Can Cover Crops Improve the Efficiency of Fall Applied Nitrogen within Conventional Midwestern Cropping Systems?

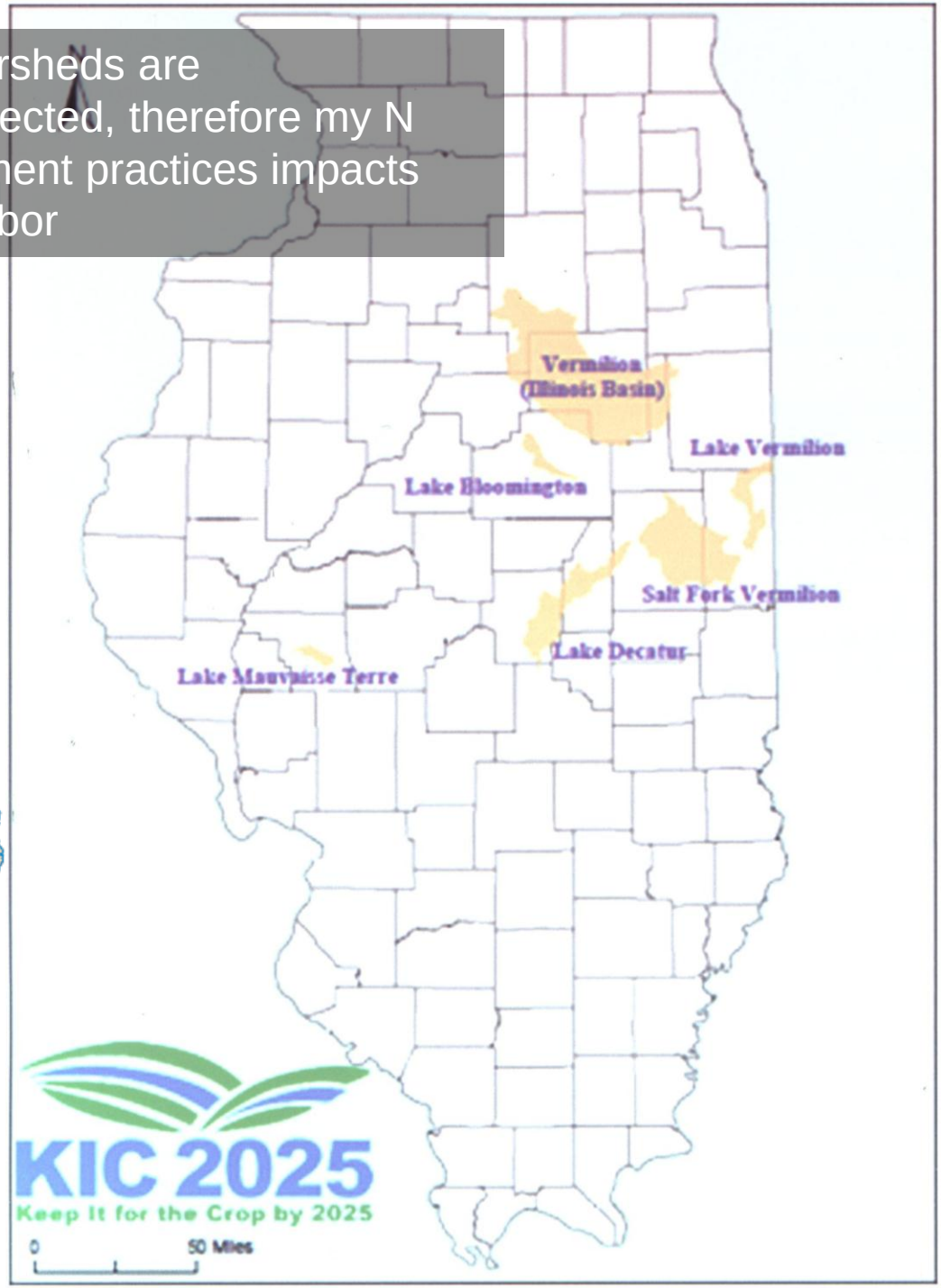
Corey Lacey
M.S. Candidate In Agriculture Sciences

Dr. Shalamar Armstrong
Assistant Professor of Soil Science and Agronomy

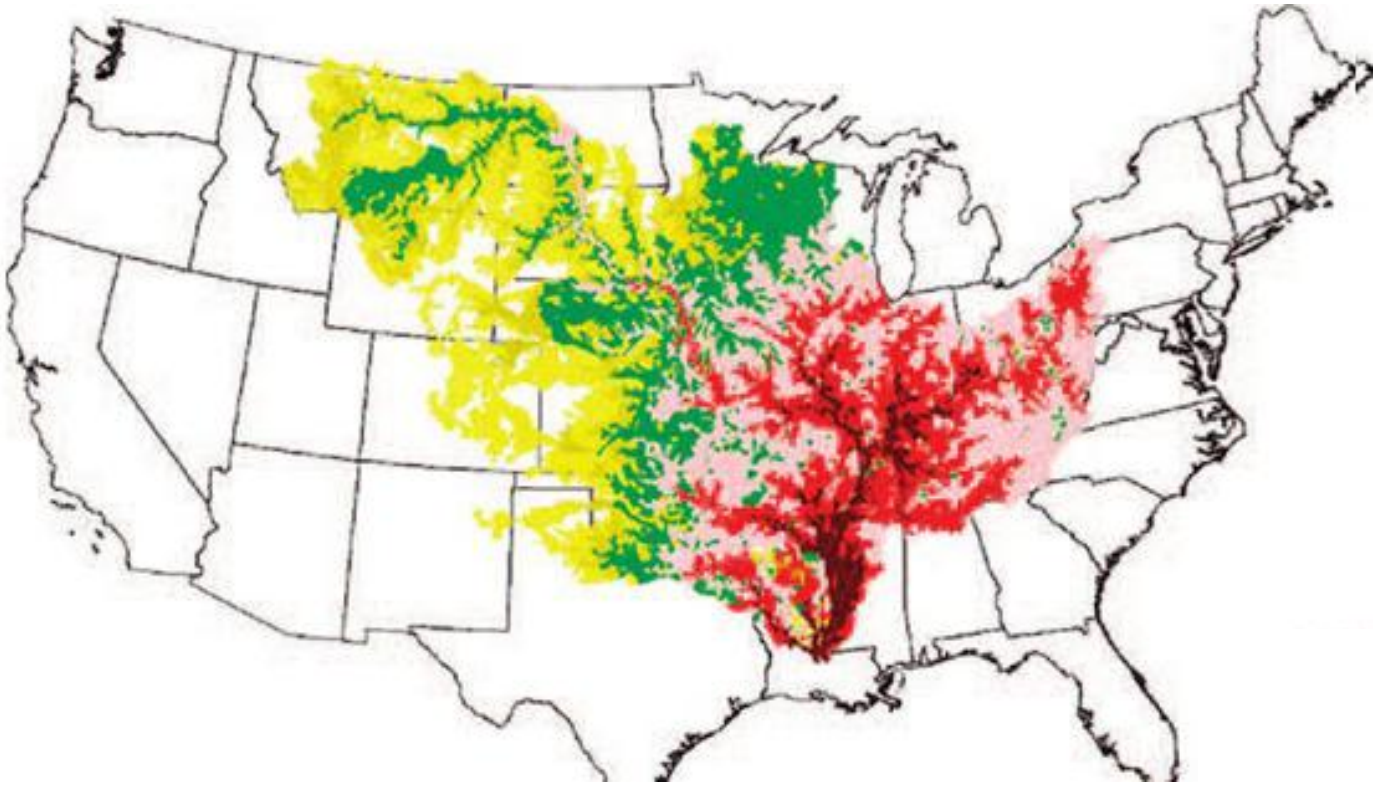
Department of Agriculture
Illinois State University

Our watersheds are interconnected, therefore my N management practices impacts my neighbor

Watershed	Target Nutrient
Lake Bloomington	Total Phosphorus Nitrate
Lake Vermillion	Total Phosphorus Nitrate
Lake Decatur	Total Phosphorus Nitrate
Vermillion River (Illinois Basin)	Nitrate
Salt Fork Vermillion River (Wabash Basin)	Nitrate
Lake Mauvaisse Terre	Total Phosphorus Nitrate

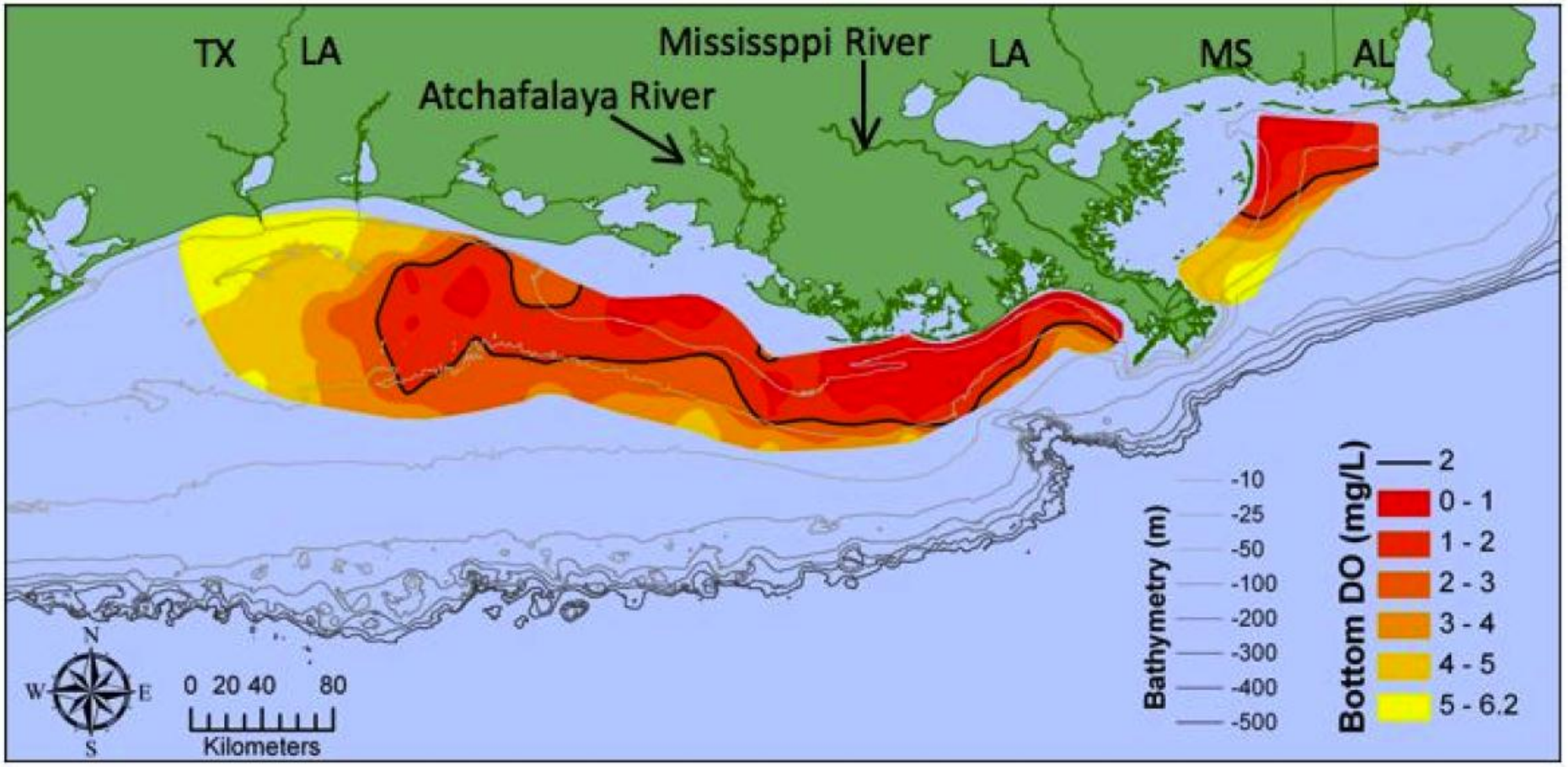


Introduction



- USGS reported that Agriculture contributes > 70% of N deliver to the Gulf of Mexico annually
- Corn and Soybean fields of the Midwest contribute contributes ~50% of the N loading to the Gulf (USGS, 2007)

Growth of the Hypoxic Zone in the Gulf



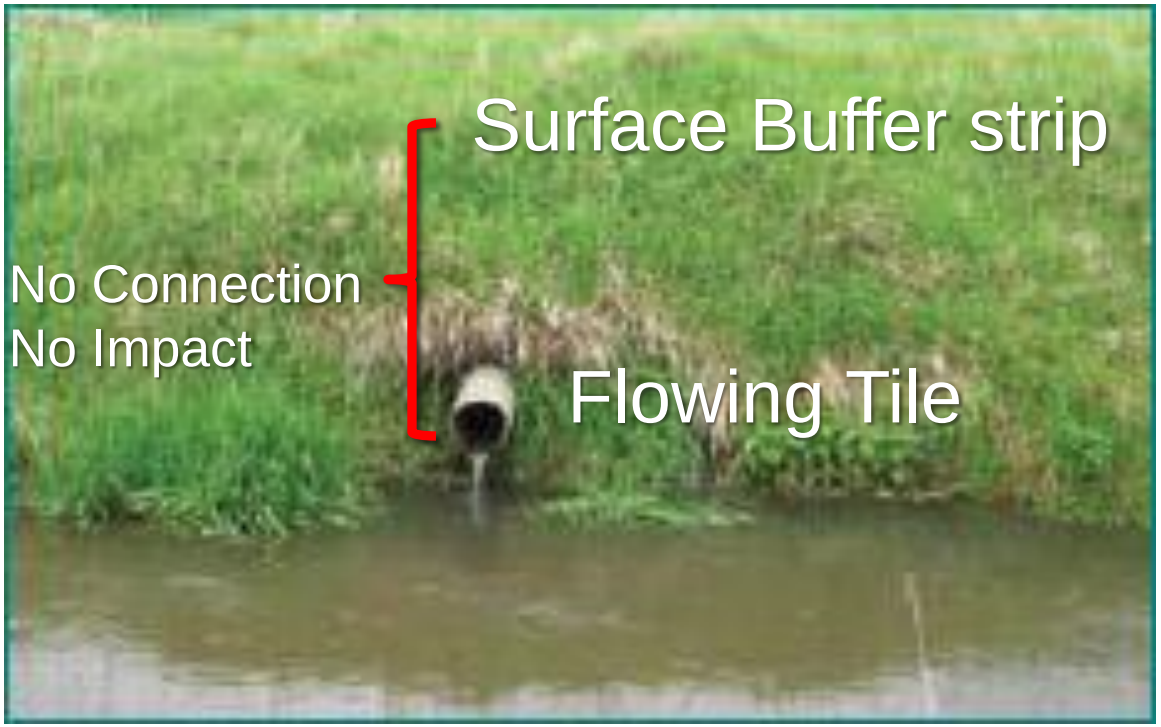
- 73% increase in size since 1987
- 87% increase in size since 2000

(NOAA, 2011)

Implementation of BMPs and Conservation to Decrease N losses

Lemke et al. 2011

- 7 years of BMP implementation, no significant difference in NO_3-N concentration in surface water.



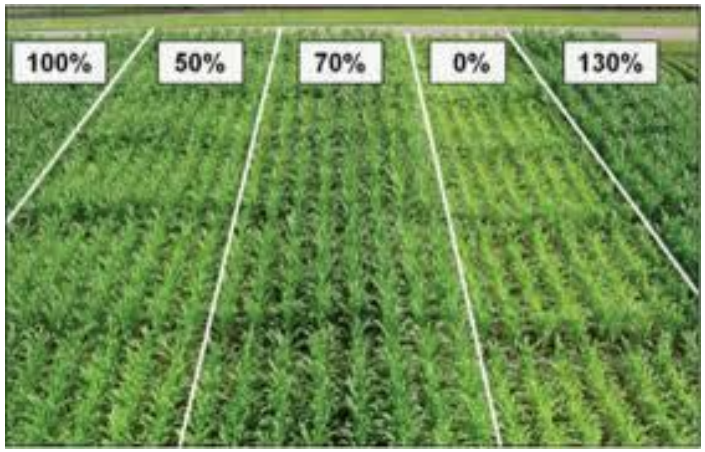
Sprague et al. 2011

estimated that the contribution of nitrate from the Illinois River to the Gulf of Mexico had decreased by only 1% between the years of 1998 and 2008.

Implementation of BMPs and Conservation to Decrease N losses

Manipulation of N rate

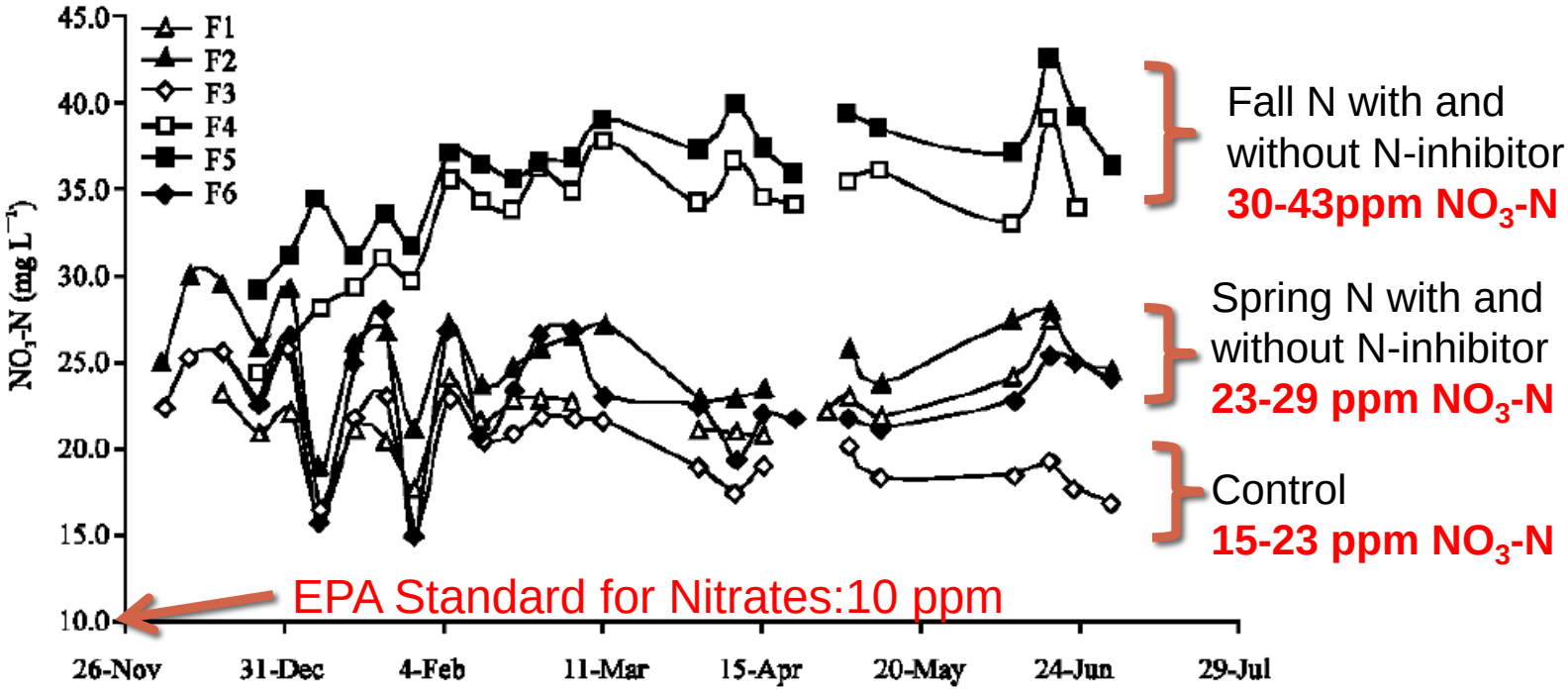
- several researchers have investigated the use of lower N fertilization rates to reduce nitrate leaching and found a direct relationship between N rates and nitrate losses via tile drainage, when the annual precipitation was normal.



- Other, studies have demonstrated that dry and wet climatic cycles more strongly influence N transport via tiles that application rate

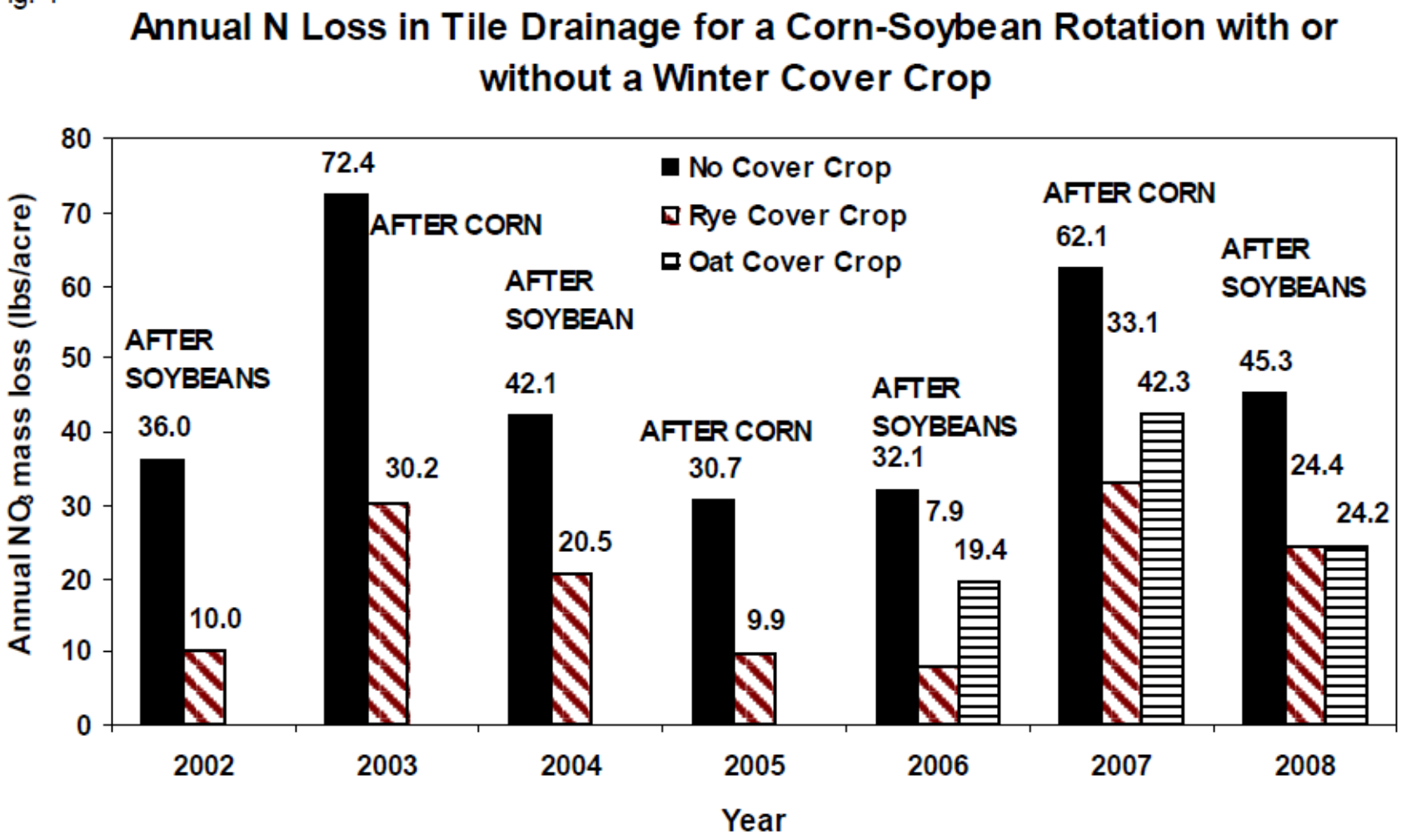
Implementation of BMPs and Conservation to Decrease N losses

- N timing most effectively reduce Nitrate leaching from tile drained fields.



Smiciklas and Moore, 2008 – Bloomington Watershed

Fig. 4



Spring Application of N + Cover Crops

Kasper et al., 2008, Iowa

Problem

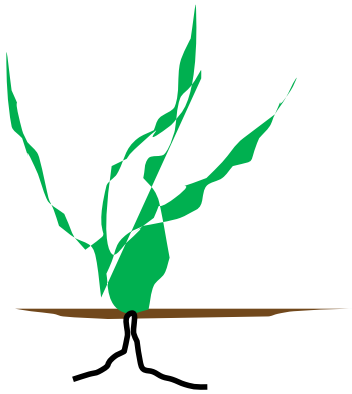
- In Central Illinois 48-52% of farmers fall apply N (Smiciklas and Moore, 2008, O'rourke, 2010)
- In Central Illinois only ~11% of farmers cover crop (Leopold Center, 2006)

Objectives

Therefore, our goals are to determine the efficacy of cover crops to improve the efficiency of fall applied N.

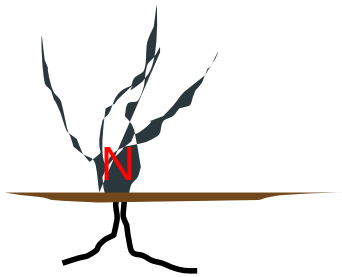
1. Investigate the effectiveness of three cover crop species to reduce nitrate leaching following fall applied N.
2. Determine impact of cover crop species on the release of stabilized fall N to the spring cash crop.

Fall N Storage Using Cover Crops

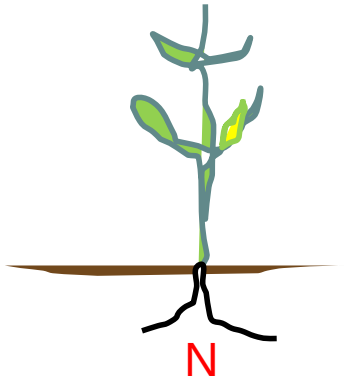


N

Fall applied N taken up by the cover crop



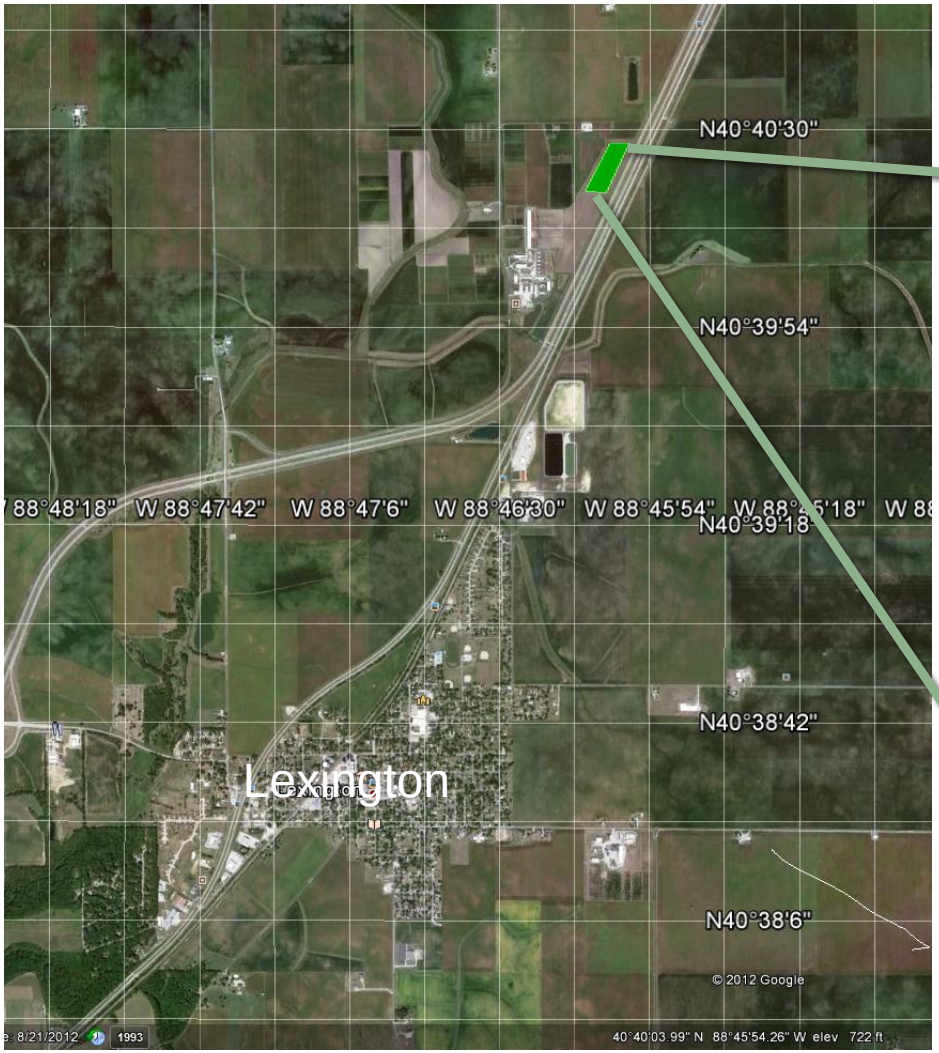
In the spring, the cover crop decomposes and releases N back to the soil



The following corn crop takes up the release N

Methodology

- The experimental site was located at the Illinois State University farm in Lexington, IL.



Methodology-Objective1 (Planting)

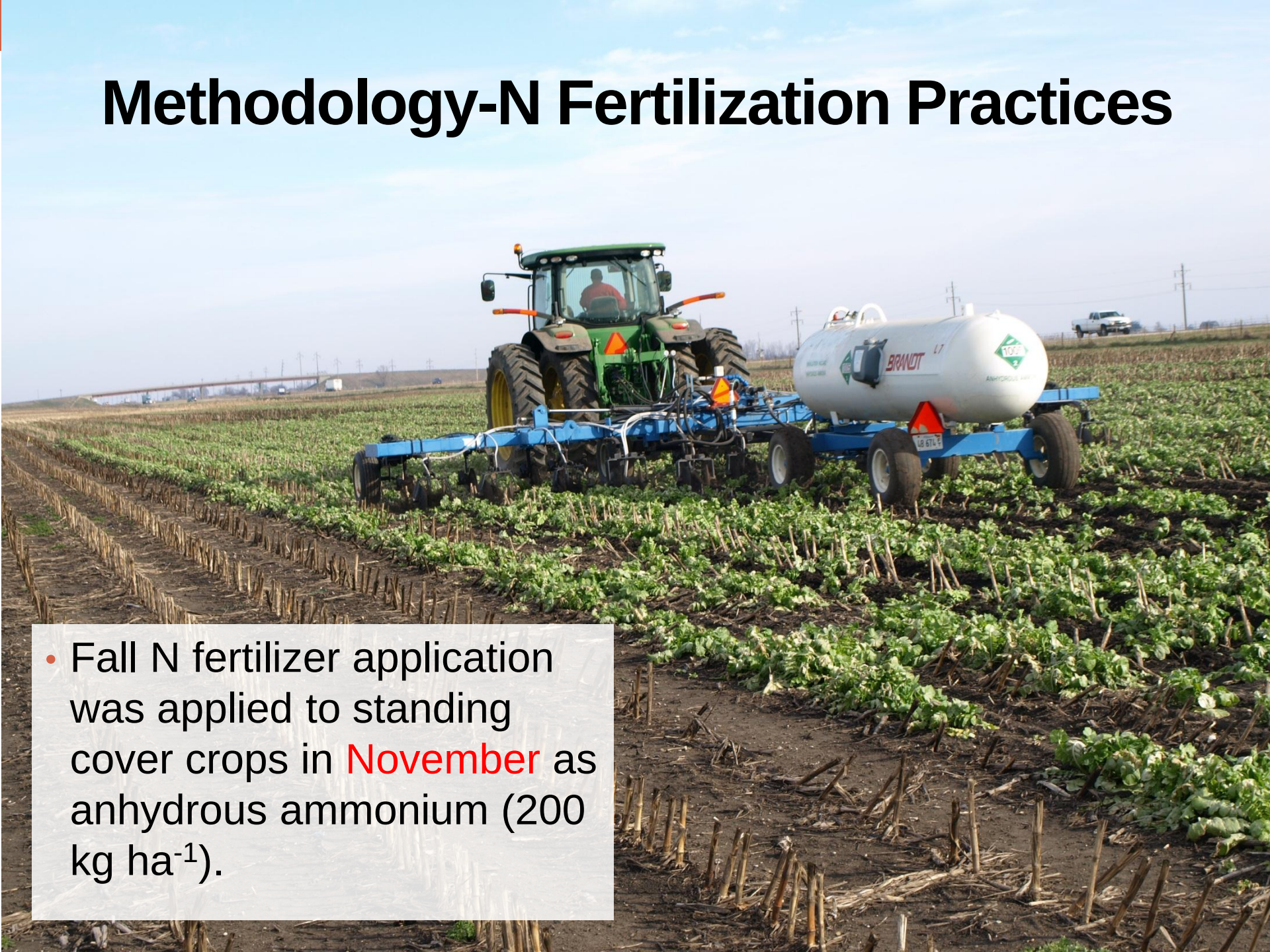
Treatments:

- Corn-Corn – no cover crop Control
- Corn-Crimson Clover-Corn
- Corn-Cereal Rye-Corn
- Corn-Tillage Radish-Corn

*All treatments receive 200 kg ha^{-1} of fall applied N into a growing stand of cover crops

Cover crops were drilled planted on September 8th, 2011,after harvesting corn silage at the recommended seeding rates.

Methodology-N Fertilization Practices



- Fall N fertilizer application was applied to standing cover crops in November as anhydrous ammonium (200 kg ha^{-1}).

Method-Plant Sampling

- Plant samples were collected before the Tillage Radish plants winter killed.
- A second plant sampling was conducted in, before the termination of Cereal Rye and Crimson Clover. Only aboveground plant material was sampled.
- Plant samples were dried and analyzed for total N to determine N uptake.

Terminated the cover crops in March

Methods-Spring Soil Sampling

Soil Profile Depth 0-80cm

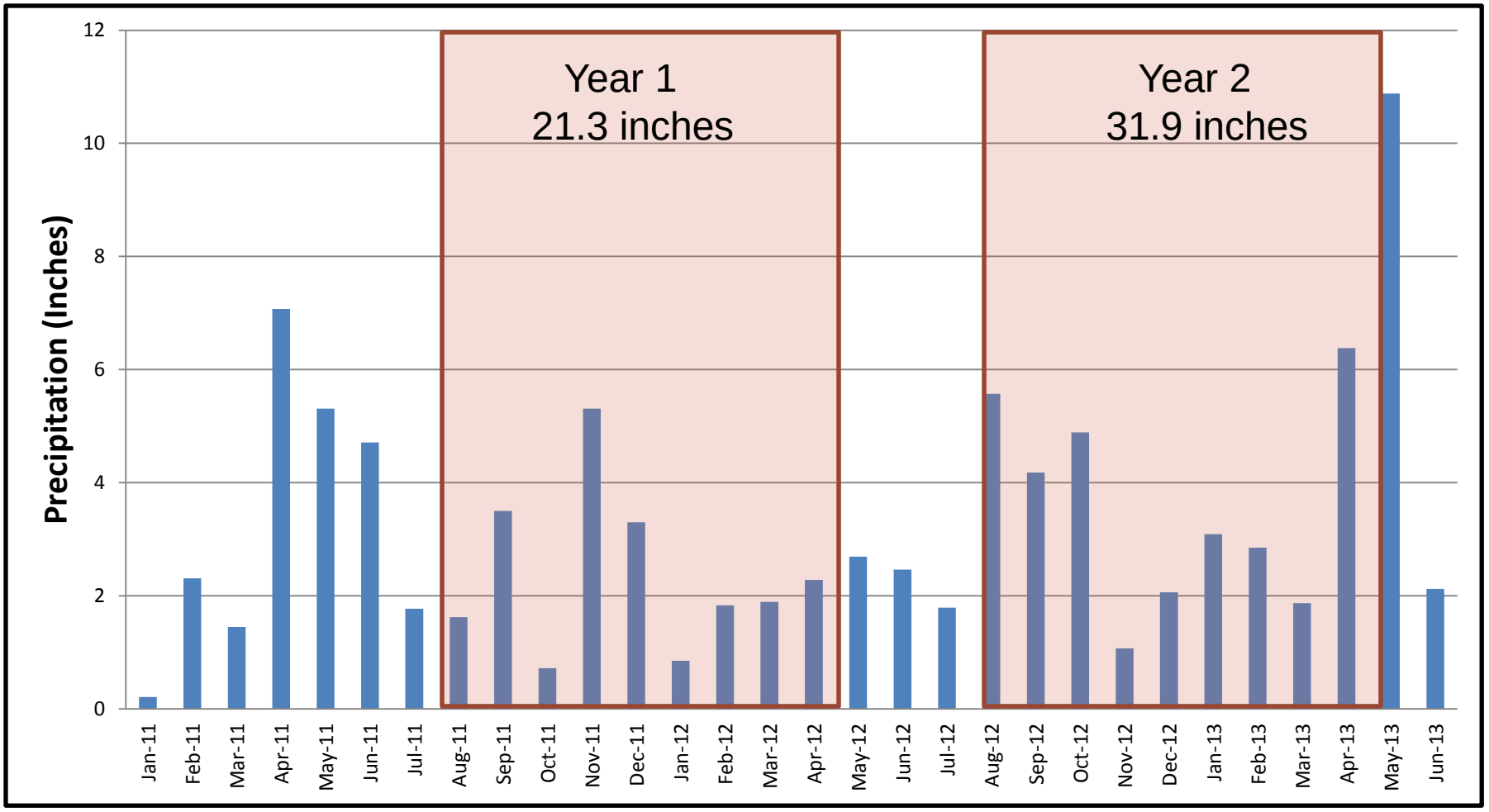
- Spring soil samples were collected in April from each plot at 4 depths: 0-5cm, 5-20cm, 20-50cm and 50-80cm.

- Soil samples were analyzed for Nitrate Nitrogen (NO_3-N)


After spring plowing corn was planted on April 23, 2012 and May 15, 2013

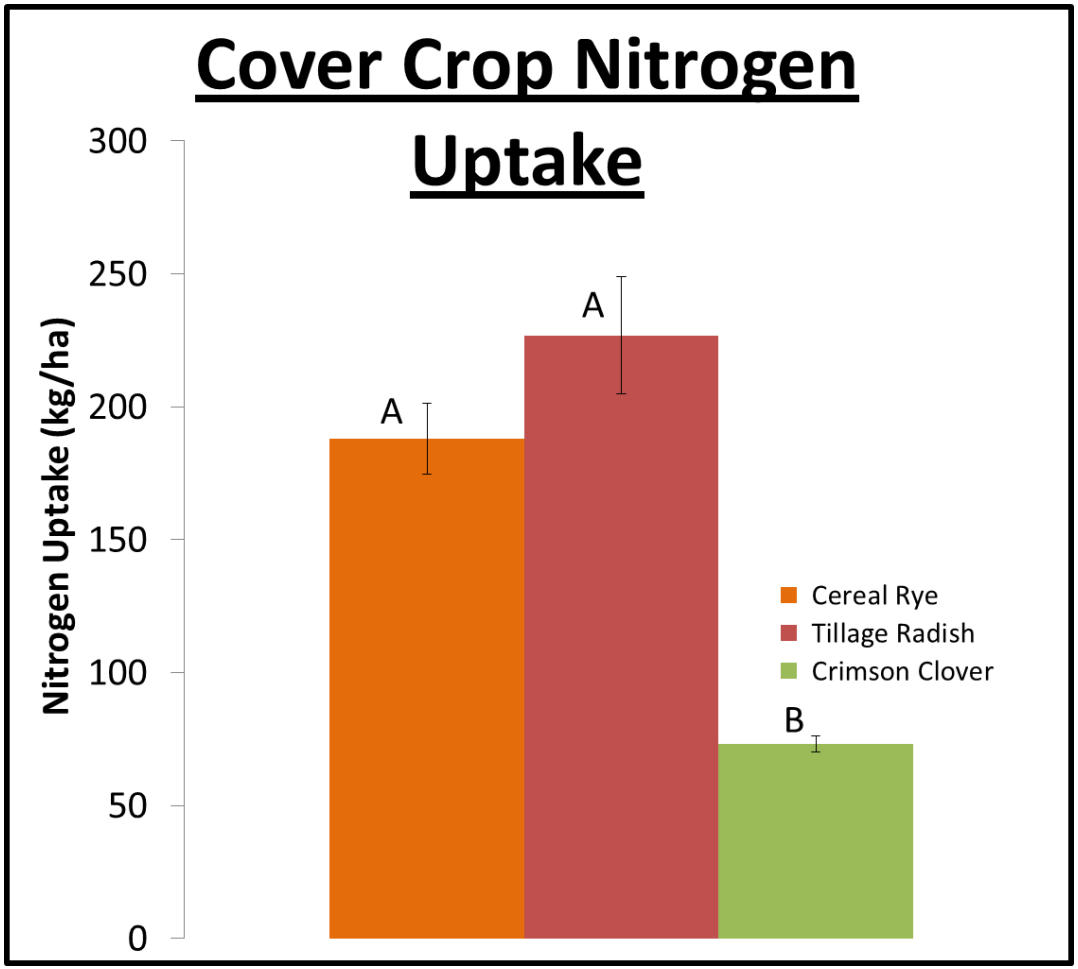
Methods-Corn Silage

Harvested corn for silage on August 12th 2012.

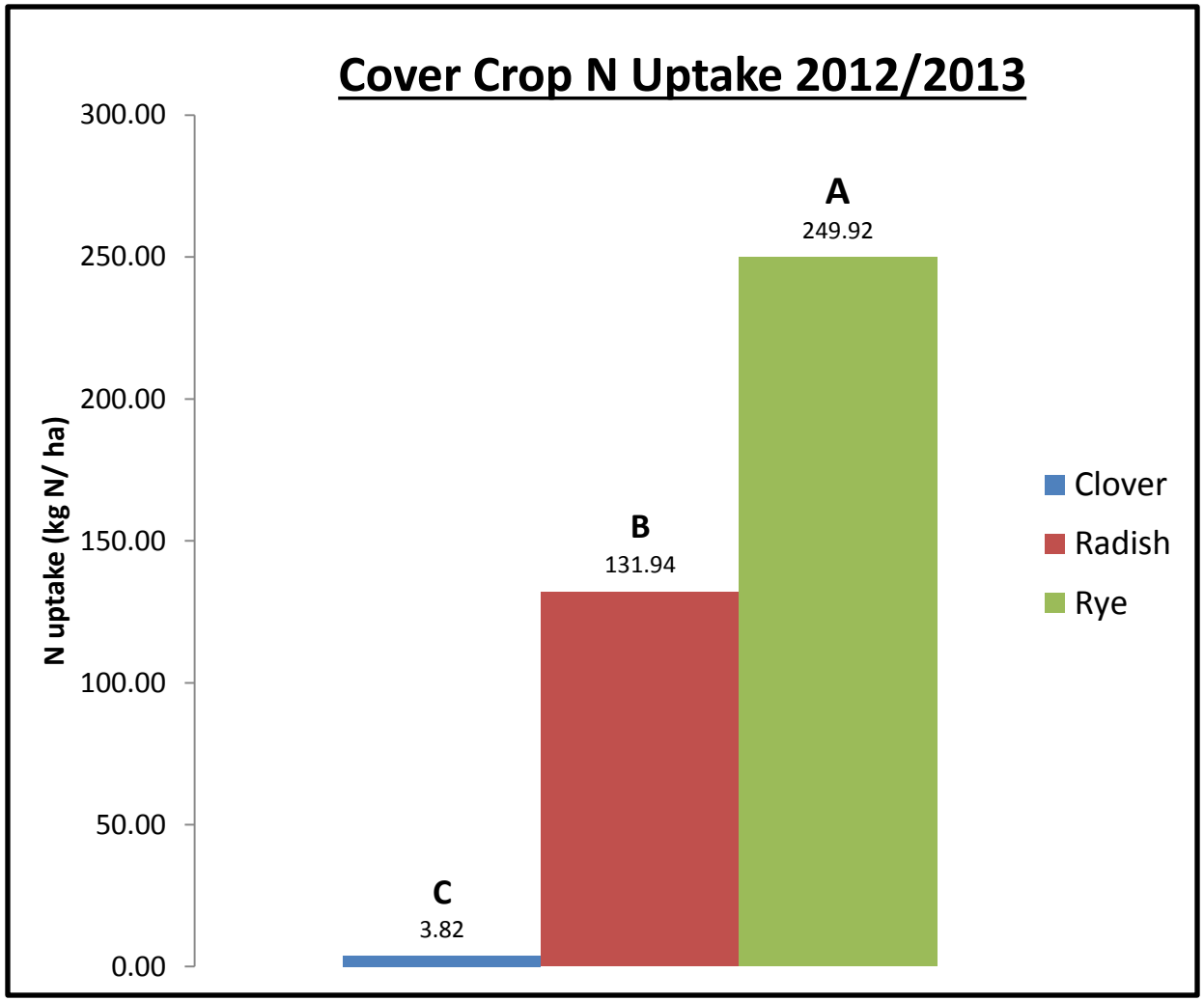

Year 1
21.3 inches
Year 2
31.9 inches
Precipitation (Inches)
0
2
4
6
8
10
12
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
Jan-12
Feb-12
Mar-12
Apr-12
May-12
Jun-12
Jul-12
Aug-12
Sep-12
Oct-12
Nov-12
Dec-12
Jan-13
Feb-13
Mar-13
Apr-13
May-13
Jun-13

Objective 1: Investigate the effectiveness of three cover crop species to reduce nitrate leaching following fall applied N.

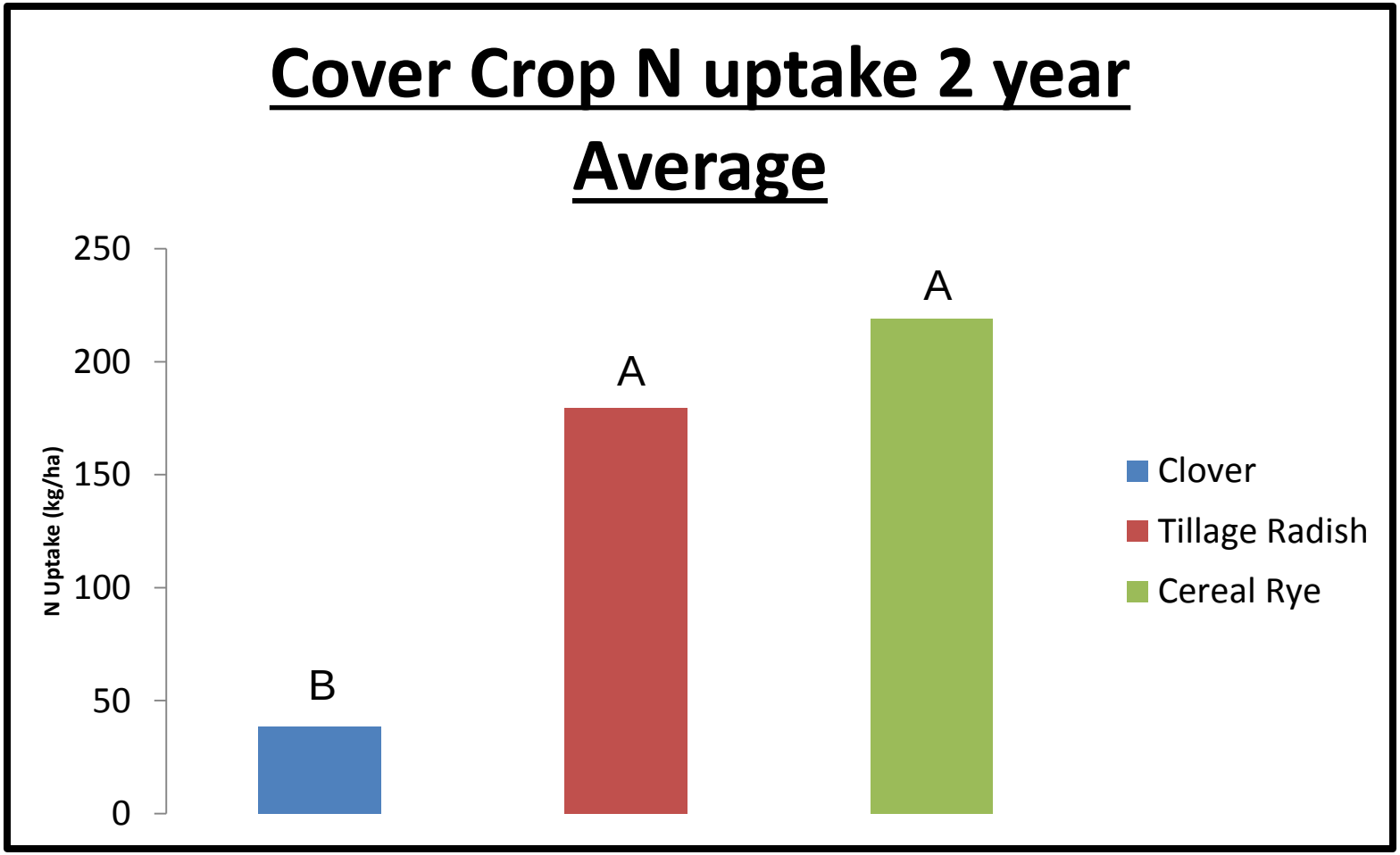
Results- Year1 (2011/2012



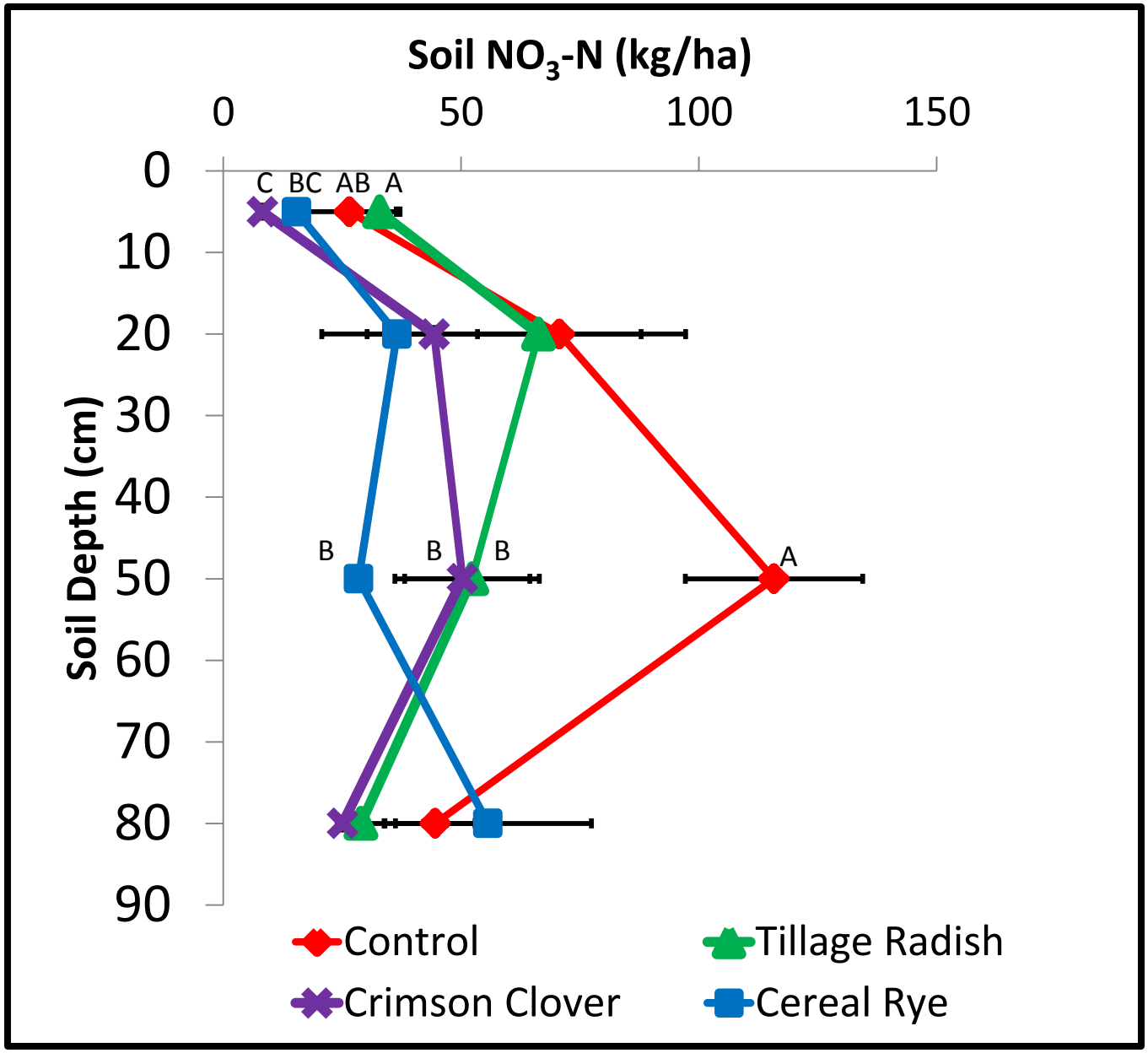
Results-Year 2
2012/2013



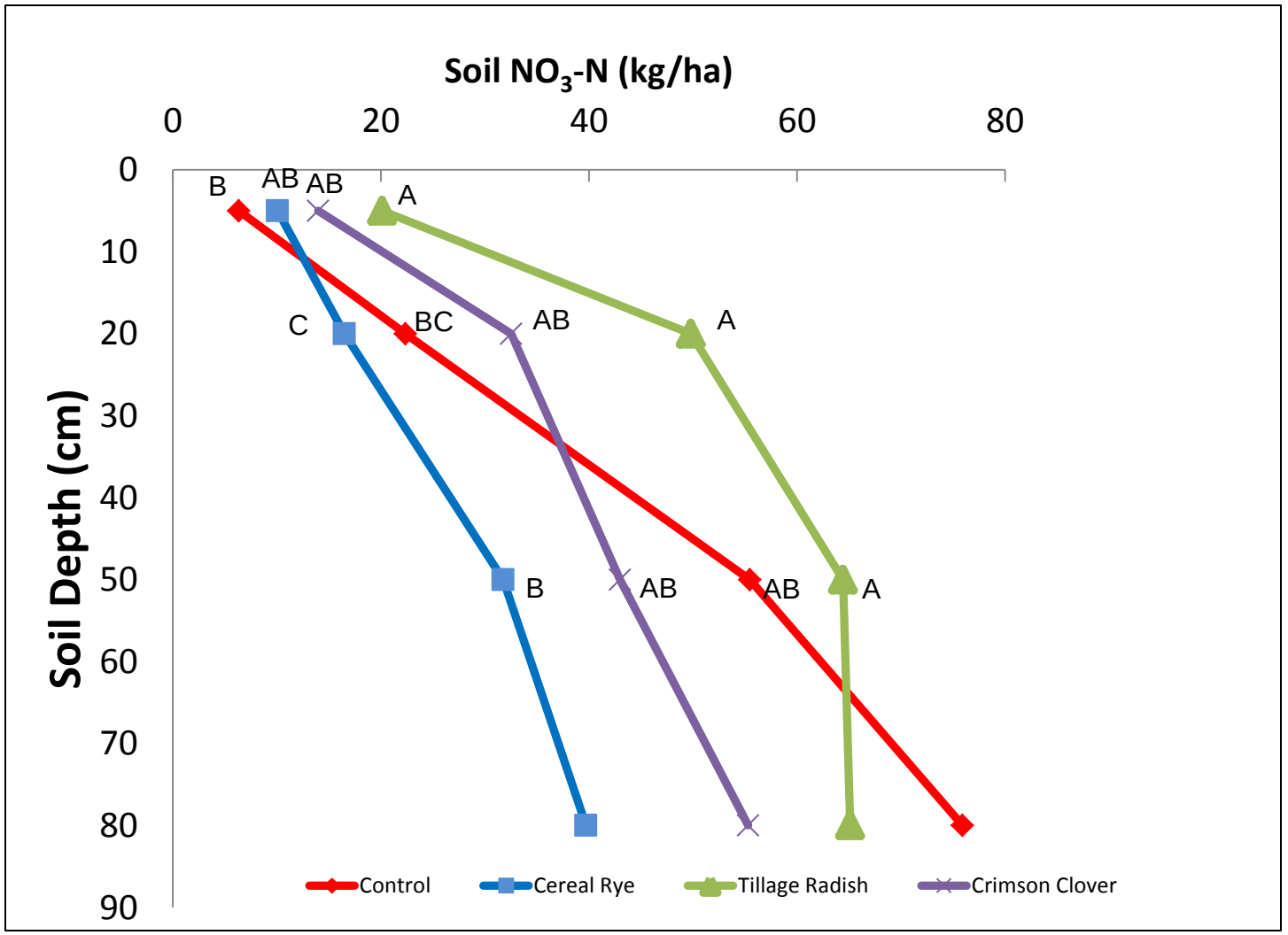
2 Average


Cover Crop N uptake 2 year Average
N Uptake (kg/ha)
250
200
150
100
50
0
B
A
A
Clover
Tillage Radish
Cereal Rye

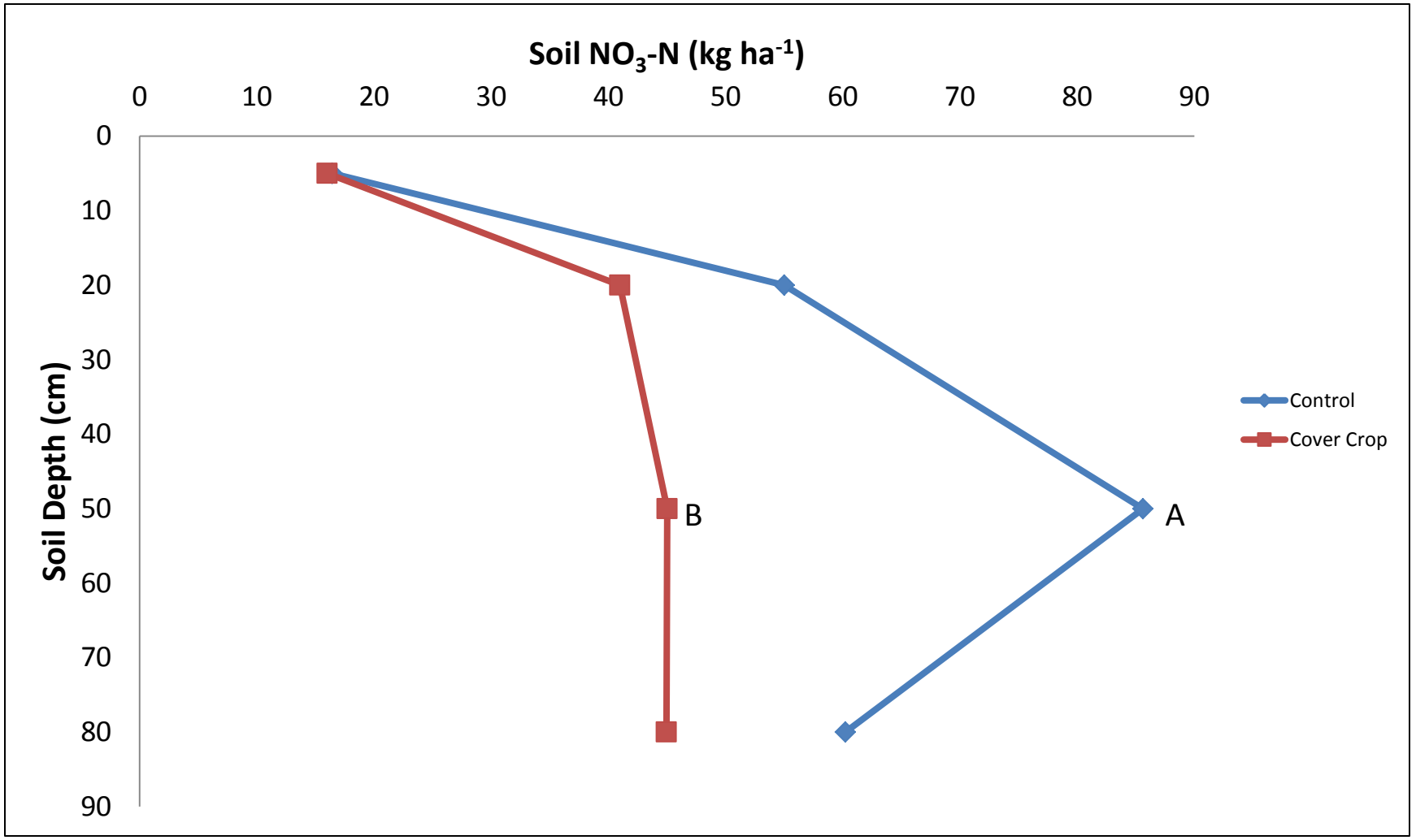
Results- Year 1- 2011/2012



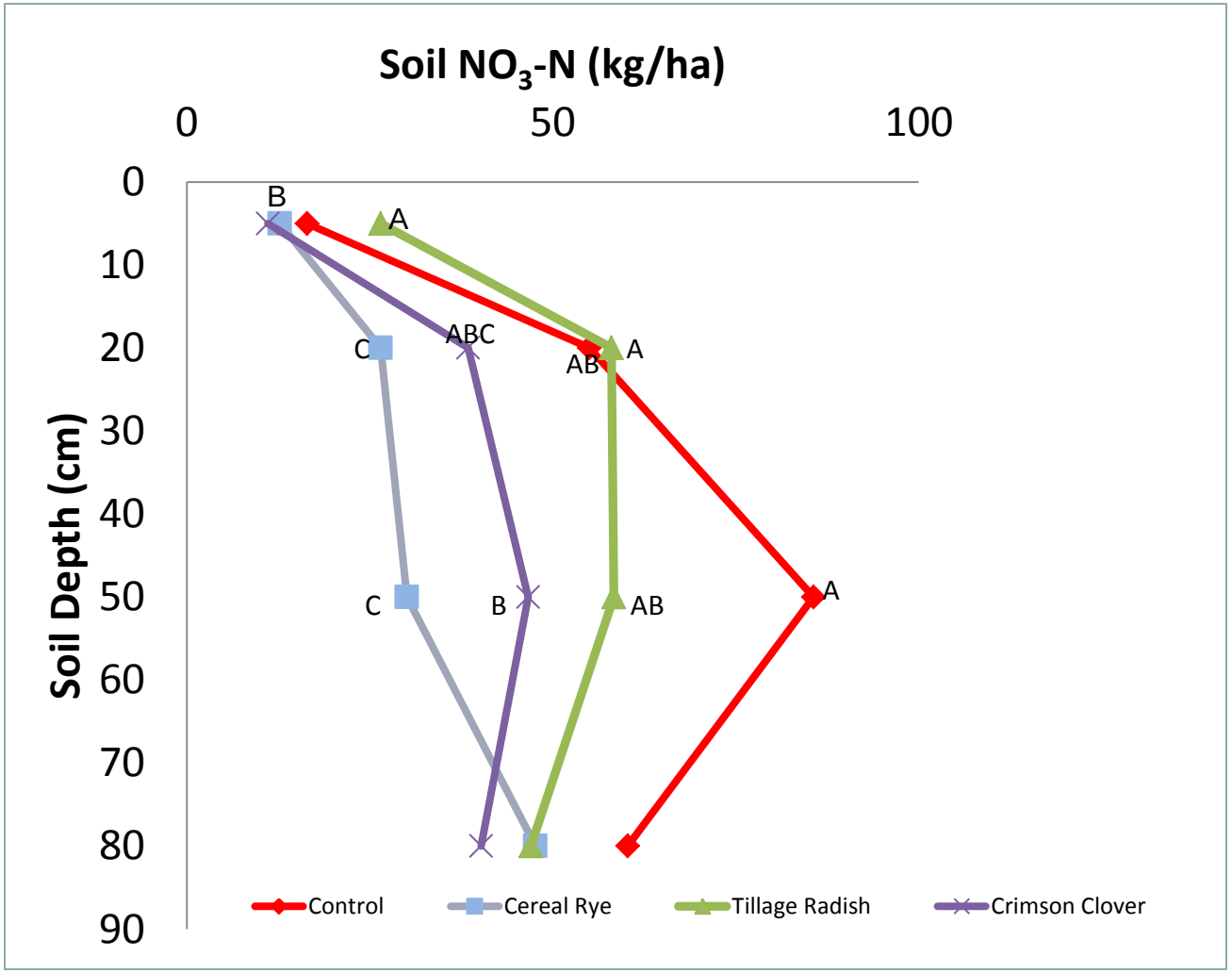
Results- Year 2- 2012/2013



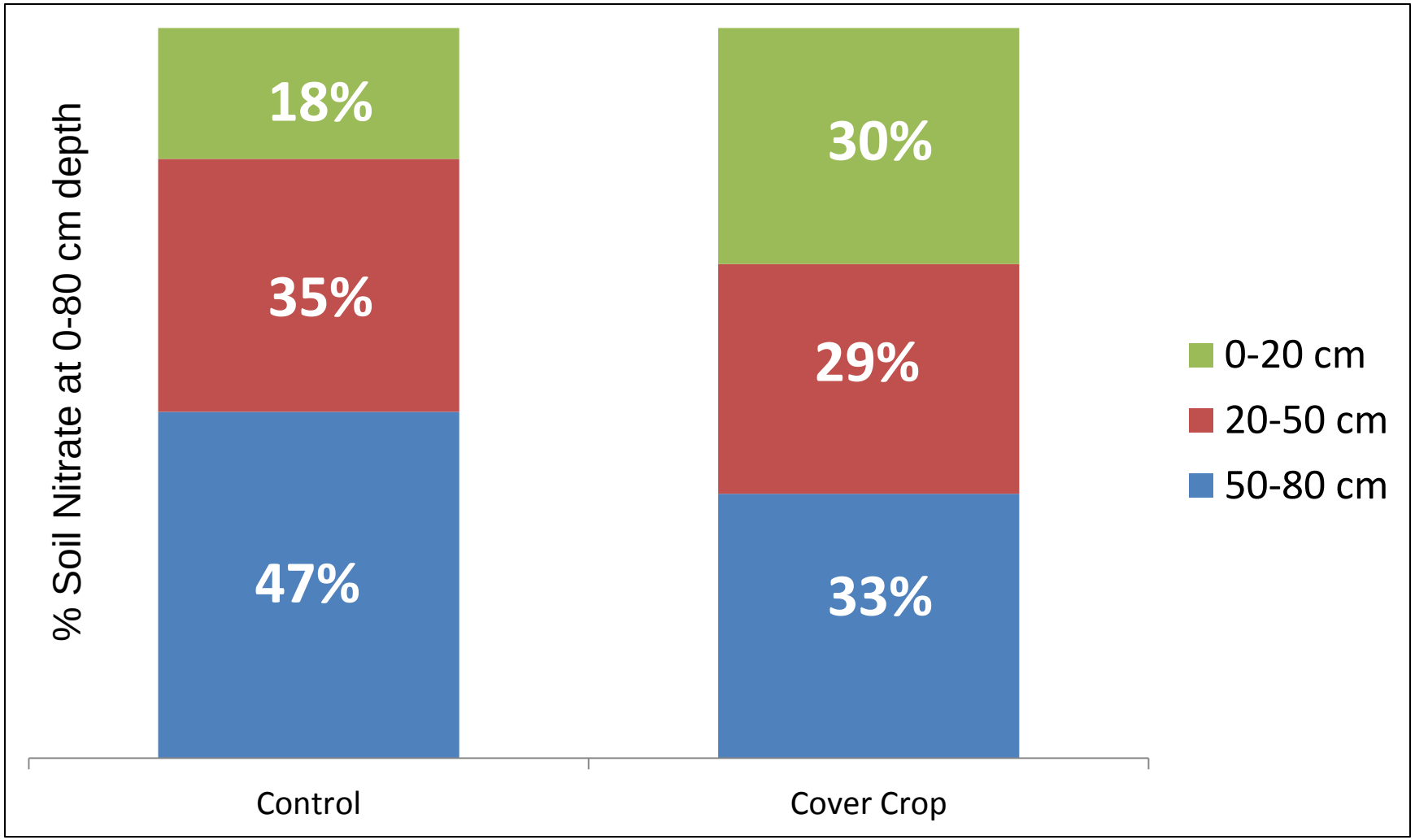
Cover Crop vs. Control Results- Year 2 Average



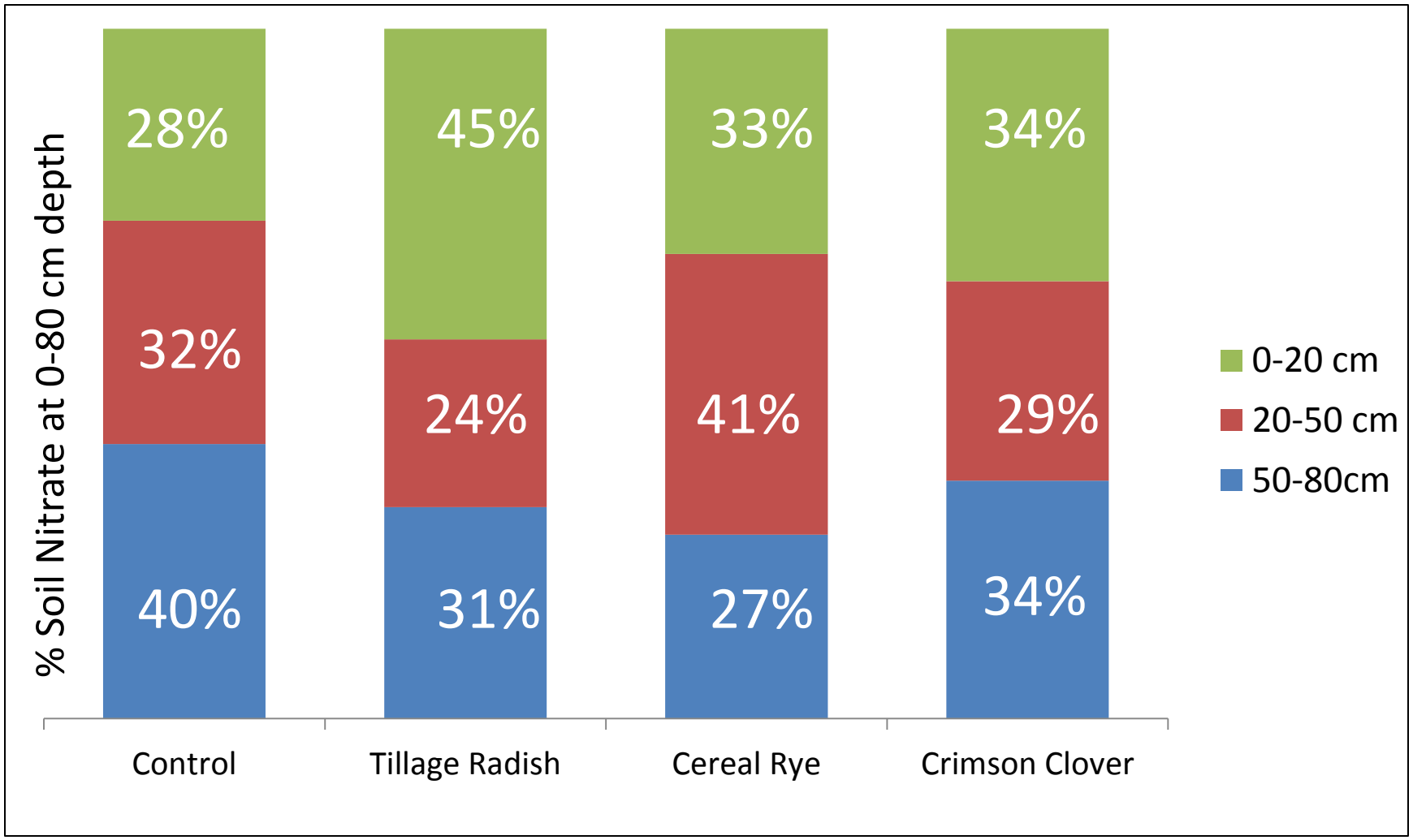
Specific Year 2 Averaged



Cover Crop Impact of Nitrate Distribution (2 year Average)



Cover Crop Impact of Nitrate Distribution (2 year Average)



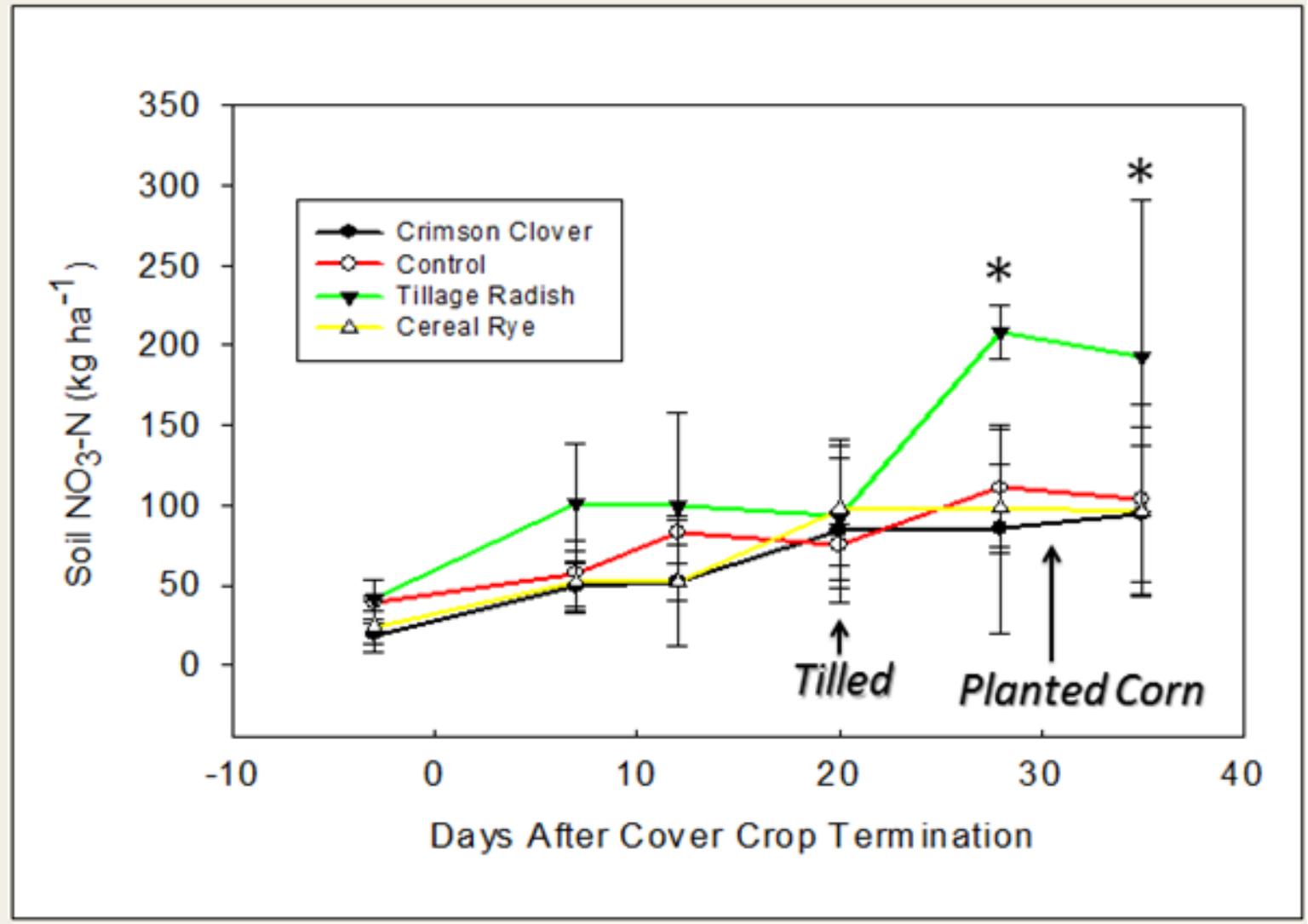
Method-Objective 2

Determine impact of cover crop species on the release of stabilized fall N to the spring cash crop.

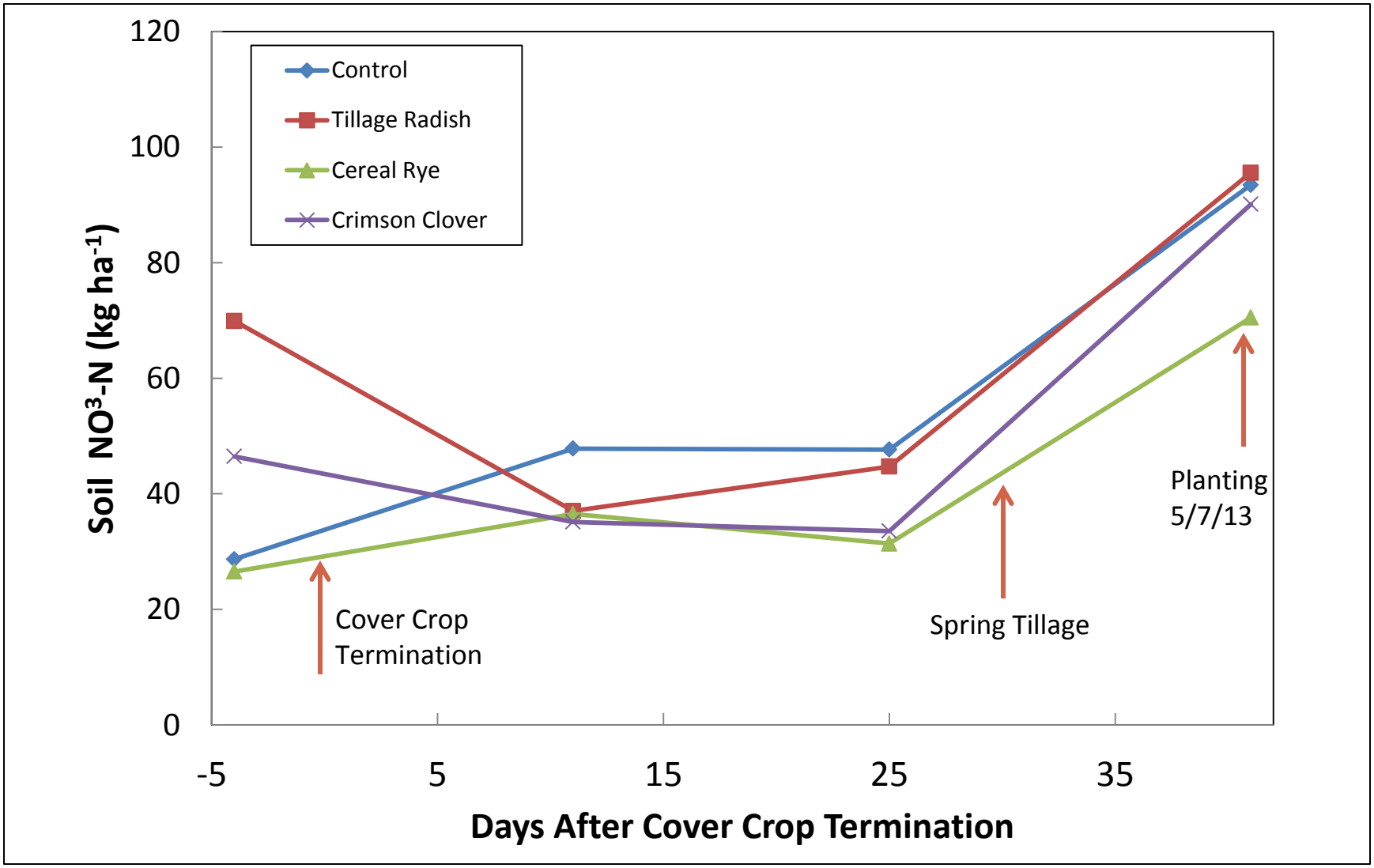
- Soil samples were collected immediately before cover crop termination and in weekly increments until 1 week after the planting date of corn.

- Soil samples were analyzed for NO_3-N.

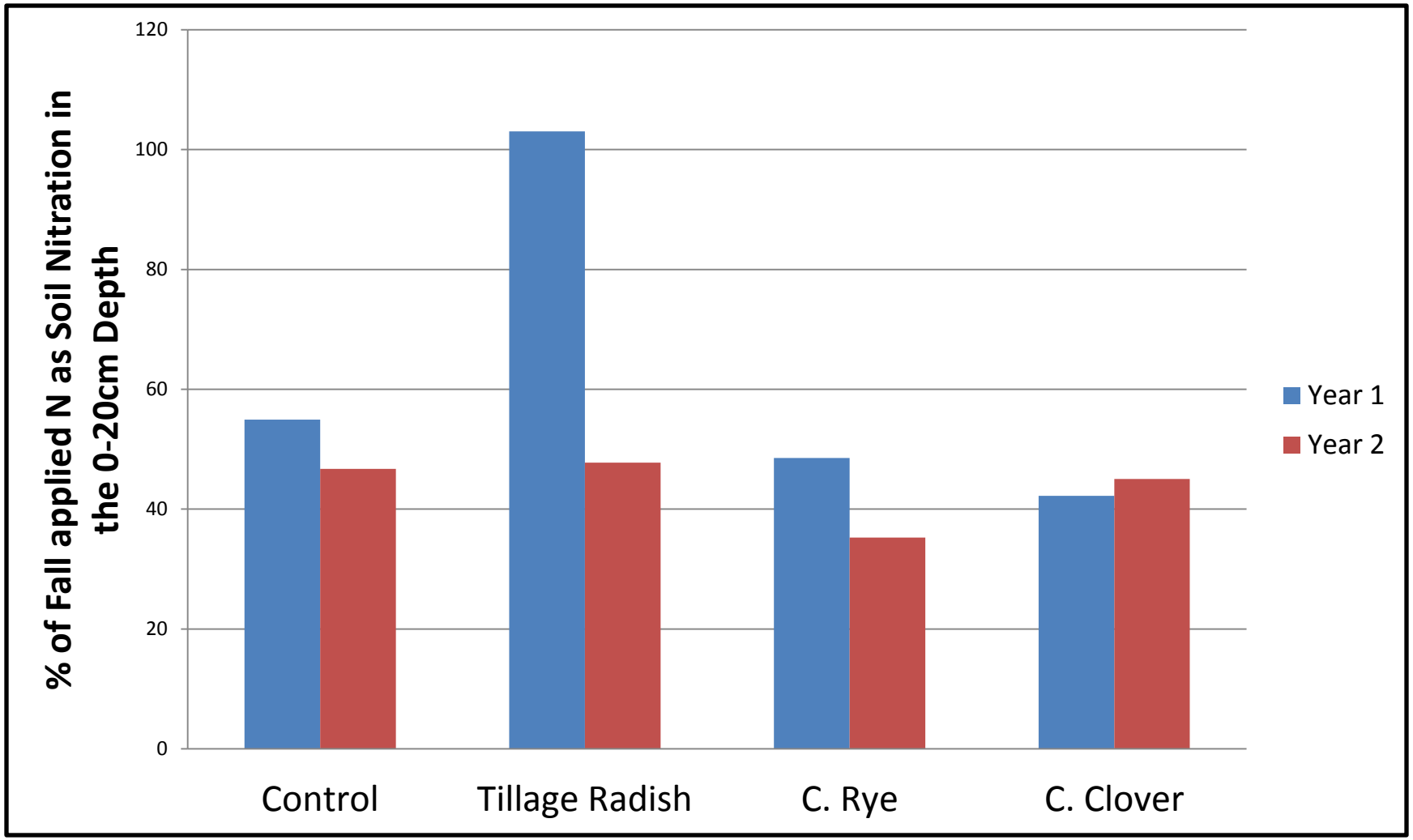
Results-Year 1
2011/2012



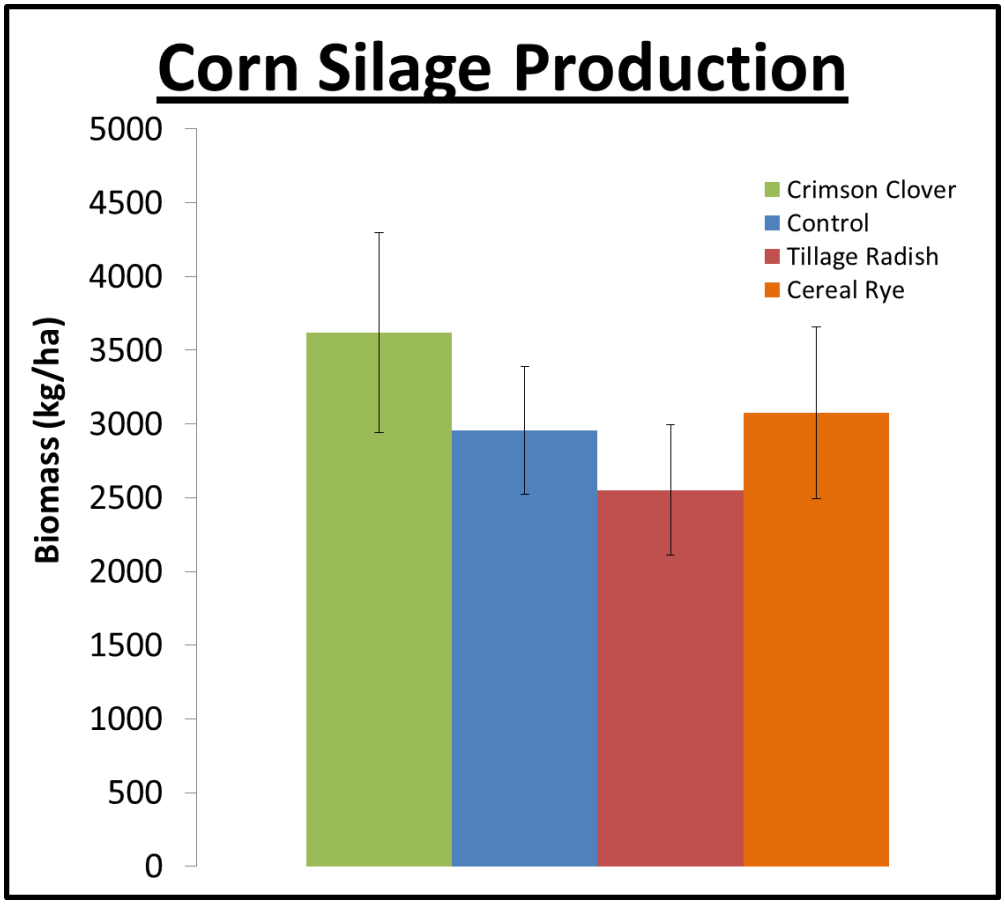
Results-Year 2
2012/2013



Nitrogen Released at Planting



Results- Year 1- 2011/2012



What did we learn?

Objective 1

- Tillage Radish and Cereal Rye were the only cover crops species that were able to absorbed the full rate of fall applied N.
- Fall application of N into a standing cover crop significantly reduces nitrate leaching. Cereal Rye>Tillage Radish>Crimson Clover
- Cover crops had no impact on corn silage production in the 2011/2012 growing season.

Objective 2

- Tillage Radish releases more fall applied N at planting relative Cereal Rye and Crimson clover.
- Extreme climatic conditions effect rate by which cover crops release fall applied N in the spring.
- The inclusion of Cover Crops into conventional cropping systems has the potential to increase the efficiency of fall applied N.