

# 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

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Adam Kiel, ISA  
Eileen Kladvko, 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?**

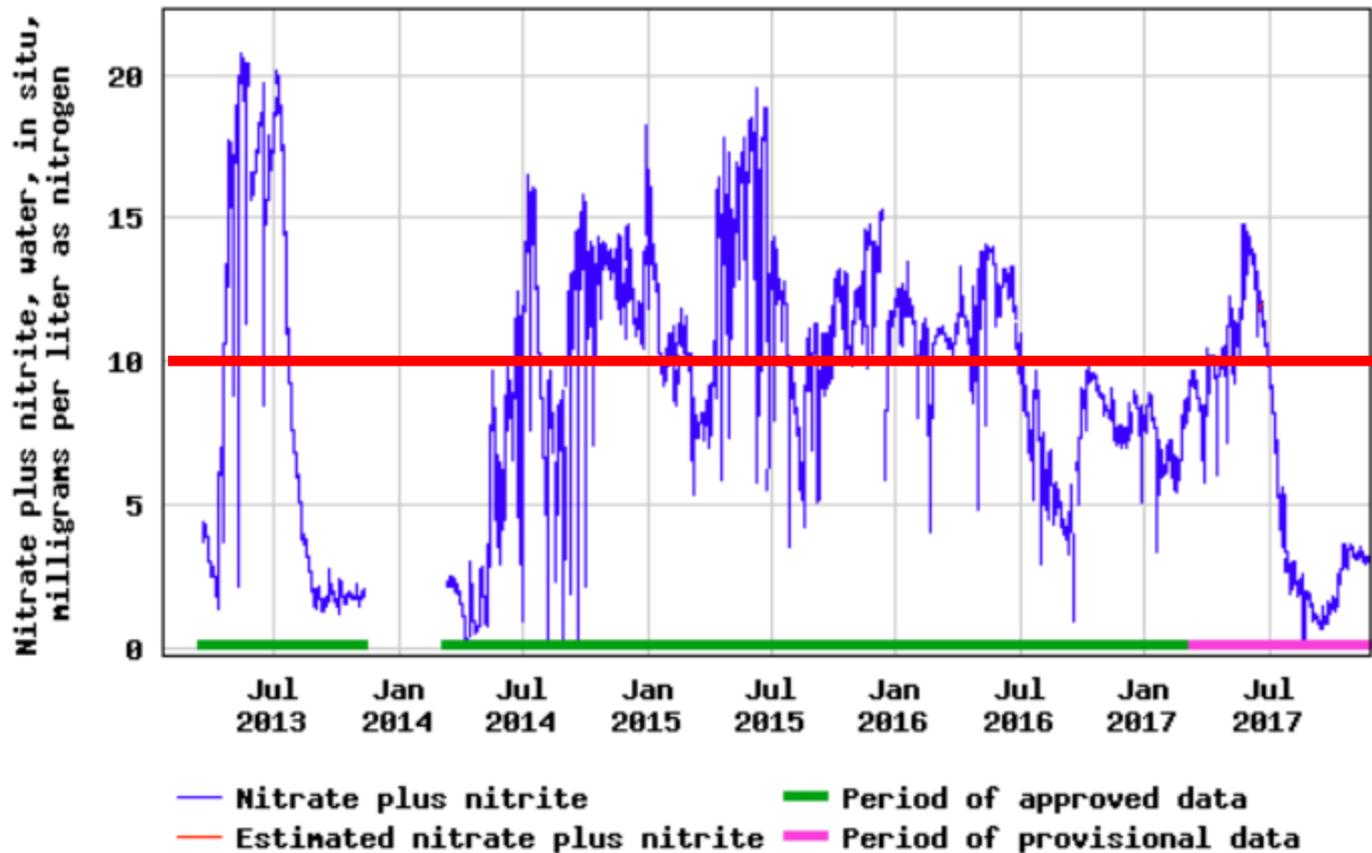
Des Moines Register Nov. 17, 2015

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

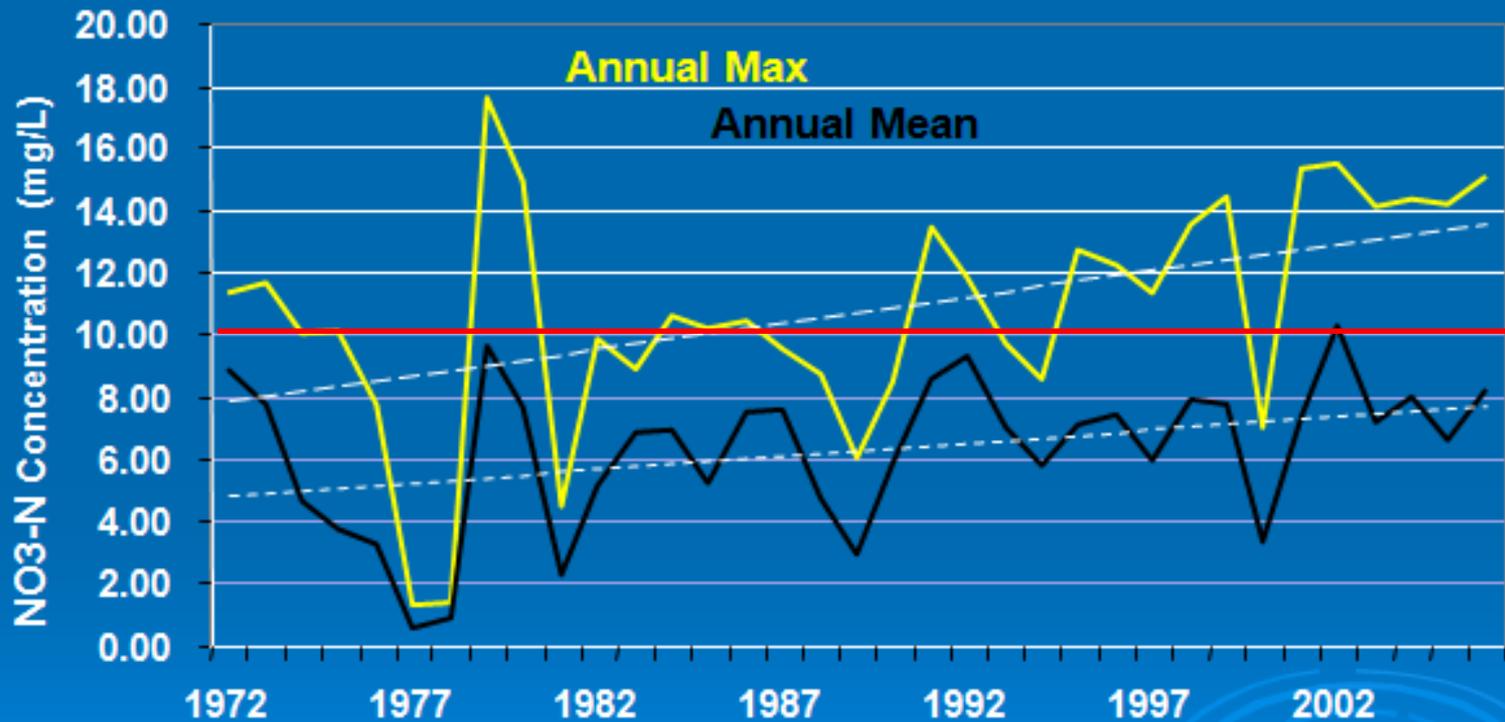
# Nitrate plus nitrite, water, in situ, milligrams per liter as nitrogen

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

USGS 05484500 Raccoon River at Van Meter, IA



# 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!

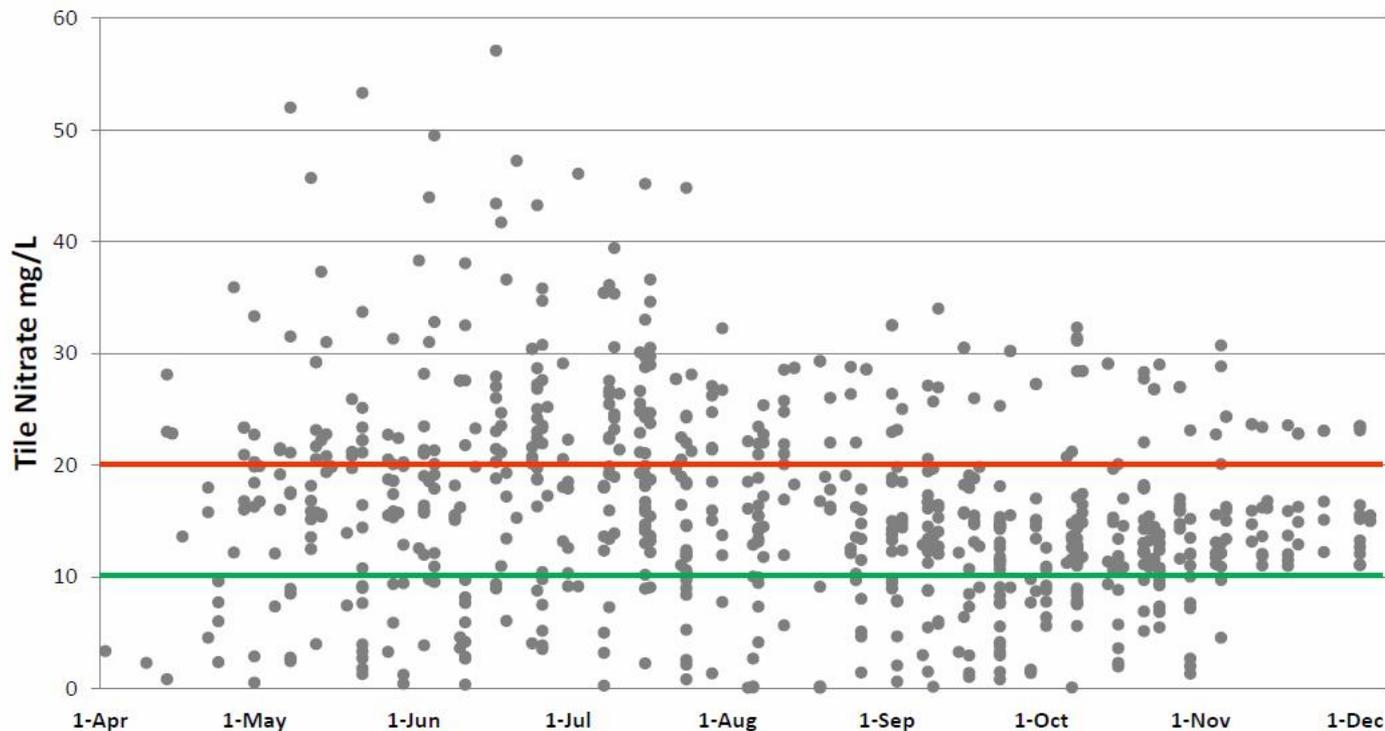
.... Nonpoint (farmland) sources  
comprise **89.6 %** of the total nitrate  
load in the watershed.

..... 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

## Statewide Tile Nitrate Results 2014



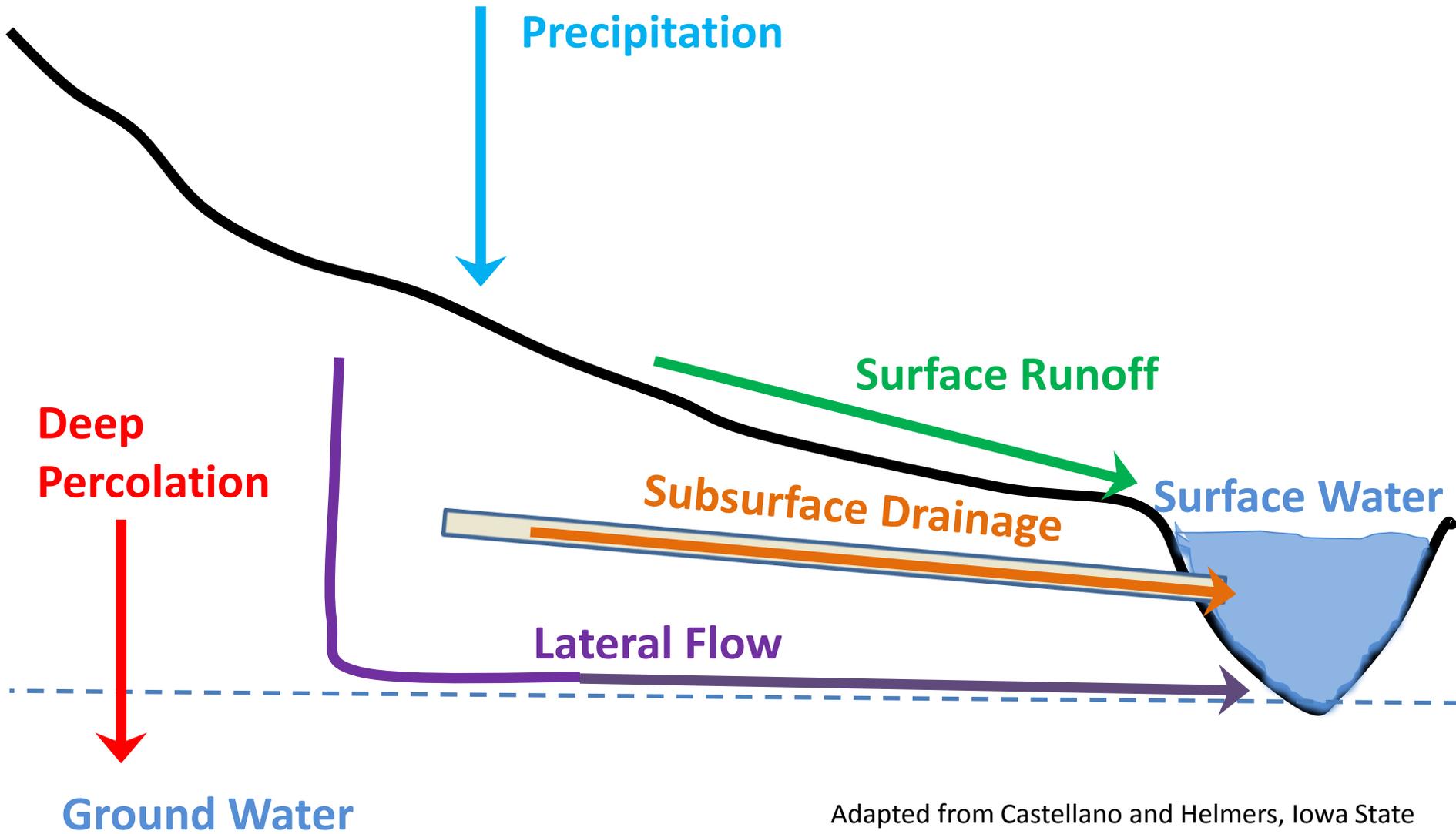
So why is this such a difficult  
problem?

We just need to manage N  
fertilizer and manure better.

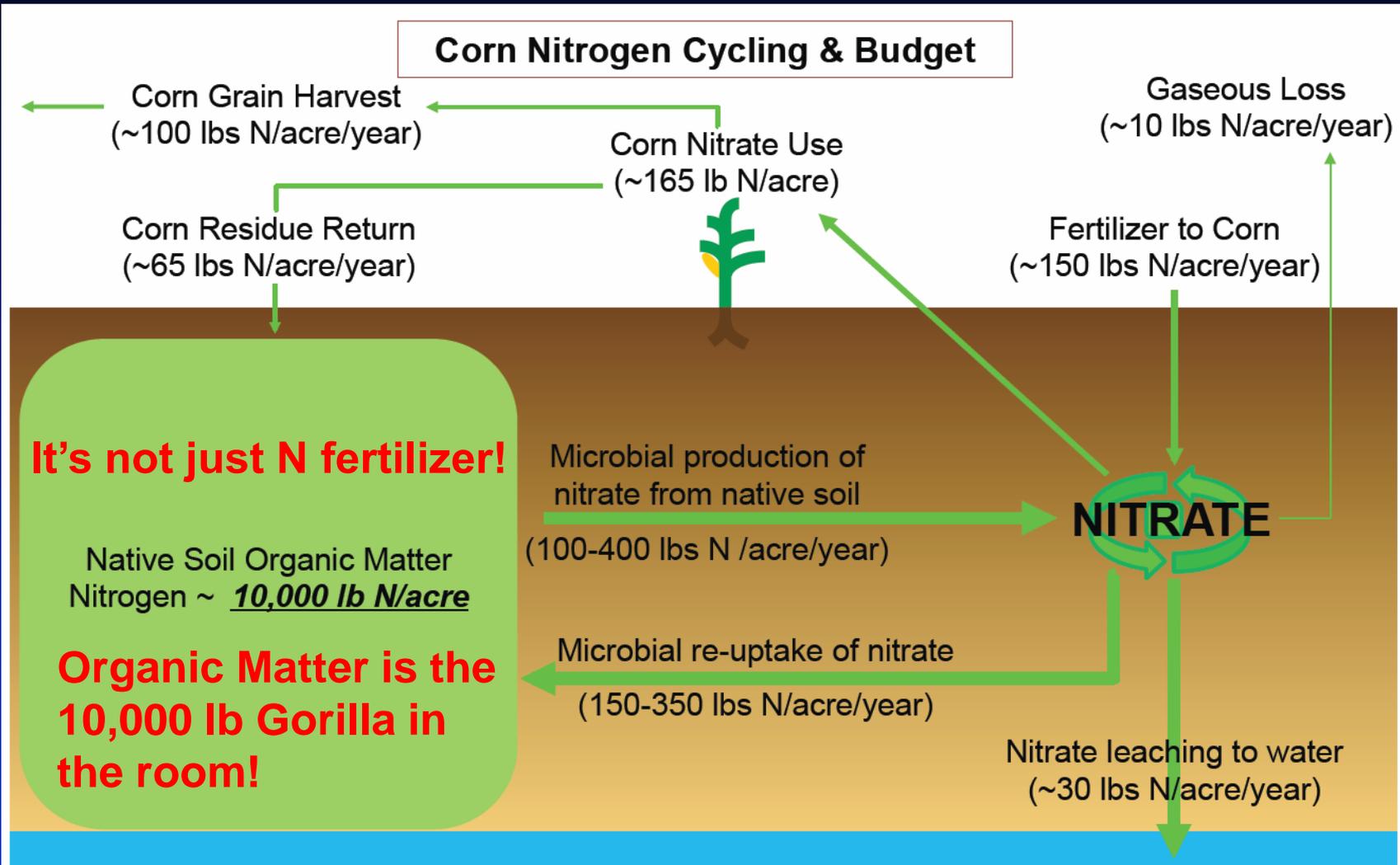
Right?

# Nitrate Moves Easily with Water

## Water and Nitrate Flow Pathways

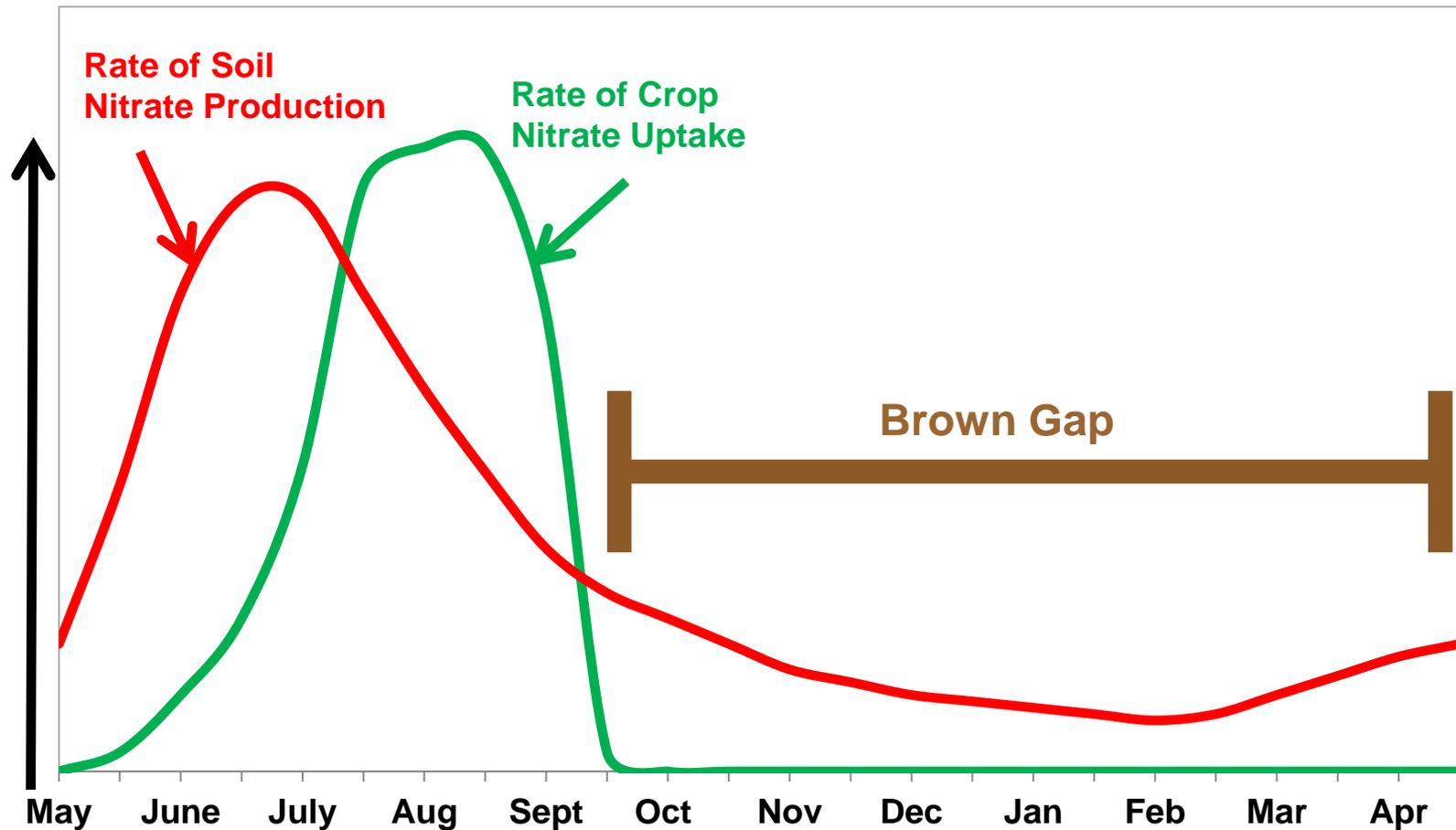


# Large Pools of N in Soil Organic Matter



# Poor Timing Between Uptake and Availability

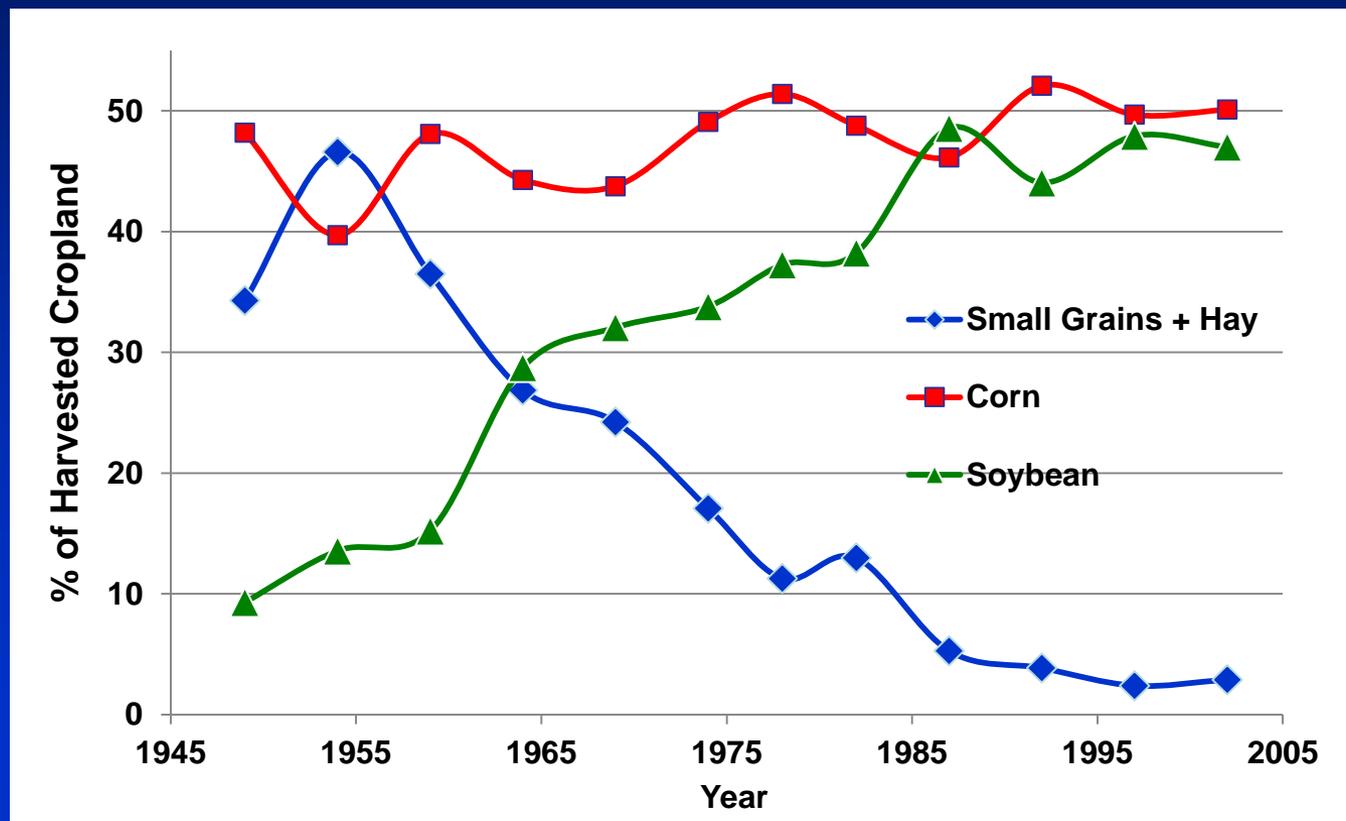
## Soil Nitrate Production vs Crop Nitrate Uptake



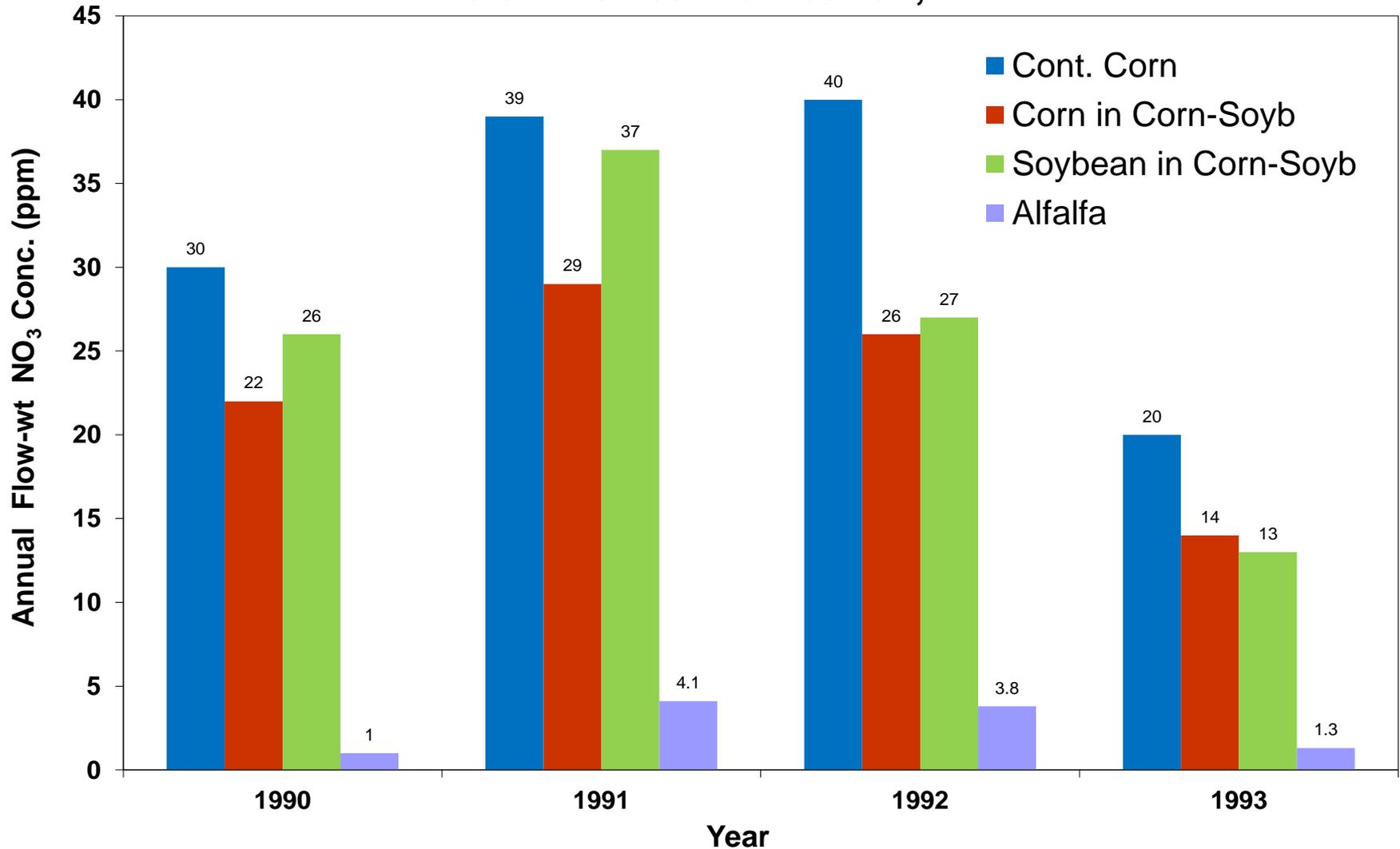
Modified from Castellano and Helmers

# Our Cropping Systems Have Changed

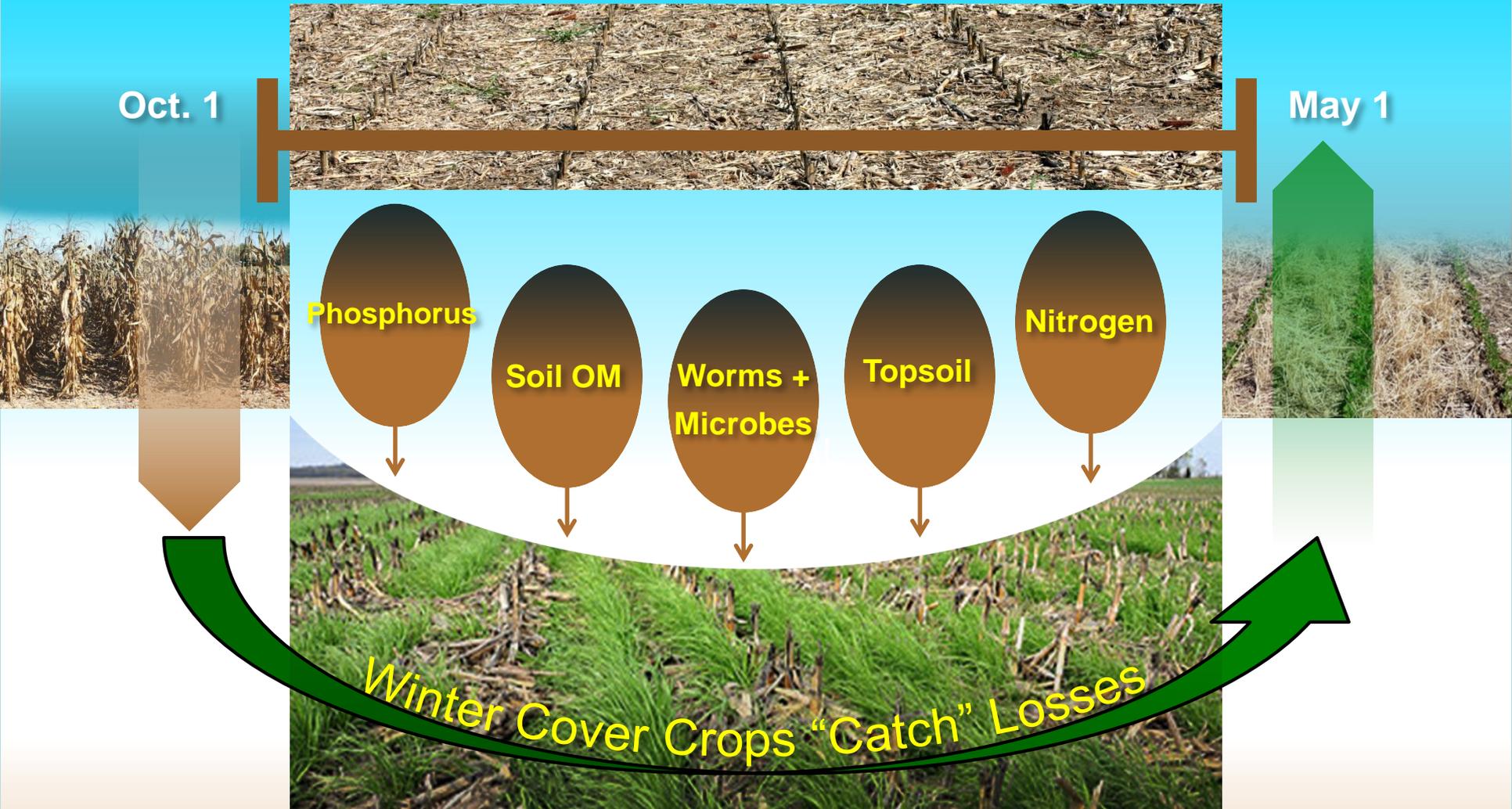
From 1949 to 2002: % of Iowa Raccoon River Basin cropland in Small Grains and Hay decreased from over 45% to less than 3%.



## Annual Flow-wt NO<sub>3</sub> Concentration of Tile Drainage for Four Rotations near Lamberton, MN

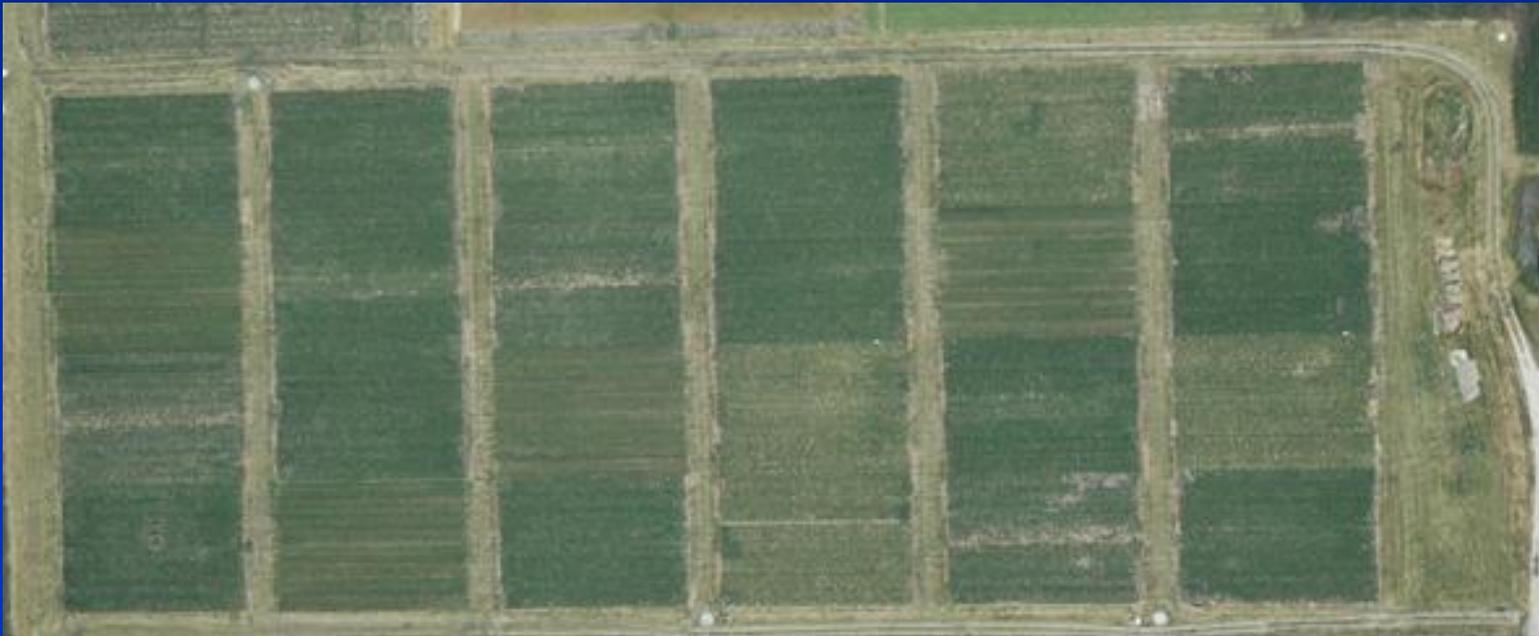


# Corn and Soybeans have a 7 Month “**BROWN**” Gap

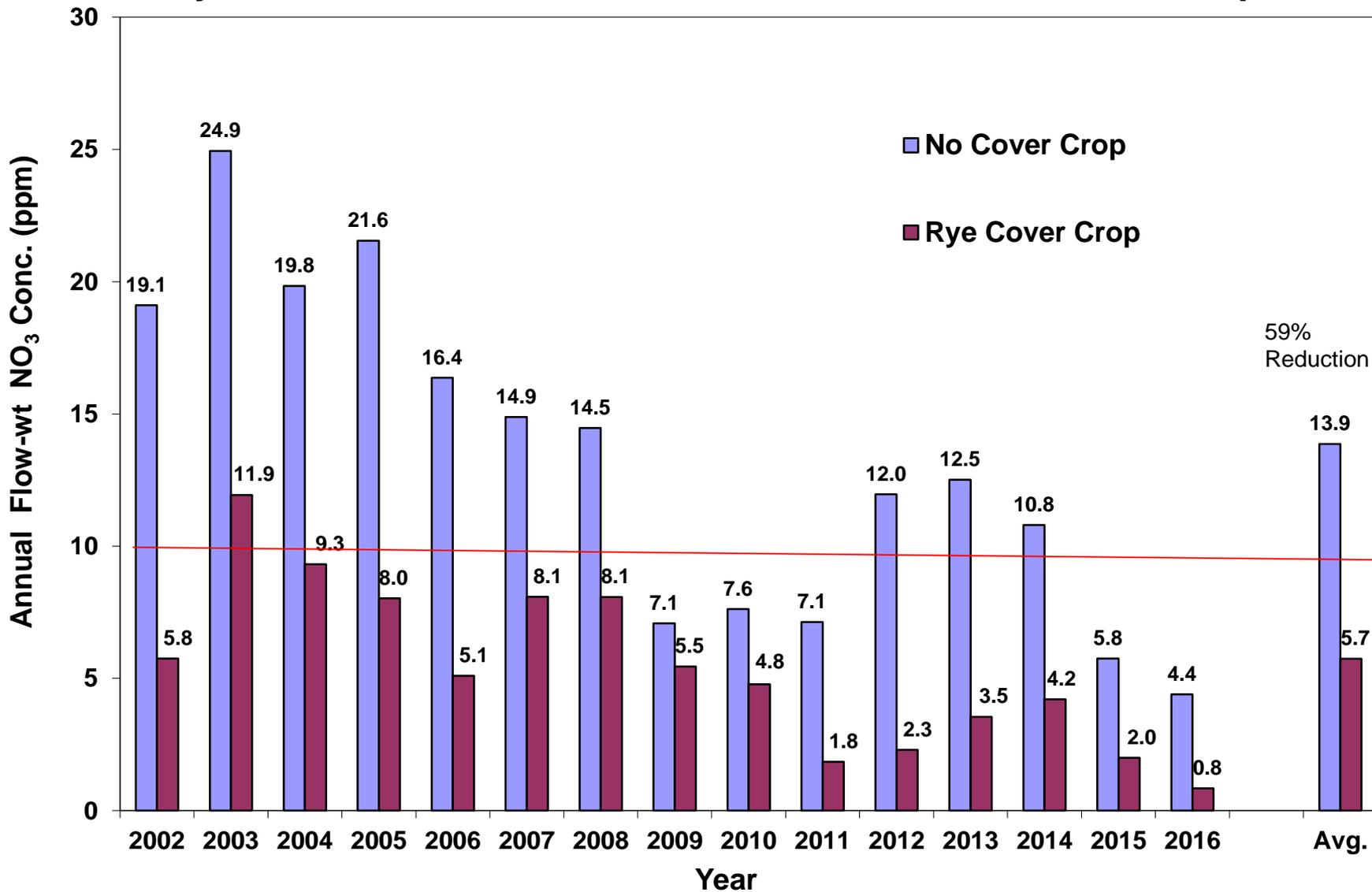


Cover Crops Fill the “**BROWN**” Gap with “**GREEN**” Plants  
The more “**GREEN**” the more benefits and protection

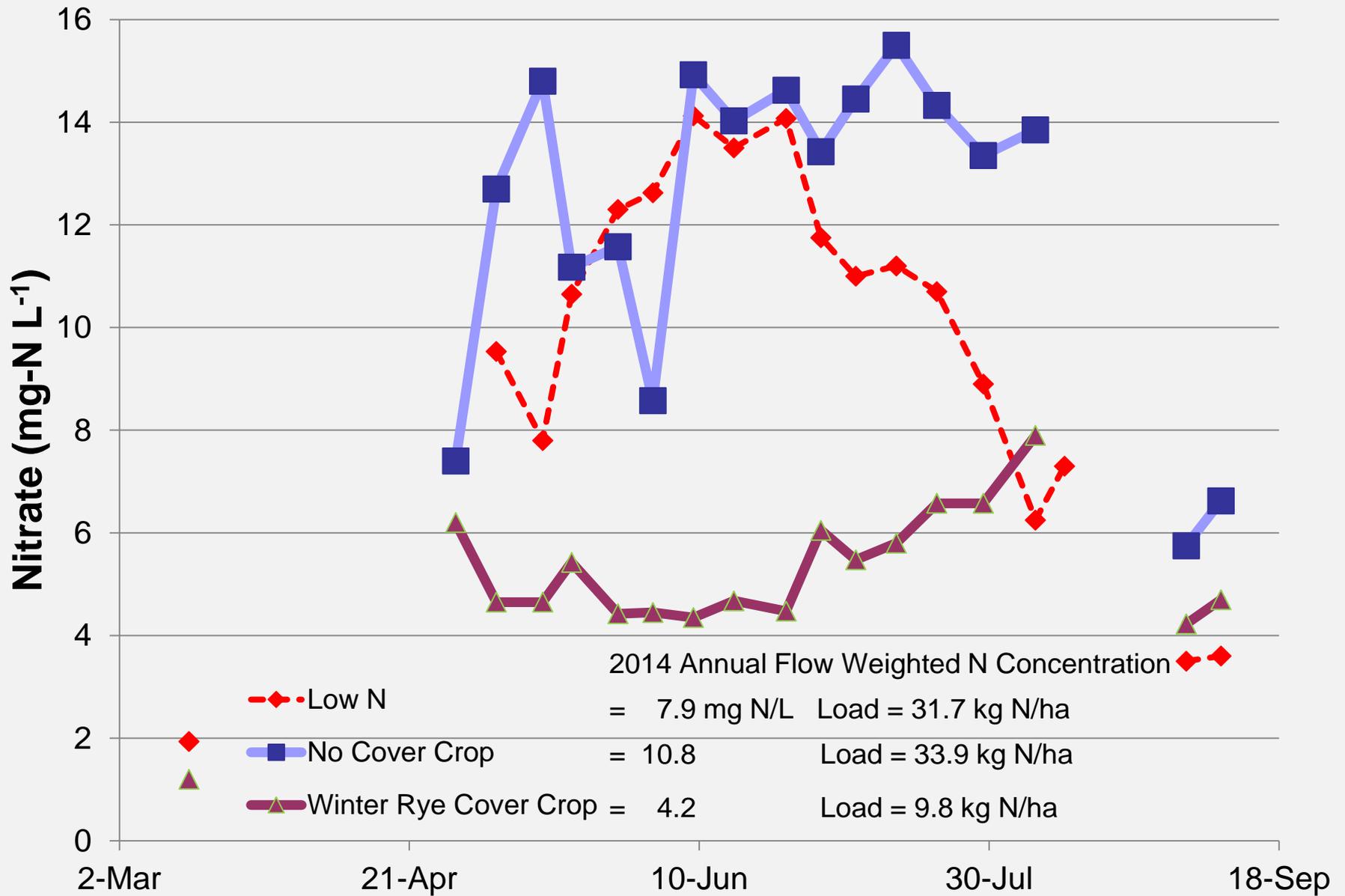
# 15 years of Measurements of Nitrate Loss in Tile Drainage with and without Cover Crops



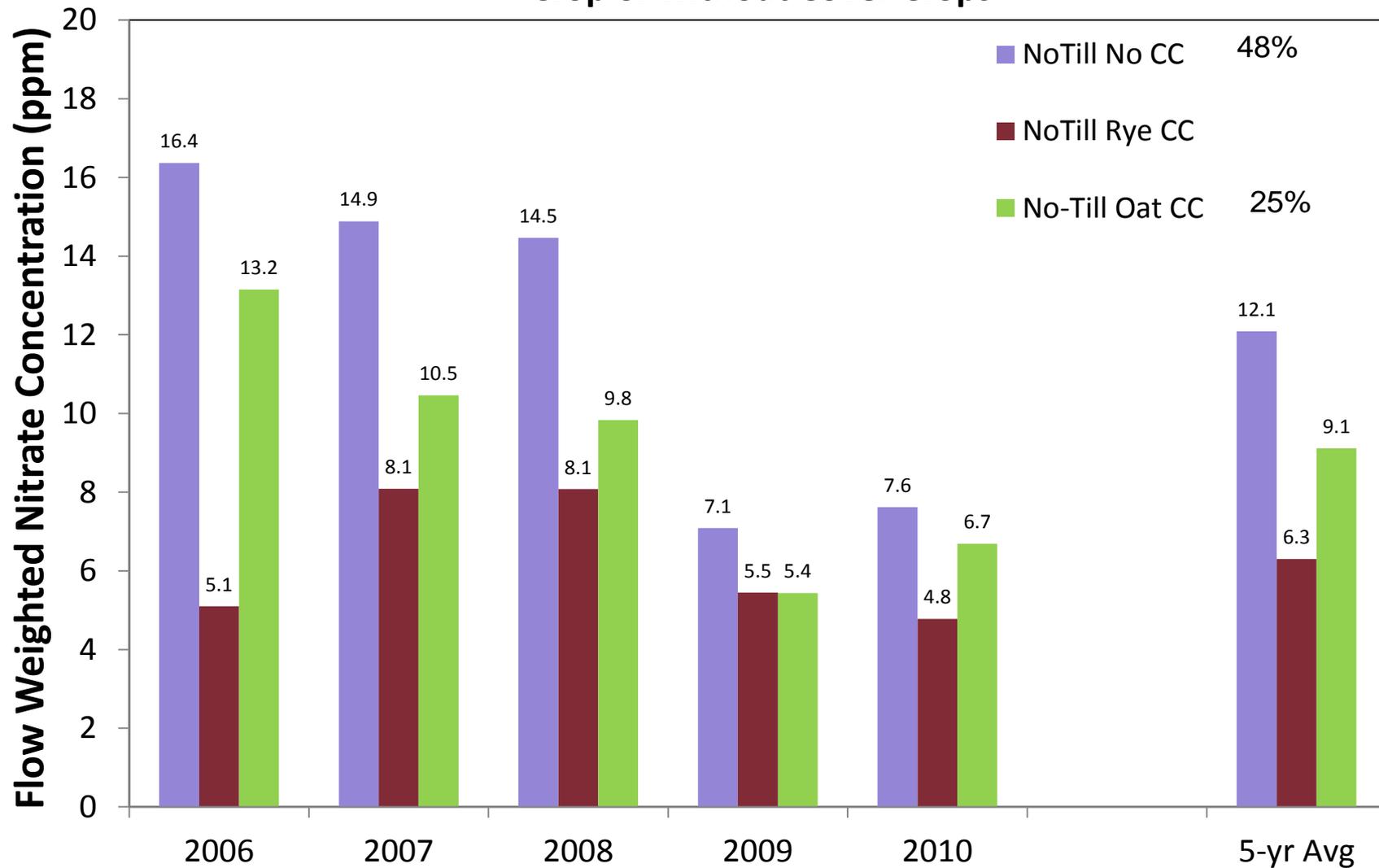
# Annual Flow-wt NO<sub>3</sub> Concentration of Tile Drainage for Corn-Soybean Rotation near Ames, IA with or without a Cover Crop



# 2014 Drainage Water Nitrate Concentration



# 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
<u>% Reduction</u>	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

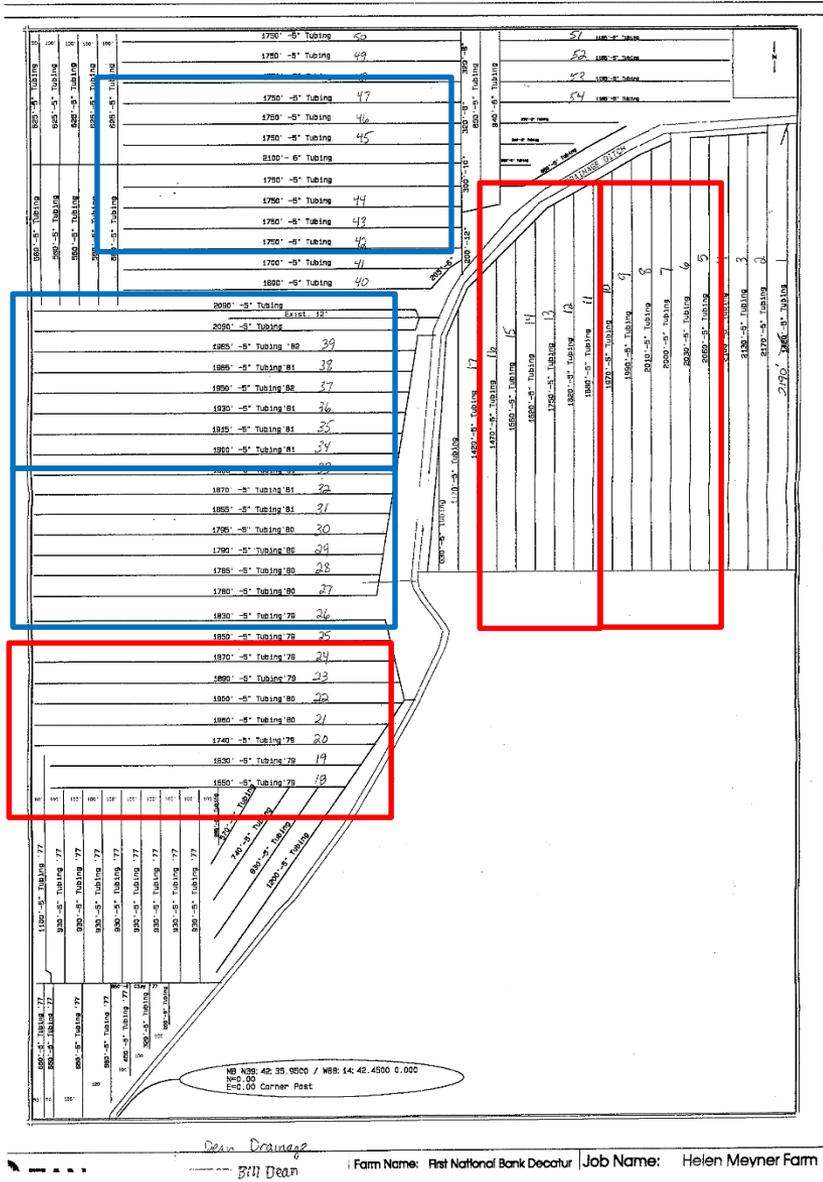
# Reduction of Nitrate Leaching with Rye Cover Crop – Four Other Iowa Sites

- 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



**Soy-2015  
Corn-2016**

**Soy-2015  
Corn-2016**

**Corn-2015  
Soy-2016**

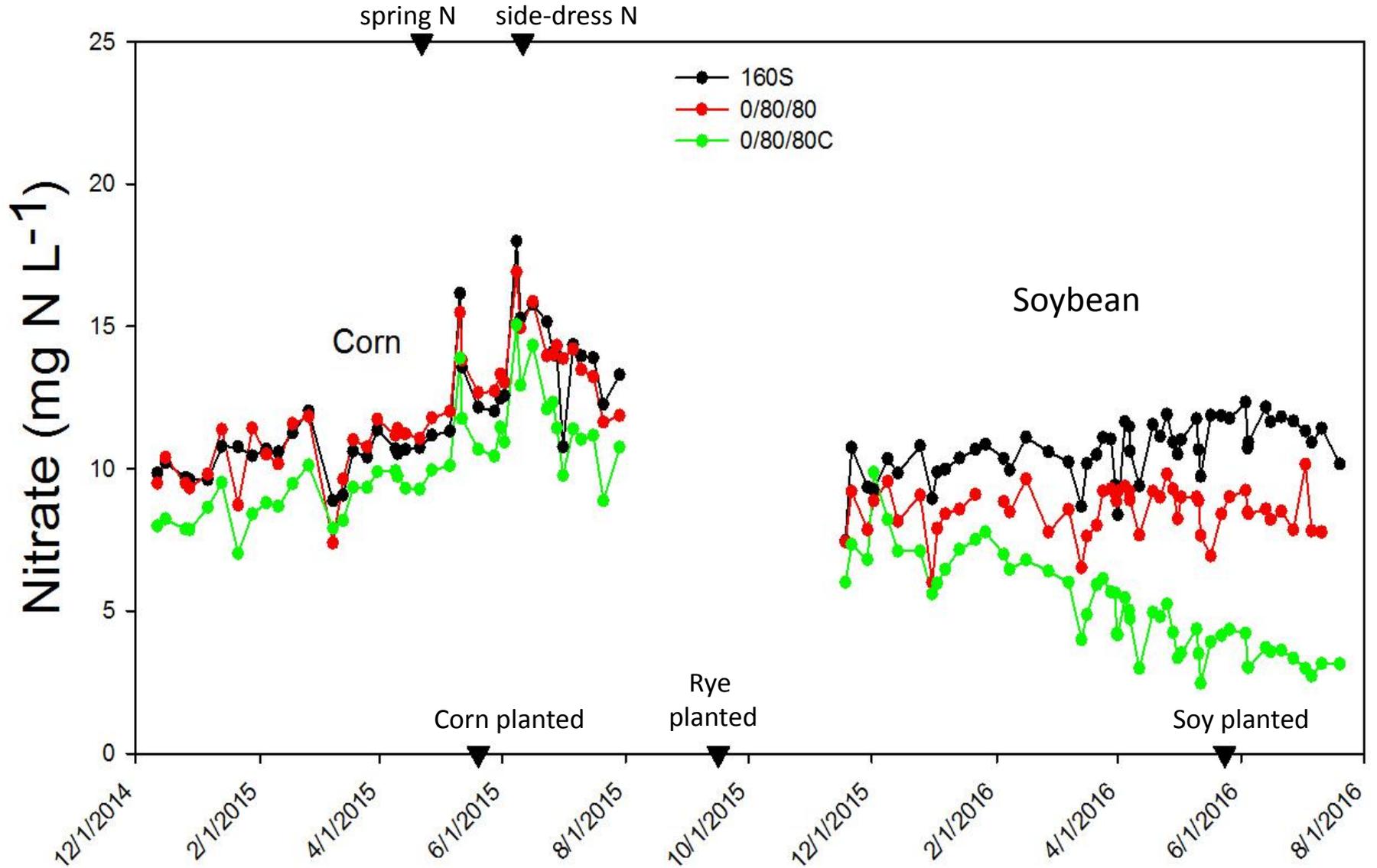
**Corn-2015  
Soy-2016**

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)

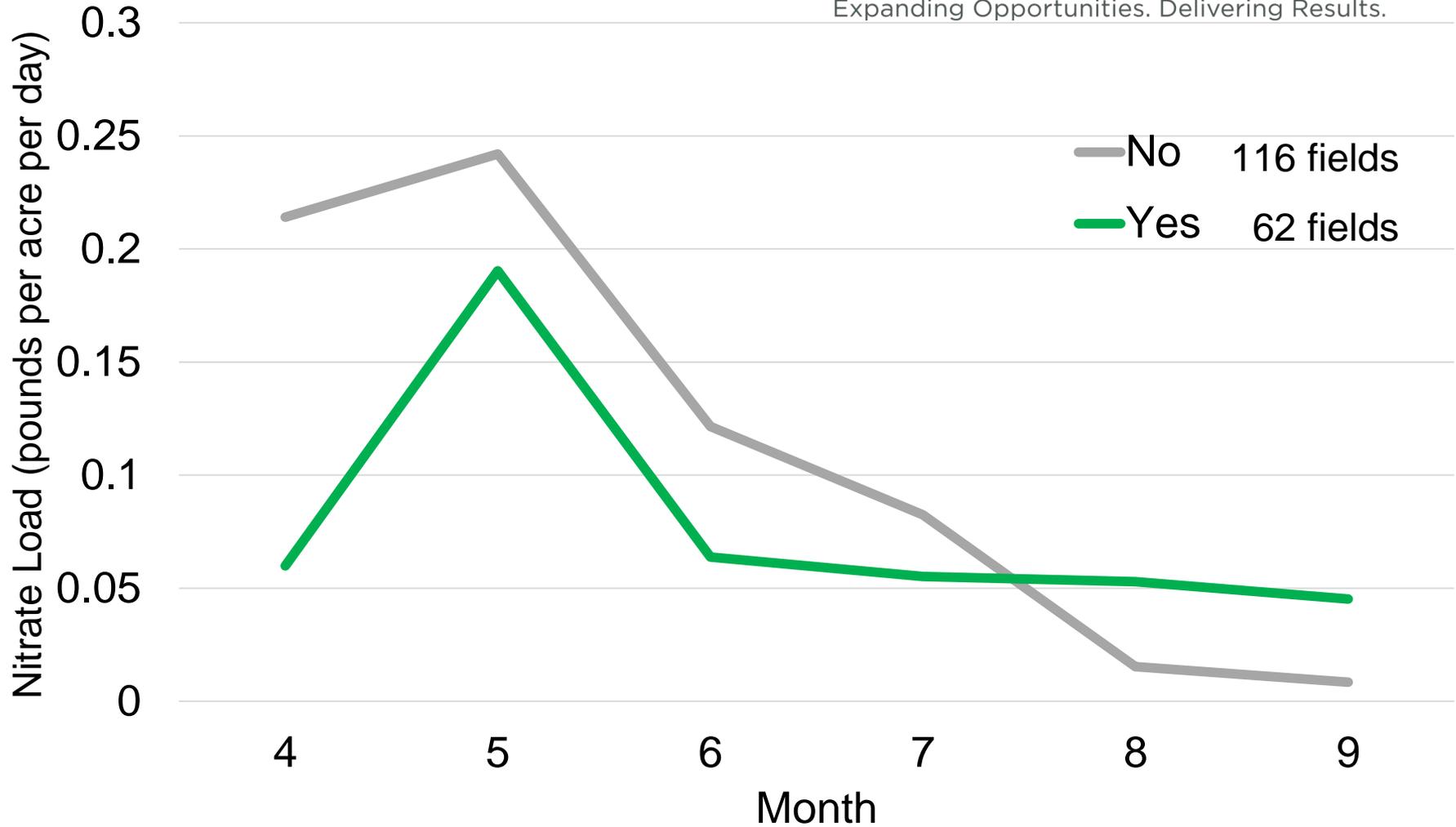
Lowell Gentry – University of Illinois at Urbana-Champaign



# Cover crop fields had 40% lower nitrate load 2016



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?

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- 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

# 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/>

The screenshot shows the homepage of the Midwest Cover Crops Council website. At the top left is the logo, which consists of a stylized green field with rays of light emanating from the center, next to the text "Midwest Cover Crops Council". To the right of the logo is a search bar with the word "SEARCH" and a magnifying glass icon. Below the logo and search bar is a horizontal navigation menu with the following items: "Home", "Getting Started", "Selector Tools", "Species", "States/Provinces", "Other Resources", "About", and "Subscribe to MCCC listserv".

The main content area features a large banner for the "2017 MCCC Meeting- Mar. 14-15, Grand Rapids, MI". The banner includes a photograph of a city skyline at night and the text: "Featuring 3 simultaneous tracks: field crops, vegetables, and grazing/forages." Below the banner are three social media icons: Facebook, Twitter, and YouTube.

Below the banner are three featured content blocks, each with a thumbnail image and a "Read more" link:

- What is a cover crop?**: The thumbnail shows a red tractor in a field of corn and cover crops.
- MCCC Calendar of Events**: The thumbnail shows a green calendar icon with the text "Upcoming Events".
- MCCC Meetings**: The thumbnail shows a large indoor meeting room with many people seated at long tables.

At the bottom of the page is a dark footer area. It contains a secondary navigation menu with the same items as the top menu: "Getting Started", "Selector Tools", "Species", "States/Provinces", "Other Resources", "About", and "Subscribe to MCCC listserv". Below the navigation menu is the text "Thank you to our many supporters." and "POWERED BY PARABOLA & WORDPRESS." At the very bottom are three social media icons: Facebook, Twitter, and YouTube.

