Precision Planted Cover Crops and Overwintering Legumes

NORTH CENTRAL SARE
Sustainable Agriculture Research & Education

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Purdue Unversity

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Indianapolis, IN

The goal of most farmers is to operate in a ***Sustainably Intensified Agriculture (SIA)*** System

SIA Principles:

- Maximize Production and Profit
- Maximize Nutrient Use Efficiency
- Minimize Environmental Degradation

Environmental Ecosystem Services

Maximize Production and Profit

Sustainably Intensified Agriculture

EFFECT OF COVER CROPS AND 4R NITROGEN FERTILIZER MANAGEMENT ON WATER QUALITY

Shalamar Armstrong and Michael Ruffatti

PURDUE UNIVERSITY

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

ILLINOIS STATE UNIVERSITY

DEPARTMENT OF AGRICULTURE

Illinois State University

ILLINOIS NREC

Nutrient Loss Reduction Strategies Evaluated

3 Scenarios Examined

1. Change N application timing from fall to spring

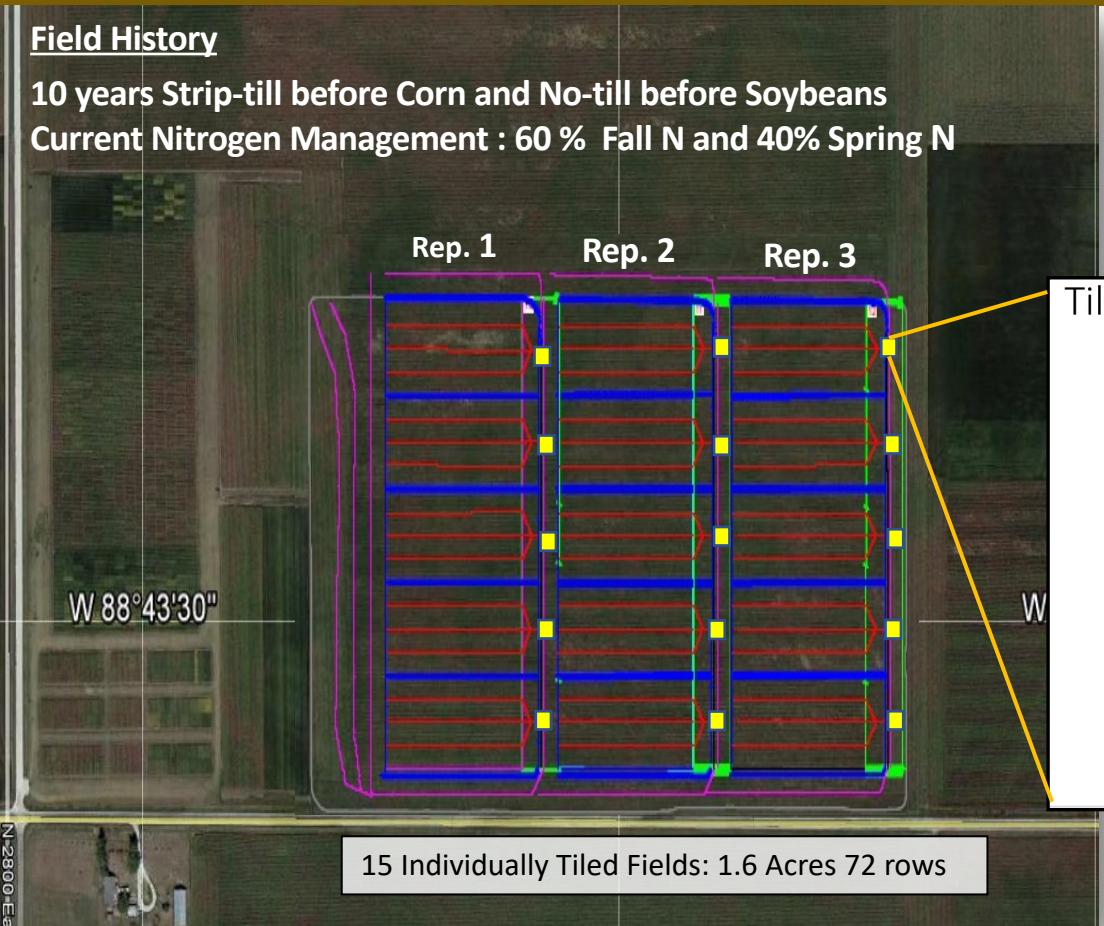
2. Change N application timing from fall to spring + cover crop

3. ***Addition of cover crops to fall applied N***
   ----Strip-till application of N into a living cover crop

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

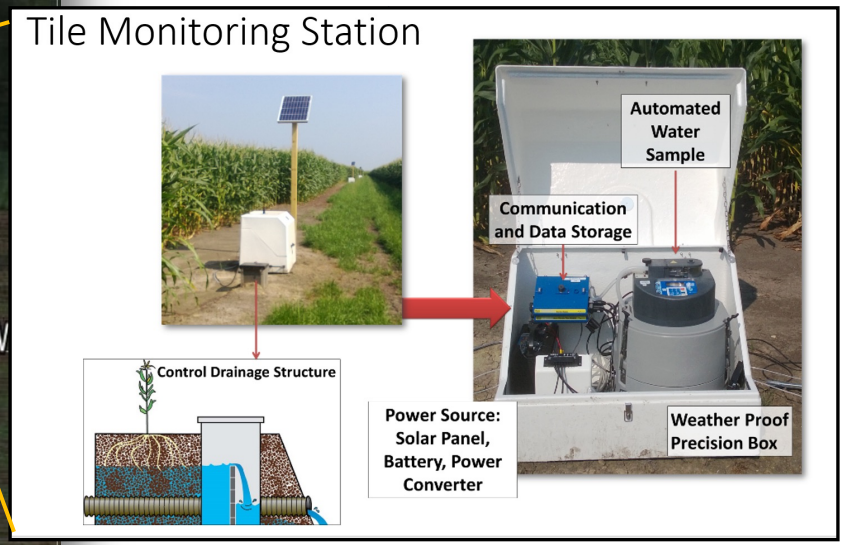


15 Individually Tiled Fields: 1.6 Acres 72 rows

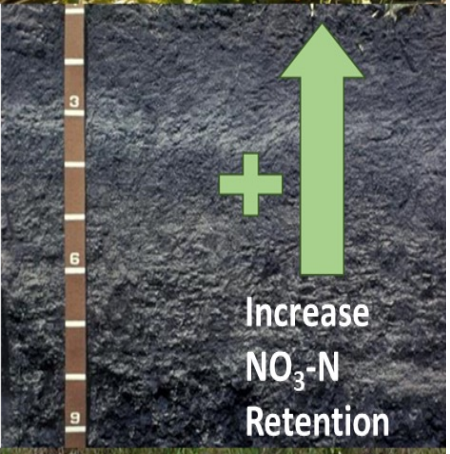
Long-term Study: 2014-Present

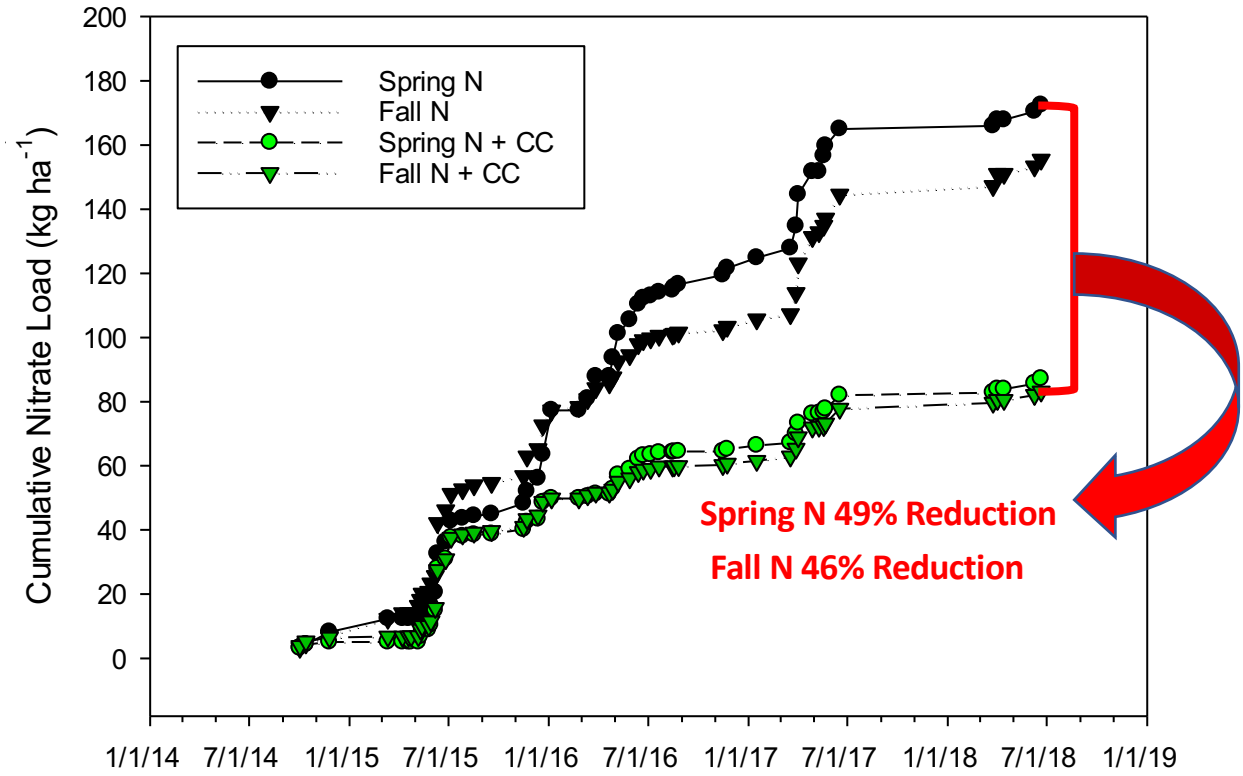
Corn and Soybean Rotation

Mollisol with 3.4% SOM



Water Quality Impacts: 4R + Cover Crops





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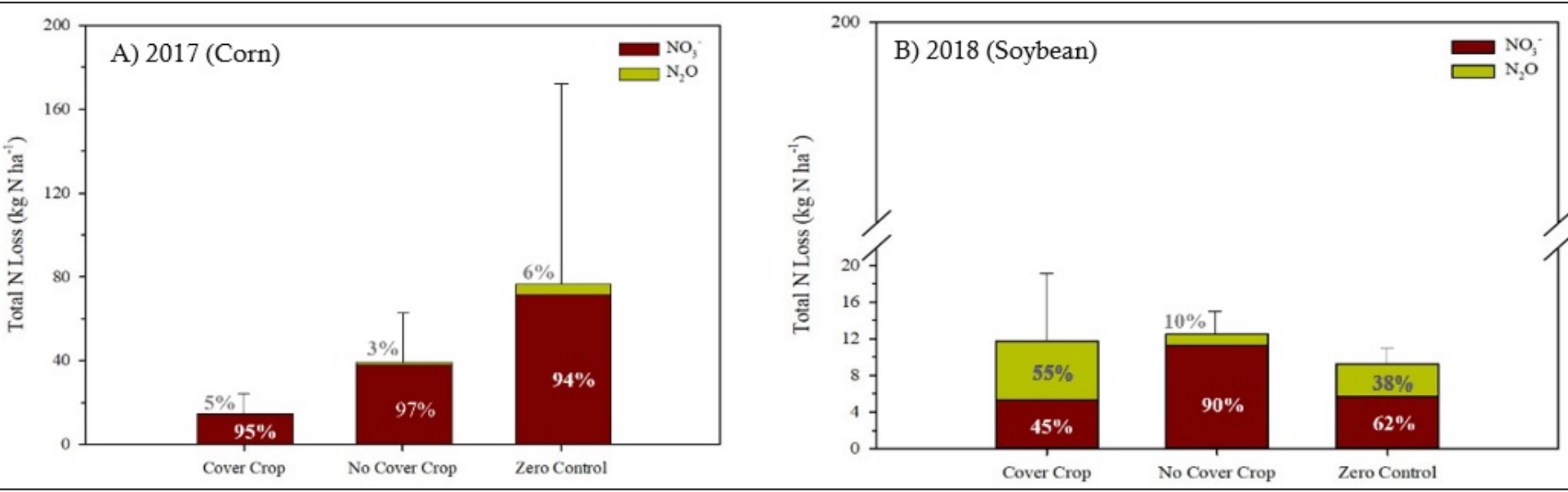
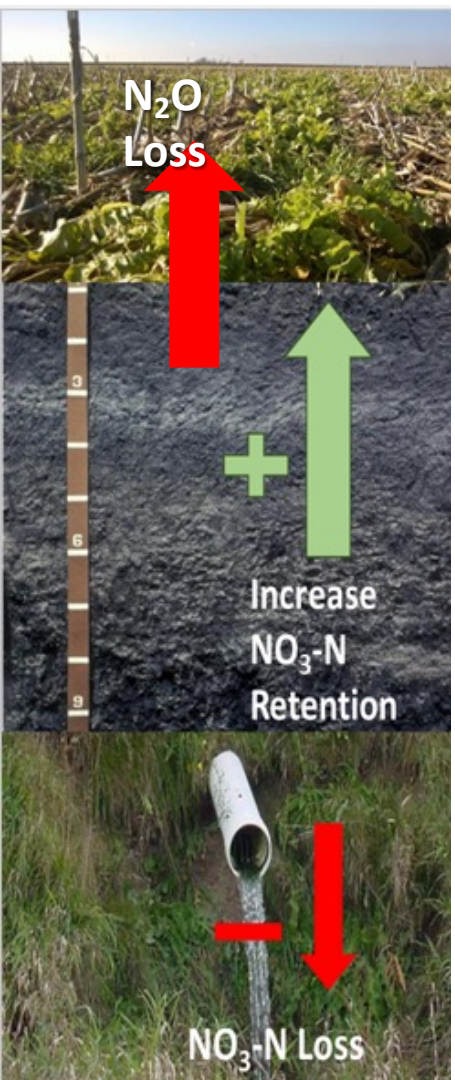
Ruffatti et al. (2018) Agricultural Water Management 211:81-88.

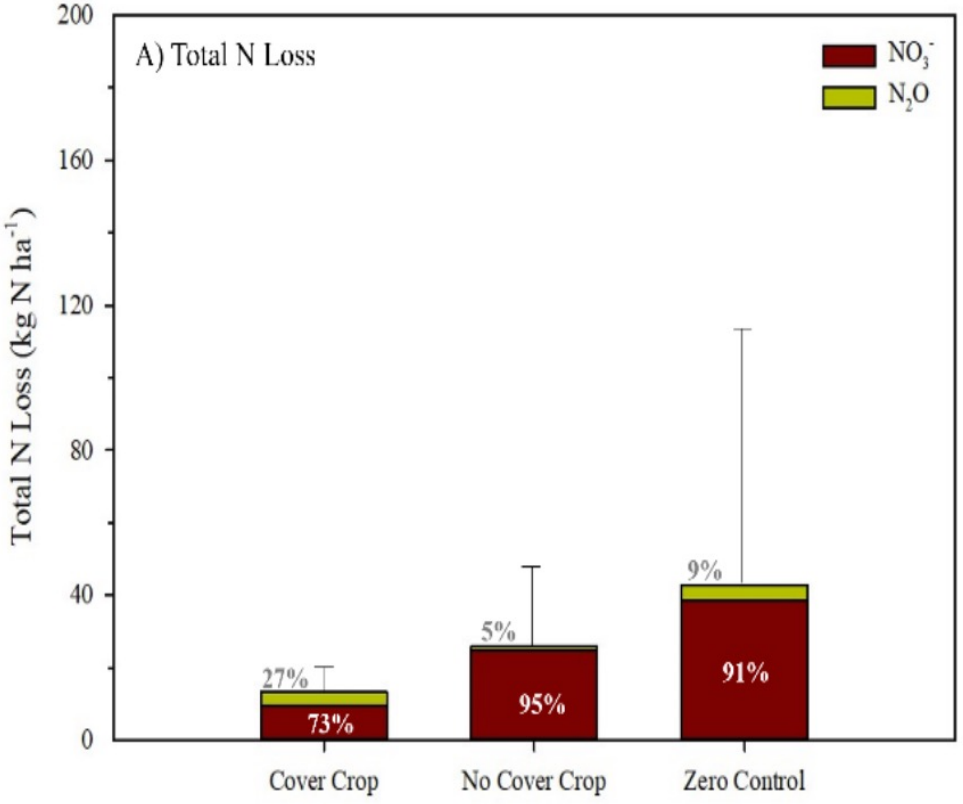
Impact of Cover Crops on N_2O and NO_3 Losses (2017-2018)



Delayed CC residue decomposition and N_20 emissions.

Impact of Cover Crops on N_2O Losses (2017-2018)





- 86% ofthe total IN loss is in the form of NO_3
- >50% reduction in total N Loss and Environmental Damage Cost in a corn-soybean rotation

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

MASS ADOPTION OF COVER CROPS ON A WATERSHED SCALE

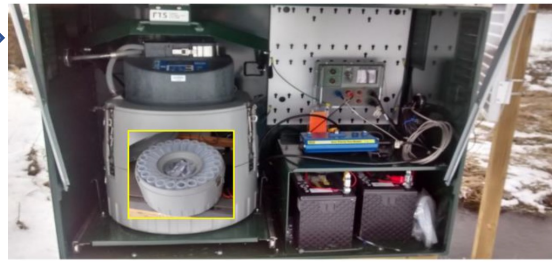
Shalamar Armstrong and Michael Ruffatti

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

Department of Agriculture
Illinois State University

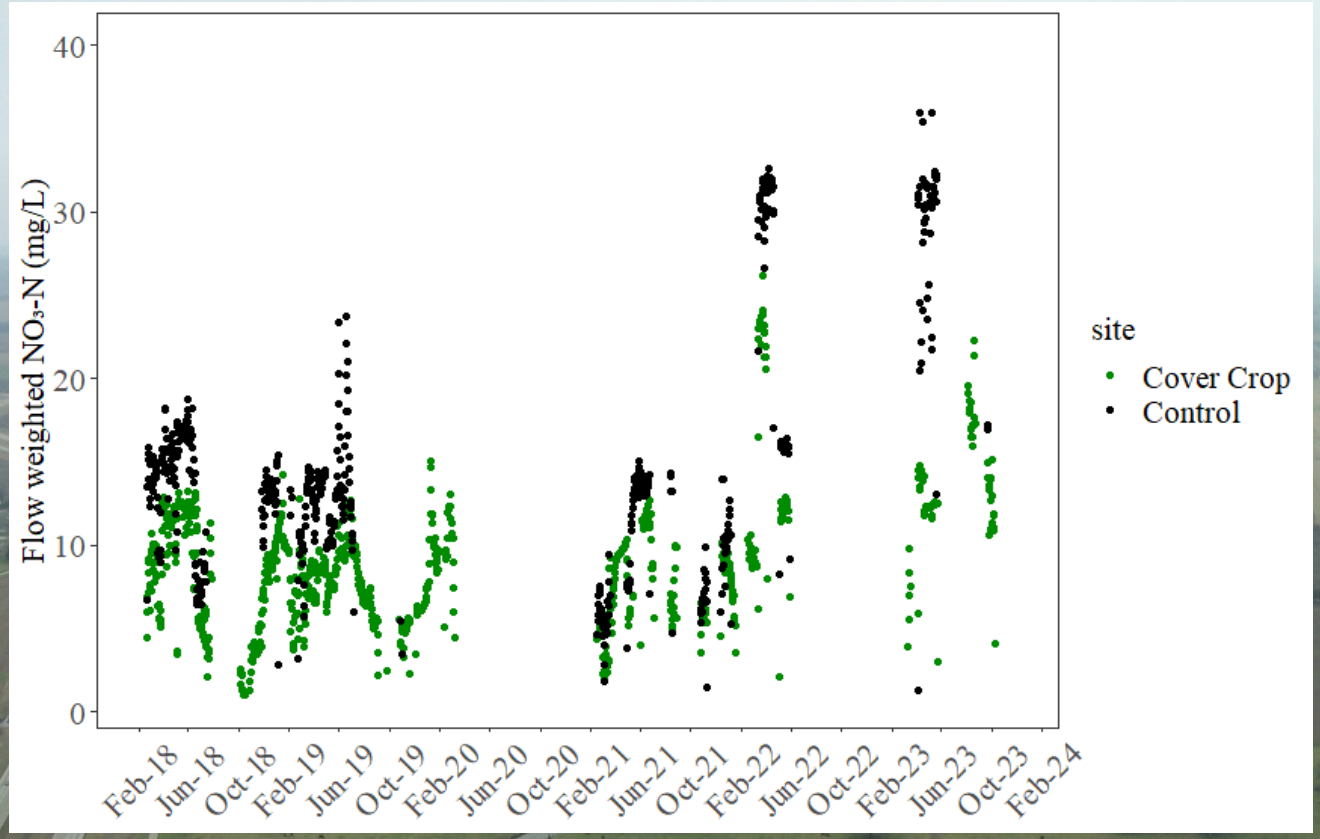
Illinois NREC

WATERSHED LOCATION



208-1722 lb A^{-1} Aboveground Cover Crop biomass on 50% of row crop acres over a 8-year period.

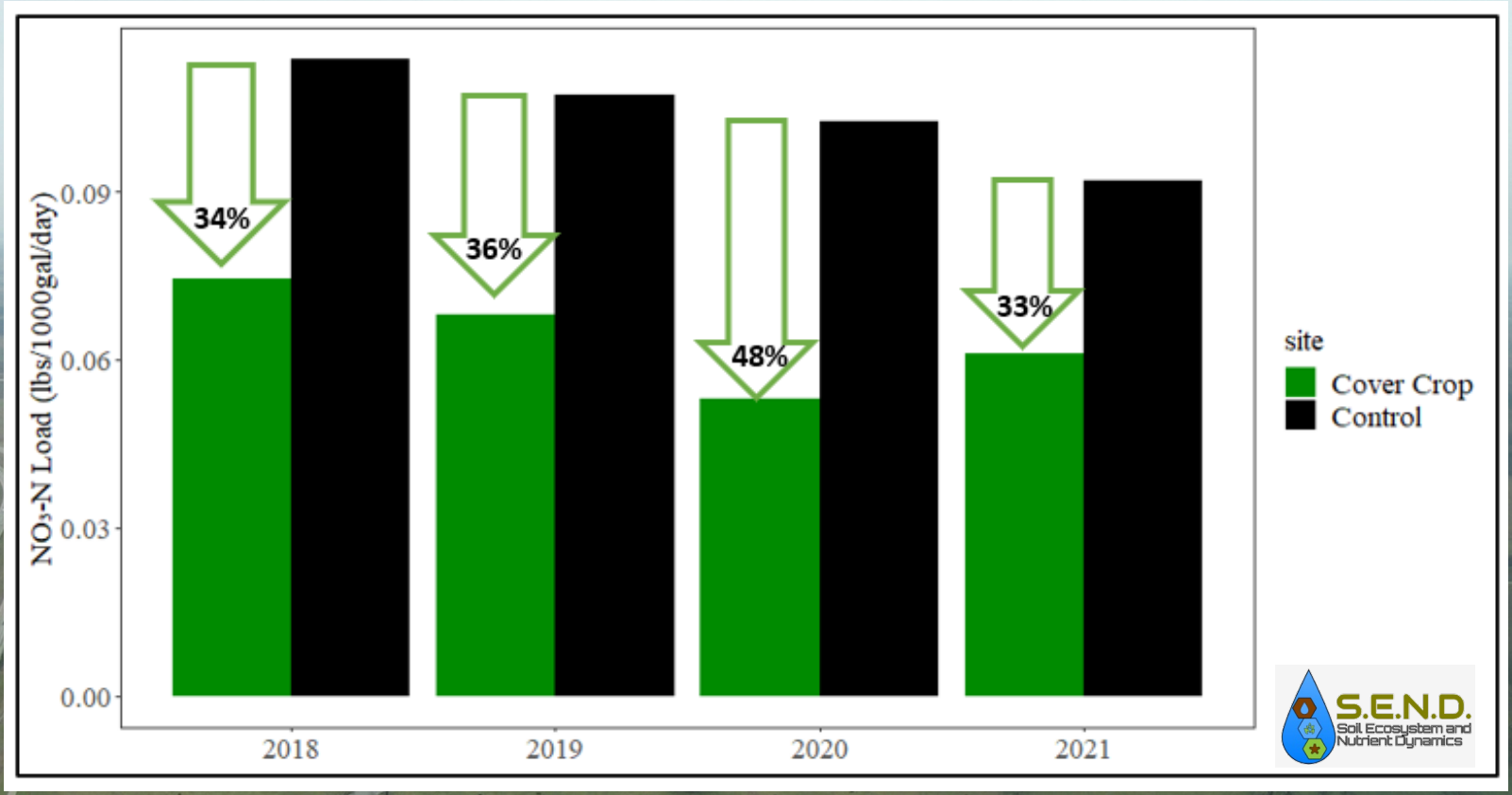
Watershed Impact of Mass Cover Crop Adoption



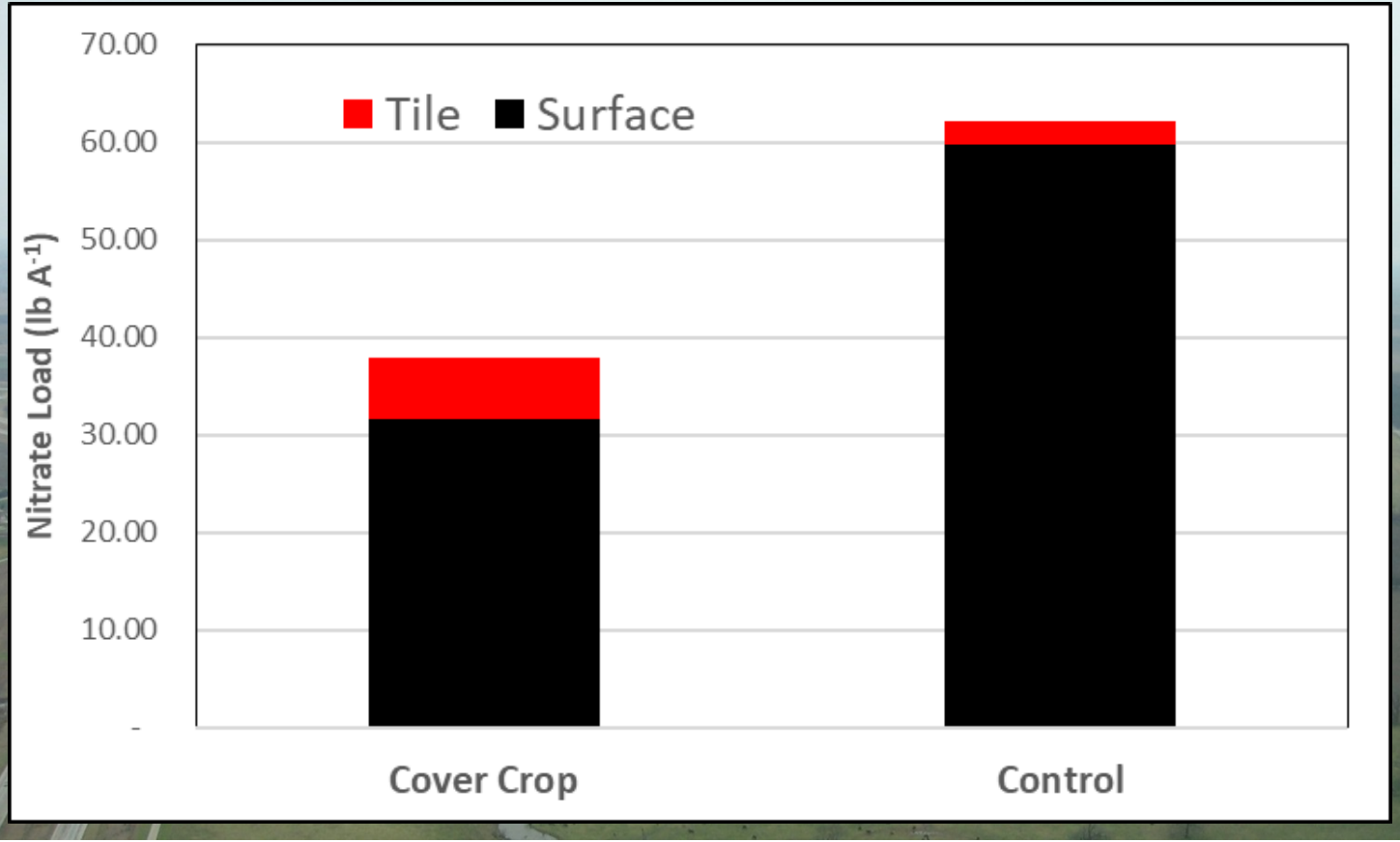
Even Years = 70% Soybean/ 30% Corn

Odd Years = 30% Soybean/70% Corn

Watershed Impact of Mass Cover Crop Adoption



Watershed Impact of Mass Cover Crop Adoption



CC Watershed

In 2023, 38% reduction in total nitrate loss with 24% more total discharge.

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Impact of long-term Cover Crop Management on DRP loss

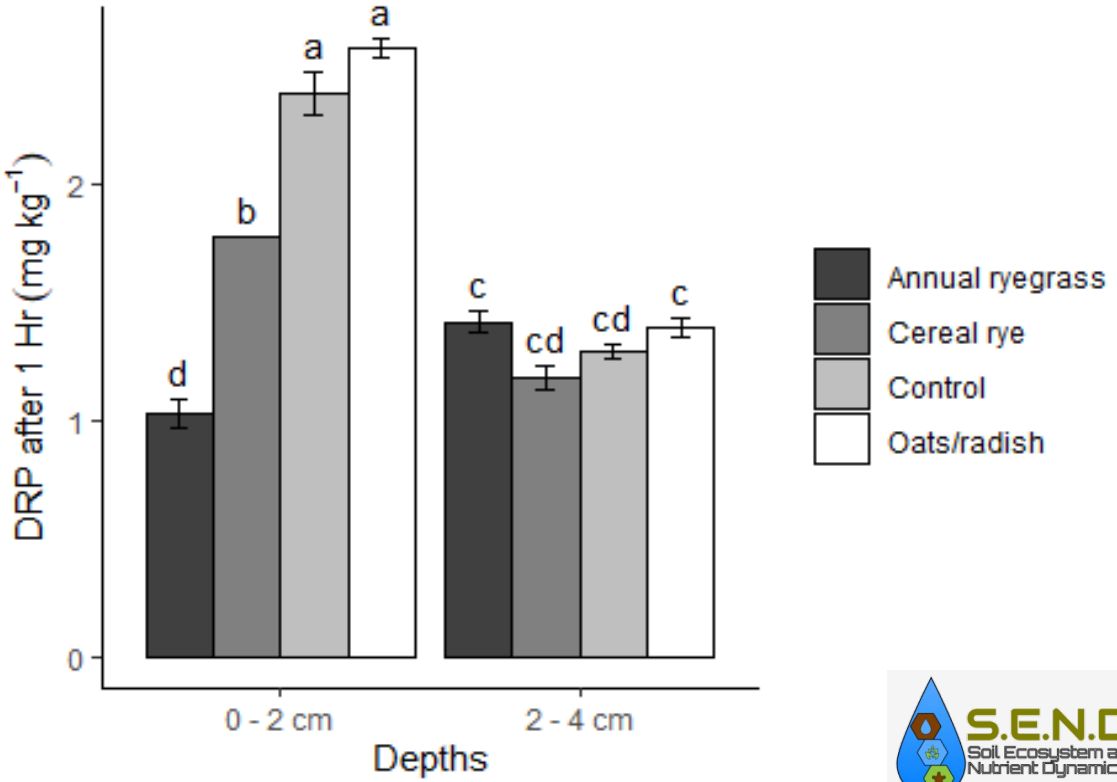
Objective

- Determine the impact long-term cover crop species management on soil P sorption.

Research Site:

- Arcadian IN (Central IN)
- 9 years of cover crop management
- Treatments ***(Control, Cereal Rye, Radish/Oats, Annual Ryegrass)***

Impact of long-term Cover Crop Species on DRP loss



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

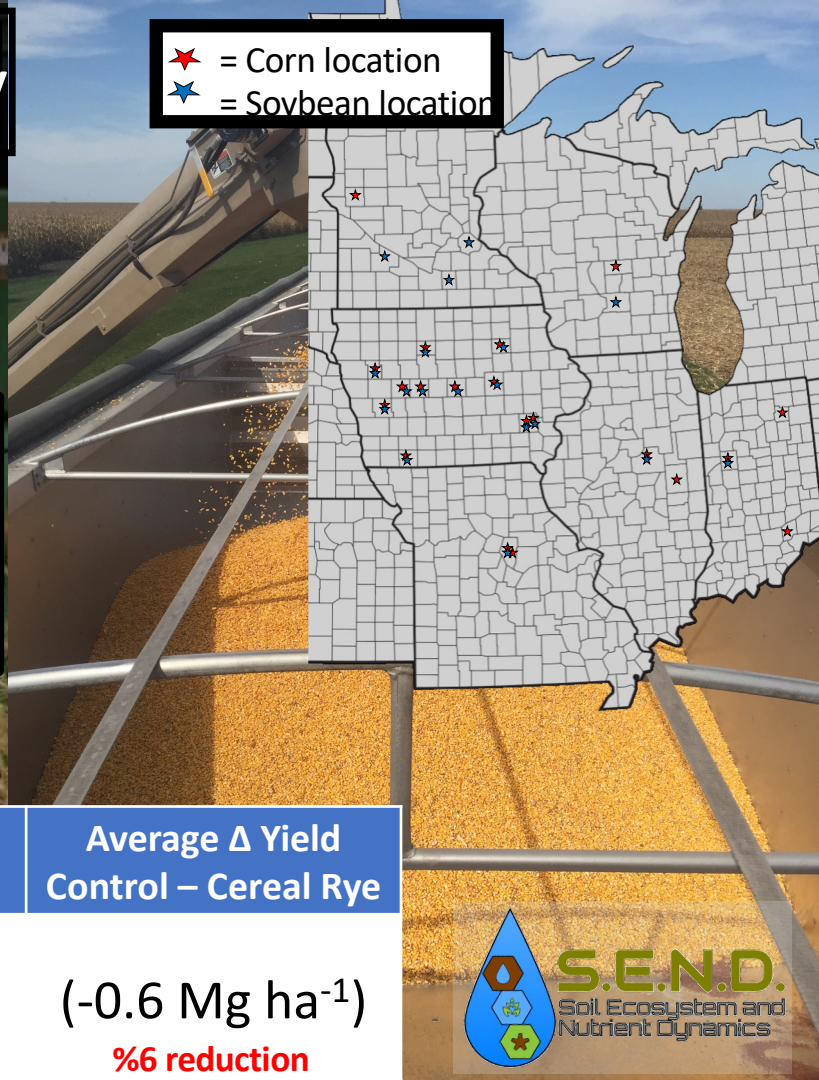
Environmental Ecosystem Services

Maximize Production and Profit

Sustainably Intensified Agriculture

Regional CR-Cash Crop Yield Study

- 430 Total **Paired** Observations from **20** different Experimental Sites
  - **430** Corn **Paired** observations from 20 Experimental sites



Crop	Treatment	Yield Mg ha^{-1} (SE)	Average Δ Yield Control – Cereal Rye
Corn N= 430 pairs	Control	9.6 (0.183)	(-0.6 Mg ha^{-1}) **%6 reduction**
	Cereal Rye	9.0 (0.162)	

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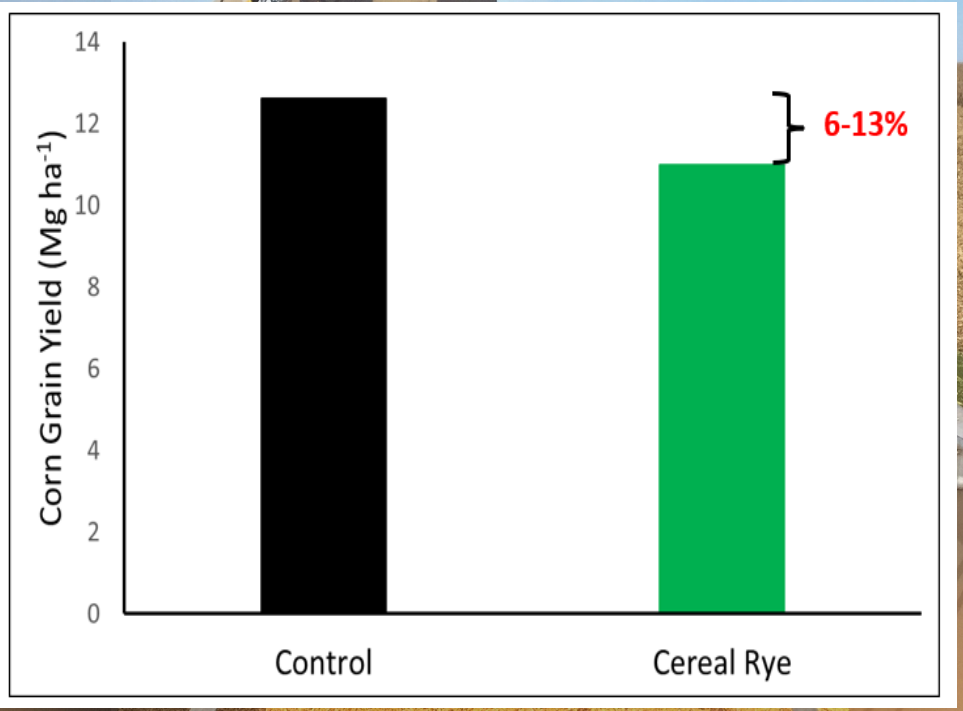
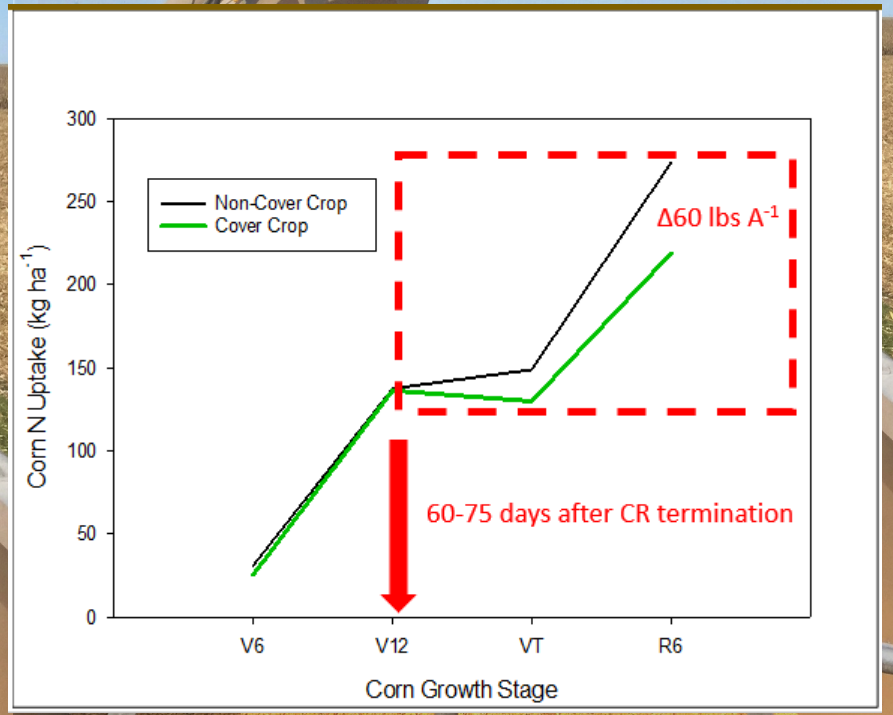
Cereal Rye Impact on Soil N Uptake and Grain Yield





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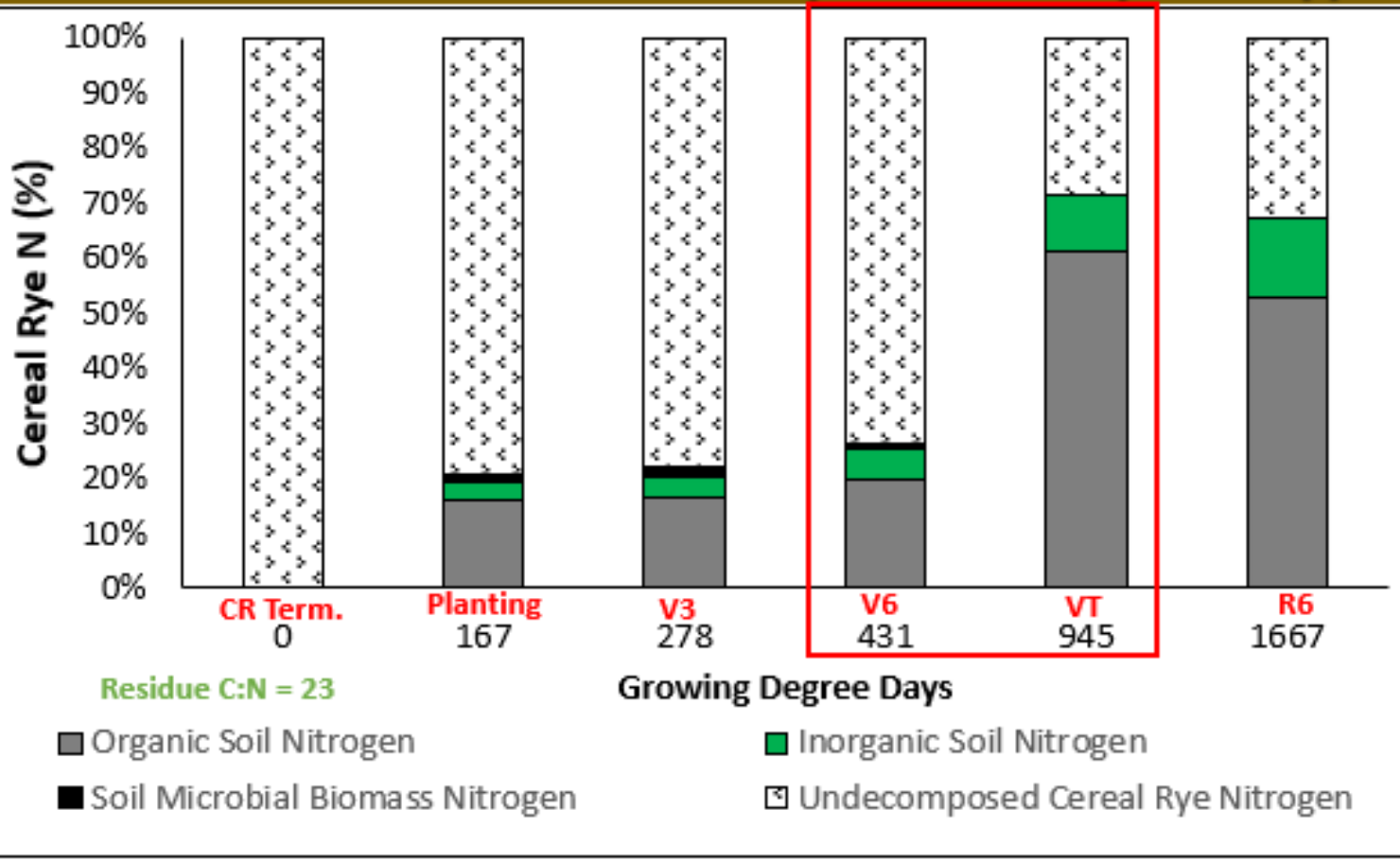
Soil Ecosystem and Nutrient Dynamics

15N Incubation Study: The Fate of Cereal Rye N Following Termination (Laboratory Study)



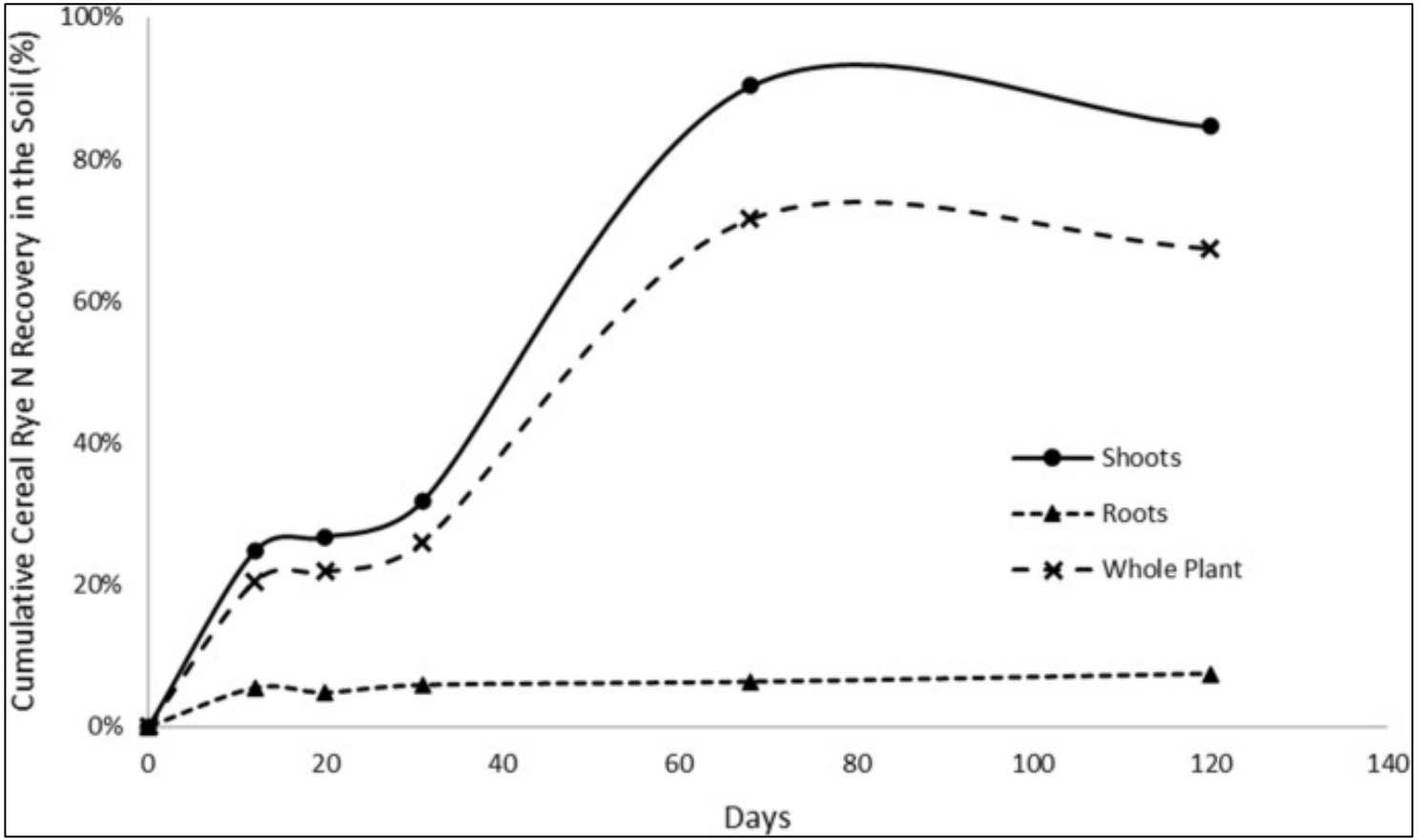
- At R6, only 15% of CR residue N is released.
- At R6, 53% of CR N was in the organic form
- 33% of CR N was undecomposed

Between V6 and VT

- 41% increase in the OSN pool
- 4% increase in the ISN pool

Roth et al., 2022 Nutr. Cycling Agroecosyst.

15N Incubation Study: The Fate of Cereal Rye N Following Termination (Laboratory Study)



Very Little N Contribution from Cereal Rye Roots

INDIANA CORN Marketing Council

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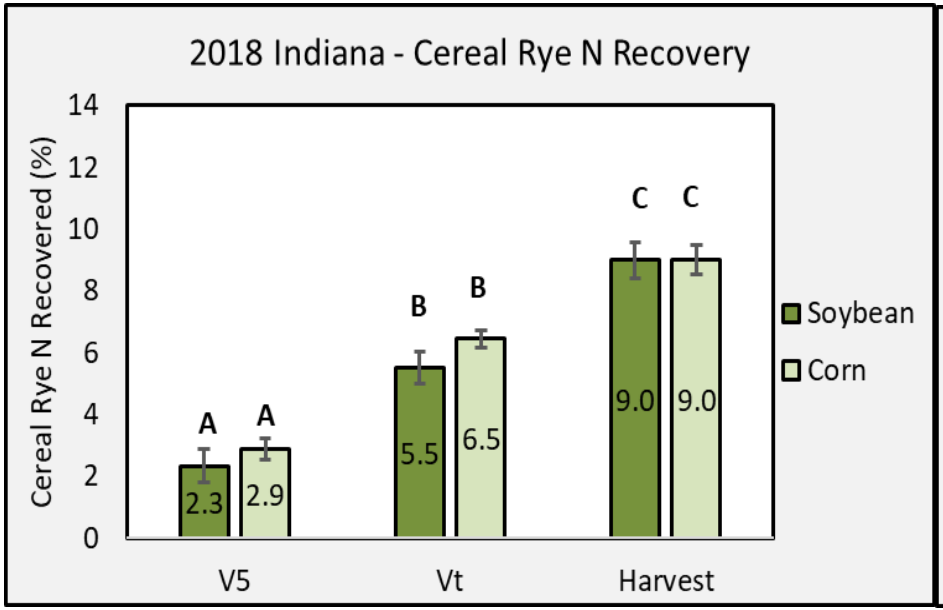
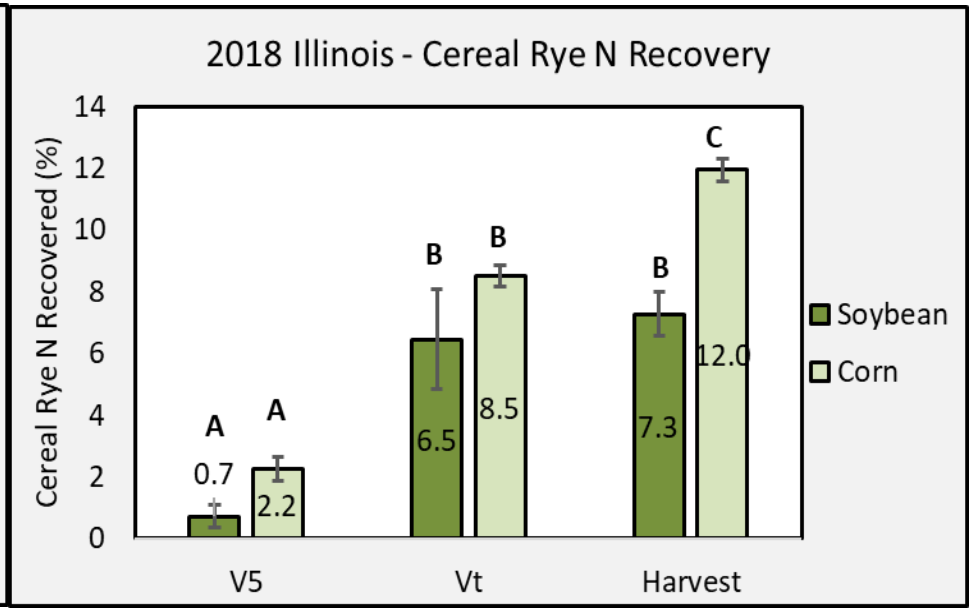
Field Based 15N Estimate of Cereal Rye Residue Nitrogen Release in a Midwest Corn and Soybean System (Field Study)

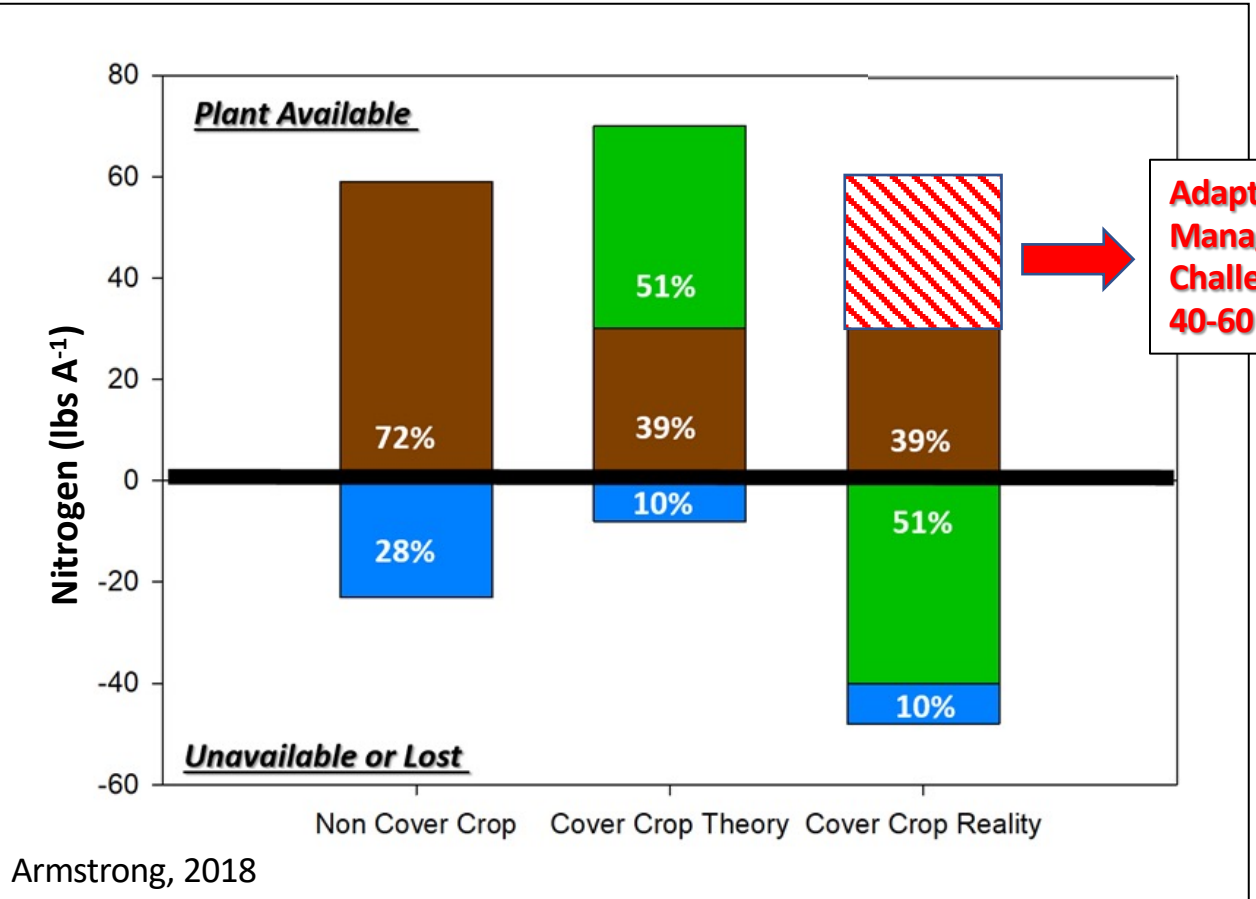




9-12% recovery of Cereal Rye N by Corn at Harvest

Lacey et al. 2020 Nutrient Cycling in Agroecosystems

Changes in Soil Nitrogen Availability During the Life Cycle of Cereal Rye



Armstrong, 2018

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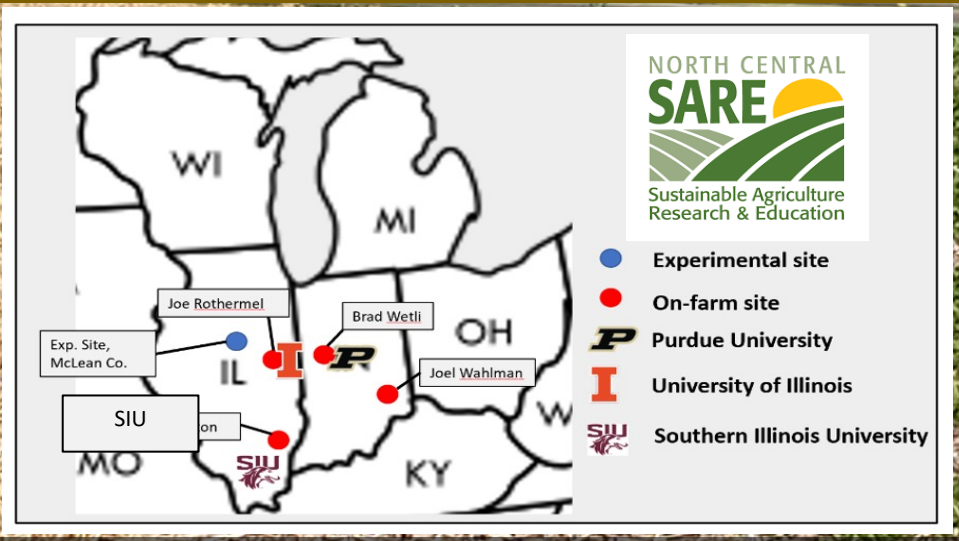
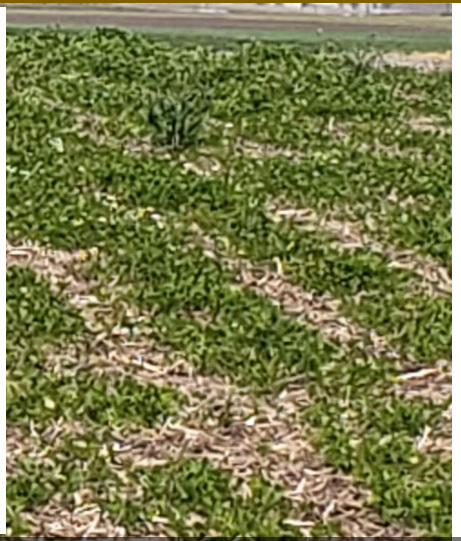
Precision Winter Cereal Rye Cover Cropping for Improving Farm Profitability and Environmental Stewardship





Dr. Shalamar Armstrong (Associate Professor of Agronomy, Department of Agronomy, Purdue University)
Dr. Amir Sadeghpour (Associate Professor of Soil Management, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University)
Dr. Andrew Margenot (Assistant Professor of Soil Science, Crop Science Department, University of Illinois)

Treatment Factors

Cover Crop Species

1. Balansa Clover
2. Cereal Rye

Planting Method

1. Conventional
2. Precision

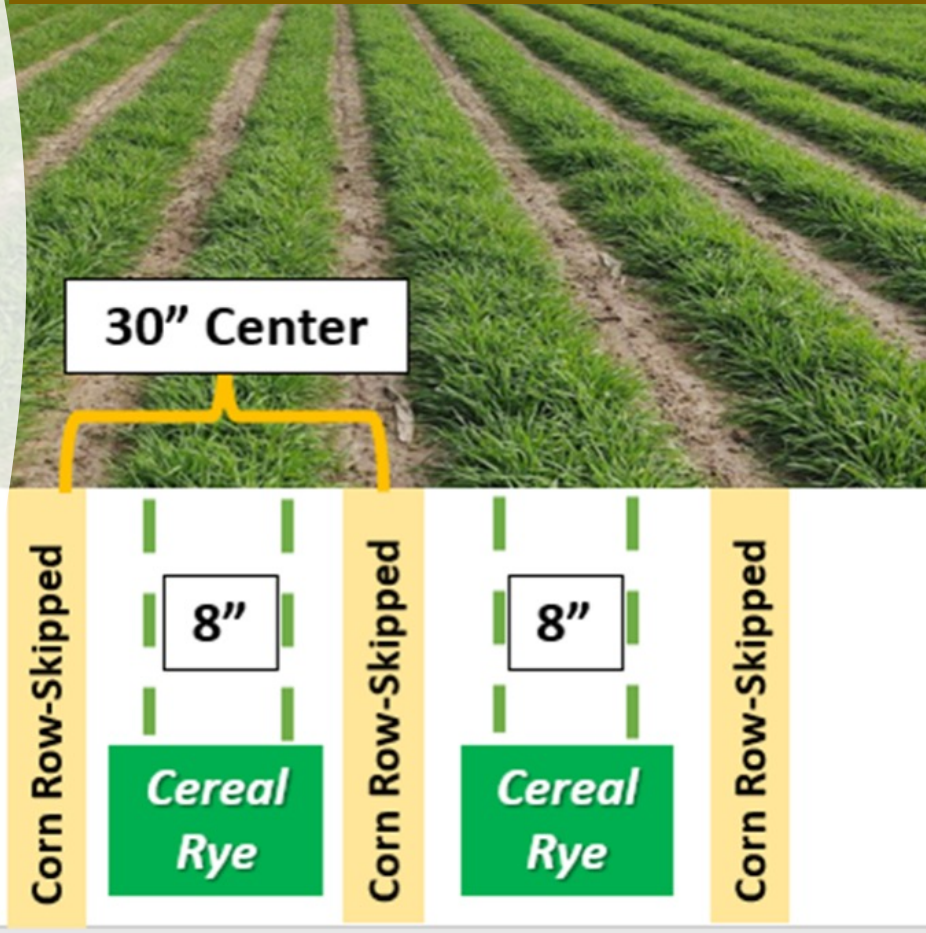
Cover Crop Seeding Rate

1. Full
2. Reduced

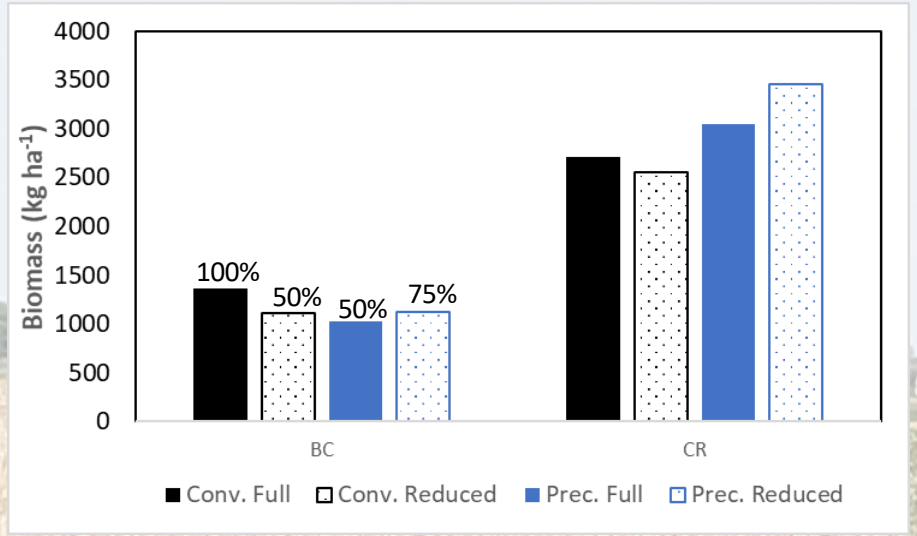
Cover crops

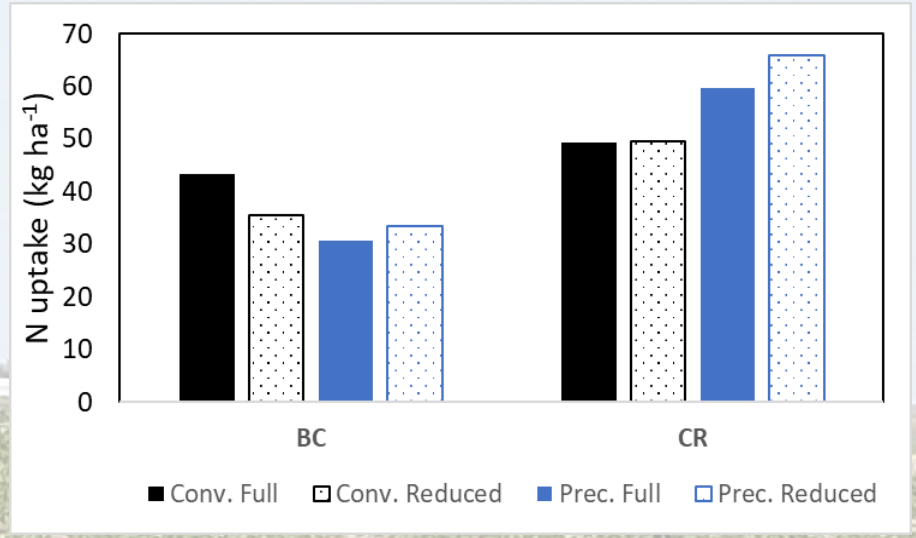
- Planted Sept. 11th
- Terminated: CR (early April)
  BC (Late April-Early May)

Precision Planted



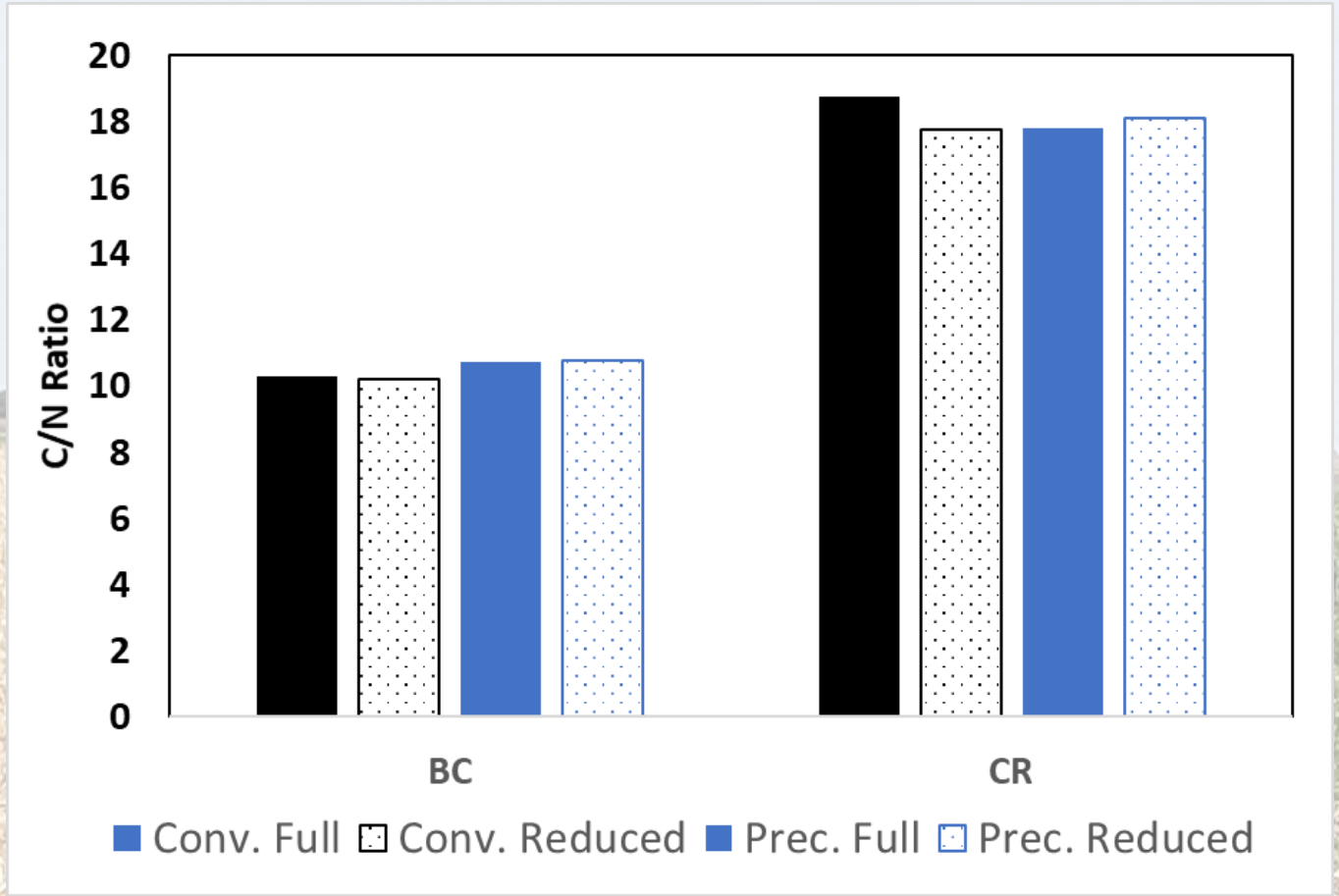
Cover Crop Performance (Central IL, 2021)



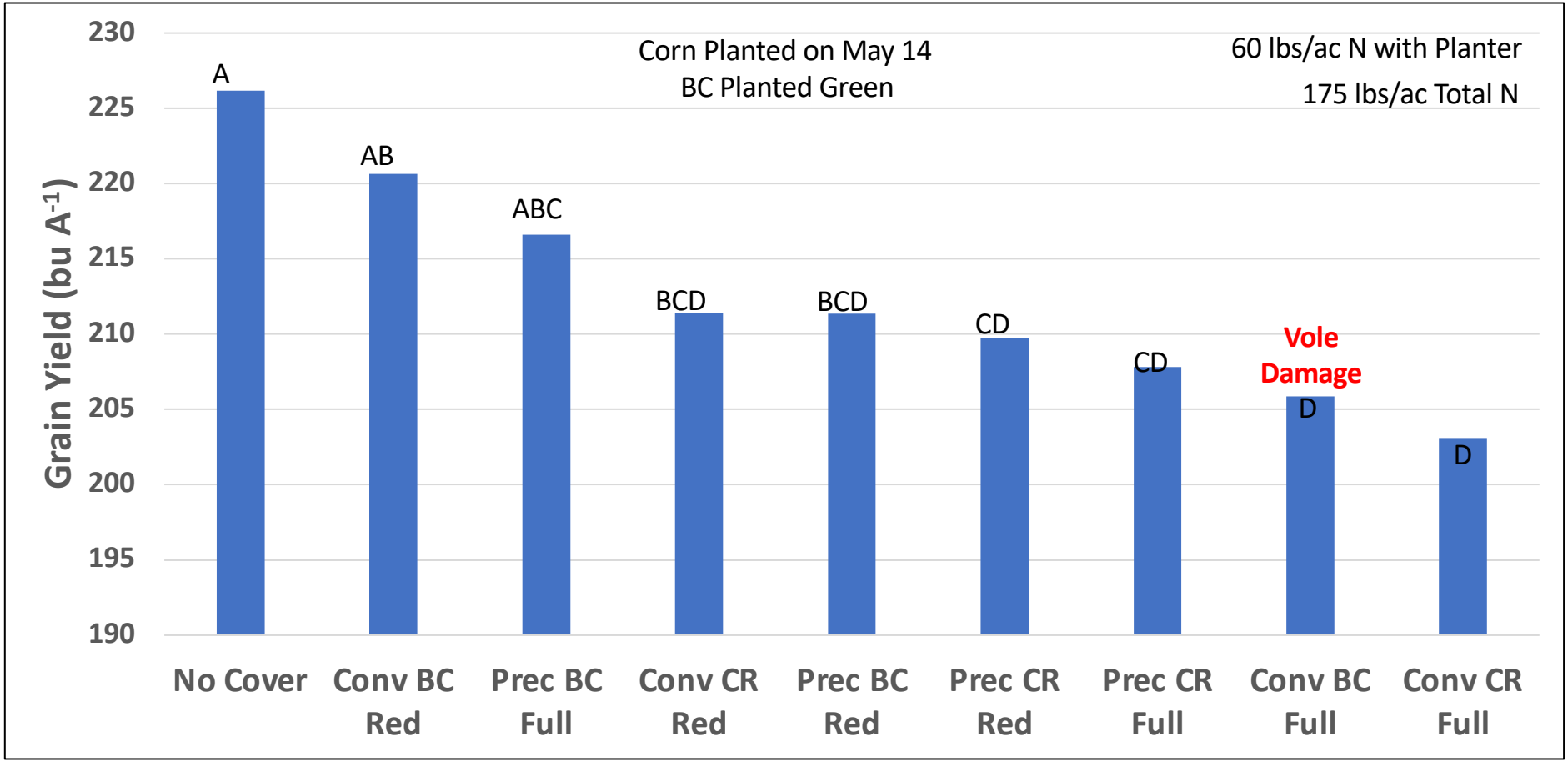


Note: Same cover crop biomass and N uptake with 50-75% less seed per acre.

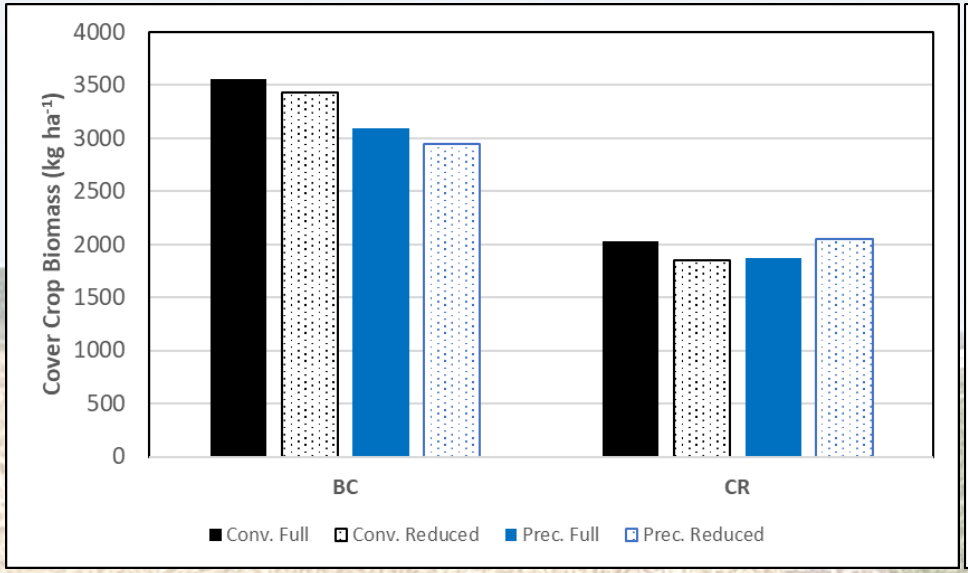
Cover Crop Performance

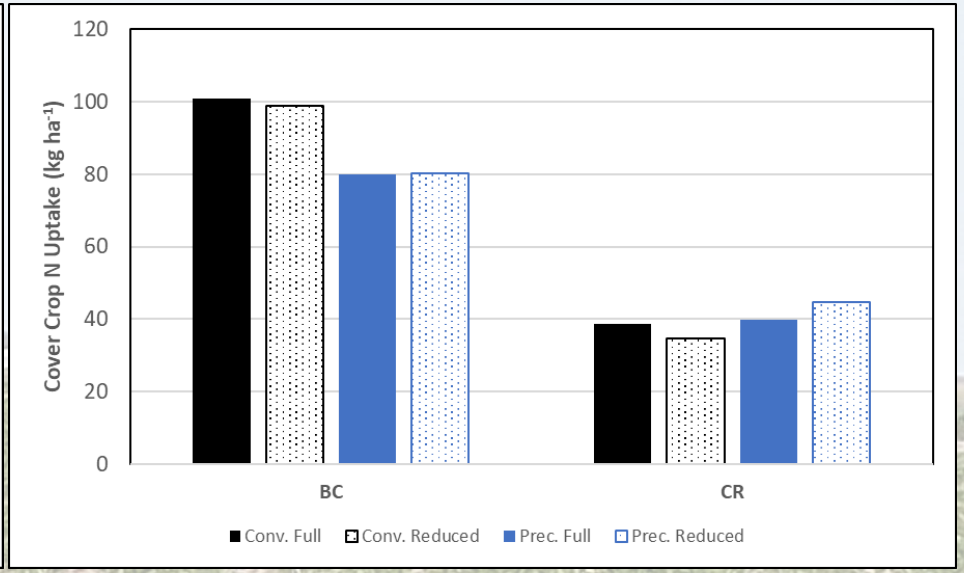


Corn Yield 2021 (Central IL, 2021)



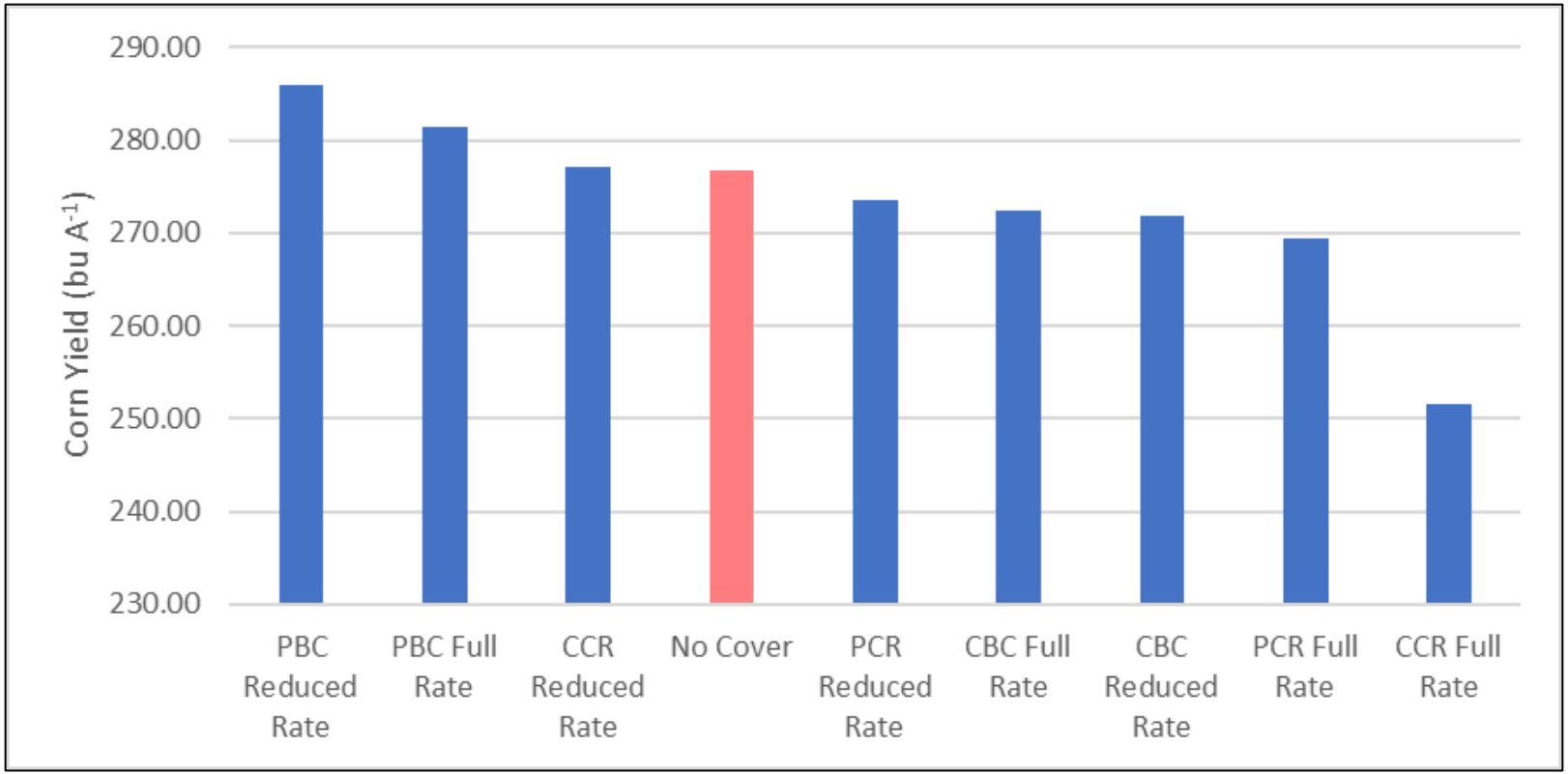
Cover Crop Performance (Southern IN, 2022)



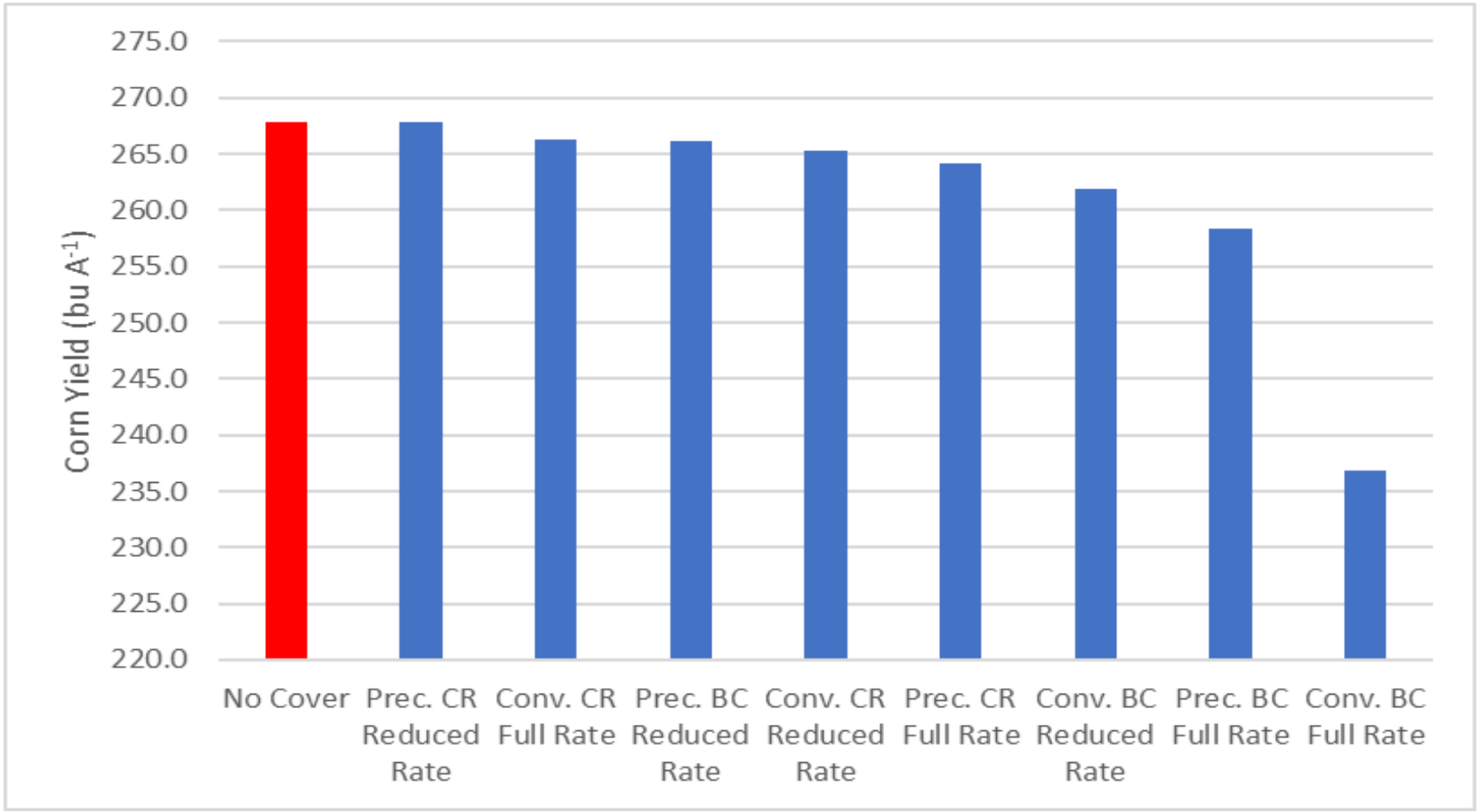


- **<u>Average C/N ratio for BC = 14 and CR=21</u>**
- Same cover crop biomass and N uptake with **50-75% less seed per acre.**

Corn Yield 2022 (Southern IN)



Corn Yield 2023 (Southern IN)



Exploring A Cereal Rye Alternative (Balansa Clover)

Cover Crop Species

1. Balansa Clover
2. Cereal Rye

Planting Method

1. Conventional
2. Precision

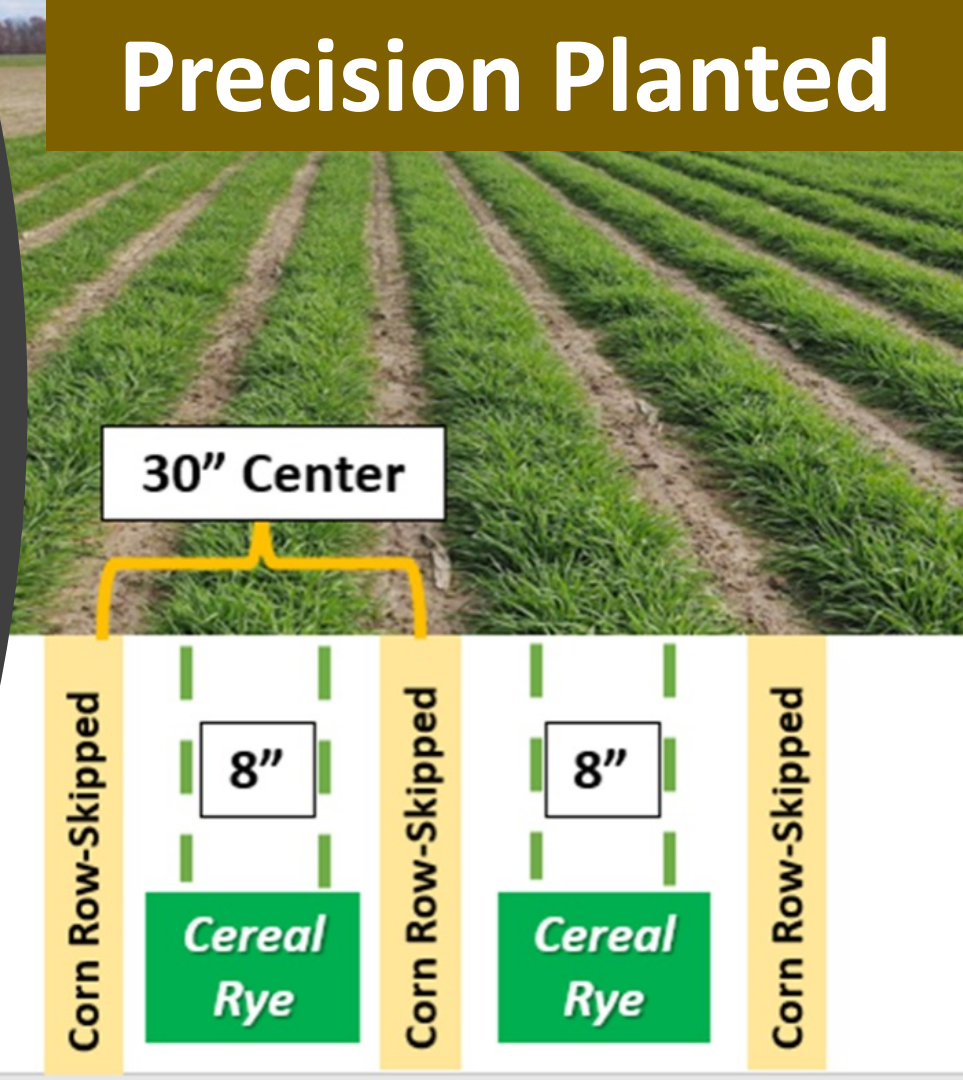
Nitrogen Rate

0, 40, 100, 150, 200, 250 lb A^{-1}

Cover crops

- **Planted Sept. 11th**
- **Terminated: CR (4/6) BC (5/20)**

Precision Planted

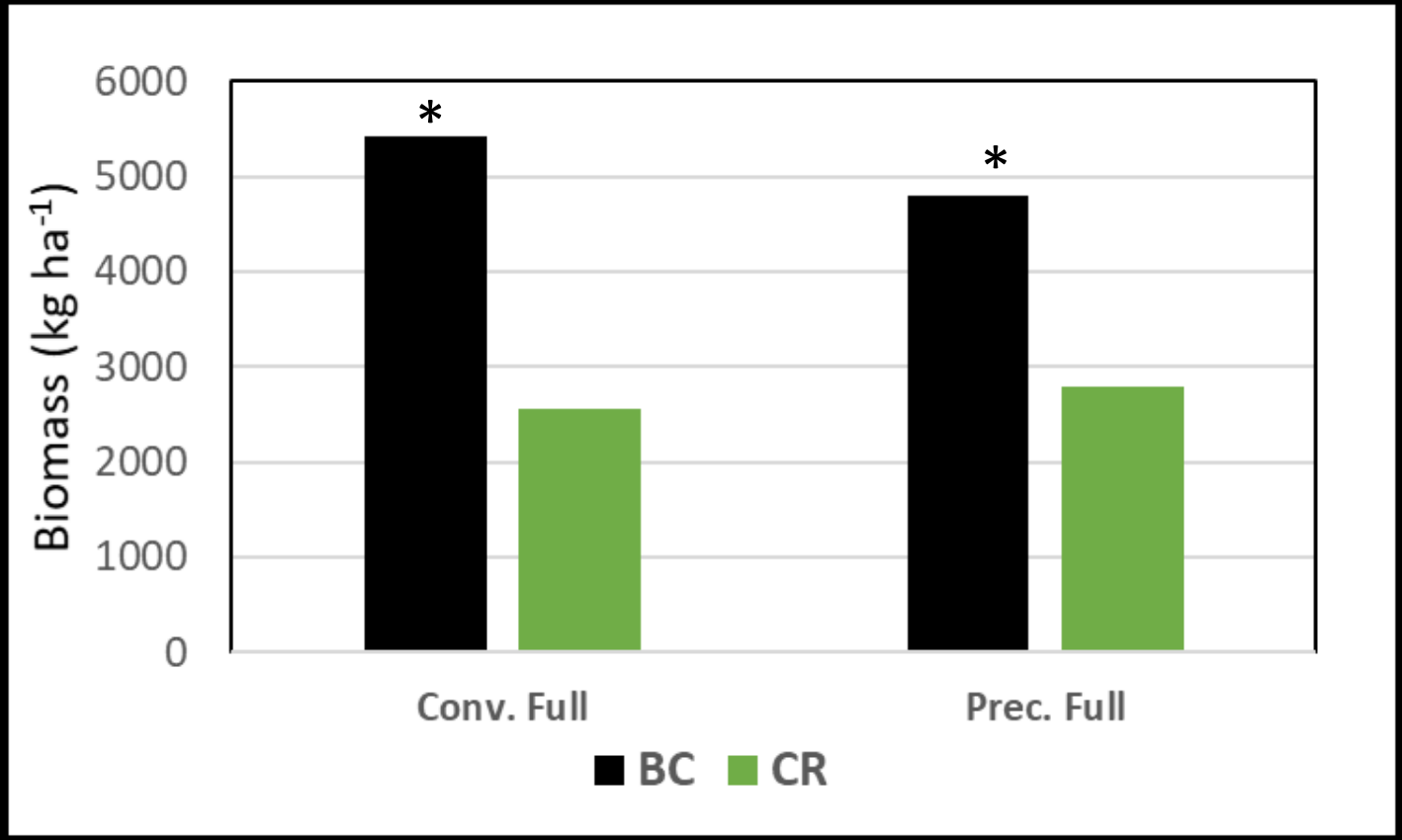


Cover Crop Growth

Balansa Clover May 15, 2021

Patience!

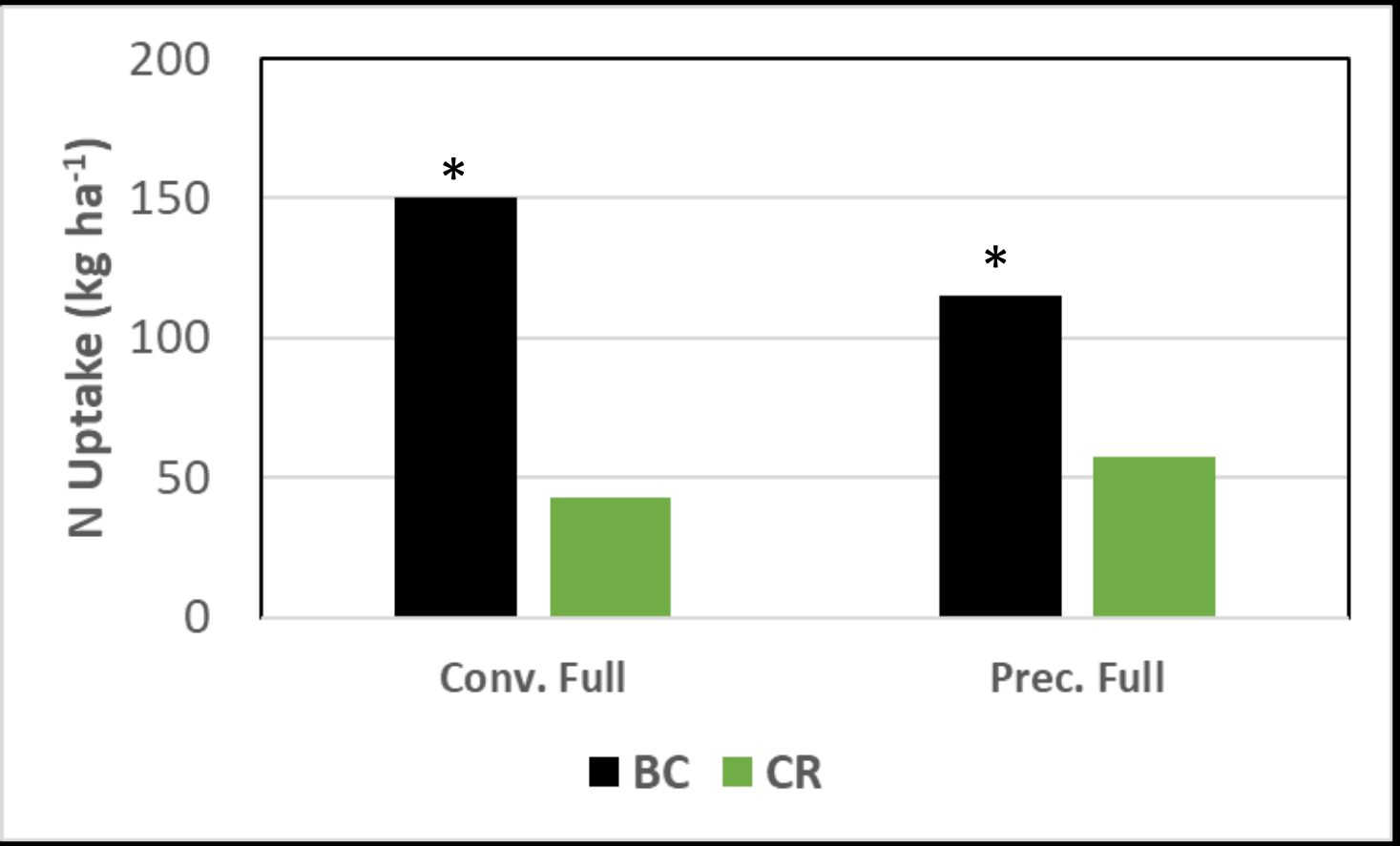
Cover Crop Performance 2021-2022



Average Biomass

- Balansa Clover **(4560 lbs A^{-1})**
- Cereal Rye **(2386 lbs A^{-1})**

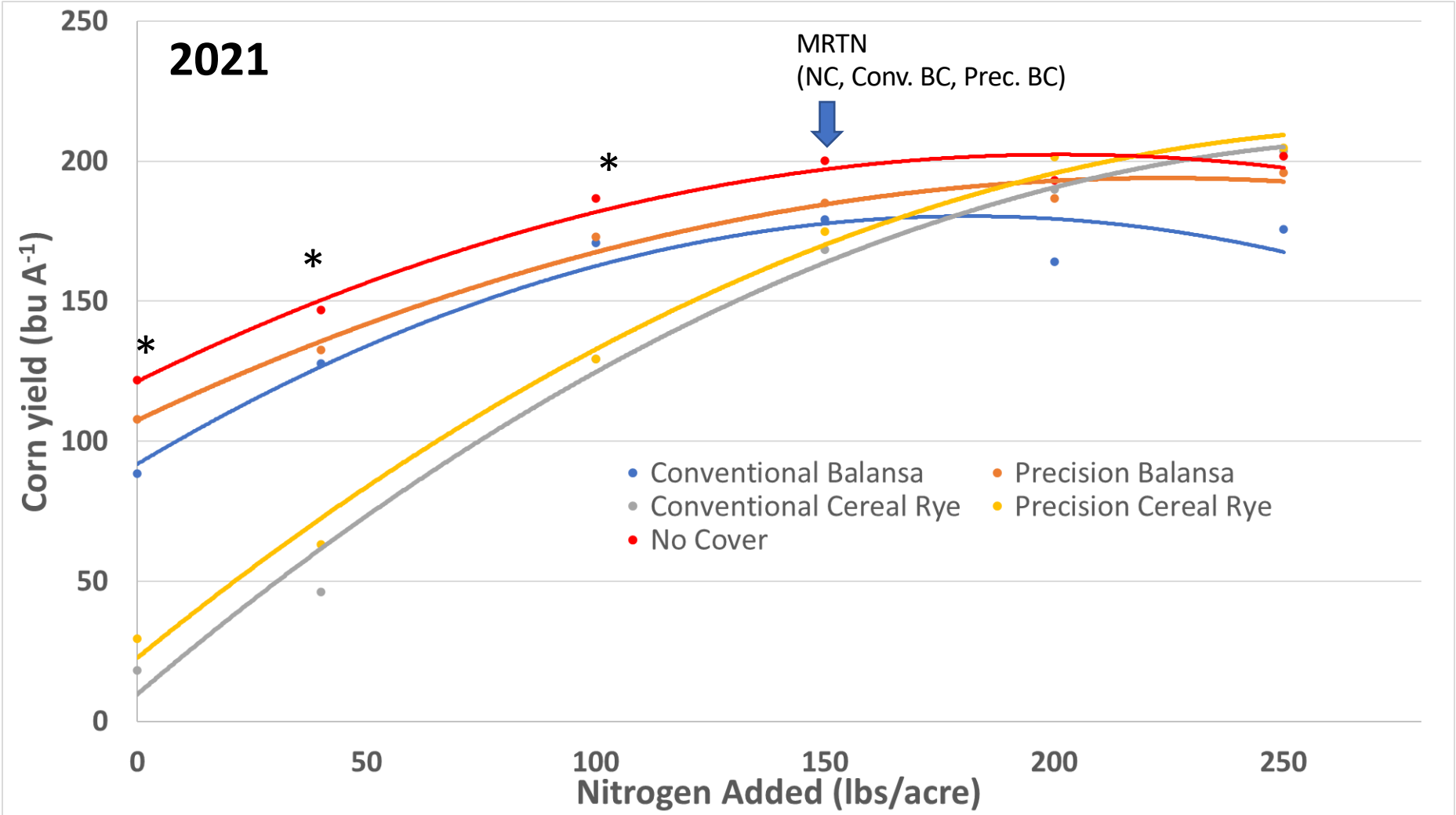
Cover Crop Performance 2021-2022



Average N Uptake

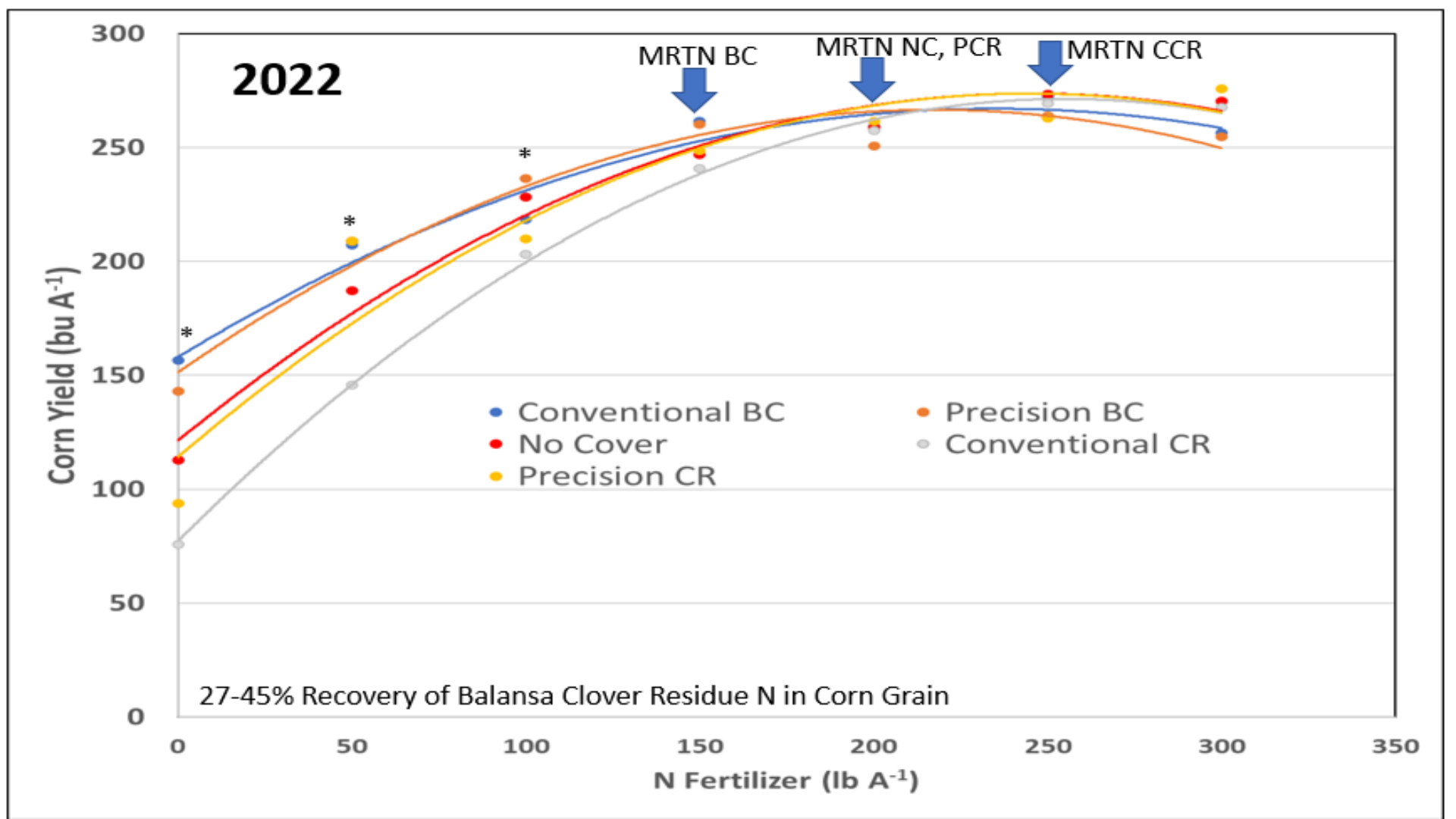
- Balansa Clover **(118 lbs A^{-1})**
- Cereal Rye **(45 lbs A^{-1})**

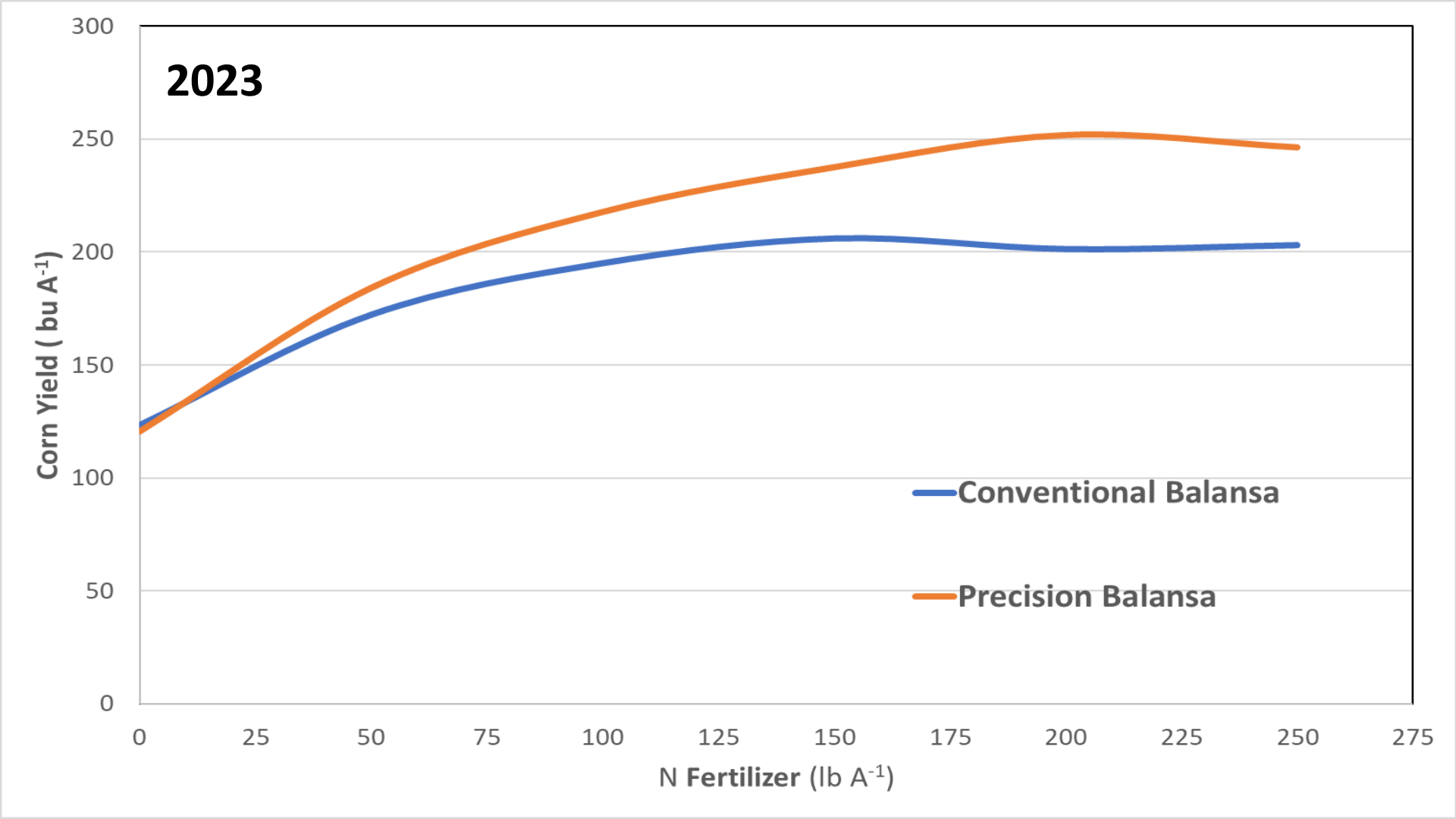
Planting Corn Green into Balansa Clover 2021


2021
MRTN
(NC, Conv. BC, Prec. BC)
Corn yield (bu A-1)
Nitrogen Added (lbs/acre)
0
50
100
150
200
250
*
*
*
Conventional Balansa
Precision Balansa
Conventional Cereal Rye
Precision Cereal Rye
No Cover

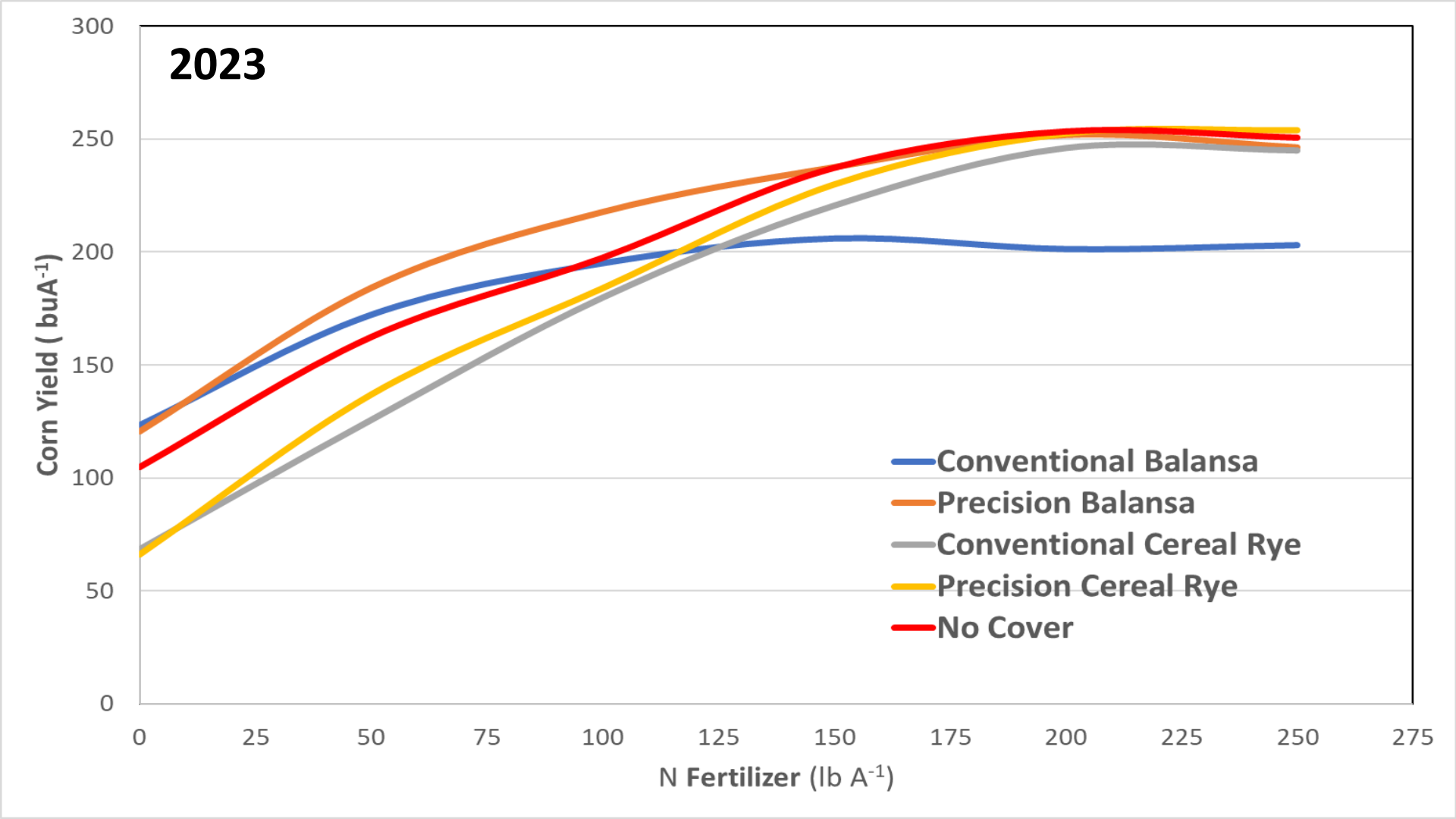
Harvest 2021

Planting Corn Brown-Green Into Balansa Clover 2022

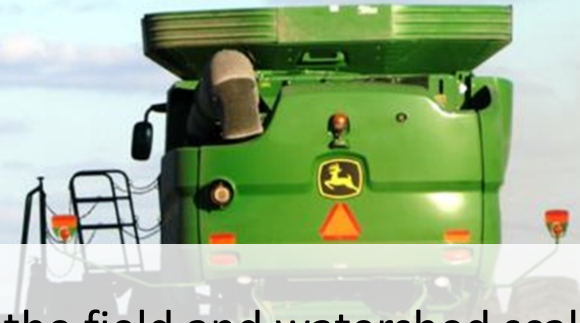

2022
MRTN BC
MRTN NC, PCR
MRTN CCR
Conventional BC
Precision BC
No Cover
Conventional CR
Precision CR
27-45% Recovery of Balansa Clover Residue N in Corn Grain
Corn Yield (bu A-1)
N Fertilizer (lb A-1)
0
50
100
150
200
250
300
350


2023
300
250
200
150
100
50
0
Corn Yield (bu A-1)
0
25
50
75
100
125
150
175
200
225
250
275
N Fertilizer (lb A-1)
Conventional Balansa
Precision Balansa


June 23, 2023
VS
Conv. BC
Prec. BC


2023
300
250
200
150
100
50
0
Corn Yield (buA-1)
0
25
50
75
100
125
150
175
200
225
250
275
N Fertilizer (lb A-1)
Conventional Balansa
Precision Balansa
Conventional Cereal Rye
Precision Cereal Rye
No Cover

Summary



- Inclusion of cover crops resulted in NO_3 loss reduction on the field and watershed scales (30-49%), reductions in N_2O, and the potential for DRP losses in surface runoff.
- Planting cover crops at 50-75% lower seeding rate generated equal biomass, biomass C and N.
- Precision planting cover crops at a reduced rate resulted in a greater corn yield potential.
- Balansa clover MRTN was 150 lb N/A, which was 100lbs N/A less than cereal rye plots 2 of 3 years and was 50lbs N/A less relative to no cover crop control 1 of 3 years.
- Adaptive management in cover crop systems can closes the yield gap while maintaining environmental quality.

Questions?

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@covercropDr

SARE PROJECT NUMBER (LNC20-432**)**

"Precision Winter Cereal Rye Cover Cropping for Improving Farm Profitability and Environmental Stewardship"

More Details on Balansa Clover Trials