Proceedings of the 4th Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference

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Cover crops: Where does the nitrogen go

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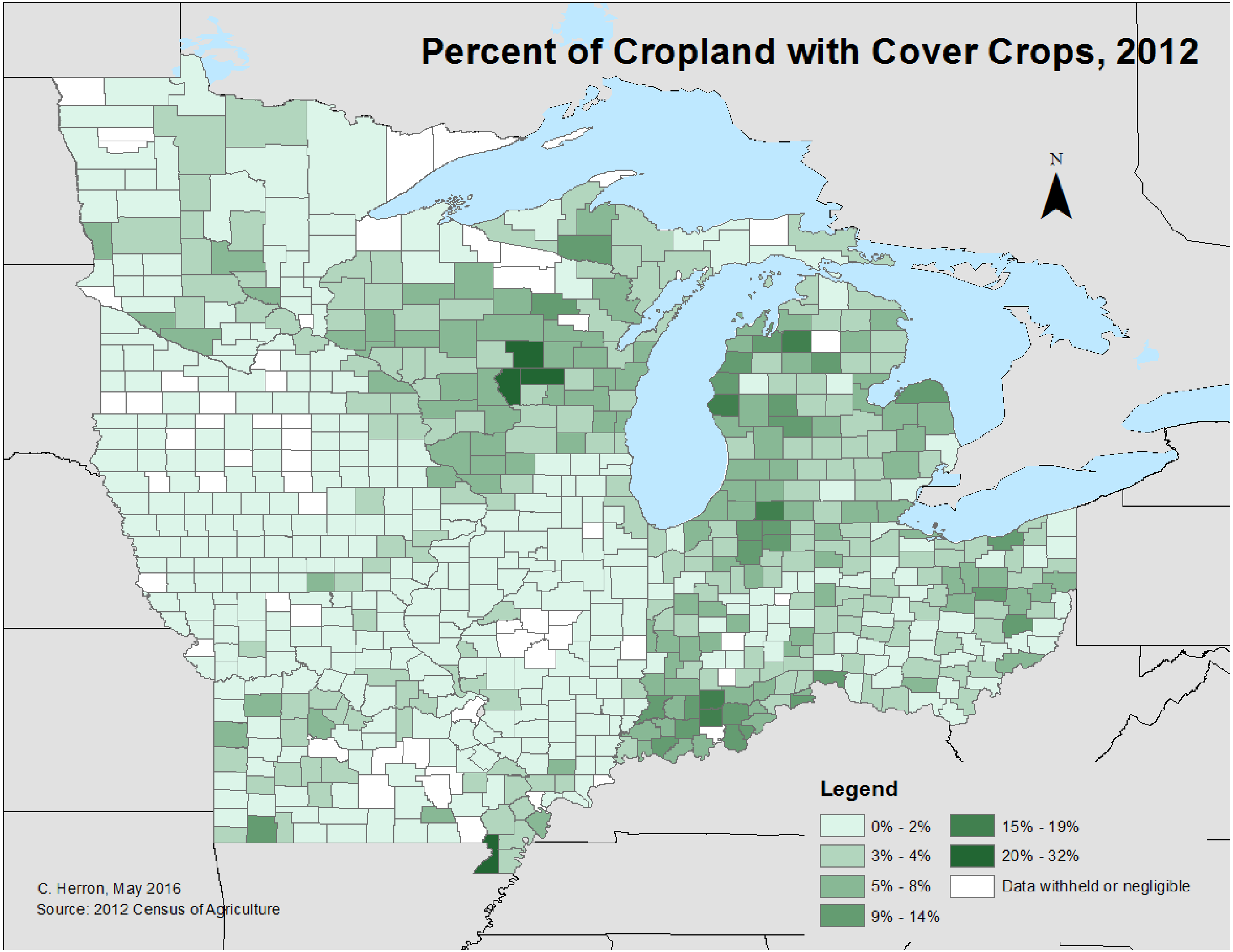

Percent of Cropland with Cover Crops, 2012
N
Legend
0% - 2%
3% - 4%
5% - 8%
9% - 14%
15% - 19%
20% - 32%
Data withheld or negligible
C. Herron, May 2016
Source: 2012 Census of Agriculture

Grasses

Winter rye (or cereal rye)
Annual ryegrass
Oat
Barley
Triticale

- Establish and grow quickly
- Scavenge soil nitrogen
- High C:N ratio

Brassicas

Radish
Mustard
Turnip

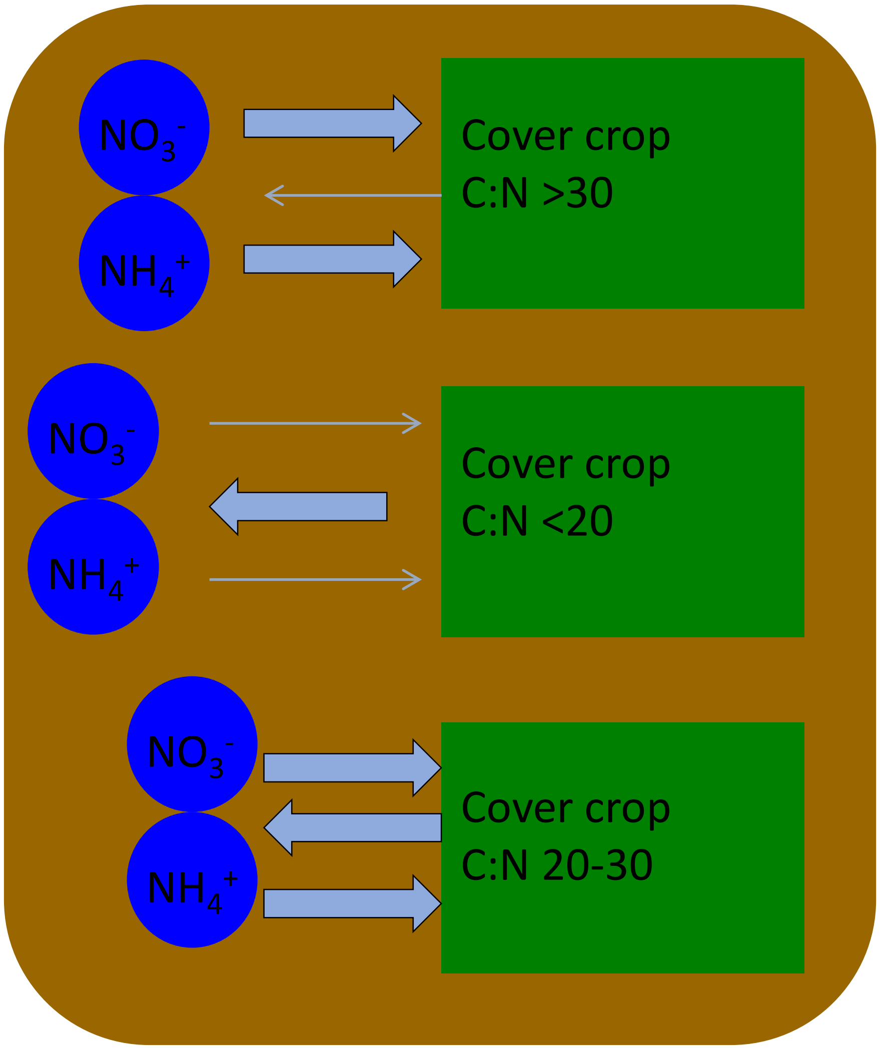
- Slower to establish
- Scavenge soil nitrogen (even more than the grasses if given enough time)
- Medium C:N ratio

Legumes

Red Clover
Berseem Clover
Crimson Clover
Hairy Vetch

- Slower to establish
- Fix N from atmosphere
- Low C:N ratio

Why the C:N ratio matters



Soil microorganisms degrade plant material.

They need nitrogen to do this.

If plant material has a high C:N ratio (>30), then the soil microbes use the N in the soil.

If the plant material has a low C:N ratio (<20), then there plant material can supply more than enough N for the microbes and a lot of N is left over after the plant decomposes

Good Opportunity for fall cover in WI

- 1,000,000 ac corn silage

(USDA-NASS, 2016)

Study objectives

- Evaluate fall seeded cover crop performance with manure
  - Cover crop growth and N uptake
  - Changes in soil N at preplant
    - Plant available N (NO_3 + NH_4)
    - Potentially mineralizable nitrogen (PMN)
  - Effect on grain yield
- Optimize nitrogen rate for corn yield following cover crop

THREE GRASS COVER CROPS

Four main treatments, RCBD:

- **Winter Rye** (90-100 kg ha^{-1} PLS)
- **Spring Barley** (85-100 kg ha^{-1} PLS)
- **Annual Ryegrass** (15-20 kg ha^{-1} PLS)
- No cover crop

Main treatments were split treated at 6 rates of N, replicated 4 times.

BARLEY		No CC		ARG		W. Rye	
1427	1428	1429	1430	1431	1432	1433	1434
1415	1416	1417	1418	1419	1420	1421	1422
1403	1404	1405	1406	1407	1408	1409	1410
1327	1328	1329	1330	1331	1332	1333	1334
1315	1316	1317	1318	1319	1320	1321	1322
1303	1304	1305	1306	1307	1308	1309	1310
1227	1228	1229	1230	1231	1232	1233	1234
1215	1216	1217	1218	1219	1220	1221	1222
1203	1204	1205	1206	1207	1208	1209	1210
1127	1128	1129	1130	1131	1132	1133	1134
1115	1116	1117	1118	1119	1120	1121	1122
1103	1104	1105	1106	1107	1108	1109	1110
15	15	15	15	15	15	15	15

STUDY TIMELINE

- Harvest corn silage
- Inject or incorporate liquid dairy manure
- Drill seed cover crops

- Winter rye burndown with glyphosate
- Plant corn
- Apply urea

- Harvest corn grain

Sept.

Nov.

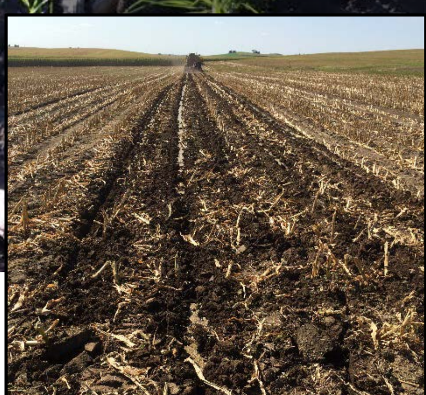
Apr.- May

Oct.-Nov.

Samples:

Winterkill

Preplant




★ **Hancock ARS**

Central Sands of WI

Sparta loamy sand

- Excessively drained
- I = 220 ton/ac/year

★ **Arlington ARS**

South-central WI

Plano silt loam

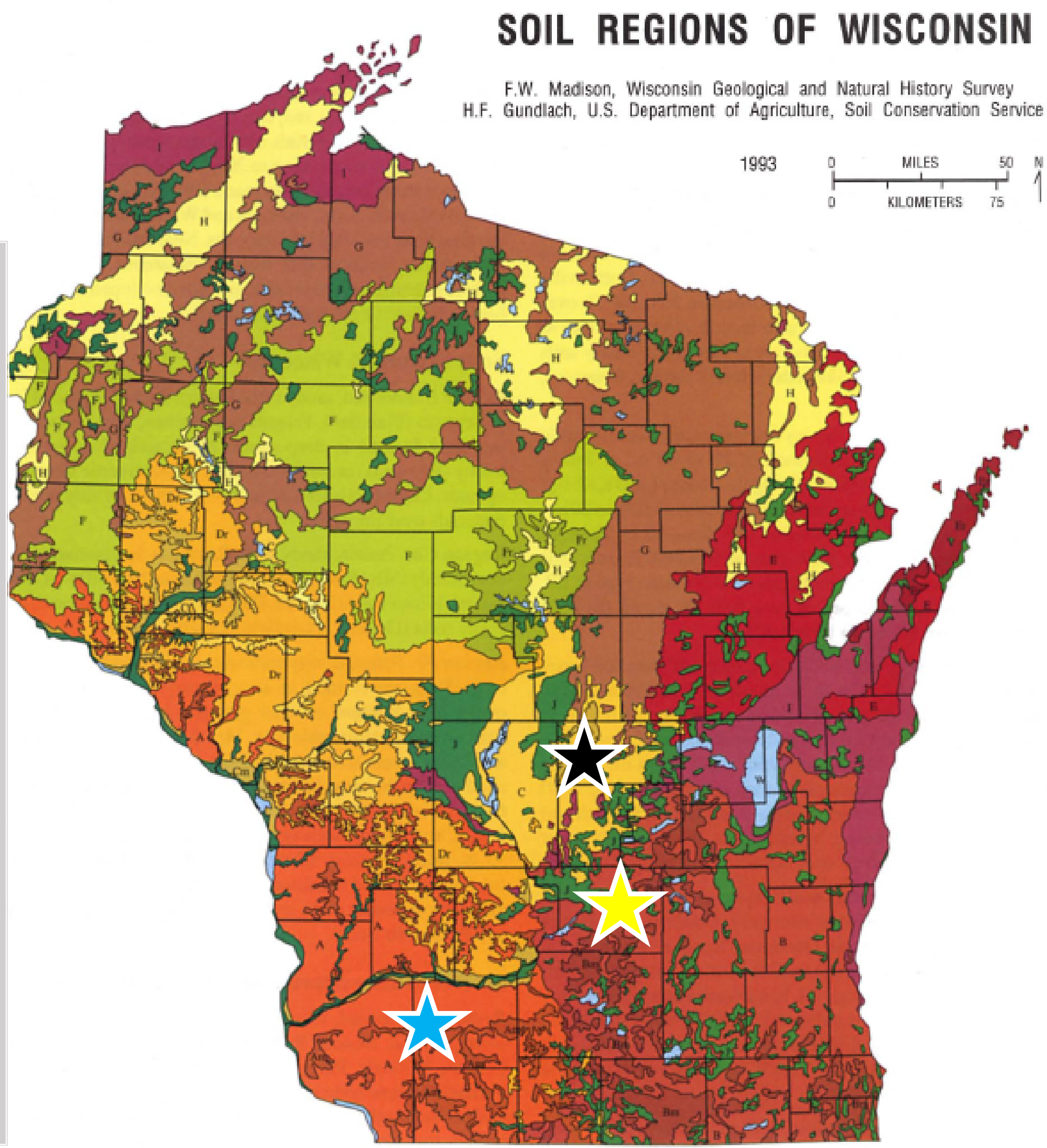
- Very deep
- Well drained

★ **Lancaster ARS**

Southwest WI

Fayette silt loam

- Well drained
- 2-6% slopes
- Moderately eroded



Adapted from Hole, F.D., et al., 1968, Soils of Wisconsin: Wisconsin Geological and Natural History Survey, scale 1:710,000.

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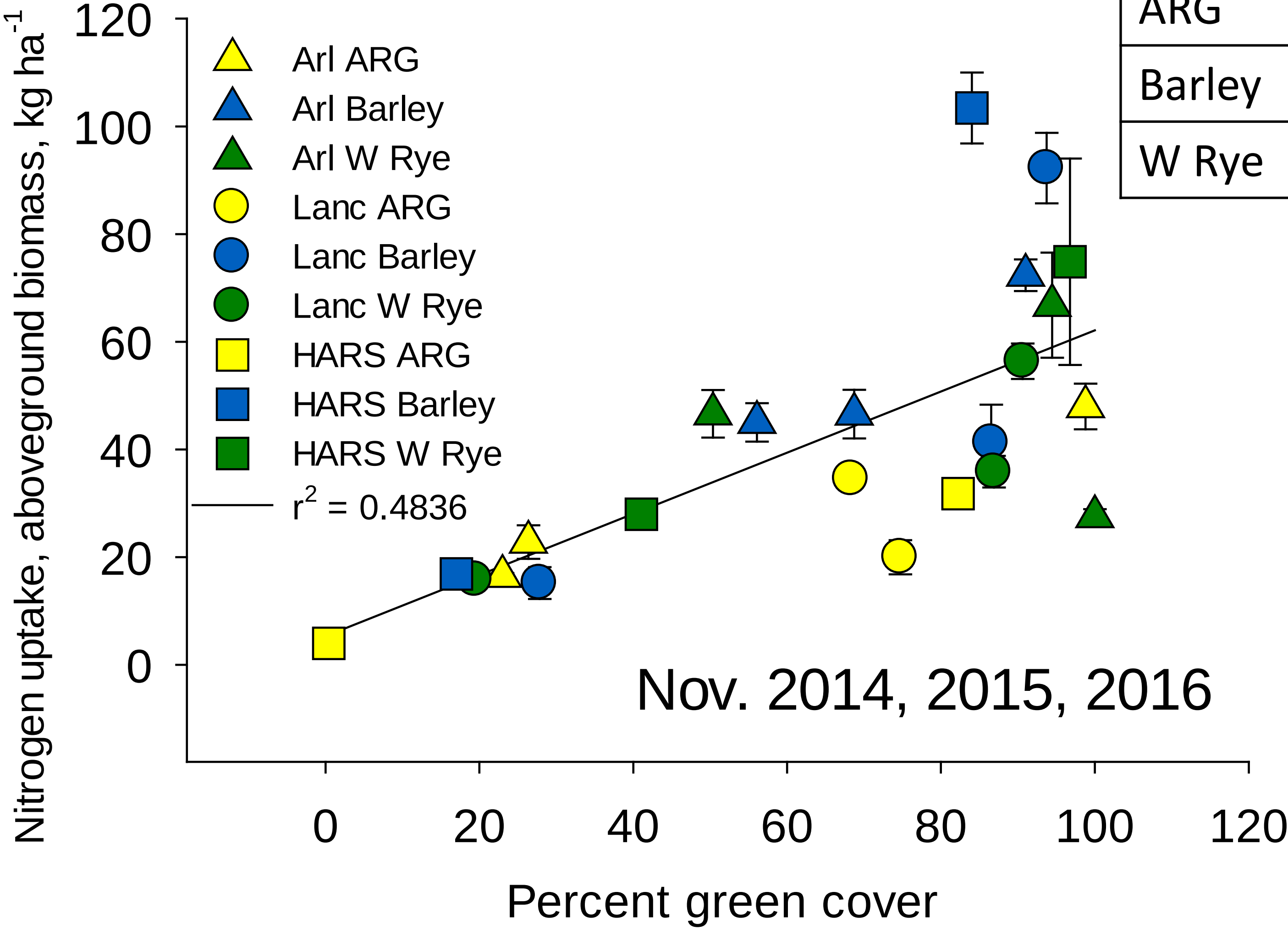
COVER & SOIL RESULTS

Cover crop growth

Ground coverage vs. N uptake

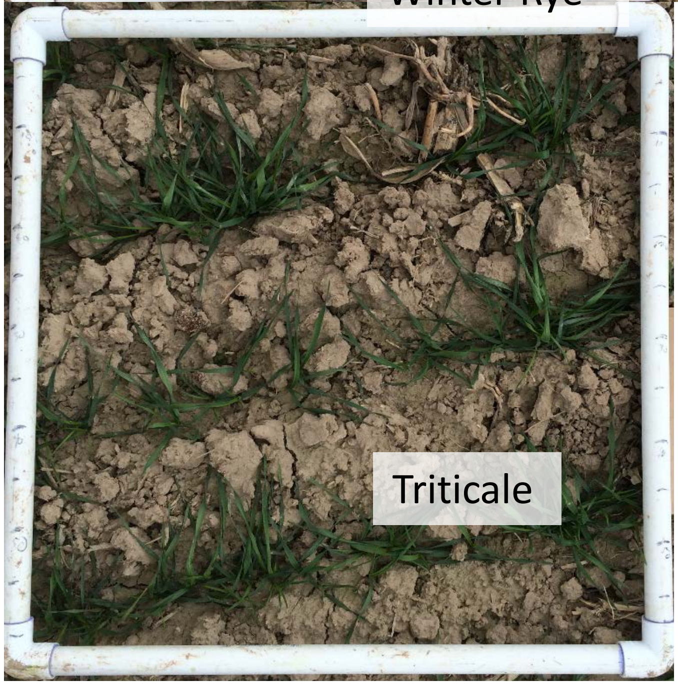


Nov. Cover	**kg N ha^{-1}**
ARG	5-45
Barley	10-110
W Rye	15-70

November 13, 2014

Lancaster ARS

1/8 ton DM biomass



November 14, 2014

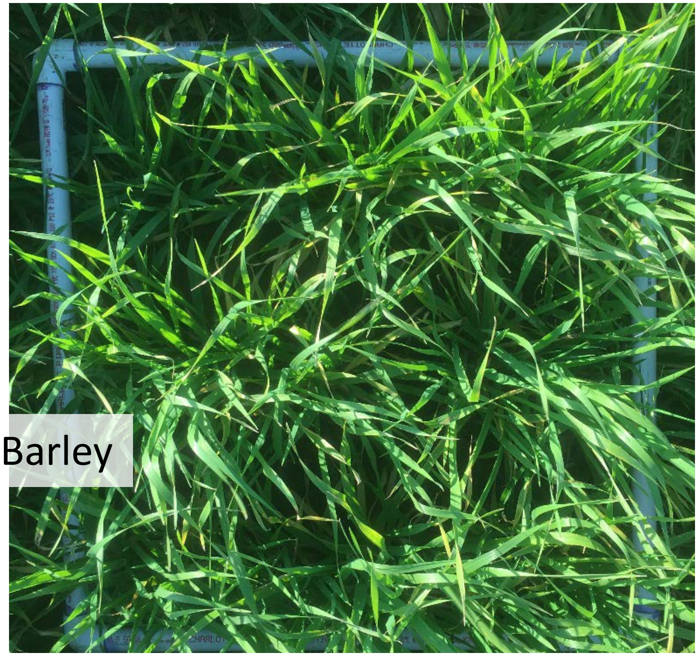
Arlington ARS

1/3 ton DM biomass

November 16, 2016

Marshfield ARS

¾ to 1 ton DM biomass



Δ Plant available nitrogen (PAN), 0-24 in

$$\Delta \text{ PAN} = (NO_3+NH_4)_{\text{Cover crop}} - (NO_3+NH_4)_{\text{No Cover crop}}$$

Mean PAN $_{\text{No Cover crop}}$ (0-24 in):

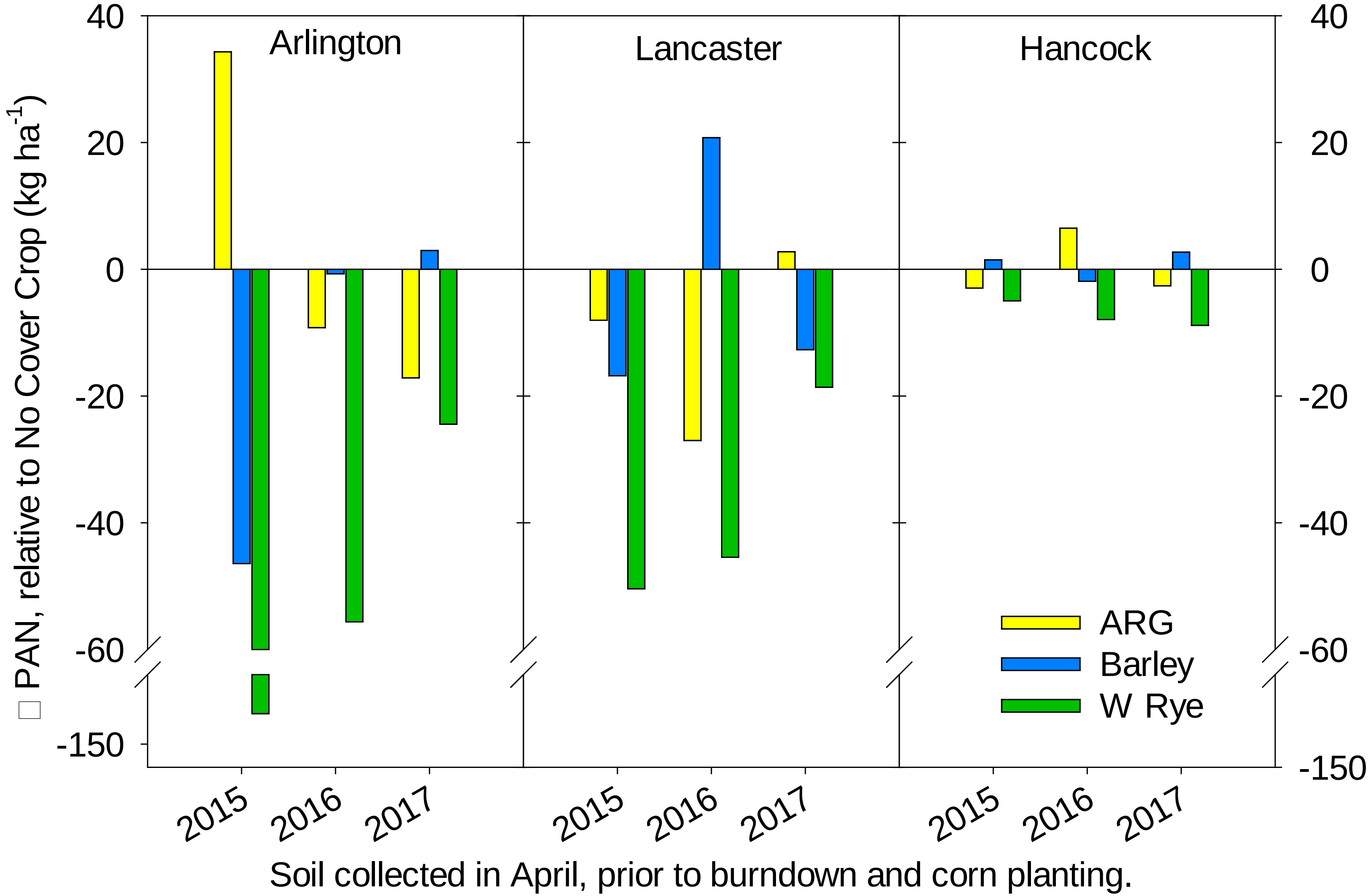
Arlington = 120 lb N ac^{-1}

Lancaster = 85 lb N ac^{-1}

Hancock = 35 lb N ac^{-1}

Δ Plant available nitrogen (PAN), 0-60 cm

$\Delta PAN = (NO_3 + NH_4)_{Cover\ crop} - (NO_3 + NH_4)_{No\ Cover\ crop}$

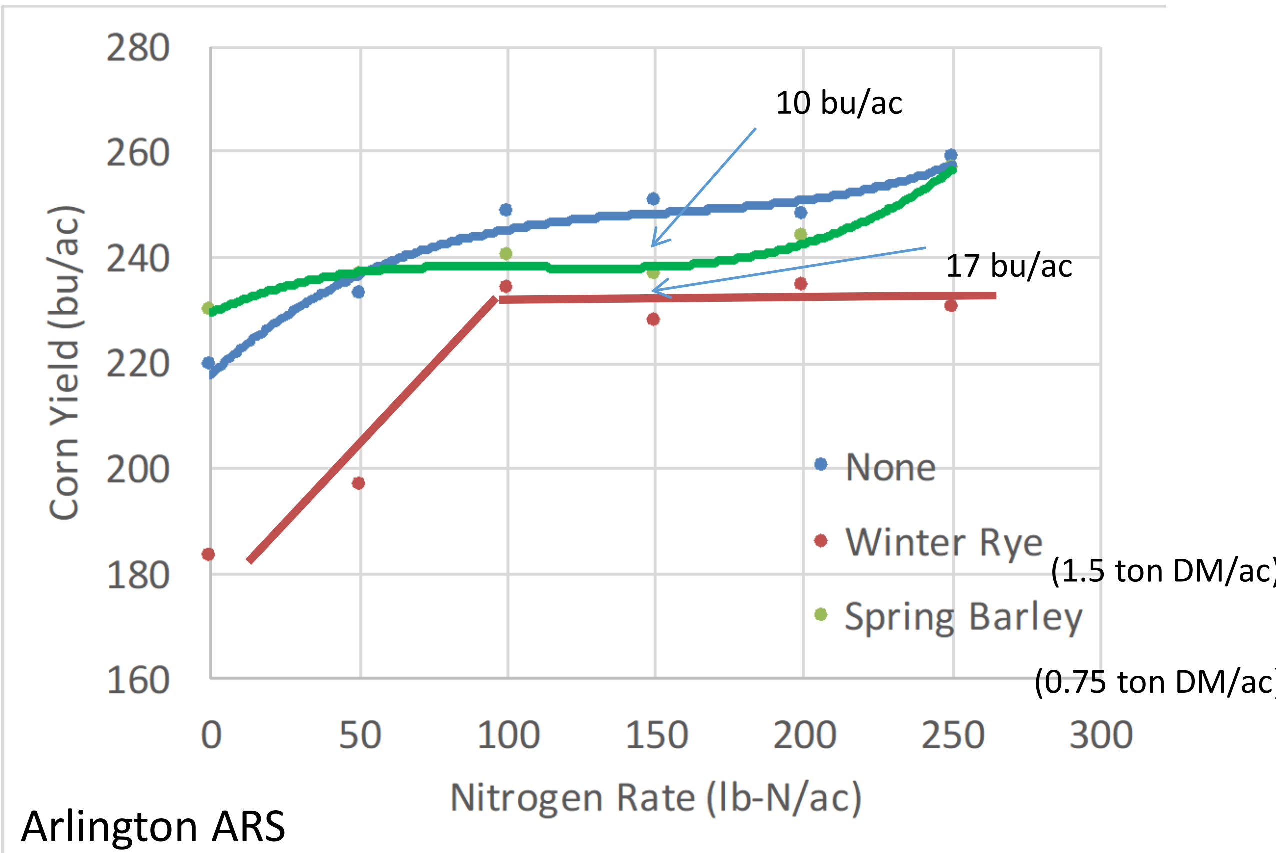


Cover crops wipe out some of the manure N credit based on PSNT

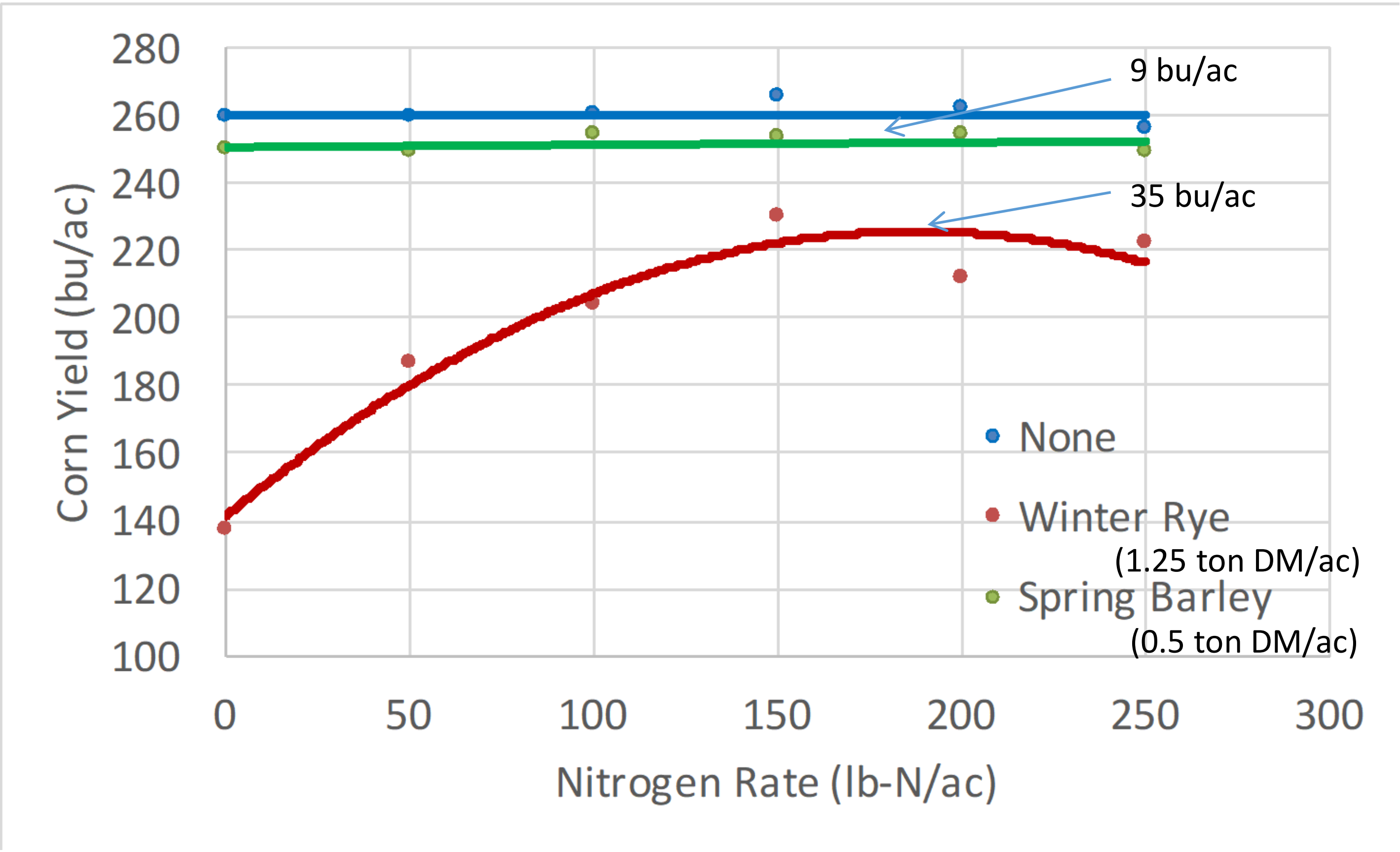
	ARL		LAN	
	ppm	N credit	ppm	N credit
None	14	35	13	35
Barley	18	100	16	60
Rye	11	10	5	0
Triticale	5	0	6	0

Yields

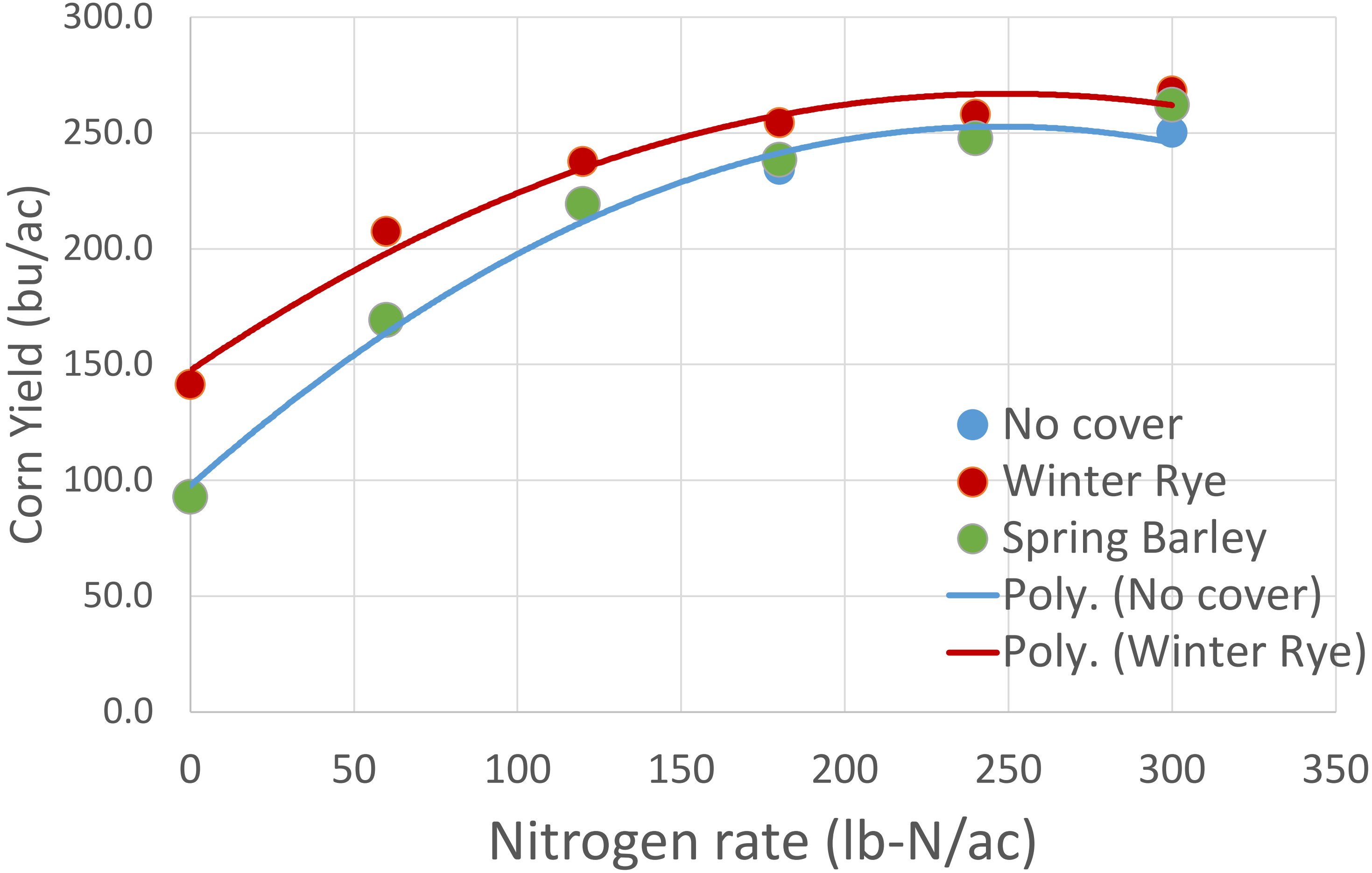
Yield drag flowing covers, although with spring barley can be reduced with more N



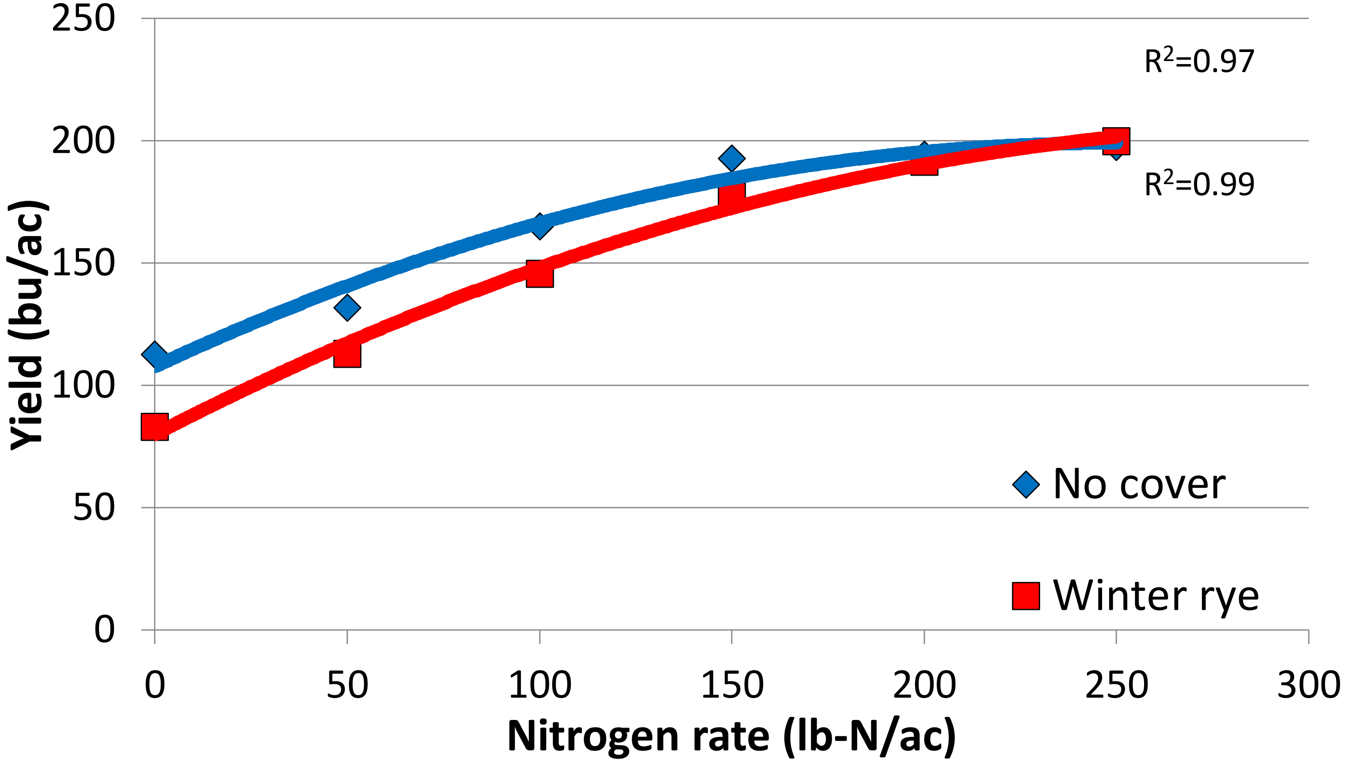
Flat responses at LAN, but still yield drag with spring barley. Larger yield drag (+30 bu/ac) with winter rye.



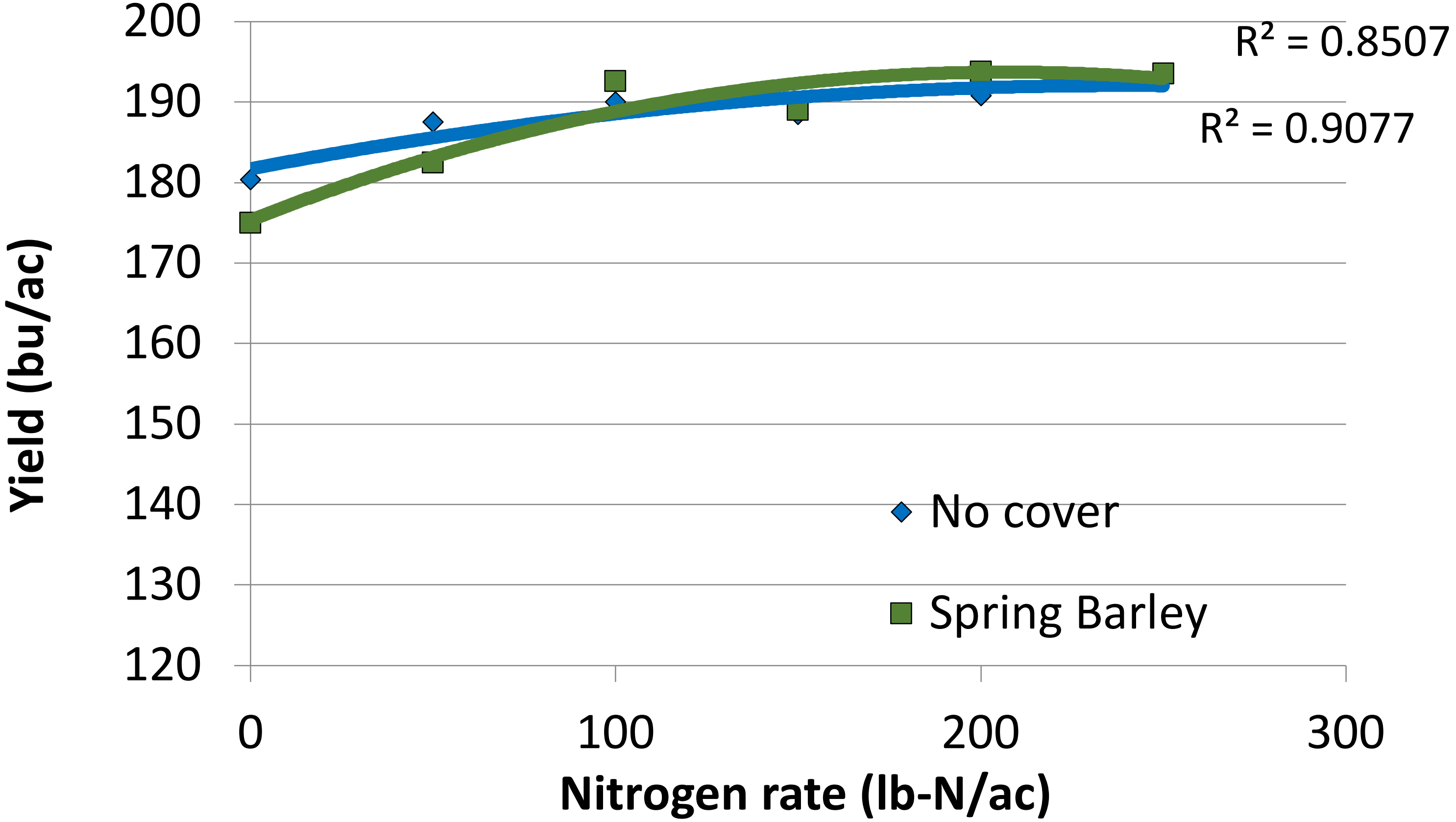
Winter rye led to yield bump on irrigated sands?



No yield drag, but different optimum N rate for winter rye (Lancaster 2015)



No statistical difference in yields among no cover and winter-killed covers (Arlington 2015)



Corn

Average Yield Difference of the 50 trials displayed: **0.0** bu/acre.

90% Confidence Interval for the Average Yield Difference: from **-1.0** to **1.0** bu/acre.

Soybean

Average Yield Difference of the 12 trials displayed: **0.2** bu/acre.

90% Confidence Interval for the Average Yield Difference: from **-0.6** to **1.0** bu/acre.

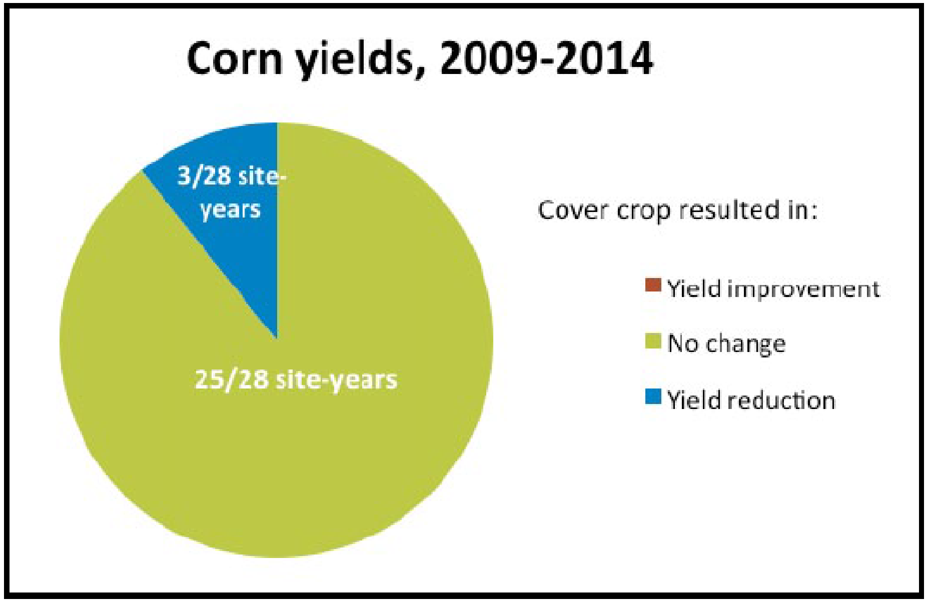


Figure 2. Trends with respect to cover crop effect on corn yields at 28 site-years from 2009 to 2014.

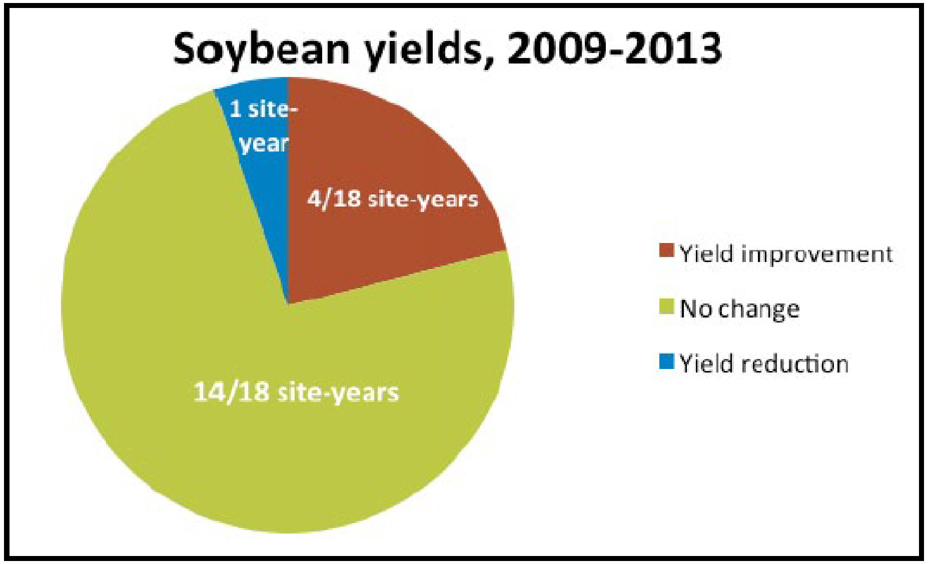
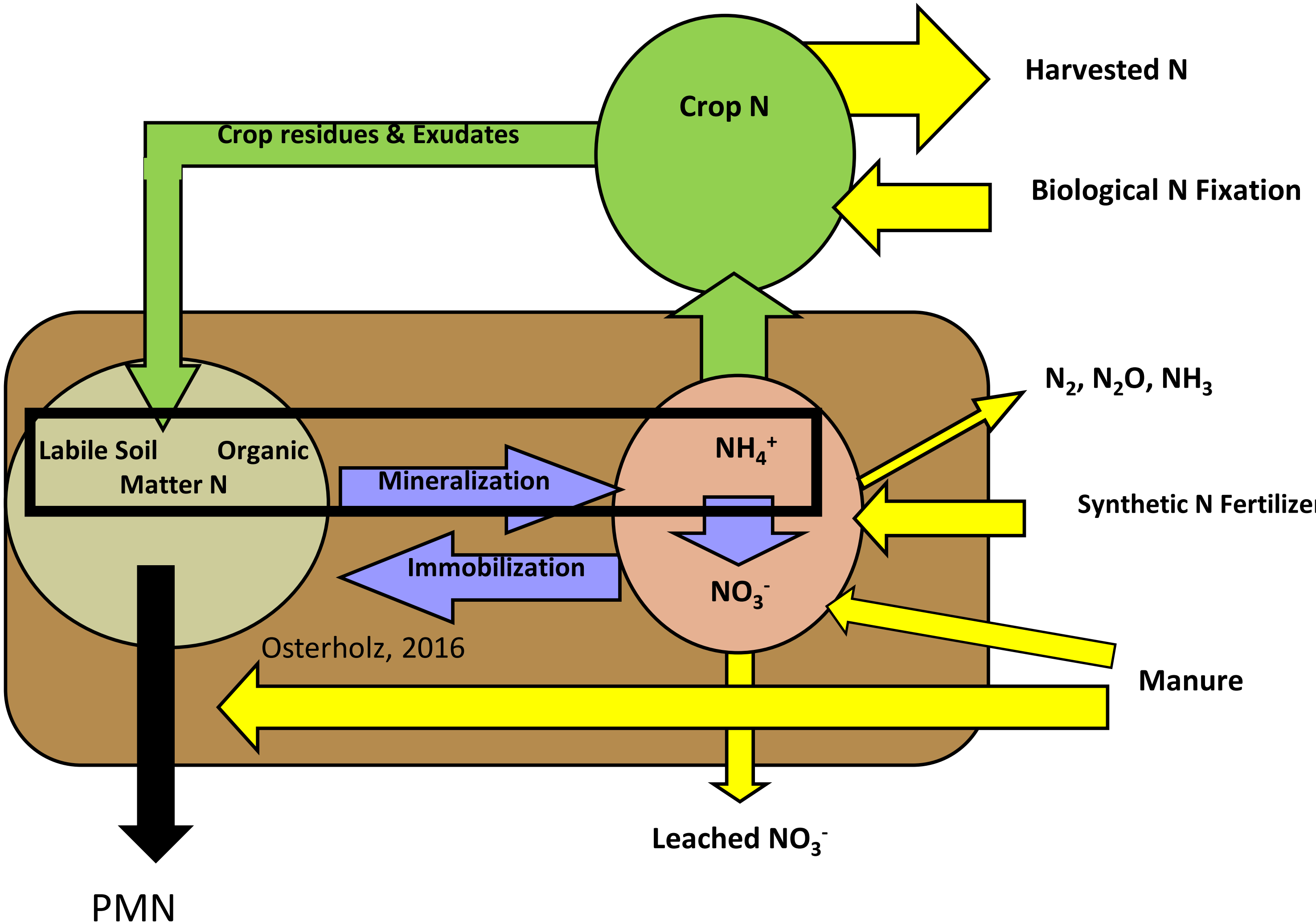


Figure 3. Trends with respect to cover crop effect on soybean yields at 18 site-years from 2009 to 2013.

Labile soil N pools indicate soil nutrient availability for crops



Potentially mineralizable nitrogen (PMN)

Organic soil N → NH_4^+

- Measure NH_4-N
- Incubate at 100°F for one week, under water
- Measure increase in NH_4-N

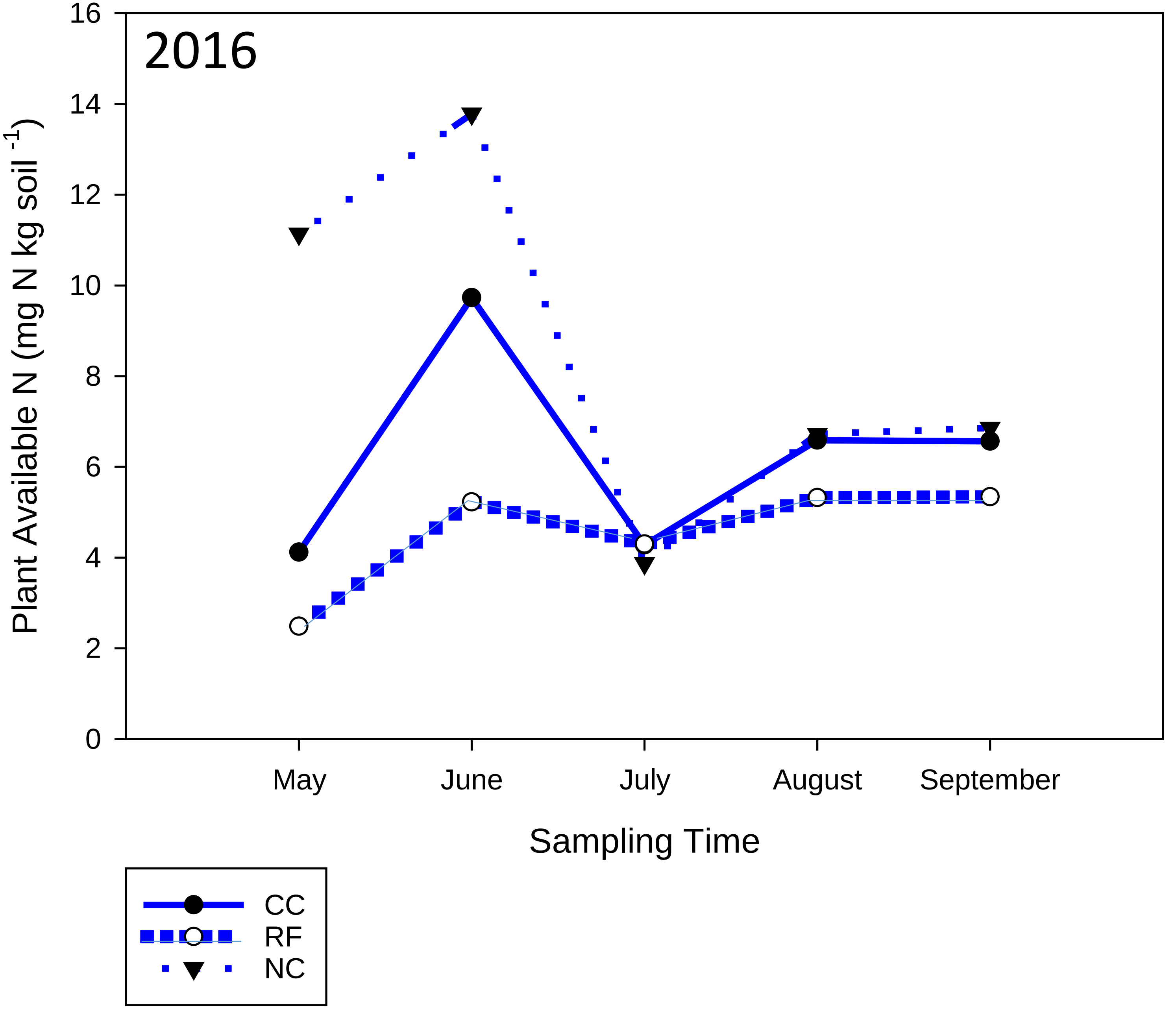
Is an indirect measure of N supply from soil

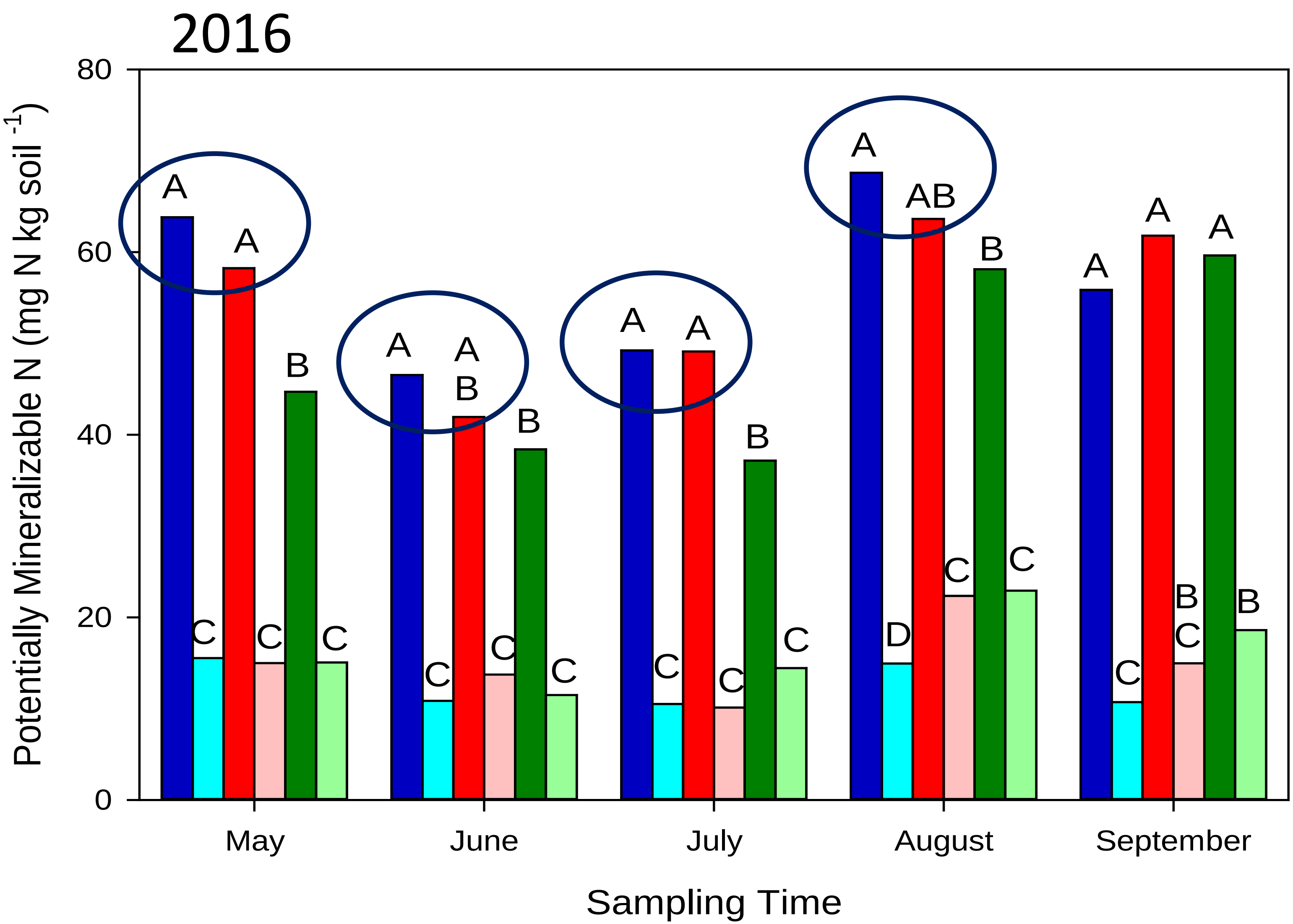
Continual cover crop rotation trial – Arlington, WI

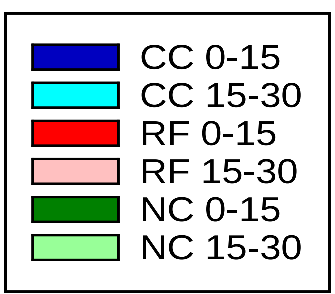
Established in 2011 a continual corn silage rotation with fall manure

Cover crop treatments:

- Rye as a cover (CC)
- Rye as a forage (RF)
- No cover (NC)


2016
Plant Available N (mg N kg soil $^{-1}$)
0
2
4
6
8
10
12
14
16
May
June
July
August
September
Sampling Time
CC
RF
NC





Rye, as a cover and as a forage, had greater PMN throughout most of the 2016 growing season.

N rate	None	Rye	Rye-forage
lb-N/ac	ton/ac (65% moisture)		
0	25.7	18.9	13.2
60	24.7	23.3	20.9
100	23.2	24.8	22.4
160	26.3	22.6	25.1

Where does the nitrogen go (grass cover crops)

- Into the plant
  - Over the short-term wipes out PPNT
  - Over the short-term reduces manure N credit
- Into the soil organic matter
  - Over the long-term builds labile N pool

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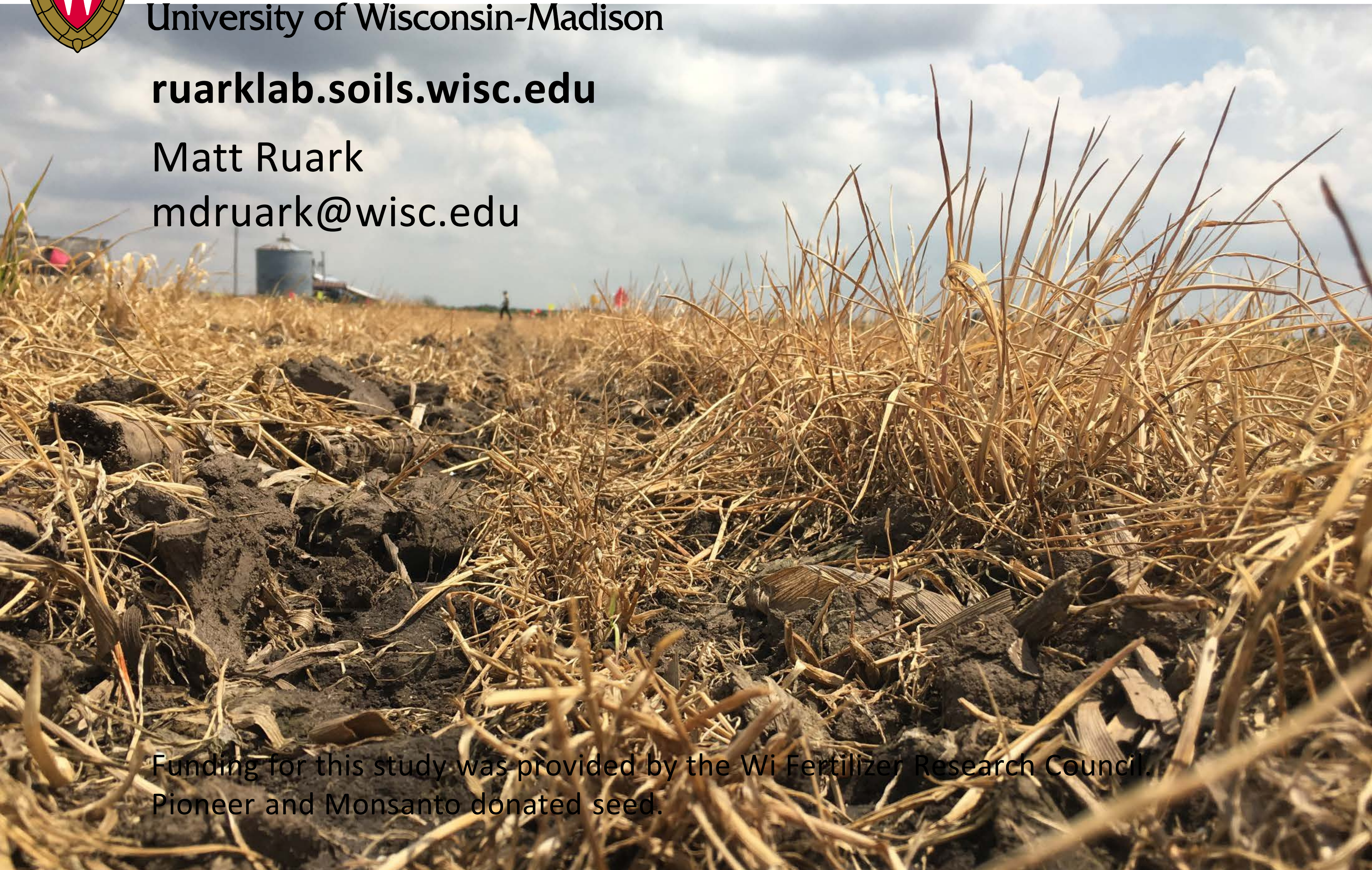

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