# Nitrogen Cycling with Cover Crops


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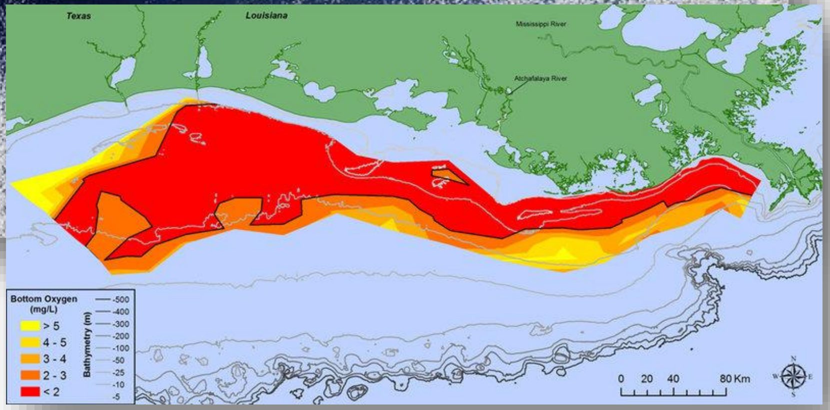
S.E.N.D.
Soil Ecosystem and Nutrient Dynamics

# The Gulf Of Mexico's Dead Zone Is The Biggest Ever Seen


This week, NOAA announced that this year's dead zone is the biggest one ever measured. It covers **8,776 square miles** — an area the size of New Jersey. And it's adding fuel to a debate over whether state and federal governments are doing enough to cut pollution that comes from farms.

**Farmers use those nutrients on fields as fertilizer.** Rain washes them into nearby streams and rivers. And when they reach the Gulf of Mexico, those nutrients unleash blooms of algae, which then die and decompose. That is what uses up the oxygen in a thick layer of water at the bottom of the Gulf, in a band that follows the coastline.




Scavia, however, recently published a blog post calling these **voluntary measures inadequate**.

# Nutrient Loss Reduction Strategy

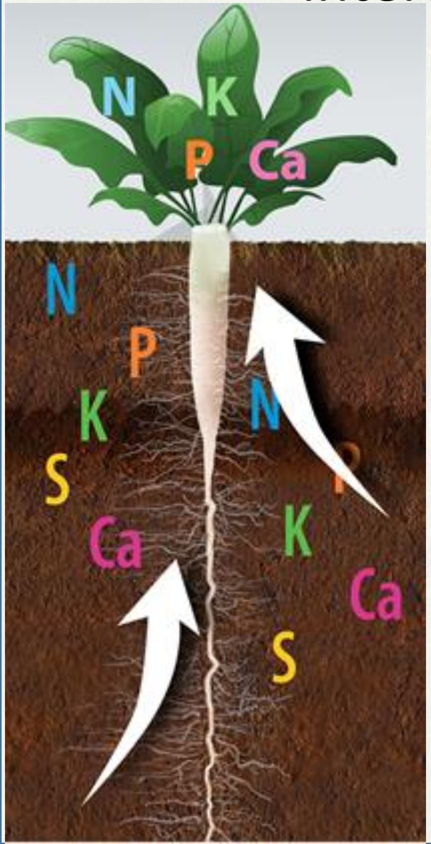
The target is a **<u>15 percent reduction</u>** in nitrate-nitrogen that reaches the Gulf of Mexico **<u>by 2025</u>**.

To achieve this reduction, N loading from **<u>all corn N management practices</u>** must be significantly reduced.

# Cover crops affect on N availability and fate within common corn N management systems

## N Conservation

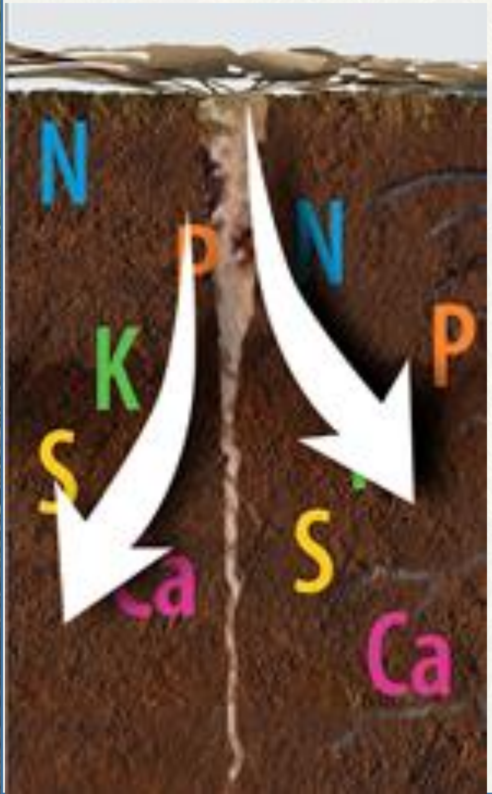
Inorganic N sources that cover crops interact with:




- Soil inorganic N from OM
- Residual N
- Applied N, if a portion of N is applied in the Fall (DAP or Manure)

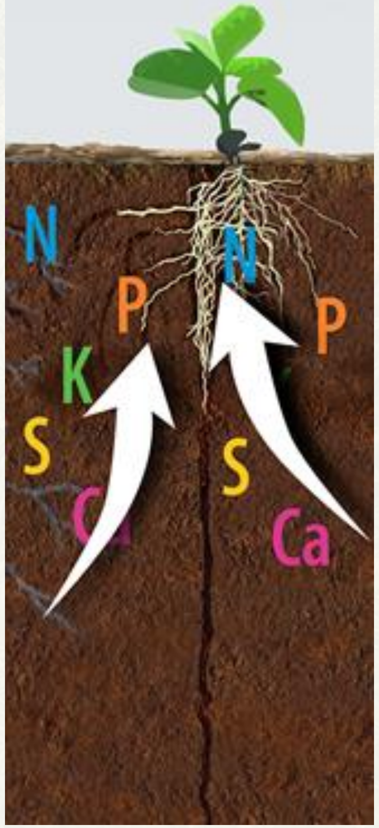
## N Release

Cover crop residue N release depends on:




- Physiology
- Species: Legume, grass, cereal
- C:N ratio

## N Uptake




Corn and Soybean N and Yield

# Effect of Cover Crops and Nitrogen Application Timing on Nutrient Loading Through Subsurface Drainage

Shalamar Armstrong[1], Catherine O'Reilly[2], Richard Roth[3], Mike Ruffatti[3],Travis Deppe[3]and Corey Lacey[4]

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[3]M.S. Candidate In Agriculture Sciences , Illinois State University Department of Agriculture, [4]Graduate Research Assistant, Purdue University Department of Agronomy

# Nutrient Loss Reduction Strategies Evaluated

1. Change N application timing from fall to spring

2. Change N application timing from fall to spring + cover crop

3. ***Addition of cover crops to fall applied N***

   ***----Strip-till application of N into a living cover crop***

# Treatments

1. Control-No Fertilizer and No Cover crop

2. Spring Split Application of Nitrogen (20% Fall -DAP and 80% Anhydrous Ammonium)

3. Spring Split Application of Nitrogen (20% Fall-DAP and 80% Anhydrous Ammonium) + **Cover Crops**

4. Fall Split Application of Nitrogen (70% Fall-DAP and Anhydrous Ammonium and 30% sidedress- Anhydrous Ammonium)

5. Fall Split Application of Nitrogen (70% Fall-DAP and Anhydrous Ammonium and 30% sidedress- Anhydrous Ammonium) + **Cover Crops**

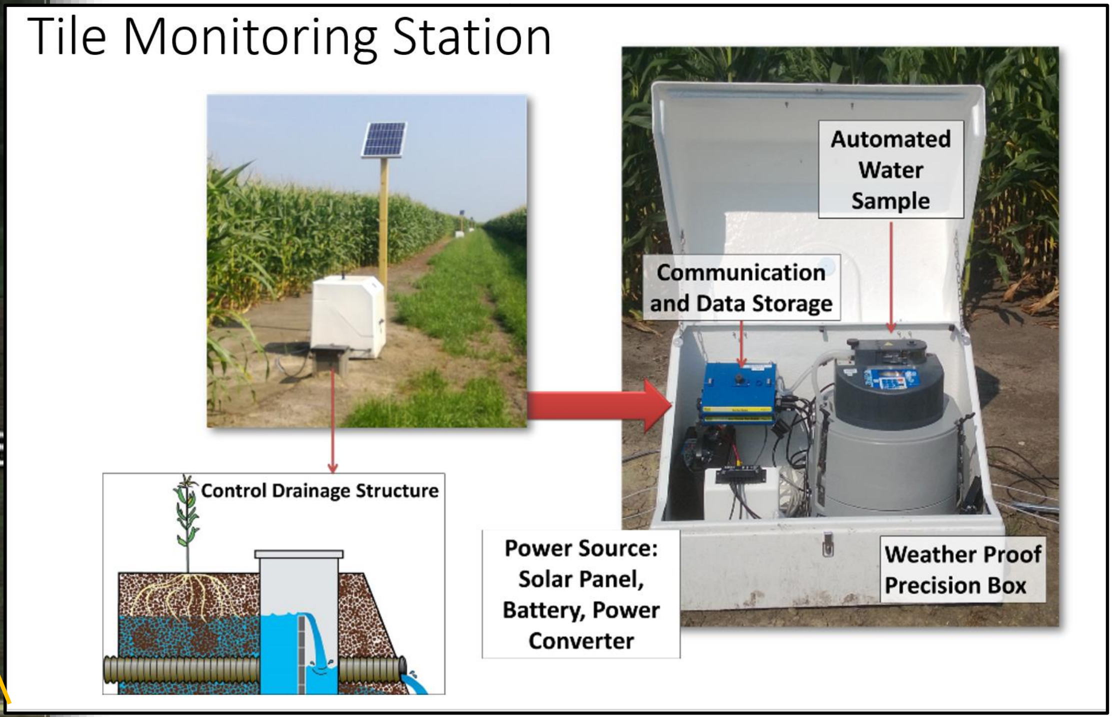
*Fall Anhydrous Ammonia was strip tilled into a living stand of **Cereal Rye and Radish Mix**

Total N rate for all plots: 224 kg $ha^{-1}$

# Research Design

**Field History**

- 10 years Strip-till before Corn and No-till before Soybeans
- Current Nitrogen Management : 60 %  Fall N and 40% Spring N

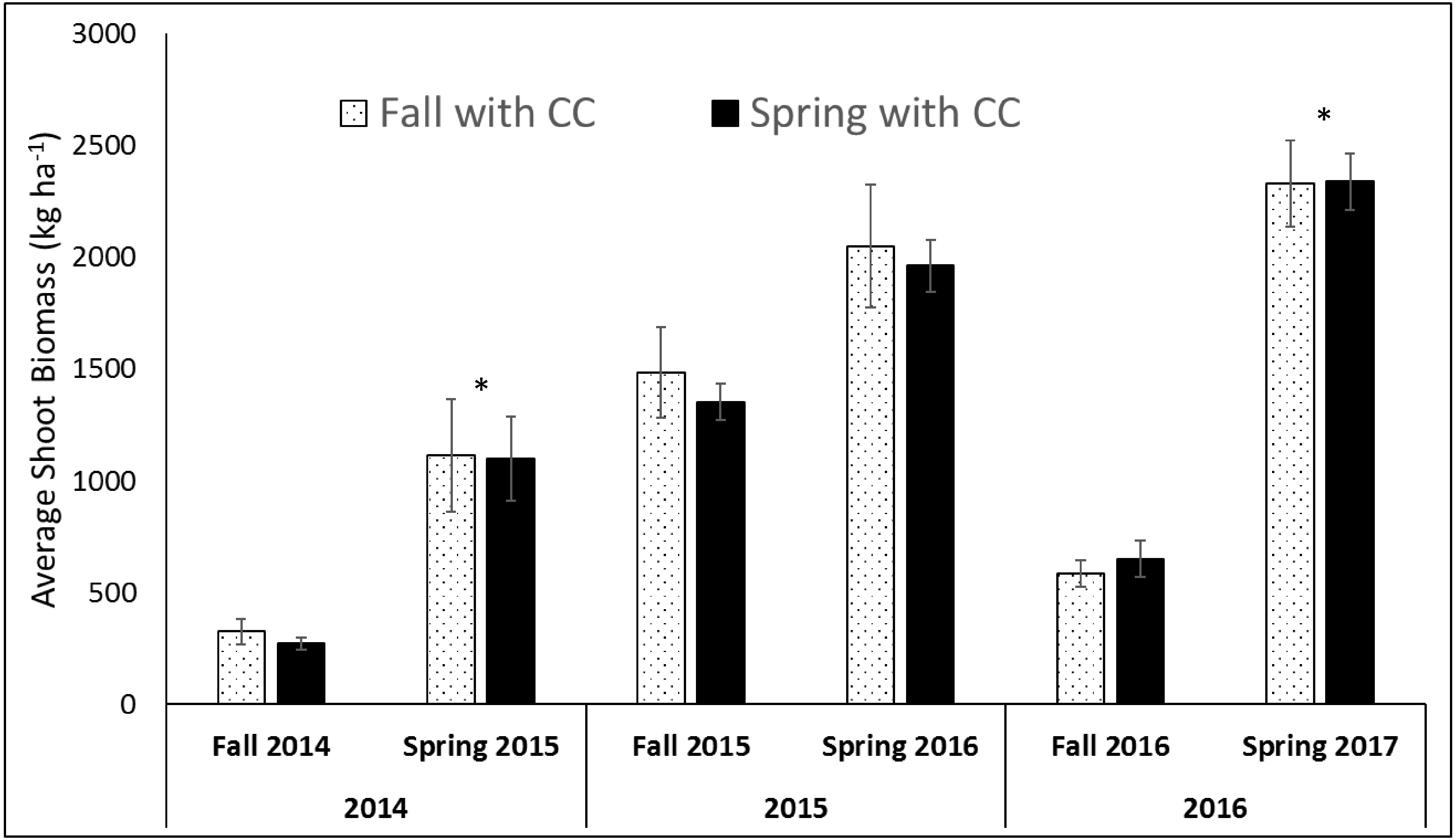
# Methodology – Cover Crop Planting

Cover Crop Mixture
Daikon Radish (8%) Cereal Rye (92%)

Seeding Rate: 84 kg $ha^{-1}$

Planting Date: Early to mid- Sept.

# Cover Crop Shoot Biomass

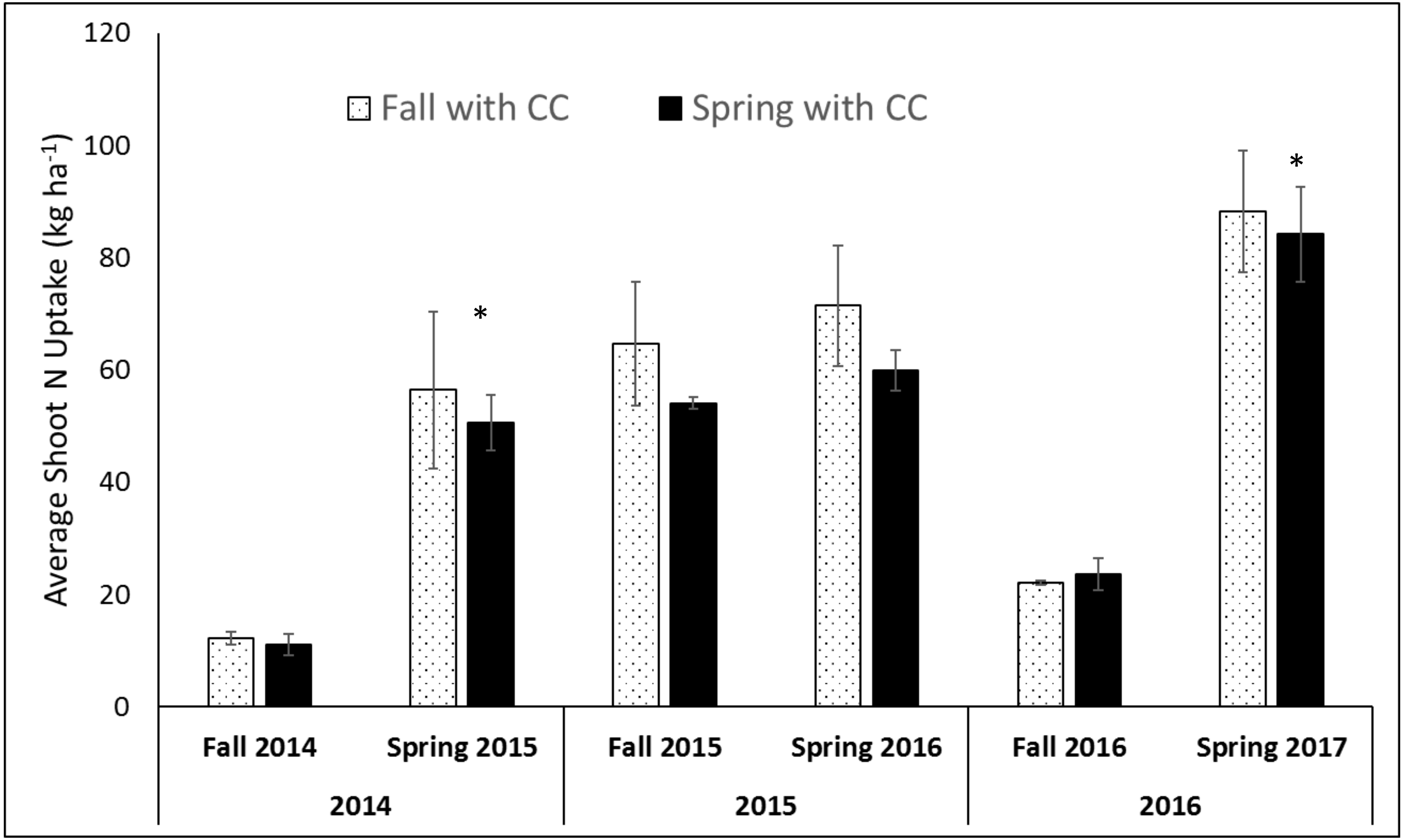



Fertilizer N application timing did not effect cover crop shoot biomass.

Average total biomass was 1,361 kg $ha^{-1}$

Normal winter conditions in the fall result in significantly more growth in the spring relative to the fall

# Cover Crop N Uptake

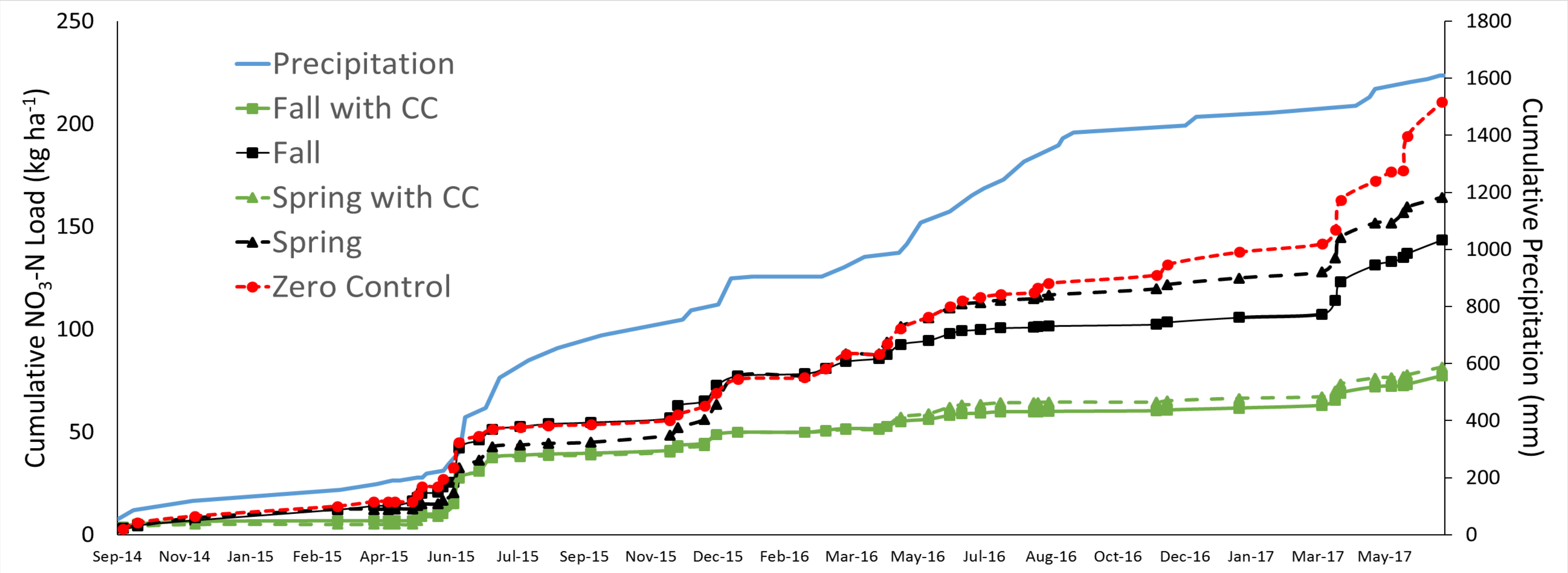



Fertilizer application timing did not significantly effect cover crop N uptake.

Average shoot N uptake was 66 kg $ha^{-1}$

On average the cover crop interacted with 30% of the N fertilizer applied.

# Cover Crop Impact on Water Quality




Precipitation

Total = 63 inches

Annual Average = 25

N Loading Treatment Comparison

| | |
|---|---|
| Fall N | 52 kg $ha^{-1}$ $year^{-1}$ |
| Fall N + CC | 30 kg $ha^{-1}$ $year^{-1}$ ***(42% reduction)*** |
| Spring N | 60 kg $ha^{-1}$ $year^{-1}$ |
| Spring N + CC | 30 kg $ha^{-1}$ $year^{-1}$ ***(50% reduction)*** |

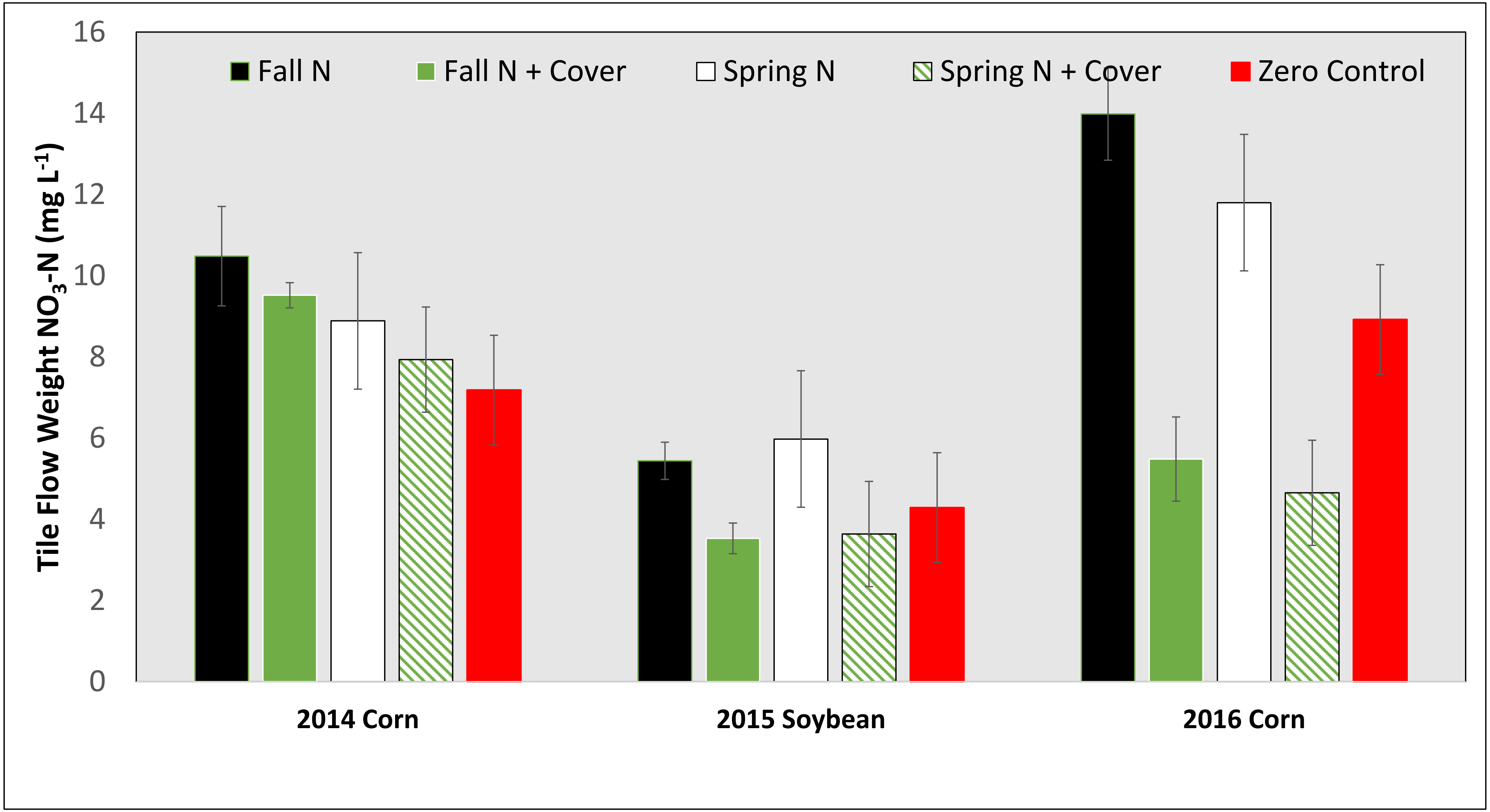
N Loading Treands

Fall N vs. Spring N = Equal

Fall N vs. Spring N + CC = ***42%*** ▼

Spring N vs. Fall N + CC = ***50%*** ▼

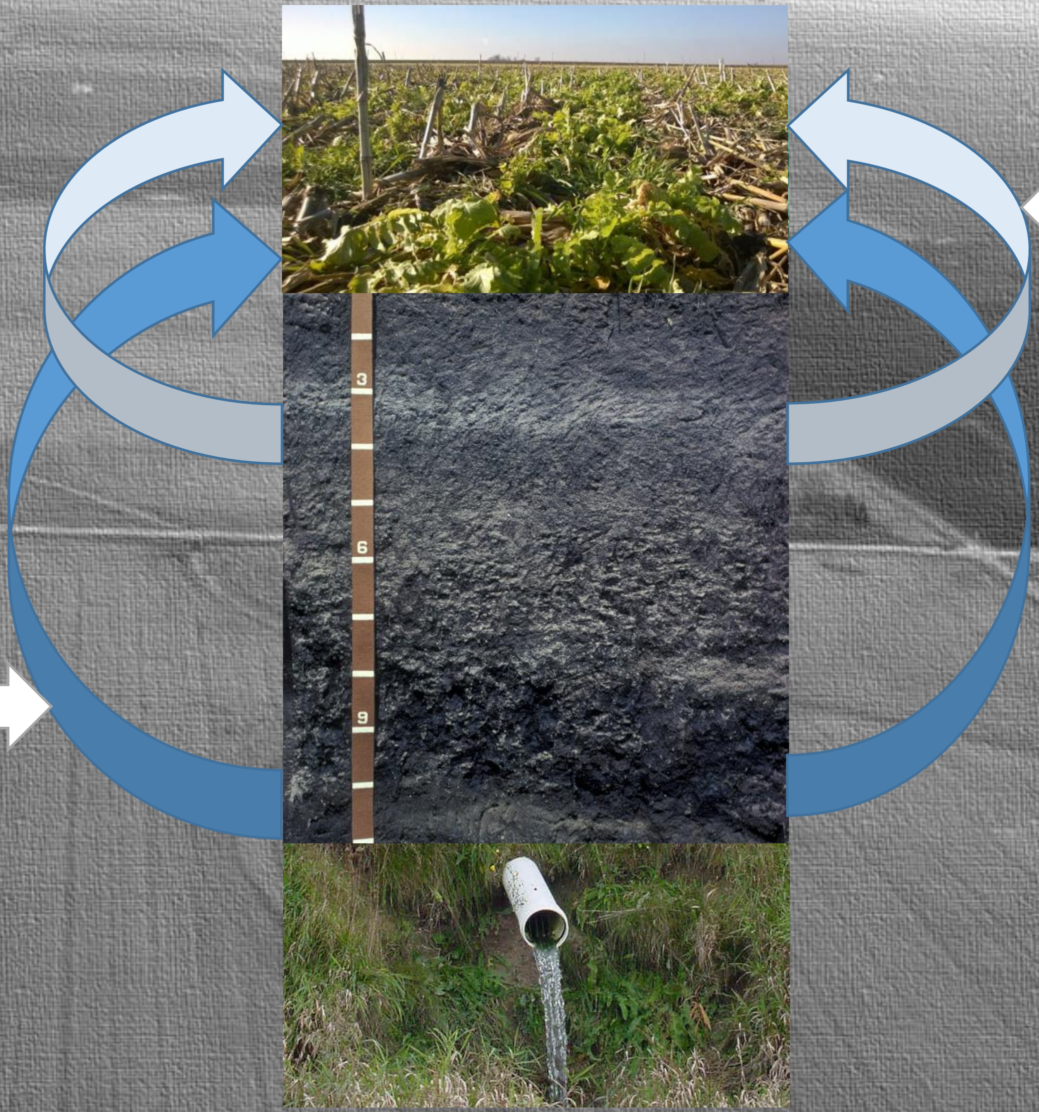
Spring N + CC vs. Fall N + CC = Equal



Fall N
Fall N + Cover
Spring N
Spring N + Cover
Zero Control
Tile Flow Weight NO3-N (mg L-1)
0
2
4
6
8
10
12
14
16
2014 Corn
2015 Soybean
2016 Corn

# Potential Cover Crop N Cycling (2:1 Ratio)

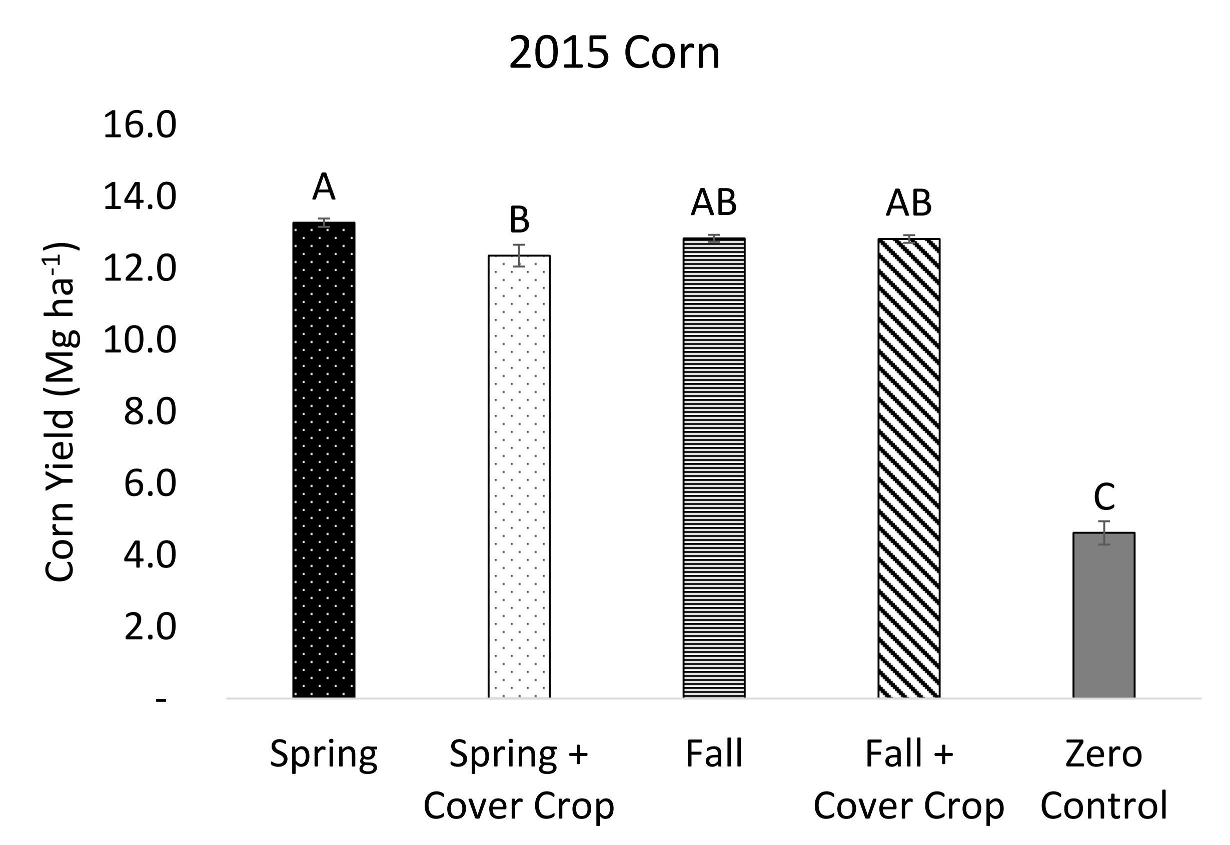
2:1 ratio between cover crop biomass N and N prevented from leaving the tile.

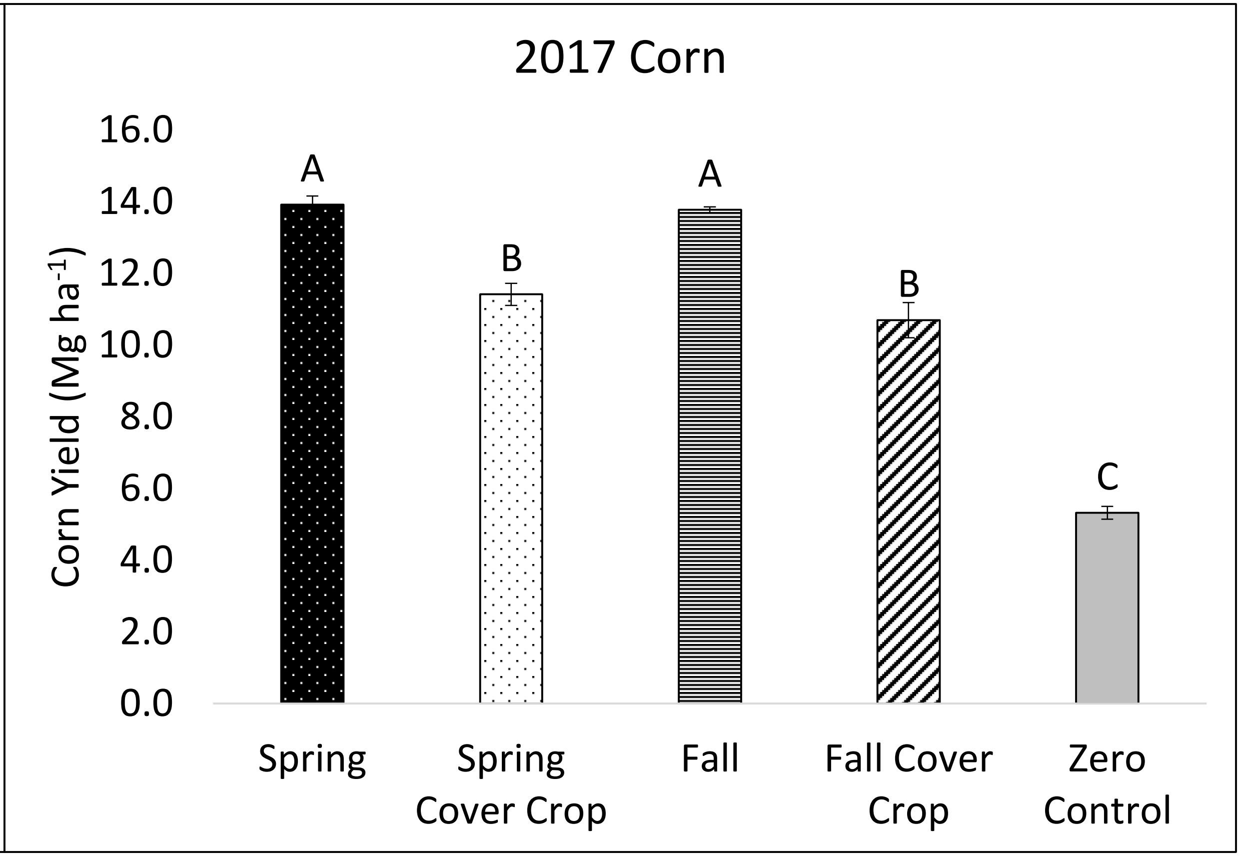


Cover Crops interacts with inorganic N within the soil solution that is less susceptible to loss via tile drainage.

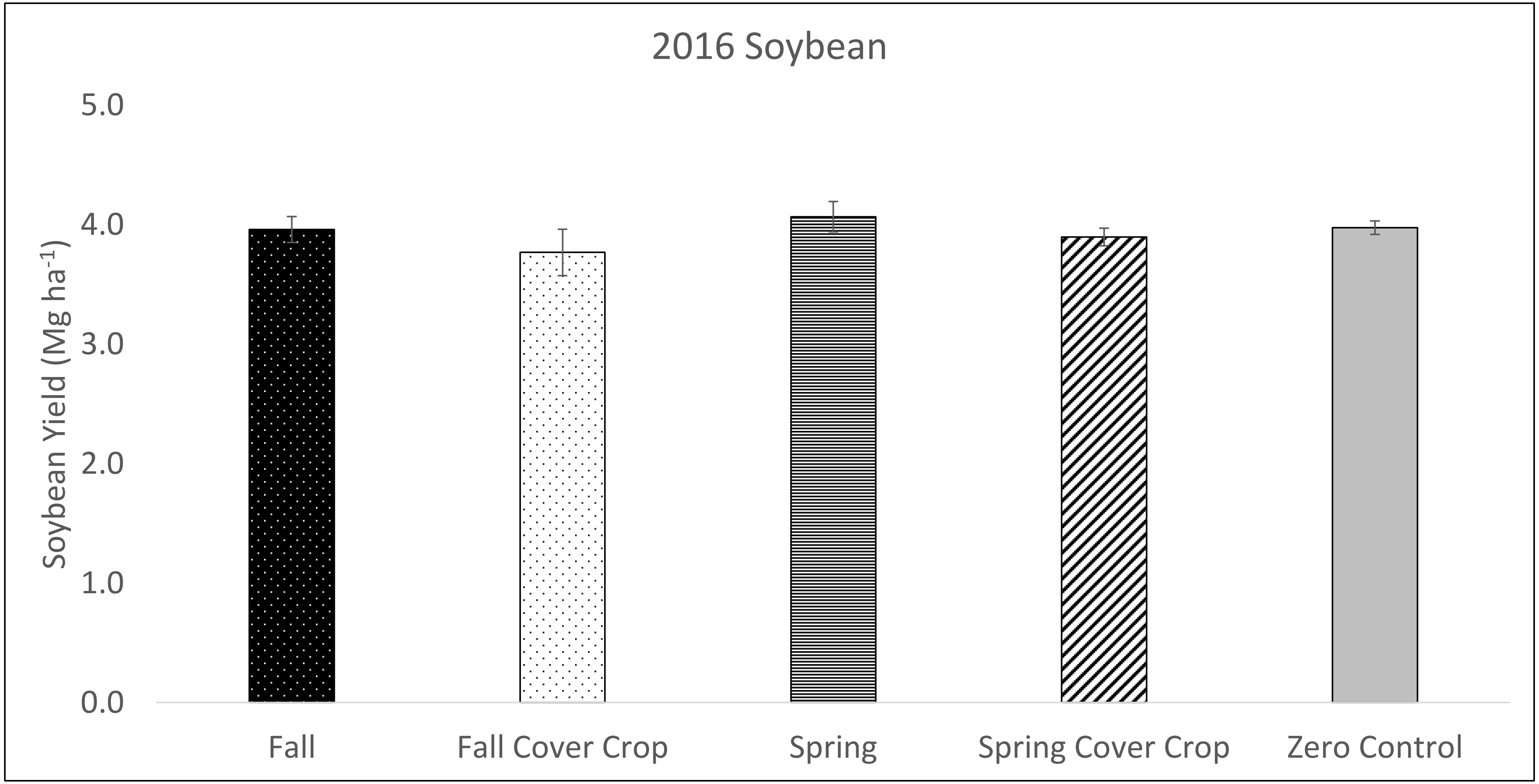
Cover Crops interacts with inorganic N within the lower portions of the soil profile that is more susceptible to loss via tile drainage.

# Corn Yield


2015 Corn
Corn Yield (Mg ha-1)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
-
A
B
AB
AB
C
Spring
Spring + Cover Crop
Fall
Fall + Cover Crop
Zero Control


2017 Corn
Corn Yield (Mg ha-1)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
A
B
A
B
C
Spring
Spring Cover Crop
Fall
Fall Cover Crop
Zero Control

# Soybean Yield



# Cover Crop Performance on a Watershed Scale: Potential Impacts on Water Quality

Shalamar Armstrong[1] , Catherine O'Reilly[2] , Ben Bruening[2], Corey Lacey[4], Richard Roth[4], Michael Ruffatti[5], and Min Xu[4]

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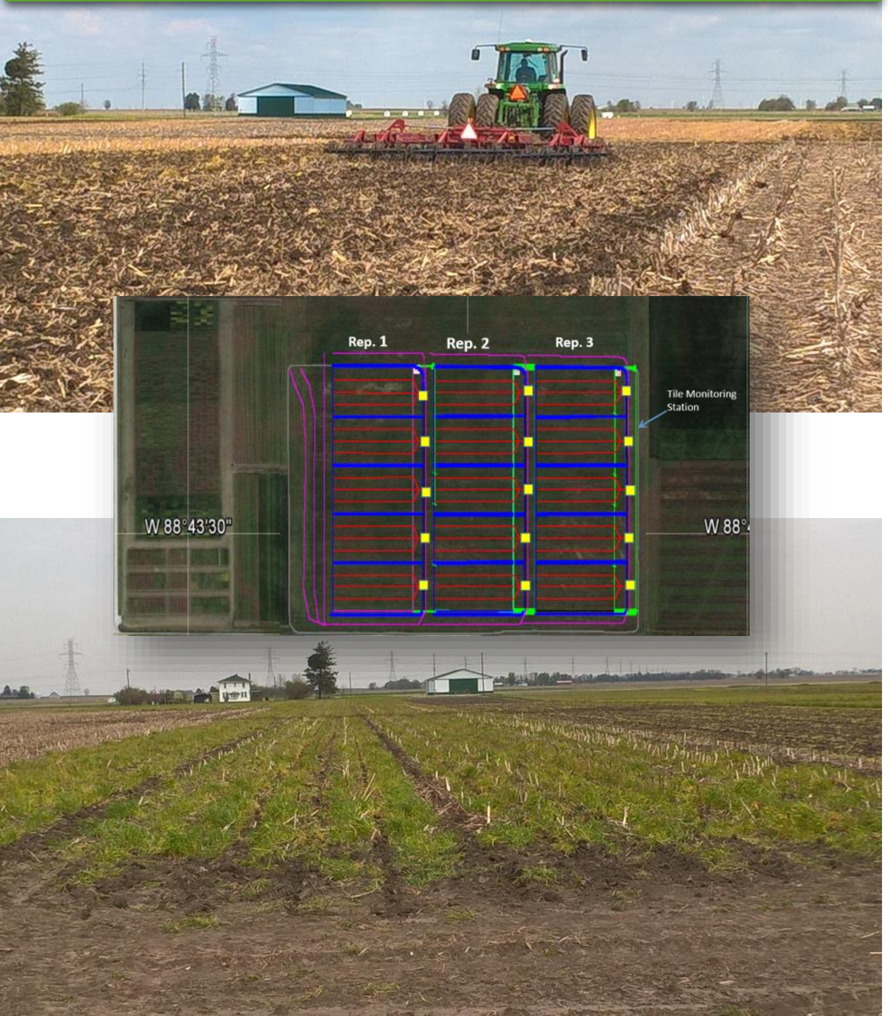
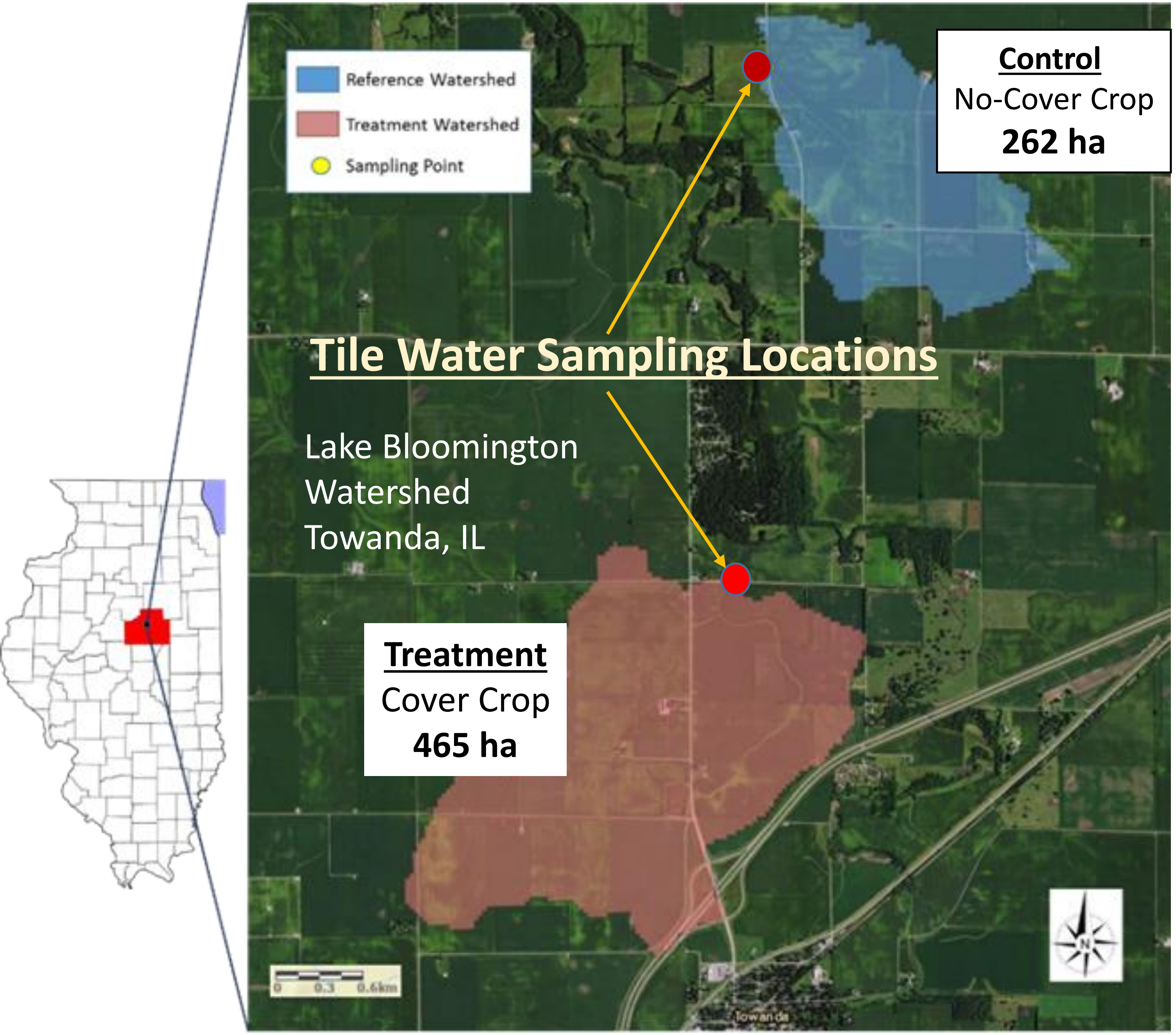
# Plot scale analysis of Cover Crops

- Controlled experiment
- Limited to no farmer influence




# Watershed scale analysis of Cover Crops

- Reduced experimental control
- Heavy farmer influence




# Study Site:

- Lake Bloomington Watershed, Towanda, IL
- Land use: 93% row crop agriculture, >90% tile drained
- Dominant soils: poorly drained silty clay loam and somewhat poorly drained silt loam that lies within a 0-2% slope
- Number of farmers involved
  - Treatment = 6 farmers
  - Control = 4 farmers

# Objectives

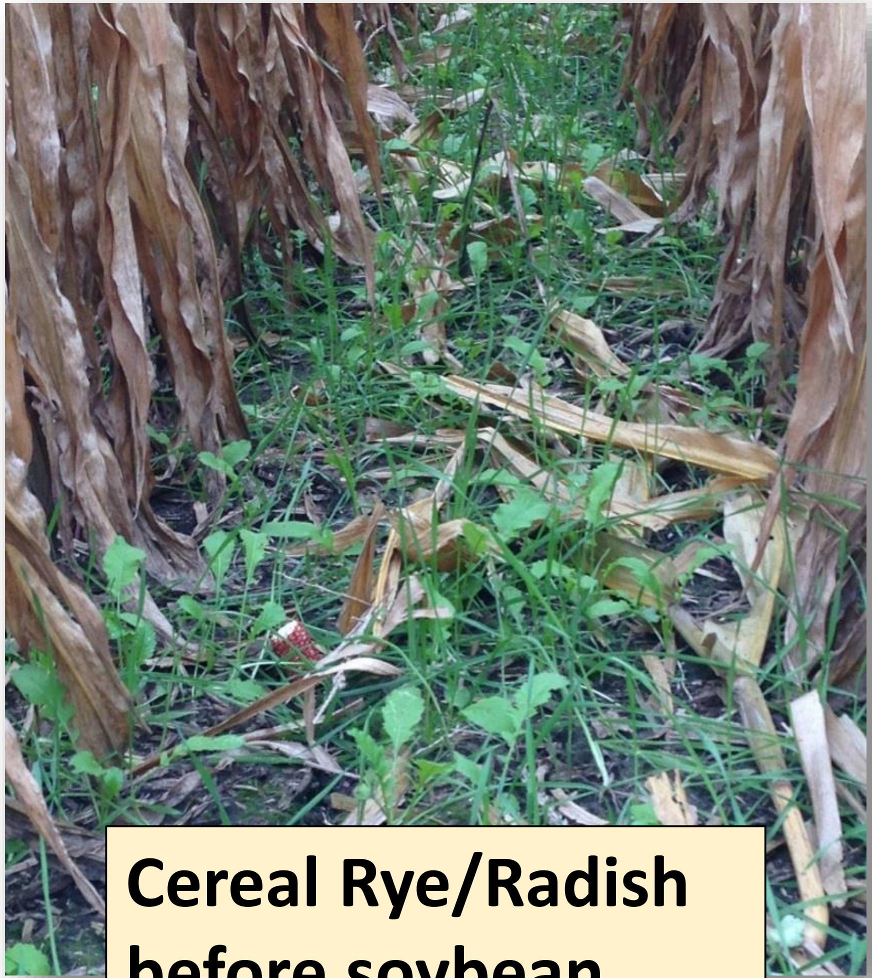
- Evaluate the above-ground biomass and N uptake of multiple cover crop mixtures on a watershed scale.
- Compare the above-ground biomass and N uptake of the cereal rye/radish mixture across the plot and watershed scales.
- Determine the impact of watershed scale mass cover crop adoption on water quantity and N loading.


Reference Watershed
Treatment Watershed
Sampling Point
Tile Water Sampling Locations
Tile Water Sampling Location

# Fall Aerial Cover Crops  Application
# 8/28-9/15
# Fall 2015, 2016, 2017

# Cover Crop Selection Uncontrolled

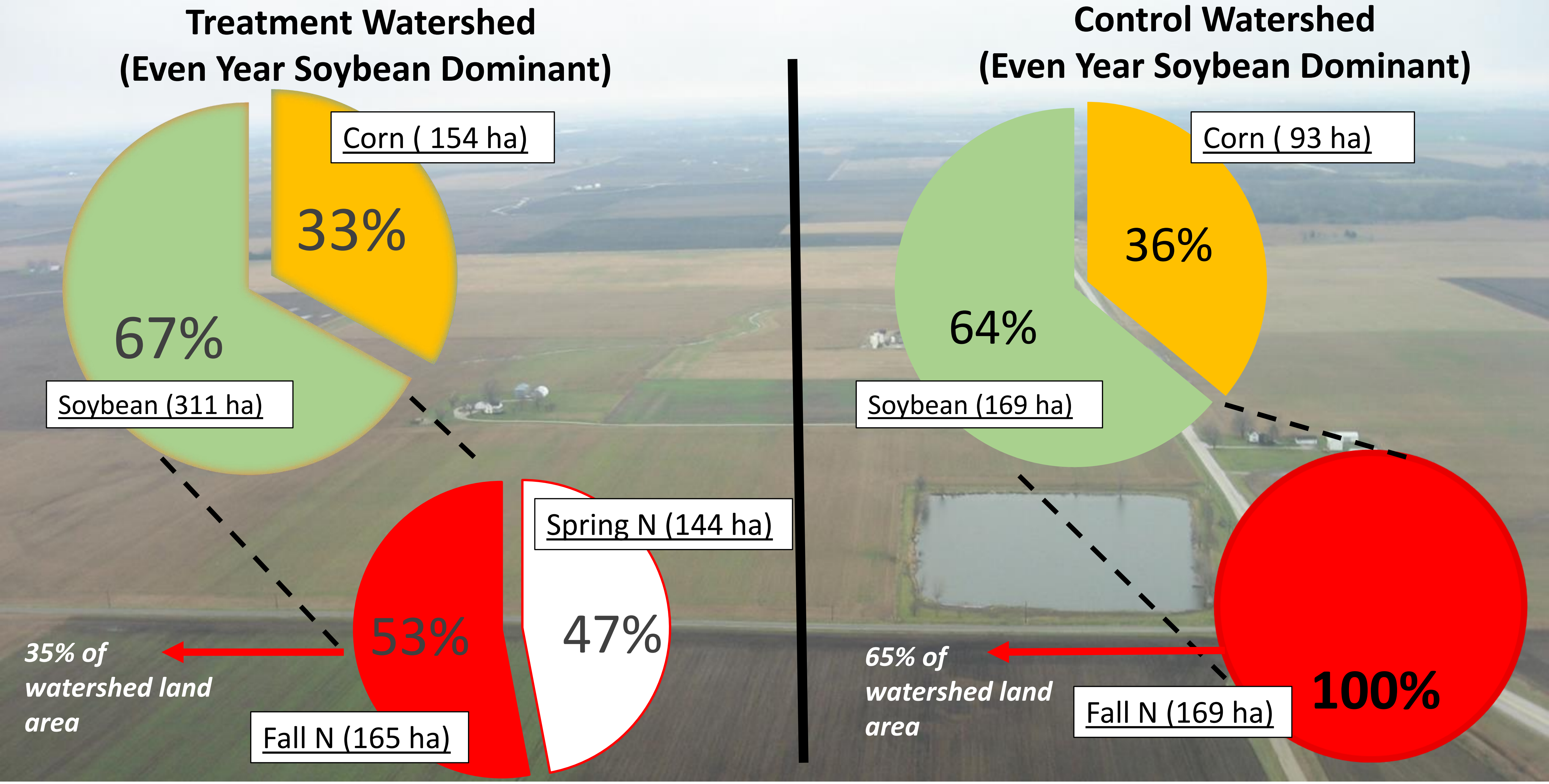
**Note: Farmers used their knowledge of cover crop C:N ratio impact corn yield to drive their cover crops selection.**



Cereal Rye/Radish before soybean

Radish/Oats or Annual Rye/Radish before corn

# Cropping Systems and N Management Uncontrolled



# Cover Crop Biomass and N Uptake (Fall 2015 and Spring 2016)

Above ground biomass was collected on 8 ha grids across the watershed and analyzed for %N.

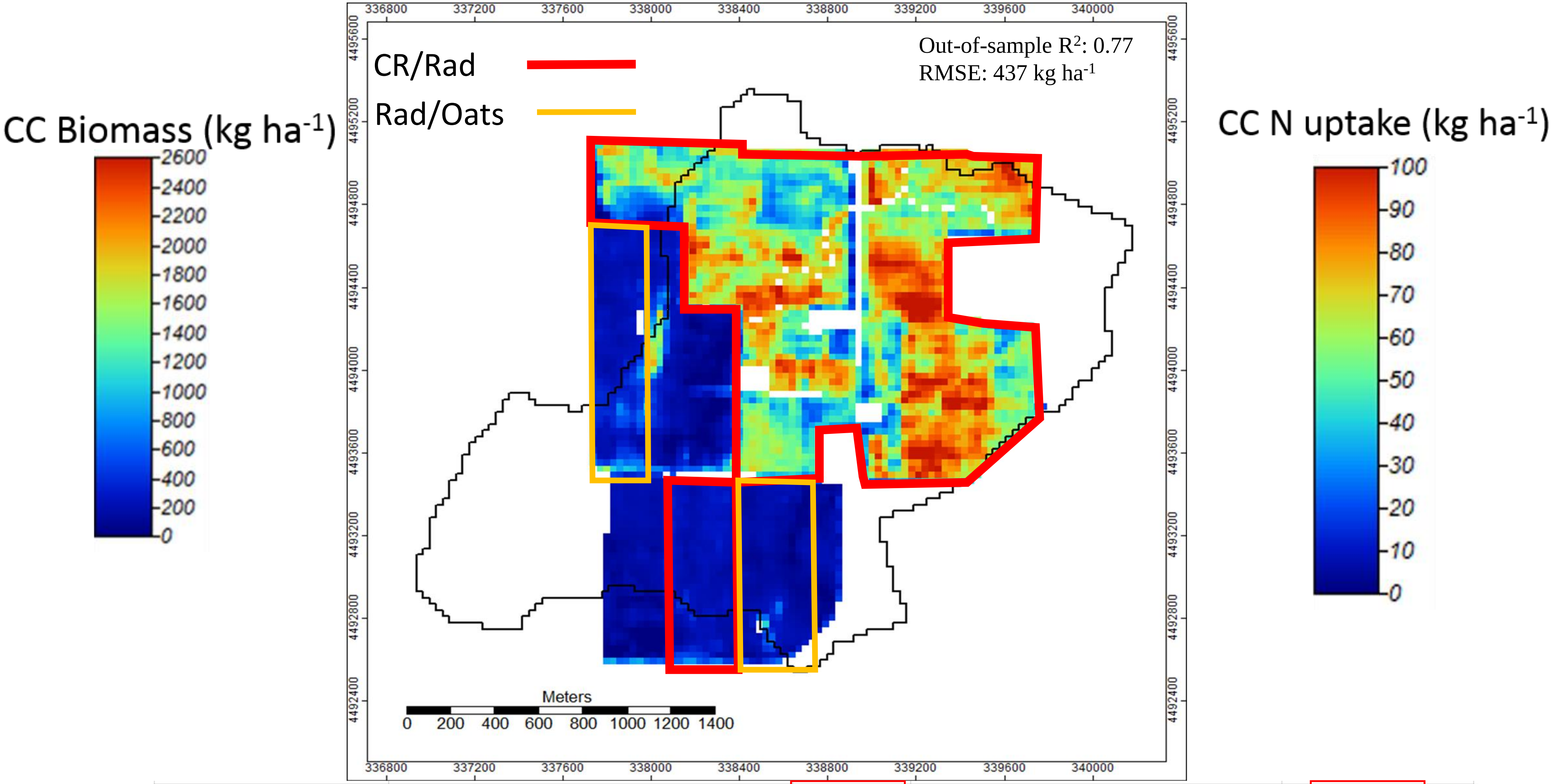
SAVI was used to create a 30m resolution continuous map of above ground biomass and N uptake.

| | Cover Crop Mixture | Fall 2015 | Total (Fall 2015+ Spring 2016) | Δ Fall to Spring |
|---|---|---|---|---|
| Biomass (kg $ha^{-1}$) | Rad/Oats | 679.4 A | 679.4 B | ----- |
| | CR/Rad | 332.0 B | 1242.0 A | 910.0 |
| | | | | |
| N uptake (kg $ha^{-1}$) | Rad/Oats | 28.8 A | 28.8 B | ----- |
| | CR/Rad | 15.4 B | 49.4 A | 34.0 |

# Cover Crop Biomass and N Uptake (Fall 2016 and Spring 2017)

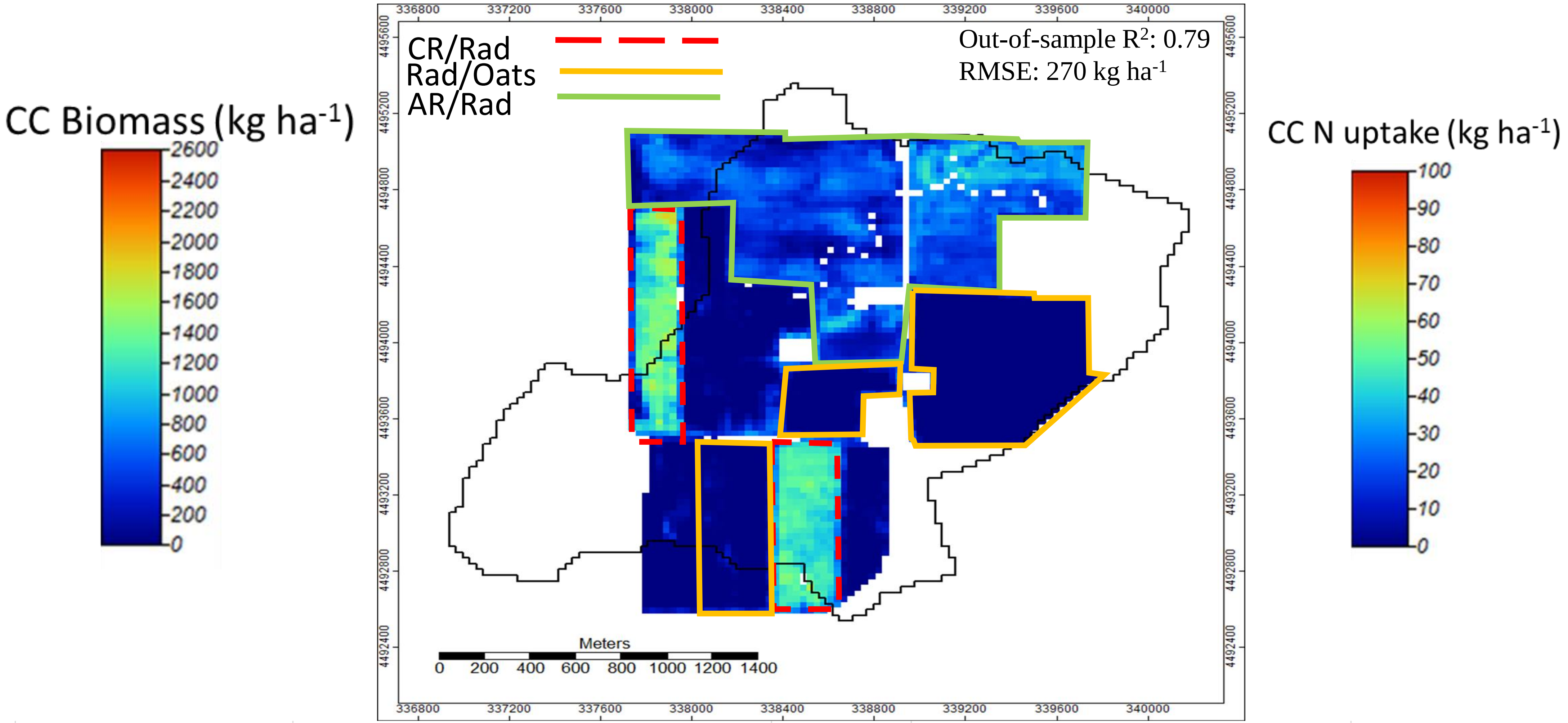
| | Cover Crop Mixture | Fall 2016 | Total (Fall 2016+ Spring 2017) | Δ Fall to Spring |
|---|---|---|---|---|
| Biomass (kg ha$^{-1}$) | Rad/Oats | 848.9 A | 848.9 B | ----- |
| | AR/Rad | 656.8 B | 645.3 C | -11.5 |
| | CR/Rad | 673.9 B | 1121.9 A | 690.3 |
| | | | | |
| N uptake (kg ha$^{-1}$) | Rad/Oats | 29.4 A | 29.4 B | ----- |
| | AR/Rad | 24.4 A | 24.2 B | -0.2 |
| | CR/Rad | 24.8 A | 52.5 A | 27.8 |

# <u>2016</u> Spring CC **Biomass** and **N Uptake**



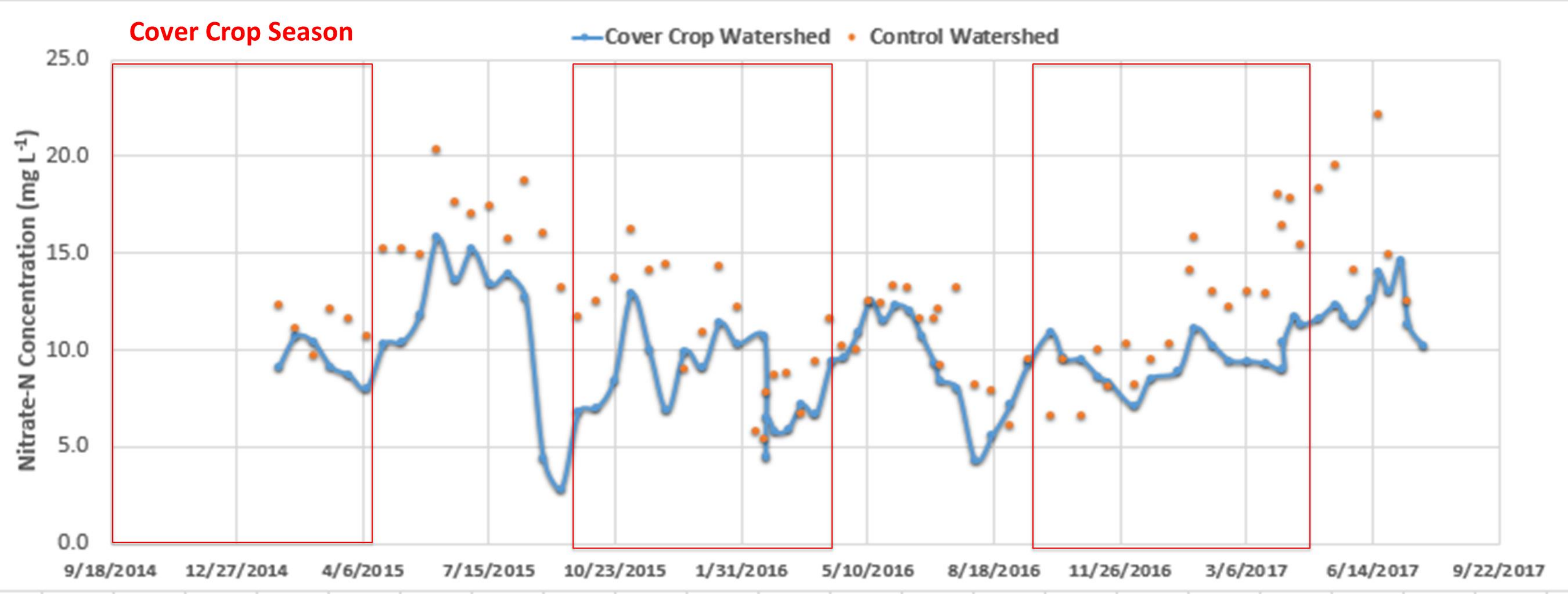

| 2016 Spring | Above ground Biomass (kg ha$^{-1}$) | % CV | N uptake (kg ha$^{-1}$) | %CV |
|---|---|---|---|---|
| Watershed CR/Rad | 1442.3 | 45.1 | 49.4 | 43.3 |
| Plot scale CR/Rad | 1223.3 | 18.9 | 31.4 | 23.6 |

# 2017 Spring CC **Biomass** and **N Uptake**




| **2017 Spring** | **Above ground Biomass (kg ha$^{-1}$)** | **% CV** | **N uptake (kg ha$^{-1}$)** | **%CV** |
|---|---|---|---|---|
| Watershed CR/Rad | 1121.9 | 25.3 | 38.7 | 24.5 |
| Plot scale CR/Rad | 2197.0 | 10 | 80.9 | 18.7 |

# Cover Crops Impact on Water Quality



# Summary

Plot Scale

- On average, the cover crop interacted with 30% of the N fertilizer applied.
- 2:1 ratio between cover crop shoot biomass N and N prevented from leaving the tile.
- Cover crops reduced N loading via tile drainage by 42-50%, despite N application timing
- Cereal/Daikon Radish mixture reduced corn yield, but did not effect soybean yield

Watershed Scale

- Mass cover crop adoption on a watershed scale is possible.
- Cereal Rye/Daikon Radish cover crop growth and N uptake means across scales were similar.
- There was significantly greater variation in cover crop growth and N uptake on the watershed scale.
- There was a signal of cover crop impacts on water quality.

# Thank You!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