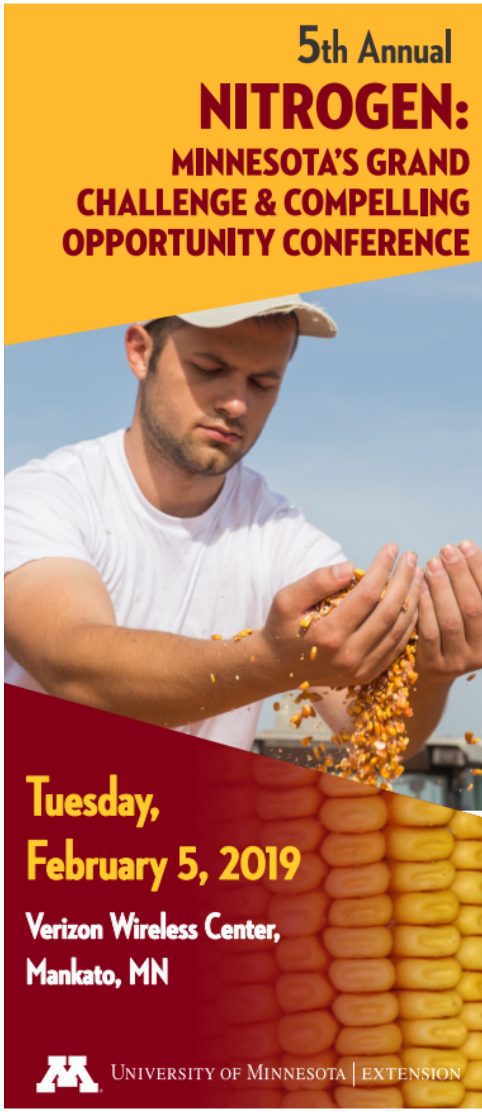
Proceedings of the 5th Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference



5TH ANNUAL NITROGEN: MINNESOTA'S GRAND CHALLENGE & COMPELLING OPPORTUNITY CONFERENCE

Sessions 9:05 a.m.-3:40 p.m.

GENERAL SESSION

8:15 a.m.	***Registration***	
9:00 a.m.	***Welcome***	
	Tom Rothman	University of Minnesota
9:05 a.m.	***Lessons Learned in 2018, Opportunities for 2019***	
	Brad Carlson	University of Minnesota Extension
	Dave Nicolai	University of Minnesota Extension
	Brandon Fast	Minnesota Corn Research & Promotion Council
9:55 a.m.	***An Industry Perspective on Nitrogen: Beginning with 4R Nutrient Stewardship***	
	Dr. Tai Maaz	International Plant Nutrition Institute
10:50 a.m.	***Break***	
11:05 a.m.	***NUE and Potential Environmental Outcomes Associated with N Application Timing***	
	Dr. Carrie Laboski	University of Wisconsin-Madison
12:00	***Lunch***	

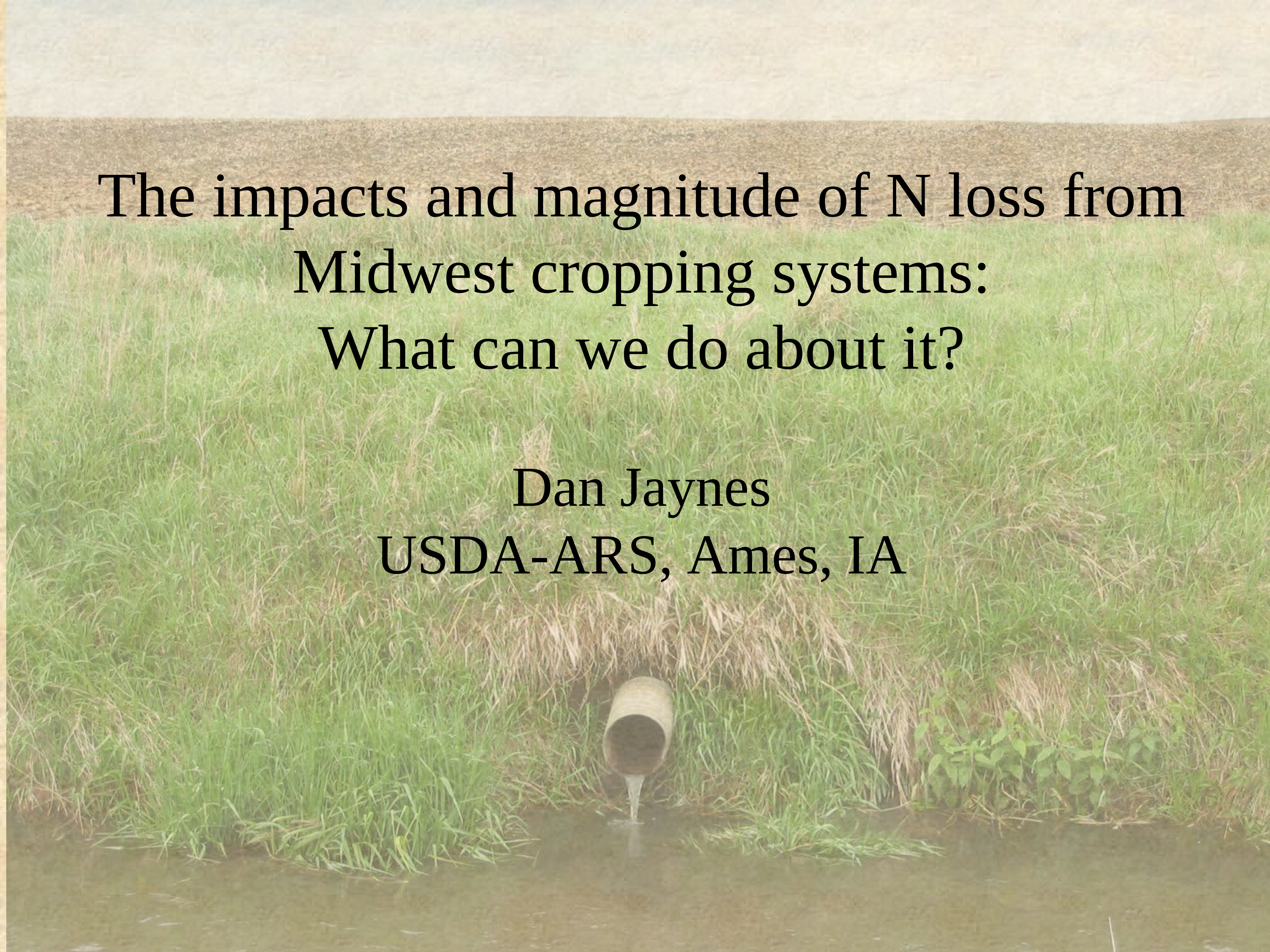
BREAKOUT SESSION #1

1:00 p.m.	***Managing Corn for High Yield and Environmental Stewardship While Controlling Costs***	
	Dr. Jeff Coulter	University of Minnesota
1:55 p.m.	***N loss from Midwest cropping systems: What can we do about it?***	
	Dr. Dan Jaynes	USDA ARS, Ames, IA
2:50 p.m.	***Urea Fertilizer Do's and Don'ts***	
	Dr. Fabián Fernández	University of Minnesota

BREAKOUT SESSION #2

1:00 p.m.	***Improving Nitrogen Mineralization Predictions***	
	Dr. Jason Clark	*South Dakota State University*
1:55p.m.	***Soil Health and Implications for Nitrogen Management***	
	Dr. Anna Cates	University of Minnesota
2:50 p.m.	***Nitrogen Management with Manure***	
	Dr. Melissa Wilson	University of Minnesota
3:40 p.m.	***Adjourn***	

Thank you to all of our Supporters!



The impacts and magnitude of N loss from Midwest cropping systems: What can we do about it?

Dan Jaynes
USDA-ARS, Ames, IA

Tests show an excess of nitrates

High levels at 5 Iowa lakes

By PERRY BEEMAN
REGISTER STAFF WRITER

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A Des Moines Register investigation of the water quality near 17 Iowa beaches found five lakes with nitrates at or above federal health limits.

TESTING THE WATERS
Pollution affecting Iowa's lakes

Nitrates have been linked to "blue-baby syndrome," in which an infant's blood is robbed of its ability to carry oxygen. Some scientific studies have raised questions about nitrates' possible role in spontaneous abortions and several types of cancer.

The Register's samples, analyzed by the University of Iowa Hygienic Laboratory, found

WATER *Turn to Page* **4A**

About the series

■ **SUNDAY:** The Des Moines Register took water samples at 17 la swimming areas. Four had high levels of fecal coliform bacteria.
Why it matters: Scienti have found that high levels of the bacteria c indicate pathogens tha can sicken swimmers.

■ **TODAY:** The Registe tests found nitrates at several lakes at levels above federal standard for drinking water.
Why it matters: Nitrate have been associated with "blue-baby syndrome" and are suspected of causing spontaneous abortions and several cancers.

■ **TUESDAY:** Many lake checked had high turbidity, or cloudiness
Why it matters: That ca harm plants and fish ar make drinking water more expensive to trea

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IOWA QUIZ
itol of Aus- in Mason

rson won rectly an- y Iowa town ry 51st citi- ation in

ur answer on a Iowa Quiz, r send your answer will be

METRO IOWA

RANDY EVANS,
ASSISTANT MANAGING EDITOR, 515-284-8065

Des Moines Sunday Register

SUNDAY **B** GC
APRIL 26, 1998

New buildings, new life for aging Iowa post offices

While old Main Street buildings are a thing of the past in some towns, many Iowans still dress up their personal mailboxes. **Iowa Journal, Page 2B**

LIVING HERE

Facts on Des Moines and Suburbs

■ **The city of Pleasant Hill** was originally named Youngstown—for the Ohio city of the same name.

Nitrate troubles won't evaporate

By PERRY BEEMAN

f fertilizer last fall y rains washed to the waterways Some observers ners put down ni zer while the soil , which sends the o the air and

s probably some ast fall when it e been applied, here are definitely d bad guys out in

Turn to Page **8B**

Tests show nitrate levels are variable

WATER

Continued from Page 1A

xcessive nitrates at Saylorville and ig Creek lakes in Polk County and t Lake Panorama in Guthrie Coun- y. Those lakes drain into rivers used or drinking water.

Saylorville and Big Creek drain in- o the Des Moines River, a source of rinking water for the 250,000 cus- omers of Des Moines Water Works. anorama drains into the Middle accoon River, from which Panora raws water. Lake Panorama resi- ents get drinking water from wells.

The Middle Raccoon eventually eeds into the Raccoon River and in- o another Des Moines drinking- ater intake.

itrate Sources

Backbone Lake in Delaware ounty exceeded the limit and Pine ake in Hardin County at one point as at the limit. Those lakes aren't sed for drinking water. The high itrates could mean farmers and omeowners are using too much ertilizer, wasting money. There ould be other sources for the itrates.

The compounds come from fertil- zers, manure, sewage systems, sep- c tanks and decaying plants.

Coralville Lake, which empties in- o Iowa City's water supply, had one

On the Web

Examine the complete test results at

DesMoinesRegister.com /extras/water/

reading just under the limit.

The U.S. Environmental Protection Agency limit for tap water is 10 milligrams of nitrate, measured as nitrogen, per liter of water. Readings can vary widely from time to time in the same lake. Often, there are high readings during spring fertilizer season, then levels drop as algae consume the nitrogen in the summer.

Lake Panorama posted the highest readings of the 15 lakes the Register checked. Though nitrates were below the limit in early April, they jumped to 16 milligrams per liter by the end of April and measured 13, still well over the limit, on May 25.

Saylorville had similar levels. Oak Grove Beach had a reading of 8.2 milligrams per liter on April 5, but that jumped to 13 a few weeks later. The reading on May 25 was 13 again.

Big Creek, which drains into Saylorville, jumped from half the limit in early April to 12 milligrams per liter in late May.

Record nitrate levels in the Raccoon River at Des Moines this year have surprised local officials, leading the manager of Des Moines Water Works, L.D. McMullen, to suggest more needs to be done to reduce farm runoff. At the same time, Paul Johnson, head of the Iowa Department of Natural Resources, has said that Iowa is "awash in nutrients." He called for new efforts to keep fertilizers out of lakes and streams, too.

Treatment

Conventional treatment won't remove nitrates, though water plants sometimes are able to blend water from other sources to keep the water safe. Des Moines' plant has a special facility, the largest in the world, to remove the compounds.

Nitrate levels in the Raccoon and Des Moines rivers have dropped slightly in the past month after the Raccoon hit an all-time record in late April.

The Des Moines Water Works, which draws water from the rivers and a shallow aquifer near the Fleur Drive plant, still is running its nitrate-removal system to keep nitrates in tap water at safe levels.

Randy Beavers of the waterworks staff said nitrates last week were at 14.5 milligrams per liter in the Raccoon and 13 milligrams per liter in the Des Moines, both over the feder-

Red Oak tests

■ Red Oak residents will find out today if they must continue boiling tap water and buying bottled water. On Friday, officials warned residents there could be dangerous levels of fecal coliform bacteria in the water supply.

Mayor James Johnson said the Iowa Department of Natural Resources instructed Red Oak residents Friday to boil all water used for drinking, cooking, bathing and washing. The latest samples taken from the underground aquifer that supplies Red Oak with its water were taken to Atlantic for testing on Saturday. Johnson said the tests take 28 hours.

The first sign of problems surfaced two weeks ago, the mayor said. During routine testing, Johnson said, "they found a couple of trouble spots." When the water was tested again one of the problems vanished but the other one did not.

in March, April and May. The water was collected at Oak Grove Beach, Saylorville Lake; Big Creek State Park; Hickory Grove Lake; Pine Lake; City Beach and McIntosh Woods

Register's water tests find high nitrates

The Des Moines Register's tests of 15 Iowa lakes showed that water at five spots reached or exceeded the federal drinking-water standard for nitrates of 10 milligrams per liter.

Numbers in milligrams per liter

Dark strips show results at or over the EPA limit

Tests taken in March, April and May.

	Oak Grove Saylorville	Big Creek State Park
TEST 1	8.2	4.7
TEST 2	13	9.2
TEST 3	13	12

	Pine Lake	Lake Panorama	Backbone State Park
TEST 1	5.4	8.5	7.2
TEST 2	8.4	16	12
TEST 3	10	13	11

Sources: The Des Moines Register, University of Iowa Hygienic Laboratory

JEFF BASH / THE REGISTER

regularly check for nitrates.

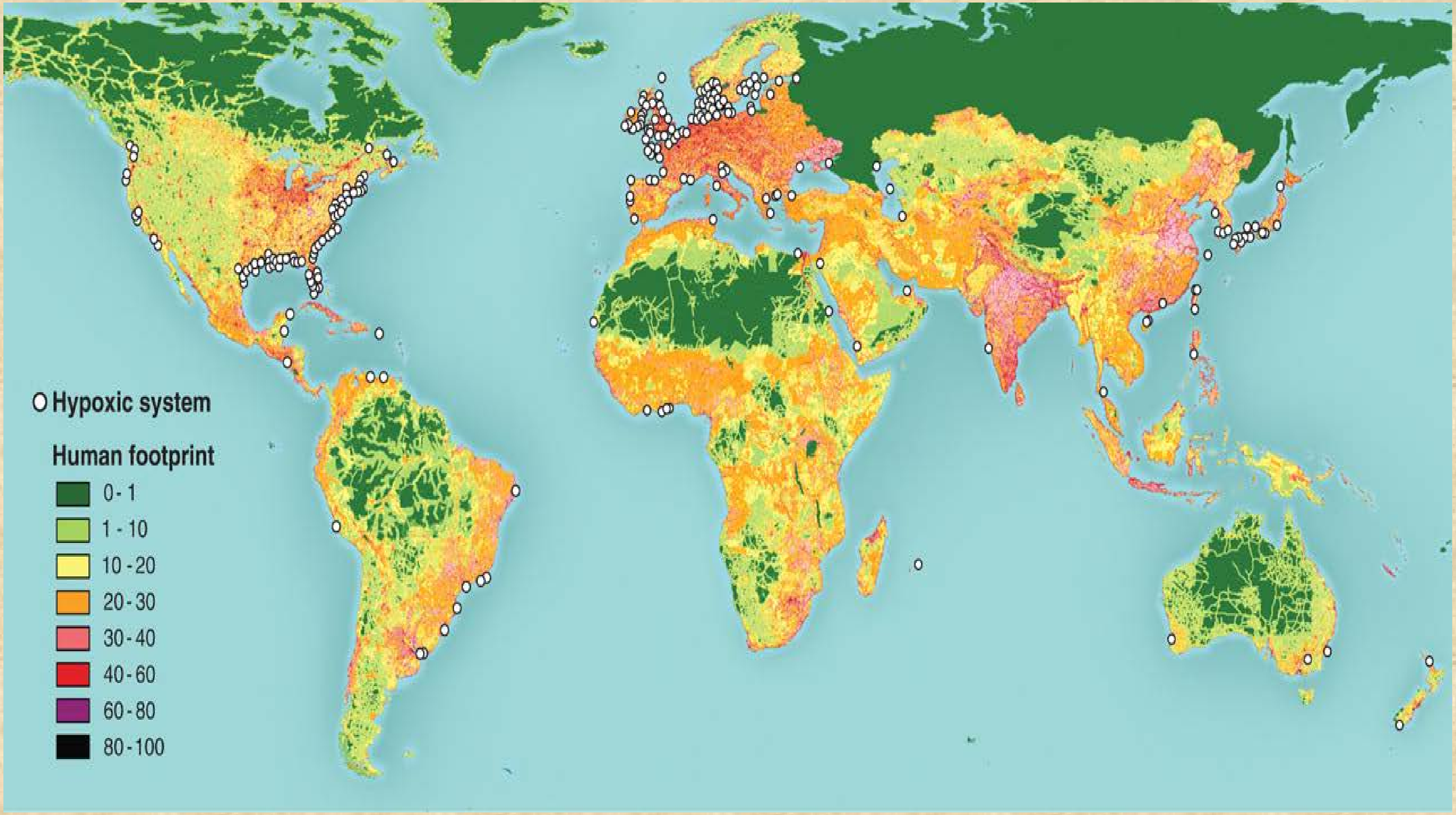
Samples were taken near beaches rather than where drinking water is collected, though the highly soluble nitrates can travel long distances.

Richard Kelley of the University of Iowa Hygienic Laboratory said the Register's findings were typical for spring in eastern Iowa, but higher than normal in central Iowa.

County found low nitrates there, too.

The tests showed how variable nitrate levels can be. In most cases, concentrations rose as the weeks went by. At some lakes, levels more than doubled between early April and late May. That included Big Creek and Darling. Nitrates also doubled at Rathbun, Three Mile and Clear lakes, but those lakes showed

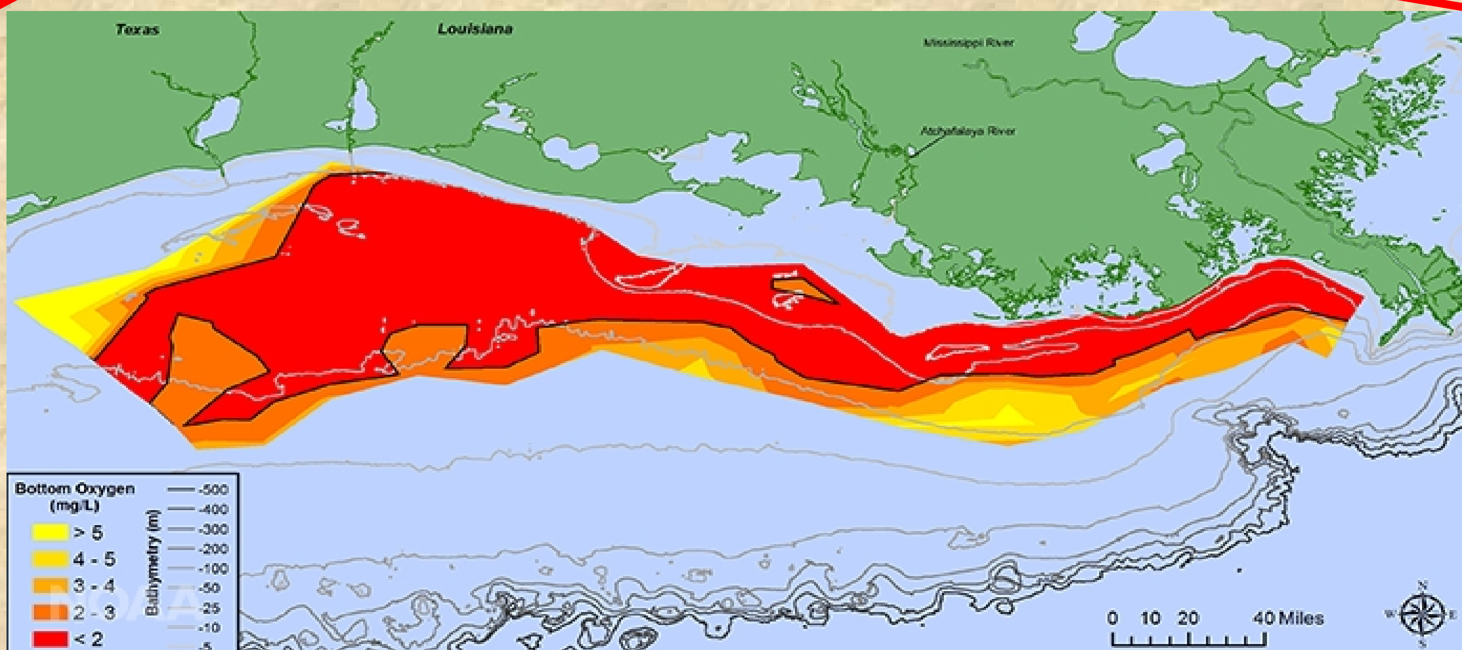
Hypoxic Zones around the World



Diaz & Rosenberg, *Science*, 2008

Gulf Hypoxic Zone or “dead zone”

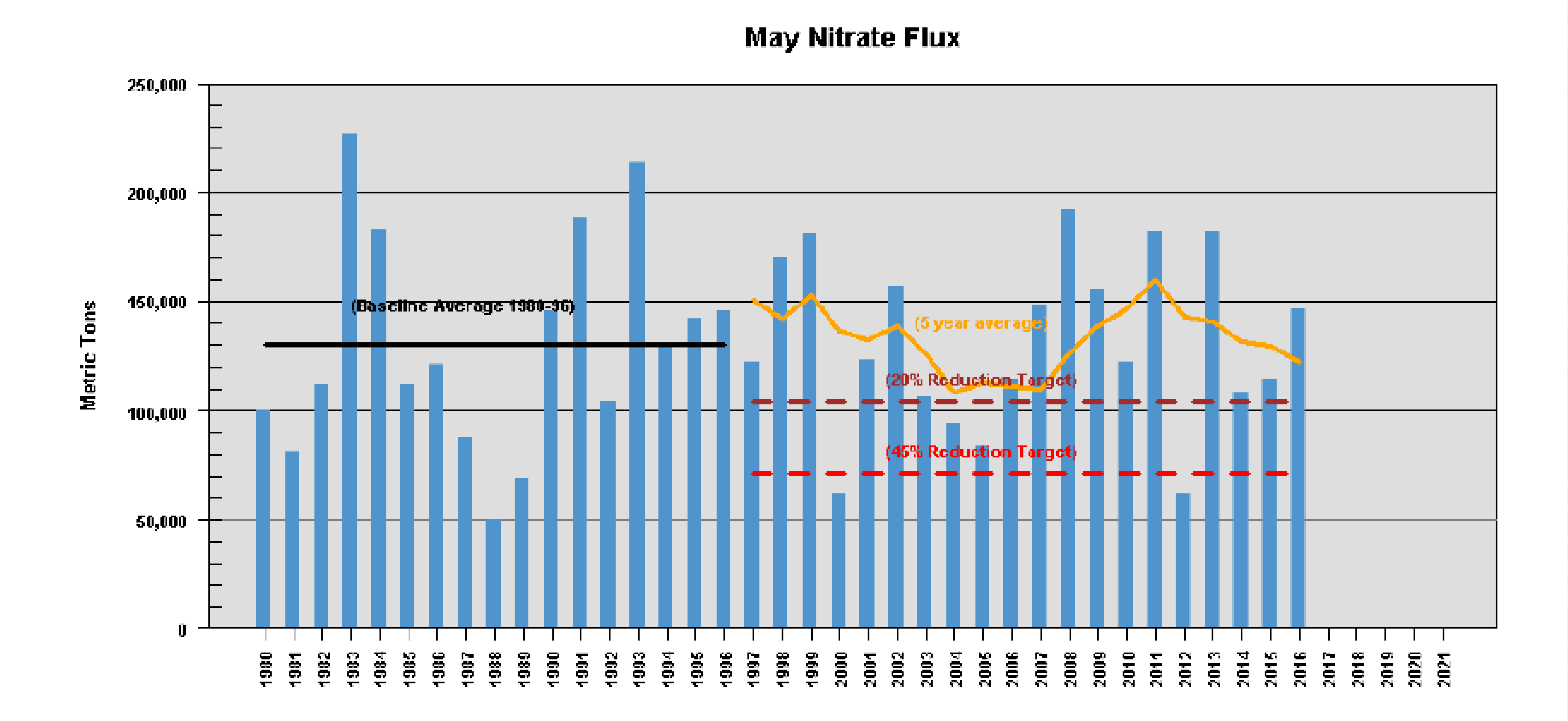
Bottom-water dissolved oxygen across the Louisiana shelf from July 24 – 30, 2017

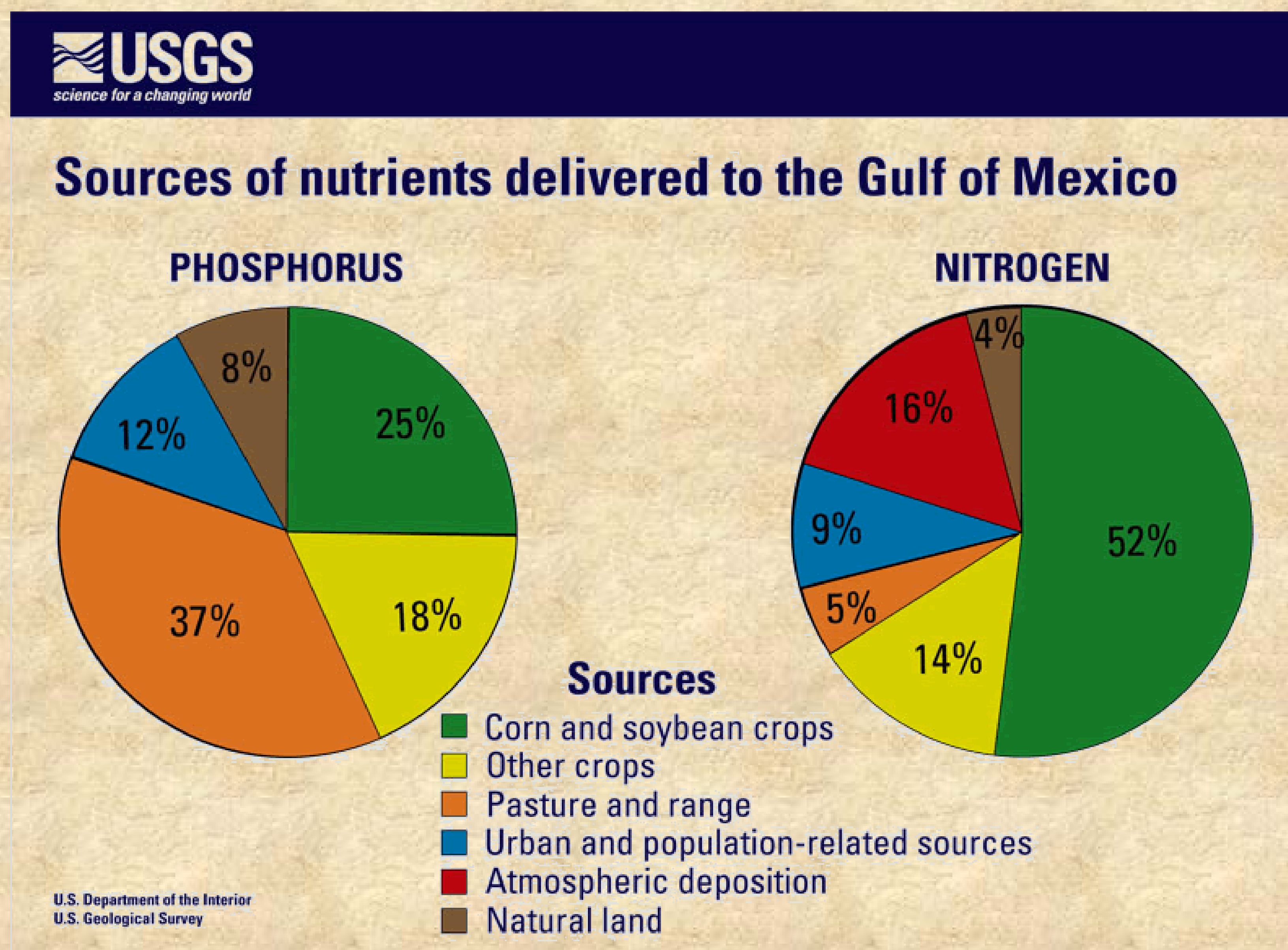


Source: **N. N. Rabalais (Louisiana Universities Marine Consortium) and R. E. Turner (Louisiana State University)** 4

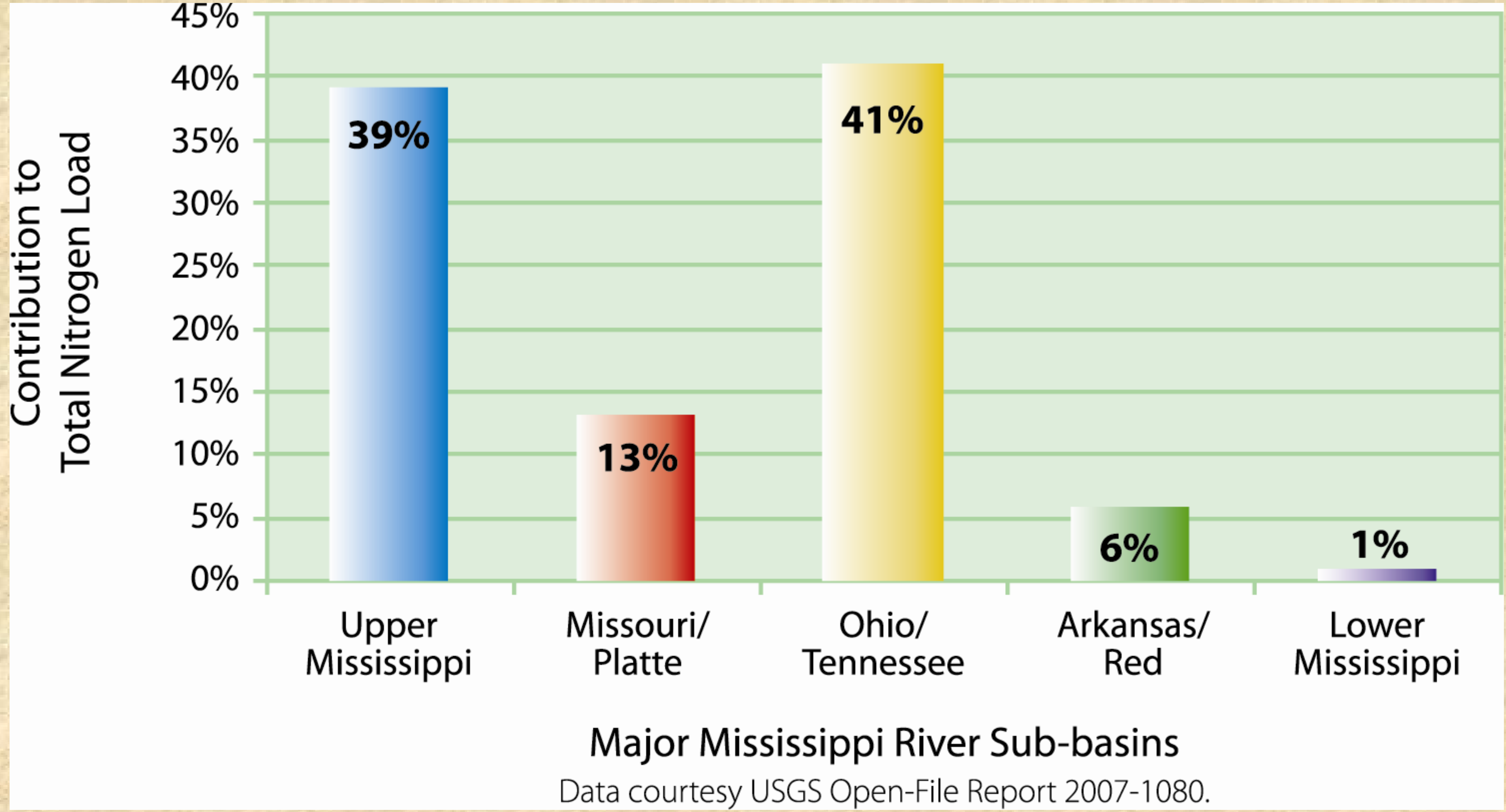
Funded by: **NOAA, Center for Sponsored Coastal Ocean Research**

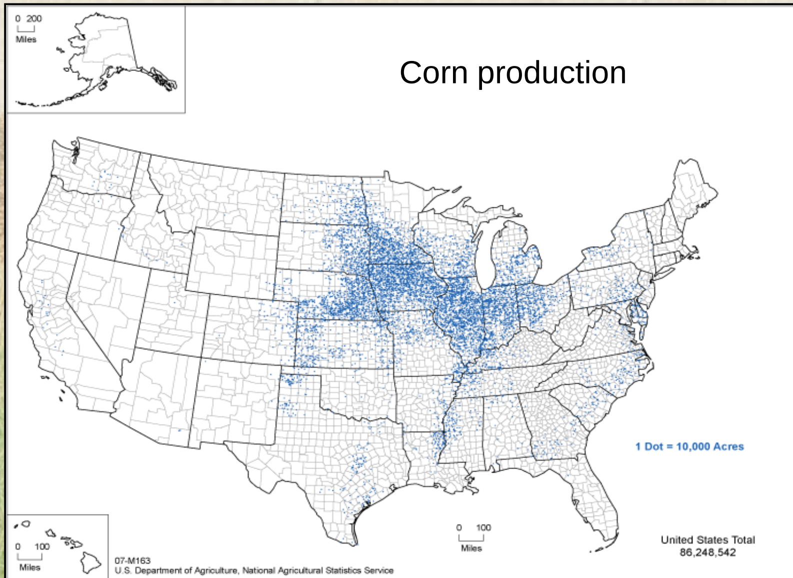
Coastal Goals of the HTF to reduce 5-year average by 20% by 2025 and by 45% by 2035

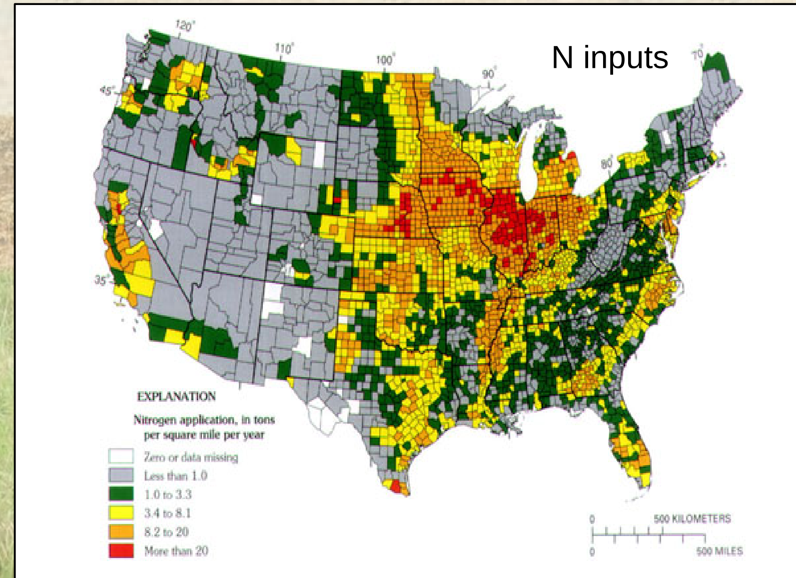


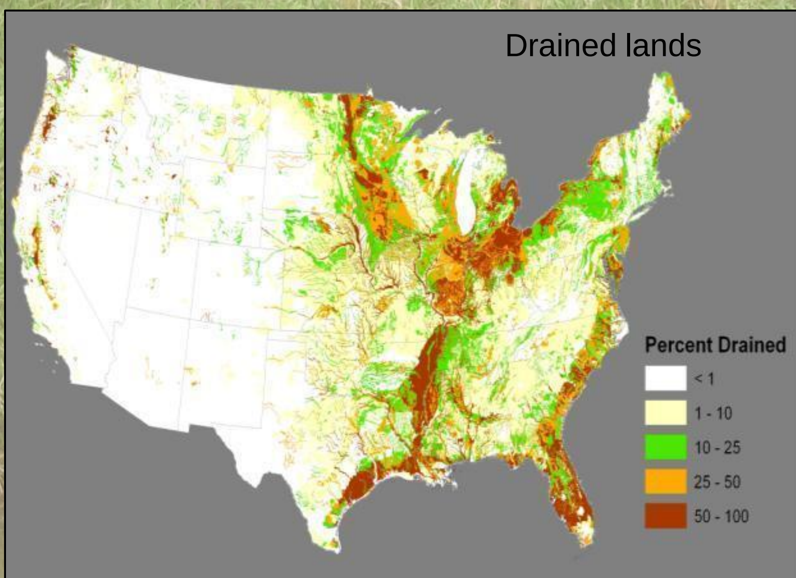

USGS
science for a changing world
Sources of nutrients delivered to the Gulf of Mexico
PHOSPHORUS
25%
18%
37%
12%
8%
NITROGEN
52%
14%
5%
9%
16%
4%
Sources
Corn and soybean crops
Other crops
Pasture and range
Urban and population-related sources
Atmospheric deposition
Natural land
U.S. Department of the Interior
U.S. Geological Survey

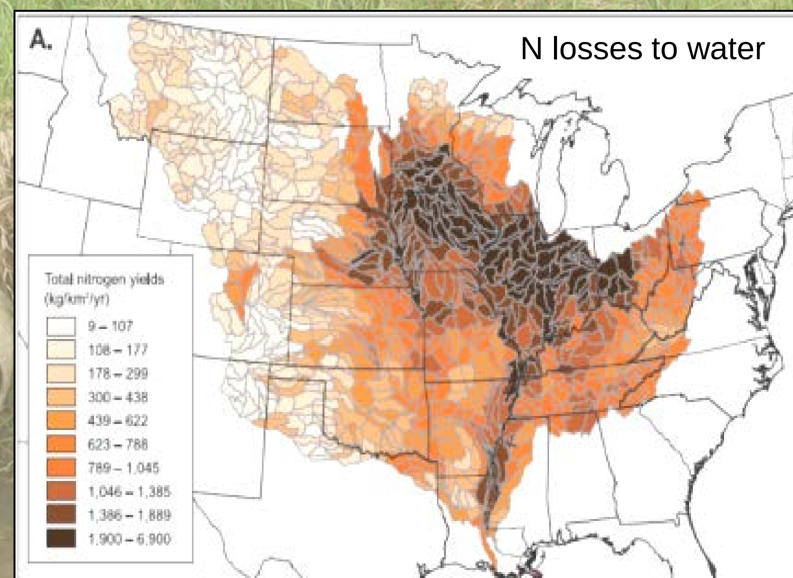
Sub-basin Nitrogen Contribution




Corn production
0 200
Miles
1 Dot = 10,000 Acres
0 100
Miles
United States Total
86,248,542
07-M163
U.S. Department of Agriculture, National Agricultural Statistics Service


N inputs
EXPLANATION
Nitrogen application, in tons per square mile per year
Zero or data missing
Less than 1.0
1.0 to 3.3
3.4 to 8.1
8.2 to 20
More than 20
500 KILOMETERS
500 MILES

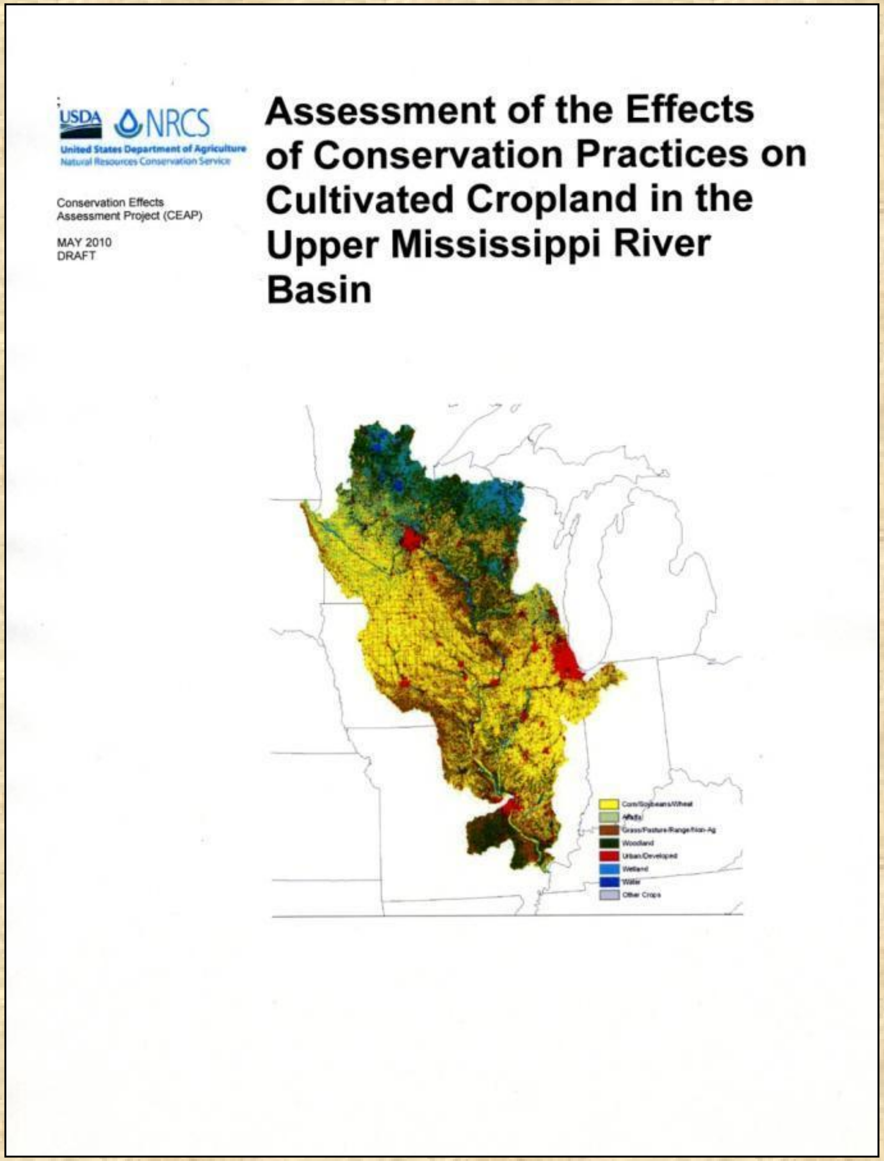

Drained lands
Percent Drained
< 1
1 - 10
10 - 25
25 - 50
50 - 100


A.
N losses to water
Total nitrogen yields (kg/km²/yr)
9 – 107
108 – 177
178 – 299
300 – 438
439 – 622
623 – 788
789 – 1,045
1,046 – 1,385
1,386 – 1,889
1,900 – 6,900

What Have We Accomplished?

Reductions from Current Practices

Contaminant	Reduction
Sediment	69%
Pesticides	51%
P	49%
N	5%



Moving forward

- No silver bullet
- Need to attack problem from all directions simultaneously

NRCS – MRBI

Practices that:

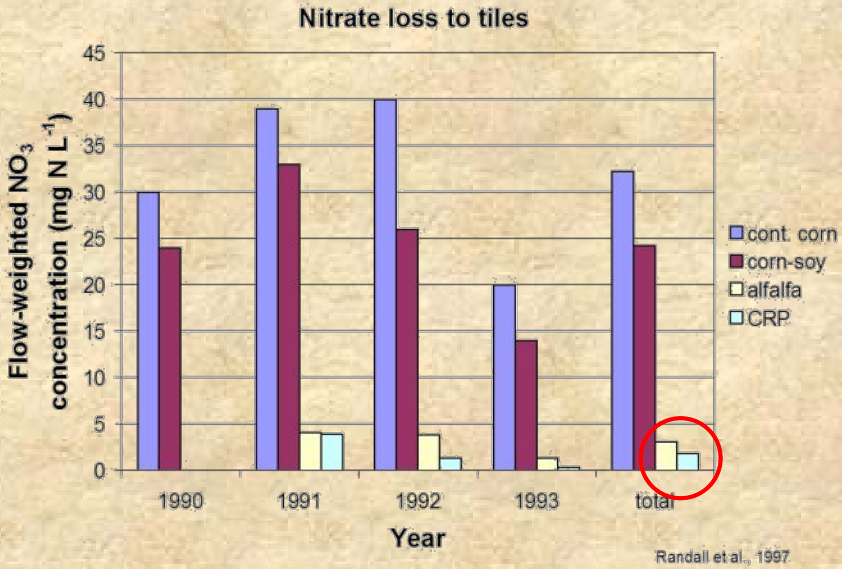
- Avoid
- Control
- Trap

Avoid

- Increase use of perennials
- Improve N fertilizer management
- Plant cover crops

Perennials

Perennials



Markets? Cellulosic biofuel crops?

Avoid

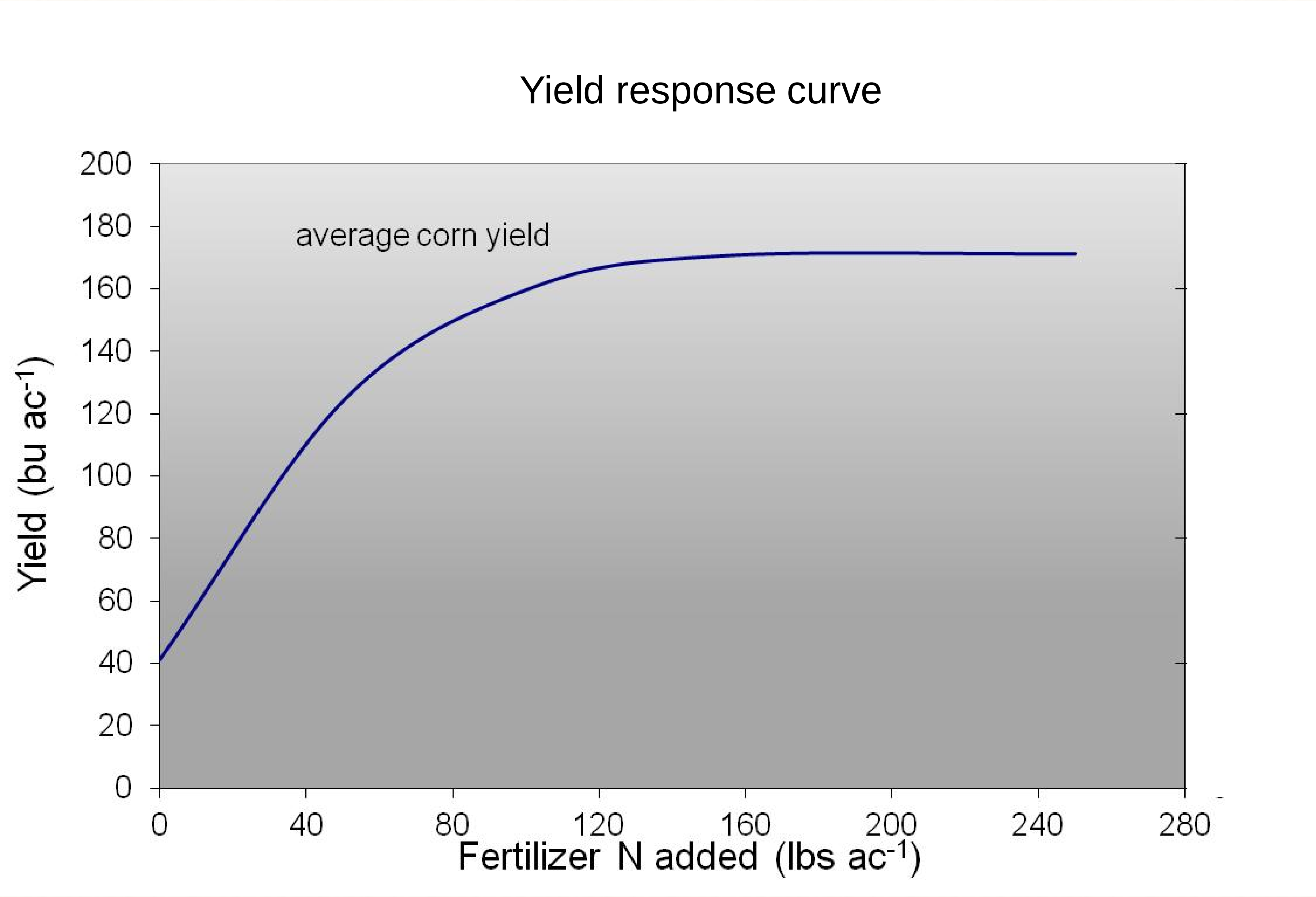
Improve N Use Efficiency

The 4 Rs

- Right Time – N is used most efficiently when its availability is synchronized with crop demand
- Right Rate – match the amount of N fertilizer applied to the crop need
- Right Place – place N where available to crops but shielded from environmental loss
- Right Source – optimize N availability and risk of loss

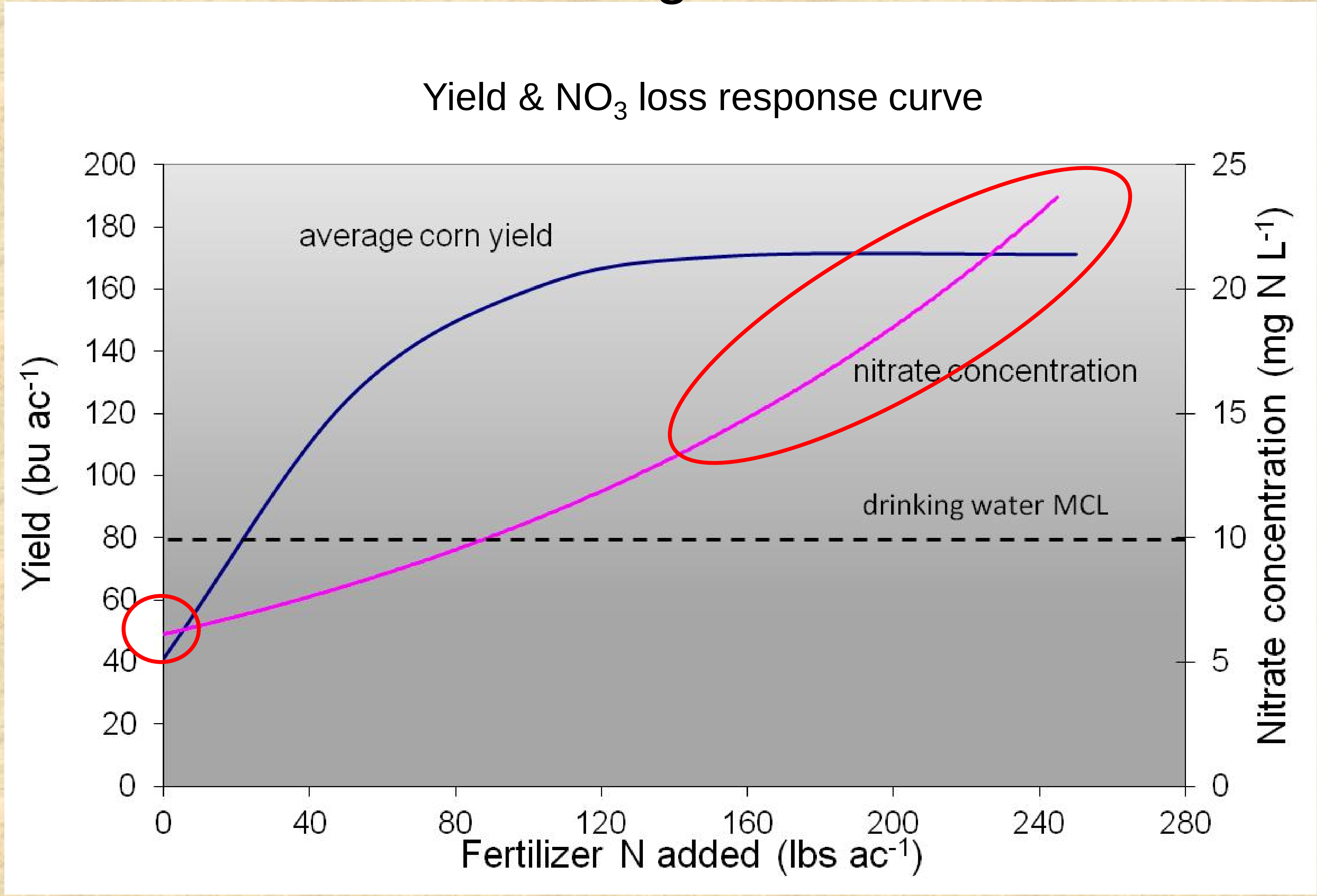
Avoid

N management



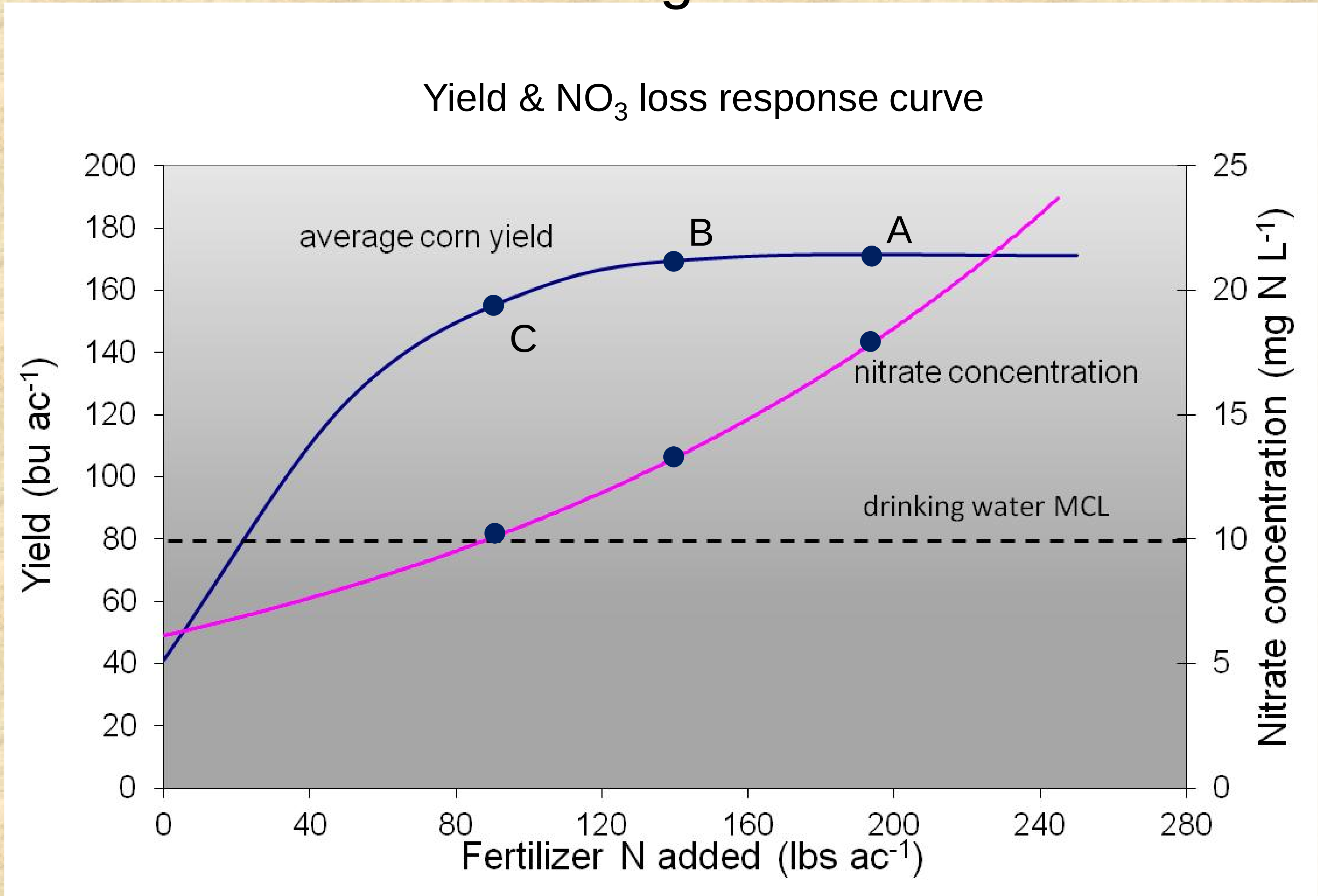
Avoid

N management



Avoid

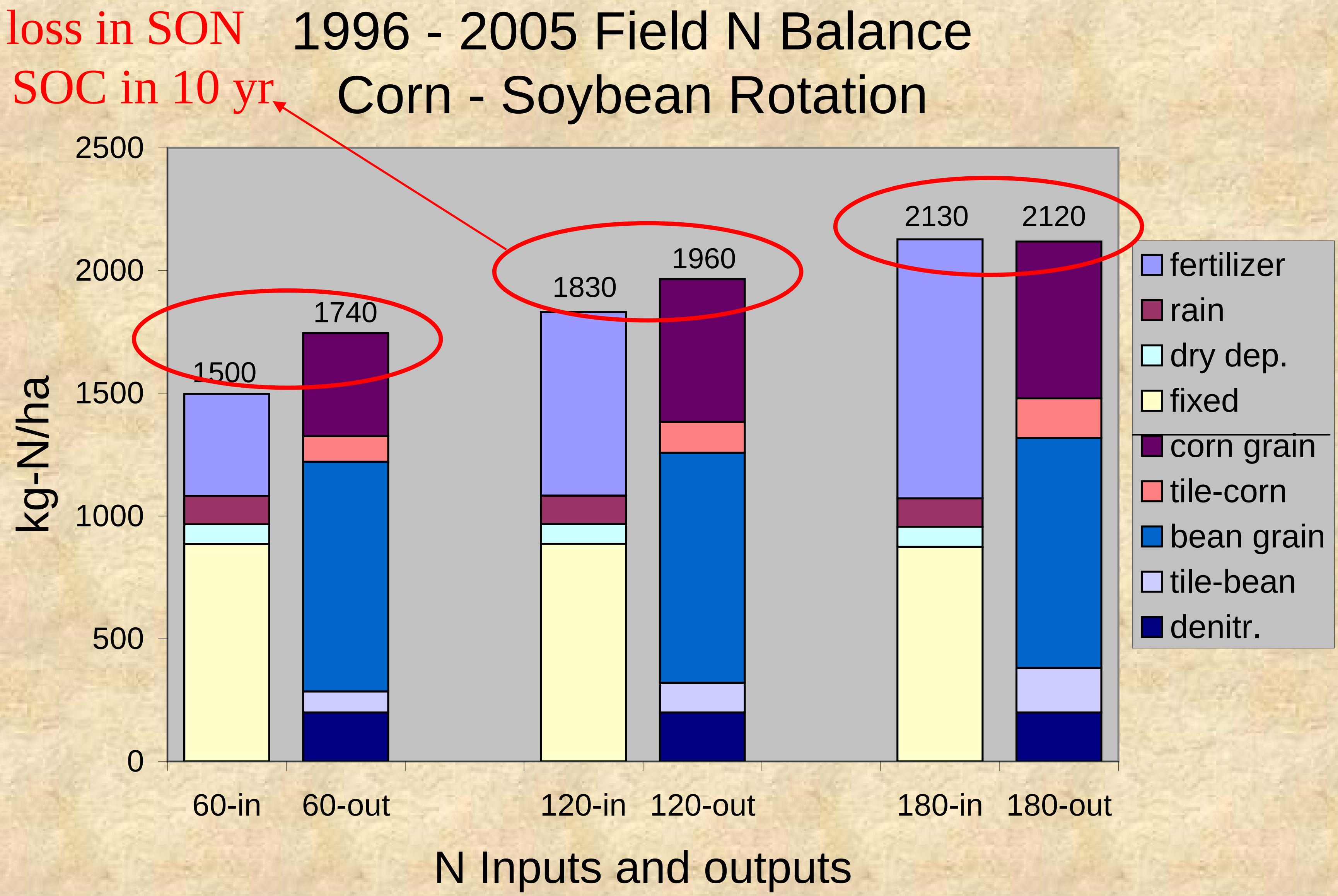
N management



Avoid

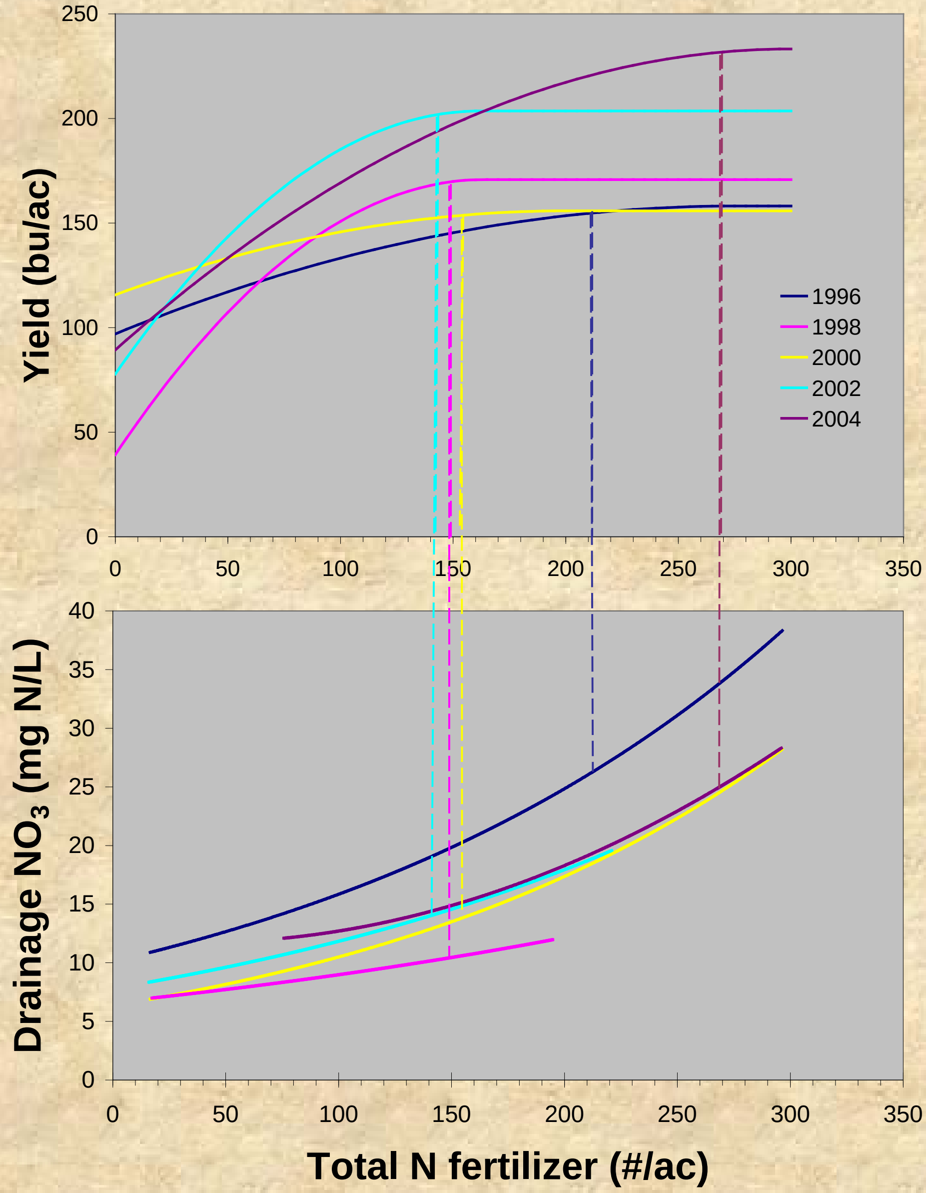
Potential for Mining of SON & SOC

2% loss in SON and SOC in 10 yr.

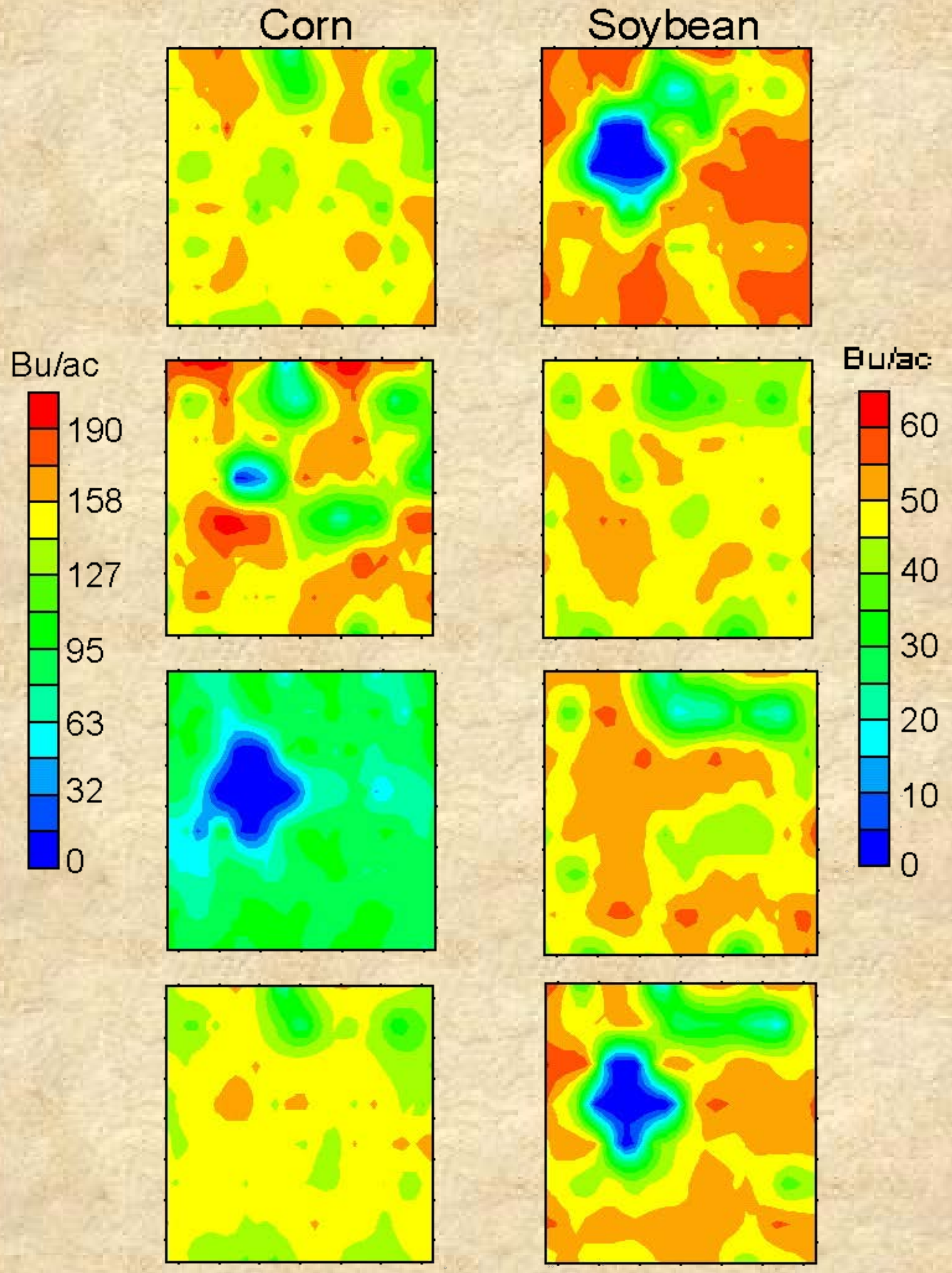


Avoid

Optimum N Fertilizer Rate Variability



Avoid

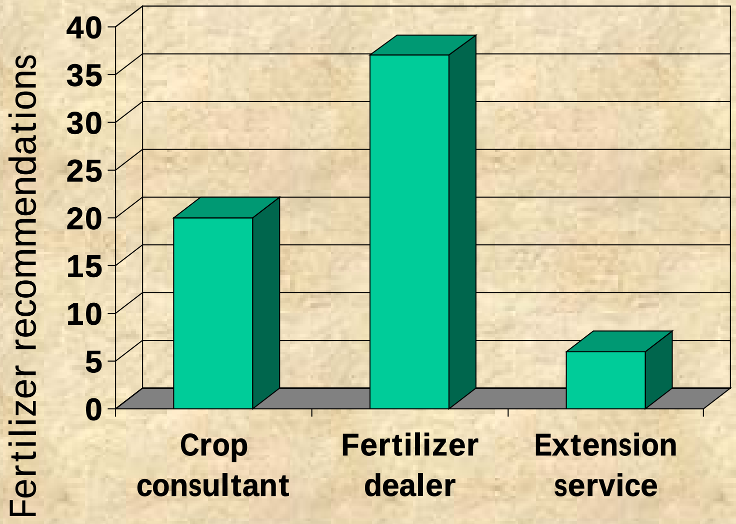


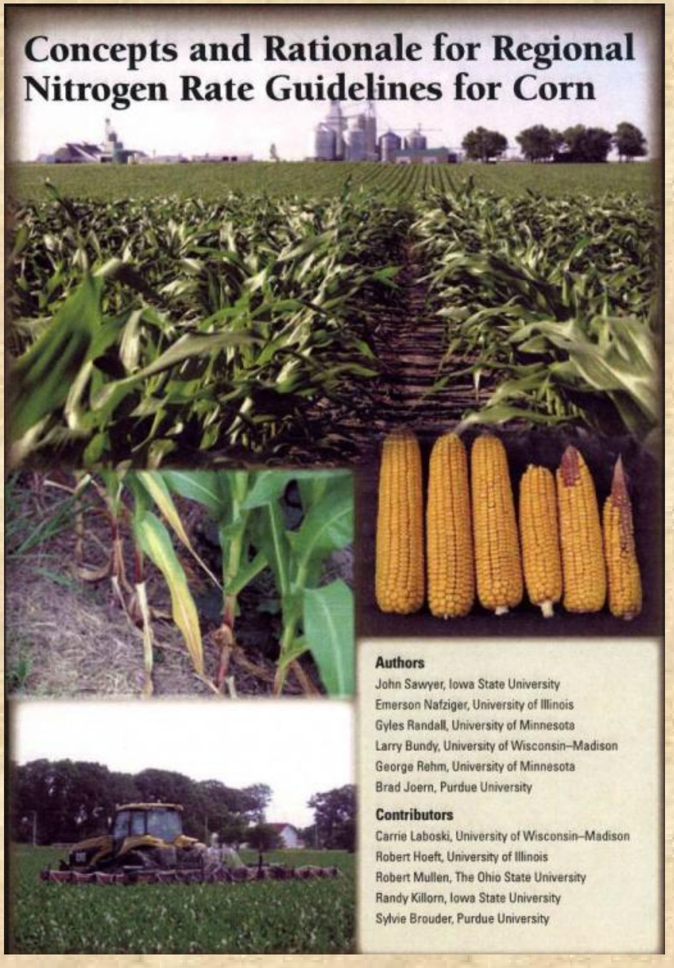
Yield varies over space and among years

Avoid

Improve N fertilizer rate

- Fine-tune N-fertilizer rates
  - Improve University recommendations
    - MRTN (Maximum Rate of Return to N)





Avoid

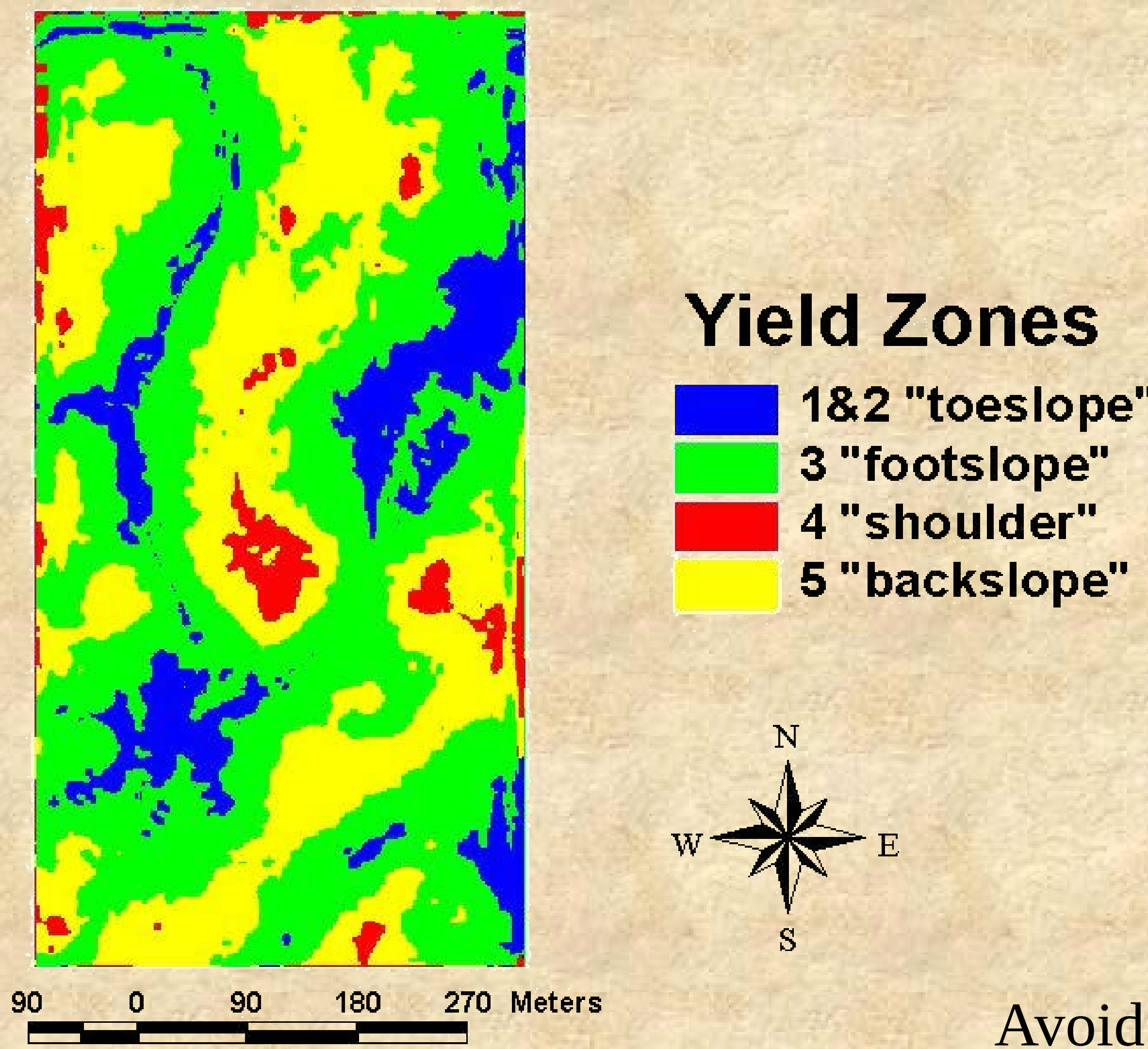
Improve N fertilizer rate

- Fertilize by zones within field

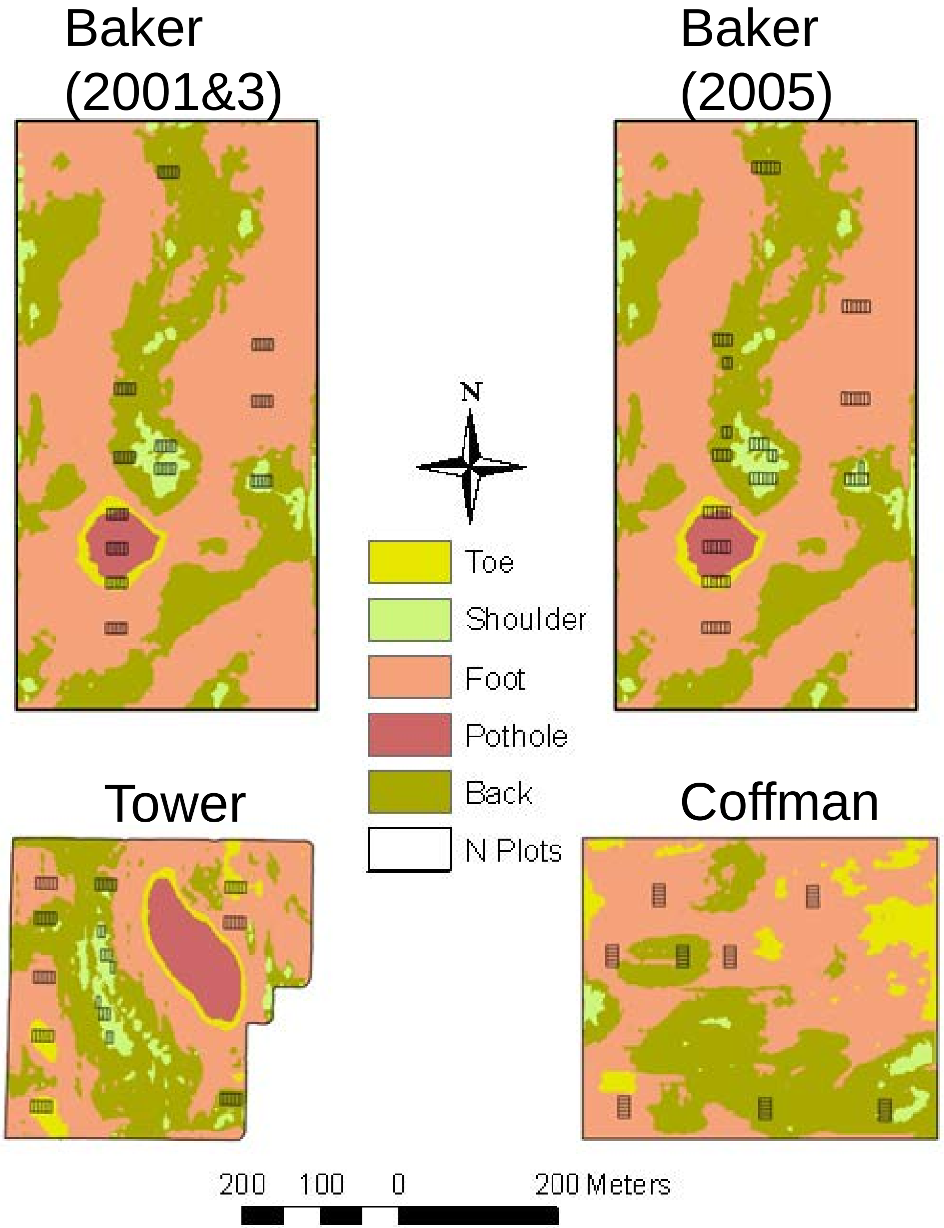
Avoid

Improve N fertilizer rate

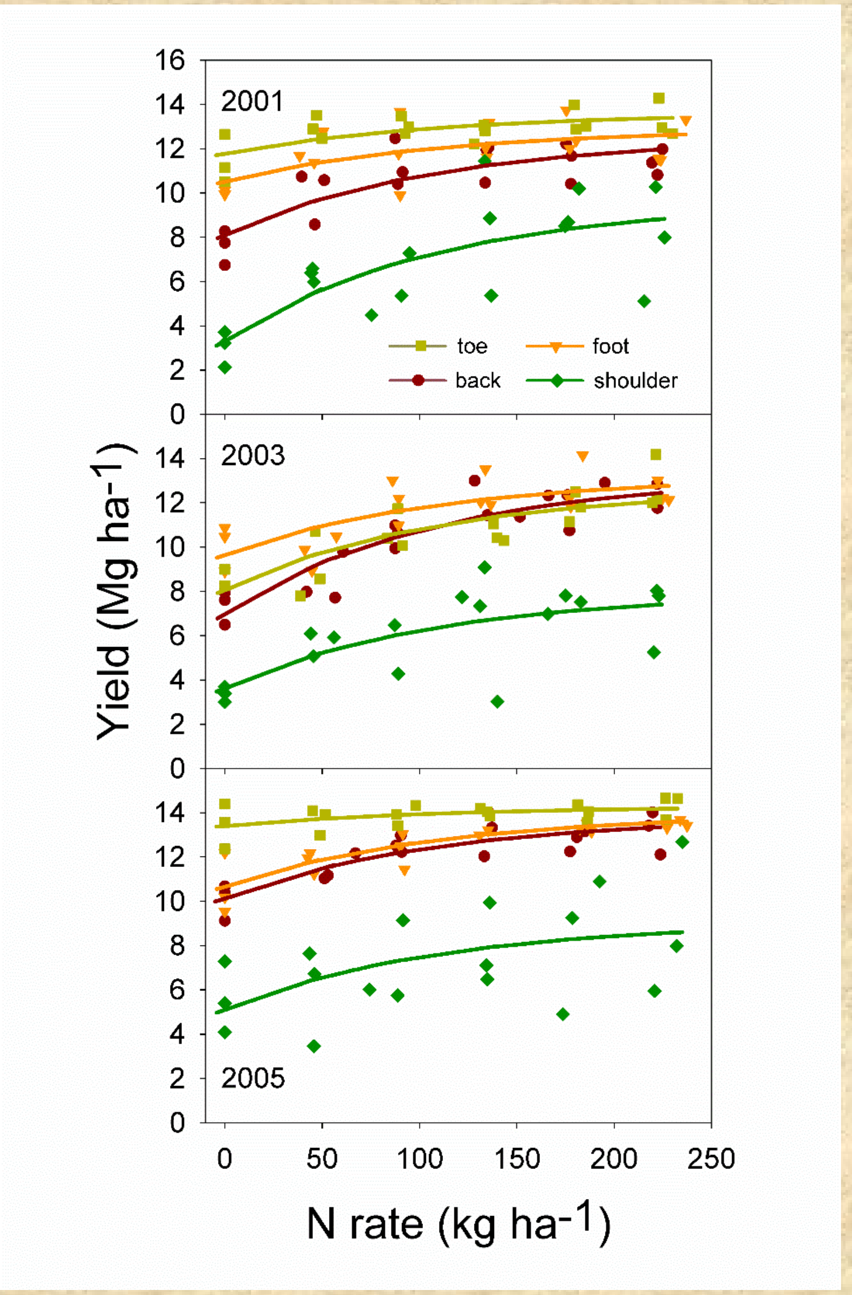
- Fertilize by zones within field



Avoid


Baker (2001&3)
Baker (2005)
N
Toe
Shoulder
Foot
Pothole
Back
N Plots
Tower
Coffman
200 100 0 200 Meters

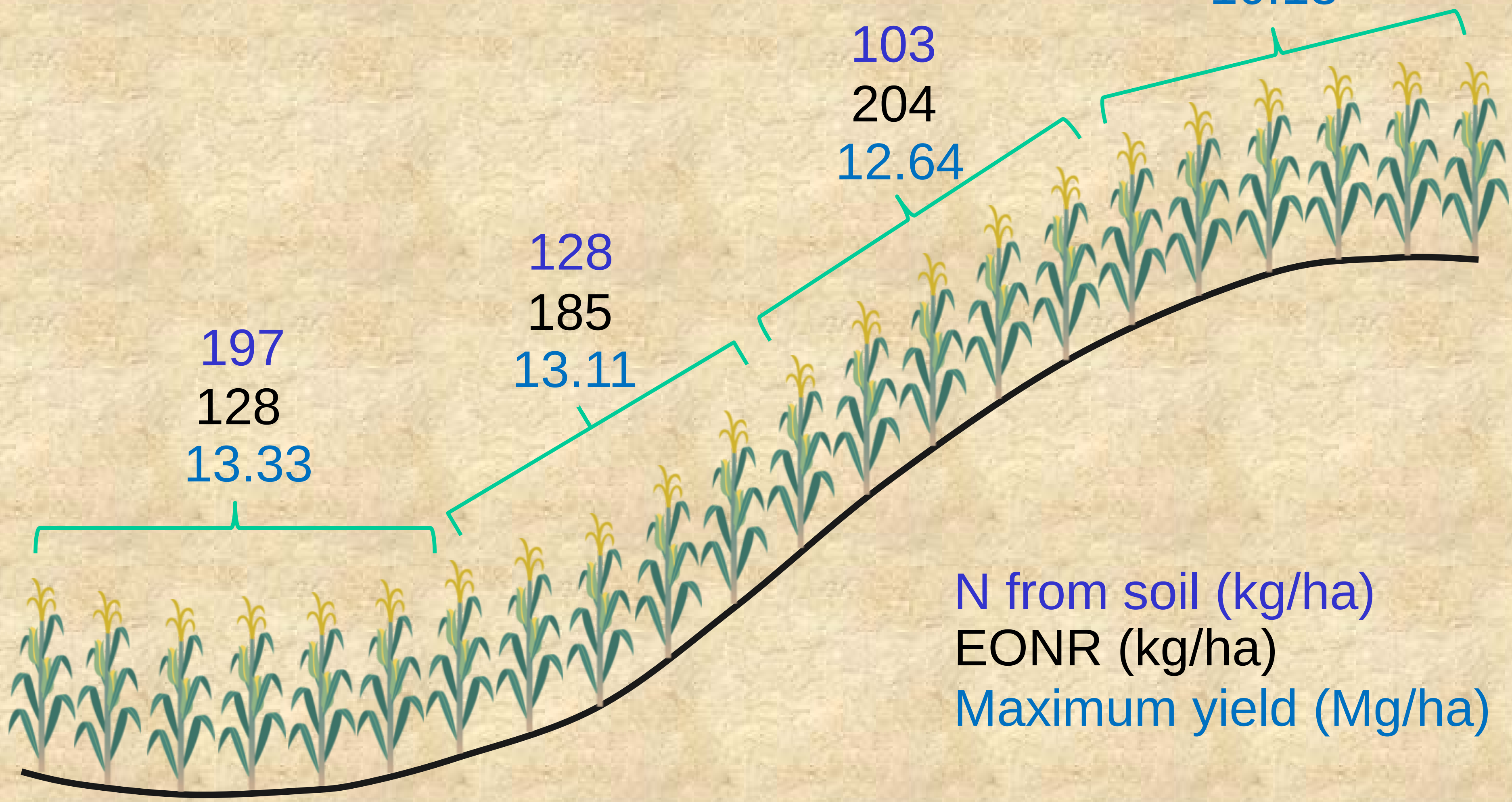
Avoid



2001
2003
2005
toe
foot
back
shoulder
Yield (Mg ha-1)
N rate (kg ha-1)
0
2
4
6
8
10
12
14
16
0
50
100
150
200
250

Avoid

Average N response per yield zone (landscape position)



Avoid

Opportunities for Improving N Use Efficiency in U.S. Agriculture

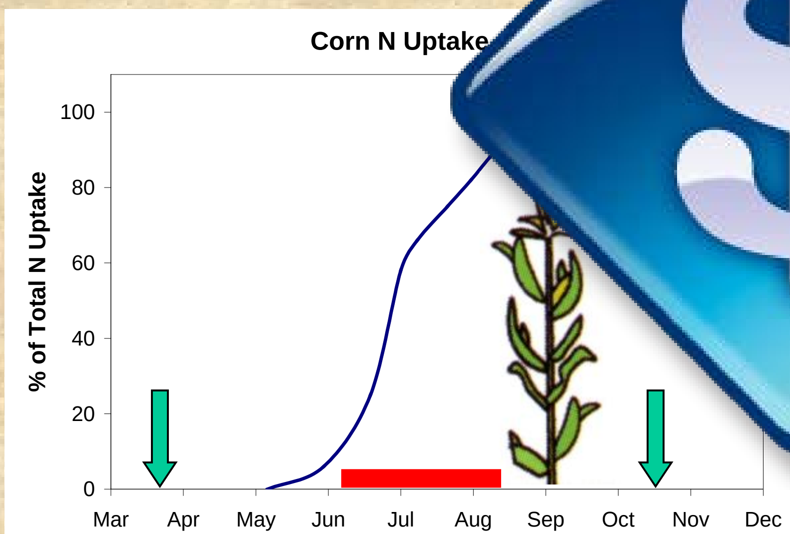
The 4 Rs

- Right Time – N is used most efficiently when its availability is synchronized with crop demand
- Right Rate – match the amount of N fertilizer applied to the crop need
- Right Place – place N where available to crops but shielded from environmental loss
- Right Source – optimize N availability and risk of loss

Avoid

N management

- Improve N synchronization
  - Polymer coated sources
  - Chemically stabilized N
  - Urease inhibitors



Avoid

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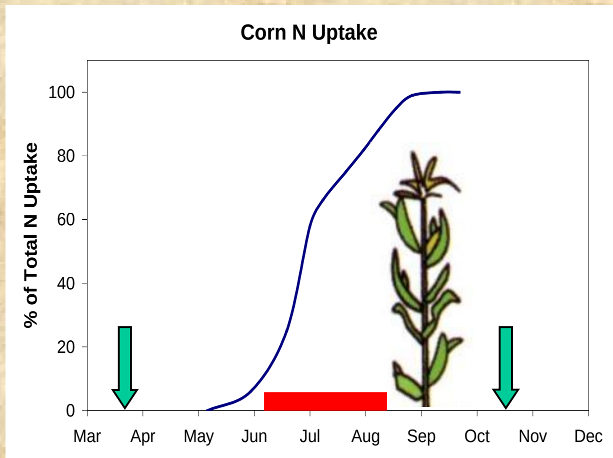
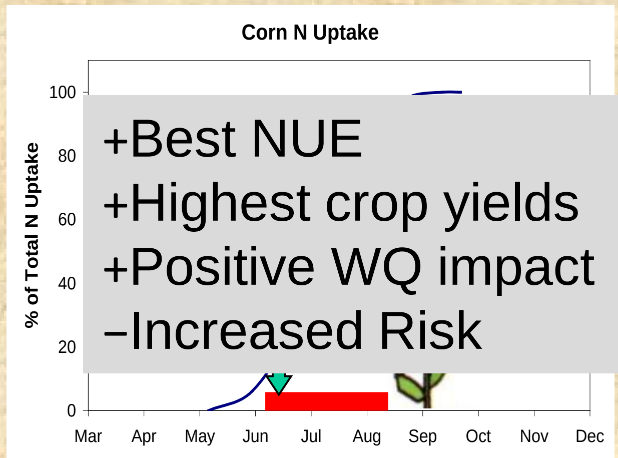
Avoid

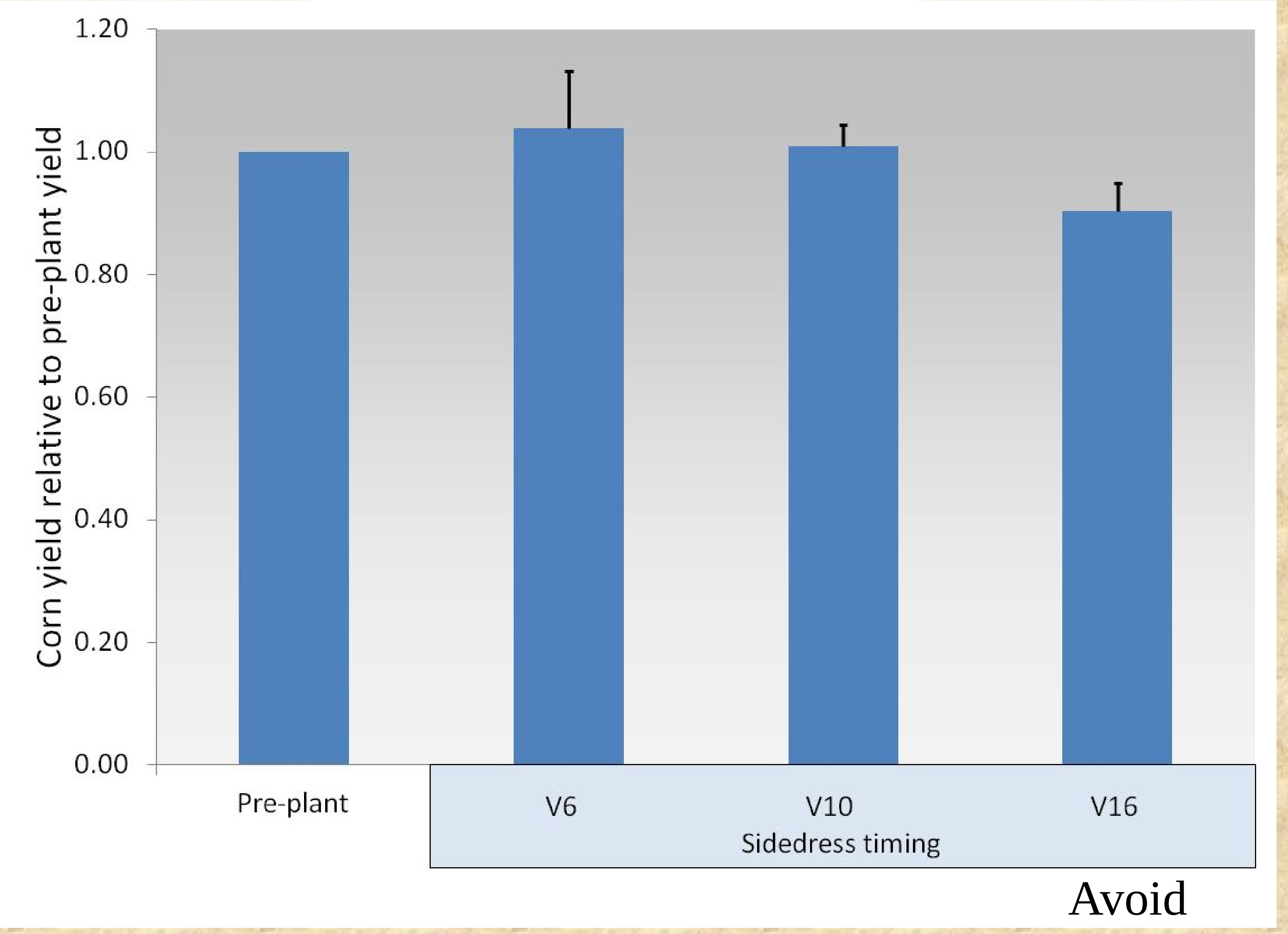
Right Time

(N is used most efficiently when its availability is synchronized with crop demand)





Improve N synchronization – sidedressing



Opportunities for Improving N Use Efficiency in U.S. Agriculture

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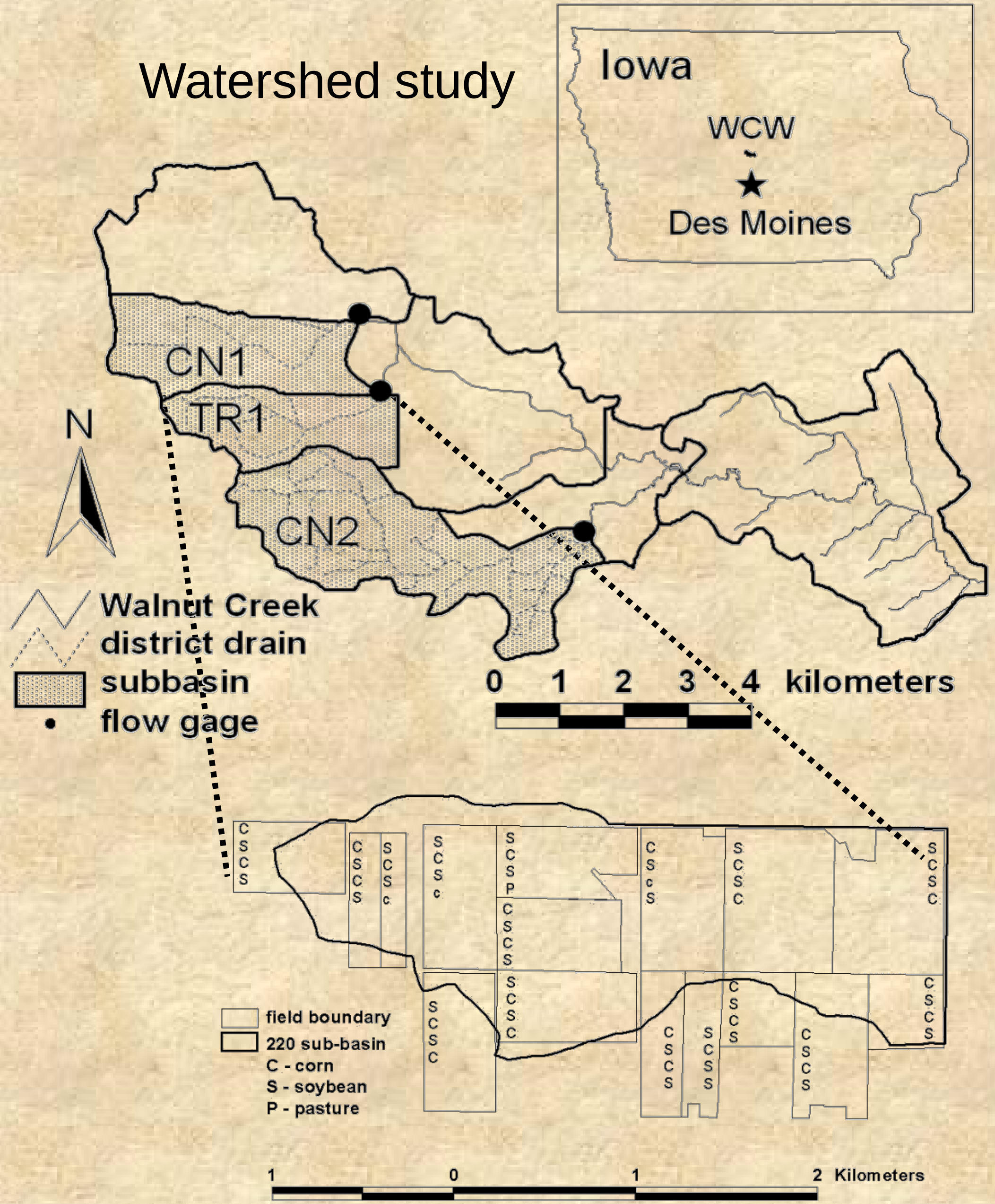
Avoid

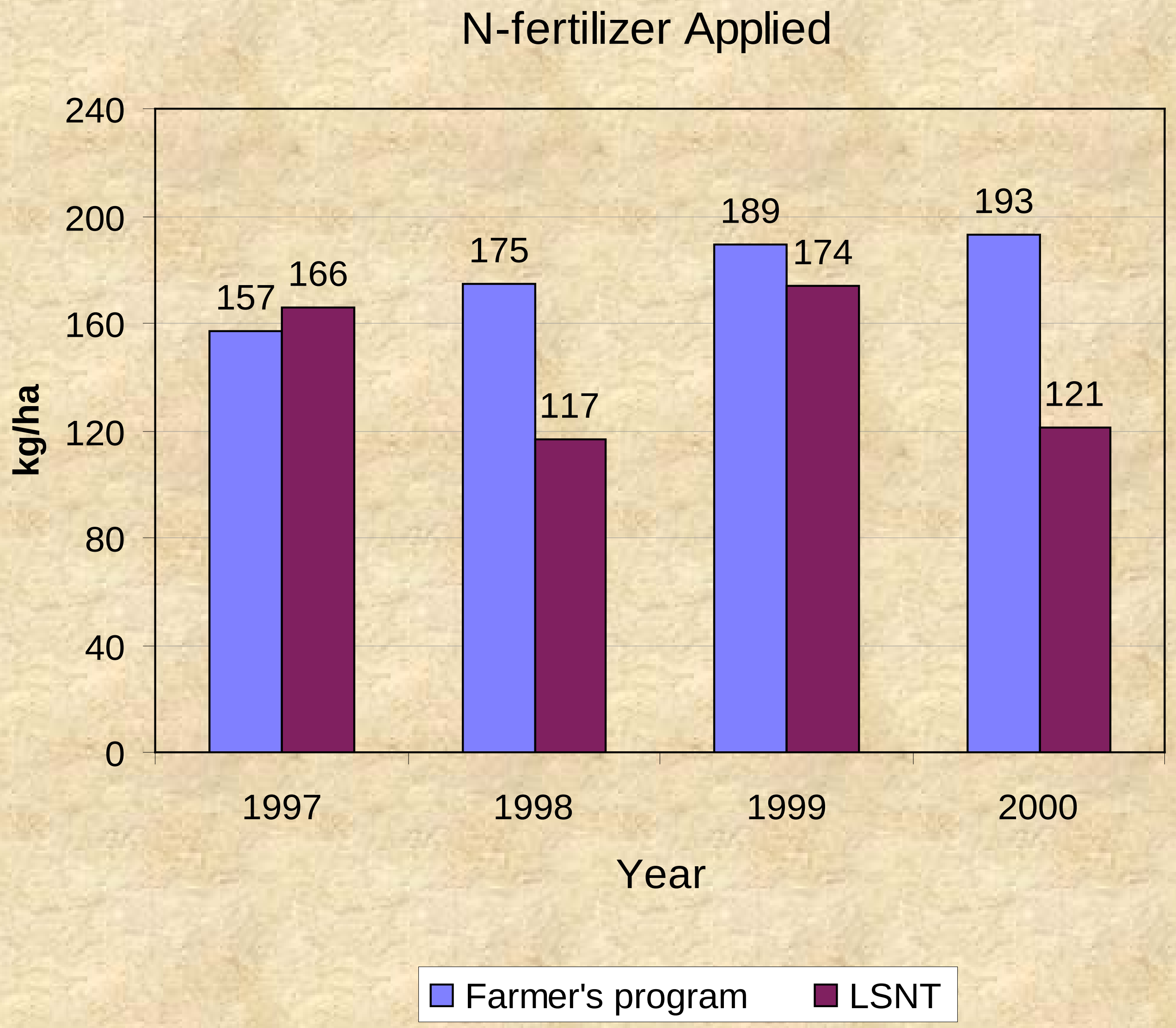
Soil test guided sidedress rate

Sidedress

Late Spring Nitrate Test

Watershed study

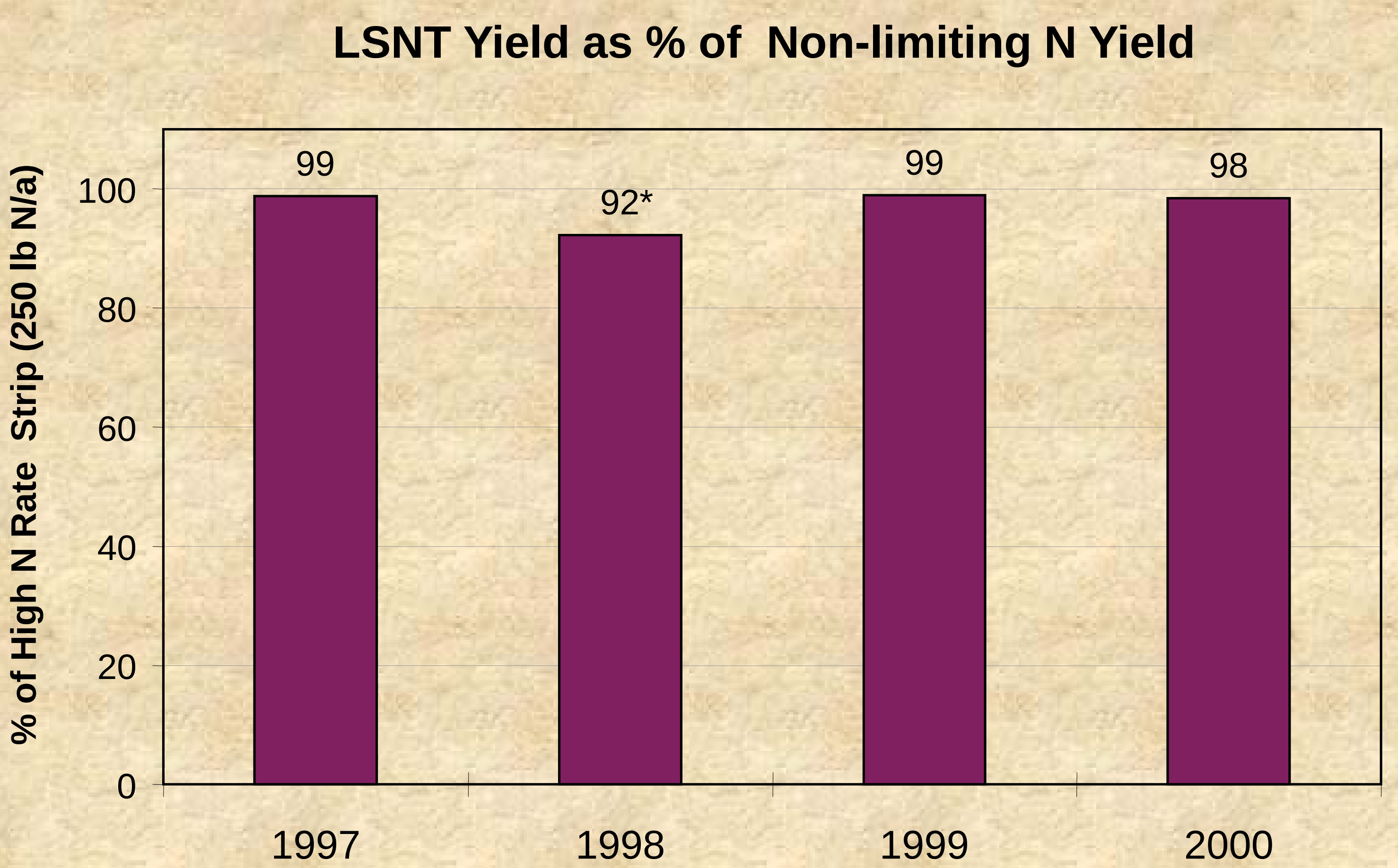




N-fertilizer Applied
kg/ha
240
200
160
120
80
40
0
157
166
175
117
189
174
193
121
1997
1998
1999
2000
Year
Farmer's program
LSNT

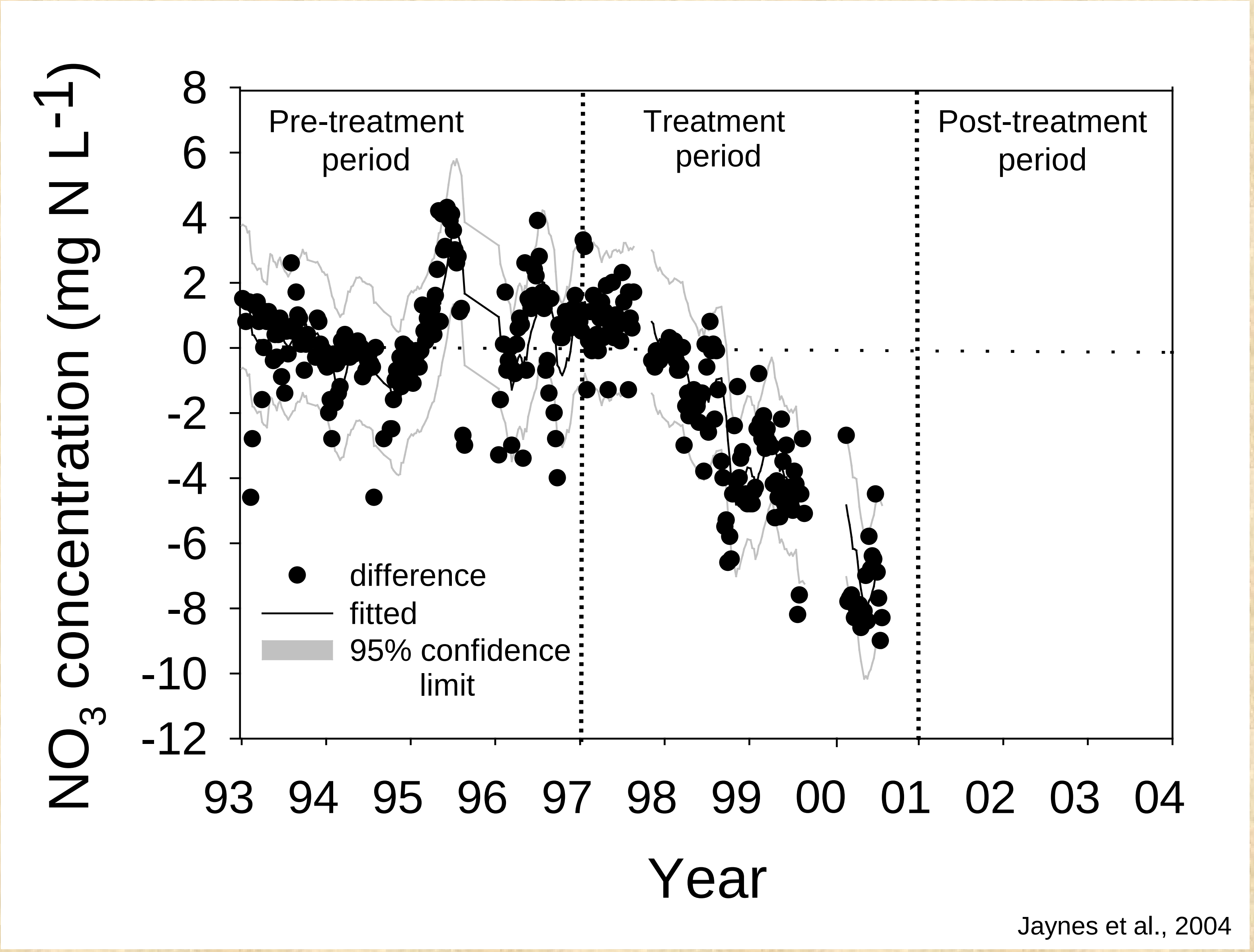
Avoid

Additional Risk to Farmers



Avoid

Change in $[NO_3]$ for LSNT vs. fall anhydrous



N Application Timing and Rate

Adjusted N rate, sidedress vs. spring pre-plant

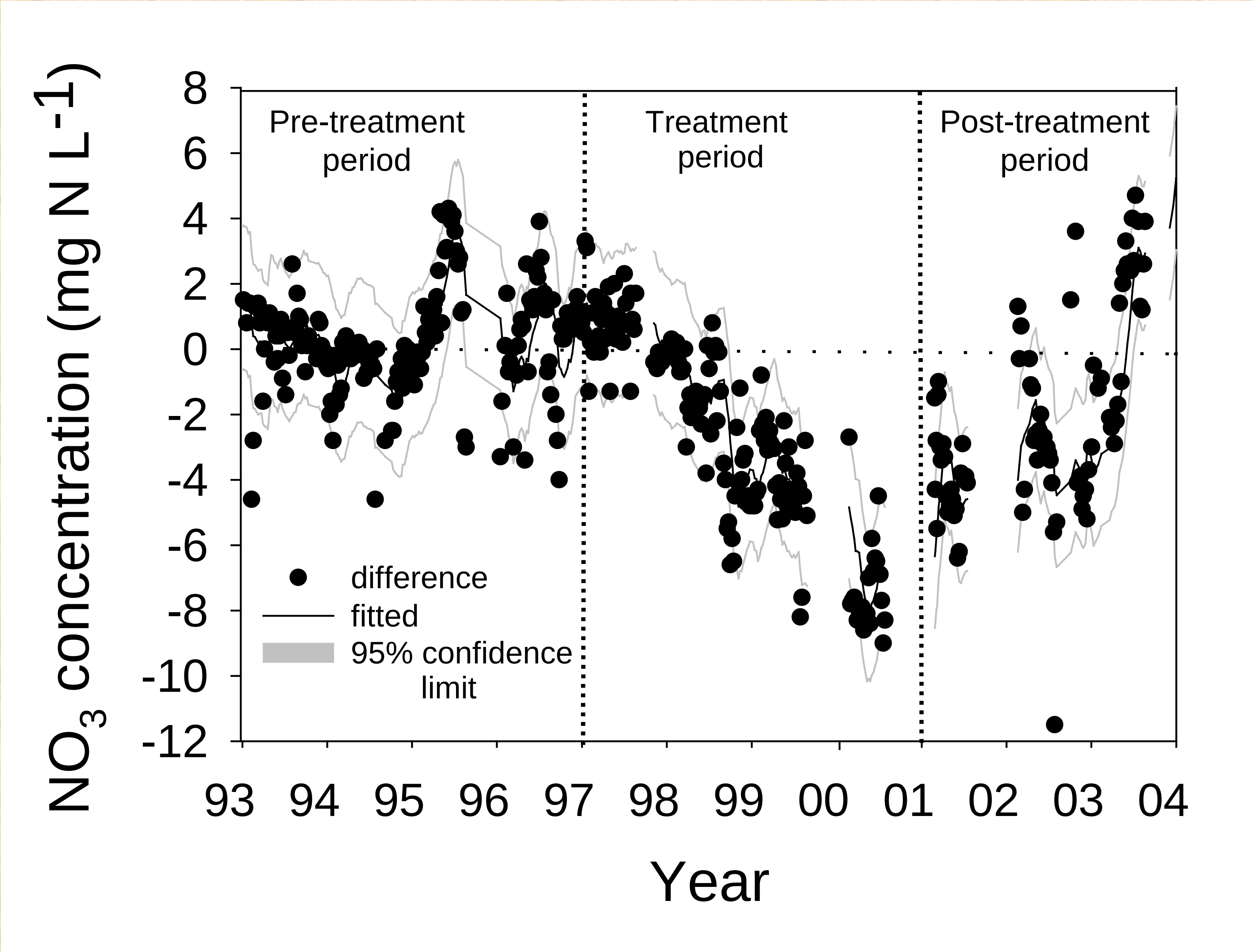
- N loss reduction: -50 to 70% reduction
- Expected long-term reduction: 15%

Adjusted N rate, sidedress vs. fall

- N loss reduction: -25 to 70%
- Expected long-term reduction: 30%

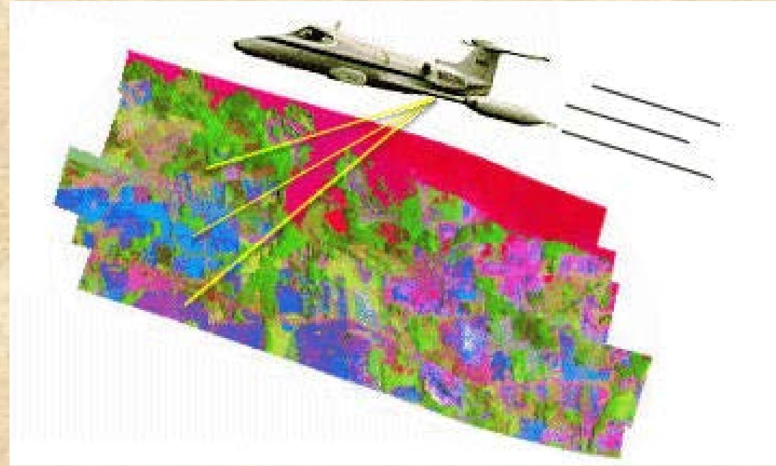
Avoid

Reduction in $[NO_3]$ for LSNT vs. fall anhydrous

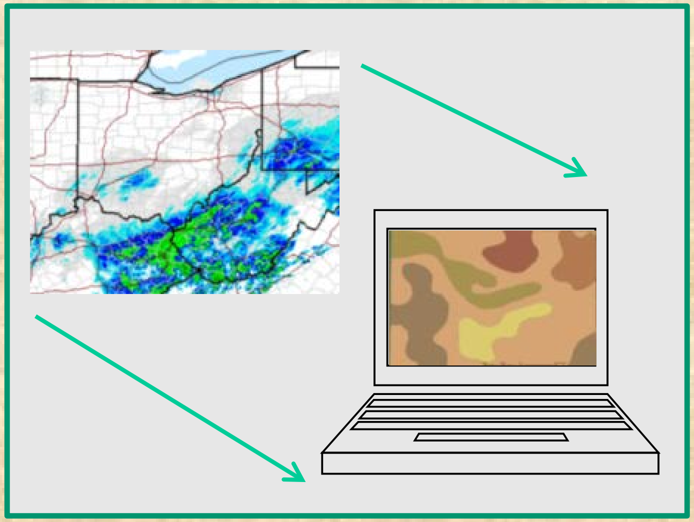


Soil sampling

On board sensors

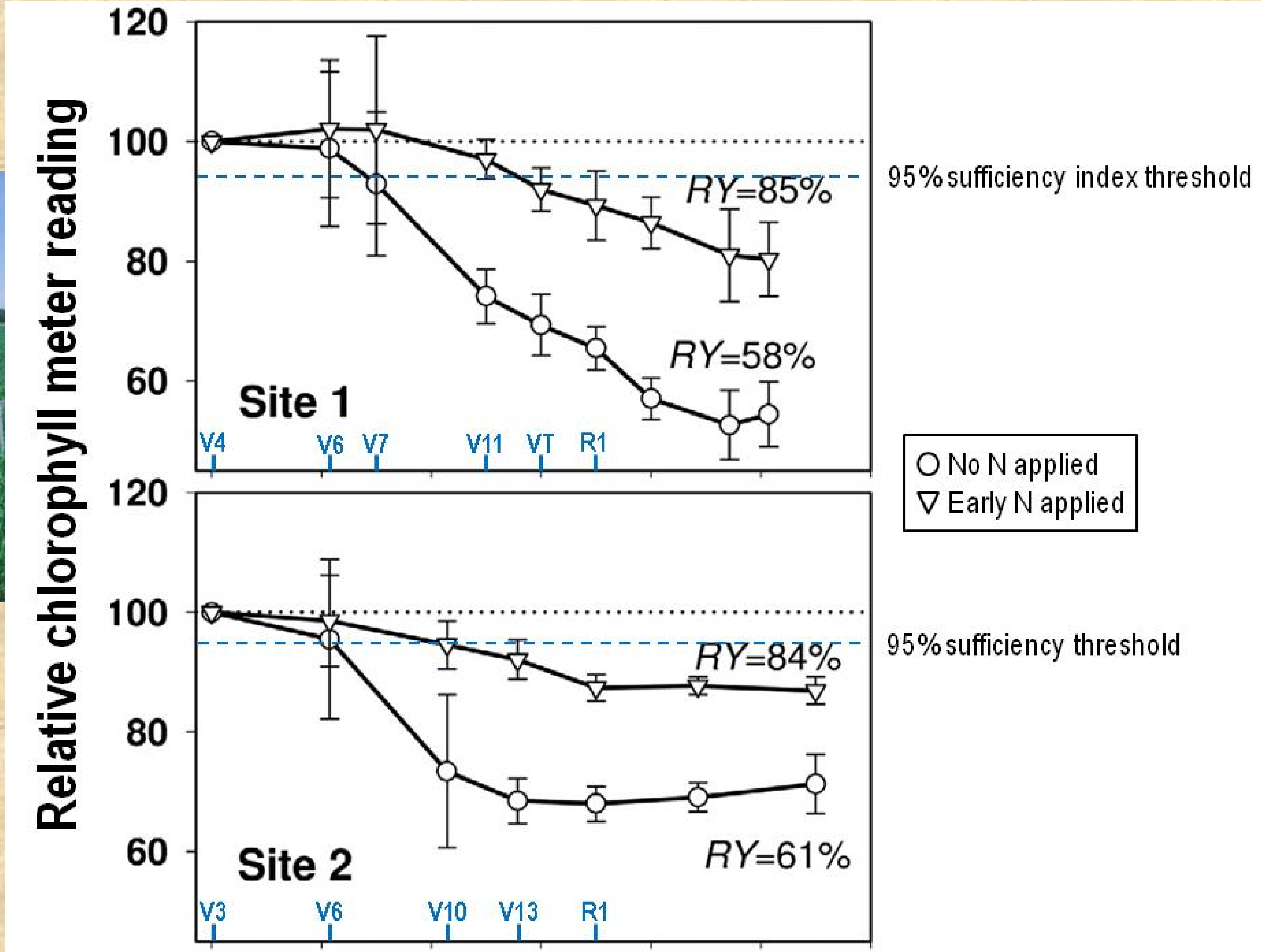


Remote sensing



Computer simulation

Problems with canopy sensing for determining rate



Avoid

Opportunities for Improving N Use Efficiency in U.S. Agriculture

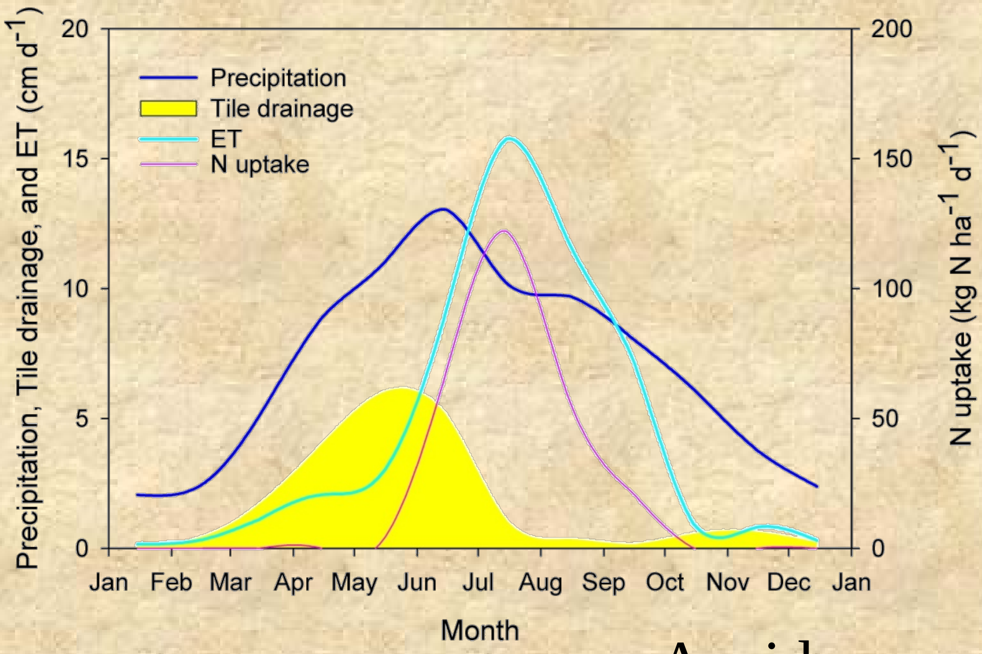
The 4 Rs +

- Right Time – N is used most efficiently when its availability is synchronized with crop demand
- Right Rate – match the amount of N fertilizer applied to the crop need
- Right Place – place N where available to crops but shielded from environmental loss
- Right Source – optimize N availability and risk of loss

Avoid

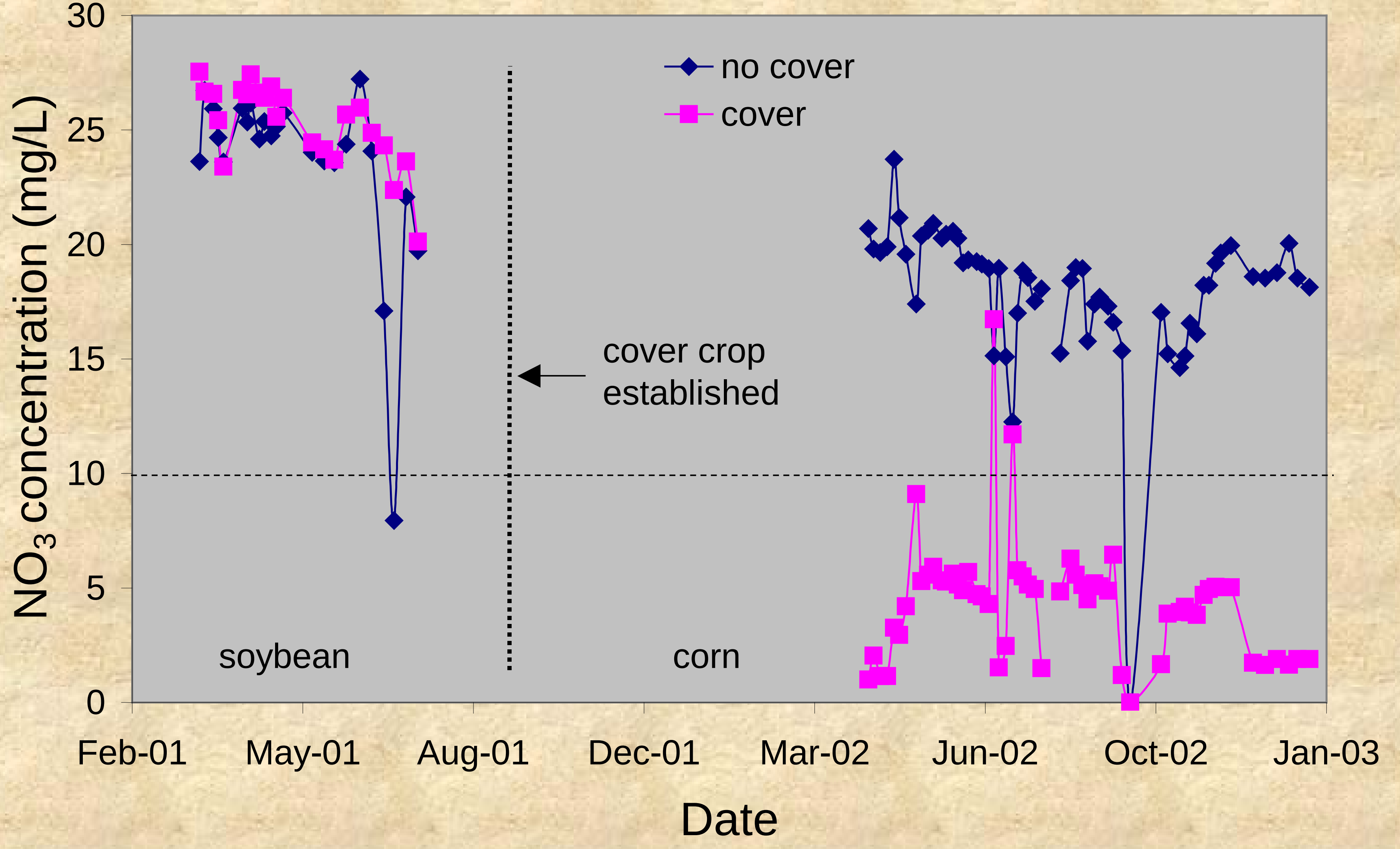
Fall Cover “Catch” Crop

Row crop



Avoid

Fall Rye Cover Crop - Results

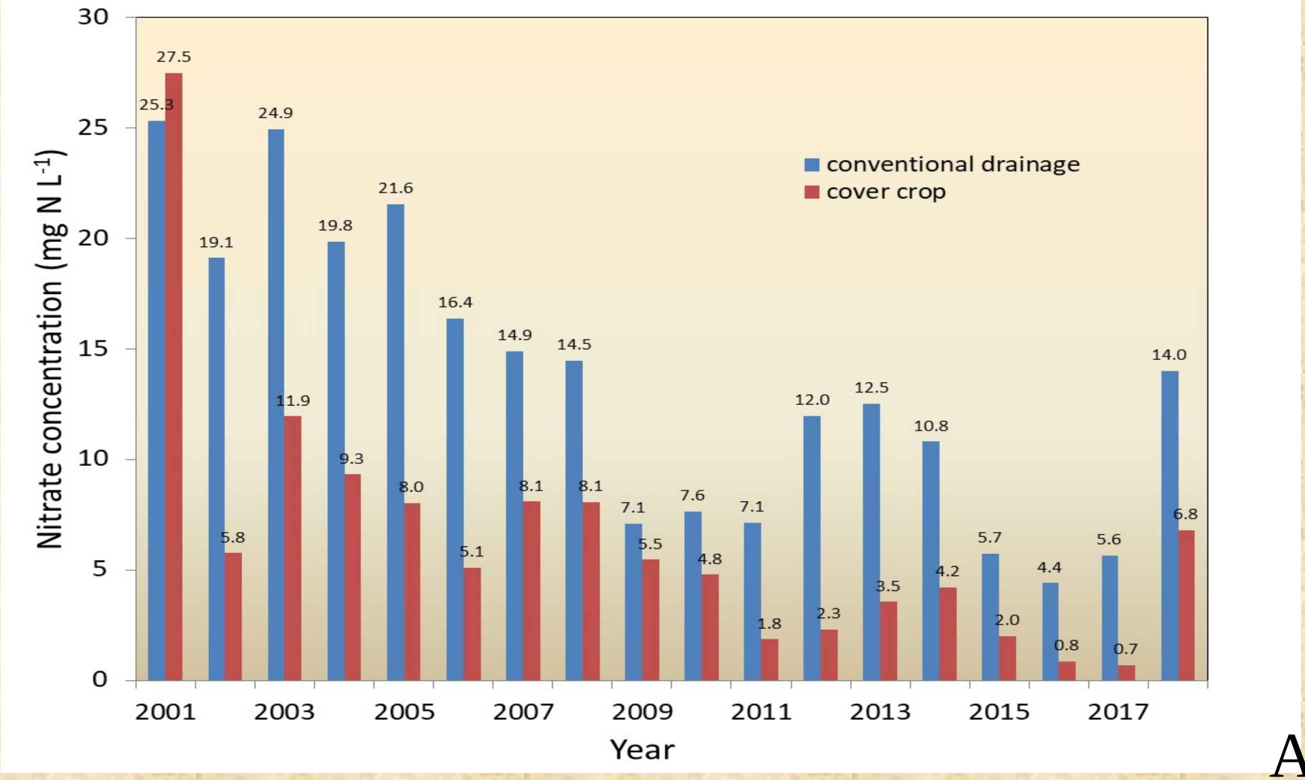


Avoid

Cover Crops and Perennials

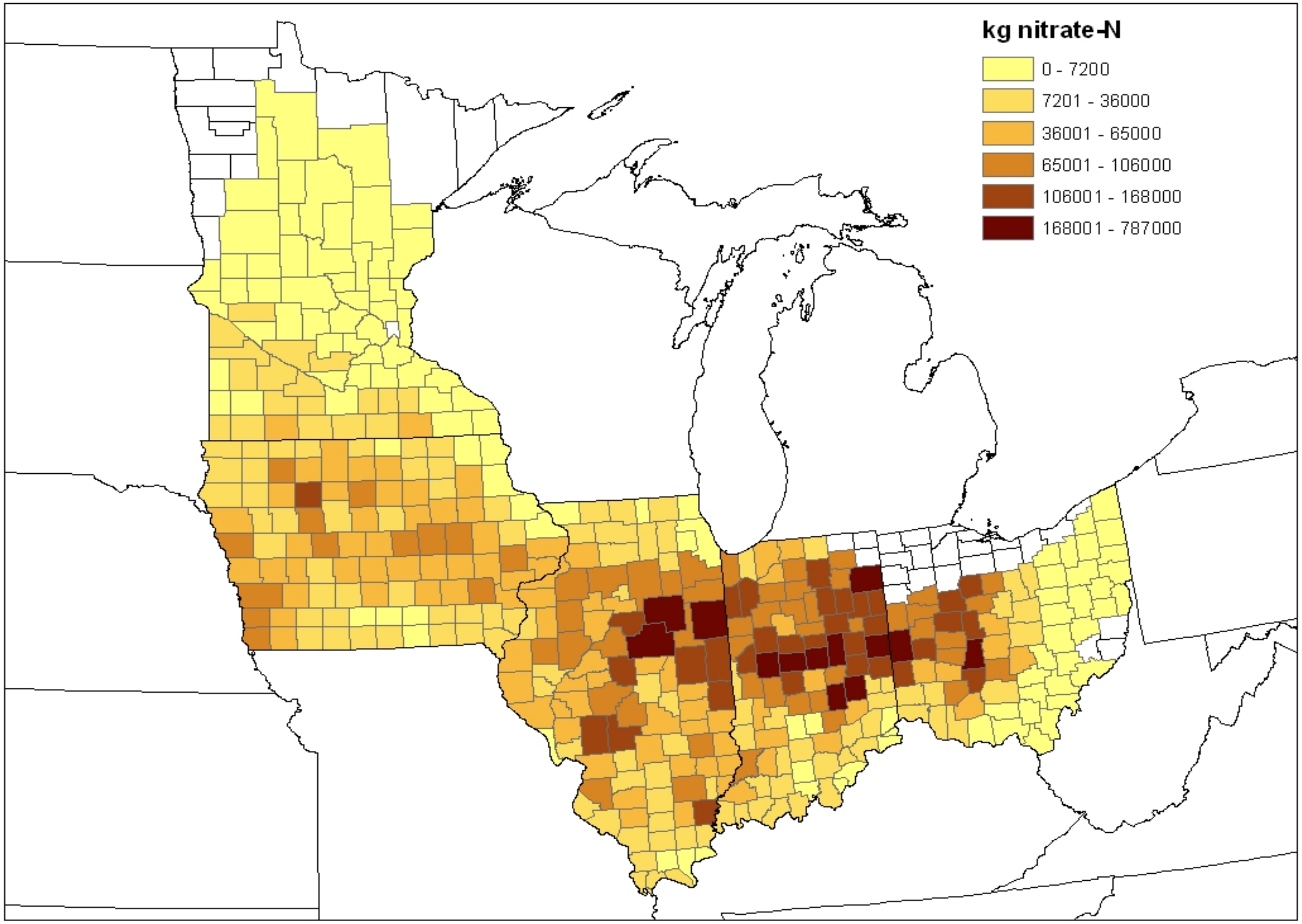
Fall planted rye vs. no cover crop

- N loss reduction: -20 to 90%
- Expected long term reduction: 50%



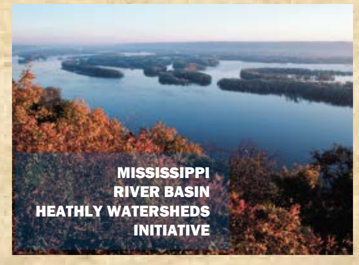
Avoid

Nitrate Load Reduction from Rye Cover Crop



Model simulations of the nitrate load reduction possible if a rye cover crop is implemented on all suitable corn acres within the 5 major cornbelt states. Total annual nitrate reductions to surface waters would be 49.2 million kg-N at a cost of \$3.87–\$5.65/kg-N removed.

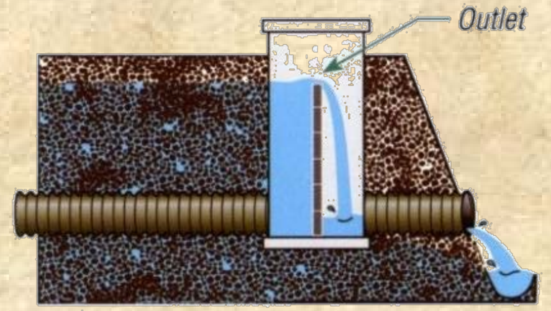
Avoid



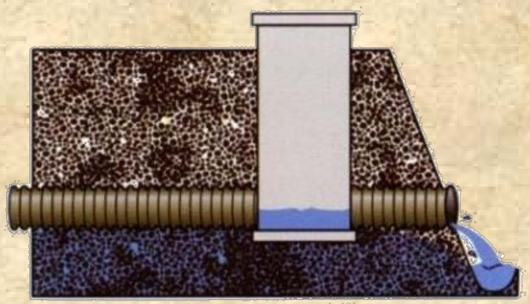
Control

- Drainage water management

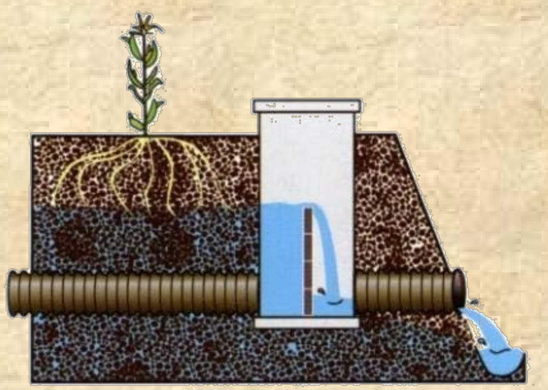
Controlled Drainage or
Drainage Water Management (DWM)



The outlet is raised after harvest to reduce nitrate delivery during winter.

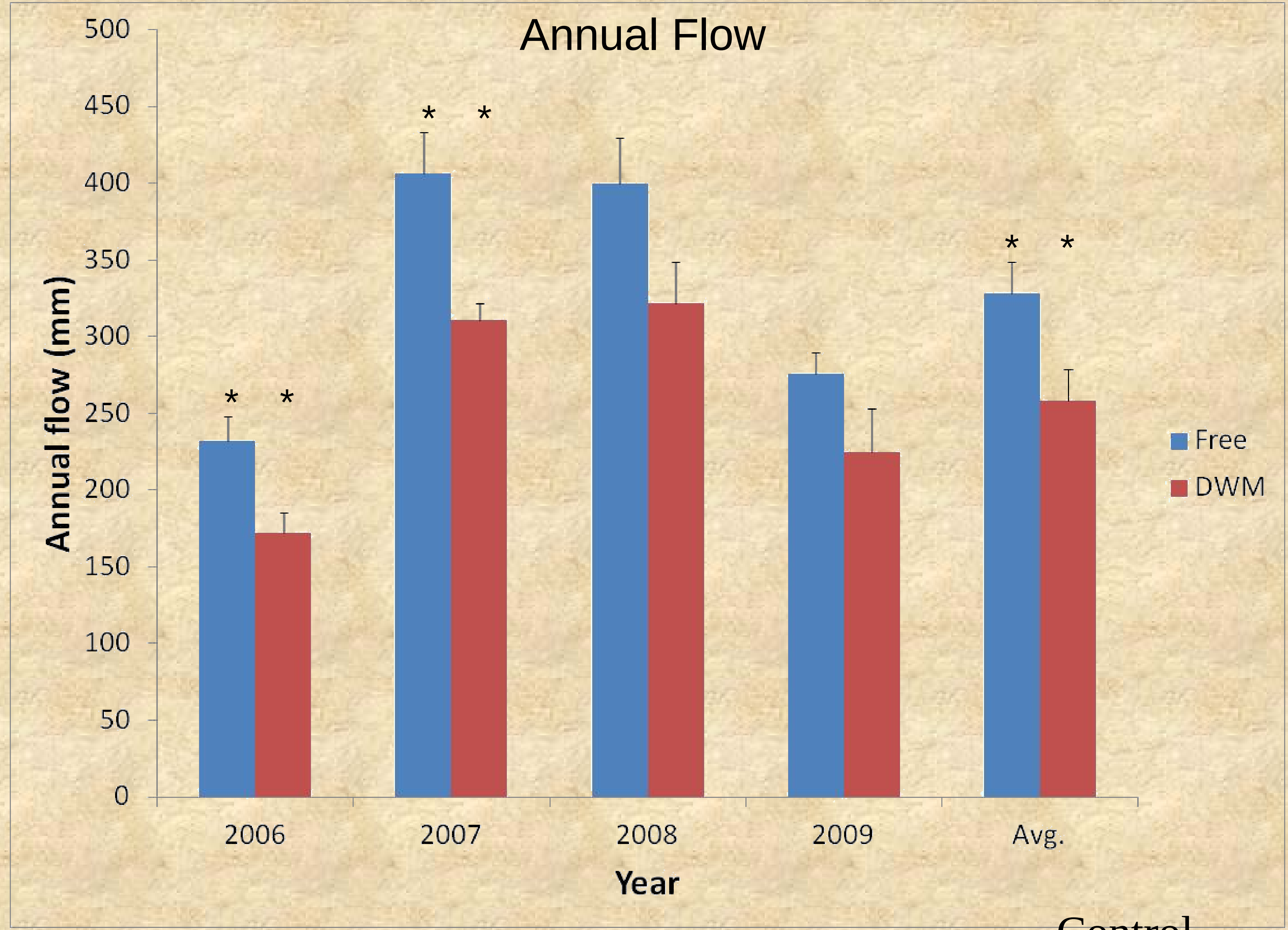


The outlet is lowered a few weeks before planting and harvest to allow the field to drain more fully.



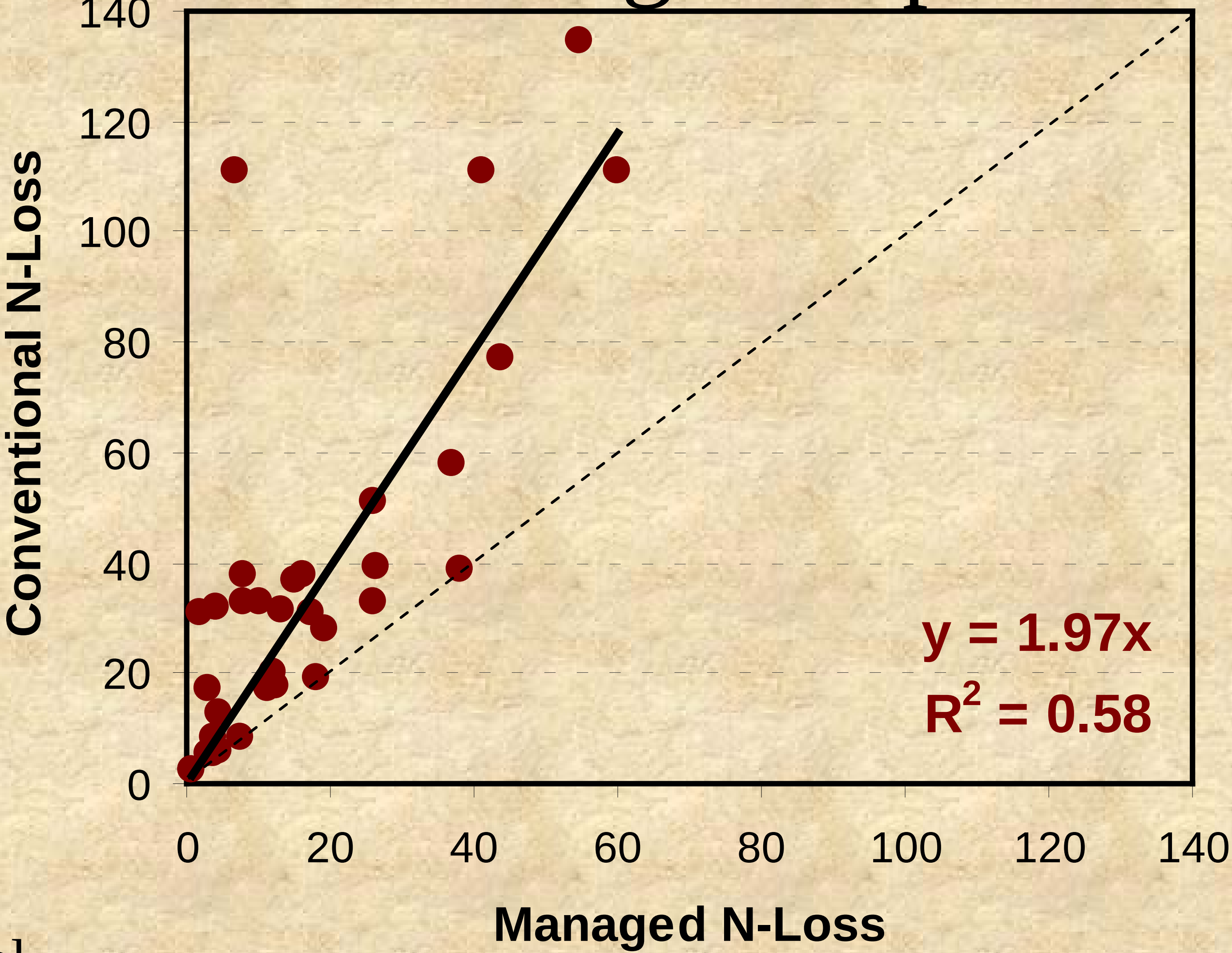
The outlet is raised after planting to potentially store water for crops.

Control


Annual Flow
500
450
400
350
300
250
200
150
100
50
0
Annual flow (mm)
*
*
*
*
*
*
2006
2007
2008
2009
Avg.
Year
Free
DWM

Control

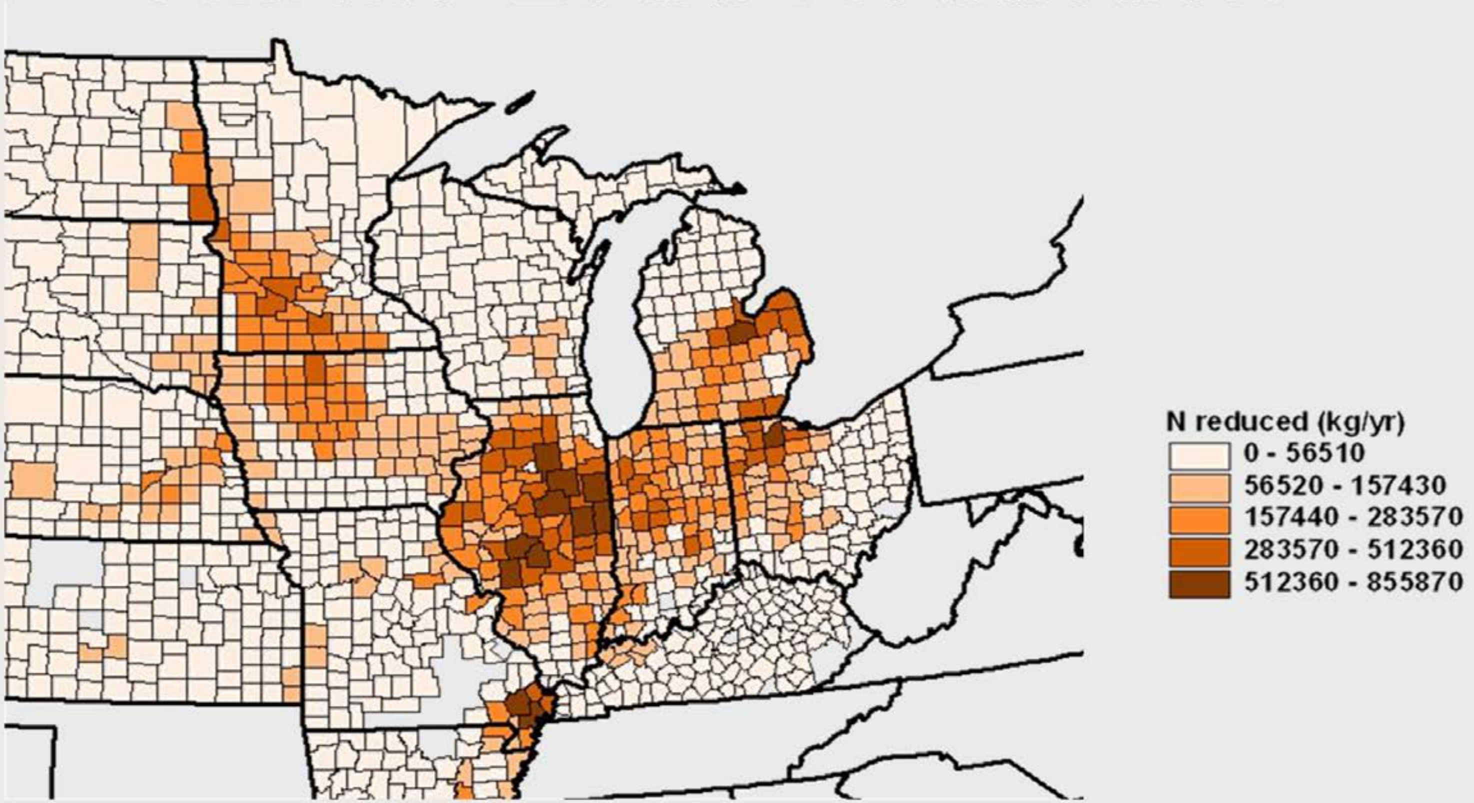
Nitrate Loading Comparison



Control

Sands and Helmers, unpub.

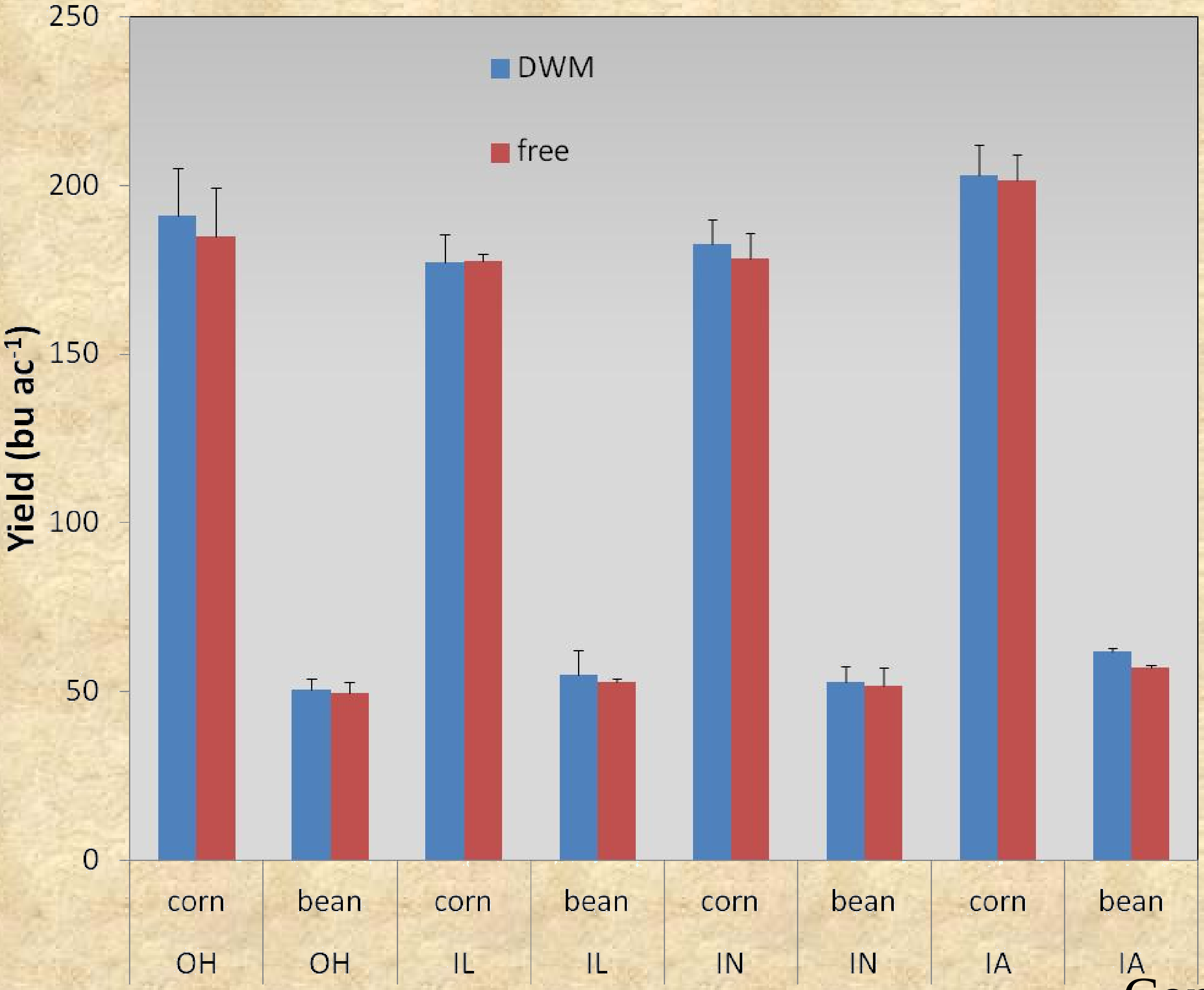
Nitrate Load Reduction



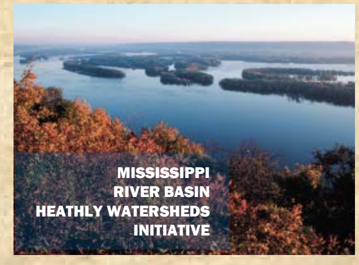
Model simulations of the nitrate load reduction possible if Drainage Water Management is implemented on all suitable corn acres within the Midwest. Total annual nitrate reductions to surface waters would be 82.1 million kg-N at a cost of $2.68/kg-N removed.

Control

Average crop yield for DWM vs. free drainage



Control

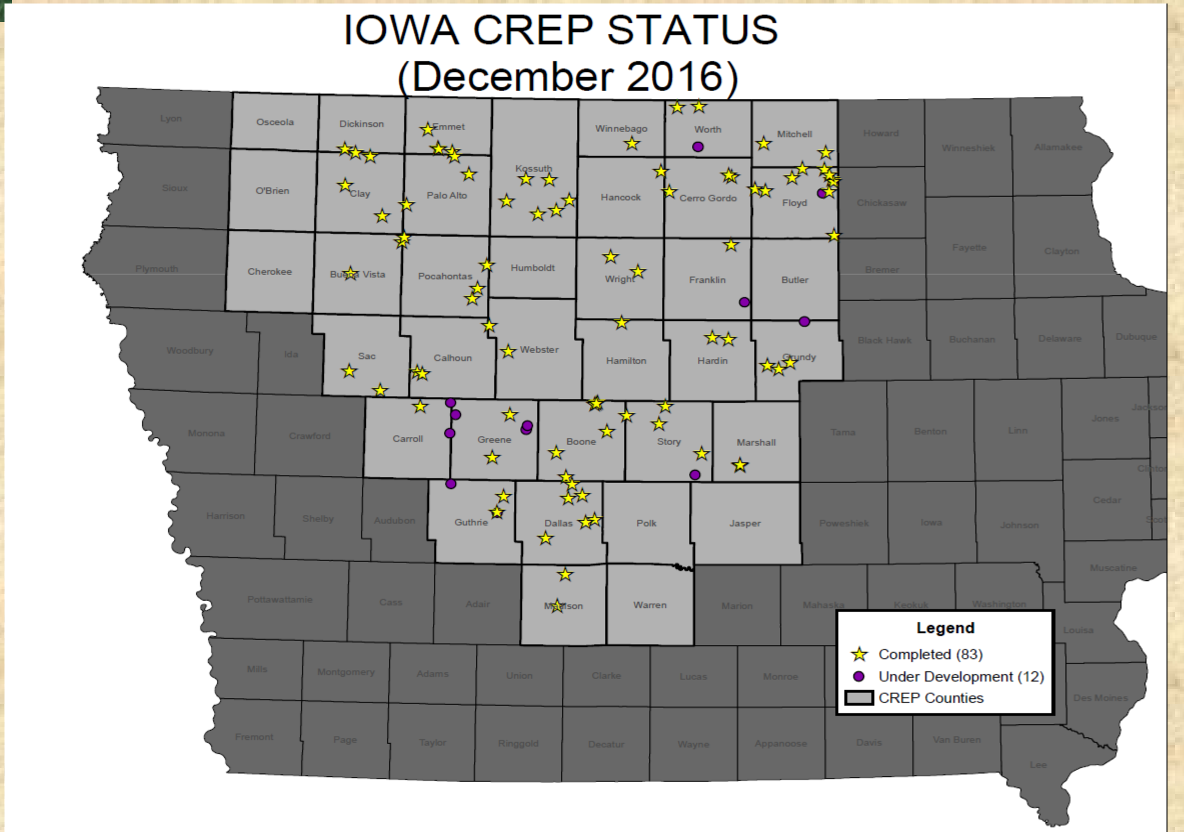


Trap

- Wetlands
- Denitrification bioreactors
- Saturate riparian buffers

Trap

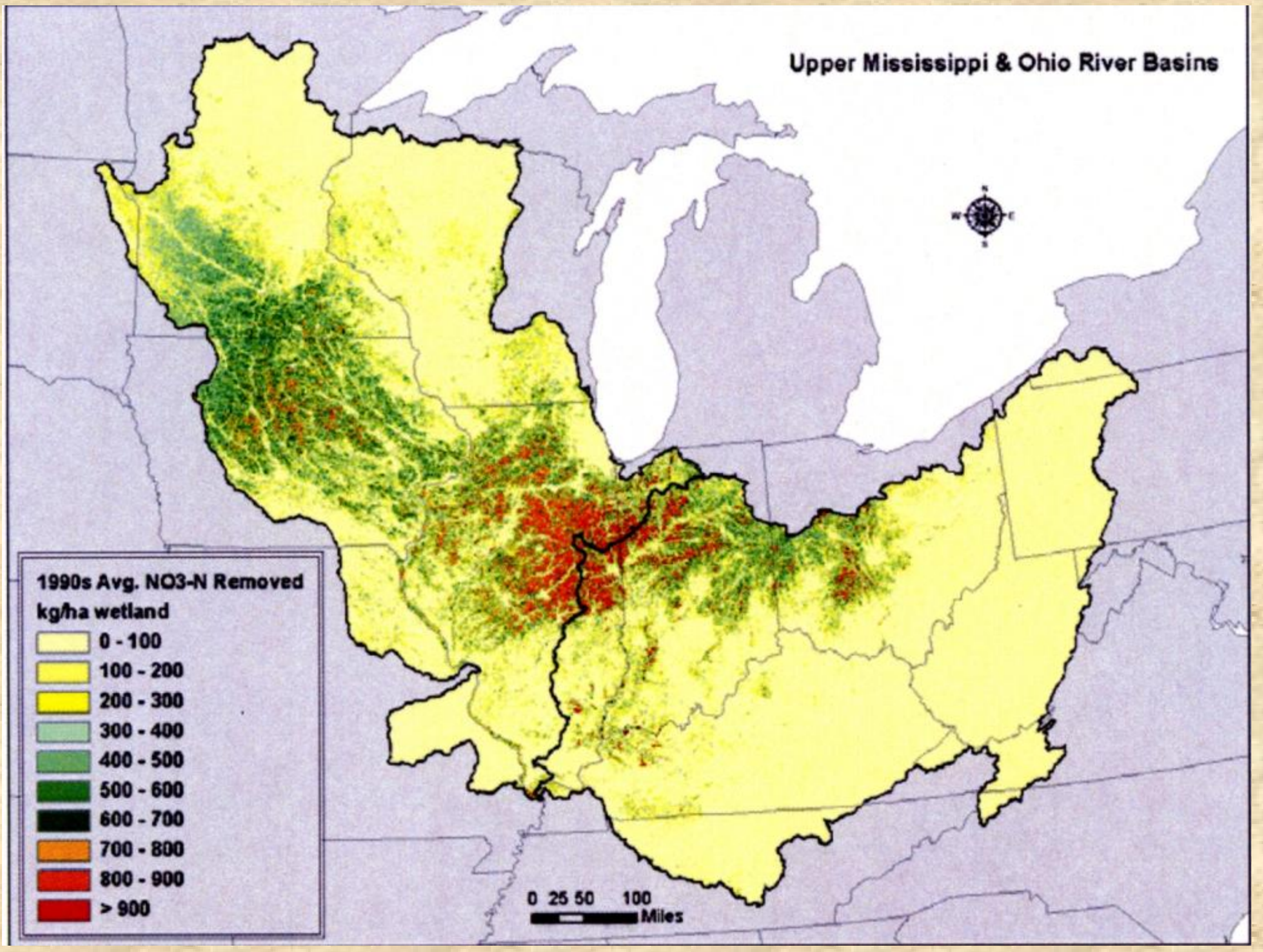
Iowa CREP wetlands



- ➢83 wetlands completed
- ➢Removing 10^6 lbs of NO_3-N/yr
- ➢= 0.2% of annual IA loss

Trap

Potential NO_3 Removal by Wetlands in the Upper Mississippi and Ohio River Basins



Requires
200,000 – 400,000 ha
of wetlands
for 30% reduction

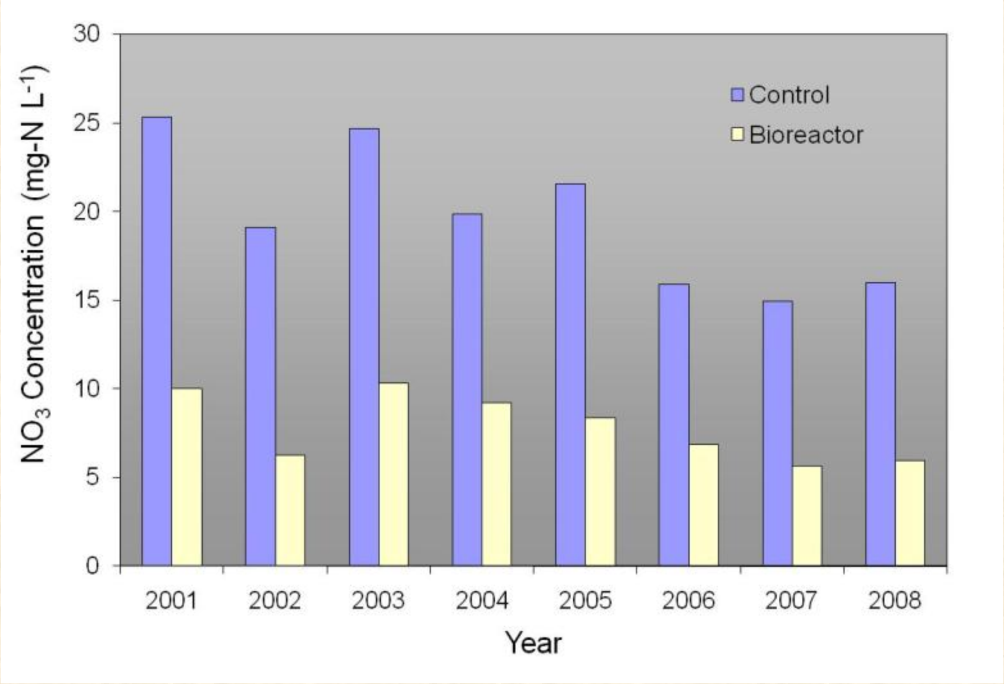
Trap

Crumpton et al., 2006

Trap – Denitrification Bioreactors

Trap

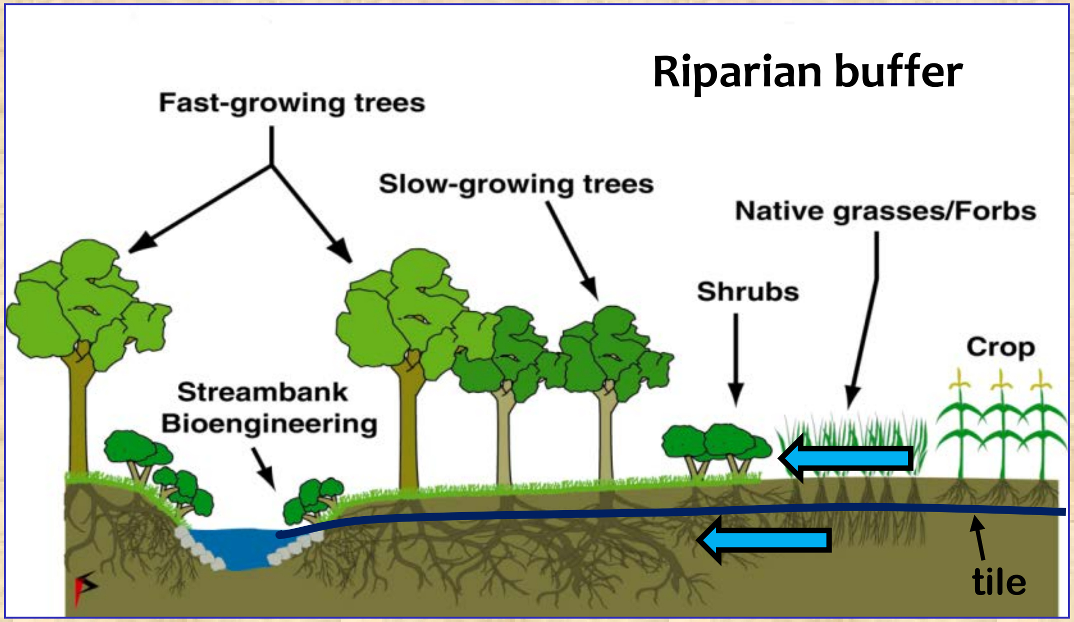
Tile drainage water under a conventional and bioreactor system

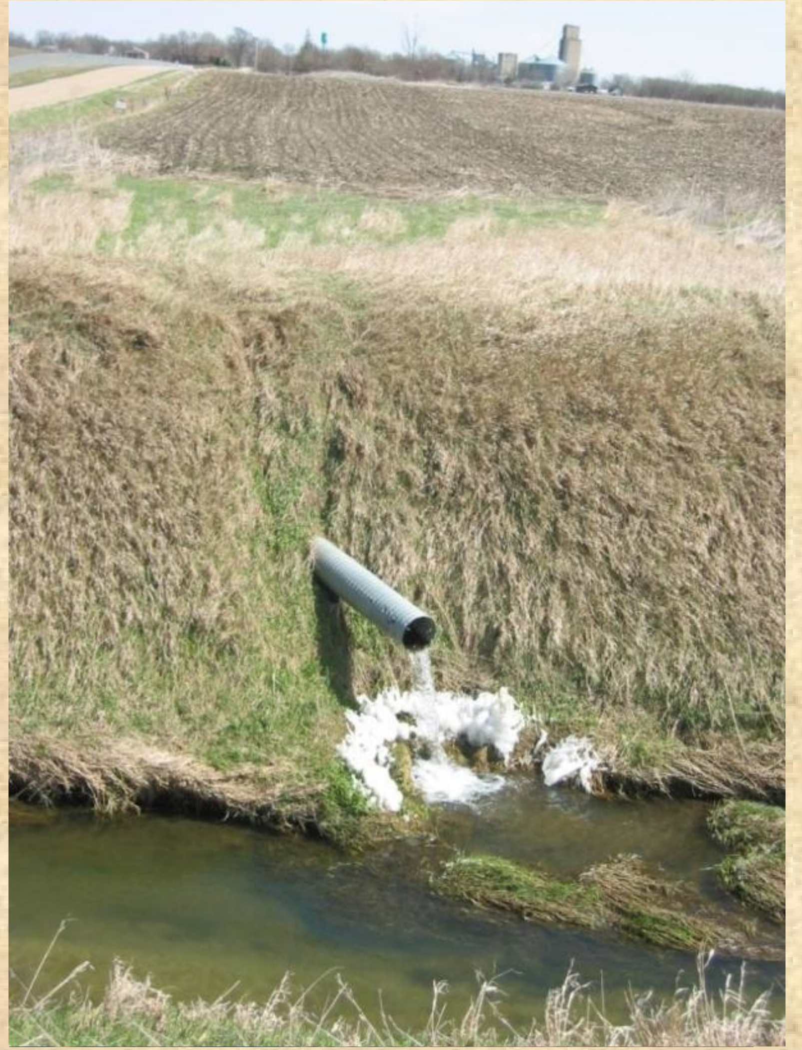


Nitrate concentration in tile drainage have been reduced by more than 65% over the past 8 yr.

Trap

Trap – Riparian buffers

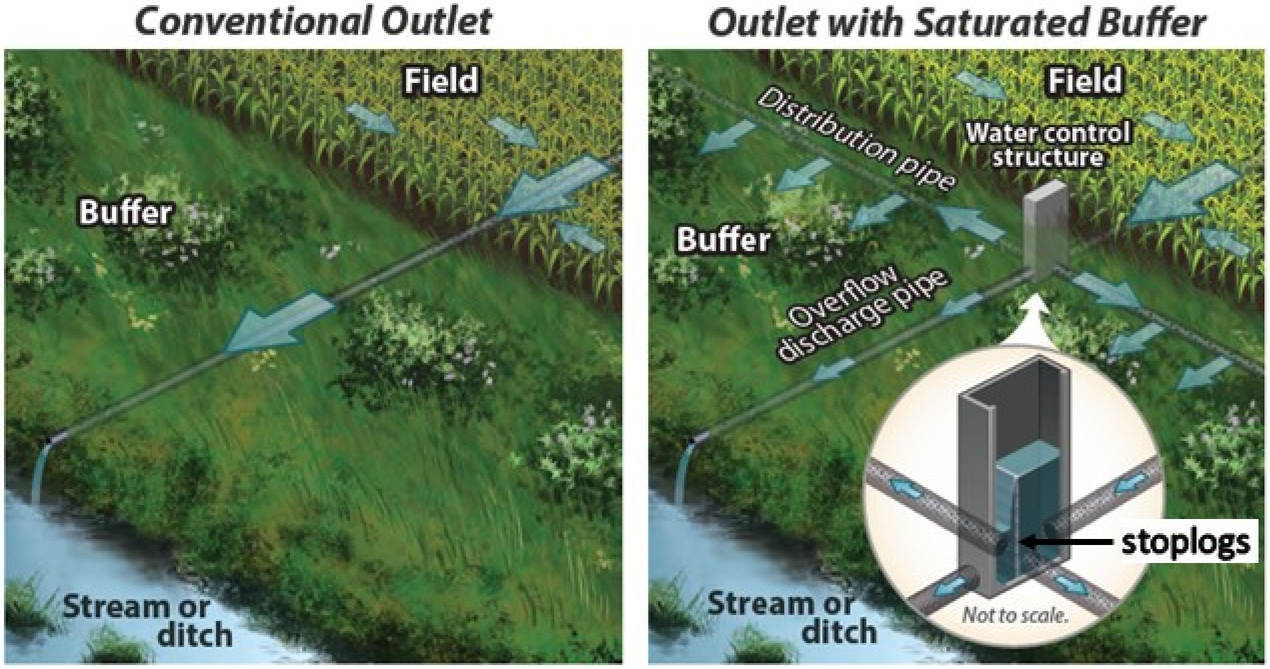




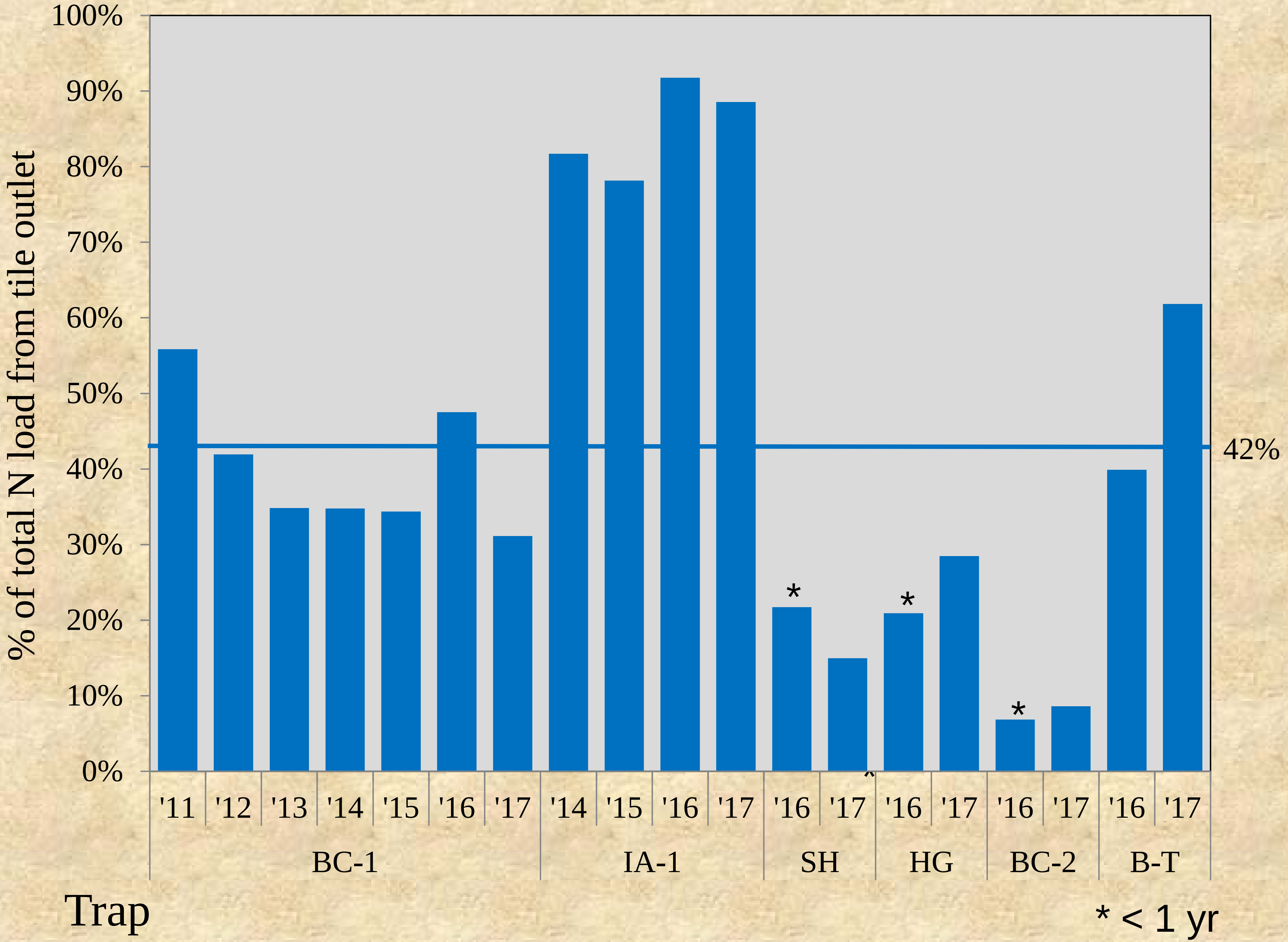
Midwest dominated by artificial subsurface drainage (tile) network

Trap

Saturated riparian buffers



Trap



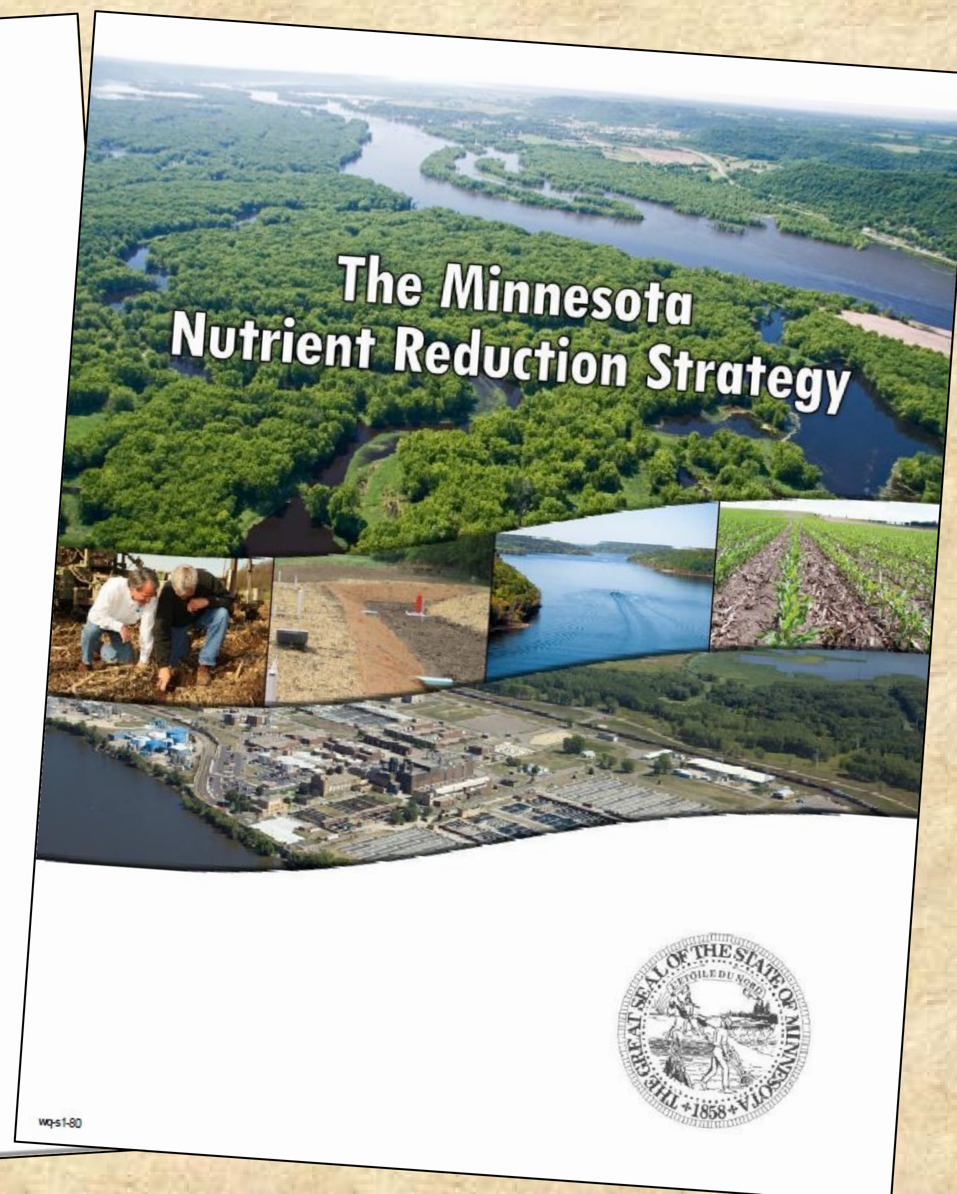
% of total N load from tile outlet
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
42%
*
*
*
'11
'12
'13
'14
'15
'16
'17
'14
'15
'16
'17
'16
'17
'16
'17
'16
'17
'16
'17
BC-1
IA-1
SH
HG
BC-2
B-T
Trap
* < 1 yr

Putting it all together

IOWA NUTRIENT REDUCTION STRATEGY

A science and technology-based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico

Prepared by:
Iowa Department of Agriculture and Land Stewardship
Iowa Department of Natural Resources
Iowa State University College of Agriculture and Life Sciences
November 2012

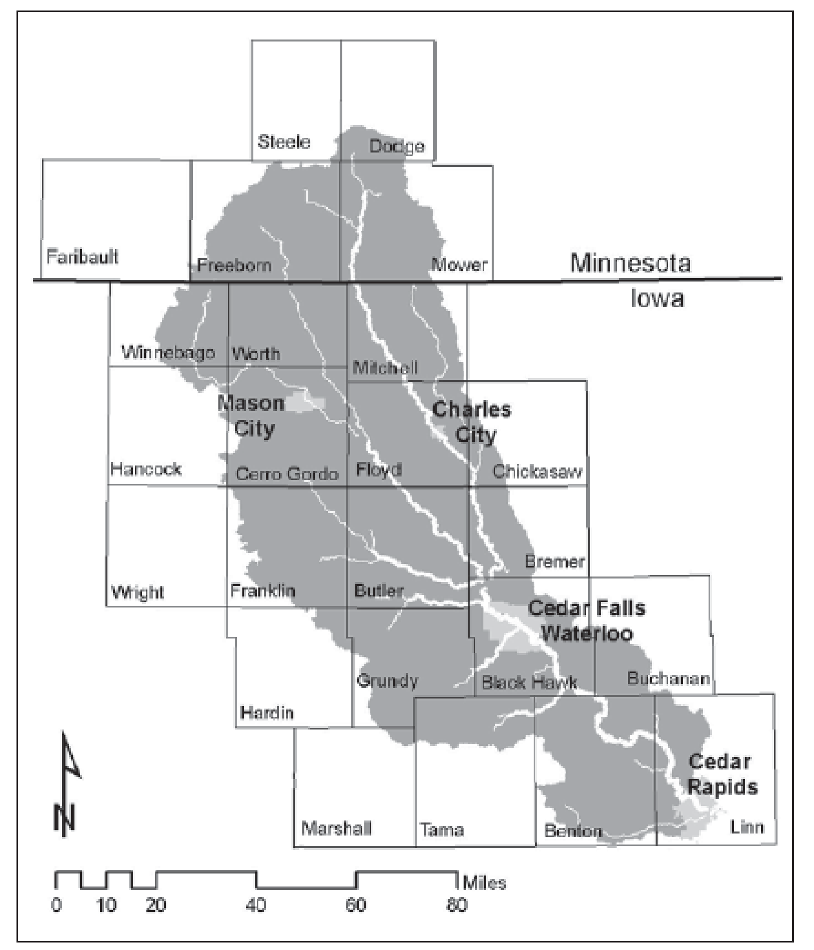


Nitrogen Reduction Practices

	Practice	% Nitrate-N Reduction [Average (Std. Dev.)]
Nitrogen Management	Timing (Fall to spring)	6 (25)
	Source (Liquid swine compared to commercial)	4 (11)
	Nitrogen Application Rate	Depends on starting point
	Nitrification Inhibitor	9 (19)
	Cover Crops (Rye)	31 (29)
Land Use	Perennial – Land retirement	85 (9)
	Living Mulches	41 (16)
	Extended Rotations	42 (12)
Edge-of-Field	Drainage Water Mgmt.	33 (32)*
	Shallow Drainage	32 (15)*
	Wetlands	52
	Bioreactors	43 (21)
	Buffers	91 (20)**

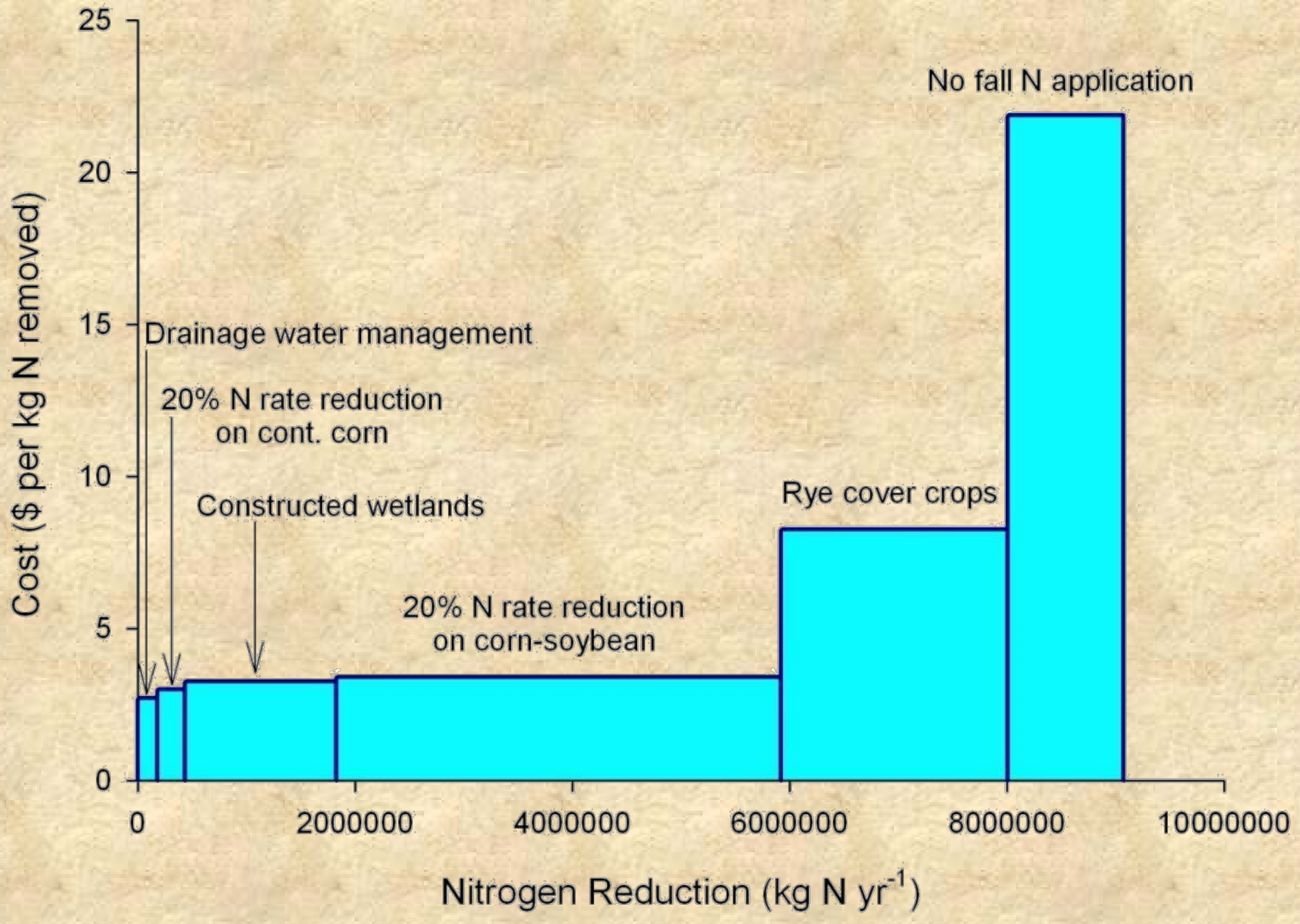
Iowa Water Quality & Cost Assessment Case Study

- Cedar River Watershed
- 2006 TMDL for NO_3
- Requiring a 35% reduction



James Baker, John Sawyer, Matt Helmers, Antonio Mallorino, Mike Duffy, Bill Crumpton, Sunday Tim, Dan Jaynes, Jack Riessen, Marty Adkins, Rick Robinson, Dean Lemke

Cost effective adoption of NO_3 BMPs



FINAL WORDS

- N management is not easy. We have practices for reducing N losses to surface waters, but need more

Avoid Control Trap

- Will take years (decades) for widespread implementation of these practices given current voluntary adoption and funding levels
- Voluntary adoption of conservation practices may get replaced by mandatory requirements
- A voluntary but not optional mindset may work best to delay future legislation.

Thank You

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