Cover Crops and Nitrogen Cycling

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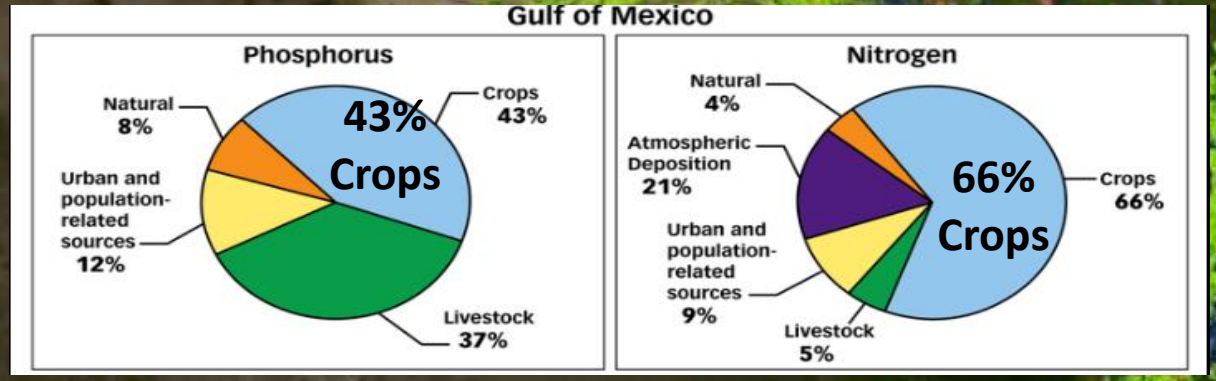
S.E.N.D. Soil Ecosystem and Nutrient Dynamics

https://ag.purdue.edu/agry/armstrong-sendlab/

Re-emergence of Cover Crop Adoption

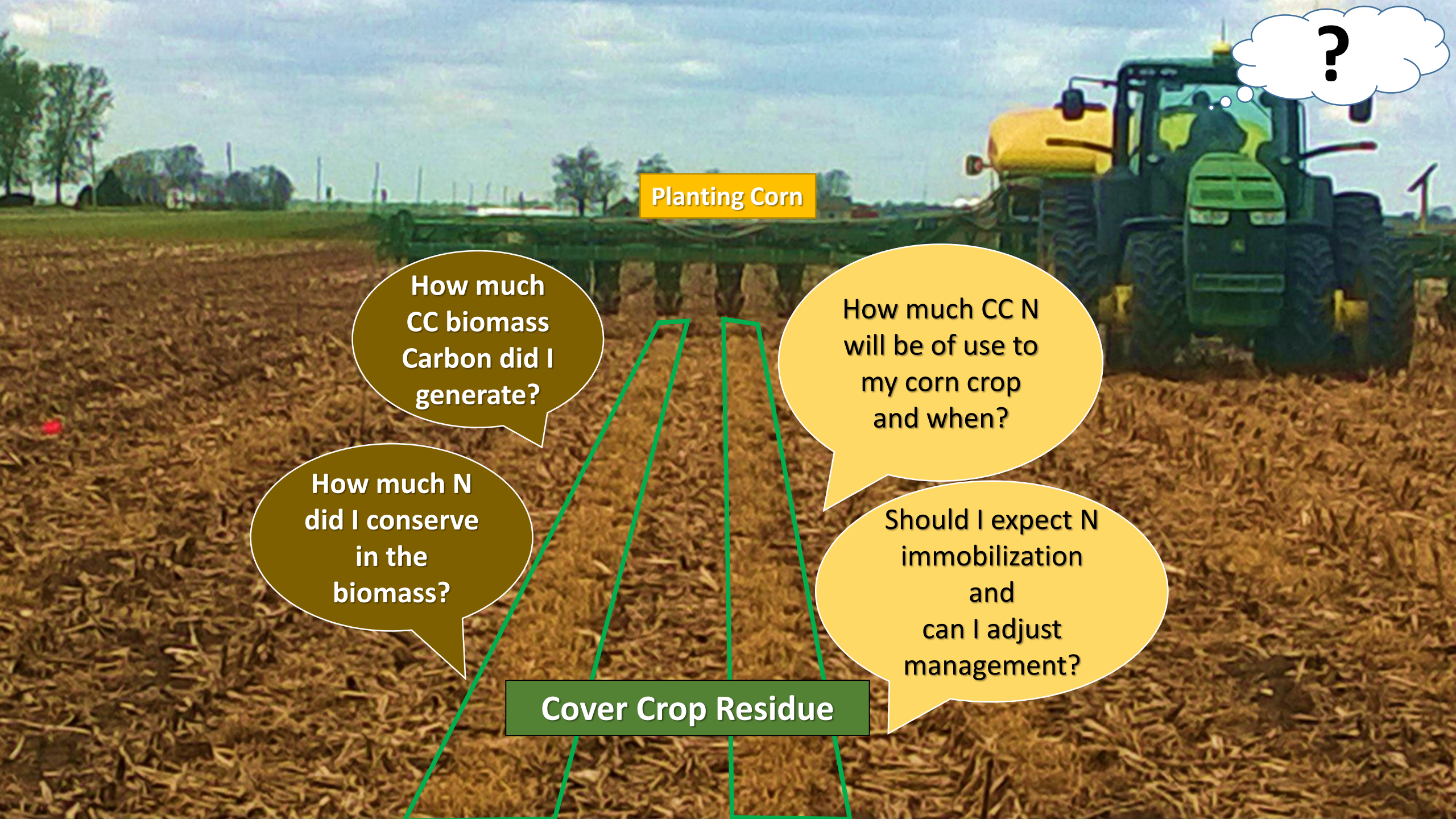
Nationally: 133% increase in cover crop acres nationally since 2011 in the U.S.

Nutrient Loss Reduction



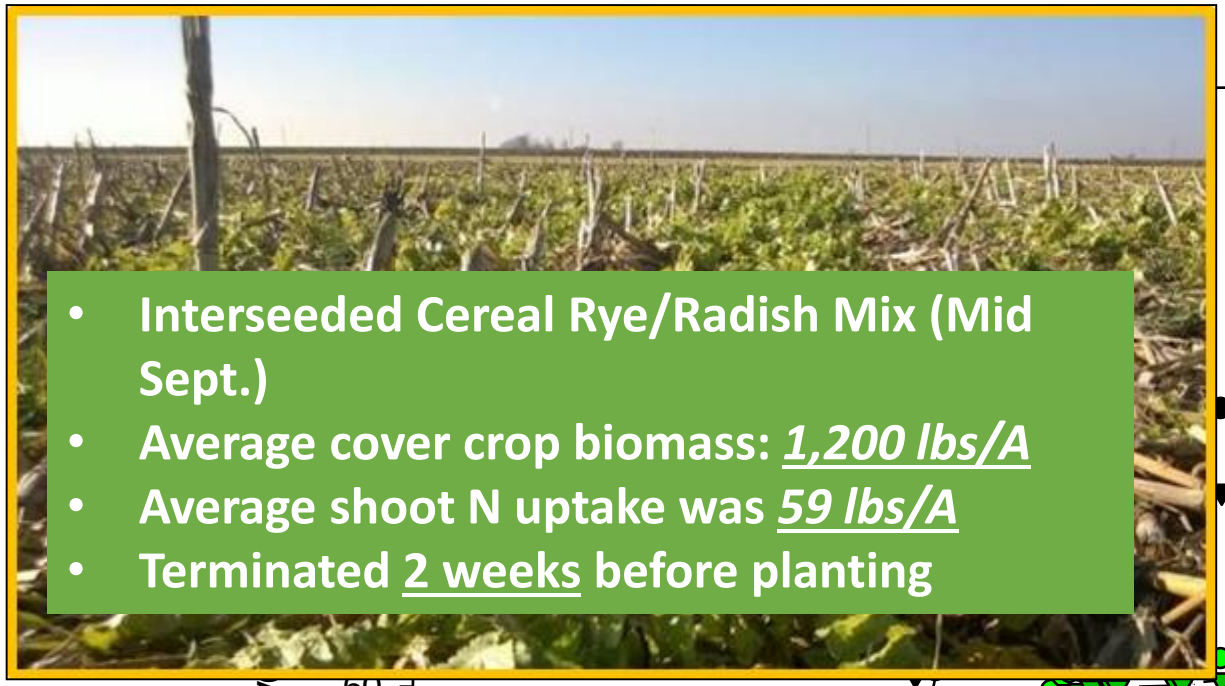
Soil Health

<5% of row crop acres receives cover crops


?
Planting Corn
How much CC biomass Carbon did I generate?
How much CC N will be of use to my corn crop and when?
How much N did I conserve in the biomass?
Should I expect N immobilization and can I adjust management?
Cover Crop Residue

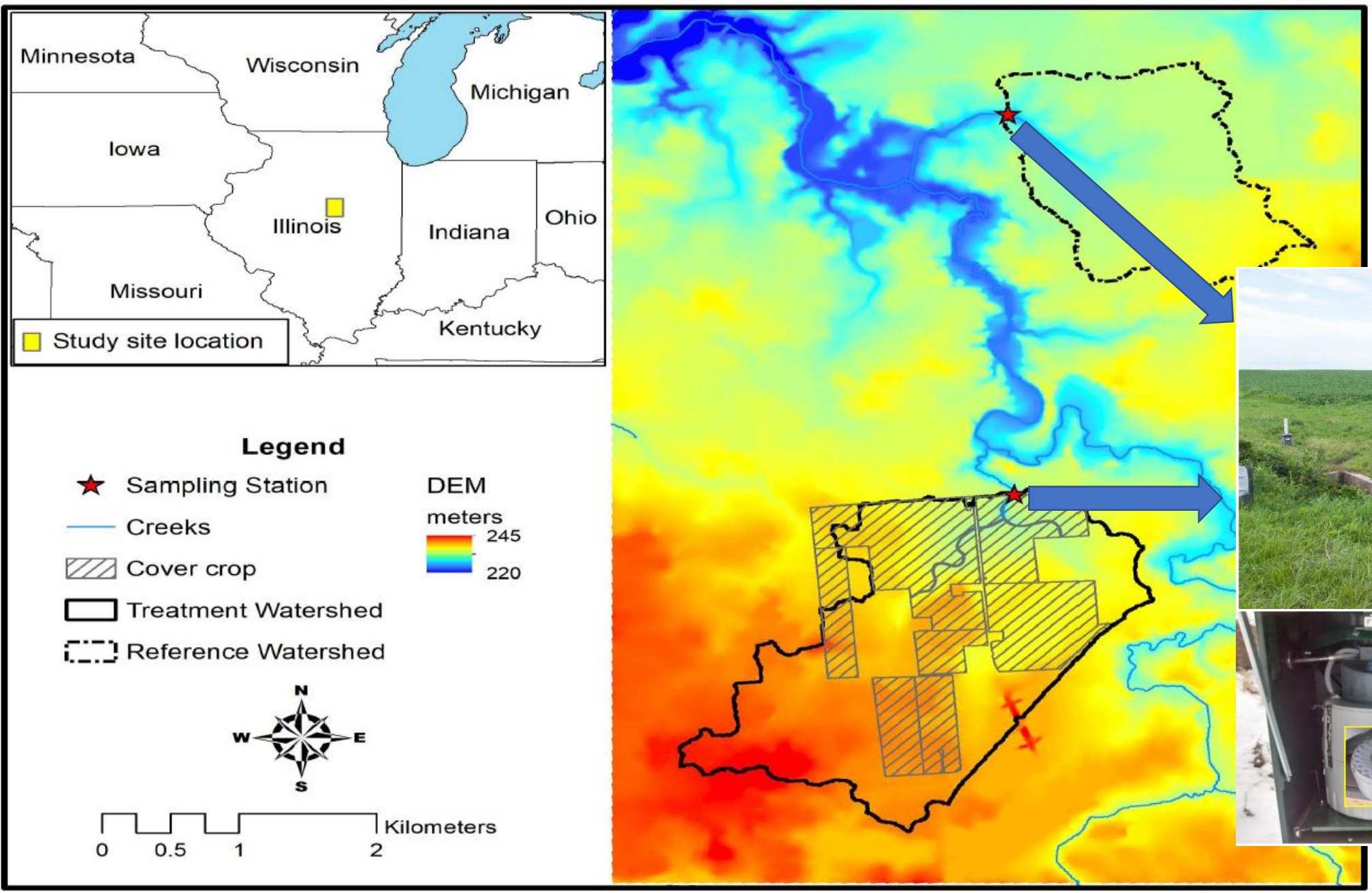
No Question about Cover Crops and Water Quality

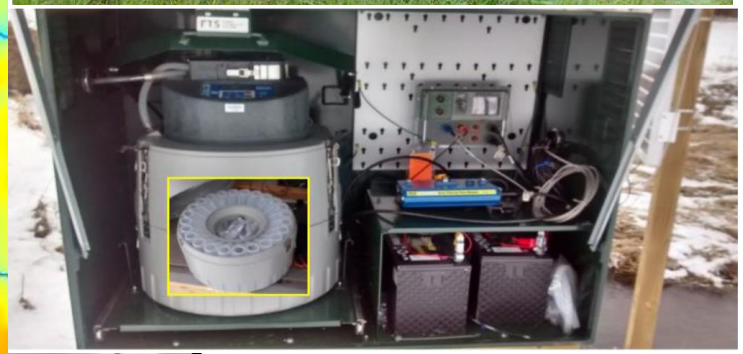
Water Quality Impacts: 4R + Cover Crops

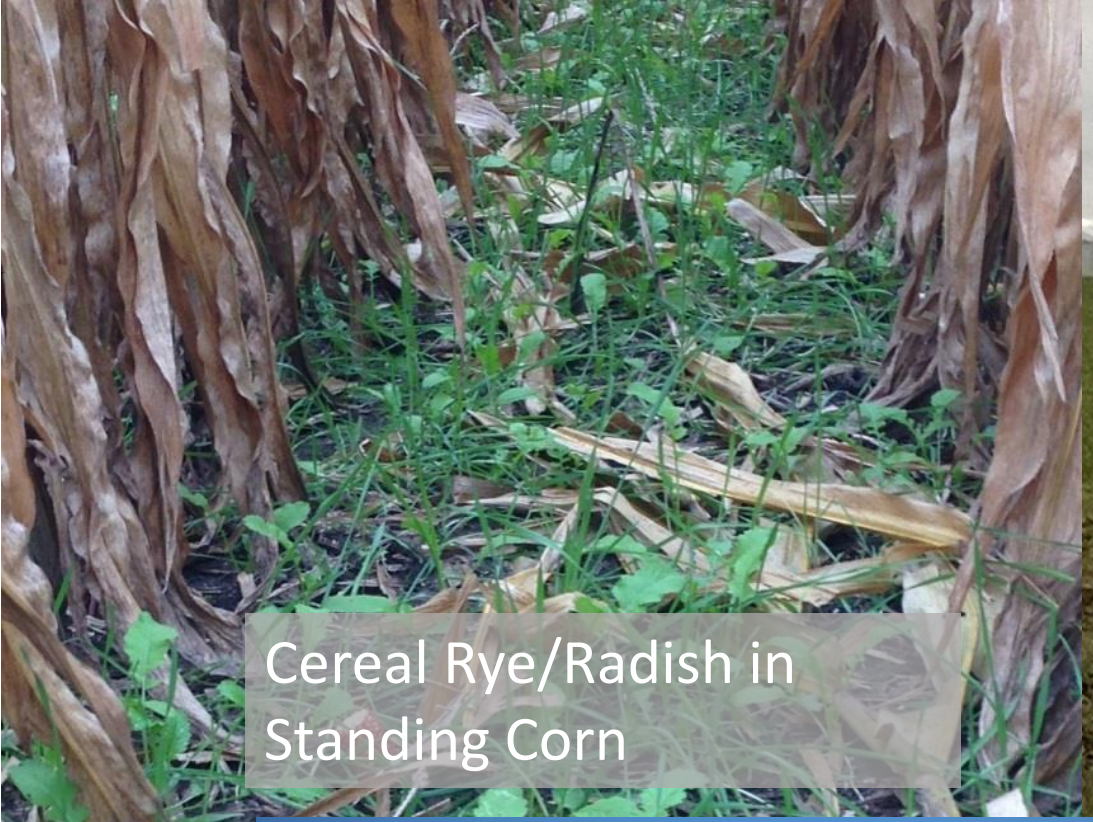


- Interseeded Cereal Rye/Radish Mix (Mid Sept.)
- Average cover crop biomass: *1,200 lbs/A*
- Average shoot N uptake was *59 lbs/A*
- Terminated 2 weeks before planting

Ruffatti et al. (2018) Agricultural Water Management 211:81-88.


Minnesota
Wisconsin
Michigan
Iowa
Illinois
Indiana
Ohio
Missouri
Kentucky
Study site location
Legend
Sampling Station
Creeks
Cover crop
Treatment Watershed
Reference Watershed
DEM
meters
245
220
N
W
E
S
0
0.5
1
2
Kilometers



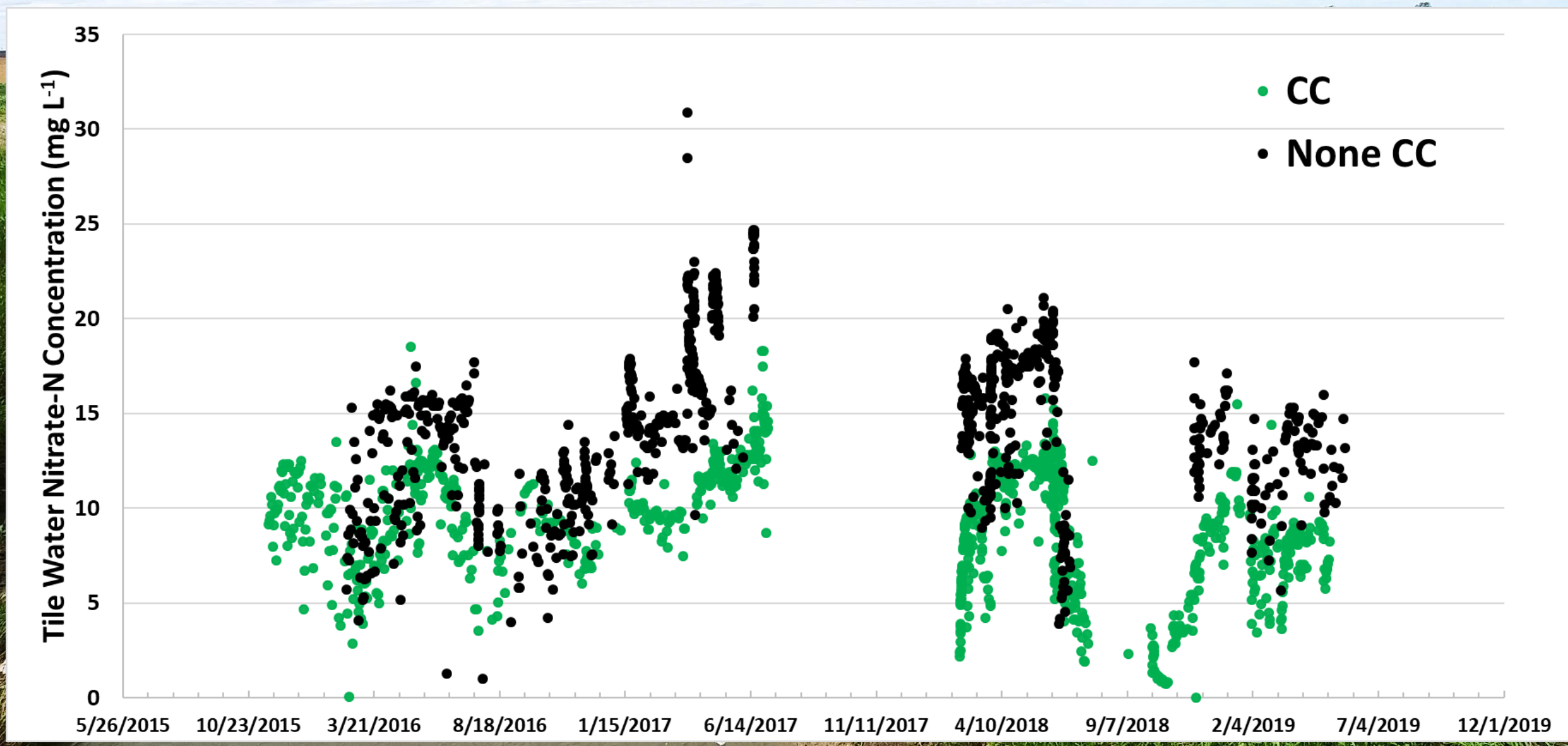


Cereal Rye/Radish in Standing Corn

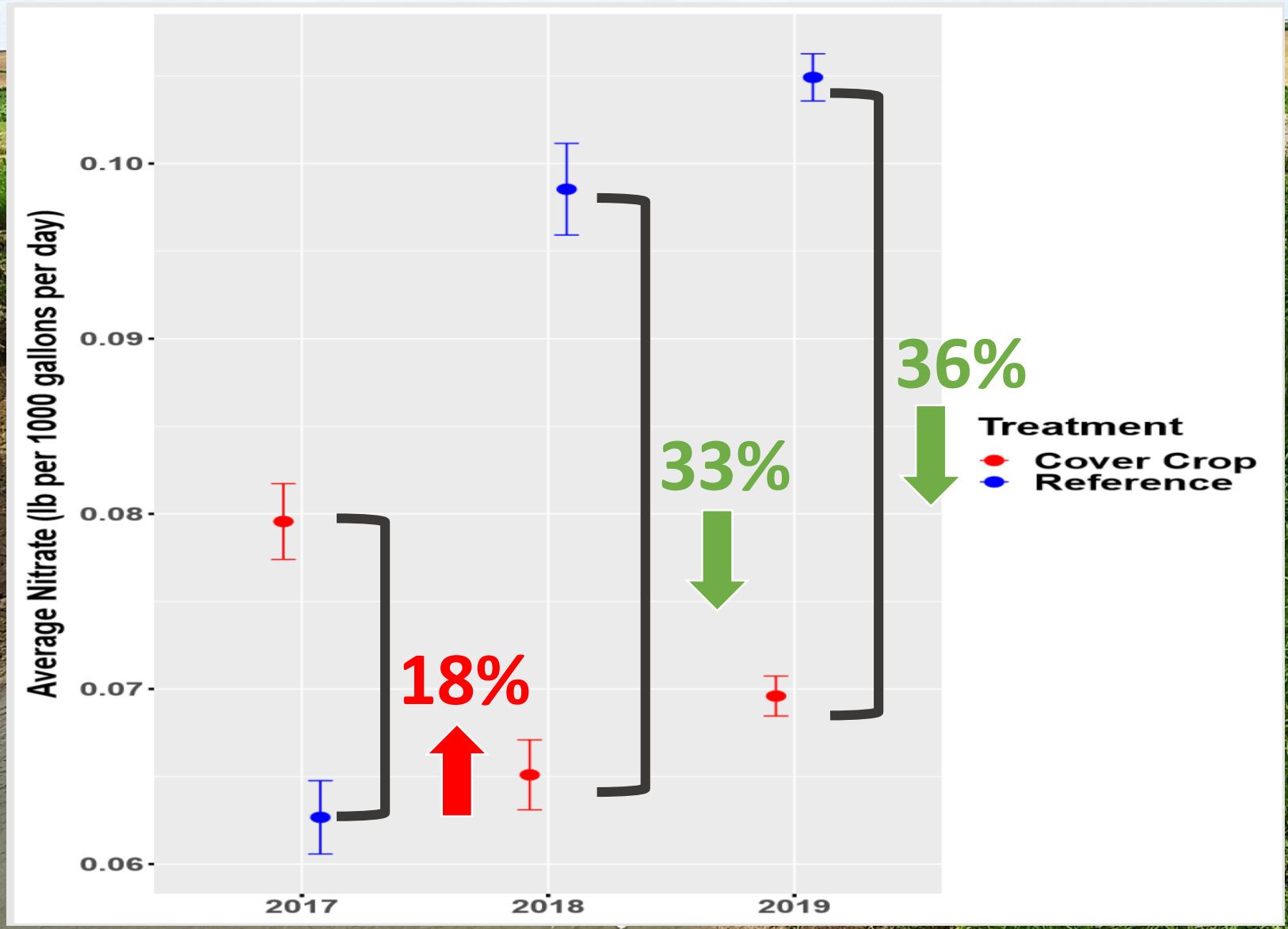
Radish/Oats in Soybean Residue

Cereal Rye/Radish in Corn Residue

Watershed Impact of Mass Cover Crop Adoption

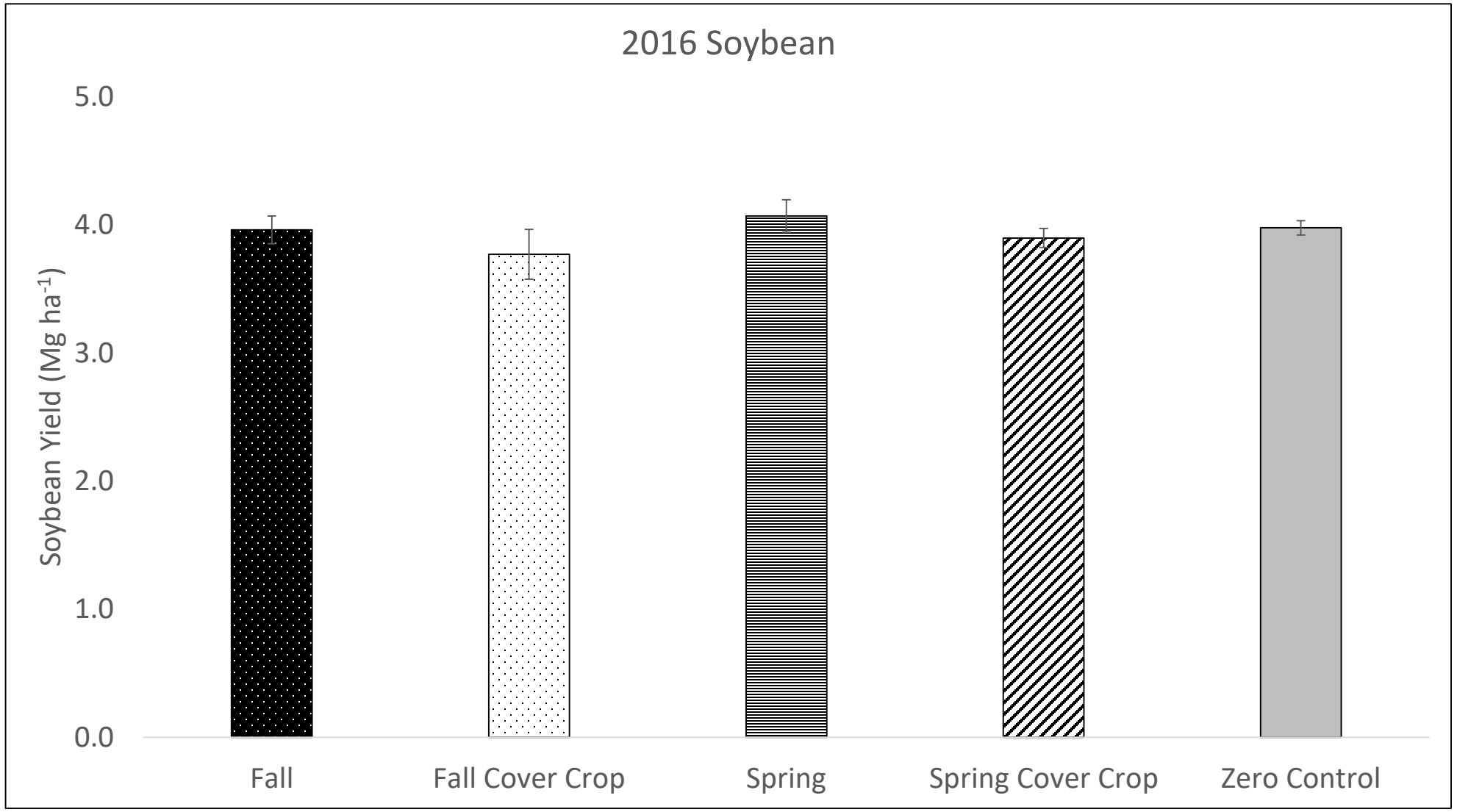


Watershed Impact of Mass Cover Crop Adoption

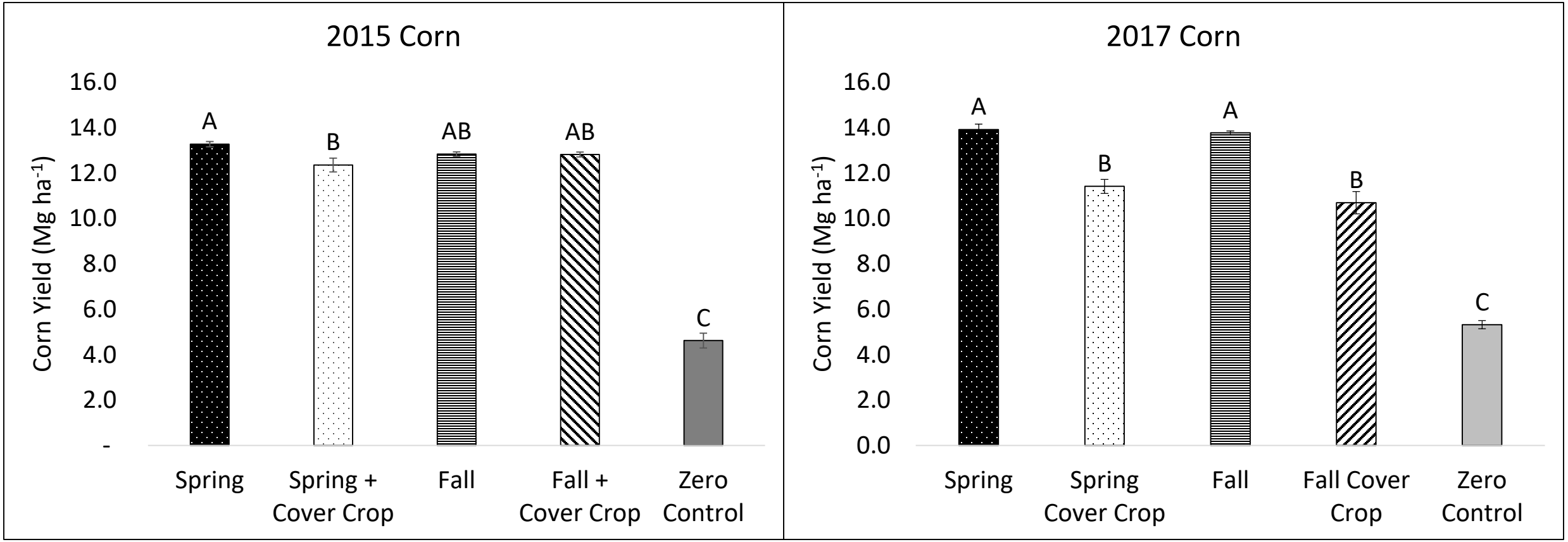


Cereal Rye Impacts on Cash Crop Yield

Soybean Yield



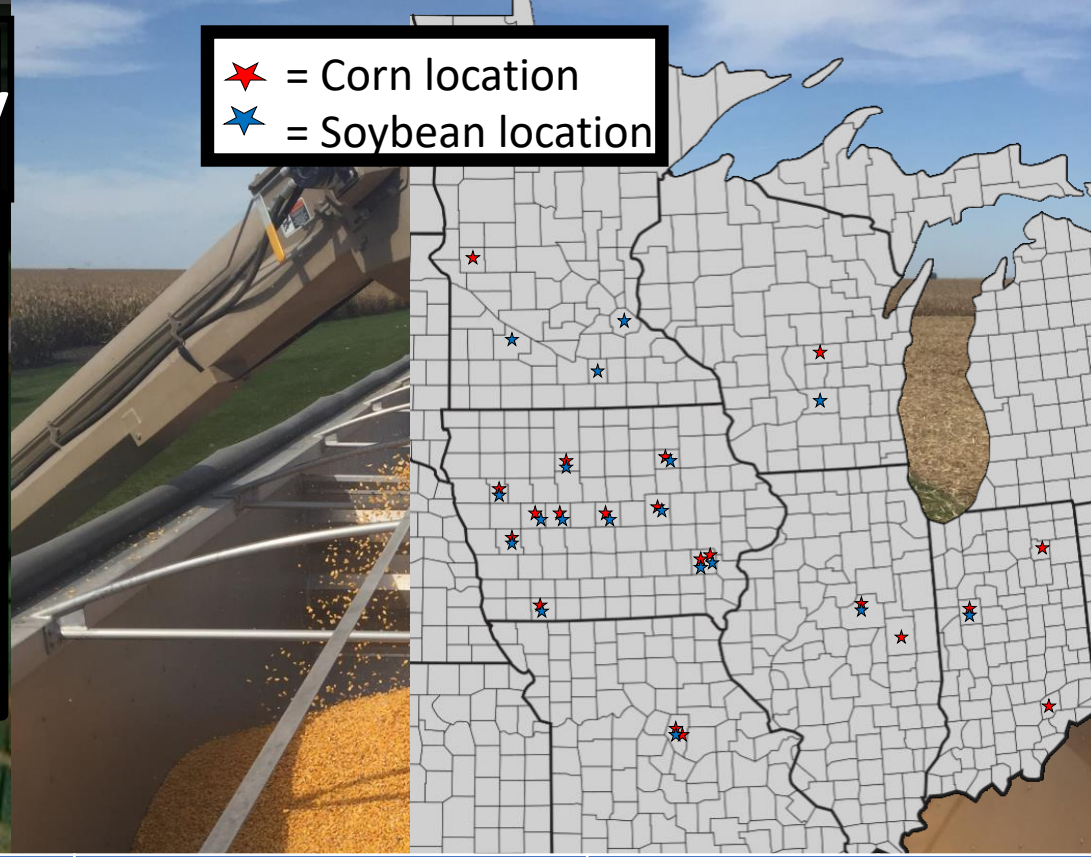
Corn Yield



***Corn following cereal rye with no starter N applied**

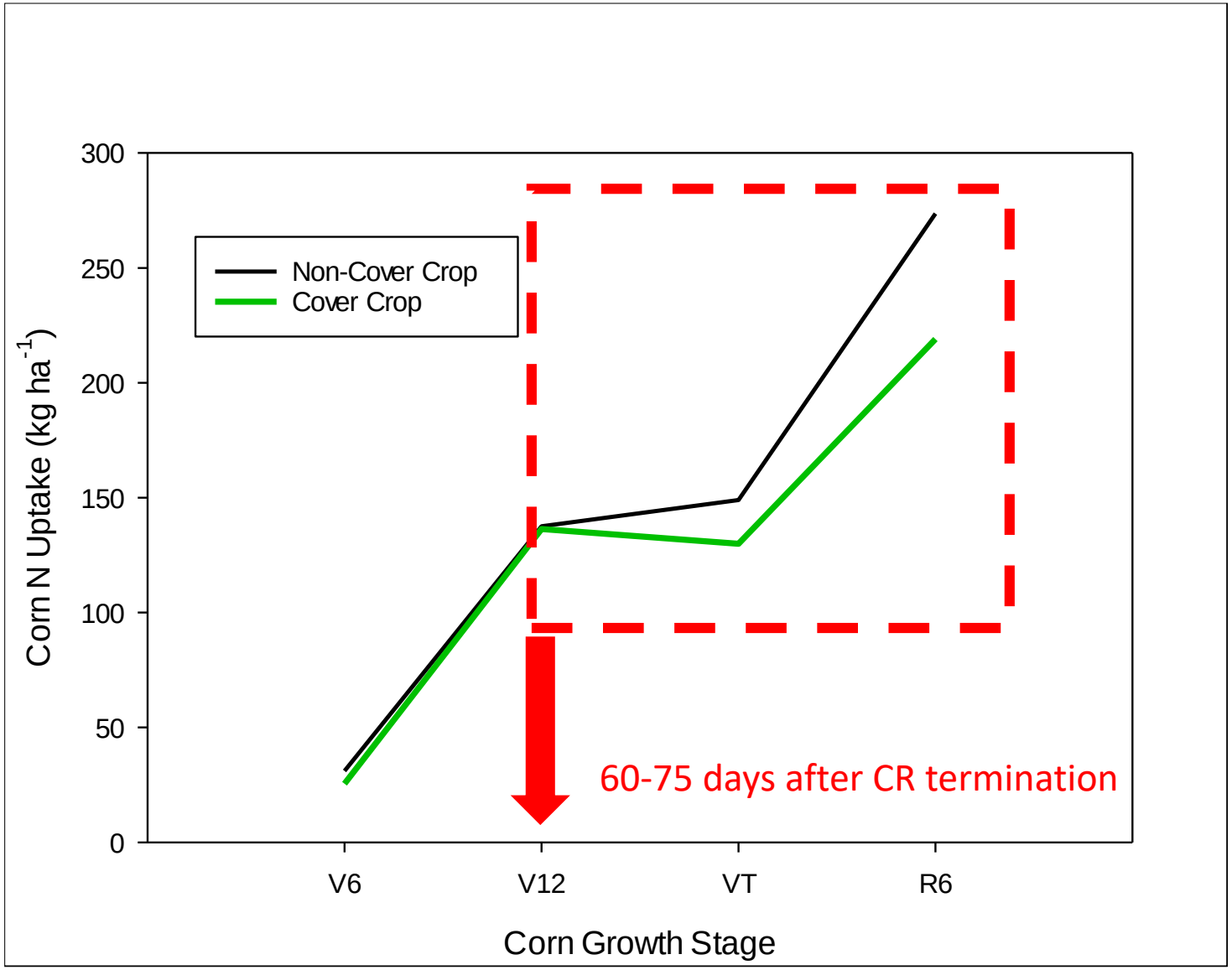
Regional CR-Cash Crop Yield Study

- 773 Total **Paired** Observations from **24** different Experimental Sites
  - **430** Corn **Paired** observations from 20 Experimental sites
  - **343** Soybean **Paired** observations from 18 Experimental Sites

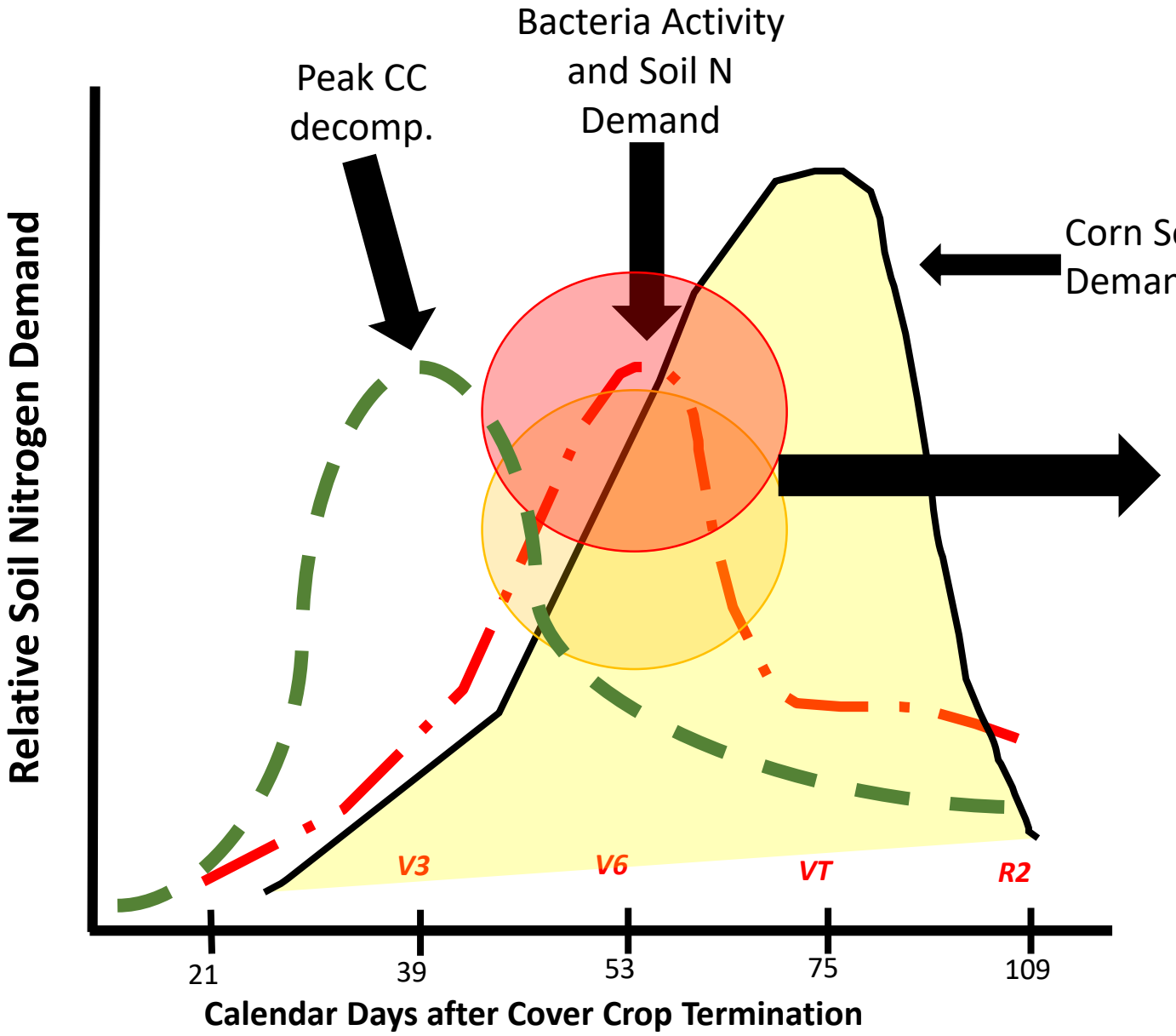


Crop	Treatment	Yield Mg ha^{-1} (SE)	Average Δ Yield Control – Cereal Rye	P-value
Corn N= 430 pairs	Control	9.6 (0.183)	6% (10 bu/A)	<0.00001
	Cereal Rye	9.0 (0.162)		
Soybean N= 343 pairs	**Control**	**3.1 (0.049)**	**6% (3 bu/A)**	**<0.00001**
	Cereal Rye	**2.9 (0.035)**		

Cereal Rye Impact on Corn N Uptake



Soil N Demand Synchrony



Soil N demand synchrony between the soil microbiome and corn that occurs approximately 53-65 days after cover crop termination.

Nevins et al. (2018) Soil Biology and Biochemistry

Cereal Residue Nitrogen Tracking N Study

Research Objectives:

- Use 15N techniques to measure the amount of cover crop residue N that is utilized by the subsequent corn and soybean crop.
- Use 15N techniques to quantify the fate of cover crop N.

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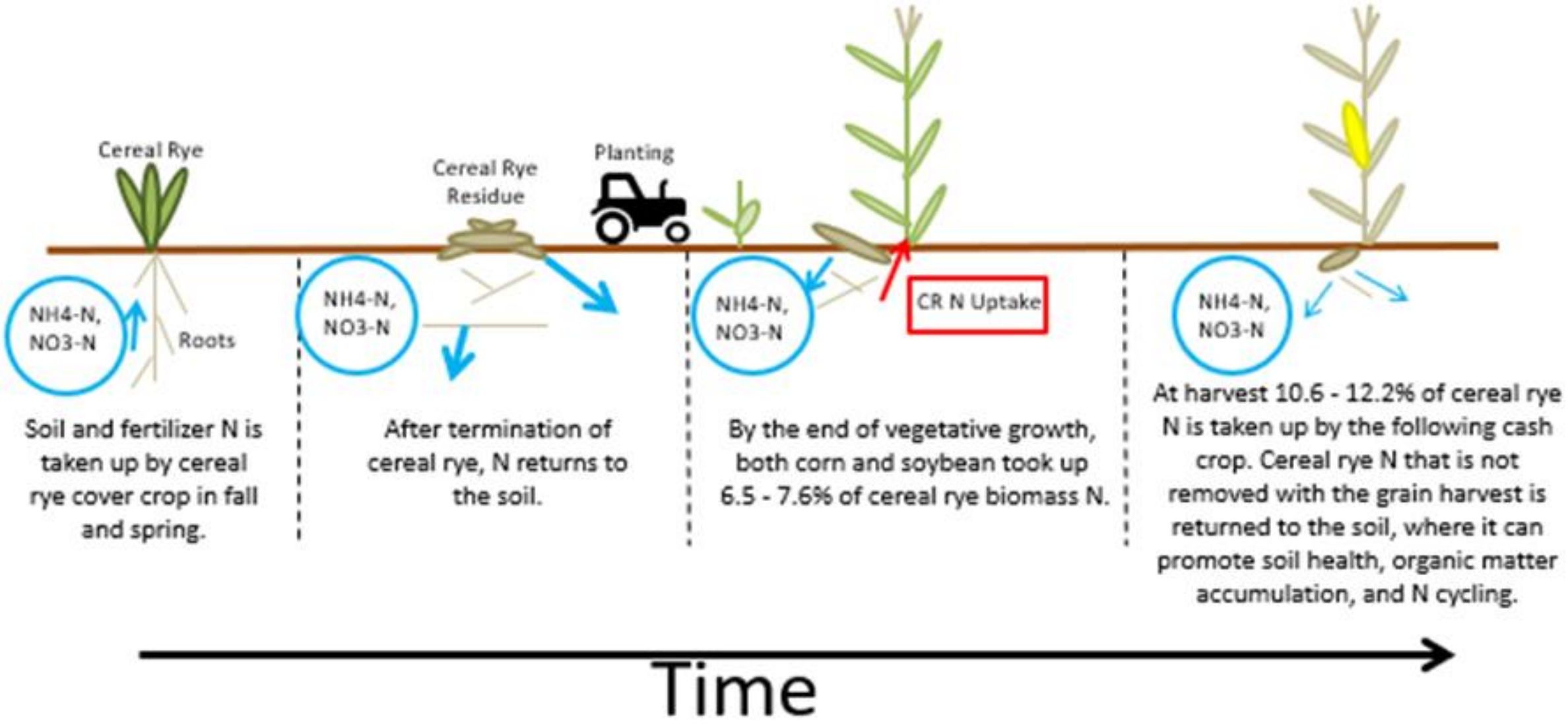
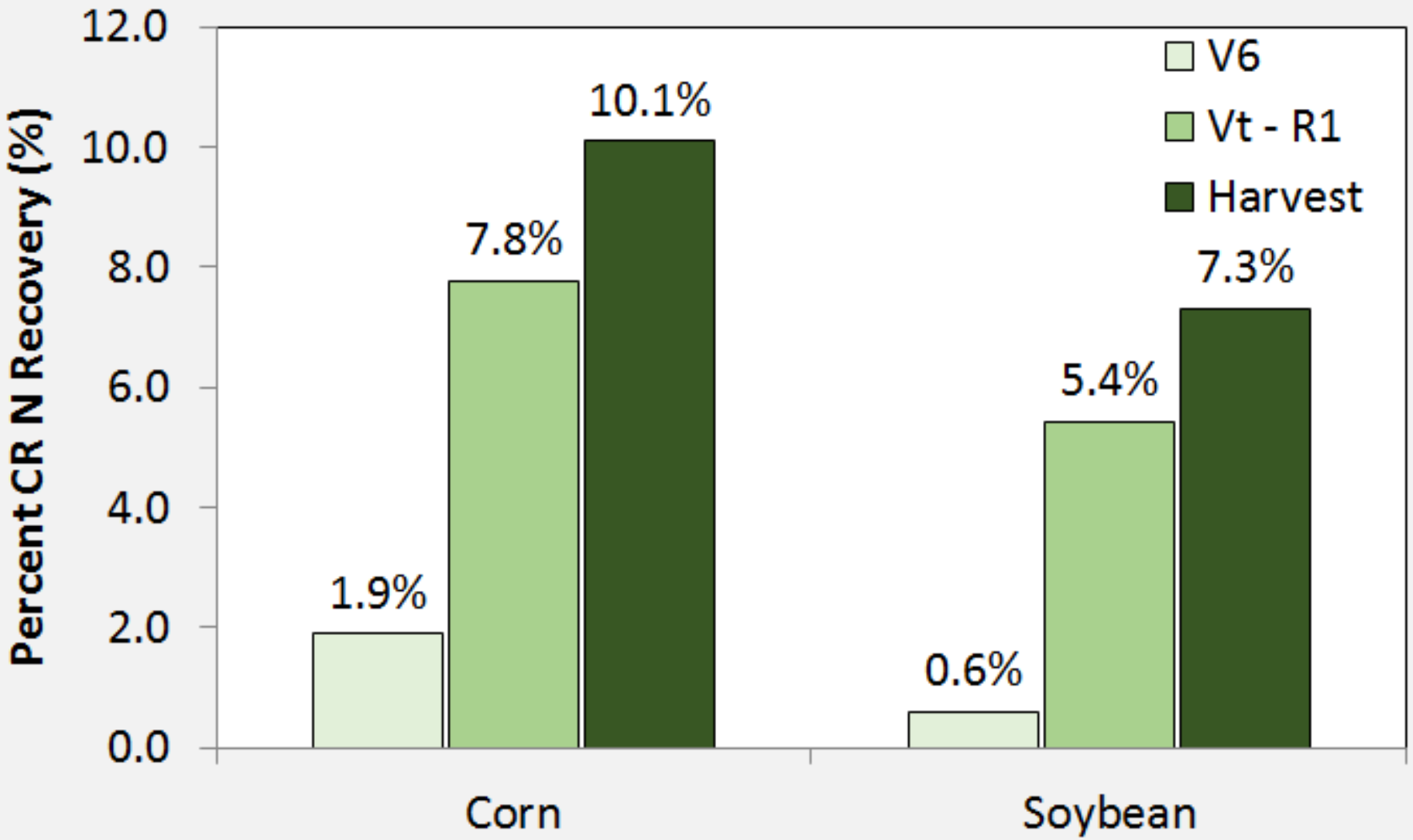
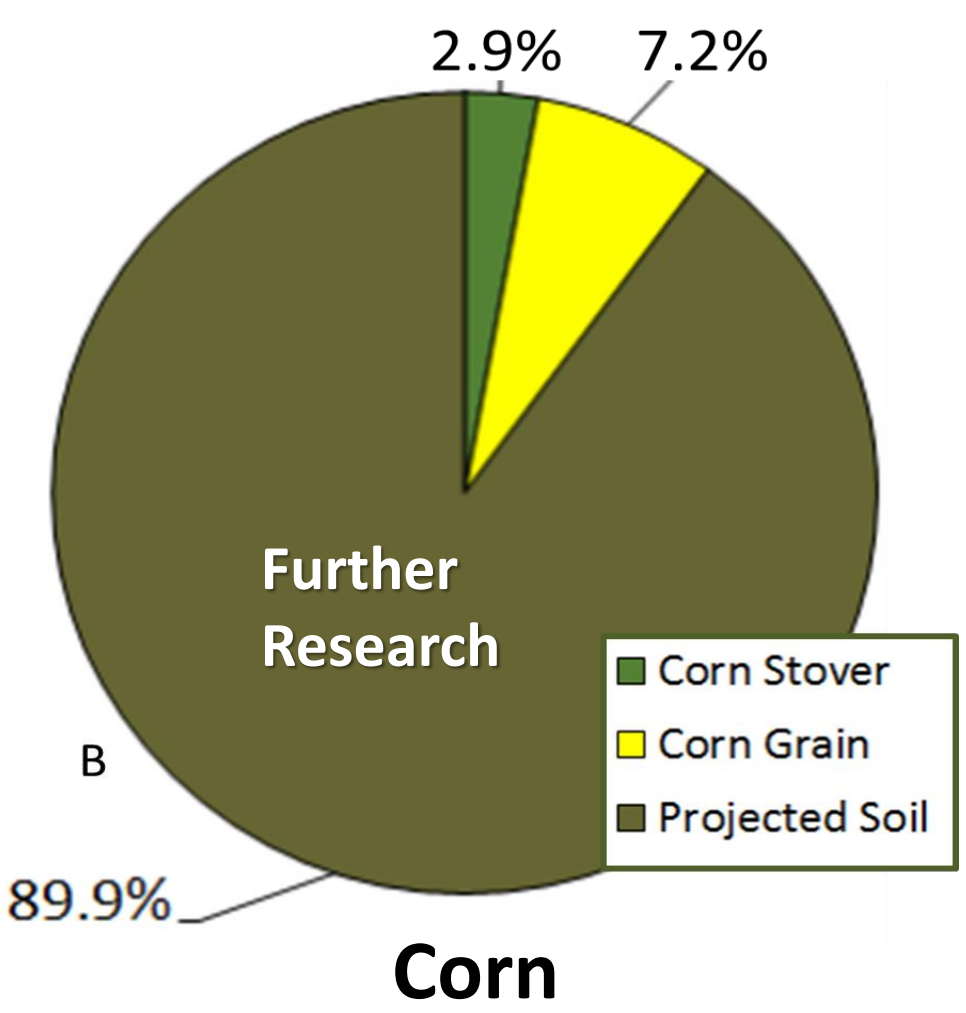
Cereal Residue Nitrogen Tracking N Study



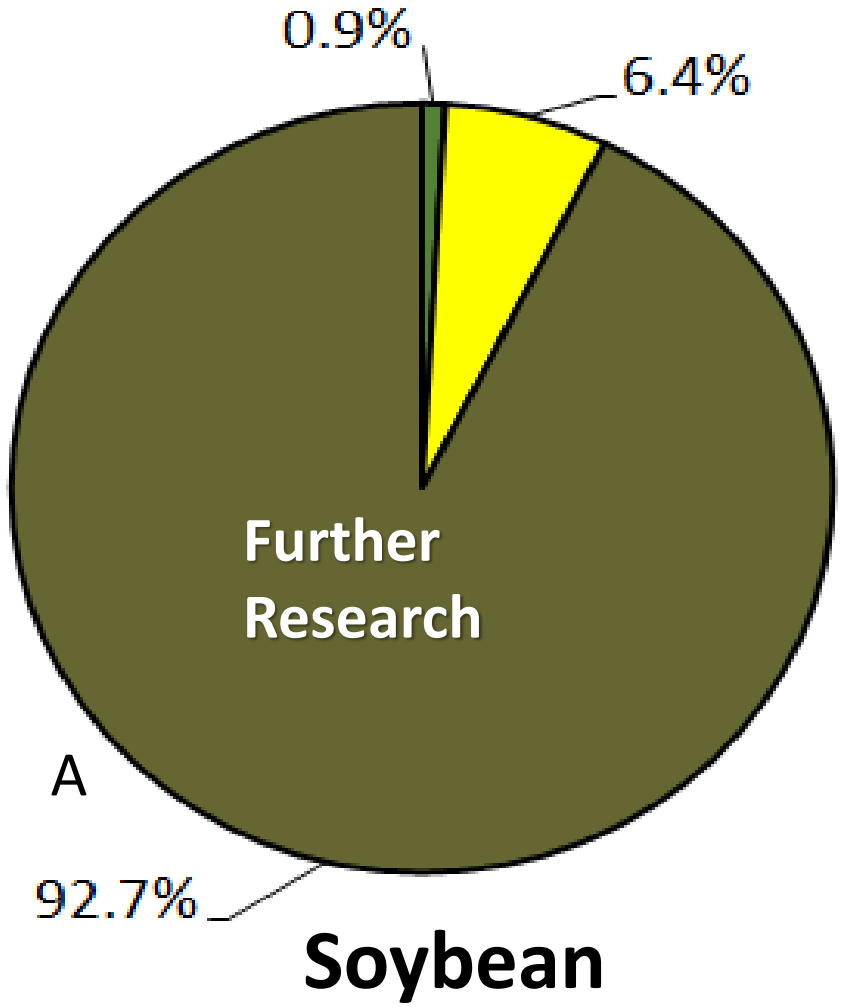
Cereal Rye (CR) Nitrogen Recovery in Corn and Soybean



Partitioning of Cereal Rye Biomass N Recovery

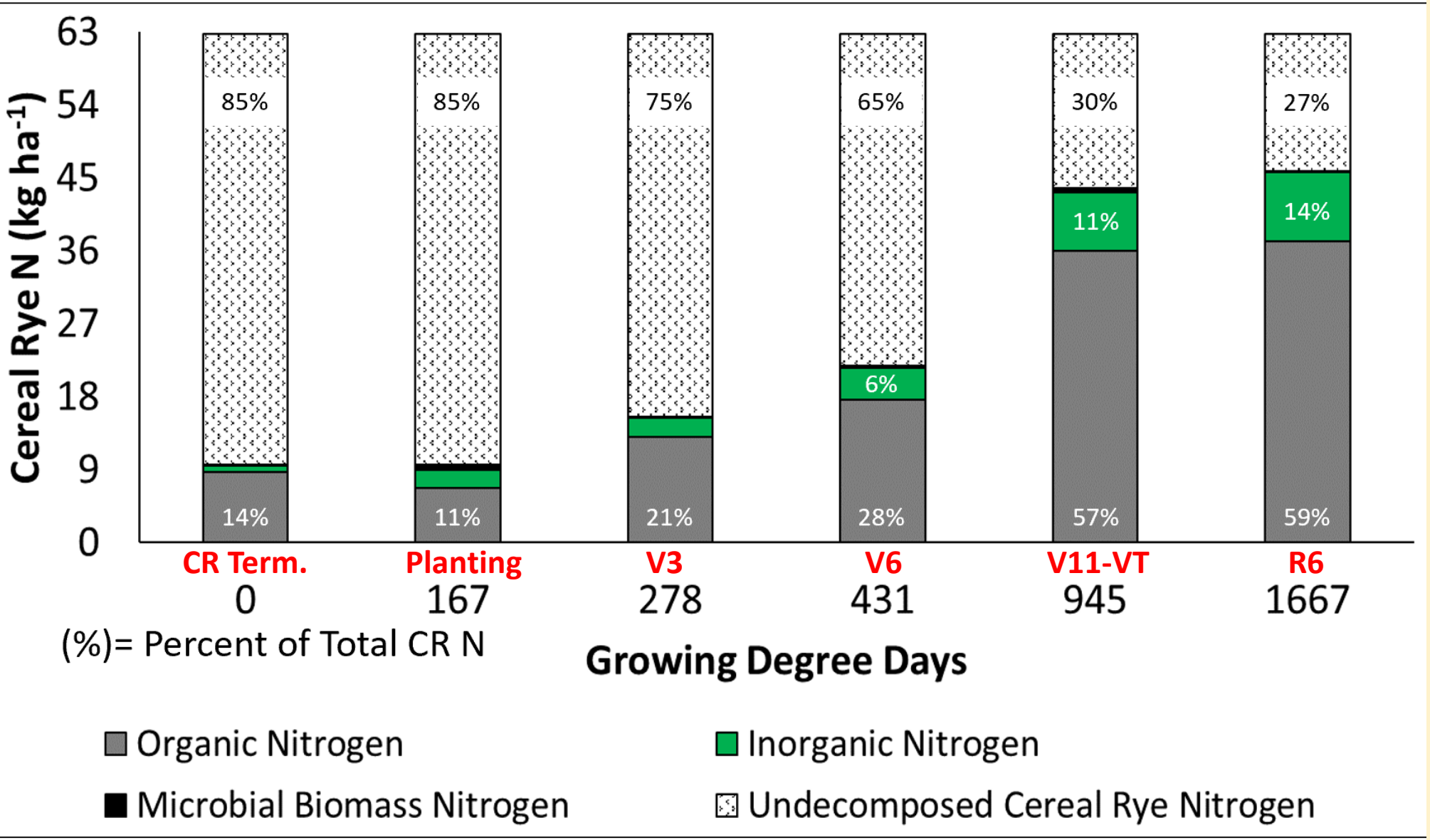


Corn



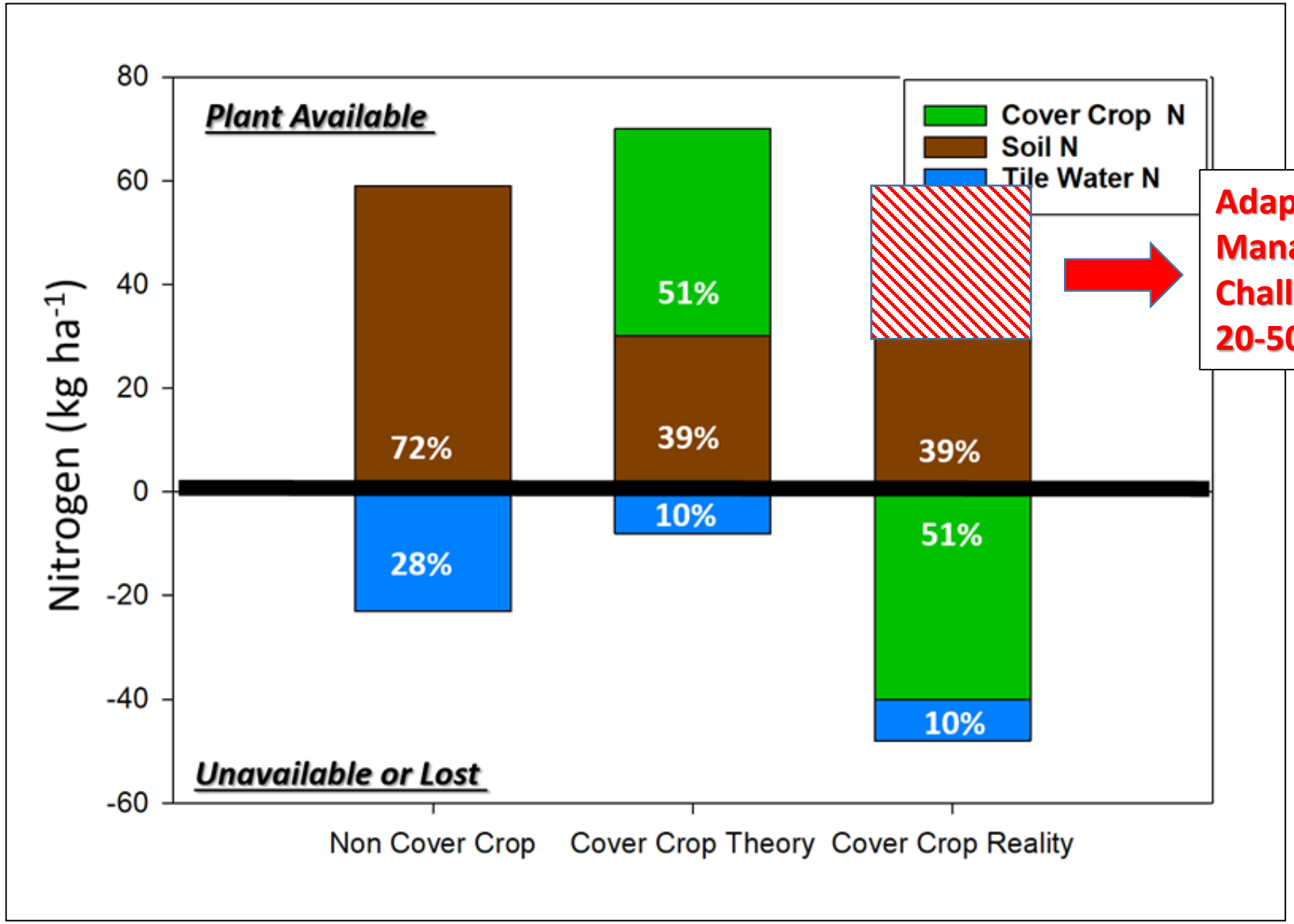
Soybean

Distribution of CR Residue N Following Termination



- The major release of CR residue N comes during the reproductive growth of corn.
- At R6, only 14% of CR residue N is released.
- At R6, the largest pool of CR N was in the organic form of N.

Changes in Nitrogen Availability During the Life Cycle of Cereal Rye



Optimization of Starter N Fertilizer for Corn following Cereal Rye

Houston Miller, Shalamar Armstrong,

James Camberato, and Robert Nielsen.

Objectives

Determine the optimal starter fertilizer N rate for corn following CR adoption to achieve competitive yield.

Cereal Rye Season

09/26/2017 - 10/18/2017
CR planted at 67 kg ha^{-1}

CR combustion analyzed for total biomass, carbon, and nitrogen (N).

Soil Sampling at planting.
30 cm depth.

5/9/2018 – 5/25/2018 Corn Planting
79,072 seeds ha^{-1}

4/13/2018 - 5/7/2018
CR sampling
- Two 1/4m^2 squares from each plot.

CR termination
- Chemical termination combination of glyphosate and saflufenacil.

Corn Season

Population, Growth Stage (# of leaf collars), and N uptake.

Corn residue combustion analyzed to determine total corn N uptake. Using Flash 2000.

V3 | V6 | V7 | V11 | R1-R2

V2
- Disease
- Population
- Growth Stage
- N uptake

Sidedress application Injection.

NRE calculation.
NRE = ((NUF)-(NUC) / R) *100
(Kovacs et al., 2015)

R6
- Nitrogen Recovery Efficiency (NRE)
- N uptake
- Grain Yield

Field-scale equipment Harvest Monitor used for yield analysis.

Cereal Rye

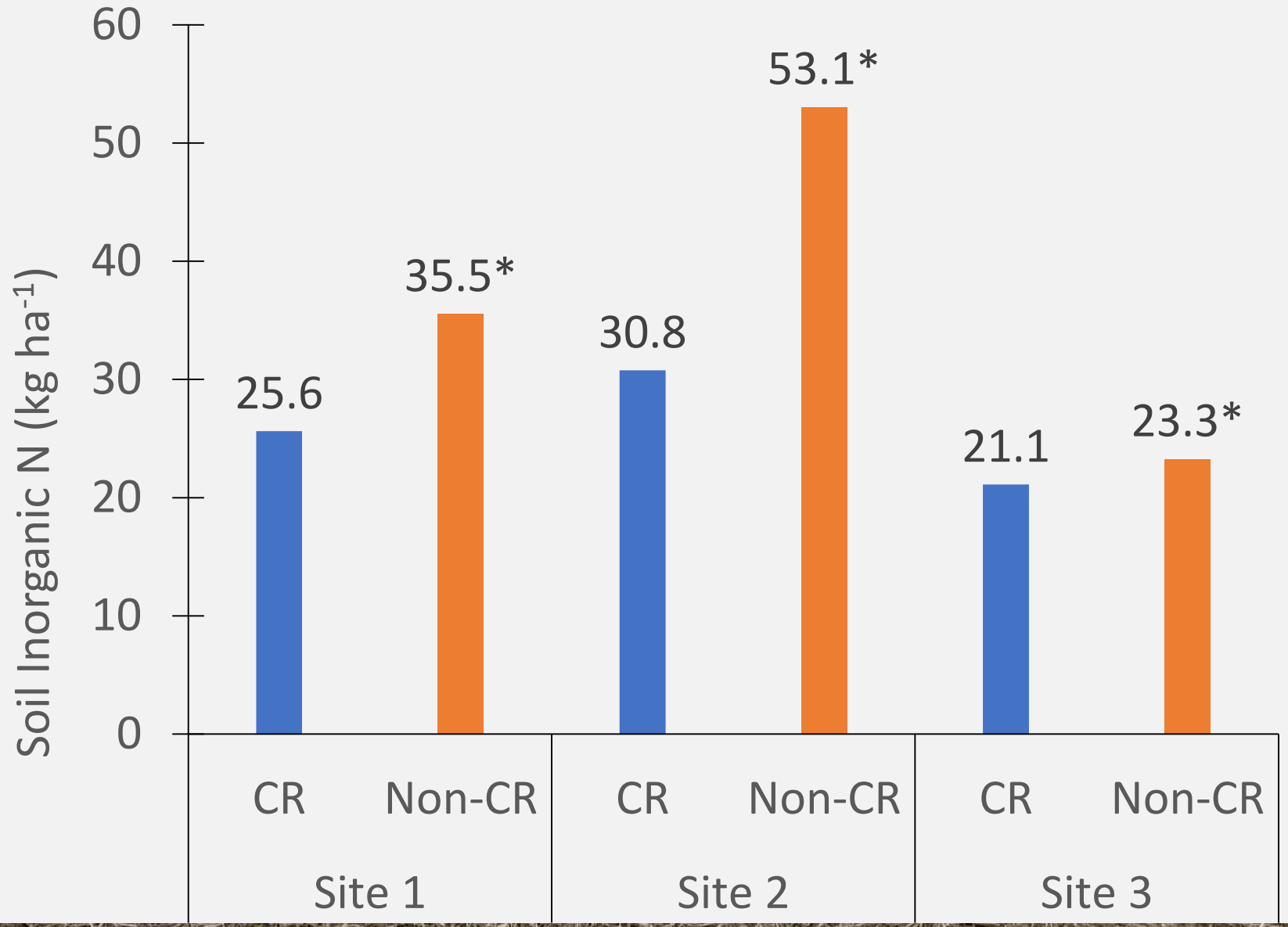
Site	Biomass (kg ha^{-1})		N uptake (kg ha^{-1})		C uptake (kg ha^{-1})		C:N ratio
1	1075.58	B	22.97	B	414.58	B	18.05
2	1083.41	B	19.77	B	414.42	B	20.96
3	1453.61	A	33.65	A	563.32	A	16.74

N- Nitrogen
C- Carbon
C:N- Carbon to Nitrogen ratio.

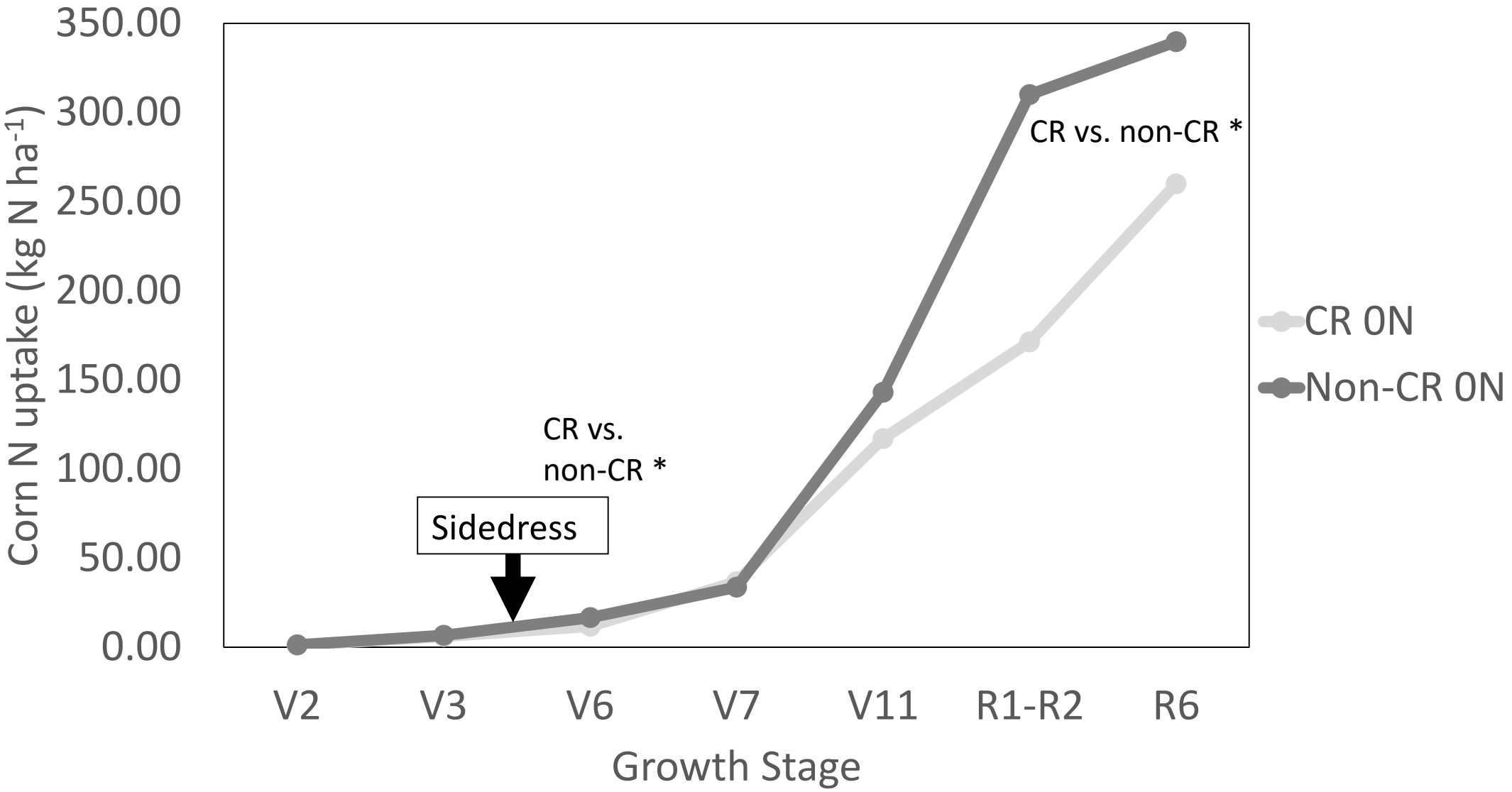
*significance between sites are indicated by a different capital letter.

Average CR biomass = 1200 (kg ha^{-1})

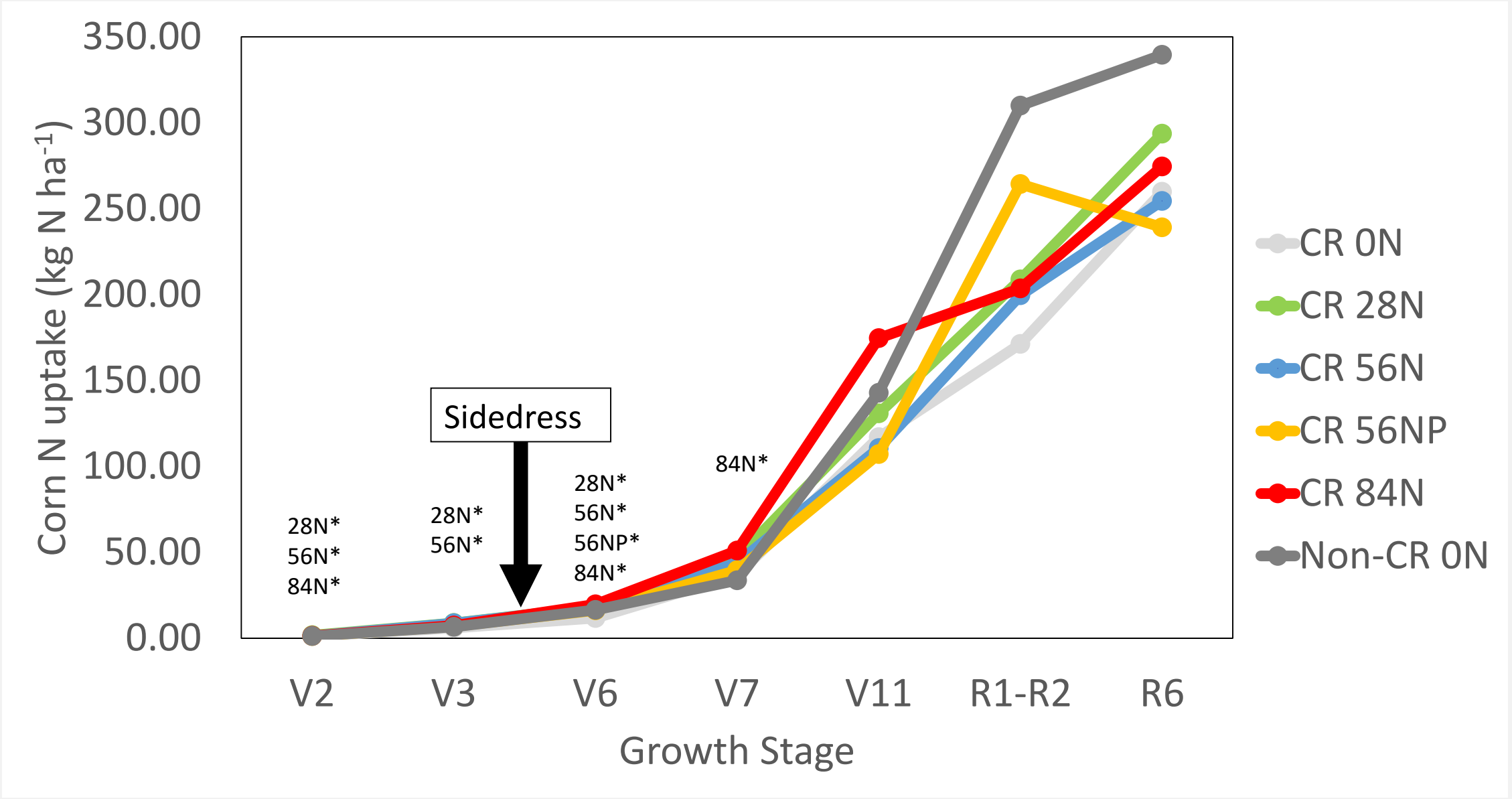
Spring Soil Inorganic N at Corn Planting



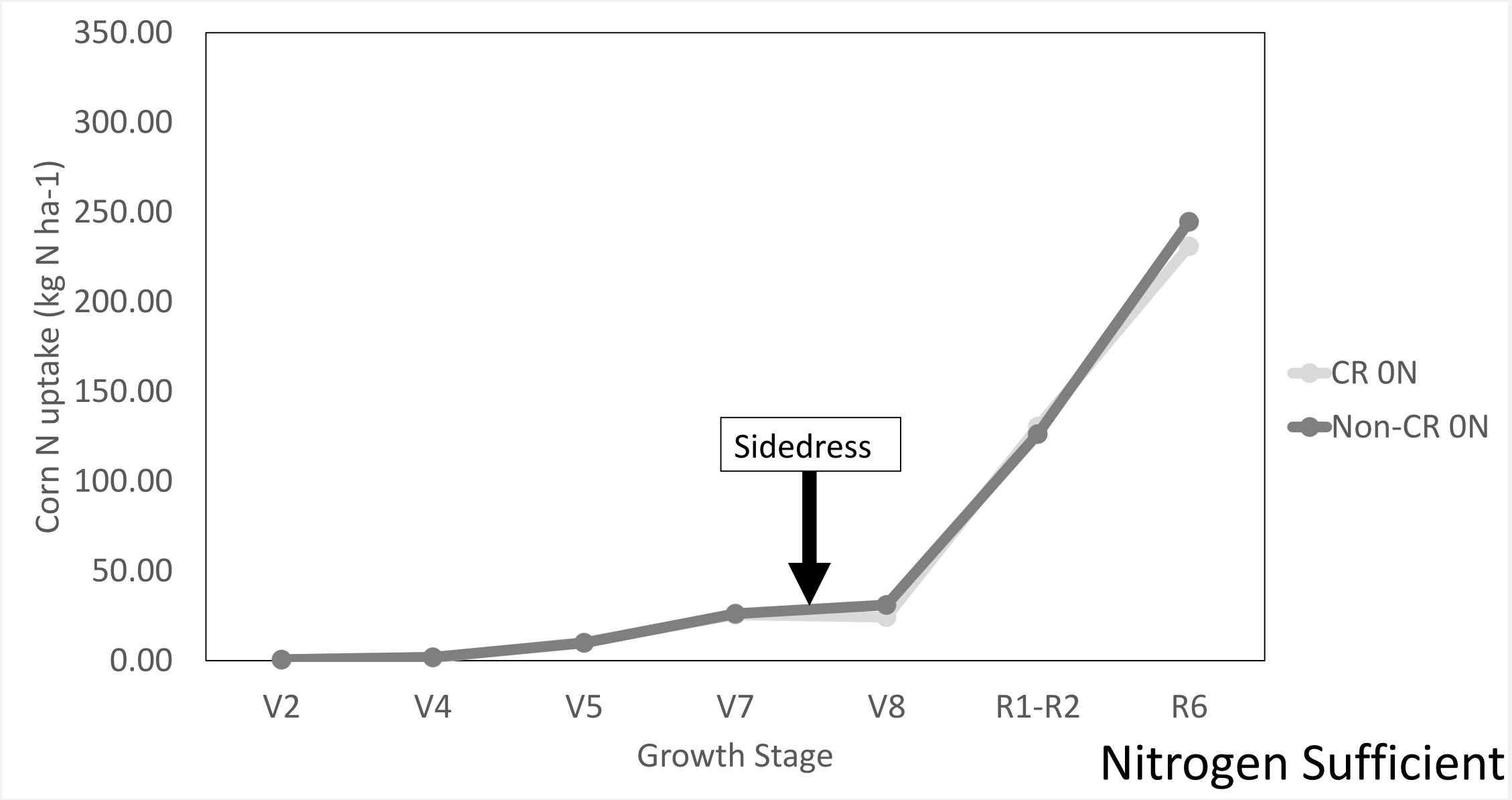
Site 1 Nitrogen Uptake CR vs. non-CR



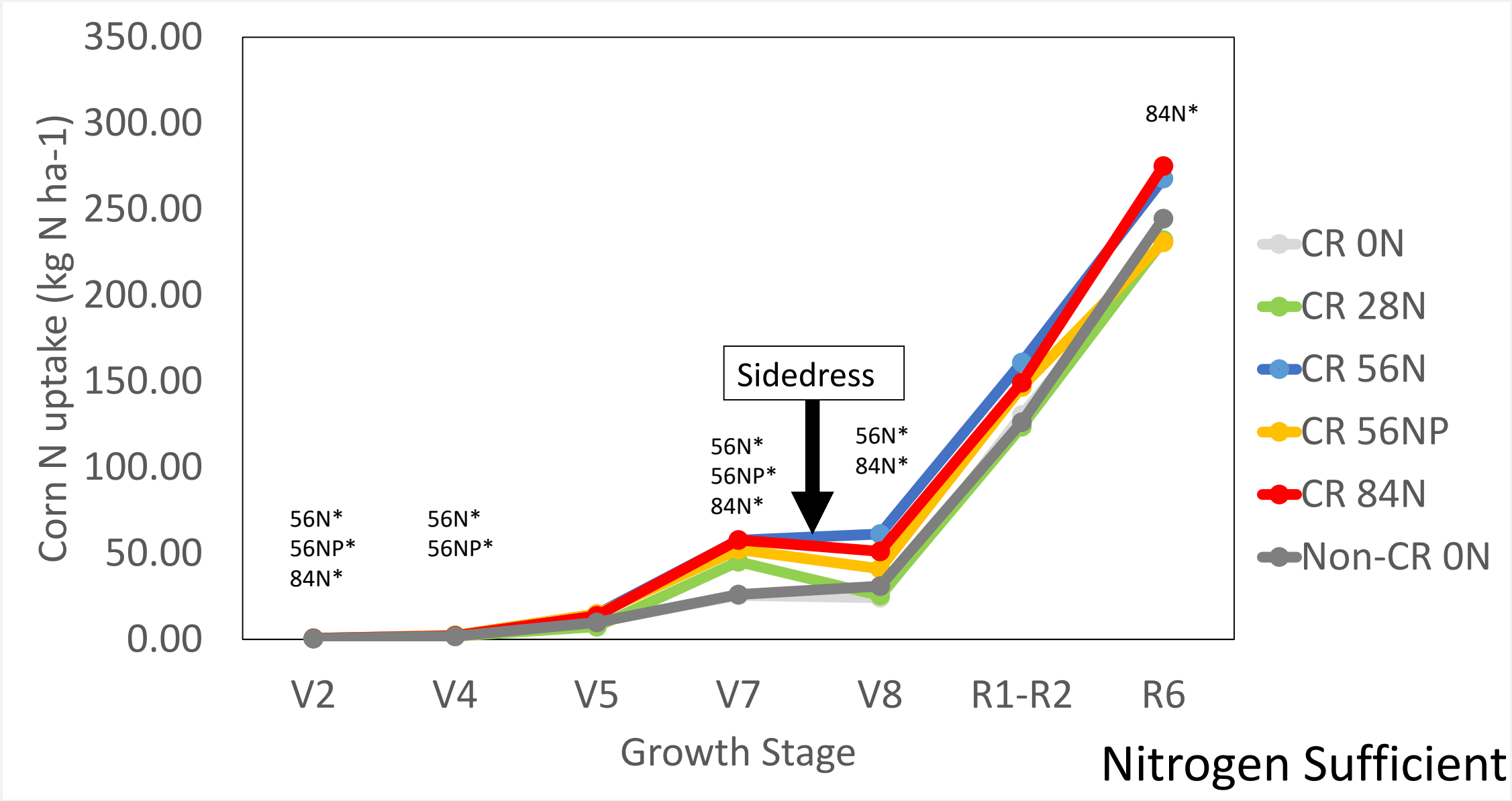
Site 1 Nitrogen Uptake in CR Plots



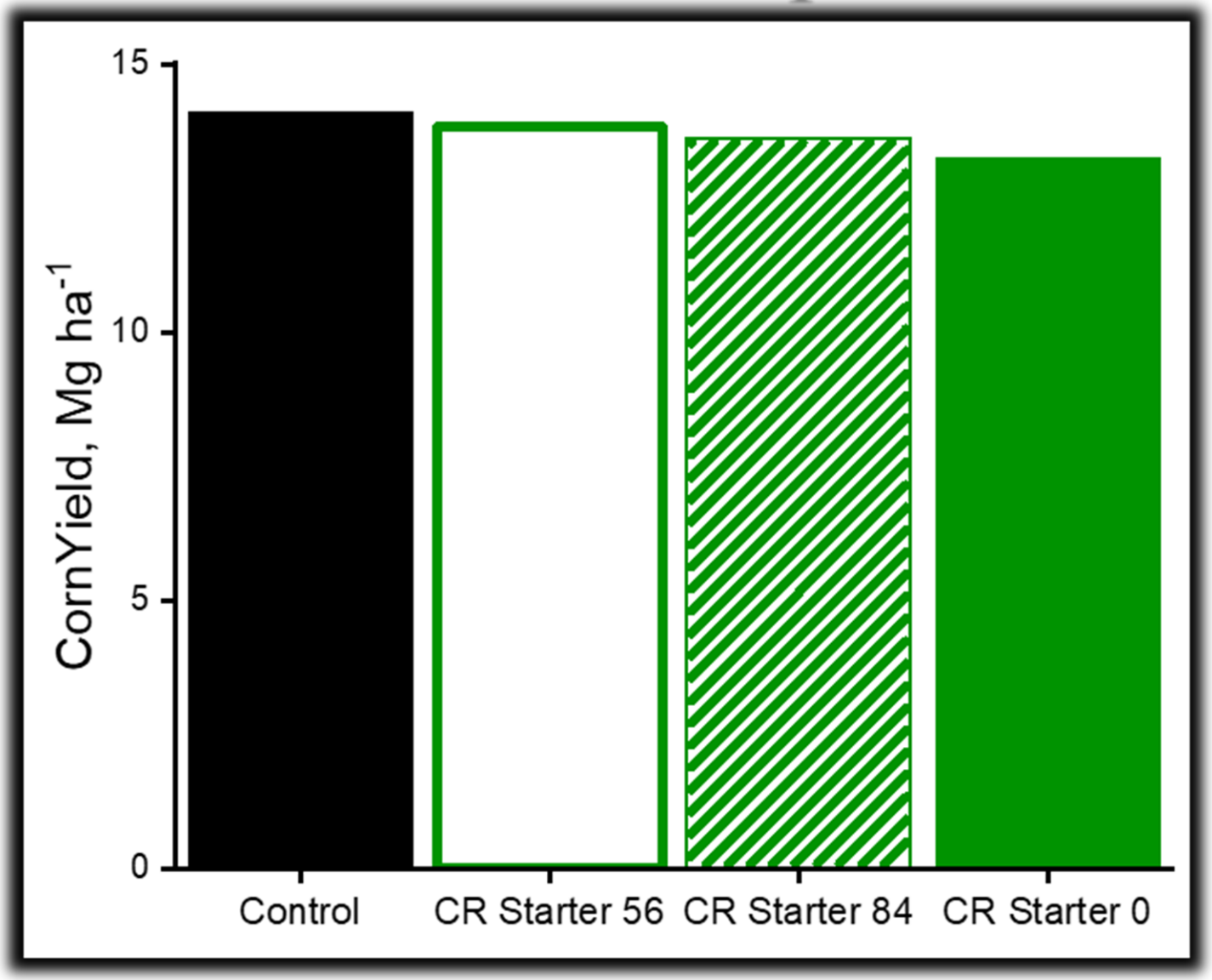
Site 3 Nitrogen Uptake CR vs. non-CR



Site 3 Nitrogen Uptake in CR plots

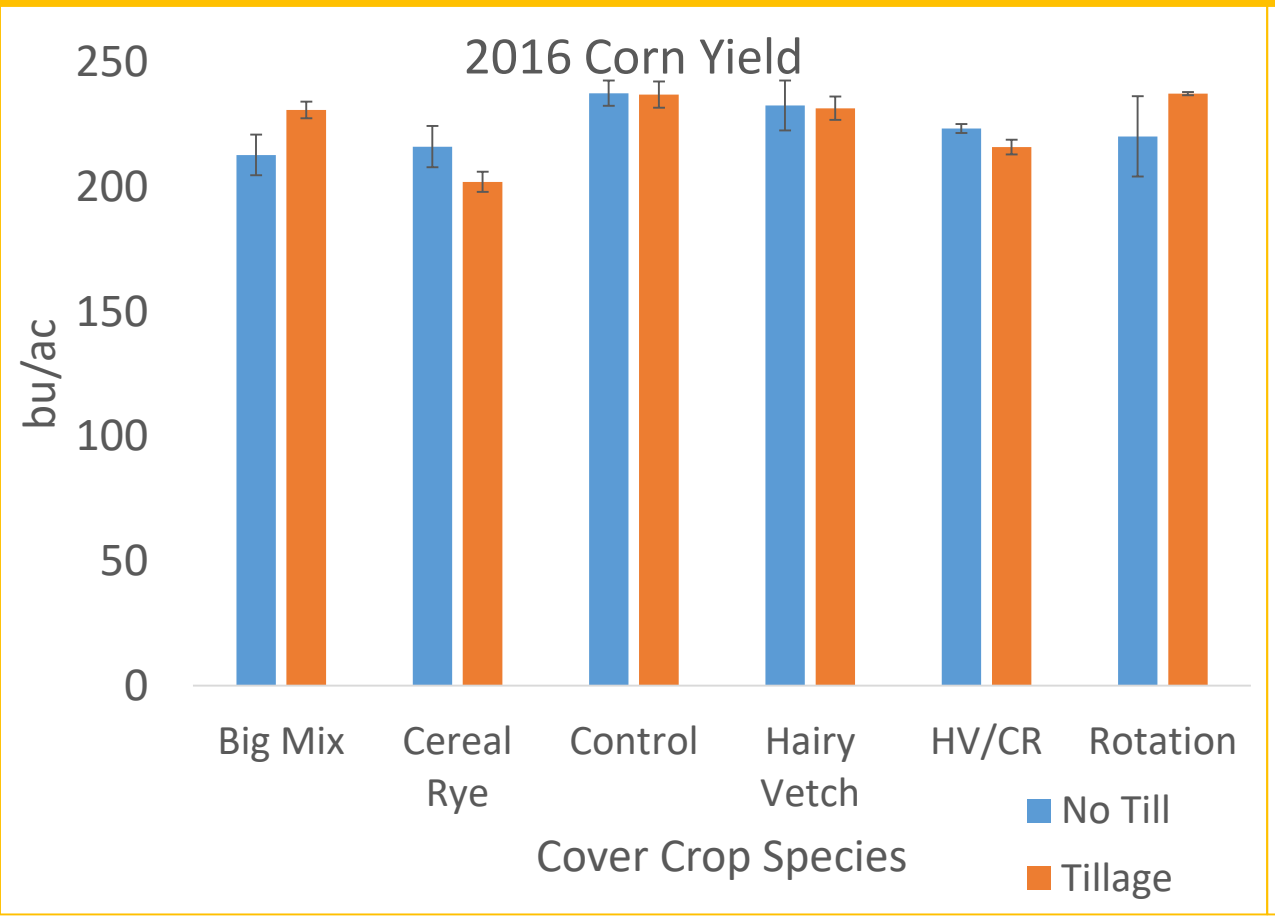


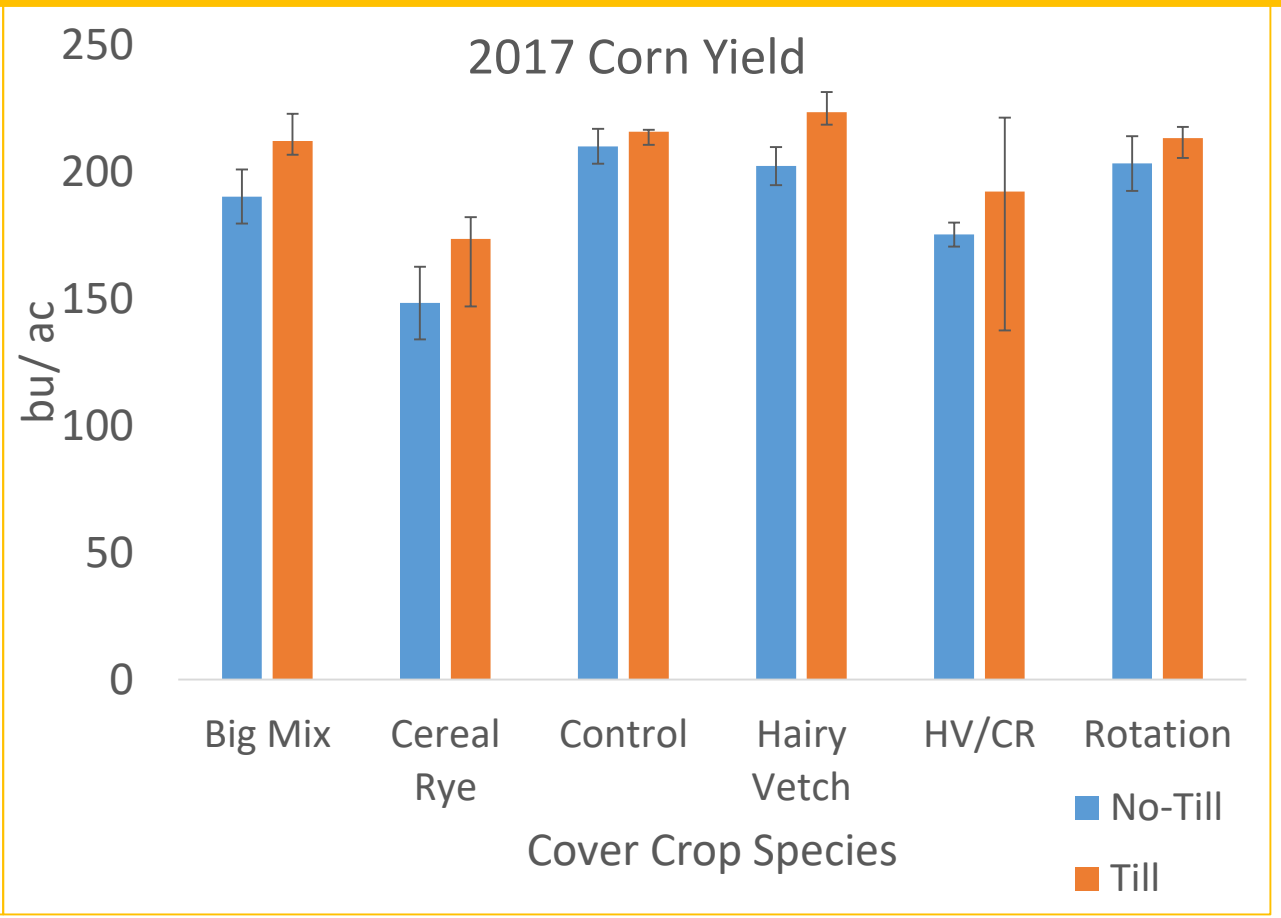
Starter N Closing the Corn Yield Gap



- At 1 of 3 sites, CR significantly reduced corn yield (2.4 -9.2 % reduction)
- Within CR treatments, at 3 of 3 sites, adding 56 and 84 kg N ha^{-1} starter resulted in significantly greater yield (1.3-13.4% greater).
- At 2 of 3 sites, adding 56 kg N ha^{-1} (50 lbs/A) resulted in equal or greater corn yield relative to the non-CR control and non-CR control with starter N.

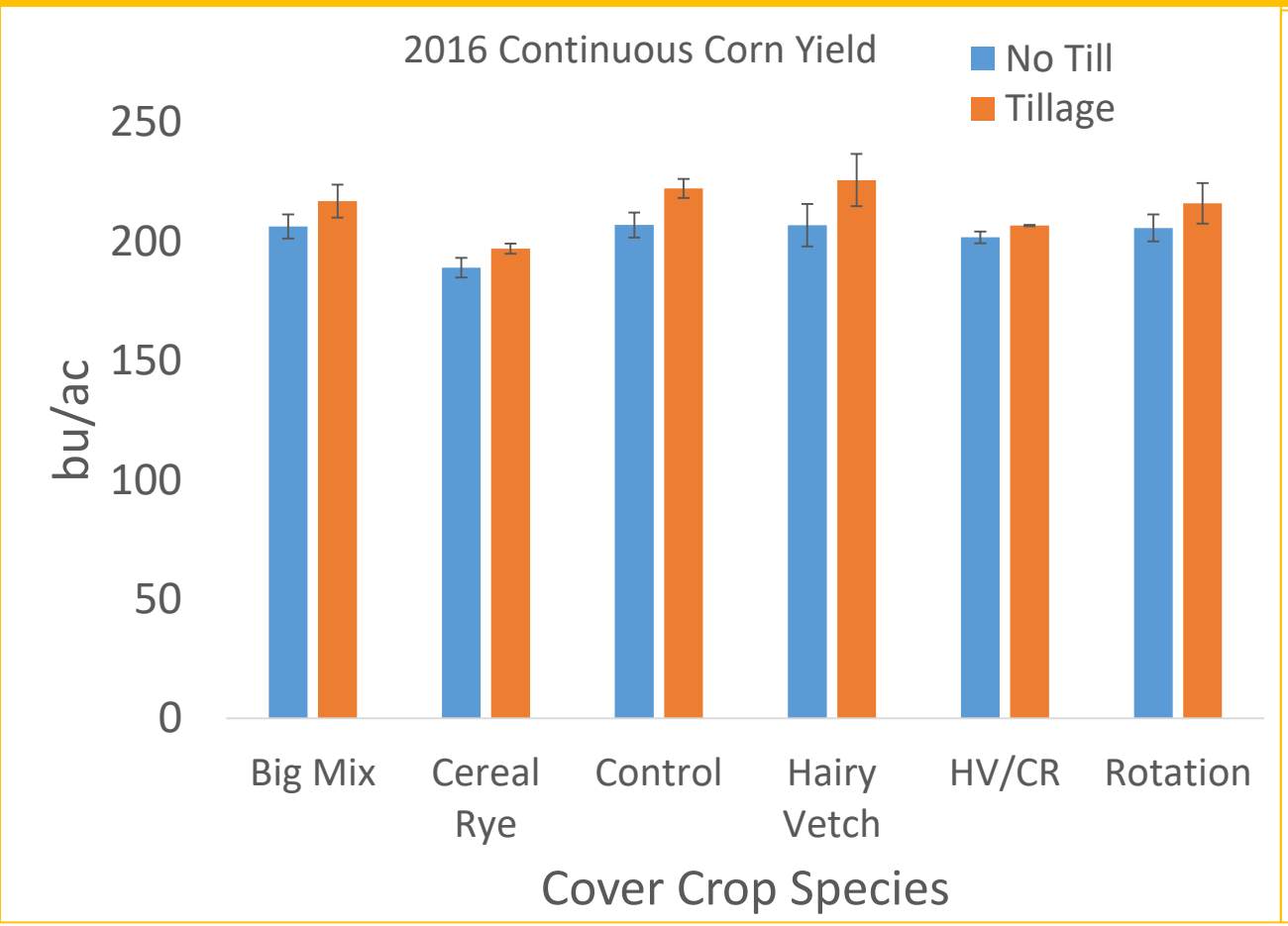
Cover Crop Selection-Soybean/**Corn** Yields

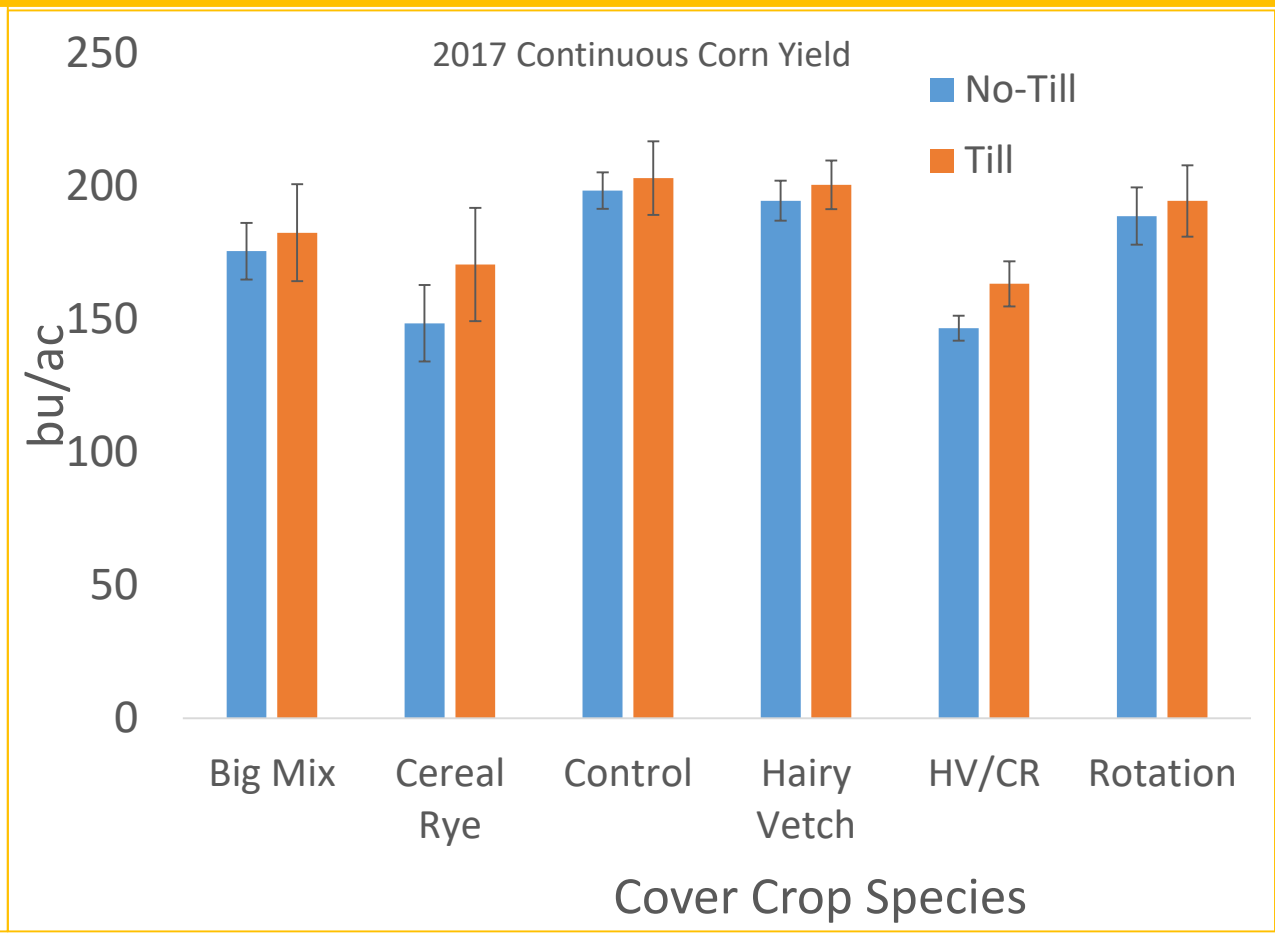




Cereal Rye: 100% CR
HV/CR: 80% CR
Big Mix: 10% CR
Rotation: 0% CR
HV: 0% CR

Cover Crop Selection-Continuous Corn Yields





Cereal Rye: 100% CR

HV/CR: 80% CR

Big Mix: 10% CR

Rotation: 0% CR

HV: 0% CR

Summary

- There is no question, the inclusion of a cereal rye base mixture increases water quality
- Cereal rye cover crop scavenges N and give it back slowly, where only 7-10% of cereal rye residue N is recovered in the subsequent crop.
- Potential adaptive N management for corn following cereal rye is adding 50-75 lbs of starter N at planting.
- Cover crop selection and rotation with cash crop is another option get achieve competitive corn yields following cover crops.

Thank You

Questions?

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