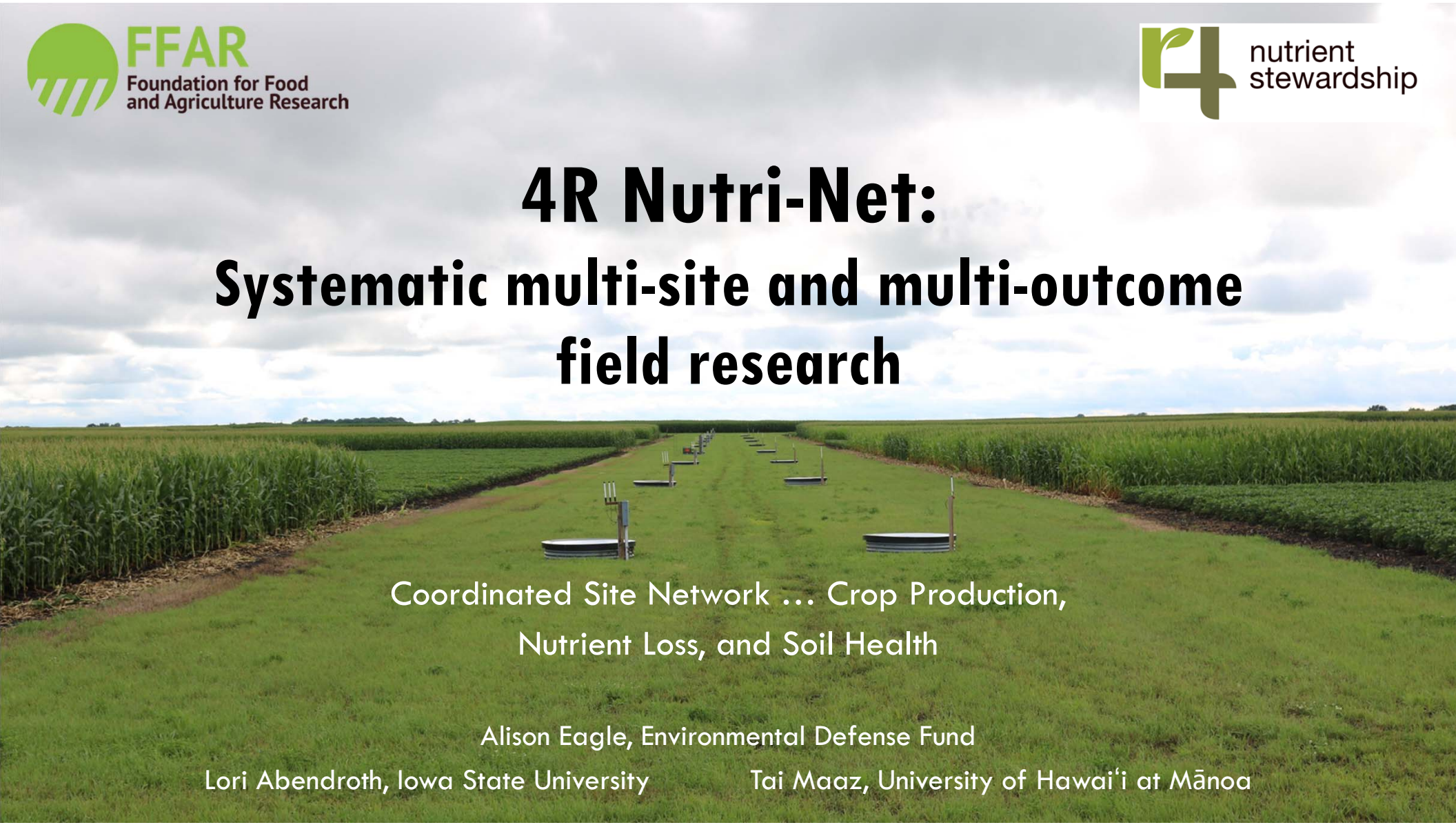

FFAR
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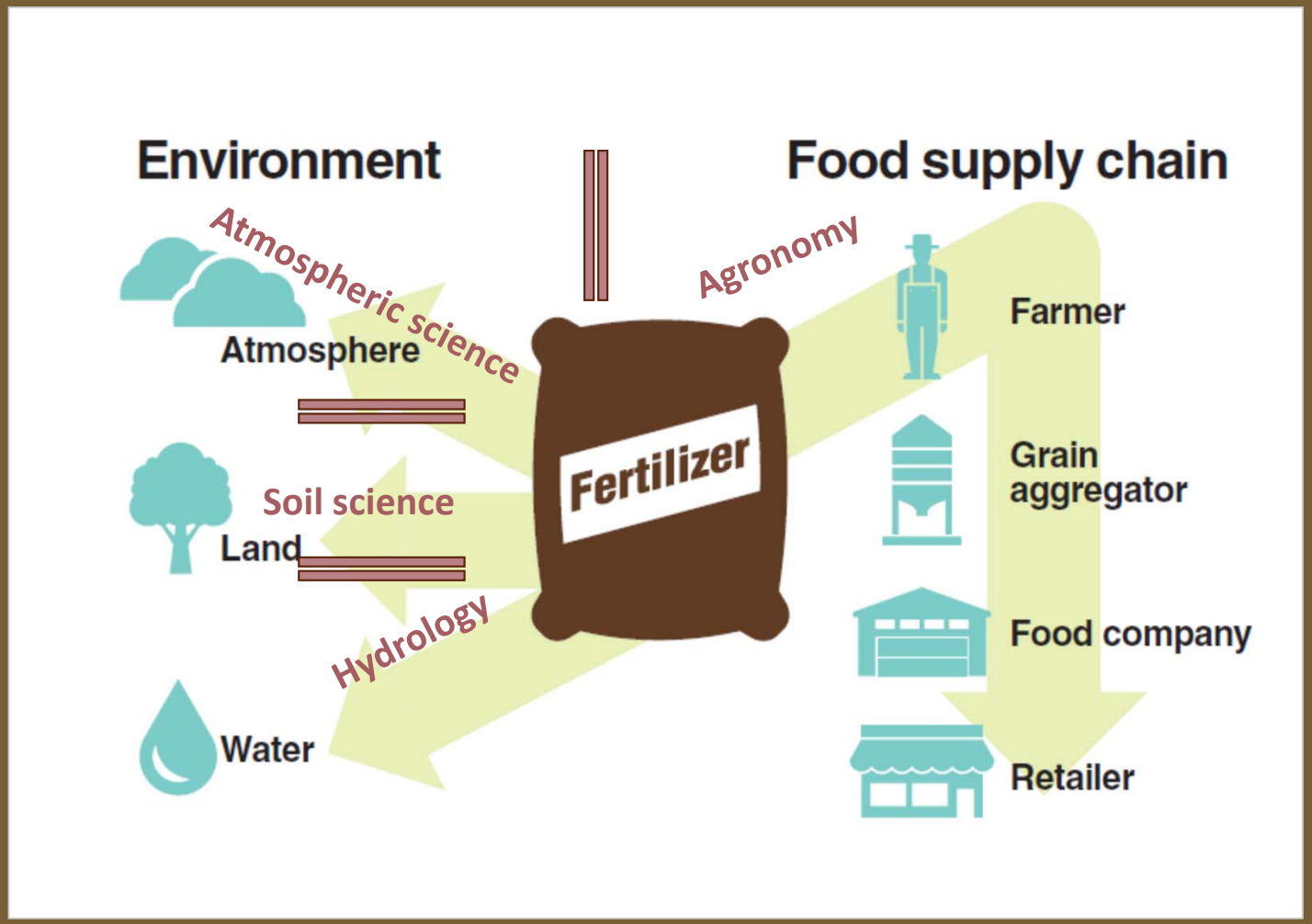
nutrient stewardship

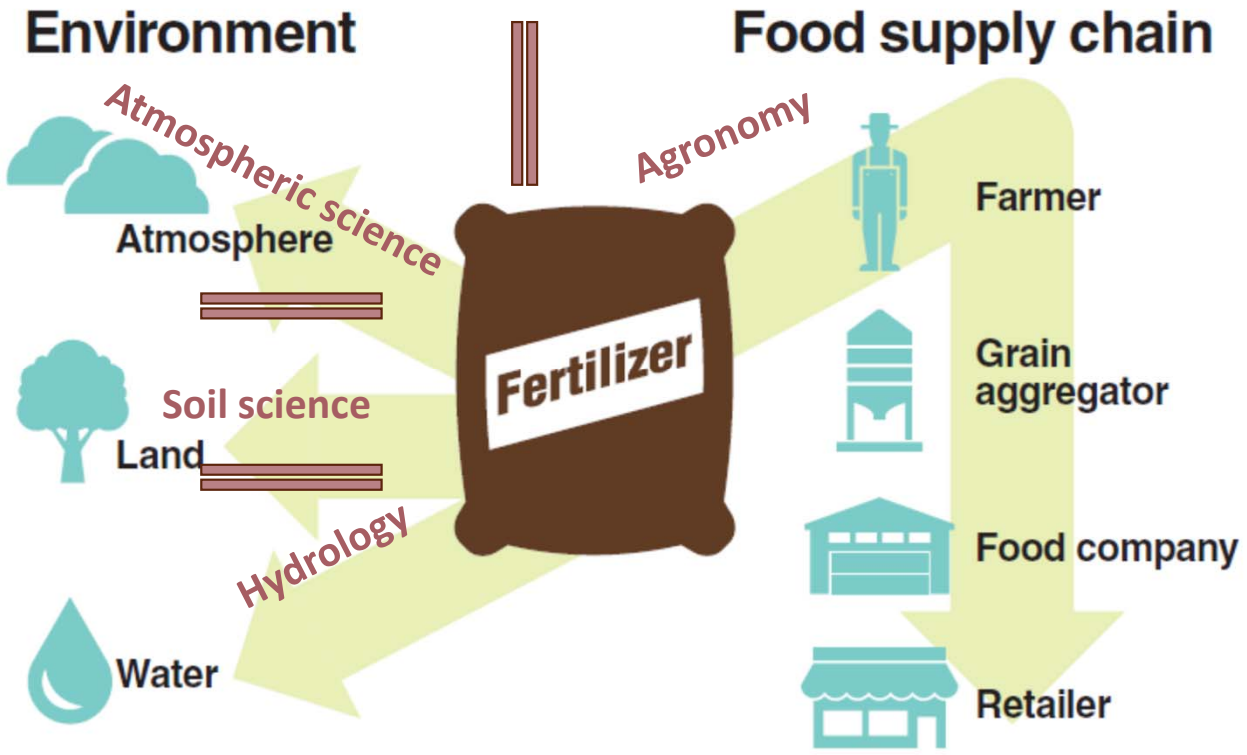
4R Nutri-Net:
Systematic multi-site and multi-outcome field research

Coordinated Site Network … Crop Production, Nutrient Loss, and Soil Health

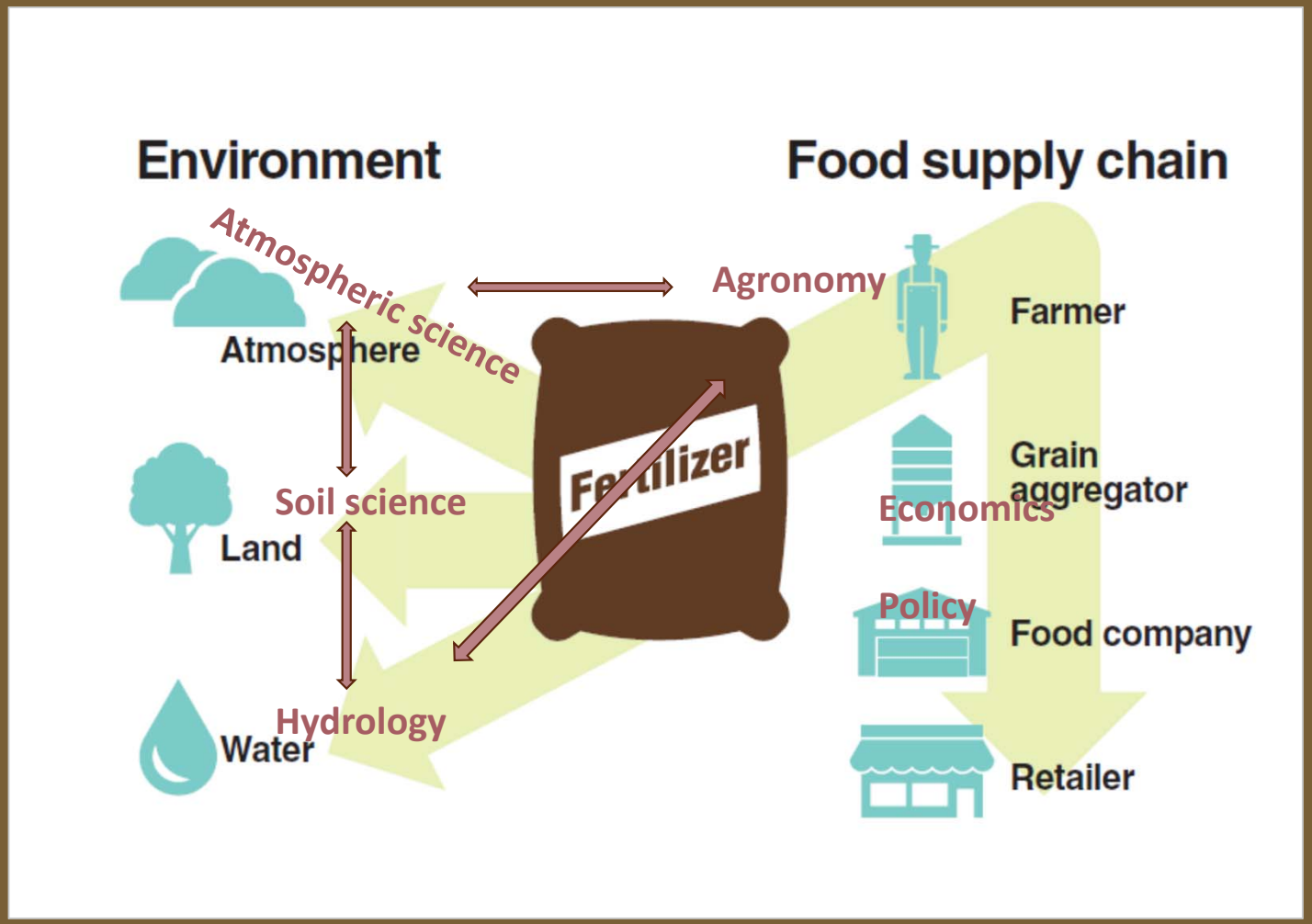
Alison Eagle, Environmental Defense Fund
Lori Abendroth, Iowa State University
Tai Maaz, University of Hawai'i at Mānoa



Nutrients in the cropping SYSTEM



Nutrients in the cropping SYSTEM



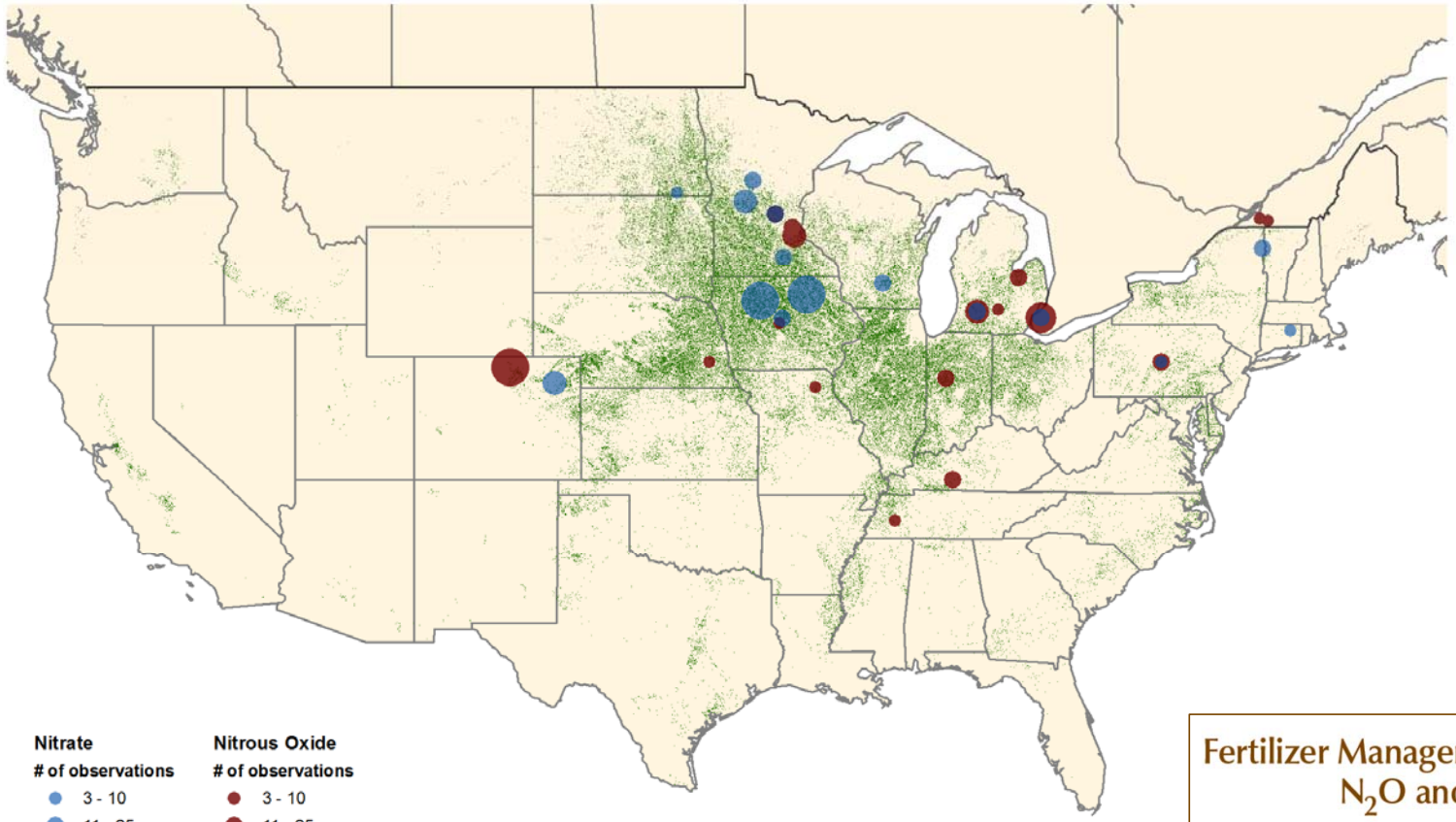
Nutrients in the cropping SYSTEM

Meta-Analysis Constrained by Data: Recommendations to Improve Relevance of Nutrient Management Research

Alison J. Eagle,* Laura E. Christianson, Rachel L. Cook, R. Daren Harmel, Fernando E. Miguez, Song S. Qian, and Dorivar A. Ruiz Diaz

Agronomy Journal • Volume 109, Issue 6 • 2017

- Identified some impact of management, weather and soil on…
  - Crop yield
  - NO_3 leaching
  - N_2O emissions
  - P losses
- Missing yield or N rate data reduced data value
- Key practices or conditions were not known or reported
- Methods (units, sample timing) were highly variable – or unclear
- Very few studies with more than one loss measured



Nitrate
# of observations
- 3 - 10
- 11 - 25
- 26 - 50
- 51 - 75
- 76 - 150

Nitrous Oxide
# of observations
- 3 - 10
- 11 - 25
- 26 - 50
- 51 - 75
- 76 - 150

*Areas where corn is grown in the USA are shaded in green

0 250 500 1,000 Miles

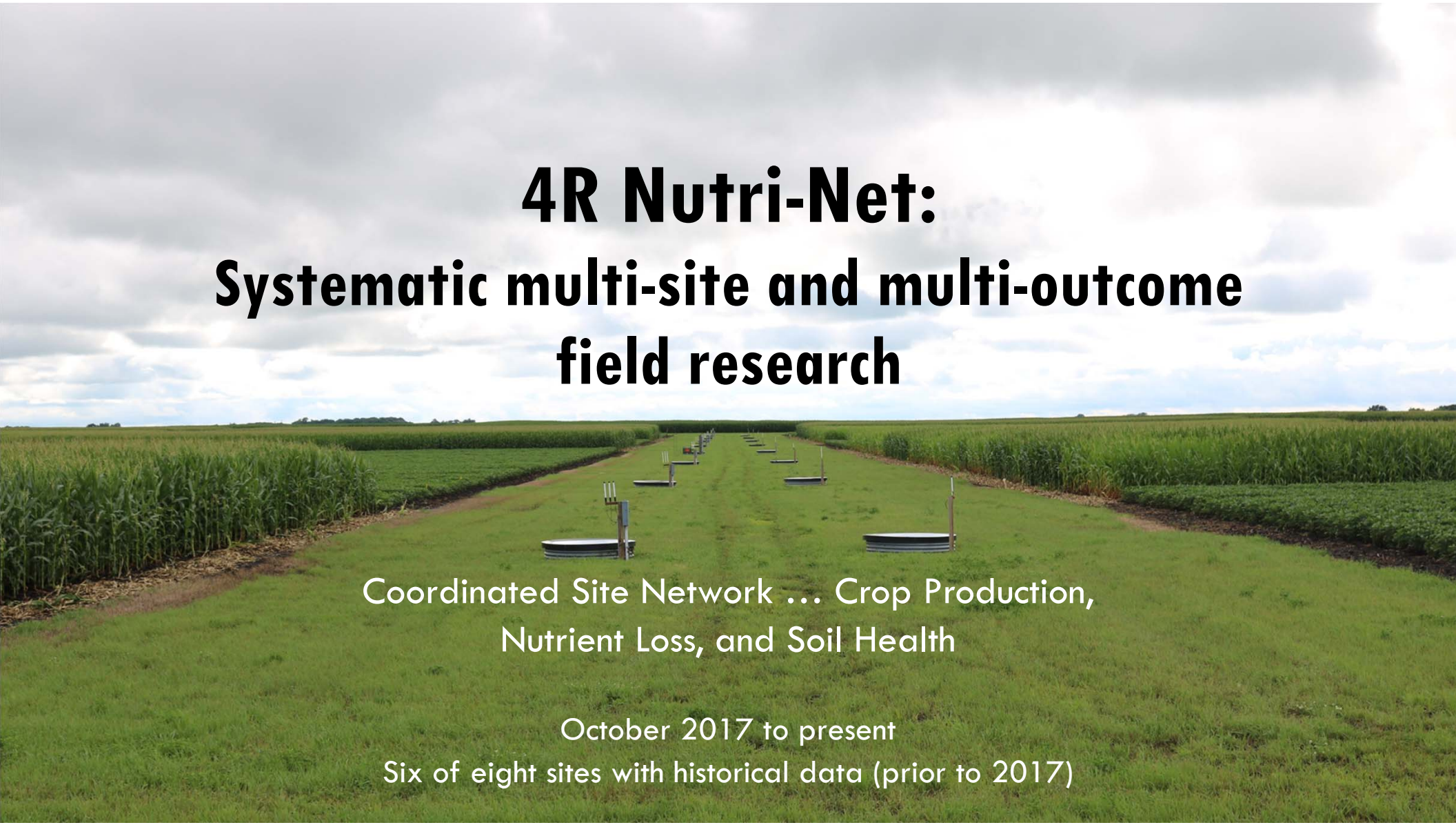
N

Source: United States Department of Agriculture (USDA), Esri
Nitrogen loss dataset

Fertilizer Management and Environmental Factors Drive N_2O and NO_3 Losses in Corn: A Meta-Analysis

Effective management of nitrogen (N) in agricultural landscapes must account

Eagle et al. 2017, Soil Science Society of America Journal



4R Nutri-Net:
Systematic multi-site and multi-outcome field research

Coordinated Site Network … Crop Production, Nutrient Loss, and Soil Health

October 2017 to present

Six of eight sites with historical data (prior to 2017)

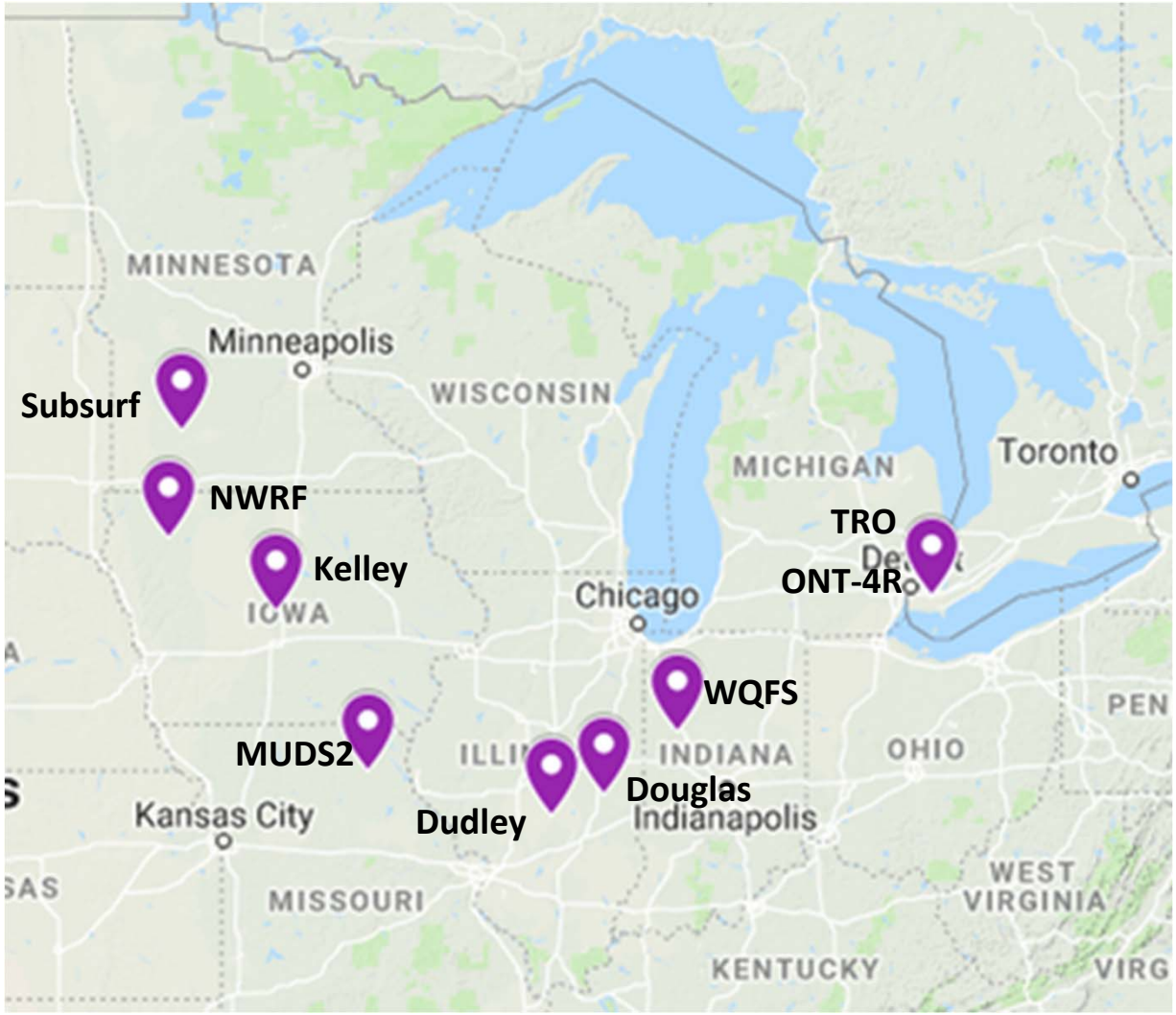
Treatments

- Tillage
  - Conv, Cons, NT
- Crop Rotation
  - C-S, C-C
- Cover/inter crop
- N Application
  - Timing
  - Placement
  - Source (incl. EEFs)
  - Rate

Data Collected

- Yield and nutrient uptake
- Soil health
- Leaching losses (N, P, K)
- Gaseous losses (N_2O, NH_3)

Location x treatments



Tillage

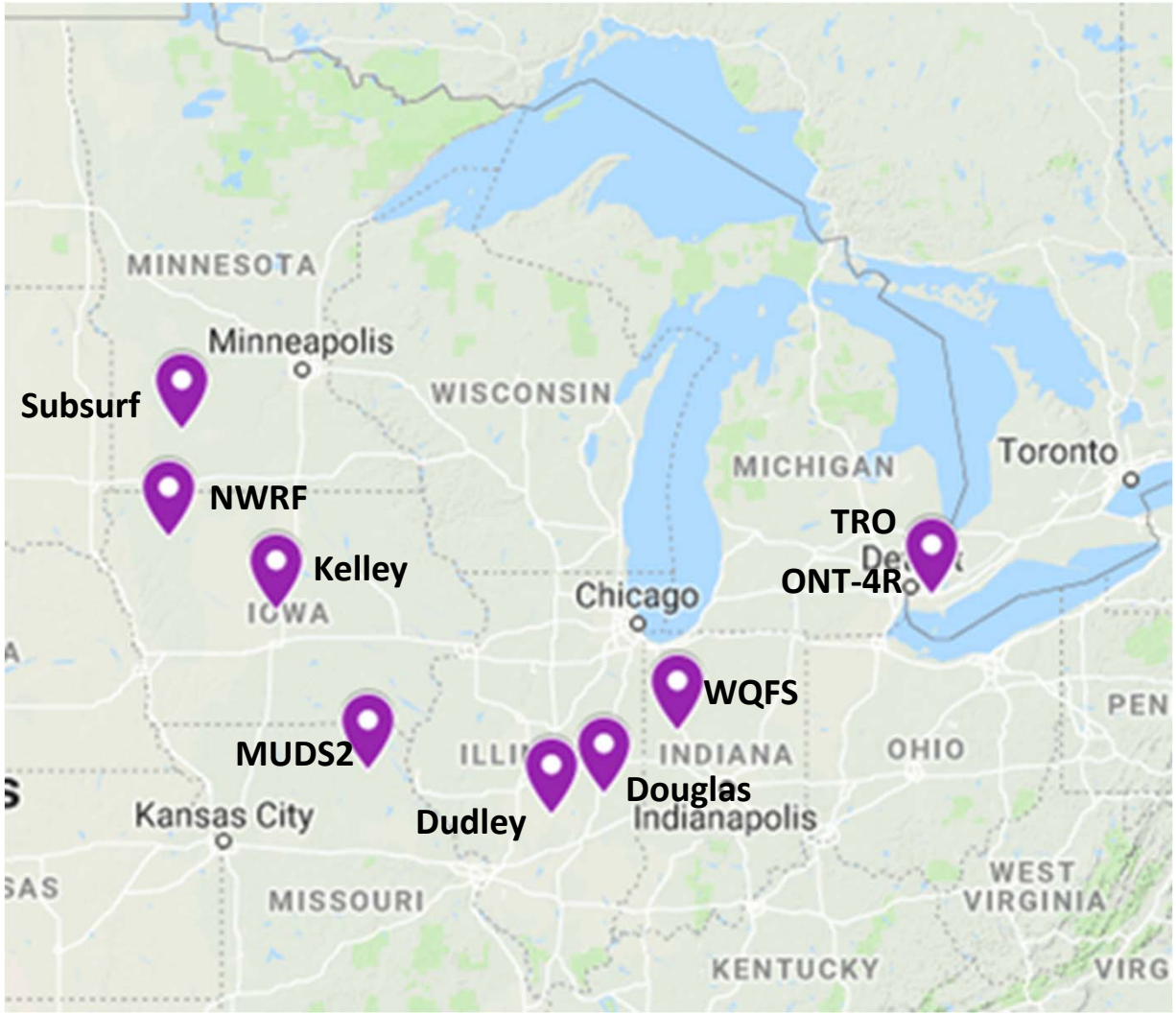
Crop rotation C-S S-C

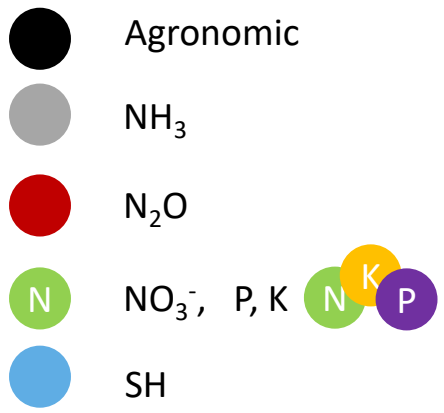
Cover crop

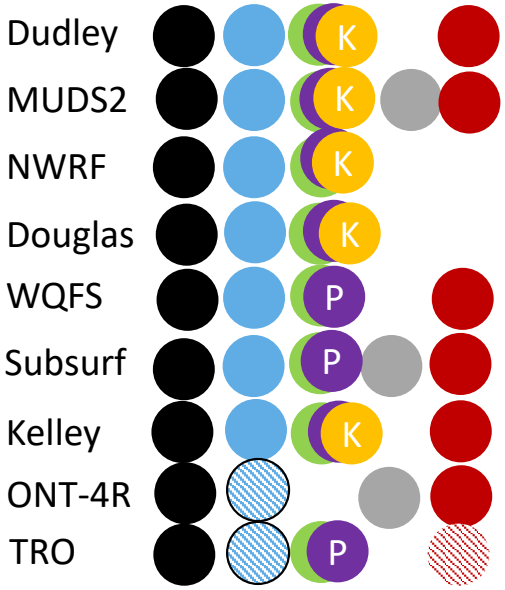
4R

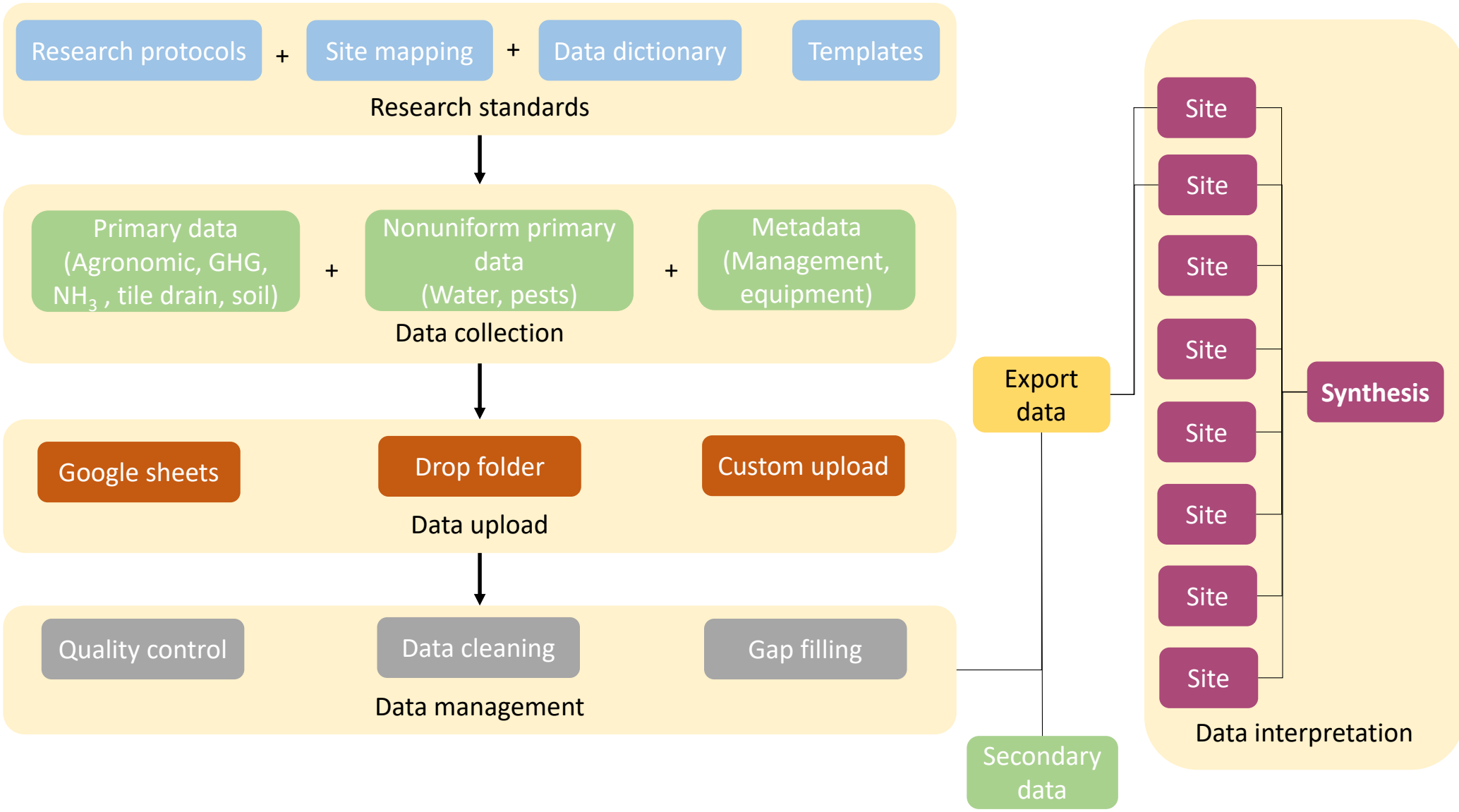
Dudley	Cover crop, 4R	S, check, T, P
MUDS2	4R	S, R, T, P
NWRF	Tillage, C-S, 4R	S, check, T, P
Douglas	Tillage, C-S, Cover crop, 4R	S, R, T
WQFS	Tillage, Crop rotation, Cover crop, 4R	R, T
Subsurf	4R	S, T, P
Kelley	Tillage, Cover crop, 4R	S, R, T
ONT-4R	4R	S, P
TRO	Tillage, Crop rotation, 4R	R

Location x measurements








Research protocols
+
Site mapping
+
Data dictionary
Templates
Research standards
Primary data (Agronomic, GHG, NH_3 , tile drain, soil)
+
Nonuniform primary data (Water, pests)
+
Metadata (Management, equipment)
Data collection
Google sheets
Drop folder
Custom upload
Data upload
Quality control
Data cleaning
Gap filling
Data management
Export data
Secondary data
Site
Site
Site
Site
Site
Site
Site
Synthesis
Data interpretation

Nutri-Net corn N management

Site Name/PI	Zero N	Farmer Norm	4R	4R+
SUBSURF/Fernandez	--	Spr[0/180/0][1,2]	Spr+PC[0/180/0] Spr+GS[0/60/120]	GS+PC[0/60/120]
NWRF/Helmers	Yes	Fall+inhib[135/0/0]	Spr[0/135/0]	GS+inhib[0/40/95]
KELLEY/Jaynes&Kovar	Yes	Spr[0/175/0]	GS+↓rate[0/30/125]	GS+↓rate+CC[0/30/125][3] GS+↓rate+Bio[0/30/125]
MUDS2/Nelson	Yes	Fall+inhib[170/0/0]	Spr[0/170/0]	GS+inhib+PC+↓rate [0/38/112]
DUDLEY/Christianson&Pittelkow	Yes	Fall+Spr [120/80/0]	Spr+GS[0/80/120]	Spr+GS+CC[0/80/120]
DOUGLAS/Gentry	--	Fall+inhib[160/0/0] Spr[0/160/0]	Fall+Spr+GS[80/40/40] Spr+↓rate[0/120/0]	Spr+GS[0/80/80] Spr+GS+CC[0/80/80]
WQFS/Brouder&Volenec	Yes	Spr[0/140_or_160/0][3]	Spr+CC[0/160/0][3]	GS+↓rate+CC[0/20/100] GS+↓rate+intC[0/0/50]
ONT_4R&TRO/Drury	Yes	GS(brd) [0/25/125]	GS(inj) [0/25/125] GS(brd)+inhib[0/25/125]	GS(inj)+inhib[0/25/125]

[1] Abbreviations: Bio = bioreactor, brd = broadcast, CC = cover crop, inhib = urease and/or nitrification inhibitors, inj = inject, intC = inter-crop, PC = polymer coated, GS = growing season, Spr = spring

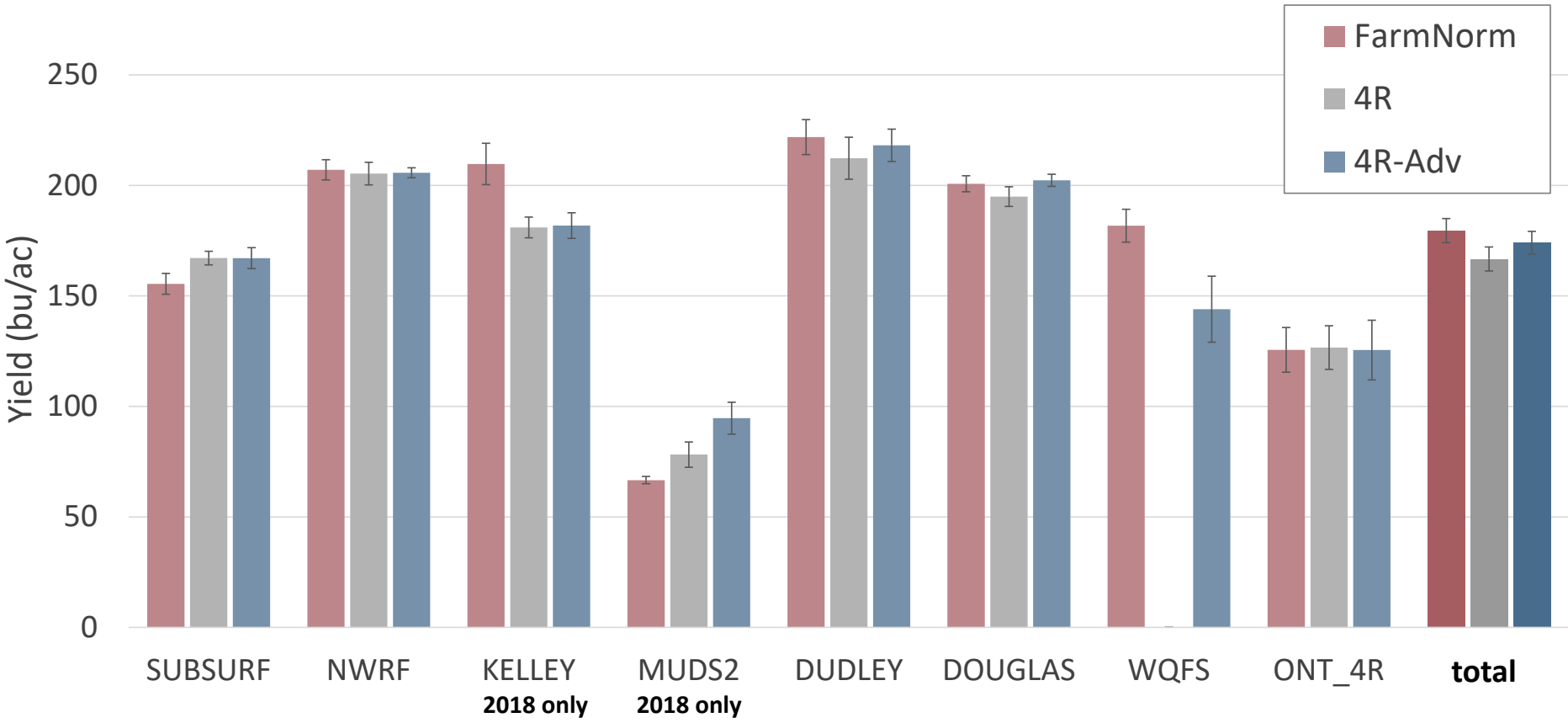
[2] Fertilizer timing, with rate (lb N/ac) in square brackets [fall/spring/growing_season]

[3] One CC trt at KELLEY had 135 lbs N/ac in the GS application; higher rate and intercrop trts at WQFS were cont. corn

4R management did not affect overall corn yield

(2018 & 2019 average)

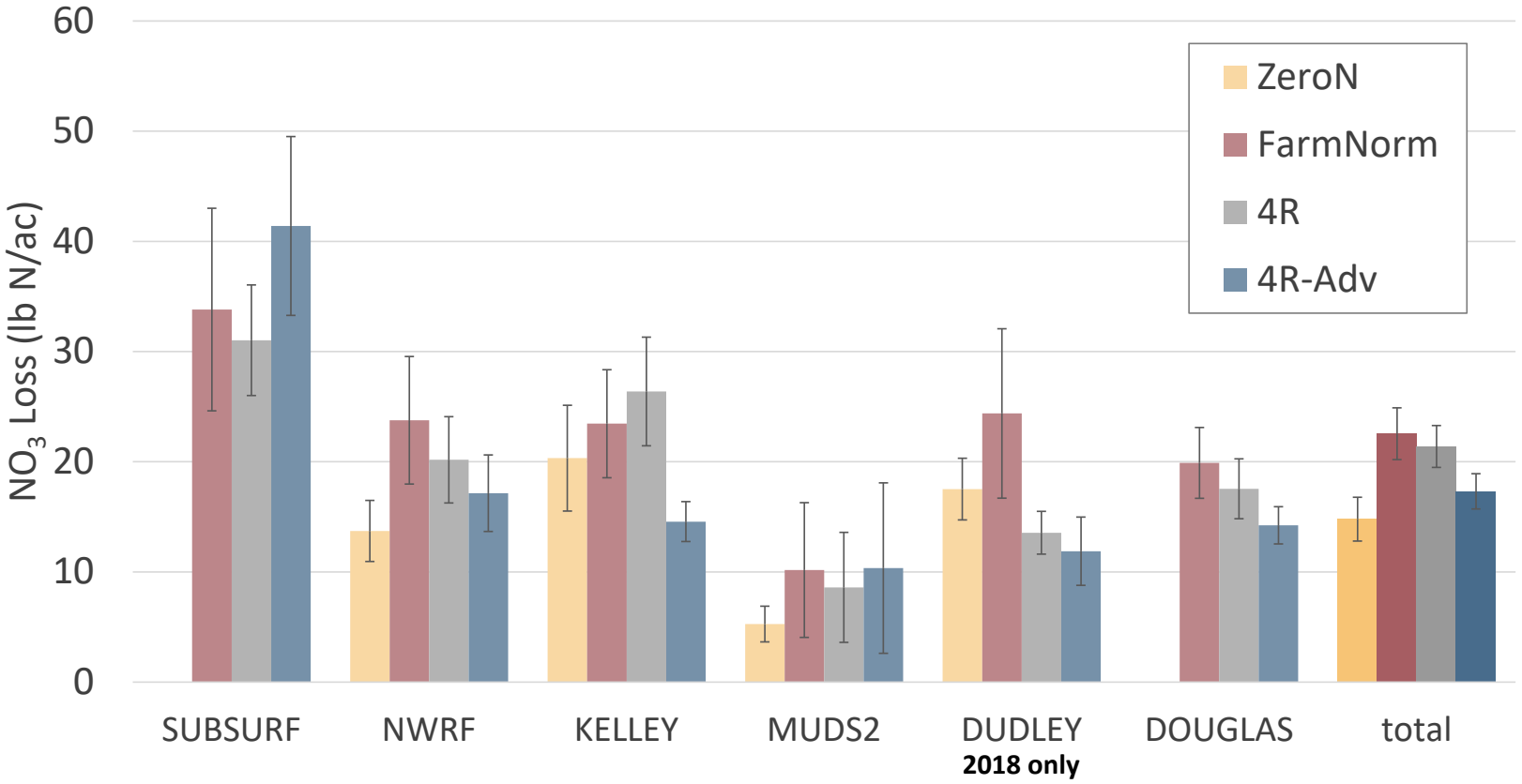
2018: 4R-Adv ↑ 7 bu/ac
2019: 4R-Adv ↓ 10 bu/ac
Overall: no impact



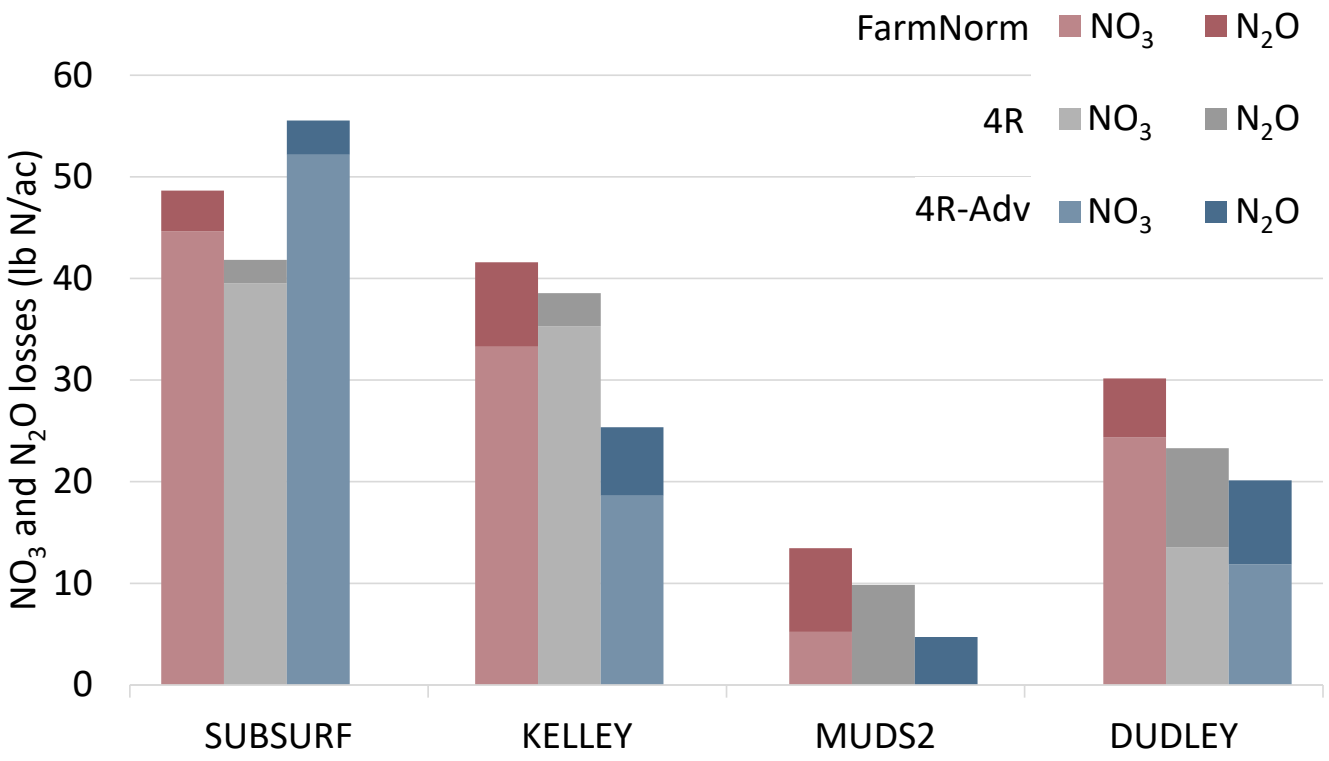
4R management reduced Nitrate-N losses

(corn & soy; 2018 & 2019 average)

4R-Adv: ↓ 5 lb N/ac
Soybean: ↓ 6 lb N/ac



More N is lost as nitrate than as nitrous oxide (usually)



NO_3-N : N_2O-N

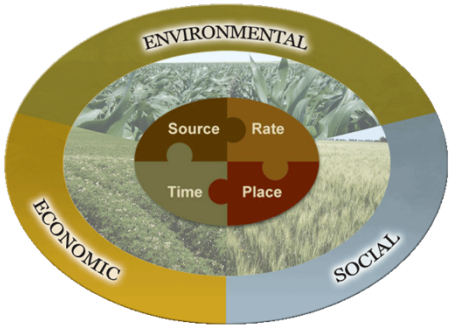
Subsurf	17.6
Kelley	9.8
MUDS2	0.5
Dudley	3.5

Key factors affecting crop yield, N Balance, and N losses

	Corn yield	**NO_3-N loss**	**N_2O-N loss**
N Rate	↑	↑	↑
N Balance		↑	- -
Coated or inhibitor	- -	- -	↓
Urea N (vs. NH3/UAN)	- -	↑	↓
Crop		corn > soybean	corn > soybean
Corn-soy (vs CC)	↓	↑	- -
Cover crop	- -	↓	↓
Conventional tillage	↑	↑	↑

Funders

4R Research Fund



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Collaborators

USDA-ARS

Iowa State University

Agriculture and Agri-Food Canada

University of Minnesota

Purdue University

University of Illinois

University of Missouri

EDF
Environmental Defense Fund
Finding the ways that work