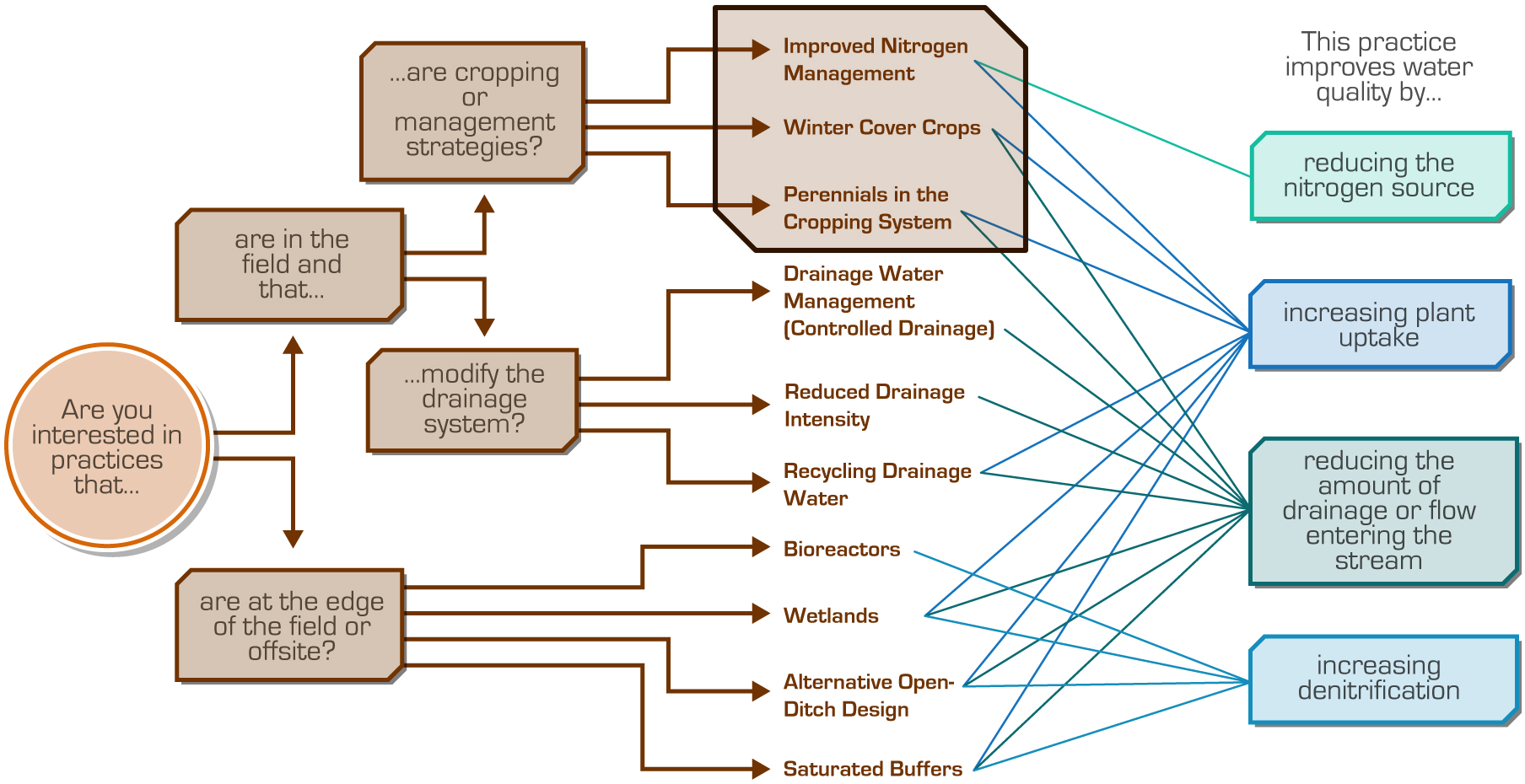
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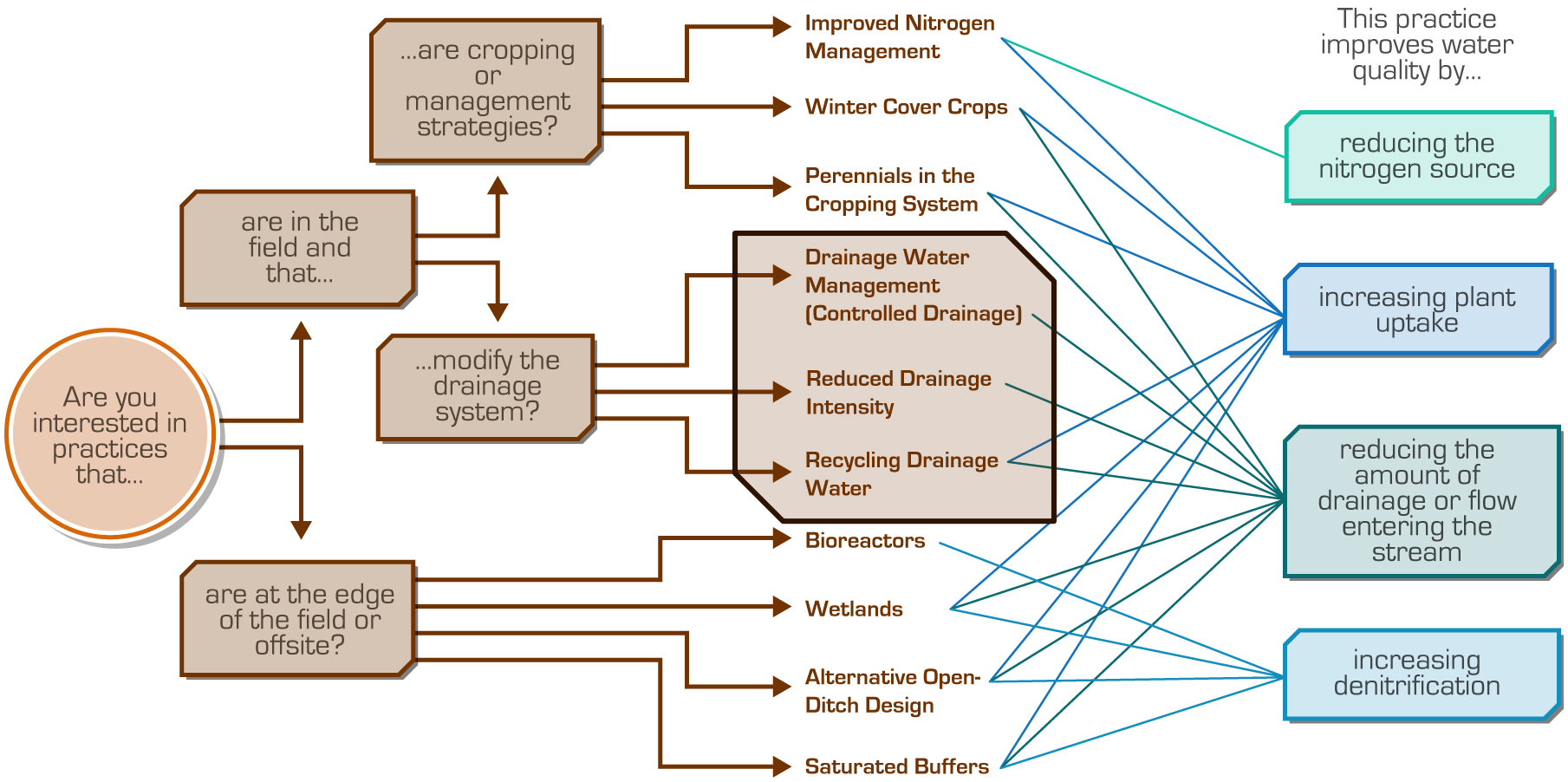
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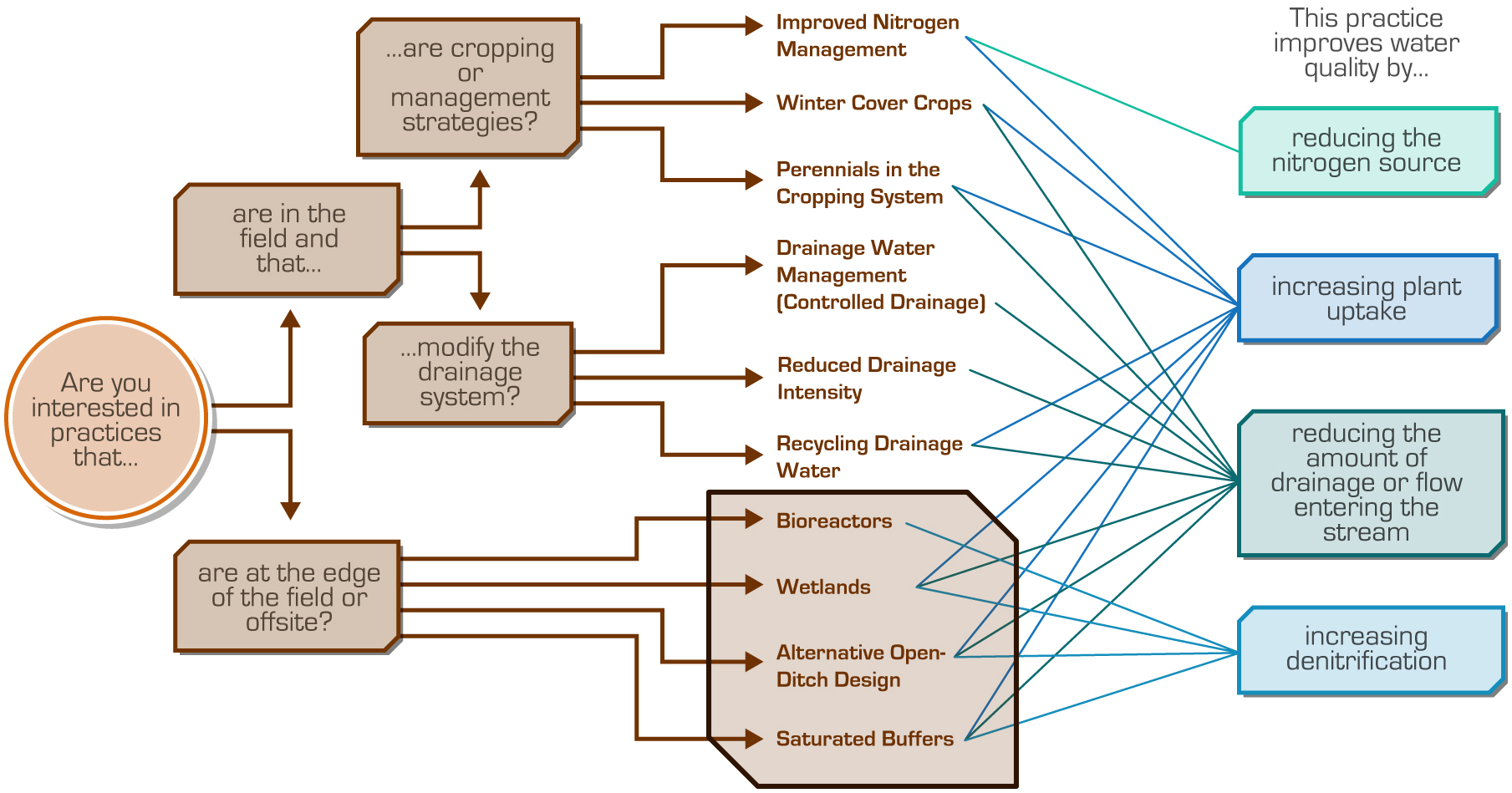
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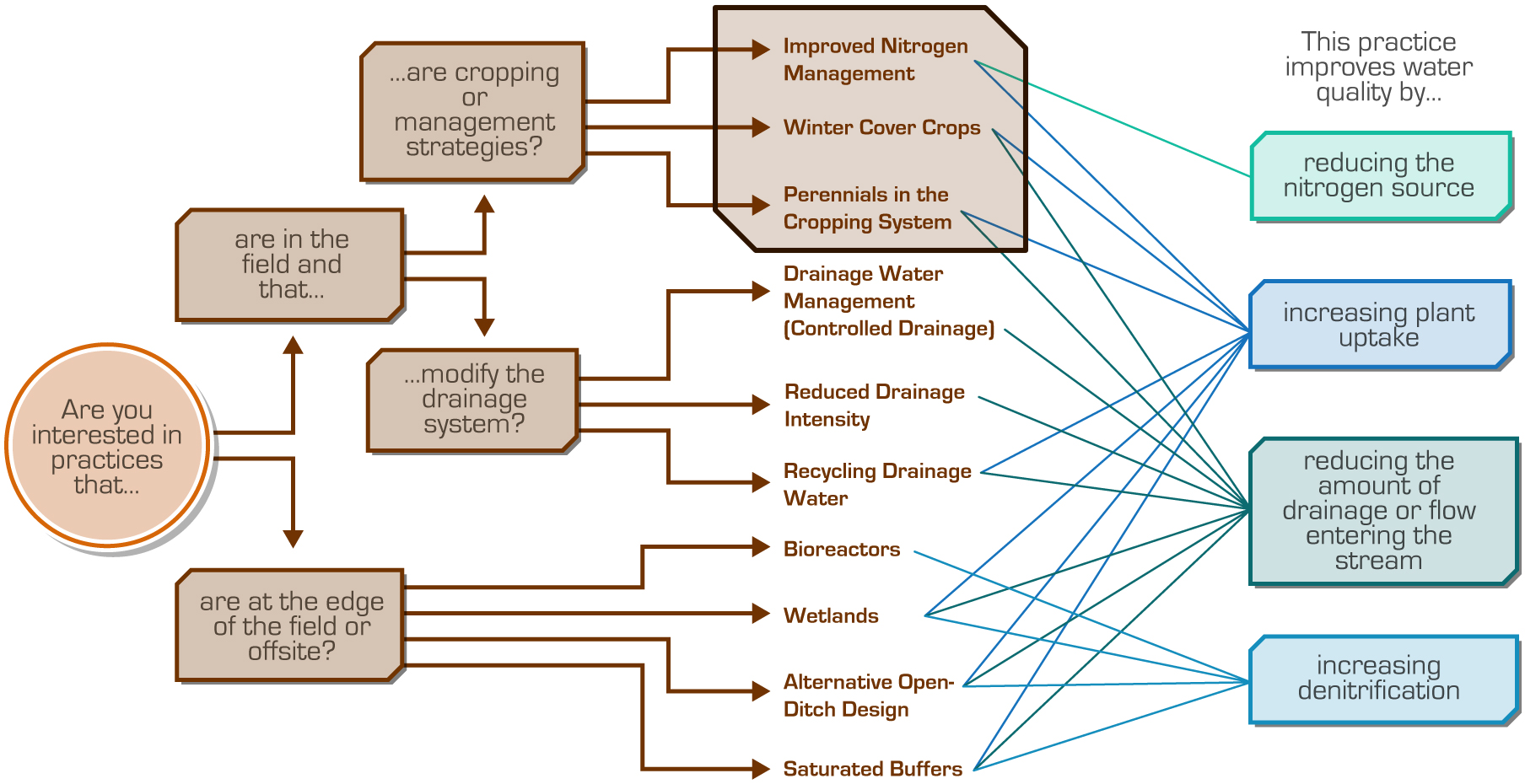
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IN-FIELD MANAGEMENT PRACTICE:

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"

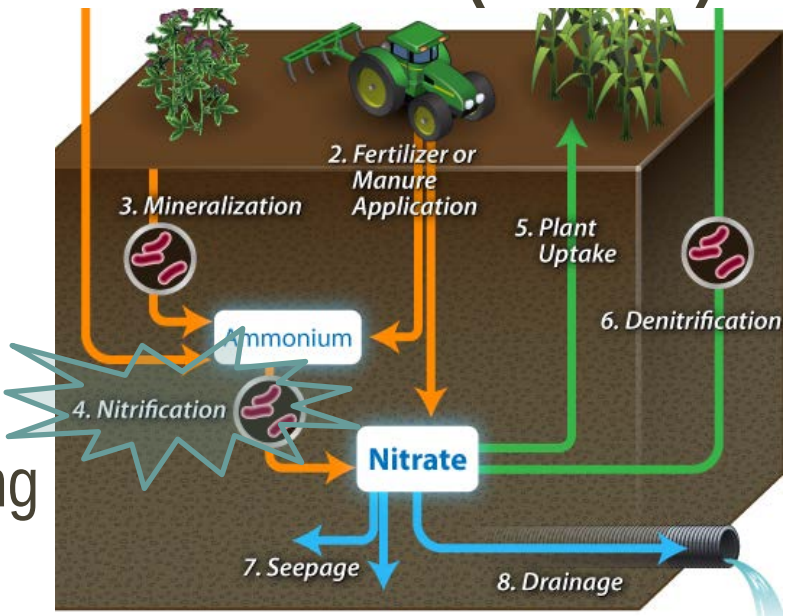
http://www.nutrientstewardship.com/what-are-4rs

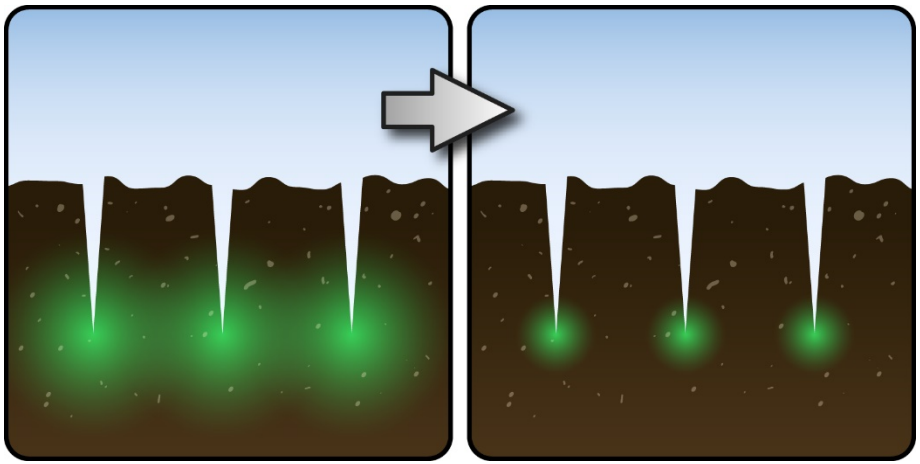
IN-FIELD MANAGEMENT PRACTICE:

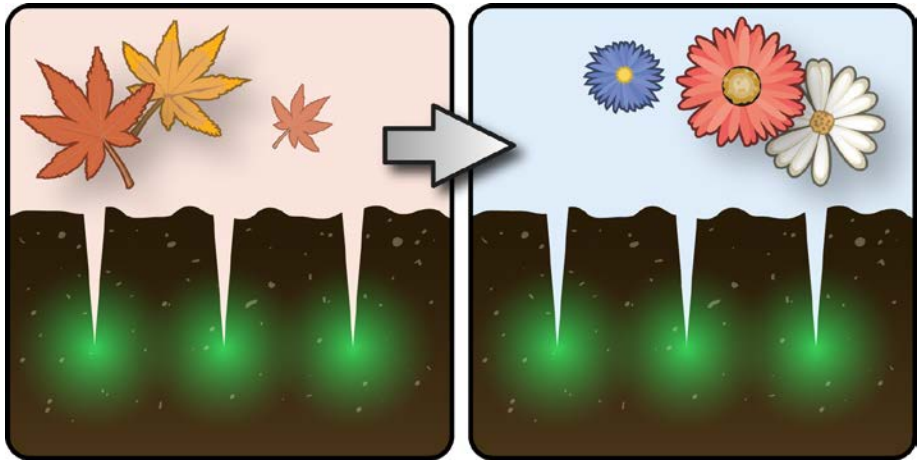
IMPROVED N MANAGEMENT (4RS)

What is it? Applying "the right source of nutrient, at the right rate, at the right time, and in the right place"

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







IN-FIELD MANAGEMENT PRACTICE:

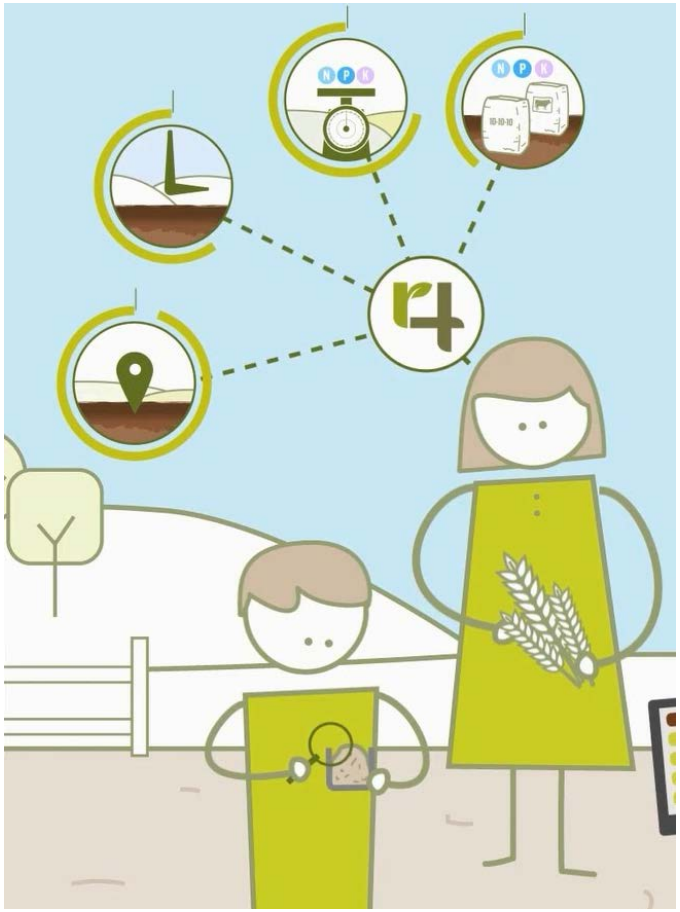
IMPROVED N MANAGEMENT (4RS)

What is it? Applying "the right source of nutrient, at the right rate, at the right time, and in the right place"

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

IN-FIELD MANAGEMENT PRACTICE:

WINTER COVER CROPS

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

Winter wheat drilled into soybeans following harvest.

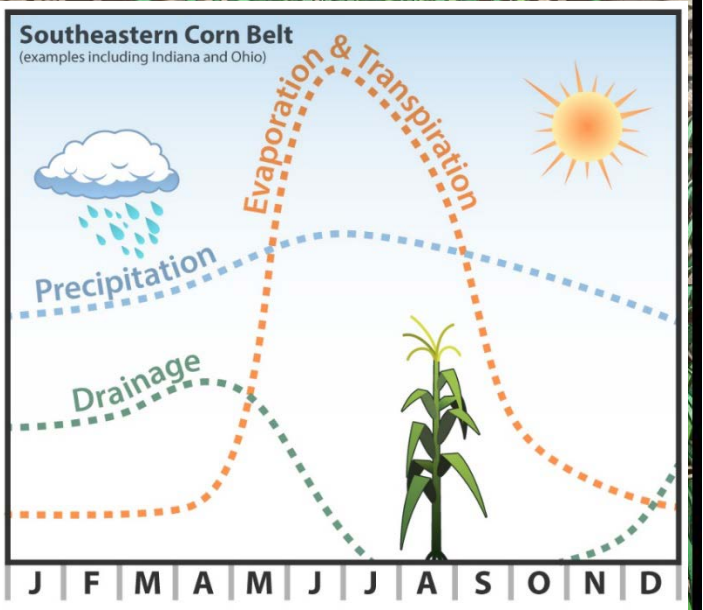
Photo: http://www.covercrops.msu.edu/general/general.html

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:

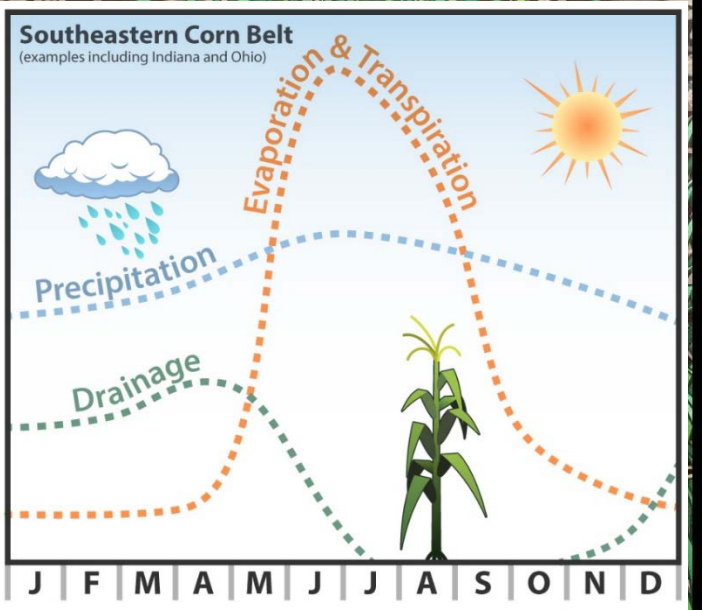
WINTER COVER CROPS

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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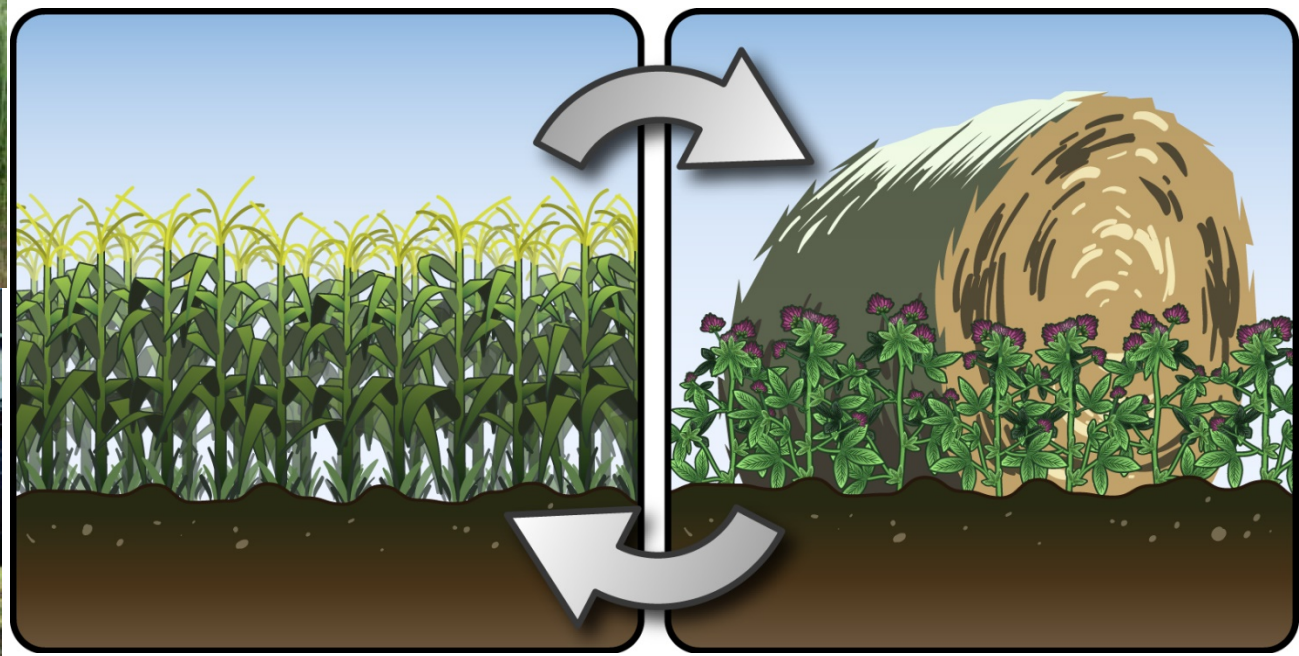
Where does it work? Robust establis… is the most important for water quality benefits

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



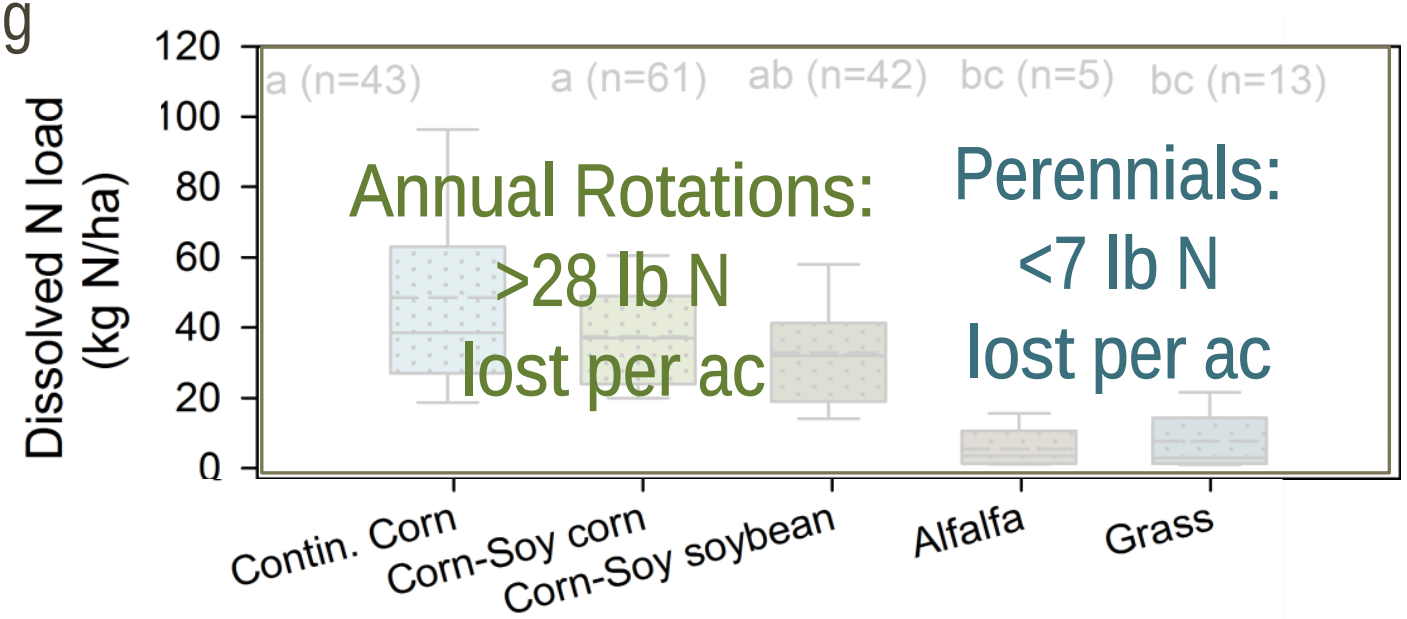
IN-FIELD MANAGEMENT PRACTICE:

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:



Source: Christianson and Harmel, 2015 (*Ag. Water Management*)

IN-FIELD MANAGEMENT PRACTICE:

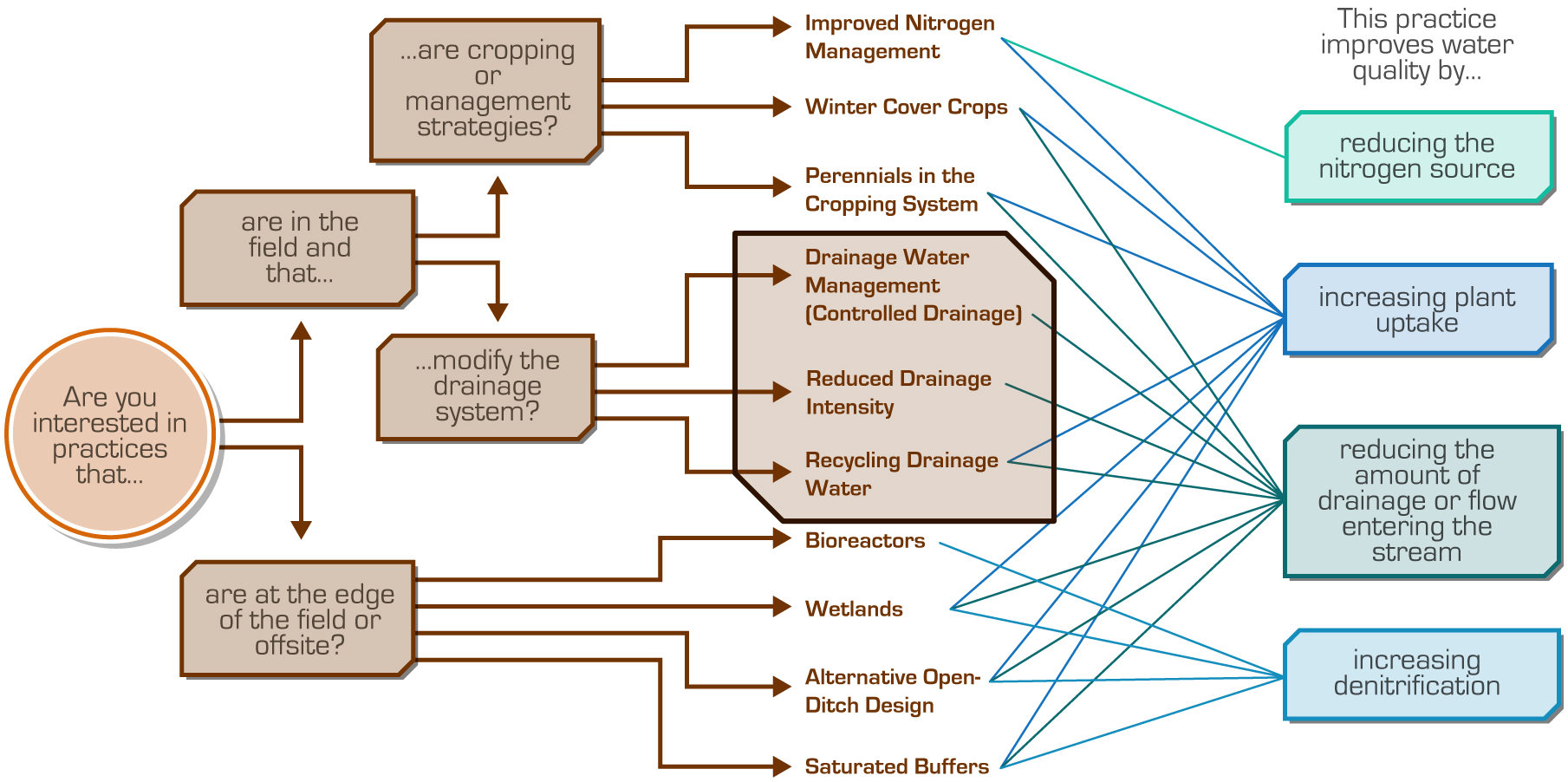
PERENNIALS IN THE ROTATION

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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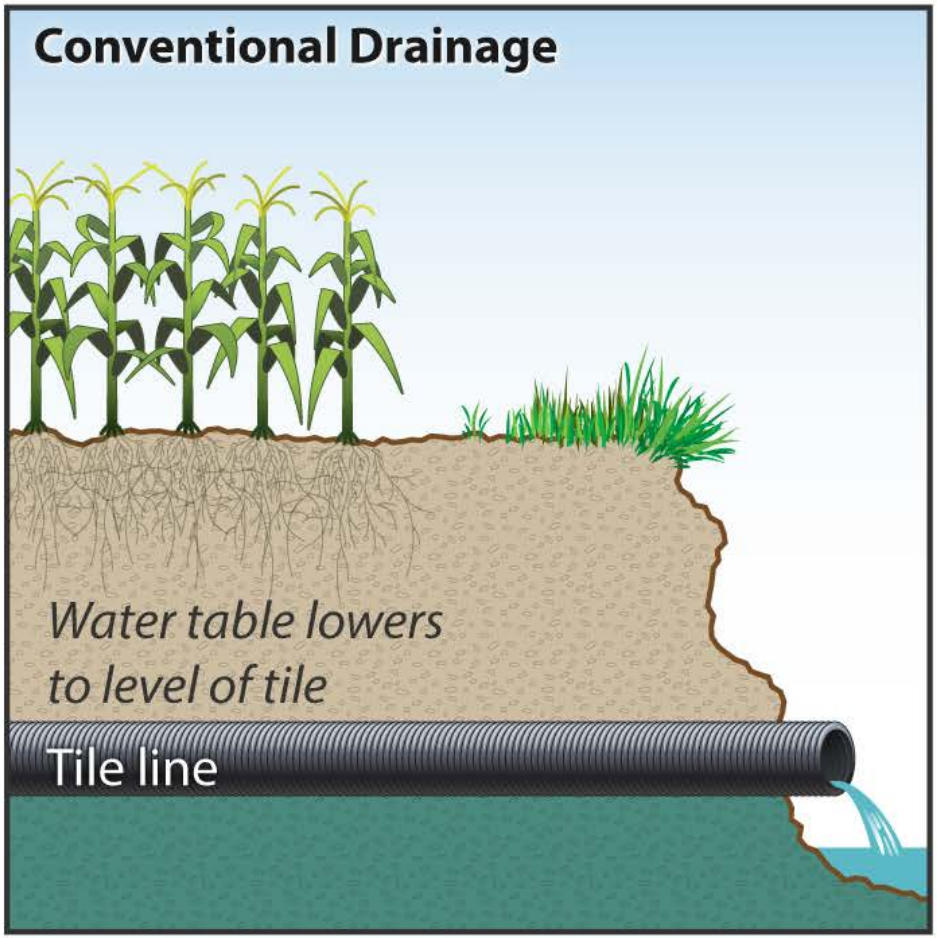
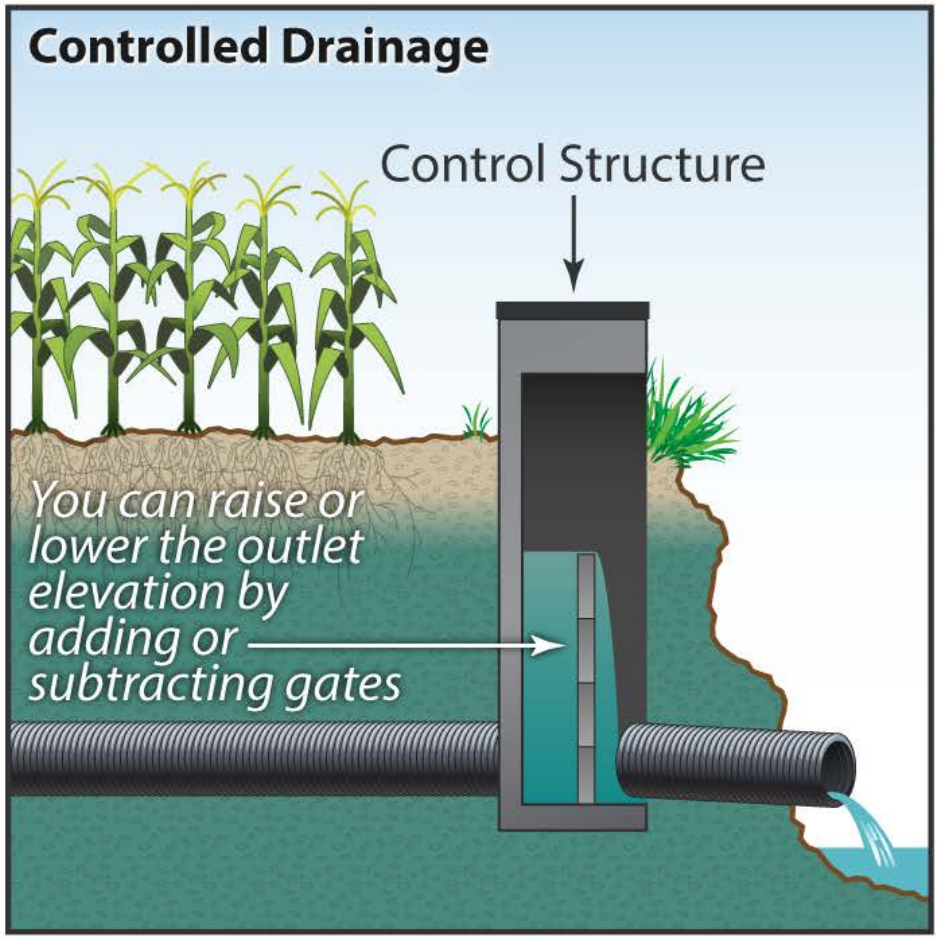
IN-FIELD DRAINAGE SYSTEM PRACTICE:

DRAINAGE WATER MANAGEMENT

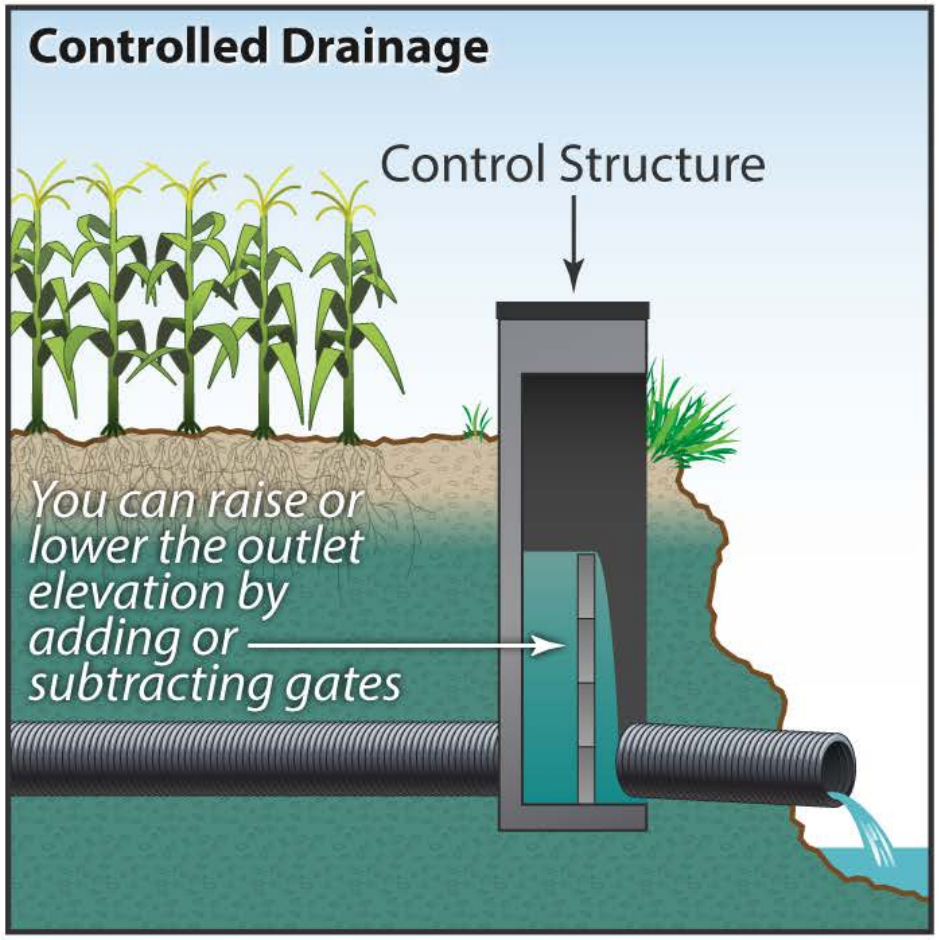




IN-FIELD DRAINAGE SYSTEM PRACTICE:

DRAINAGE WATER MANAGEMENT

What is it? Adjustable structures to manage the level of the drainage outlet



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

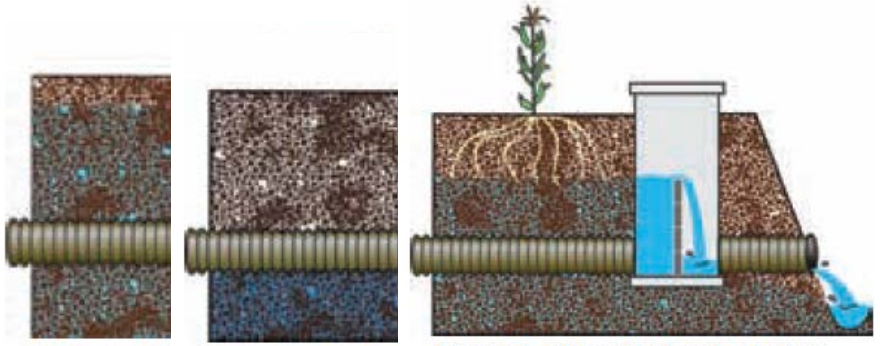
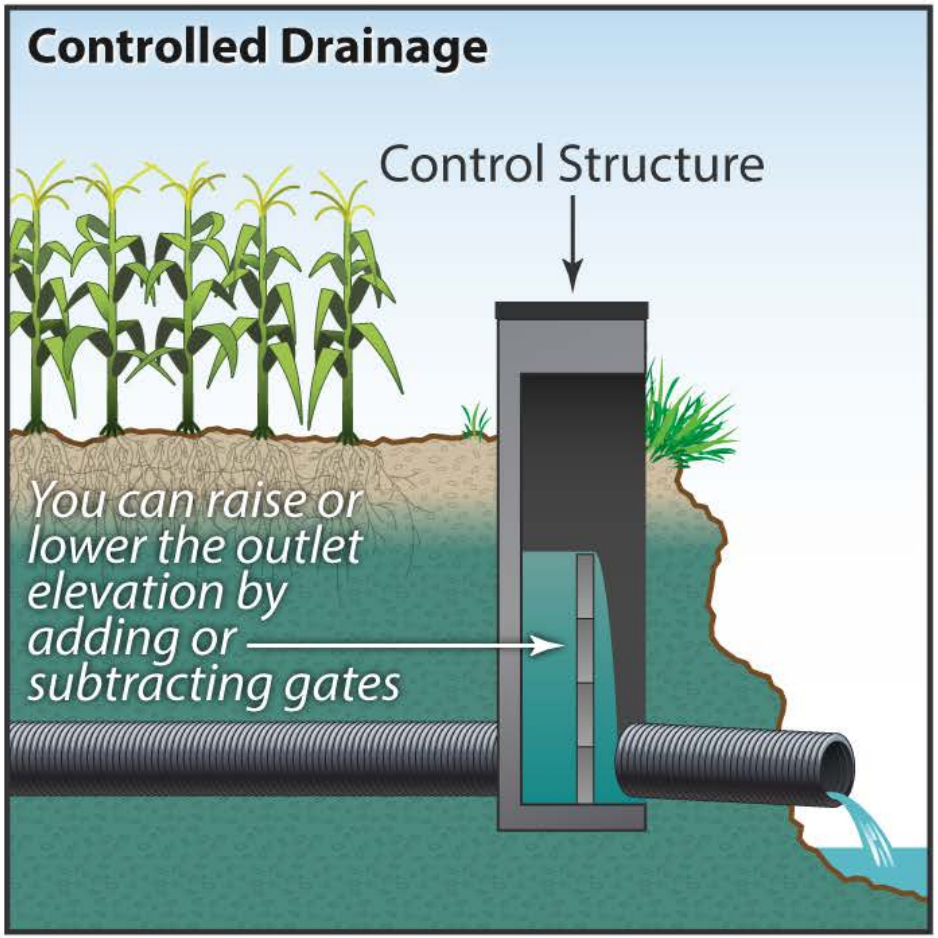


Figure 1. *T harvest to*

Figure 2. *The c weeks before p allow the field t*

Figure 3. *The outlet is raised after planting to potentially store water for crops.*



Source: Frankenberger et al. (Purdue Extension publication WQ-44)

IN-FIELD DRAINAGE SYSTEM PRACTICE:

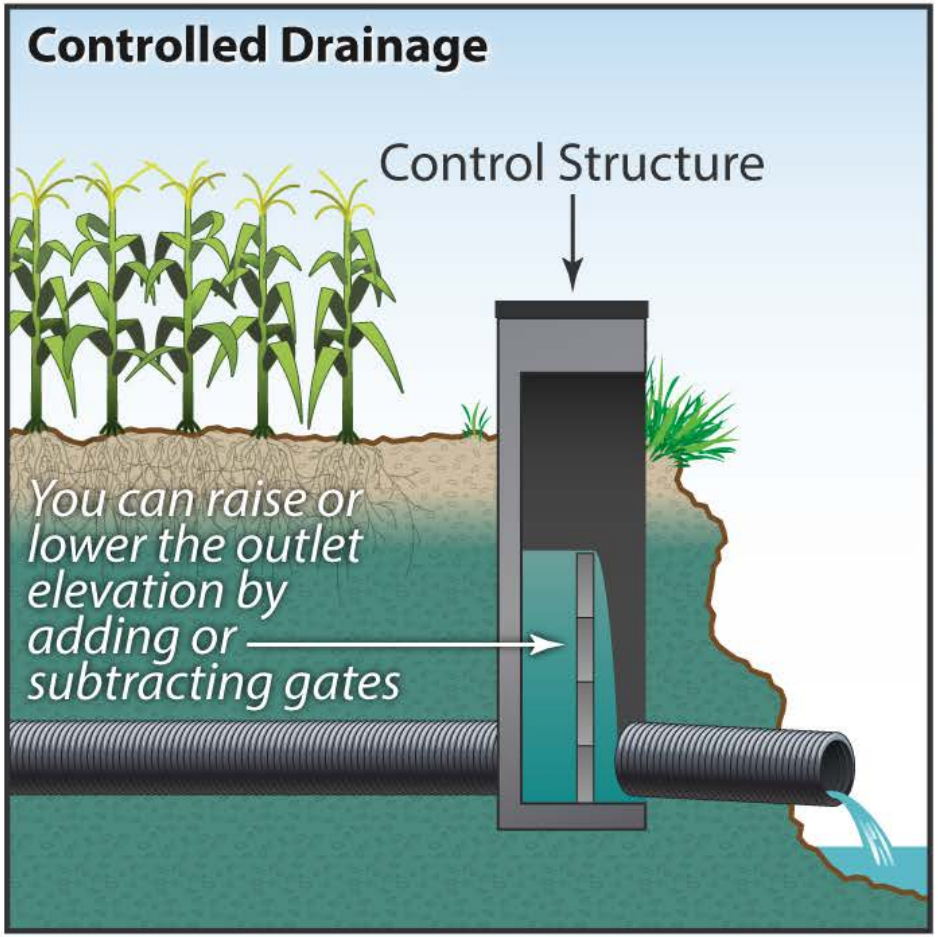
DRAINAGE WATER MANAGEMENT

What is it? Adjustable structures

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

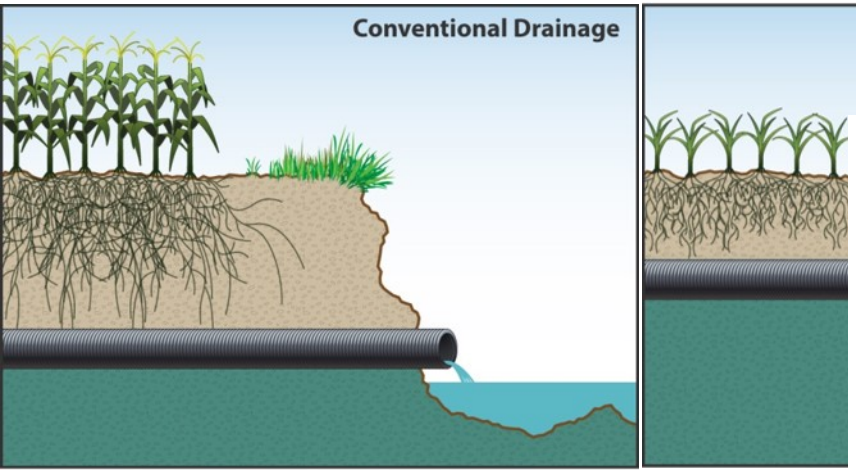
How effective is it? Generally a 30% N loss reduction (15-75%)

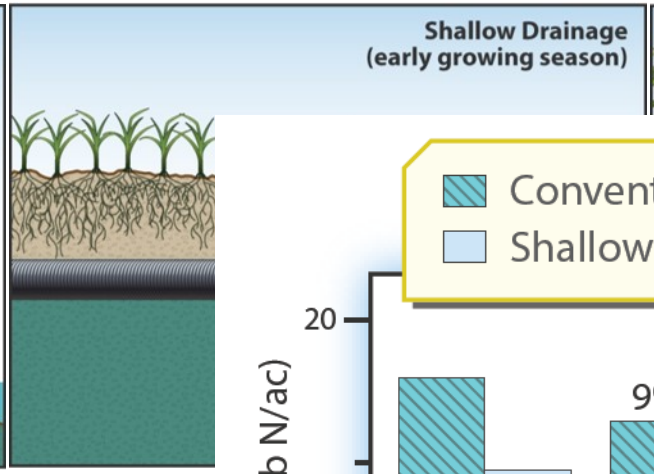
Where does it work? Most practical on slopes of <0.5% because more structures are needed with steeper slopes

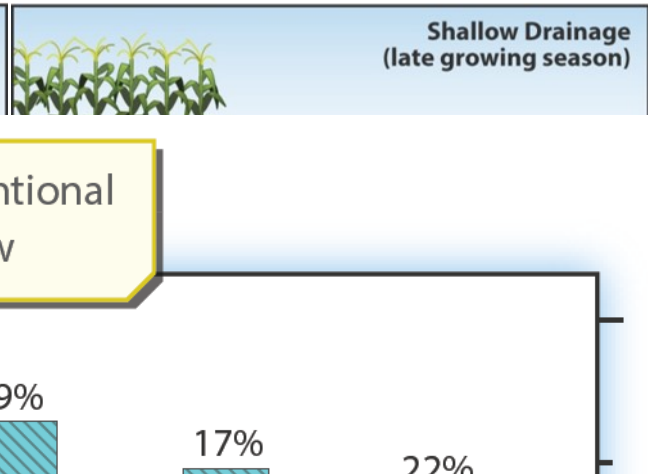


IN-FIELD DRAINAGE SYSTEM PRACTICE:

REDUCED DRAINAGE INTENSITY





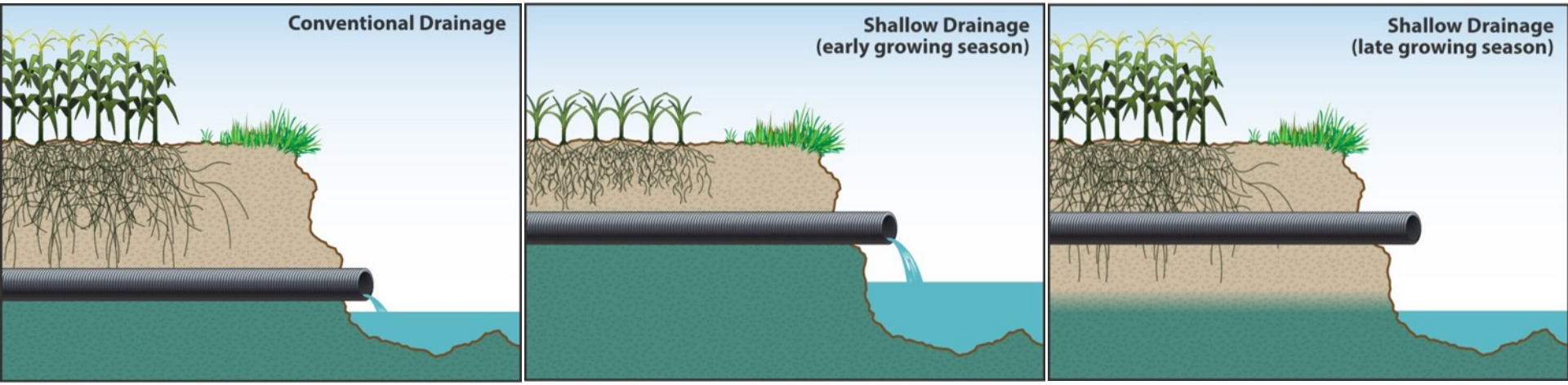


What is it? Installation of subsurface drains either closer to the surface or with wider spacing than conventionally done

Source: Luo et al., 2010

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

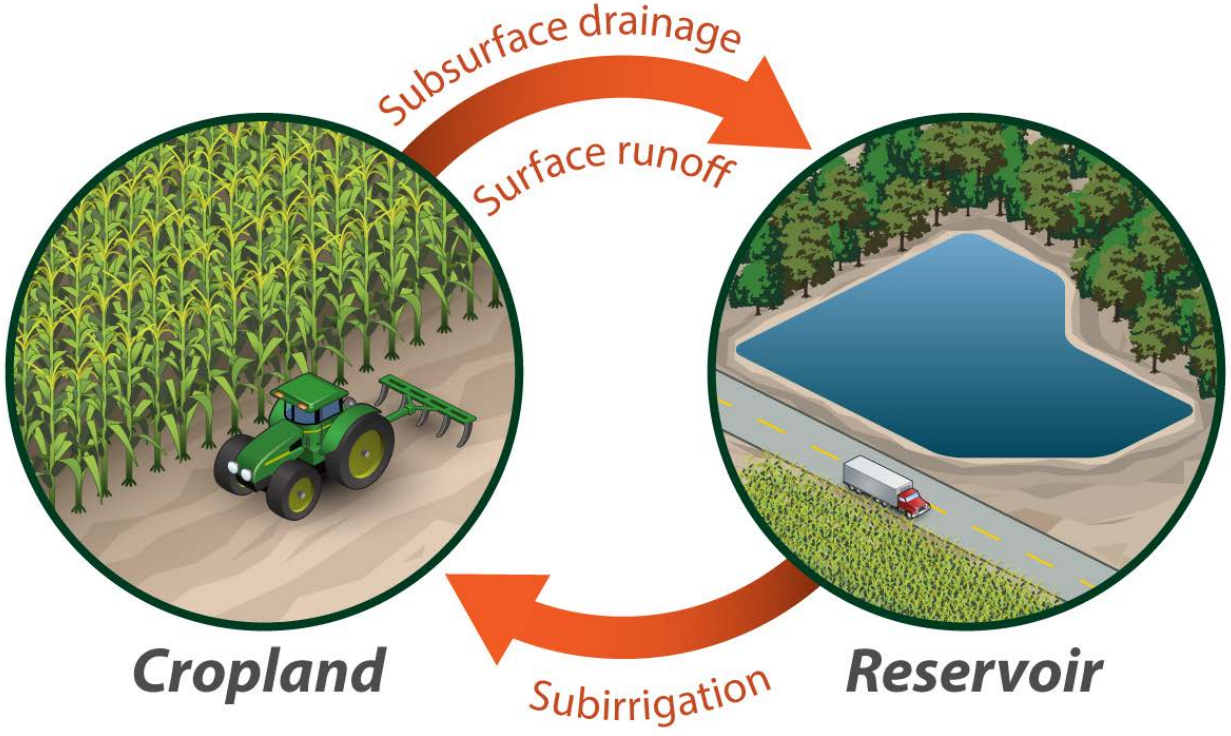
How effective is it? Approximately a 20-30% annual N loss reduction

Where does it work? Anywhere subsurface drainage is installed

IN-FIELD DRAINAGE SYSTEM PRACTICE:

RECYCLING DRAINAGE WATER

What is it? Drainage water is stored in a pond or reservoir and then returned it to the soil through irrigation during dry periods

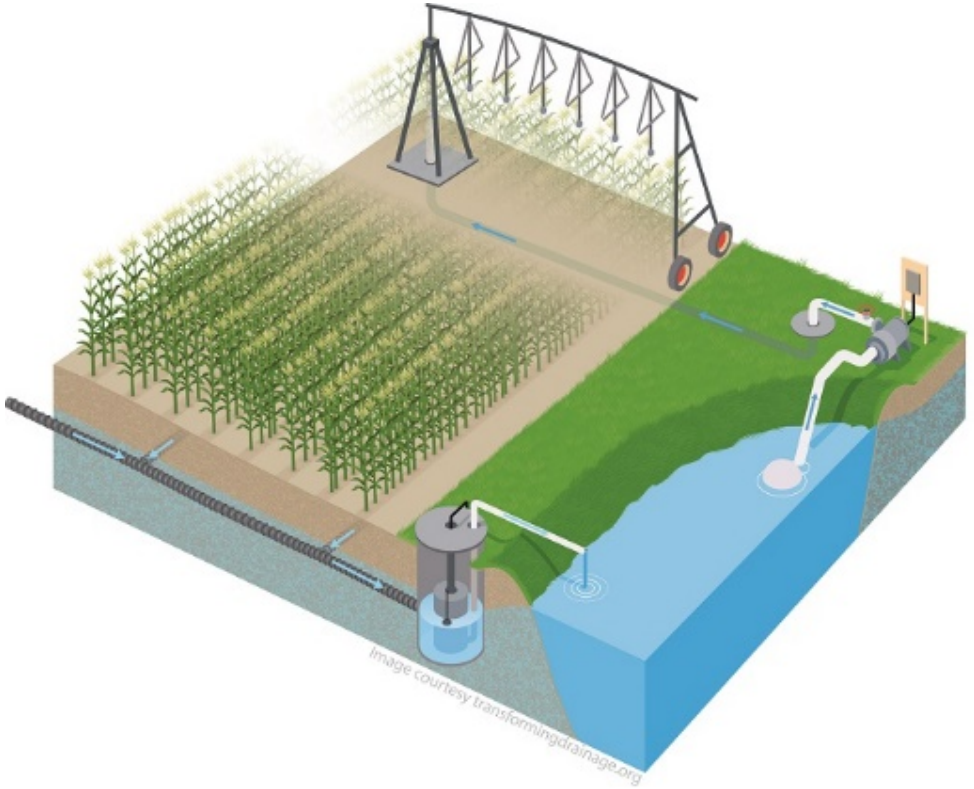


How does it reduce N loss in drainage?

Recycling the drainage water can reduce or even potentially eliminate nitrate loss by reducing or eliminating the water that leaves the site

IN-FIELD DRAINAGE SYSTEM PRACTICE:

RECYCLING DRAINAGE WATER

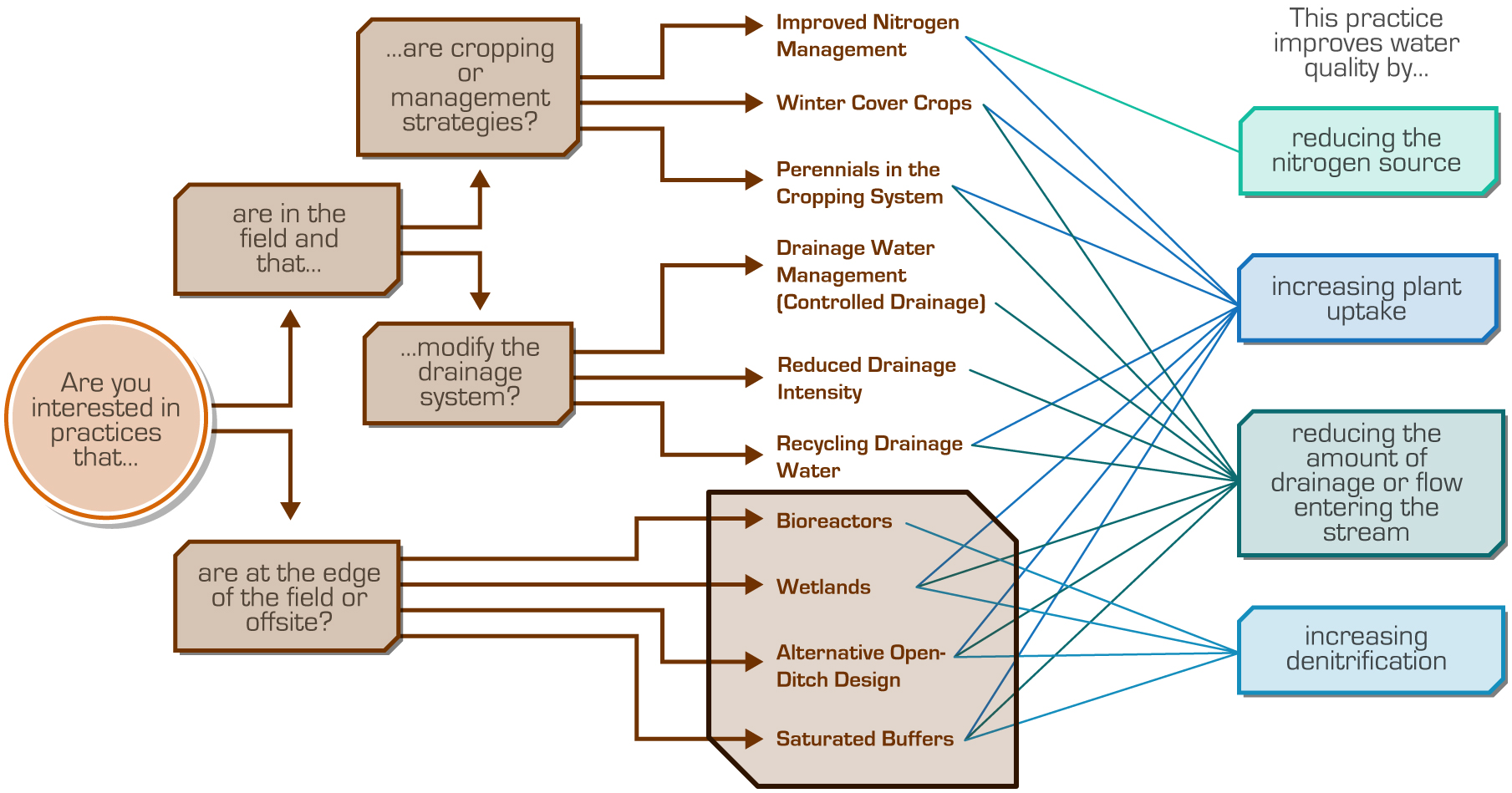


What is it? Store drainage water for later crop application

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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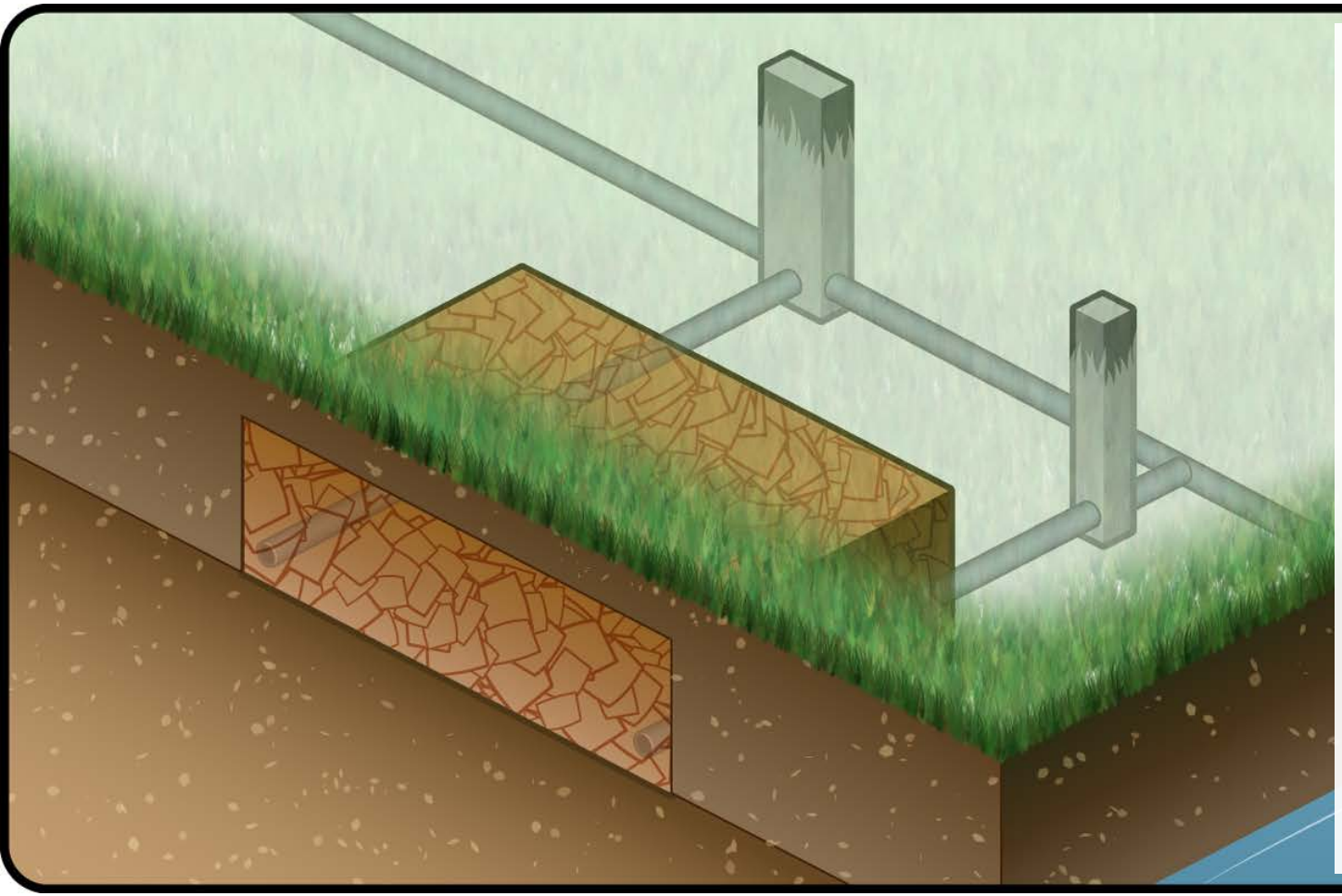
EDGE-OF-FIELD OR OFF-SITE PRACTICE:

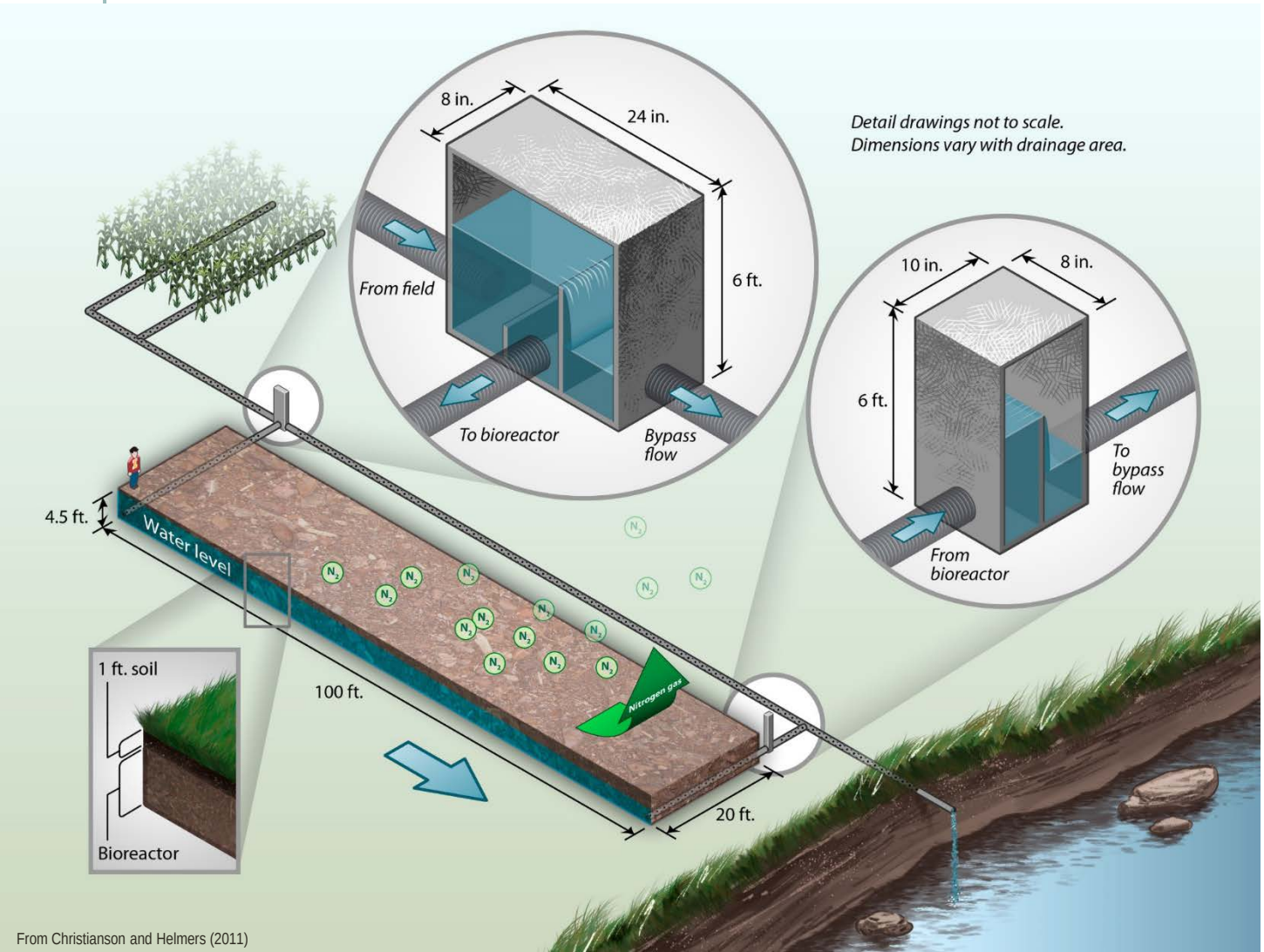
WOODCHIP BIOREACTORS



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



From Christianson and Helmers (2011)

What is it?

Woodchip-filled trench

How does it reduce N loss in drainage?

Additional carbon "super-powers" the natural process of denitrification

EDGE-OF-FIELD OR OFF-SITE PRACTICE:

WOODCHIP BIOREACTORS

What is it? Woodchip-filled trench

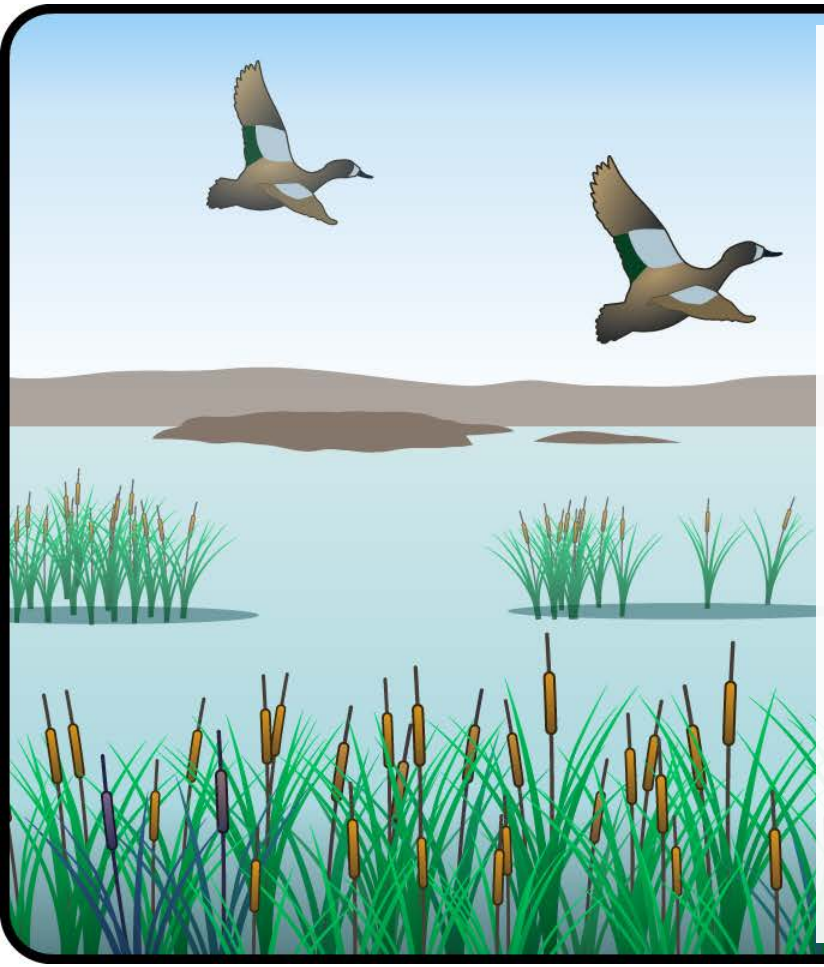
How does it reduce N loss in drainage? Enhances the natural process of denitrification

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 w tlands are dynamic ecosyste

How does d drainage?

and

How ef nual N los

Where erns about the ou of production limits wide read implementation

Lots of additional benefits! Flood retention, wildlife habitat…

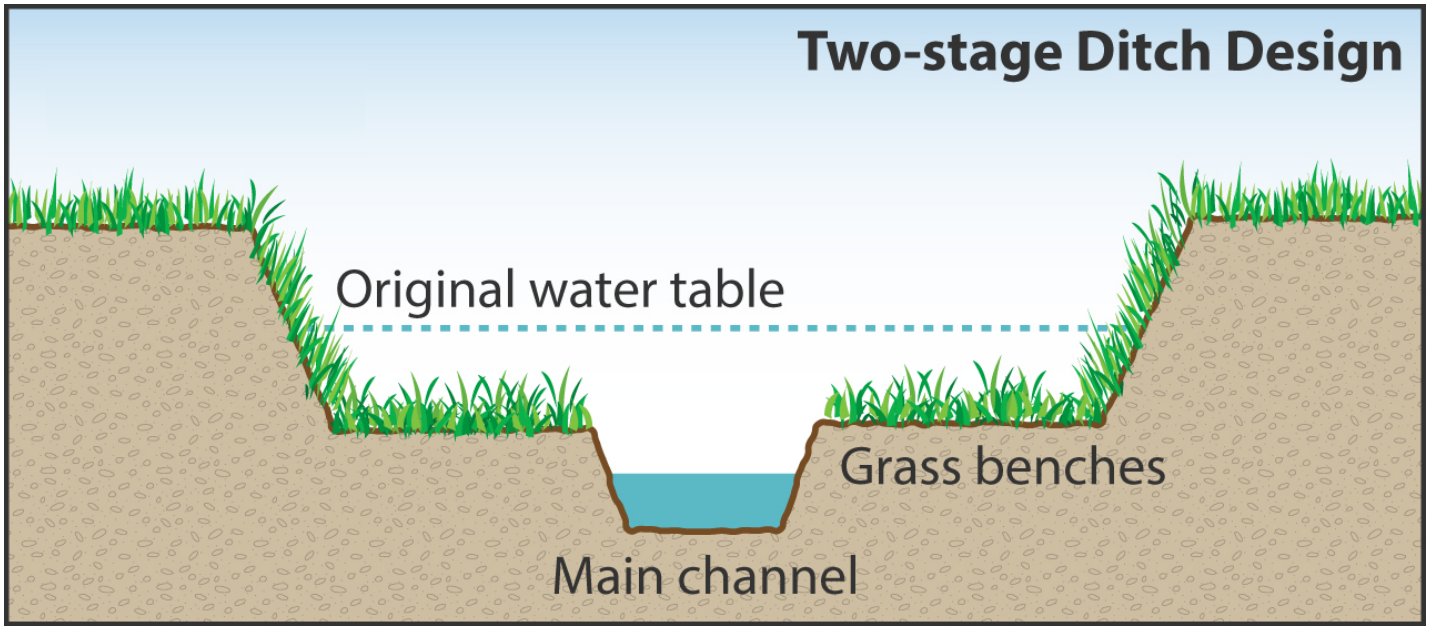
Photo: https://iowalearningfarms.wordpress.com/2014/06/26/incredible-wetlands/

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

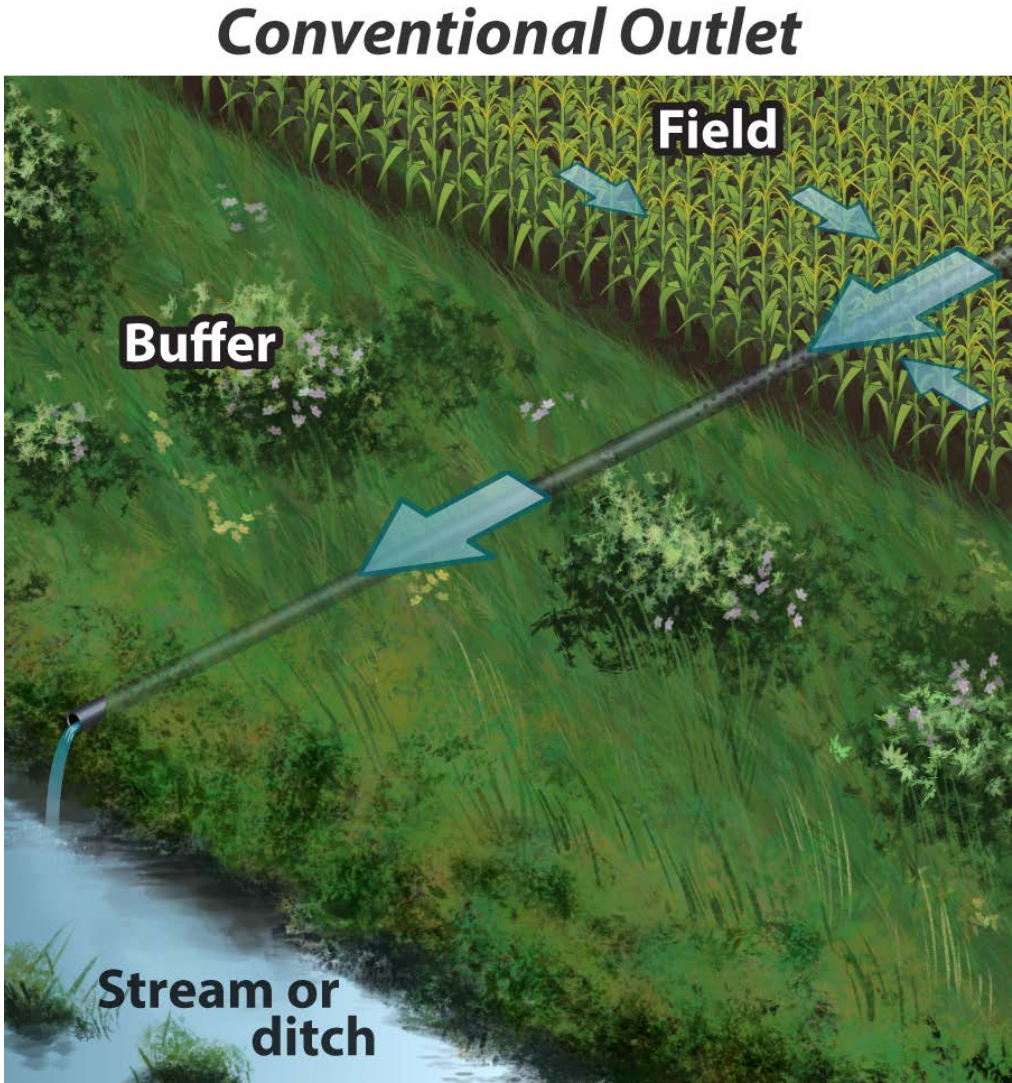
Where does it work? Where there are existing ditches; ditch may need to be widened, but may reduce cleanout costs

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/indiana/placesweprotect/two-stage-ditches-the-wabash.xml; http://www.nature.org/cs/groups/webcontent/@web/@indiana/documents/document/prd_034172.pdf

EDGE-OF-FIELD OR OFF-SITE PRACTICE:

SATURATED BUFFERS

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

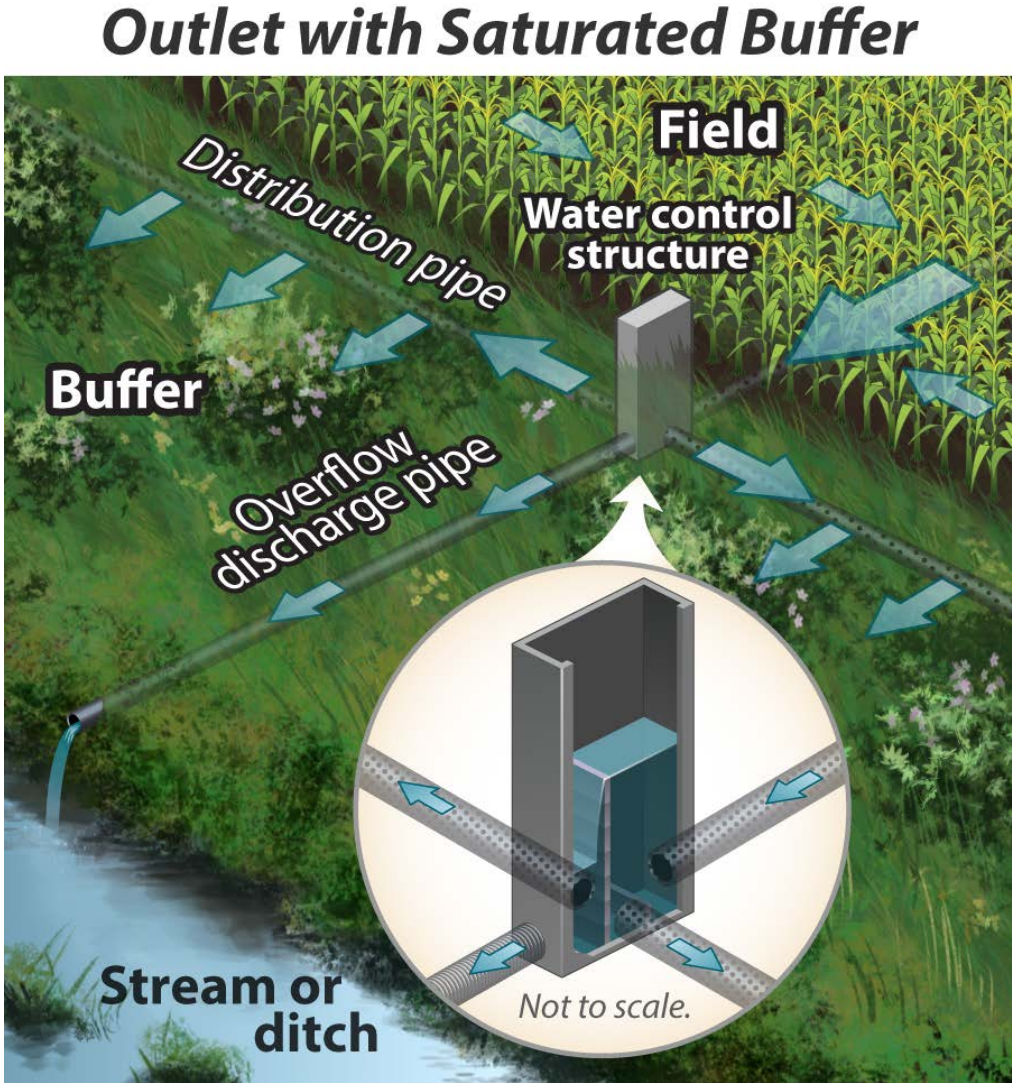


EDGE-OF-FIELD OR OFF-SITE PRACTICE:

SATURATED BUFFERS

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

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

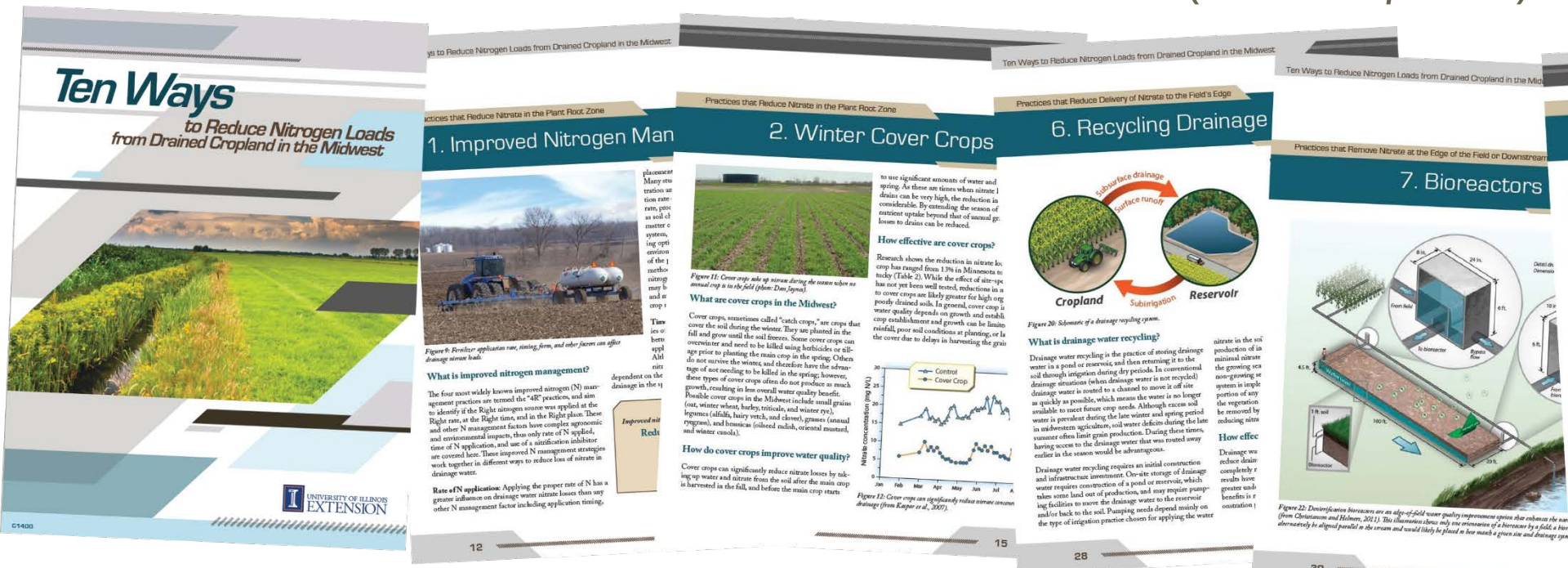
Practices to reduce N loads in drainage vary in:

- 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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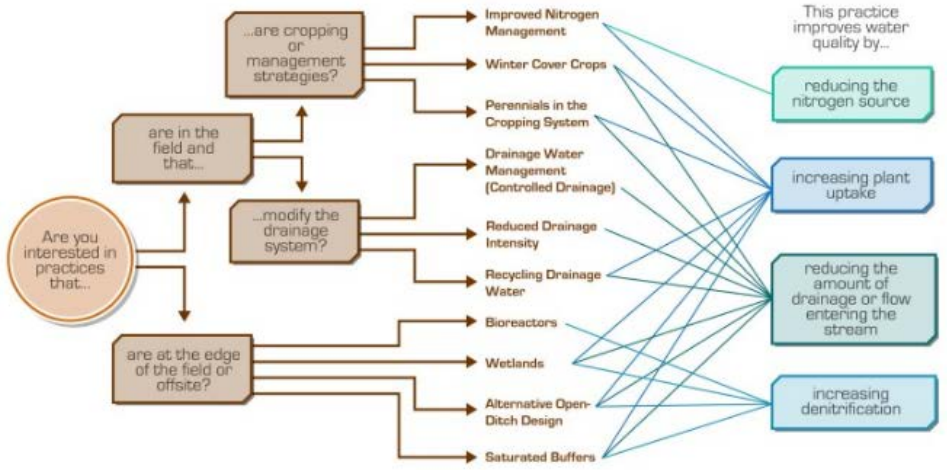
The *Ten Ways* strategies include in-field cropping and management strategies (i.e., practices that reduce nitrate in the root zone), in-field strategies that modify the drainage system (i.e., practices that reduce delivery of nitrate to the field's edge), and edge-of-field strategies (i.e., practices that remove nitrate at the edge of the field or downstream).



Are you an educator?

Please click here to complete a Google Form requesting access to the PowerPoint presentation modules that accompany the *Ten Ways* booklet. We'll also provide a survey for your program to help us track understanding of the the *Ten Ways* and to evaluate the impact of this project.

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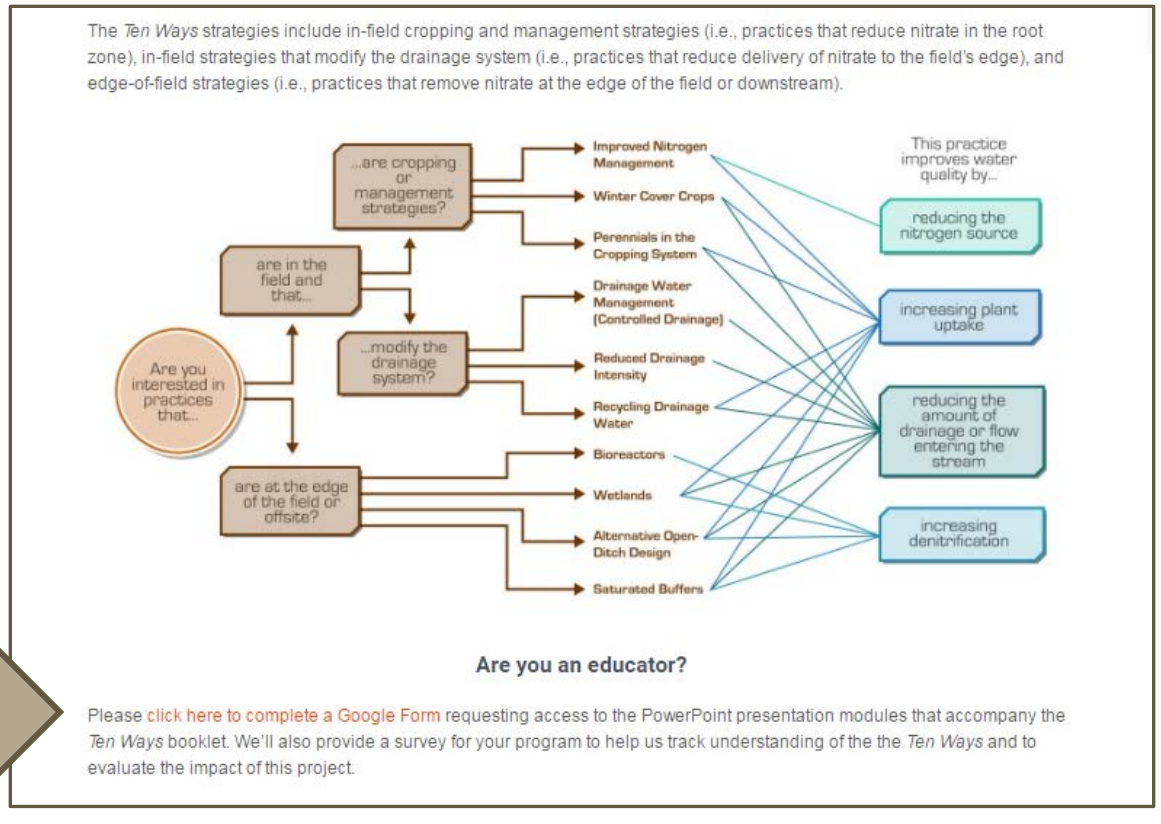

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