# Using Cover Crops to Reduce Leaching Losses of Nitrate

National Conference on Cover Crops and Soil Health
Friday, December 8, 2017

USDA-ARS
National Laboratory for Agriculture and the Environment
Ames, Iowa

Tom Kaspar, Ben Knutson, Keith Kohler, Kent Heikens, Dan Jaynes, Tim Parkin, Tom Moorman, and Rob Malone

Thanks to:
Lowell Gentry, Univ. IL
Adam Kiel, ISA
Eileen Kladivko, Purdue
Matt Helmers and Mike Castellano, Iowa State

# What's the Problem?

**Nitrates in rivers hit record levels**

Des Moines Register Friday May 10, 2013

**Finding Fixes for Nitrates**

Des Moines Register  Sunday Sept. 13, 2015

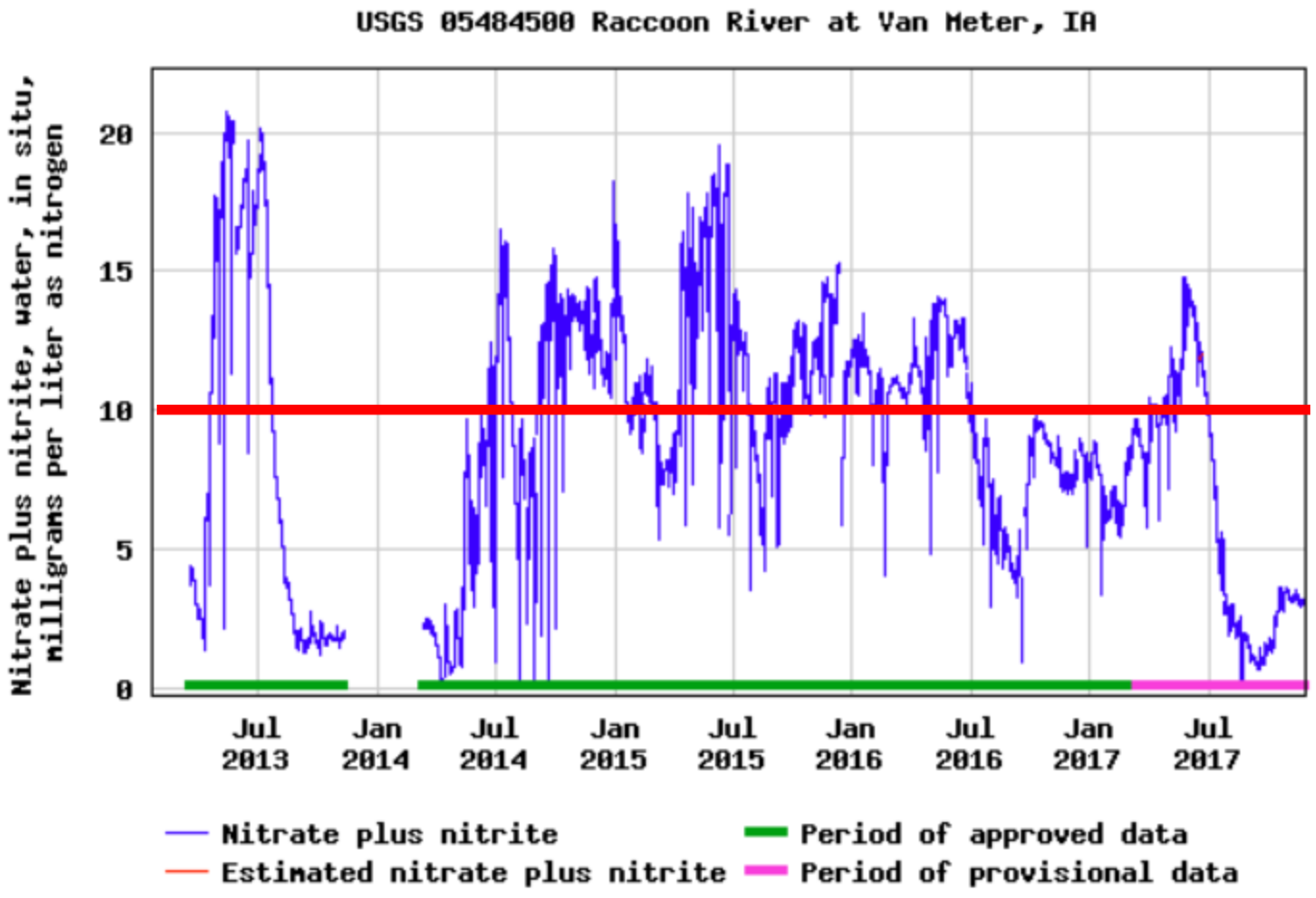
**Chesapeake Bay cleanup: Is Iowa next?**

Des Moines Register  Nov. 17, 2015

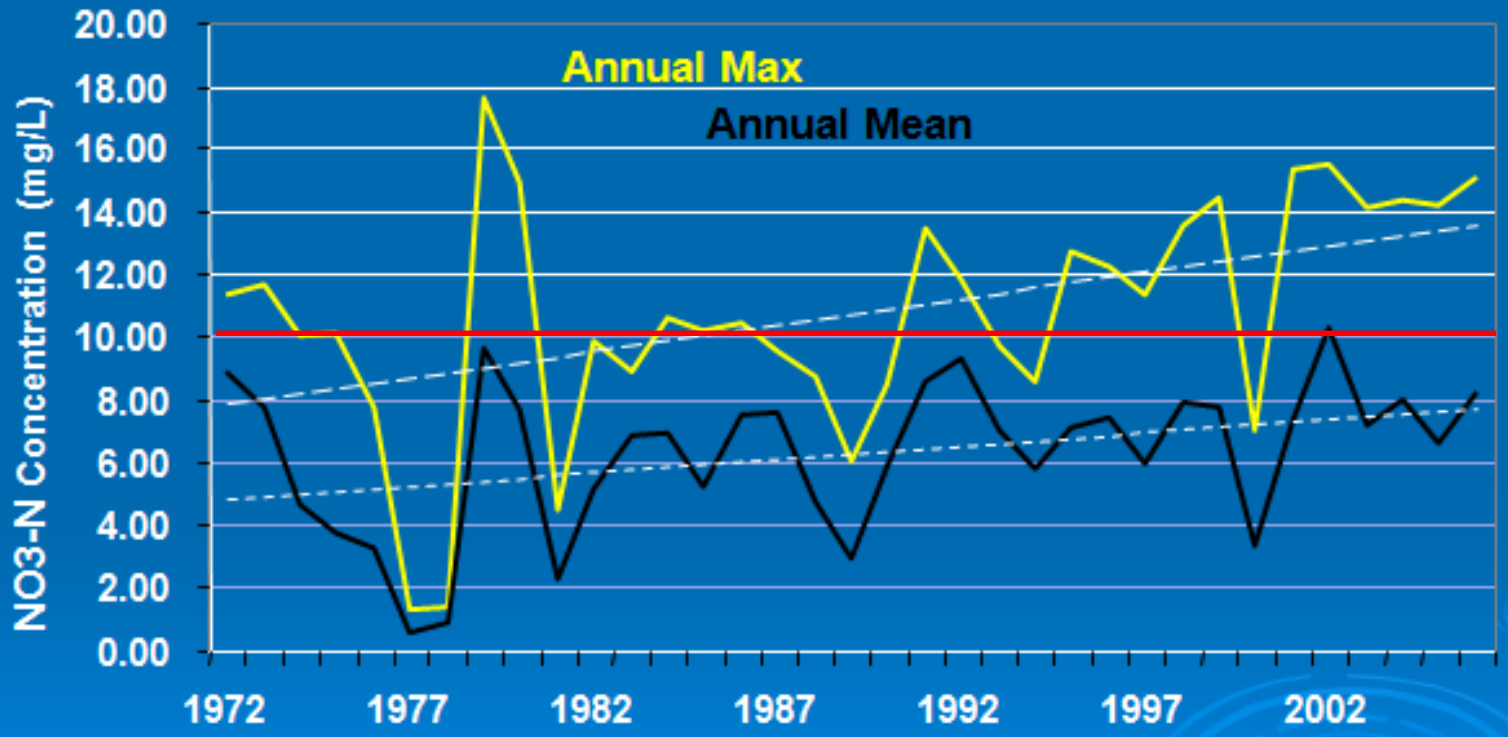
**And of course the nitrates in rivers in Iowa end up in the Mississippi River and the Gulf of Mexico**

**Nitrate plus nitrite, water, in situ, milligrams per liter as nitrogen**

Most recent instantaneous value: 2.94 11-27-2017 16:00 CST



# NO3-N Concentration in the Raccoon River at Des Moines




Data provided by Chris Jones
Des Moines Water Works

# What Causes the Problem?

## It's the Golf Courses and Lawns!

| | |
|---|---|
| Corn & Soybean (Acres) | 24,507,219 |
| Golf Courses (Acres) | 49,172 |
| Lawns (Acres) | 154,064 |
| Total | 24,710,455 |

There are 120X more corn & soybean acres than golf courses and lawns in Iowa.

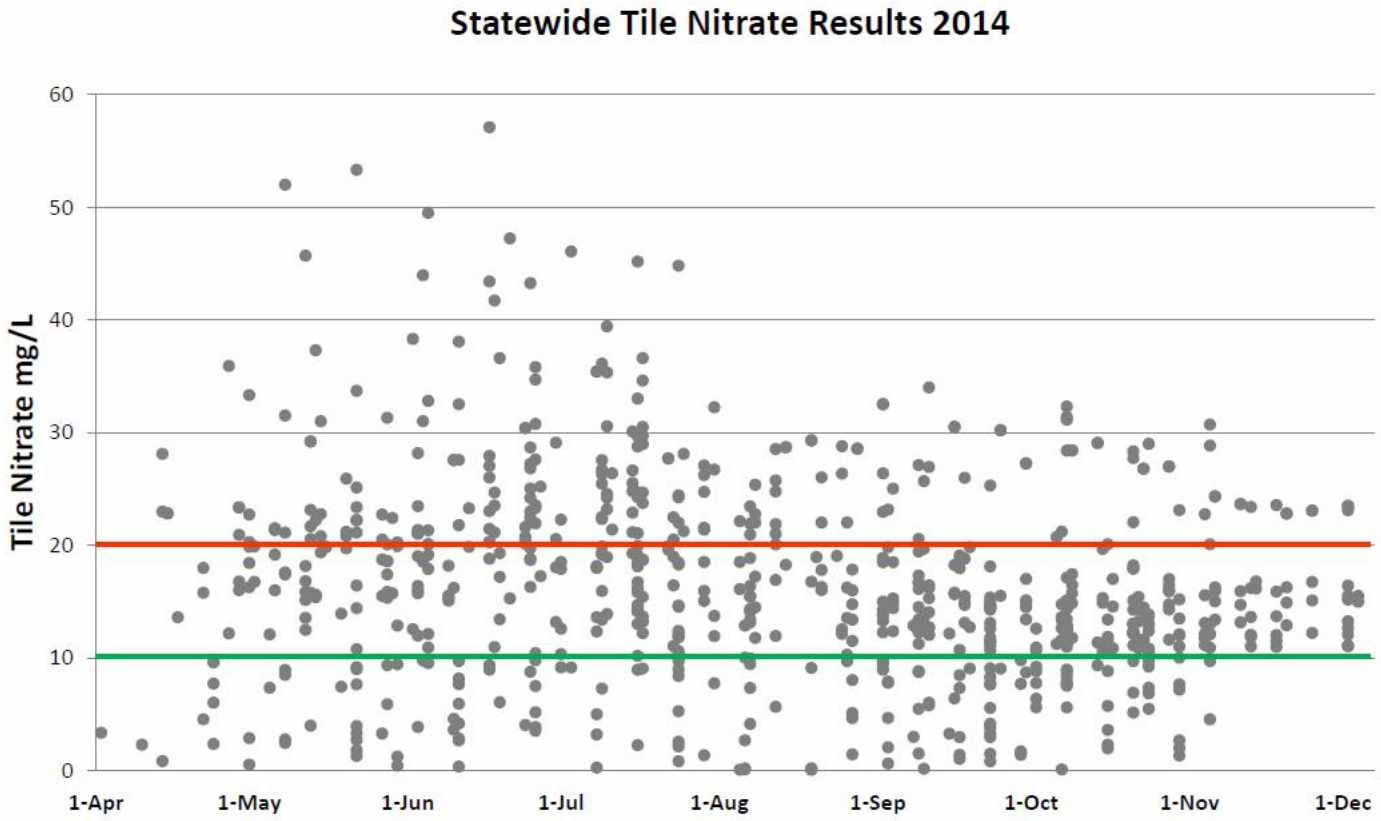
# It's the Sewage Treatment Plants!

…. Nonpoint (farmland) sources comprise 89.6 % of the total nitrate load in the watershed.

….. So it's mostly farmland again.

Water Quality Improvement Plan for Raccoon River Iowa. Shilling, K.E. and C.F. Wolter. Iowa Dept. Natural Resources. 2007

# Statewide Tile Nitrate Results






*Funded in part by the soybean checkoff*

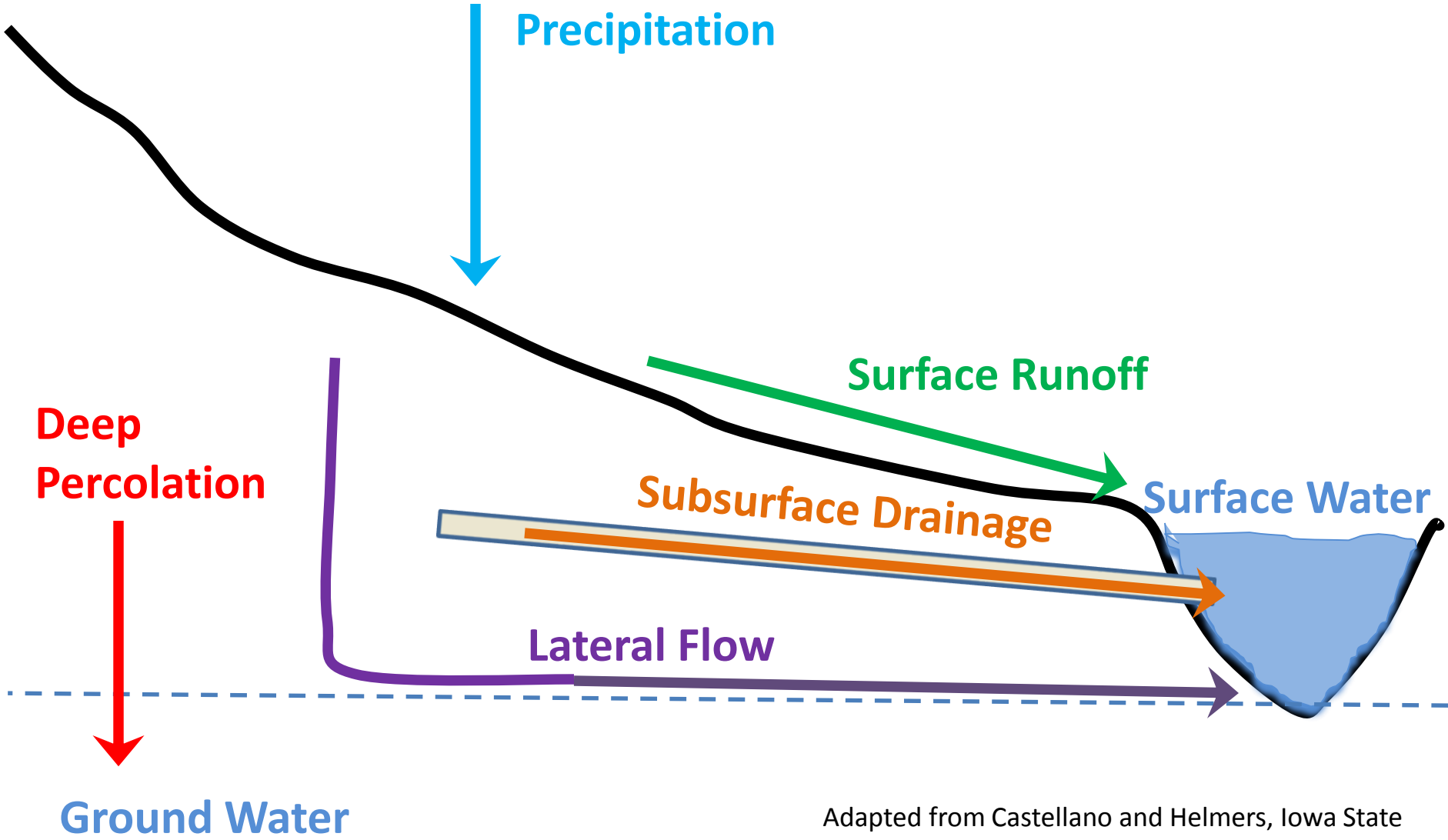
So why is this such a difficult problem?

We just need to manage N fertilizer and manure better.

Right?

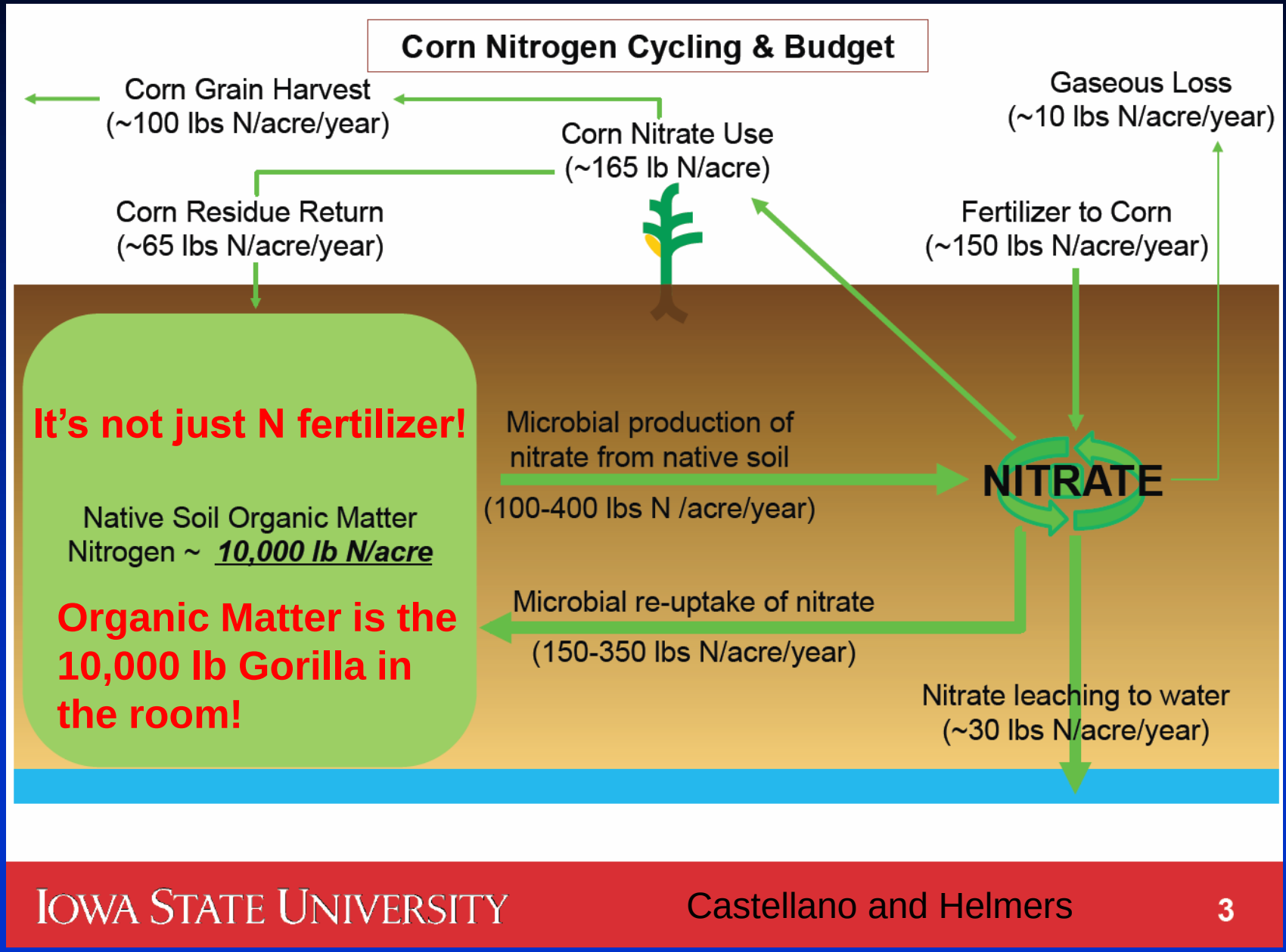
# Nitrate Moves Easily with Water

## Water and Nitrate Flow Pathways

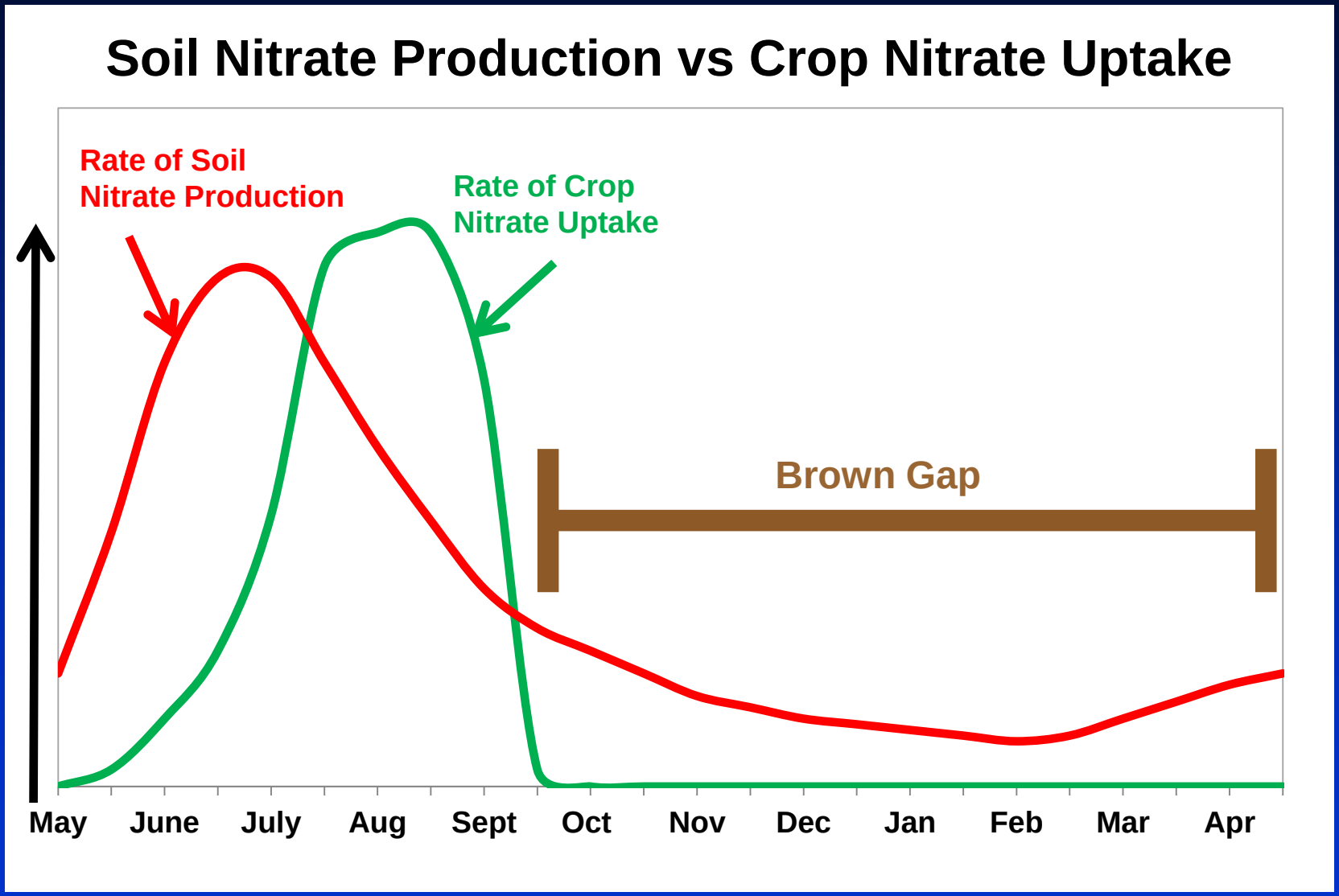



Adapted from Castellano and Helmers, Iowa State

# Large Pools of N in Soil Organic Matter



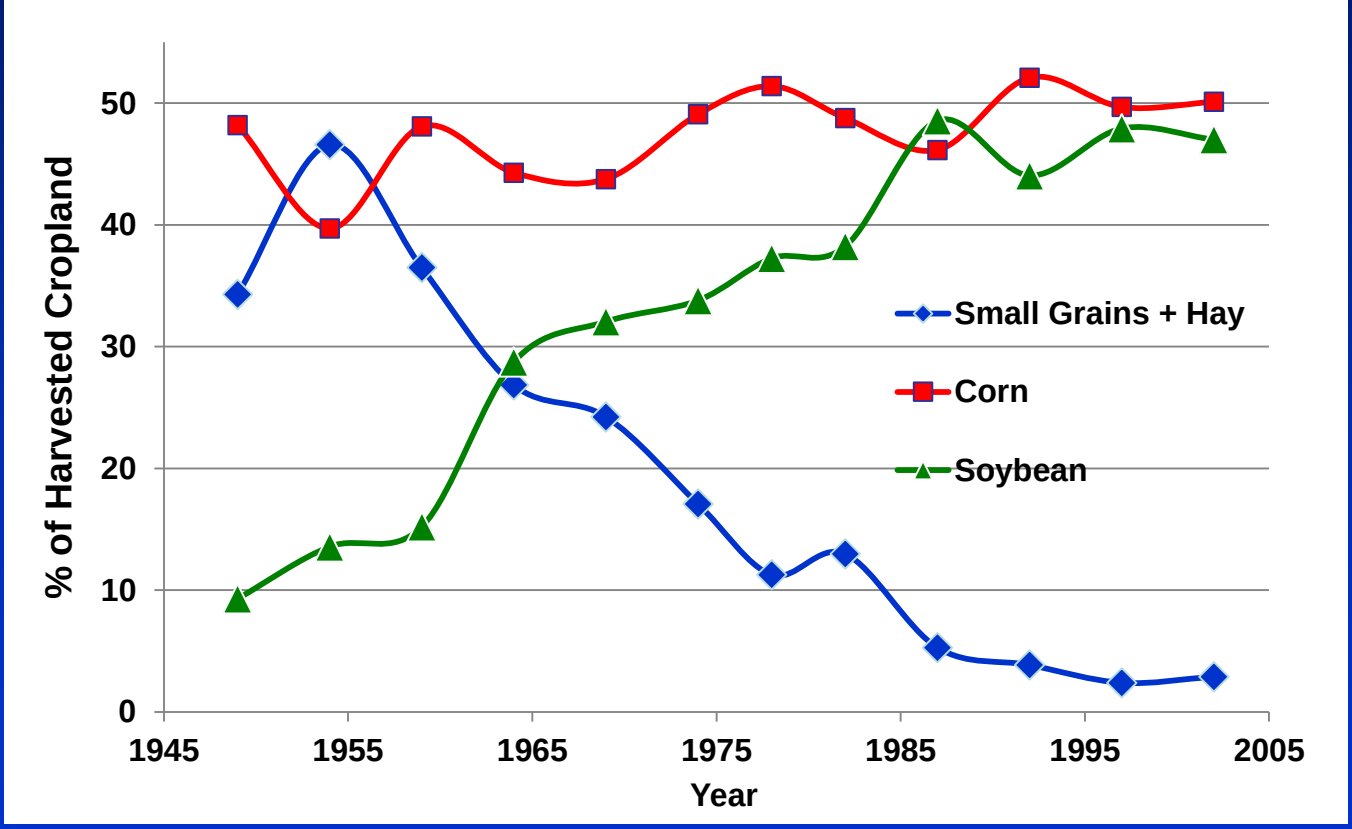
# Poor Timing Between Uptake and Availability




Modified from Castellano and Helmers

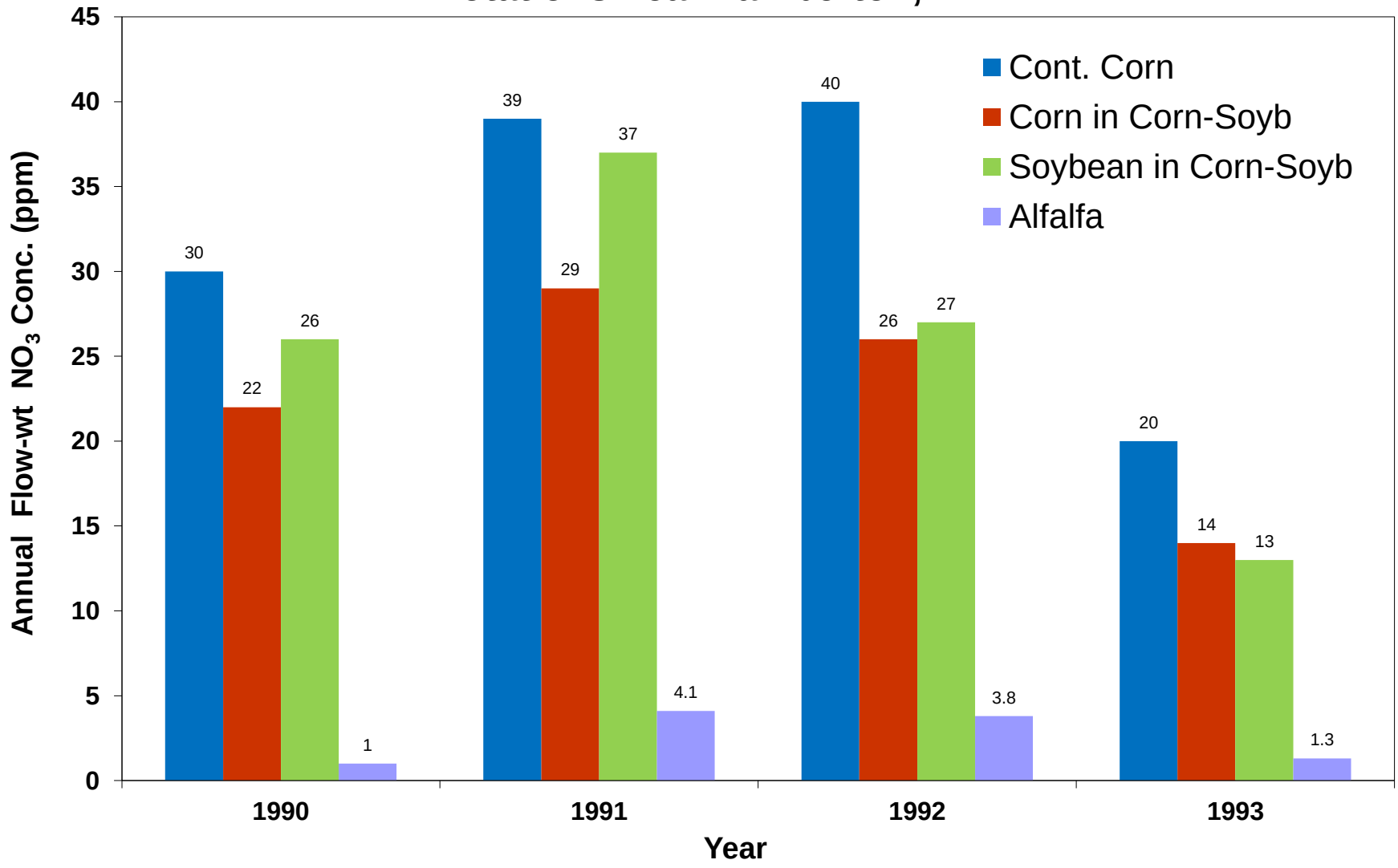
# Our Cropping Systems Have Changed

From 1949 to 2002: % of Iowa Raccoon River Basin cropland in Small Grains and Hay decreased from over 45% to less than 3%.



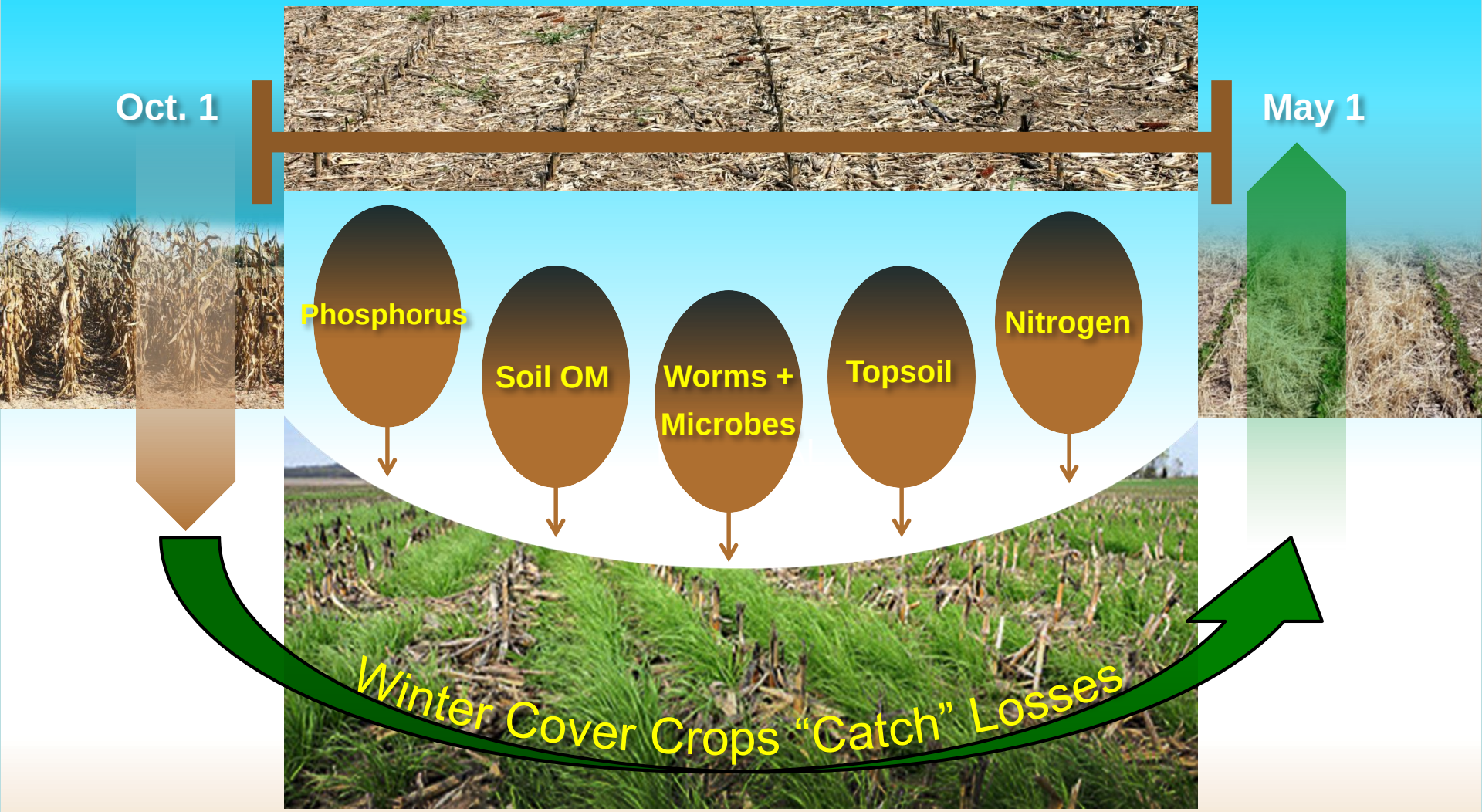

Hatfield et al. 2009

# Annual Flow-wt NO3 Concentration of Tile Drainage for Four Rotations near Lamberton, MN




Randall et al. 1997

# Corn and Soybeans have a 7 Month "BROWN" Gap

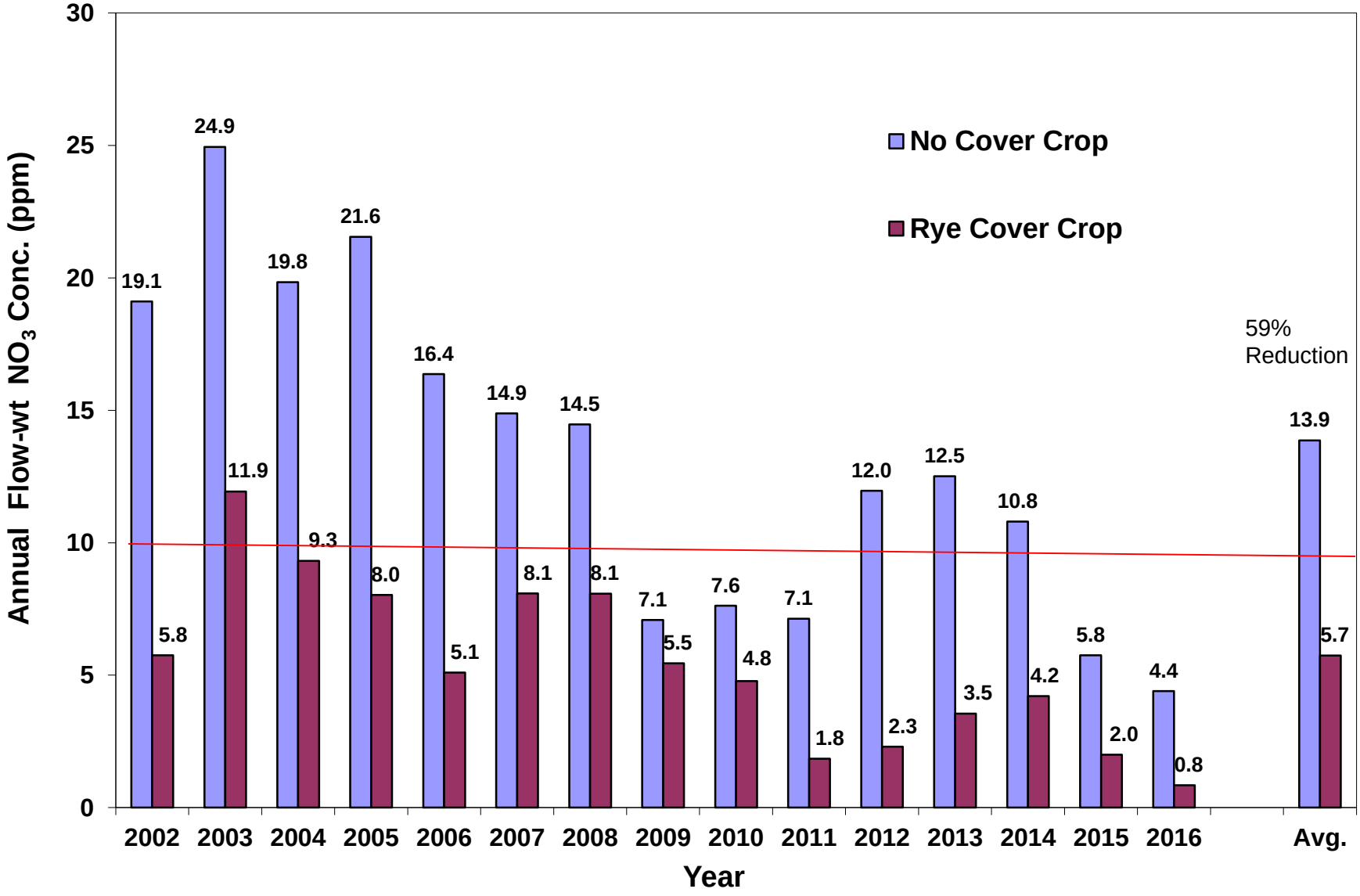


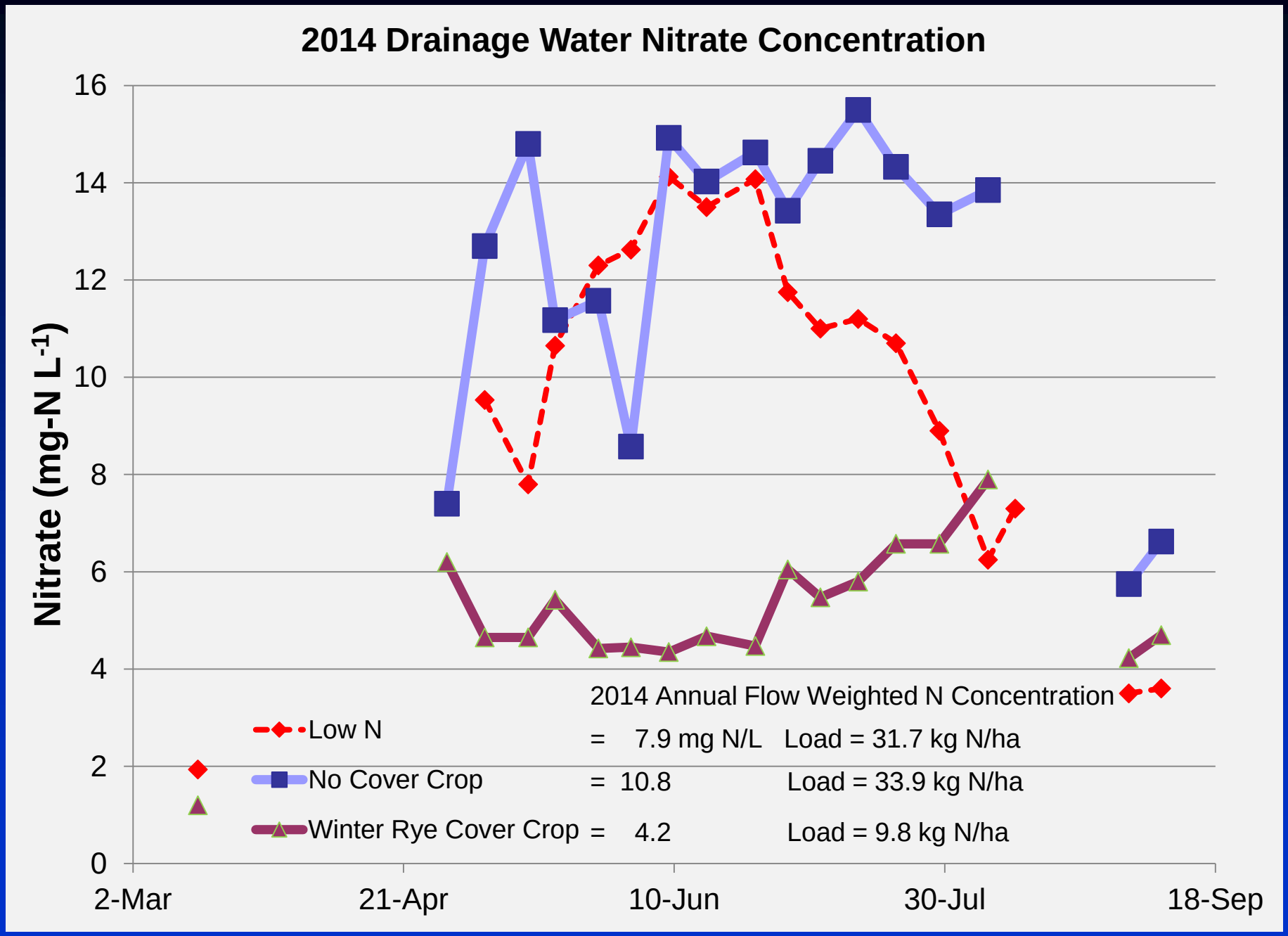

**Cover Crops Fill the "BROWN" Gap with "GREEN" Plants**

**The more "GREEN" the more benefits and protection**

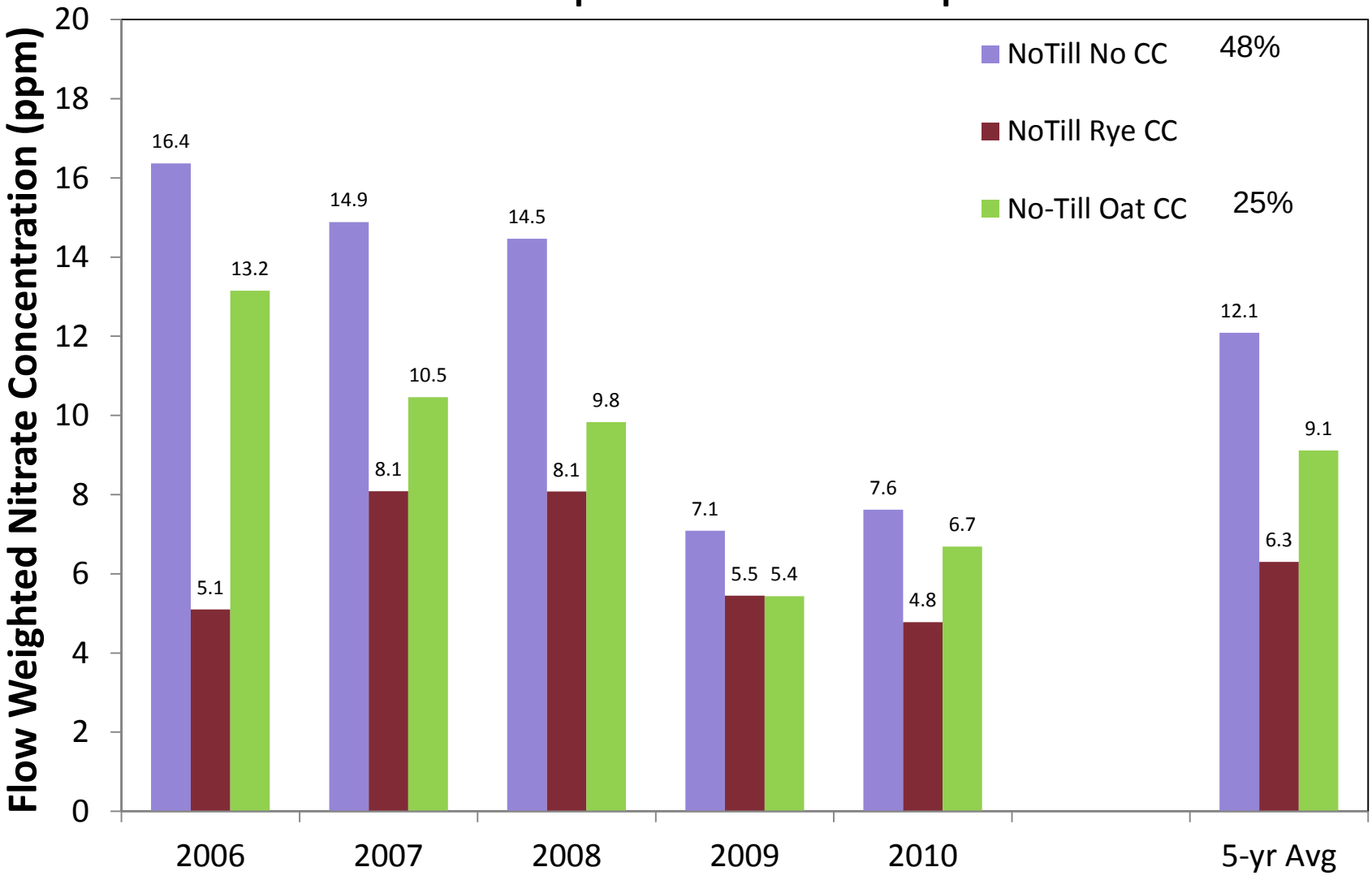
# 15 years of Measurements of Nitrate Loss in Tile Drainage with and without Cover Crops

# Annual Flow-wt NO3 Concentration of Tile Drainage for Corn-Soybean Rotation near Ames, IA with or without a Cover Crop




2014 Drainage Water Nitrate Concentration
Nitrate (mg-N L-1)
16
14
12
10
8
6
4
2
0
2-Mar
21-Apr
10-Jun
30-Jul
18-Sep
2014 Annual Flow Weighted N Concentration
Low N = 7.9 mg N/L Load = 31.7 kg N/ha
No Cover Crop = 10.8 Load = 33.9 kg N/ha
Winter Rye Cover Crop = 4.2 Load = 9.8 kg N/ha

## Annual Flow Weighted Nitrate Concentration in Tile Drainage for a No-till Corn-Soybean Rotation near Ames, IA with either Rye or Oat Cover Crop or without Cover Crops



# Total Nitrate-N Lost 2002-2016 in Tile Drainage

| Treatment | Nitrate-N Lost in Drainage | |
|---|---|---|
| | 15-yr total lbs/acre | 15-yr avg. lbs/acre |
| Corn-soybean no-till | 503 | 34 |
| Corn-soybean no-till w. rye cover crop | 214 | 14 |
| Reduction | 289 | 19 |
| % Reduction | 57 | |

# Total Nitrate-N Lost 2012-2015 for Fall Chisel vs No-Till

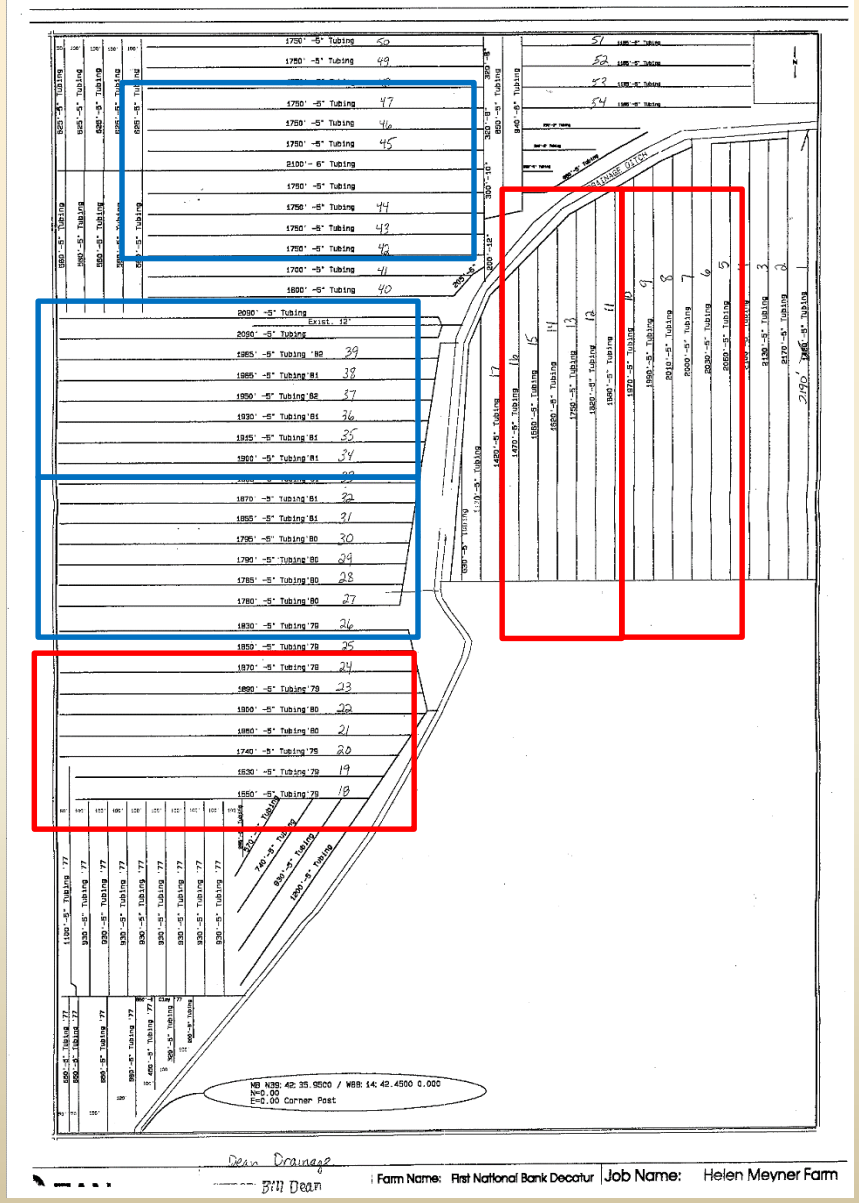
| Treatment | Nitrate-N Lost in Drainage | |
|---|---|---|
| | 4-yr total lbs/acre | 4-yr avg. lbs/acre |
| Corn-soybean no-till | 90 | 23 |
| Corn-soybean no-till w. rye cover crop | 29 | 7 |
| Corn-soybean fall chisel plow | 78 | 19 |

# Reduction of Nitrate Leaching with Rye Cover Crop – Four Other Iowa Sites

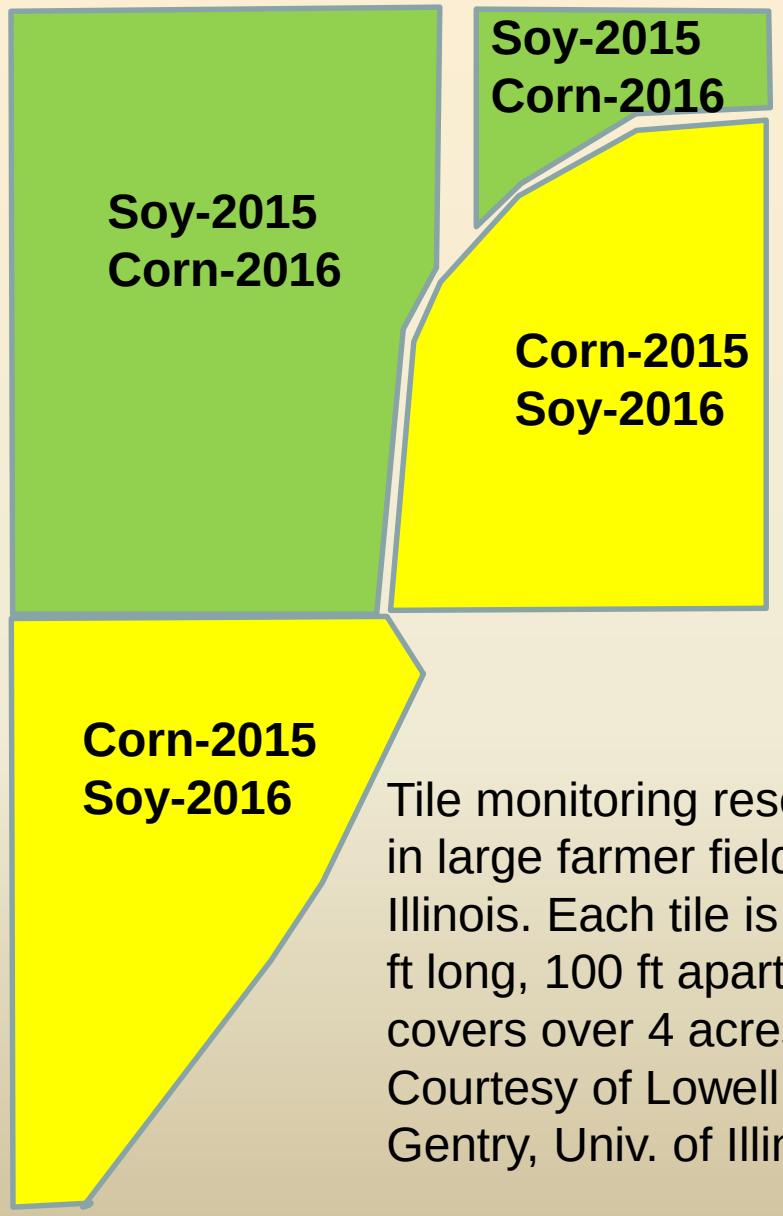
- Nashua, Iowa 22 – 29%
- Gilmore City, Iowa 15 -20%
- COBS Experiment, Kelly, Iowa 36%
- Tim Smith farm, Eagle Grove, Iowa 48%

Data from Matt Helmers, Eileen Bader, Tim Smith, and A.L. Daigh

# Tile Map




# Cropping Pattern

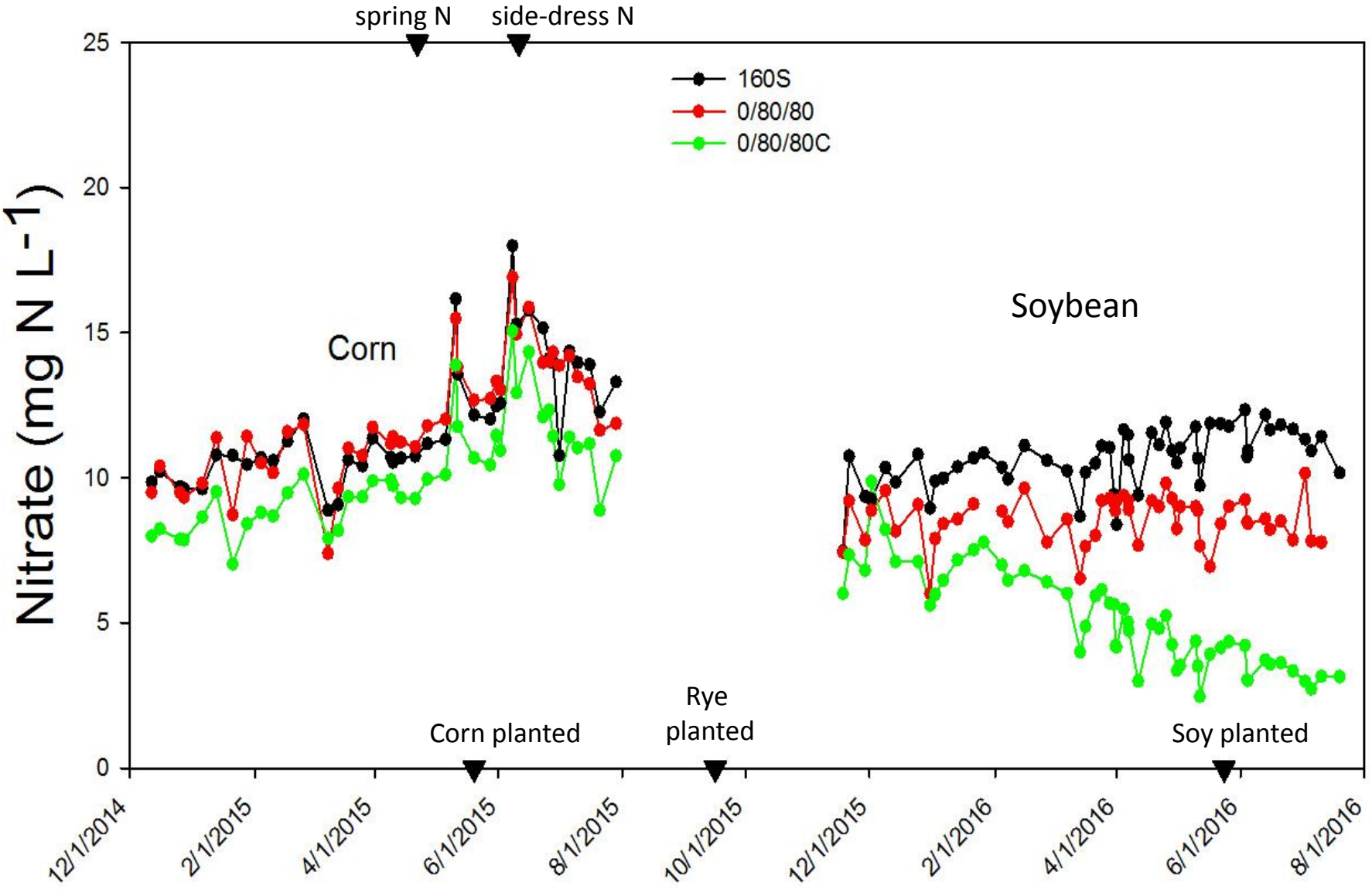



Tile monitoring research in large farmer fields in Illinois. Each tile is 2000 ft long, 100 ft apart, and covers over 4 acres. Courtesy of Lowell Gentry, Univ. of Illinois.

# Tile Nitrate Concentrations Averaged across Treatments

(from 12/12/14 to 08/01/16)

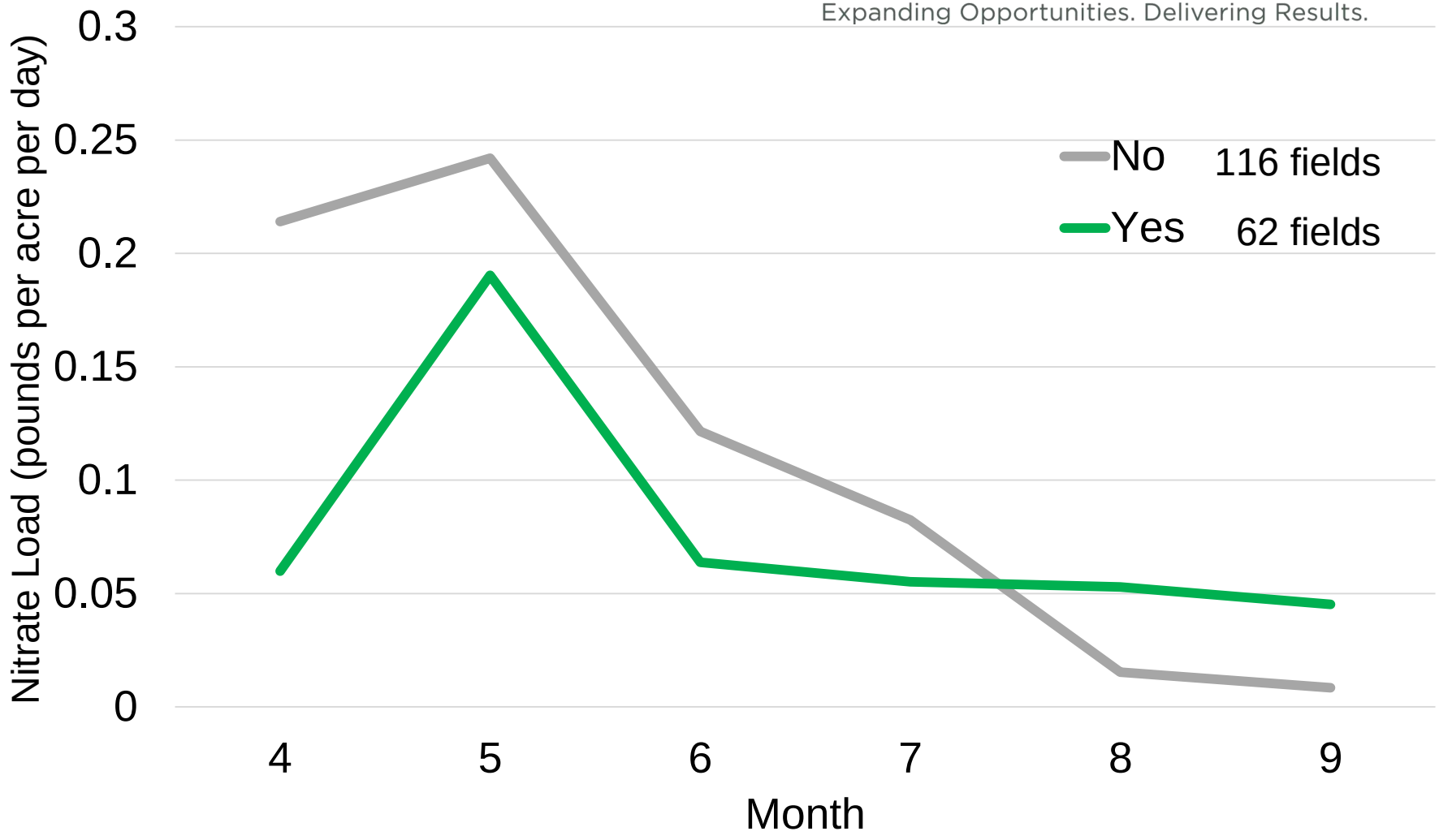
Lowell Gentry – University of Illinois at Urbana-Champaign



# Cover crop fields had 40% lower nitrate load 2016

IOWA SOYBEAN Association

Expanding Opportunities. Delivering Results.



# Why Does Cover Crops Effectiveness Vary from Site-to-Site?

- Would expect it to vary
- Different amounts of cover crop growth
- Different weather/rainfall at the sites
- Different soil types – OM, texture
- Tile spacing, tile depth, effectiveness
- Different crop management
- Different field history

# How much impact could widespread adoption of cover crops have in Midwest?

- In OH, IN, IL, IA, MN we estimated that 21% of the harvested acres could adopt cover crops “relatively easily”
- Used Root Zone Water Quality Model to predict reduction in nitrate-N losses
- Cover crop predicted growth and benefit greatest in southern IL and IN
- Estimated 19% reduction in nitrate-N load to Mississippi River

PURDUE UNIVERSITY

Kladivko, Kaspar, et al., 2014, J. Soil Water Cons., 69:279-291

# Cover Crop Summary

- Cover crops reduce N losses in tile drainage by taking up N during the "**Brown Gap**" between maturity and planting of corn and soybean.
- Unlike other practices used to reduce N losses to water, cover crops will provide other benefits.

# Midwest Cover Crops Council

## Working to Keep Fields Green All Year Long

## http://www.mccc.msu.edu/