Drainage Nutrient Losses Under Multiple Conservation Practices

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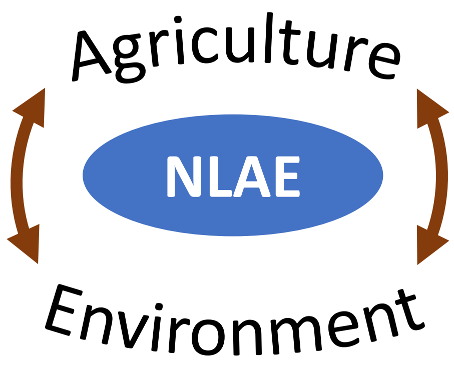
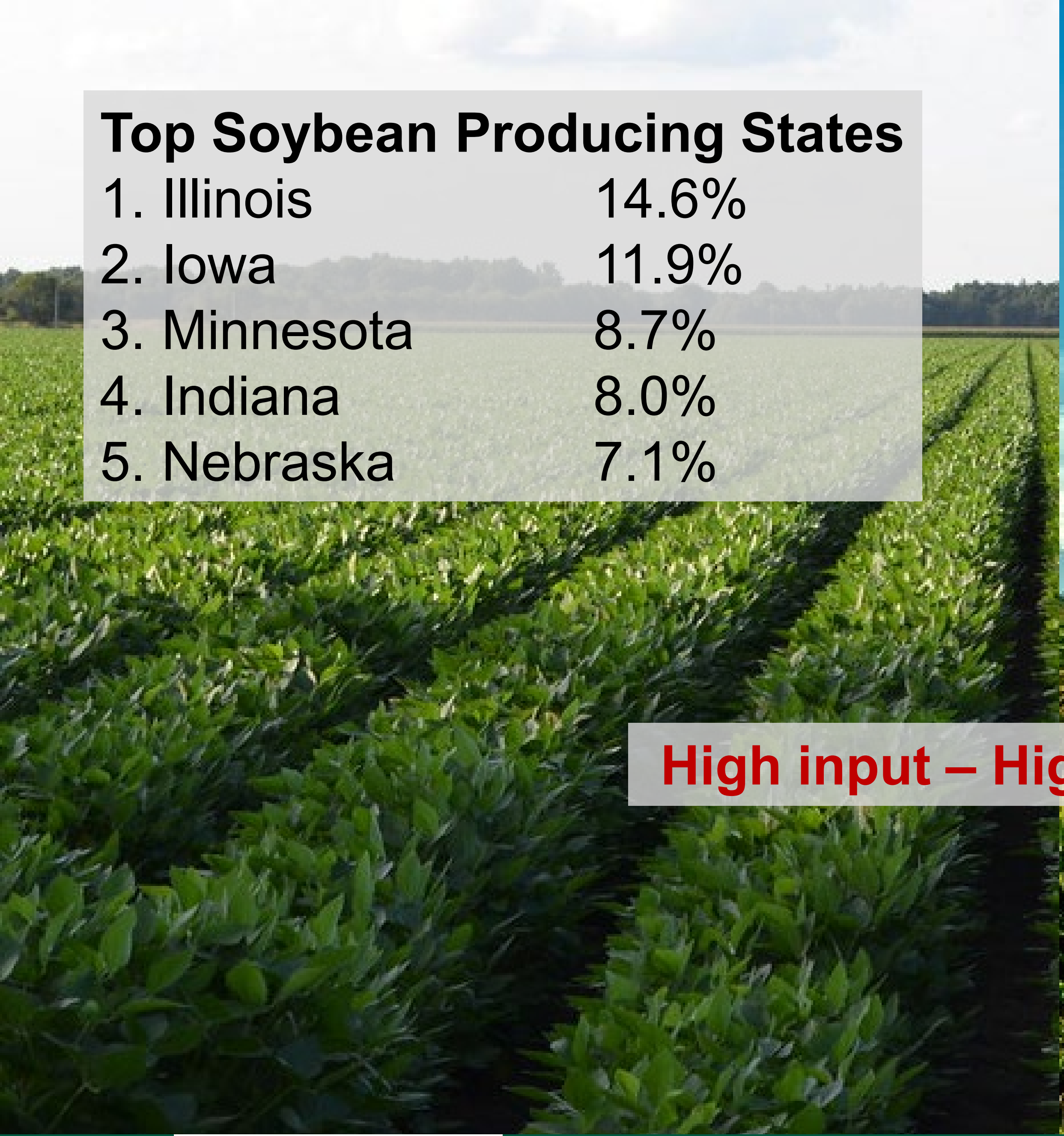
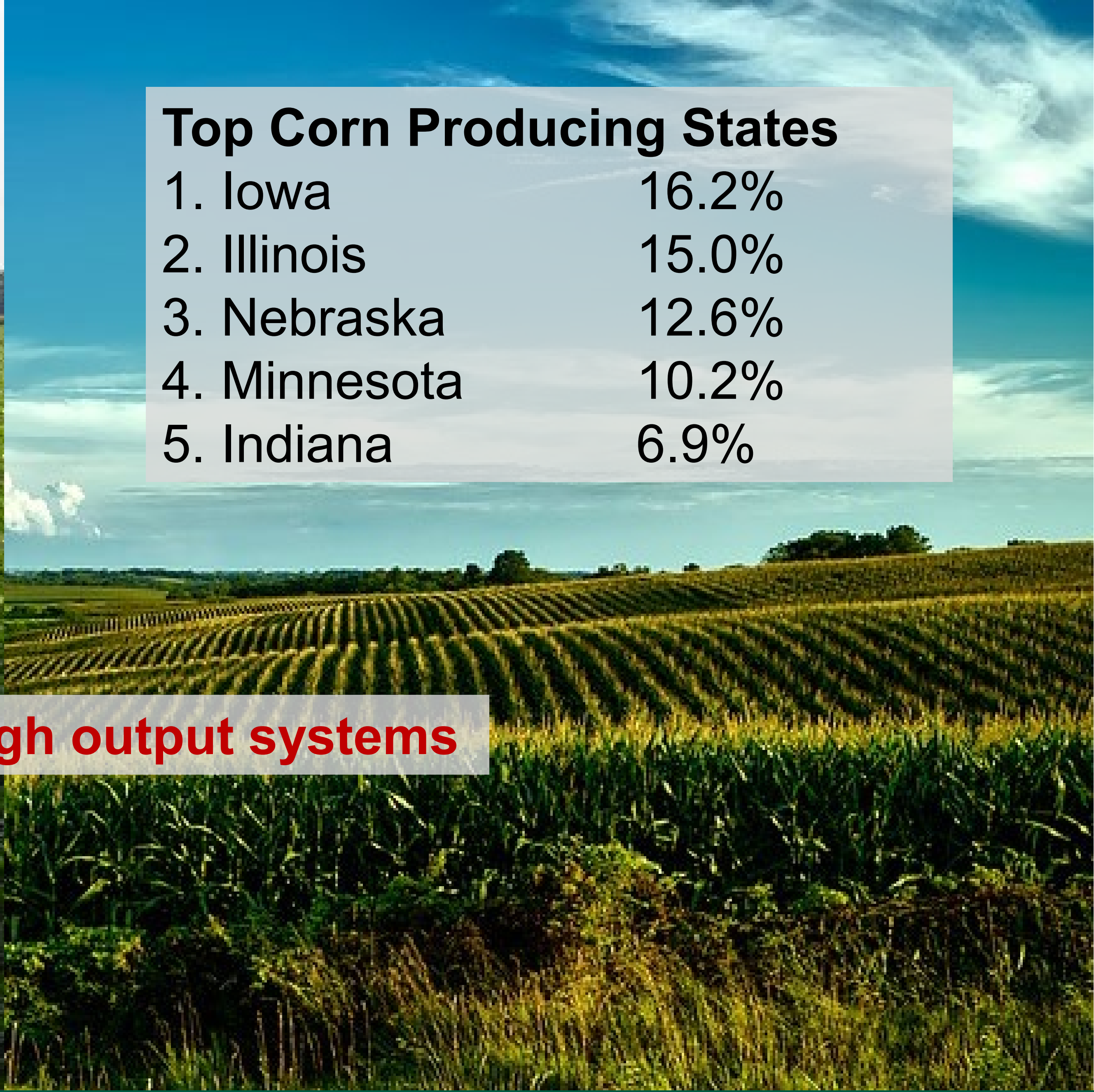
USDA Agricultural Research Service

USDA-ARS: National Laboratory for Agriculture and the Environment



Mission: *The mission of the lab is to generate information addressing critical problems in agriculture and watershed management to develop innovative solutions which increase the efficiency of agriculture systems and reduce environmental risk. Transdisciplinary teams address this through coordinated research in abiotic and biotic systems.*

Top Soybean Producing States	
1. Illinois	14.6%
2. Iowa	11.9%
3. Minnesota	8.7%
4. Indiana	8.0%
5. Nebraska	7.1%

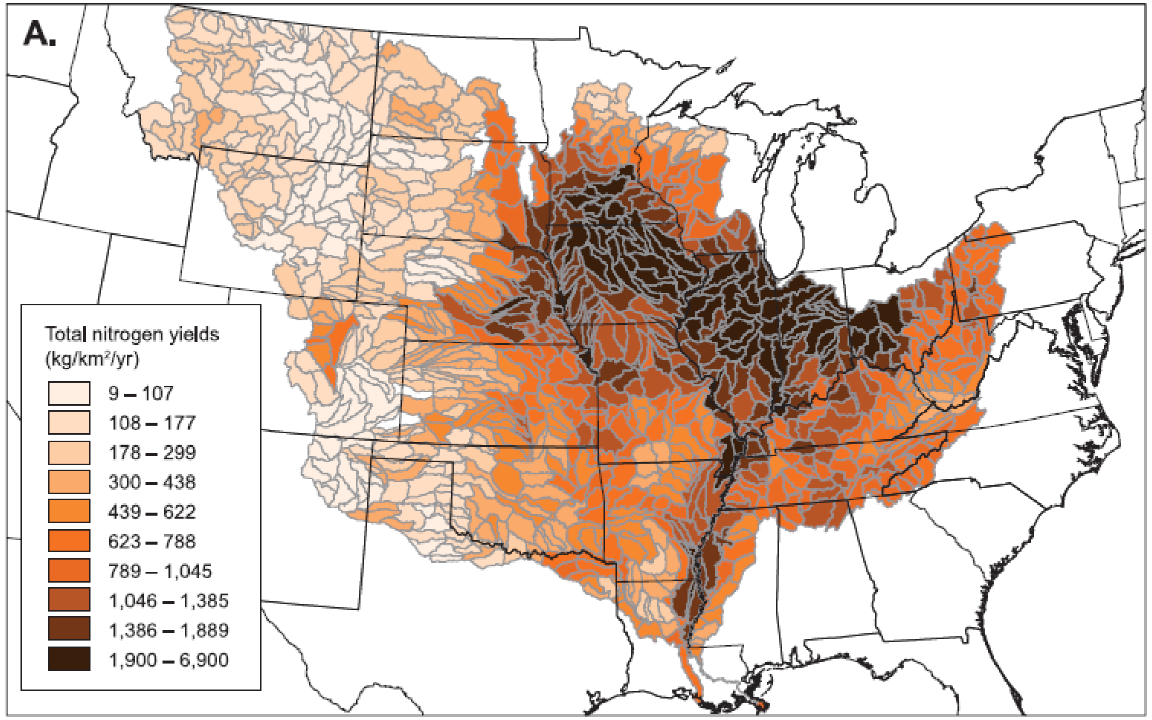
Top Corn Producing States	
1. Iowa	16.2%
2. Illinois	15.0%
3. Nebraska	12.6%
4. Minnesota	10.2%
5. Indiana	6.9%

High input – High output systems

Subsurface drainage and nutrient transport

Special focus on (nitrate) NITROGEN

Continental implications of nitrate loss



N losses are bad for:
Environment, Production, and Profitability

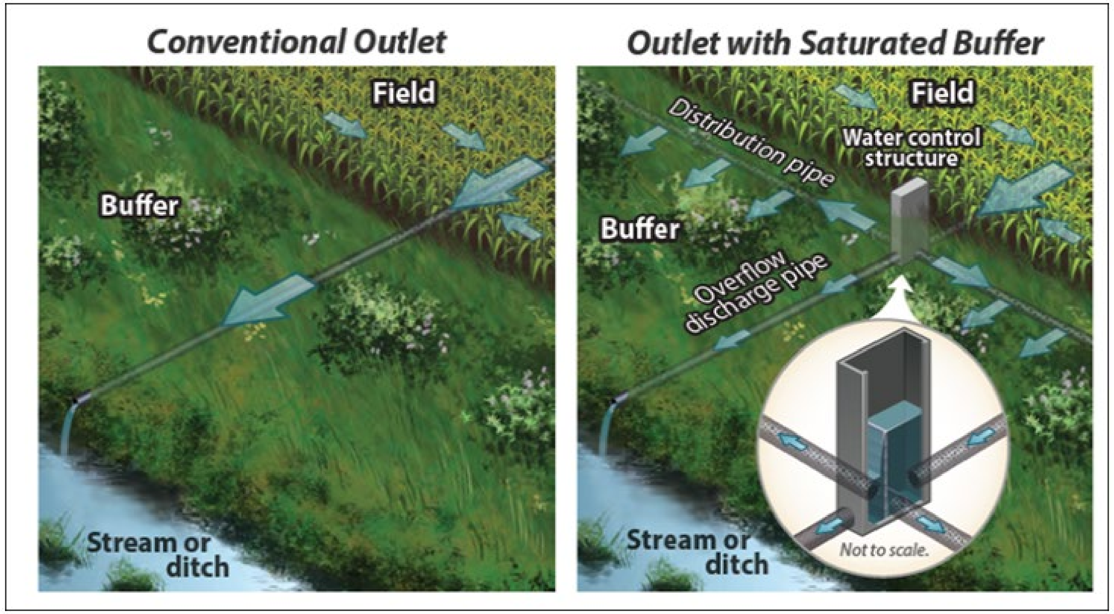
Strategies to reduce nitrate loss

Edge of field practices

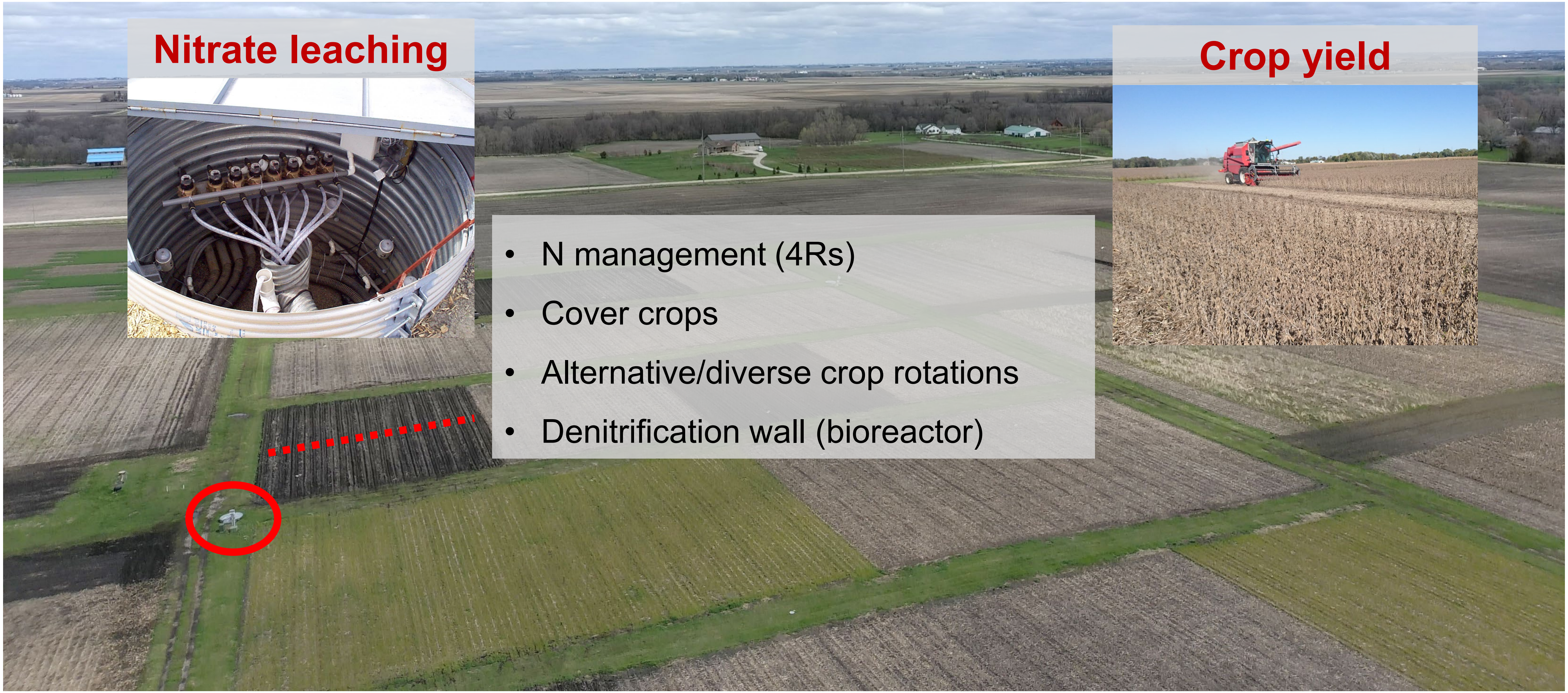
- Drainage water control
- **Buffer strips**
- Bioreactors
- Wetland management

In-field practices

- N management (4Rs)
- **Cover crops**
- Alternative/diverse crop rotations
- Denitrification wall (bioreactor)



Experimental Field Plots – Data Collection



- N management (4Rs)
- Cover crops
- Alternative/diverse crop rotations
- Denitrification wall (bioreactor)

Fertilizer N Management

1. Zero N application
2. 4Rs

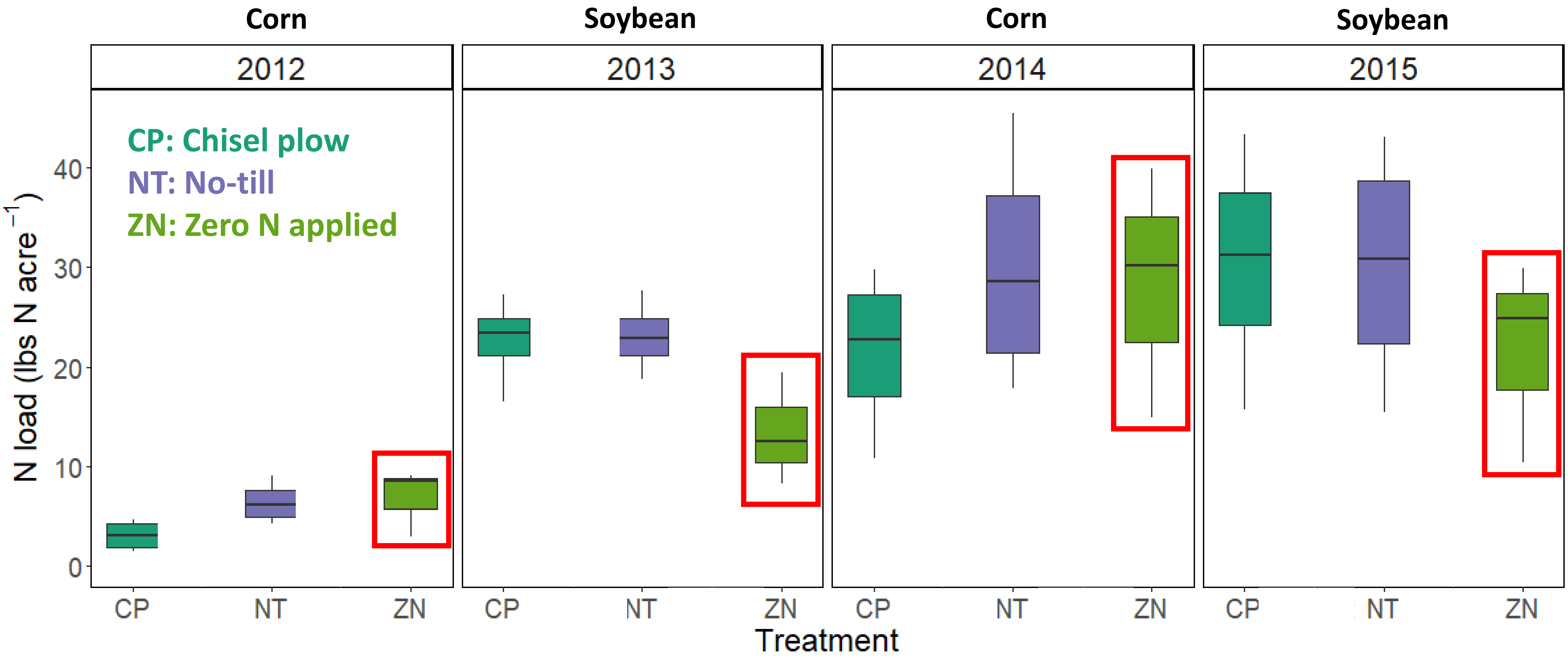
RIGHT SOURCE

RIGHT RATE

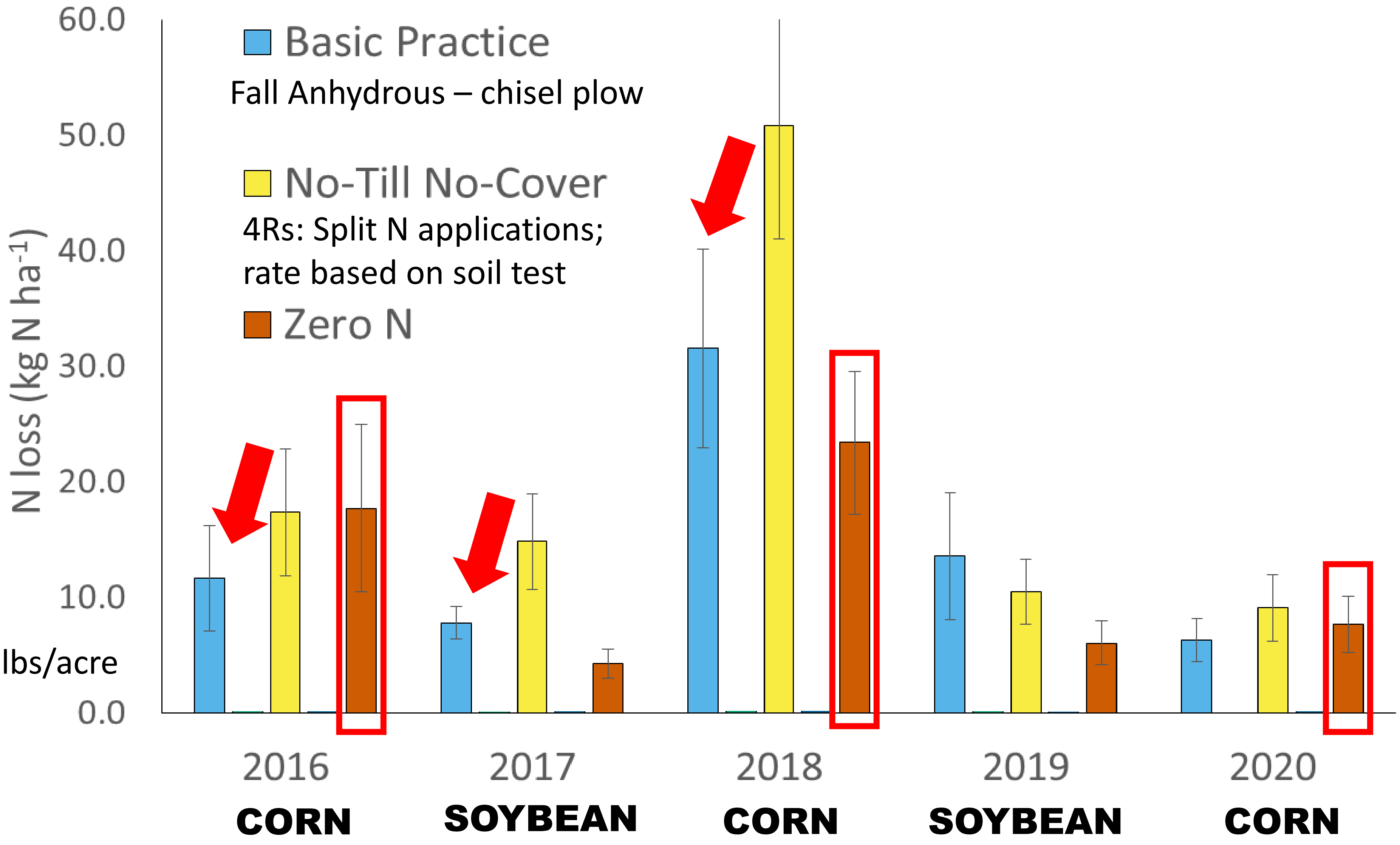
RIGHT TIME

RIGHT PLACE

Fertilizer N Management (and tillage)



Fertilizer N Management



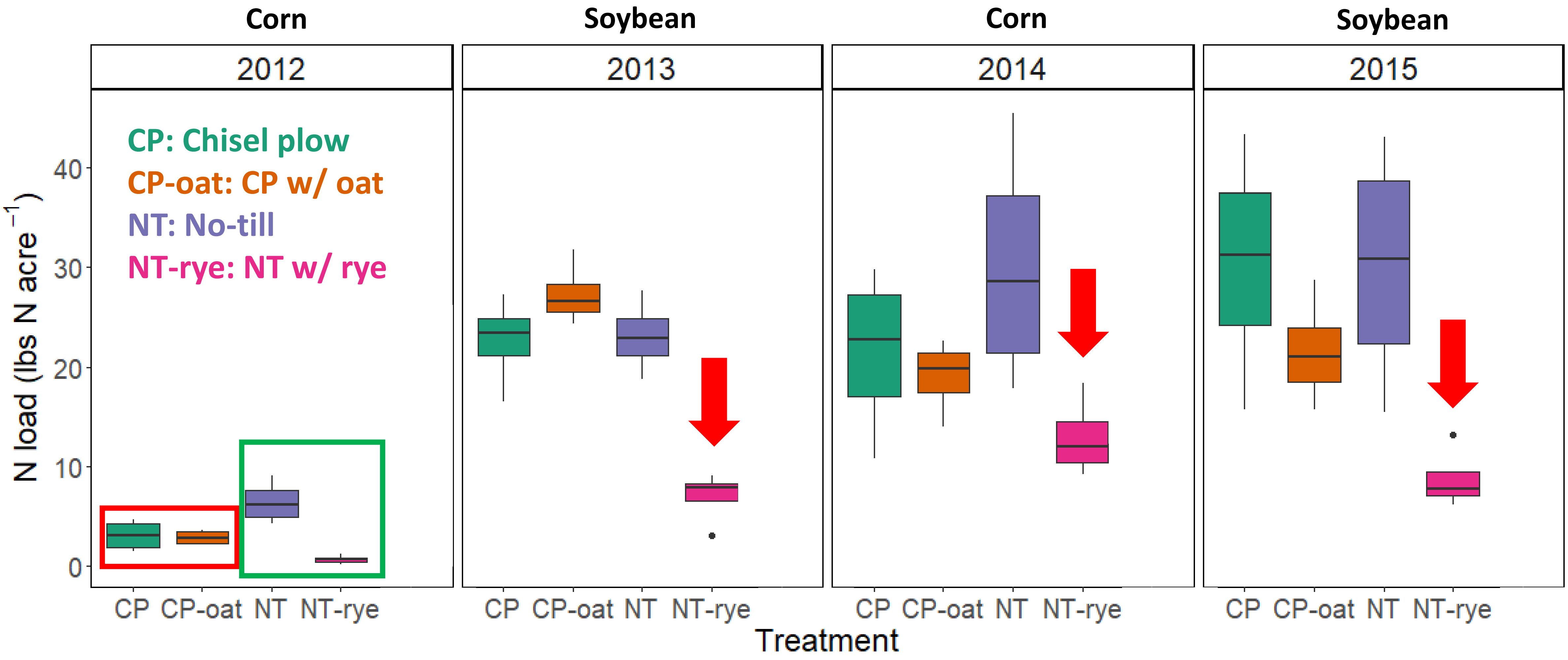
10 kg/ha = 8.9 lbs/acre

Cover Crops

1. Cover crop species
   Oat vs Cereal rye
   (winter kill) vs (winter hardy)

2. Cover crop vs no-cover crop

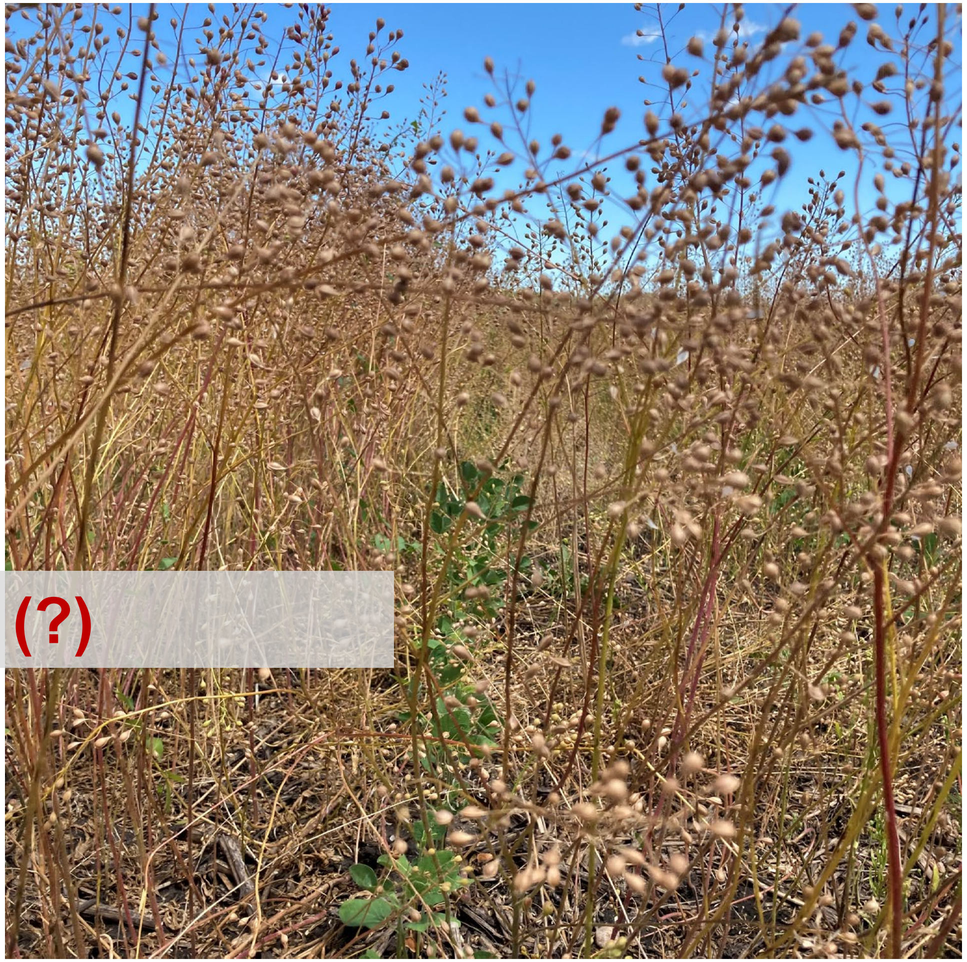
Cover Crop Species (and tillage)



Relay Cropping – Winter Camelina

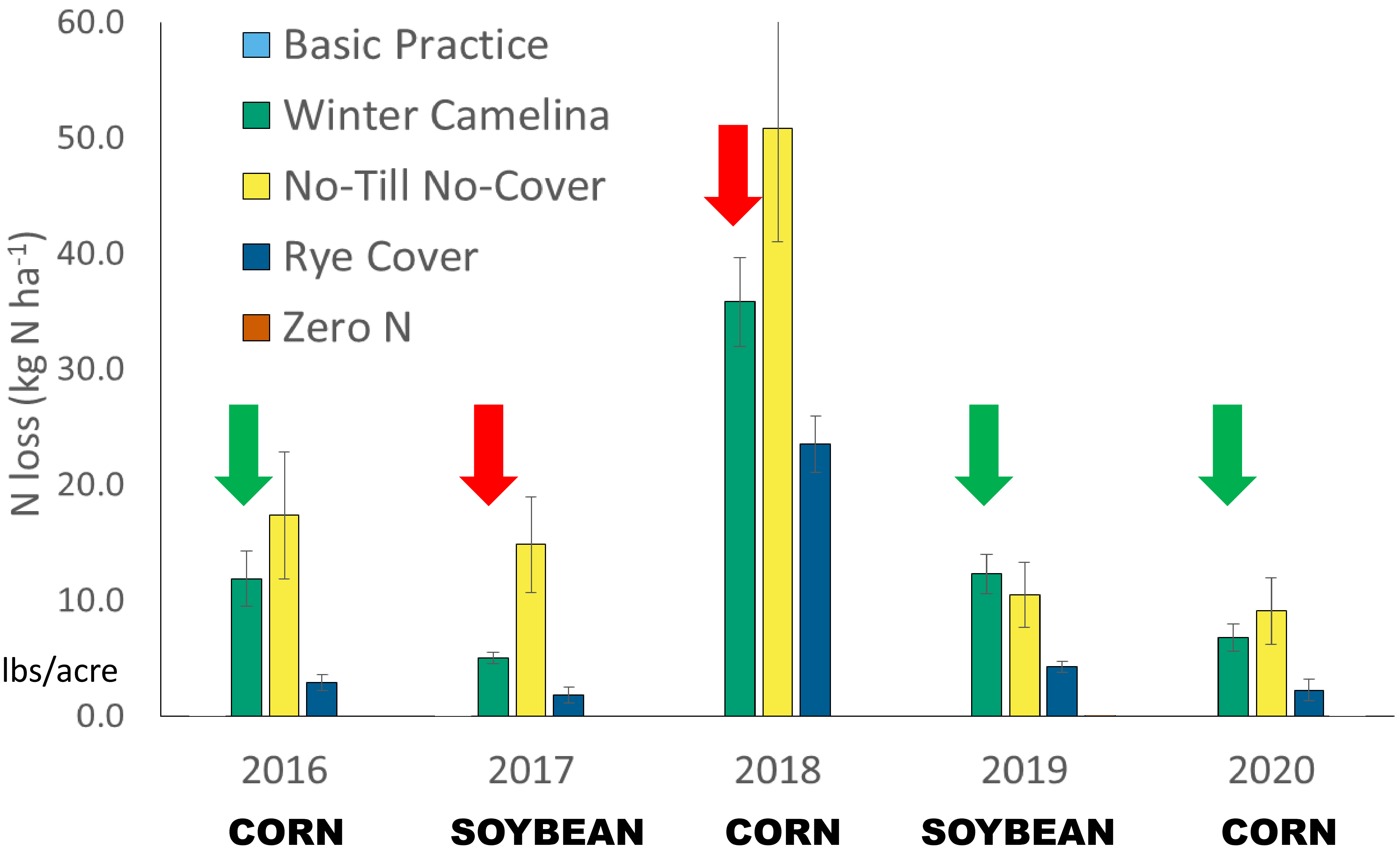
Growing two different crops in the same field during a single year with an ***overlapping period*** of growth

- Winter annual oilseed crop
- Consistently overwinters, relatively early harvest date
- Desirable for both oil and biofuel production



Cover crop + (?)

Relay Cropping – Winter Camelina

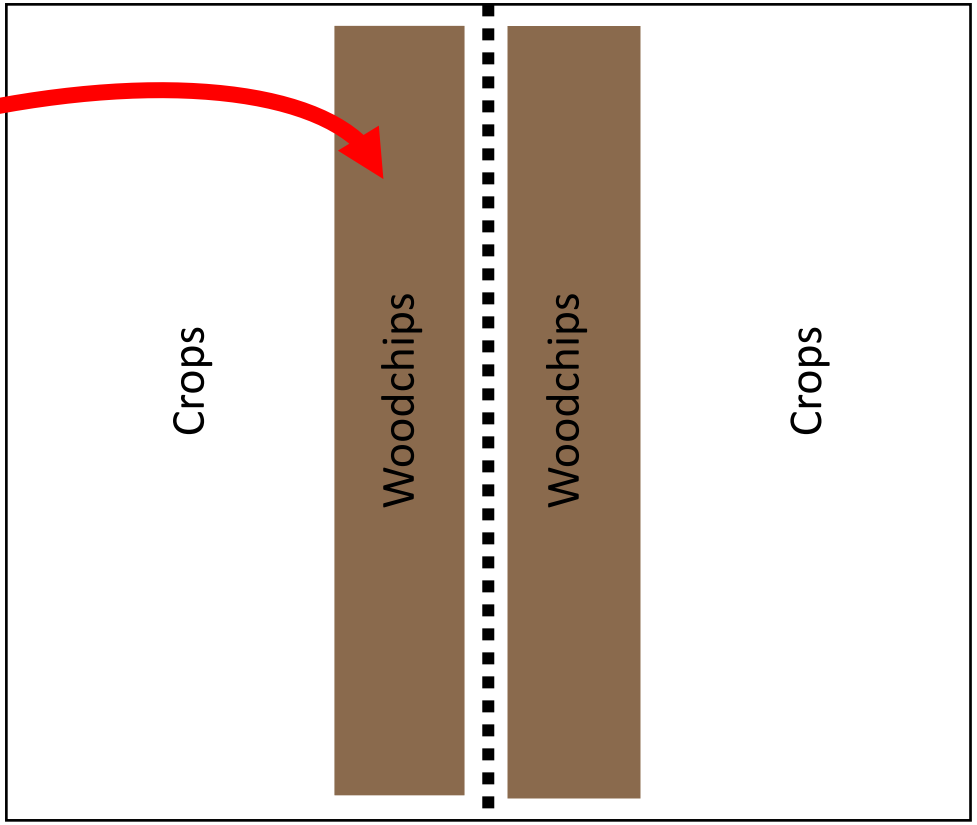


10 kg/ha = 8.9 lbs/acre

In-situ bioreactor (and cover crops)

1. <u>In-situ bioreactor vs cover crop vs none</u>

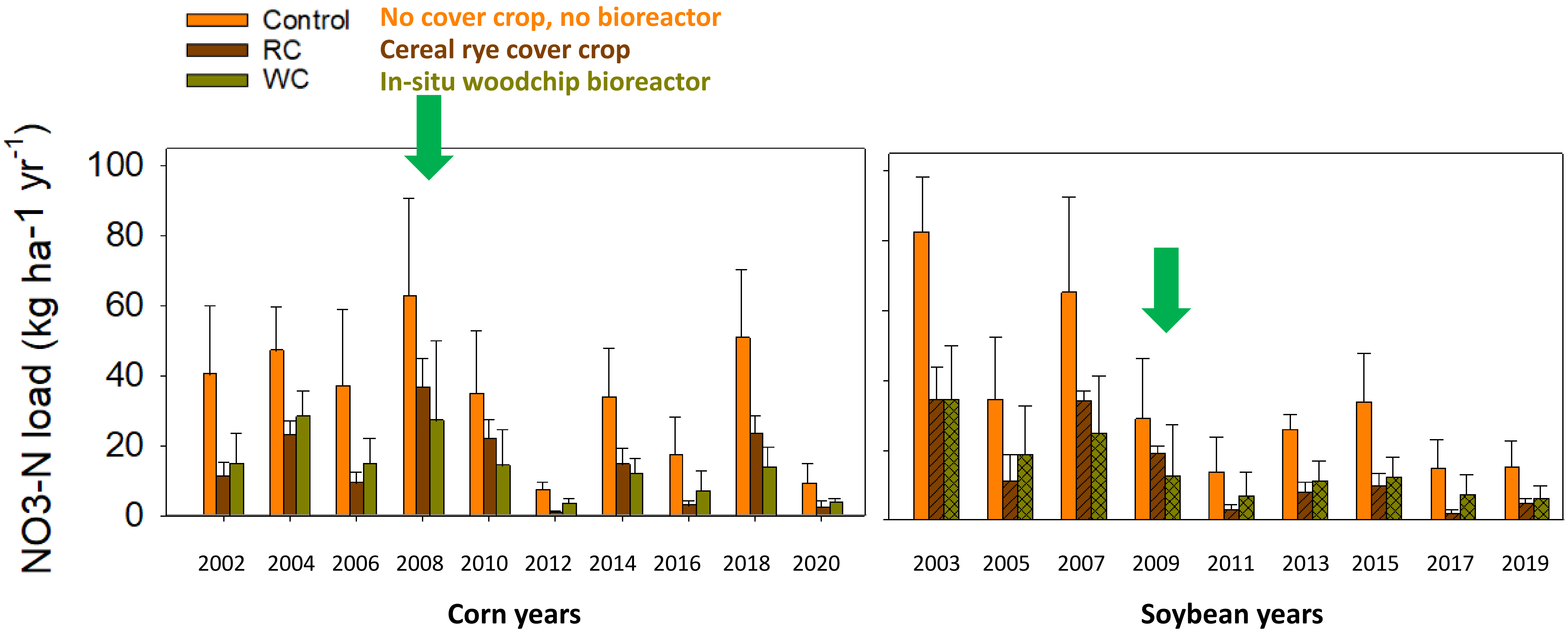
Typical bioreactor



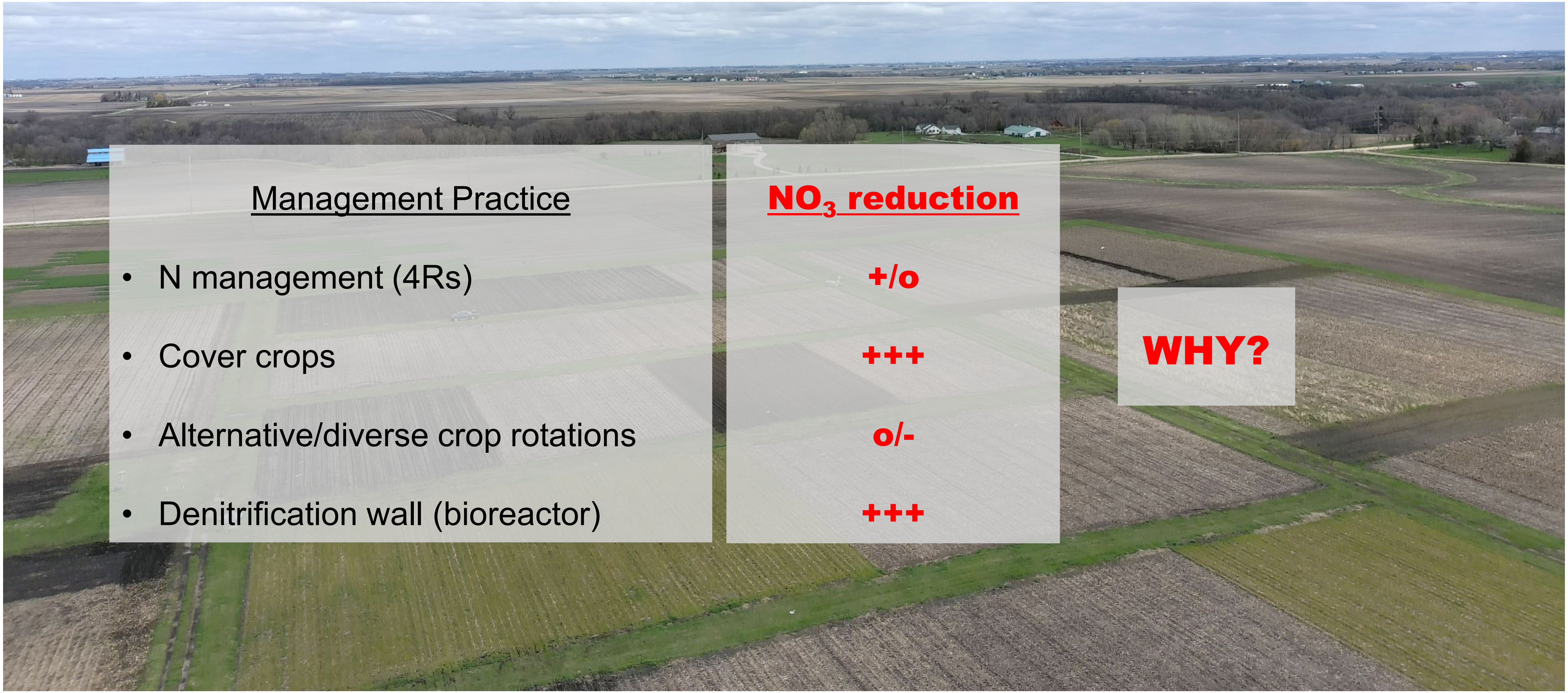
In-situ bioreactor

Longest running comparison – since 2002

Cover crops and in-situ bioreactor



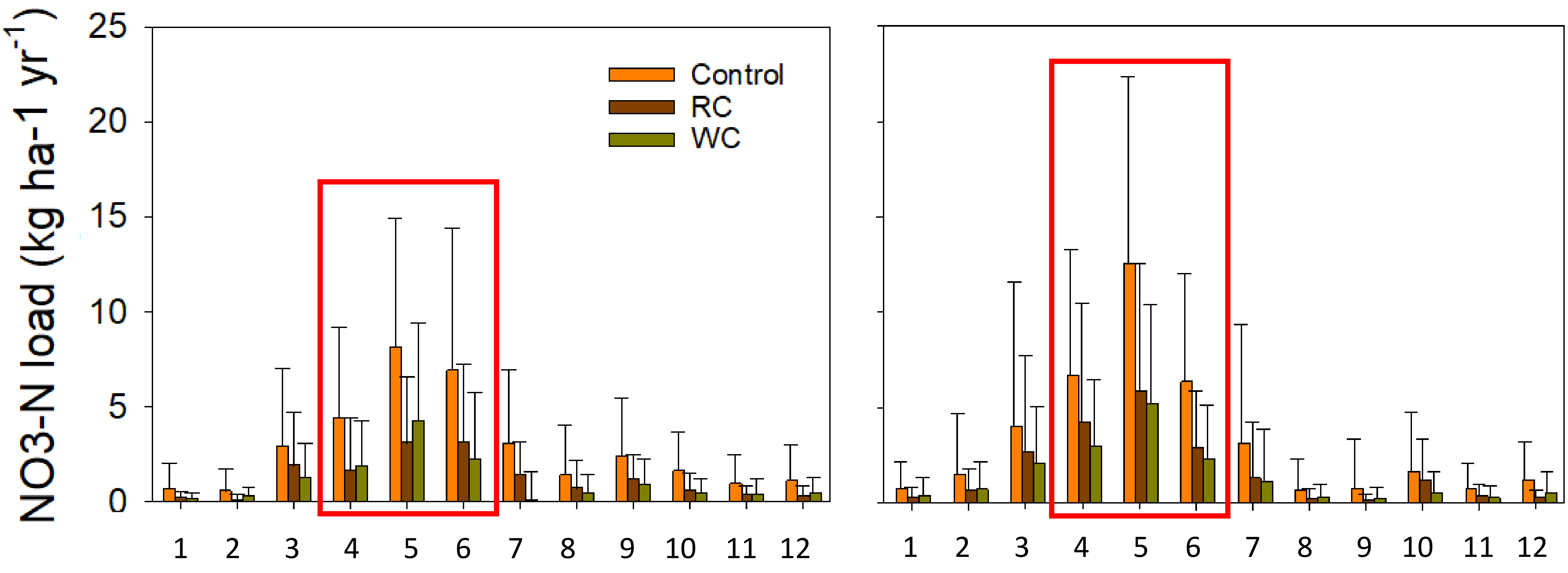
Experimental Field Plots – Findings



Management Practice	NO_3 reduction
• N management (4Rs)	+/o
• Cover crops	+++
• Alternative/diverse crop rotations	o/-
• Denitrification wall (bioreactor)	+++

WHY?

When are losses occurring?

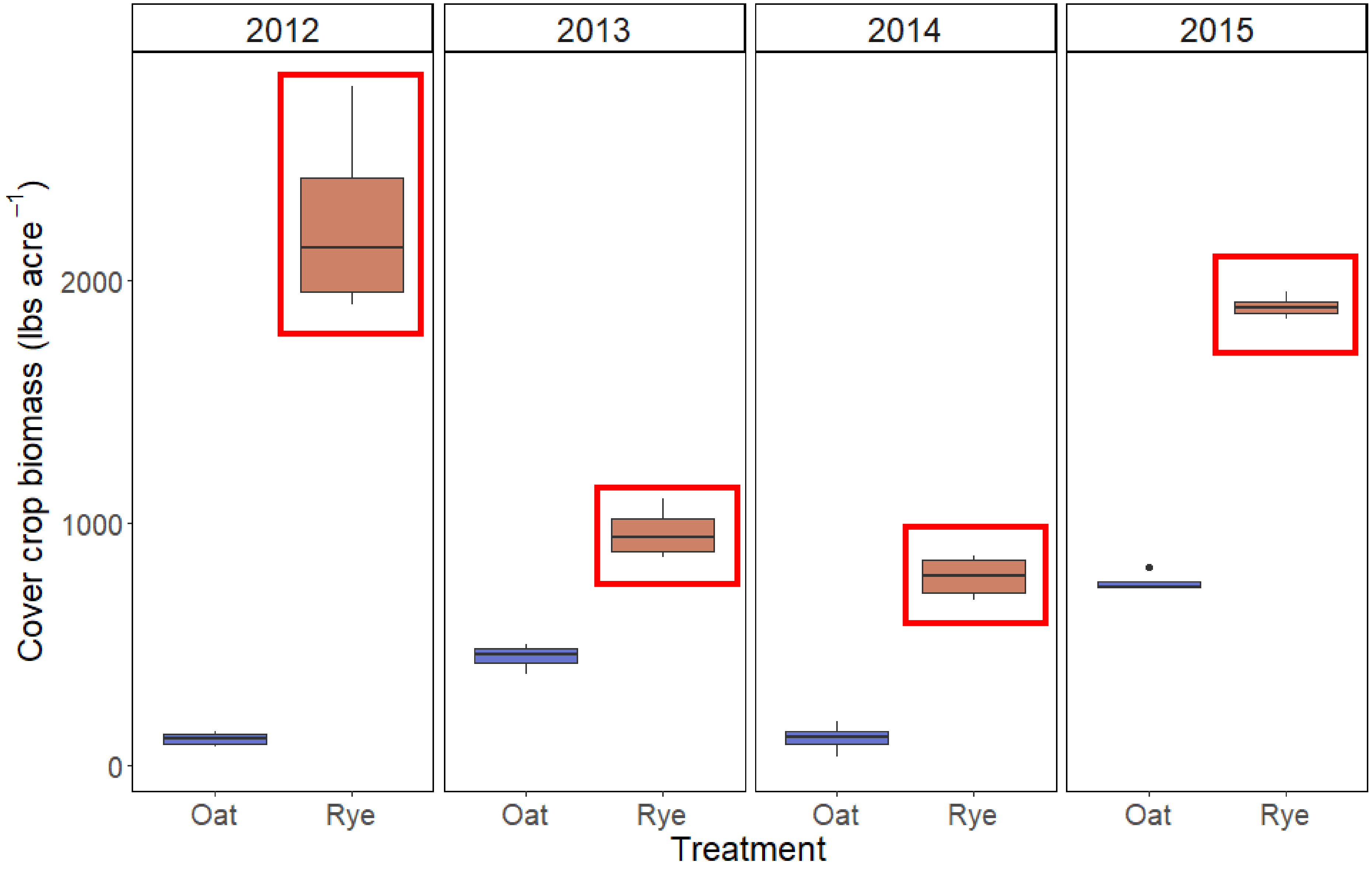


Corn years

Soybean years

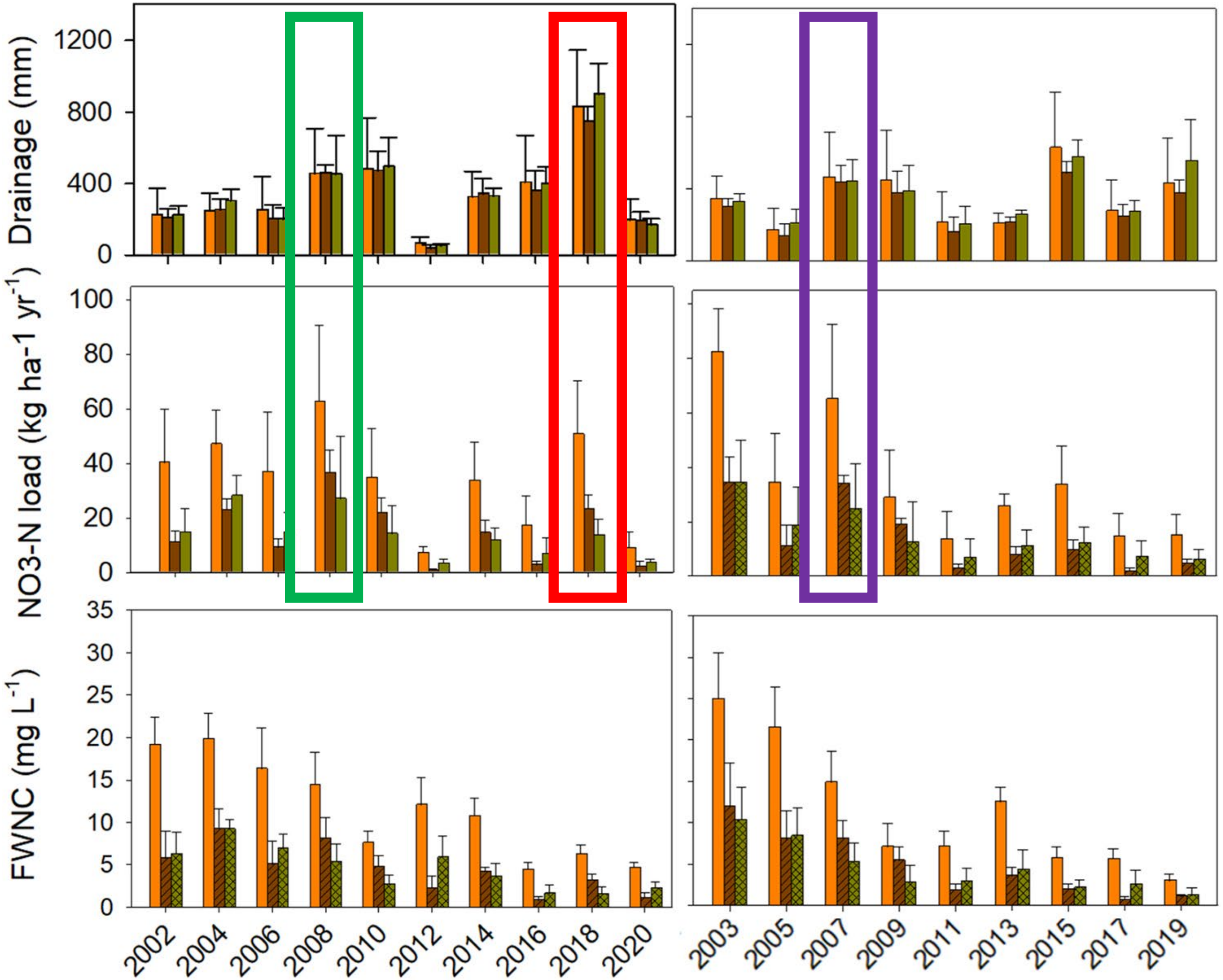
Cover Crop Biomass

- **Benefits in nitrate leaching tied to biomass production**
- **Fall growth + Spring growth for rye**



What drives nitrate losses?

Year	Precipitation
2002	655
2003	716
2004	908
2005	873
2006	868
2007	1033
2008	1157
2009	905
2010	1334
2011	806
2012	675
2013	883
2014	1226
2015	1258
2016	944
2017	876
2018	1302
2019	916
2020	605



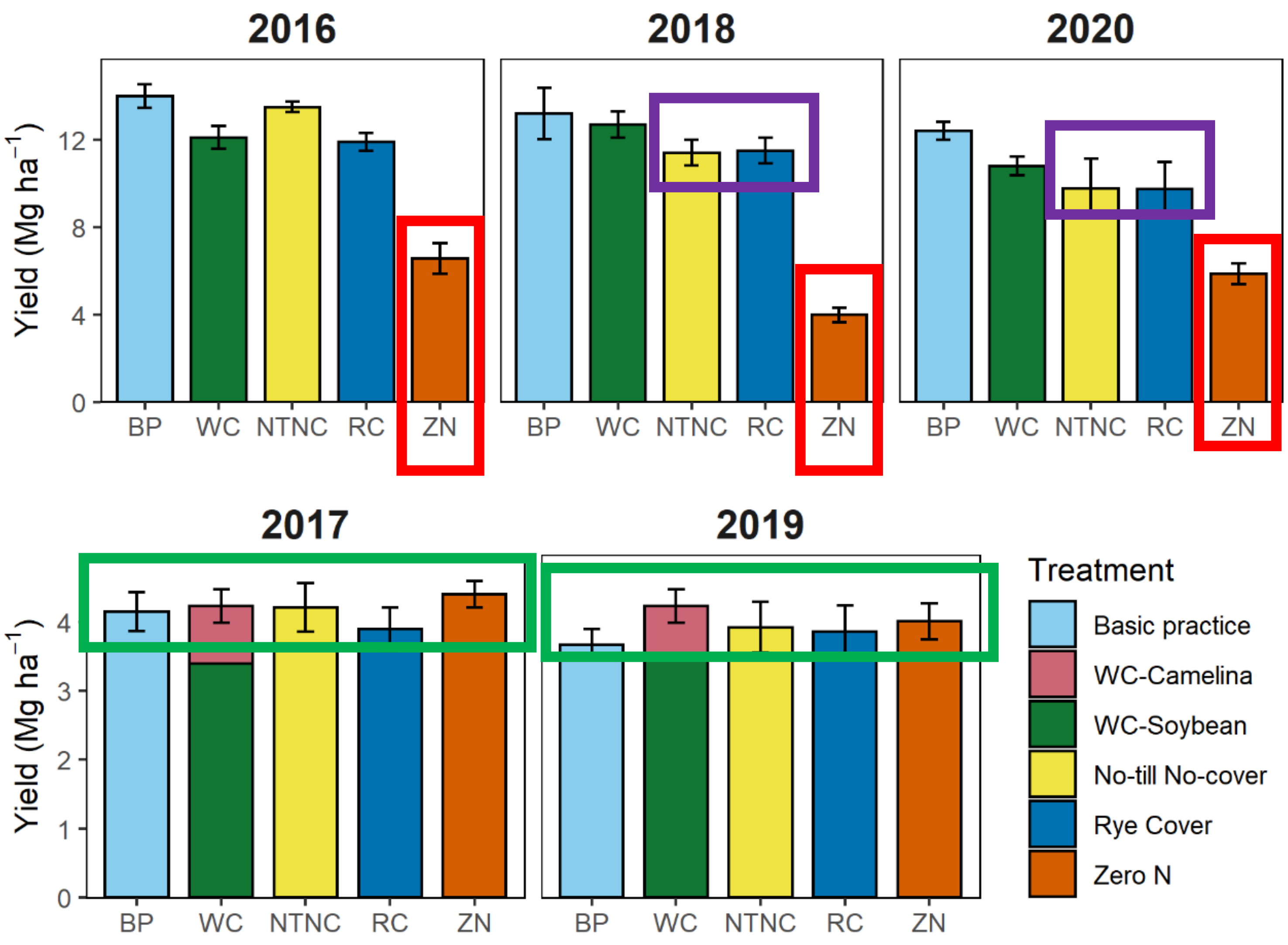
Experimental Field Plots – Summary

Management Practice	NO_3 reduction	Why?
N management (4Rs)	+/o	N Mineralization; fertilizer rates
Cover crops	+++	Scavenge soil N
Alternative/diverse crop rotations	o/-	Low biomass production
Denitrification wall (bioreactor)	+++	Year-round effectiveness*

Crop Yields

Corn
Soybean
Camelina

Crop Yields



CORN YEARS

SOYBEAN YEARS

Cover crops and in-situ bioreactor

	Corn years			
	Grain yield			
	Control	RC	DW	LSD
	(Mg ha^{-1})			
2002	12.41a	11.24b	11.86ab	0.65
2004	13.27	13.32	13.51	0.53
2006	13.44	13.13	13.33	0.33
2008	13.25a	13.51a	12.61b	0.52
2010	12.29	12.29	11.57	1.27
2012	11.78	11.18	11.68	0.89
2014	12.51a	12.49a	11.94b	0.52
2016	13.48a	11.95b	13.07a	0.51
2018	11.37a	11.50a	10.05b	0.96
2020	9.77	9.73	11.14	1.86
Average	12.11	11.93	12.25	0.53

	Soybean Years			
	Grain yield			
	Control	RC	DW	LSD
	(Mg ha^{-1})			
2003	2.73	2.70	2.56	0.29
2005	4.46	4.15	4.13	0.47
2007	2.26	2.02	2.16	0.29
2009	2.41	2.41	2.24	0.29
2011	3.62	3.58	3.63	0.21
2012	2.96	2.99	2.76	0.45
2015	4.41	4.32	4.03	0.41
2017	4.21	3.90	3.95	0.52
2019	3.92	3.86	3.69	0.49
Average	3.44	3.32	3.24	0.32

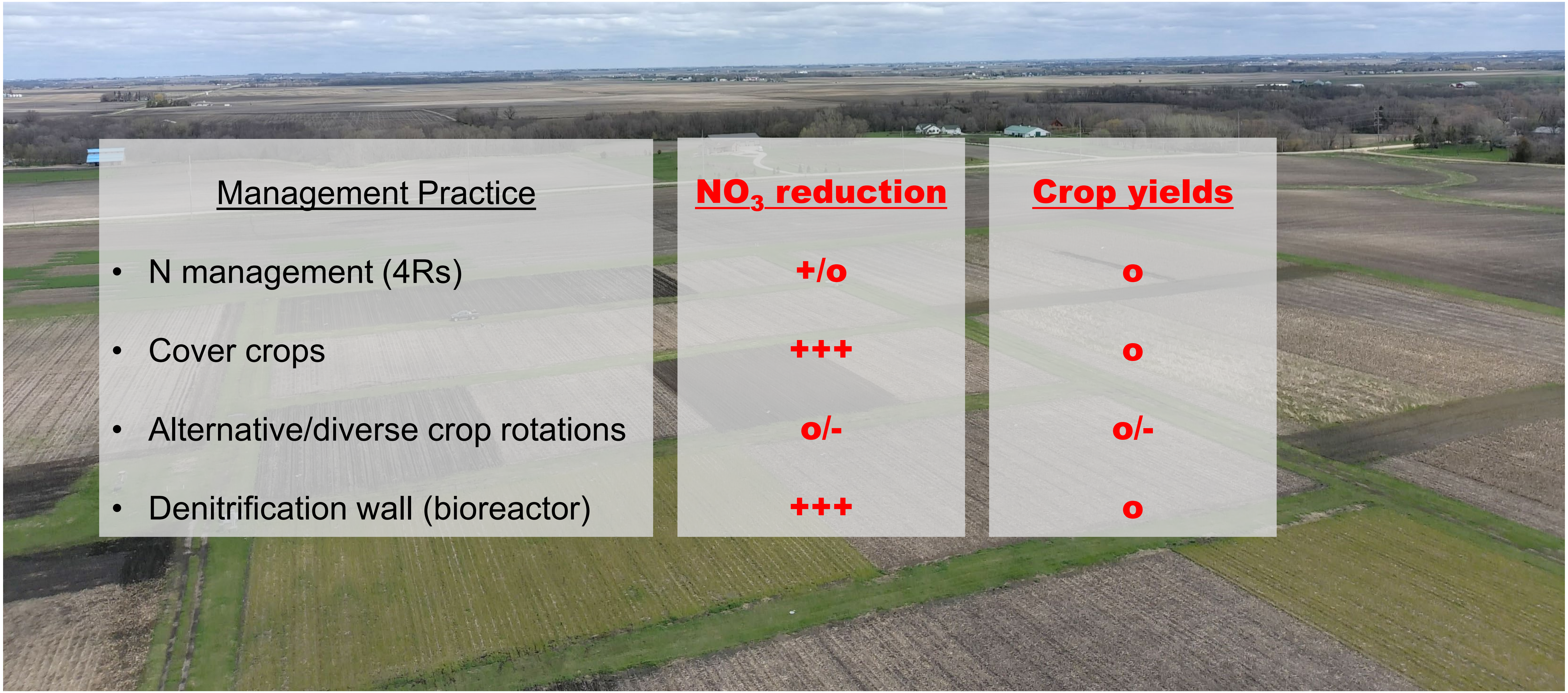
Rye cover crop: Decreased in 2 of 10 years

Woodchip bioreactor: Decreased in 3 of 10 years

No differences across years and treatments

1 Mg/ha = 15.9 bu/acre

Experimental Field Plots – Summary

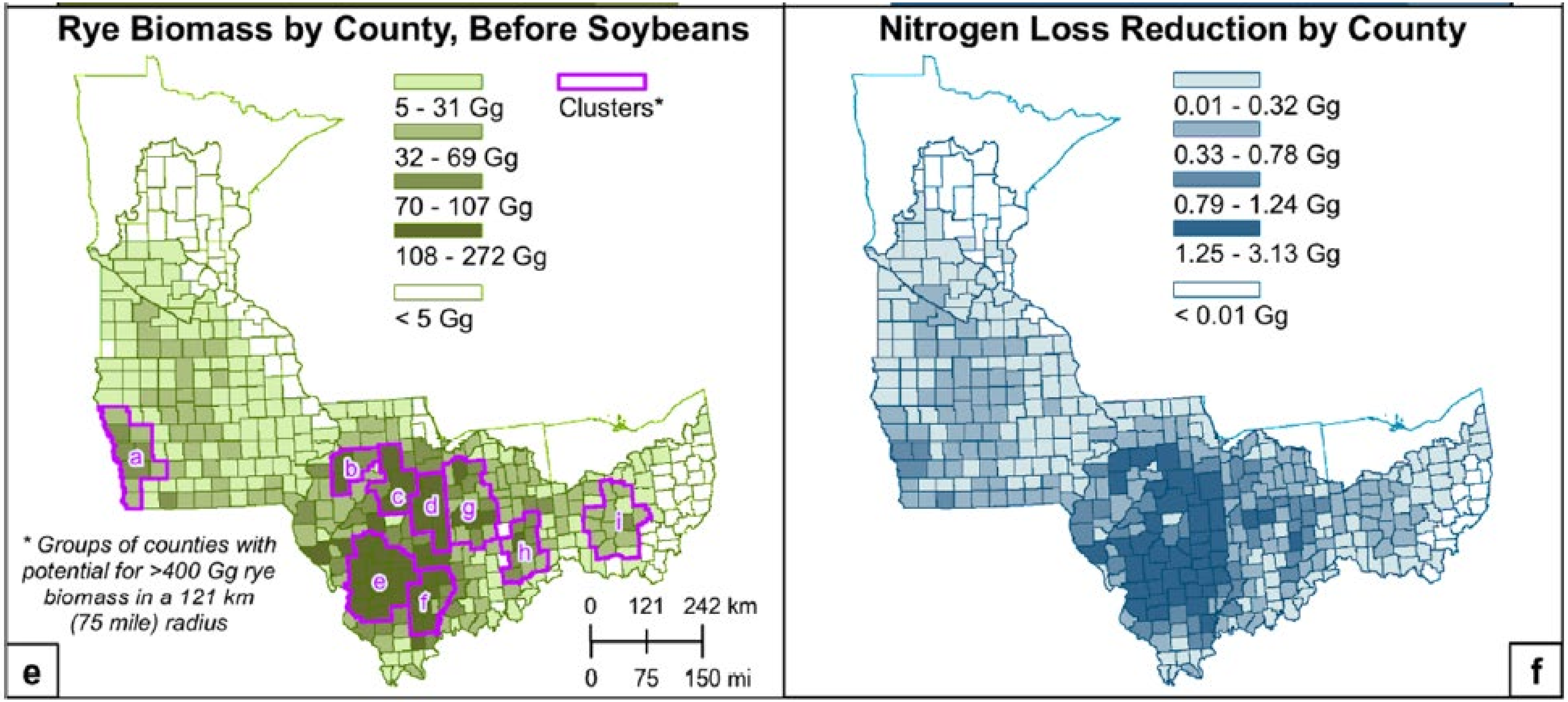


Management Practice	NO_3 reduction	Crop yields
• N management (4Rs)	+/o	o
• Cover crops	+++	o
• Alternative/diverse crop rotations	o/-	o/-
• Denitrification wall (bioreactor)	+++	o

Future work – rye as energy crop

Can we fertilize cereal rye in the spring to:

1) **Maintain environmental benefits AND**
2) **Gain economic benefits through bioenergy or animal uses**



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Summary and conclusions

- Importance of weather conditions
- N management only goes so far
- Long-term effectiveness of cover crops and bioreactors
- Not a tradeoff with crop yields
- Future pathways for more economical cover cropping

THANK YOU

Questions or comments?
Please reach out to:
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