Instrumentation, Measurement and Findings from the USDA-ARS Edge-of-Field Research Network

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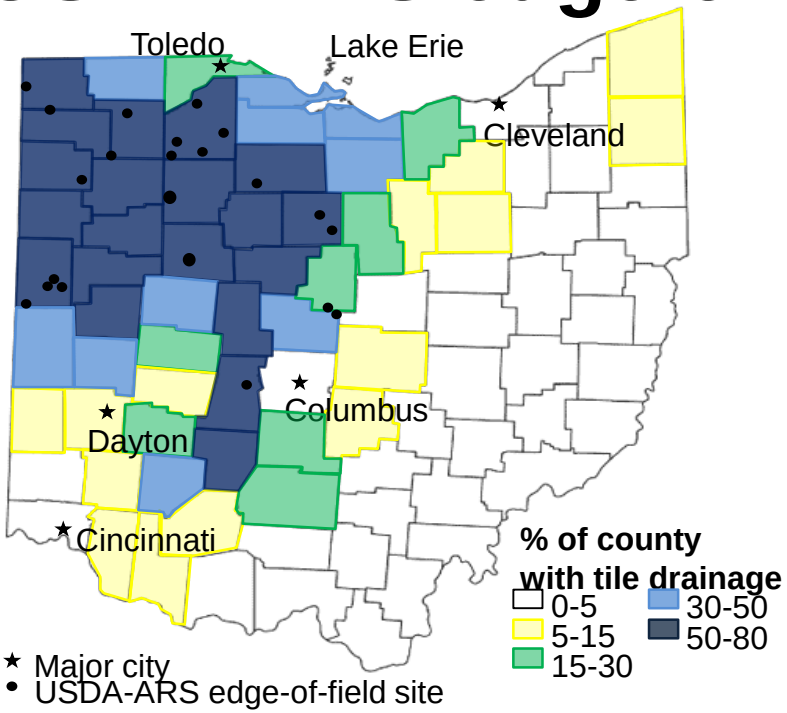
Collaborators, Partners, and Outreach

- SWCDs
- OSU Extension and OARDC
- Agri-businesses (Commodities, retailers)
- Ohio Farm Bureau
- TNC
- State agencies (ODNR, ODA, OEPA)
- NRCS (local, state, and federal)
- Crop consultants
- Producers/landowners
- Lake Improvement
- Other ARS locations
- NOAA and NWS
- Great Lakes Commission
- Great Lakes Protection Fund
- Greenleaf Advisors
- Multiple University Partners (OSU, U Toledo, Oklahoma State Univ., Univ. of Waterloo, NC State, Purdue Univ., Univ. of KY)
- 4R Research Fund (IPNI, TFI)
- NCWQR at Heidelberg
- Agriculture and Agri-Food Canada
- Consultants (Limno-Tech)
- USGS
- Private Industry (Agri-Drain, ADS, Hancor, John Deere, The Andersons, Becks Hybrids)
- Gypsoil

USDA-ARS edge-of-field network in Ohio

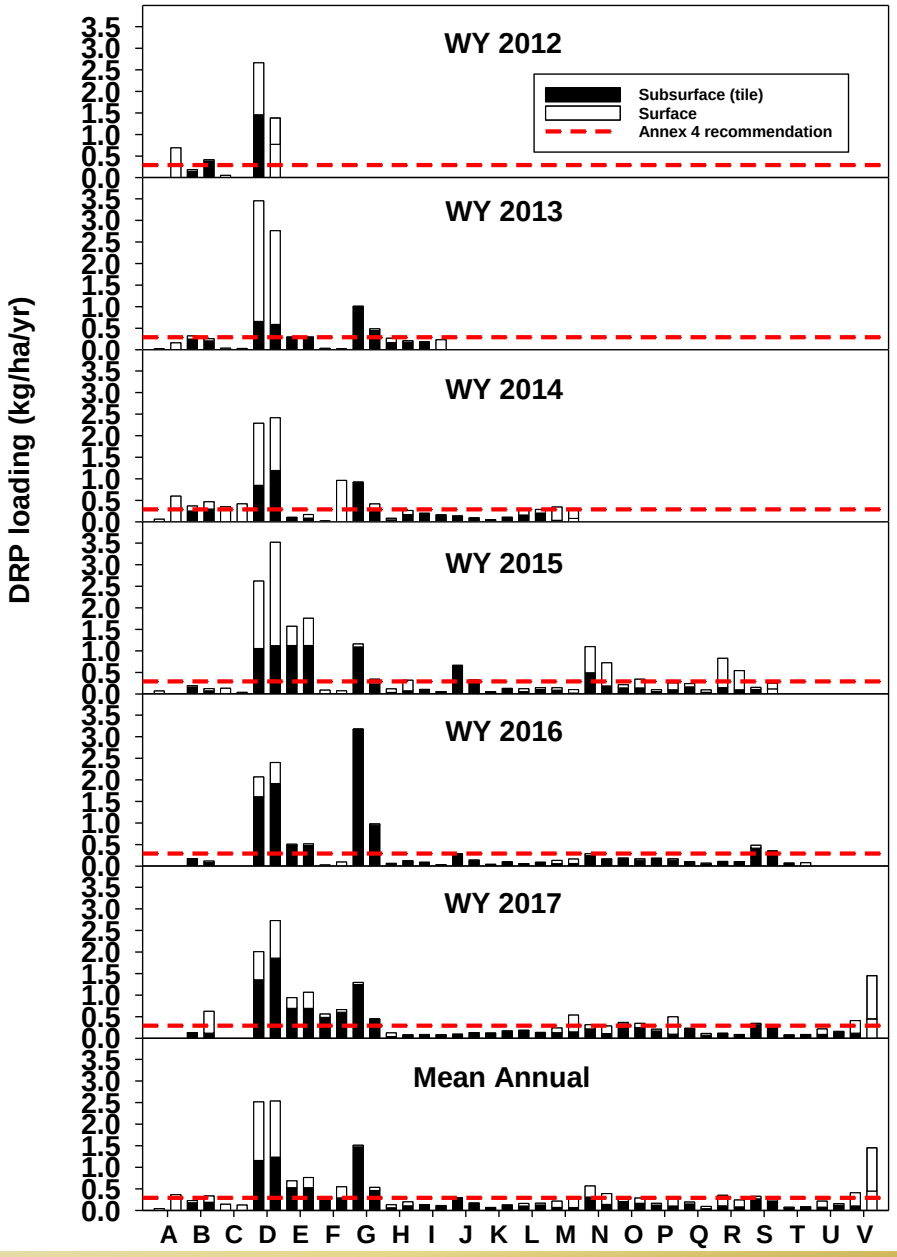


By the numbers

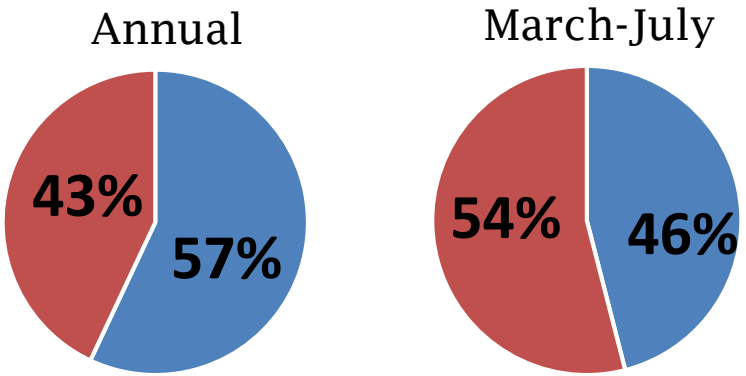
- **40 paired fields located on 20 farms**
- **97 automated Isco samplers**
- **Over 200+ site years of data (surface & subsurface)**

Typical edge-of-field site

Williams et al. 2016. J. Soil Water Conserv. 71:9-12



---- If 40% load reduction was applied to entire Maumee Basin

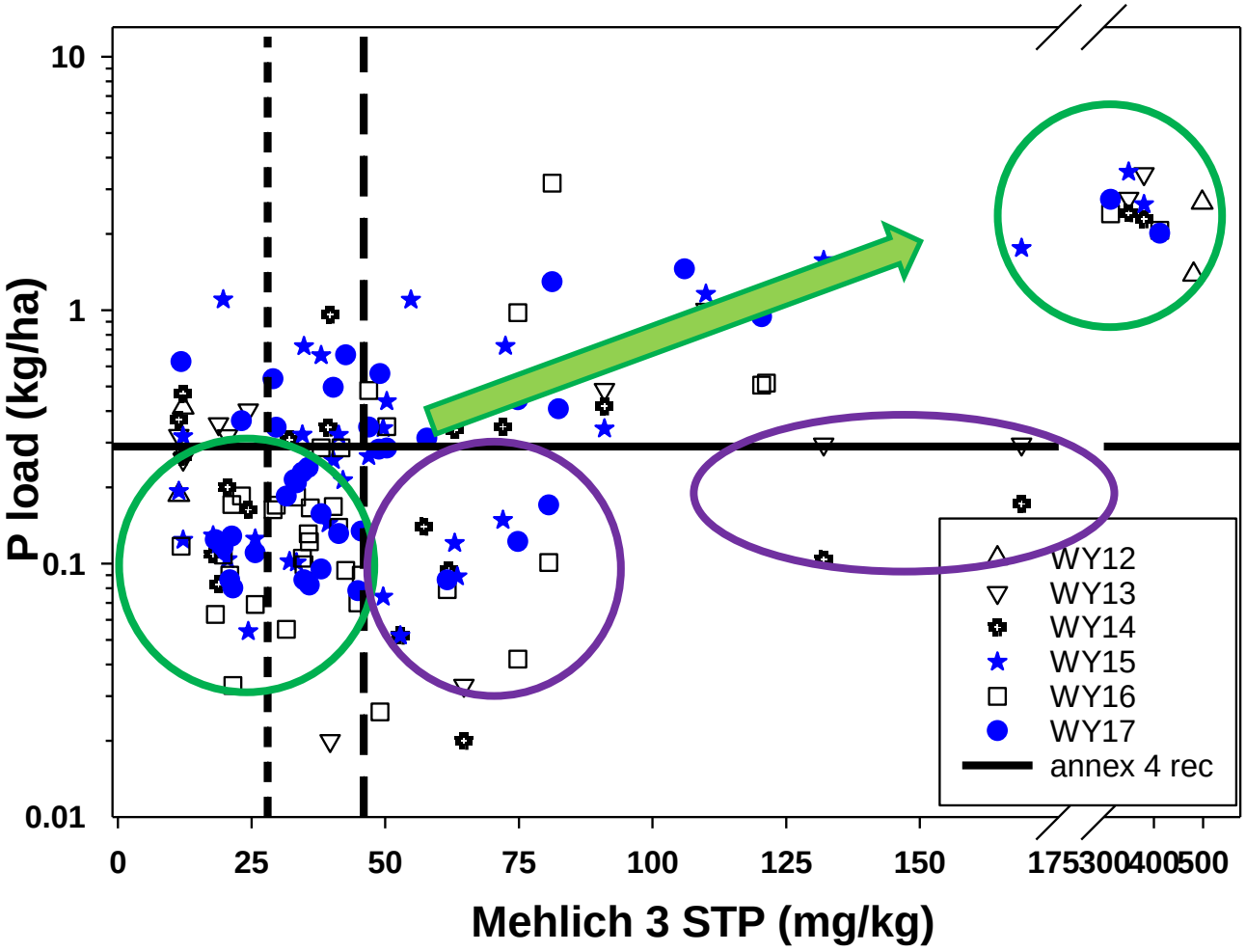


Meets target

Exceeds target

70±30% of total DRP load was from tile drainage

Soil Test P vs Environmental Risk



Soil Test P above **agronomic rates** poses an **environmental risk**

BUT **Soil Test P above agronomic rates** does **NOT** equal **environmental risk**

King et al., 2018

Duncan et al., 2017

Precipitation and Discharge Volume

Statistical Analysis of Event Magnitude

Size of surface runoff events tied to the size of the rainfall event

Larger rainfall event = larger runoff event

Size of tile discharge event tied to antecedent conditions

Higher flows associated with:

- Consecutive rainfall events within 48-h

Lower flows associated with:

- Single events and short duration events

Treatment practices

In-field

- 4Rs (source, rate, time, placement)
  - Organic vs inorganic
  - Zero P, half-rate, full-rate
  - Fall vs spring (manure)
  - Surface vs subsurface
- Gypsum as a surface amendment
- Cover crop vs no cover crops
- Crop rotation

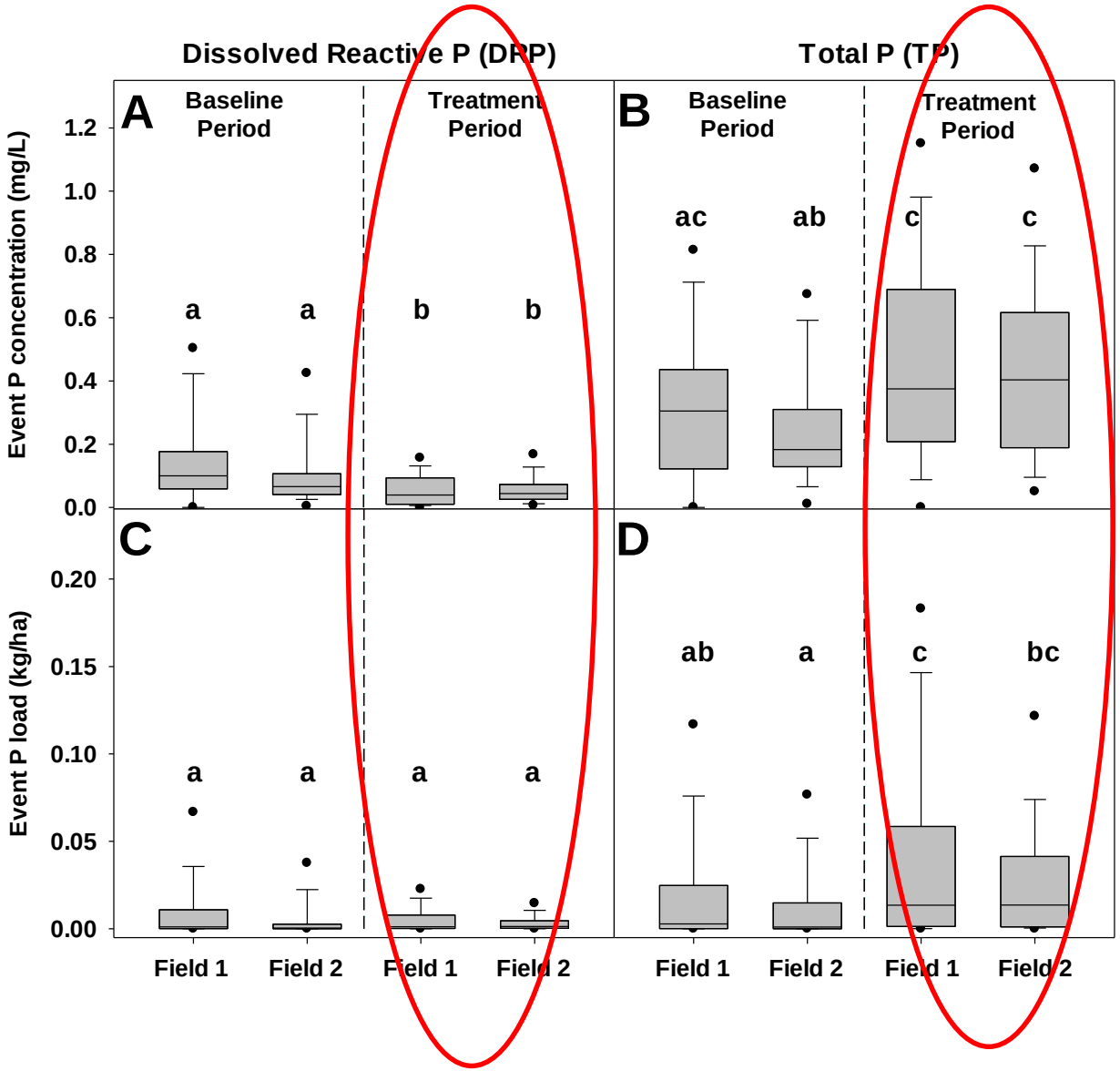
Edge-of-field

- Drainage water management
- Woodchip bioreactors and P filters

In-stream

- Two-stage ditch design

Fertilizer Source



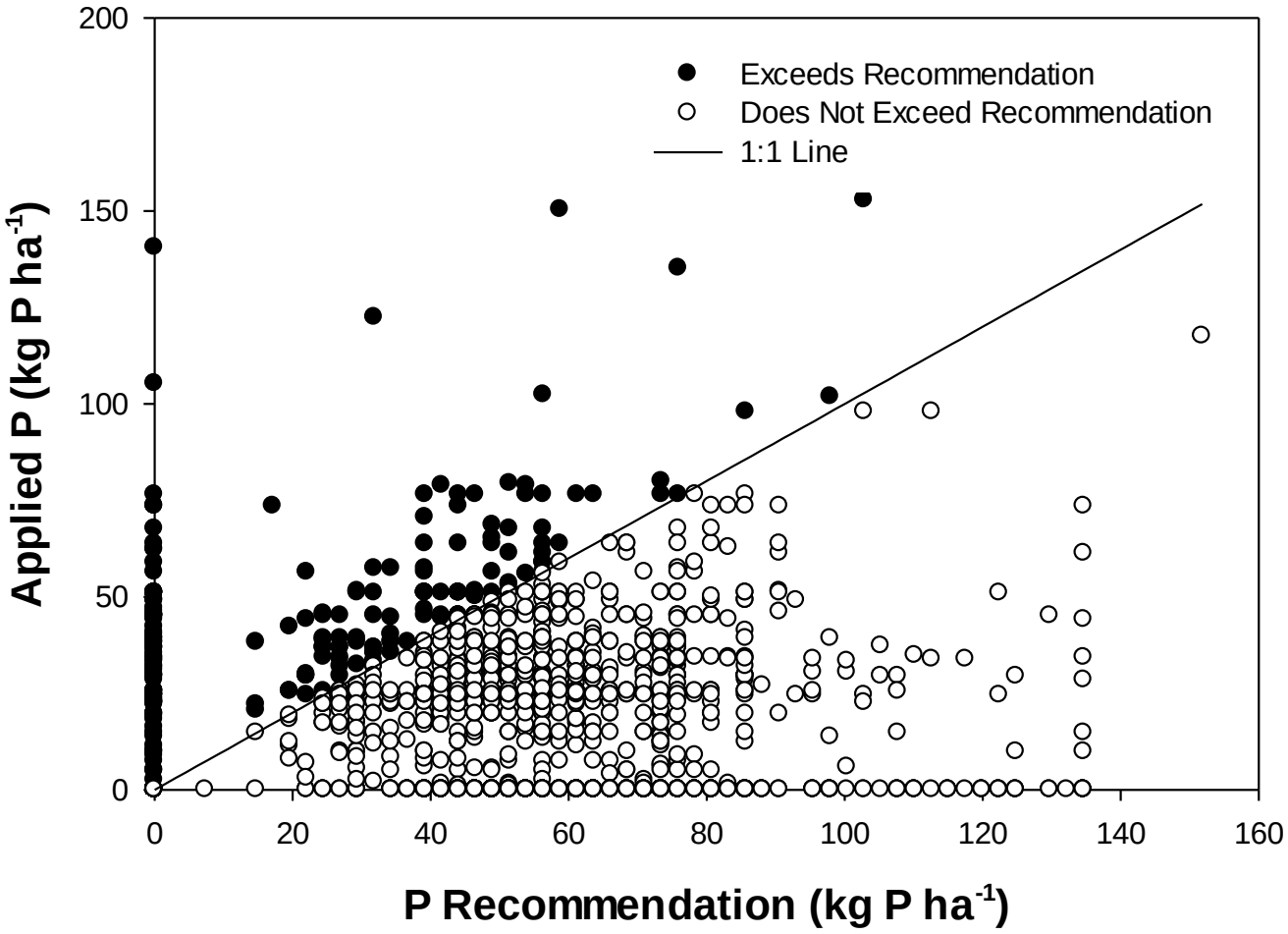
Field 1: Liquid dairy manure

Field 2: MAP

Ohio – Crop Rotation Application Rates

90% of fields have P application at or below recommendations

58% of fields had zero P applied

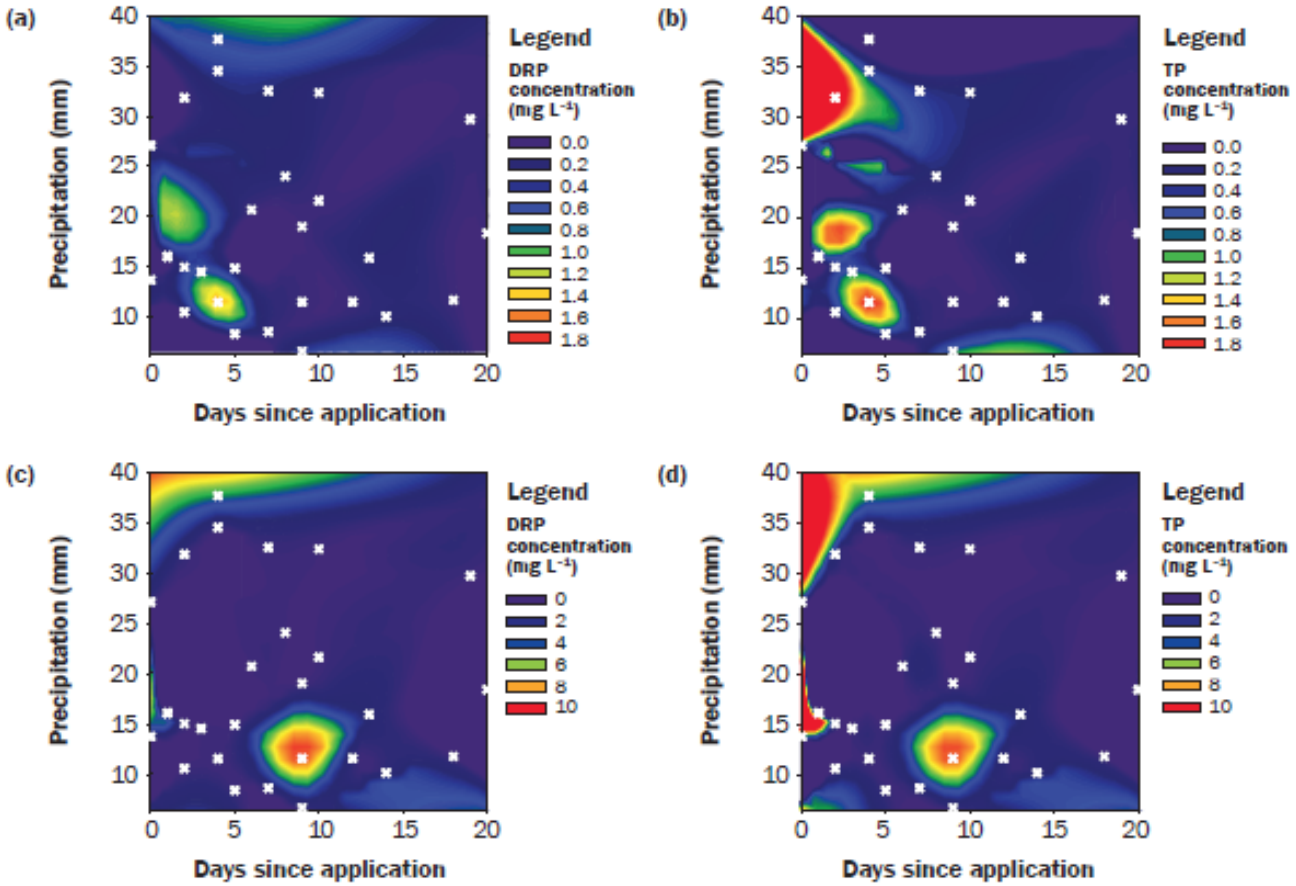


Provided by Doug Smith

P losses and time of application

Tile drainage

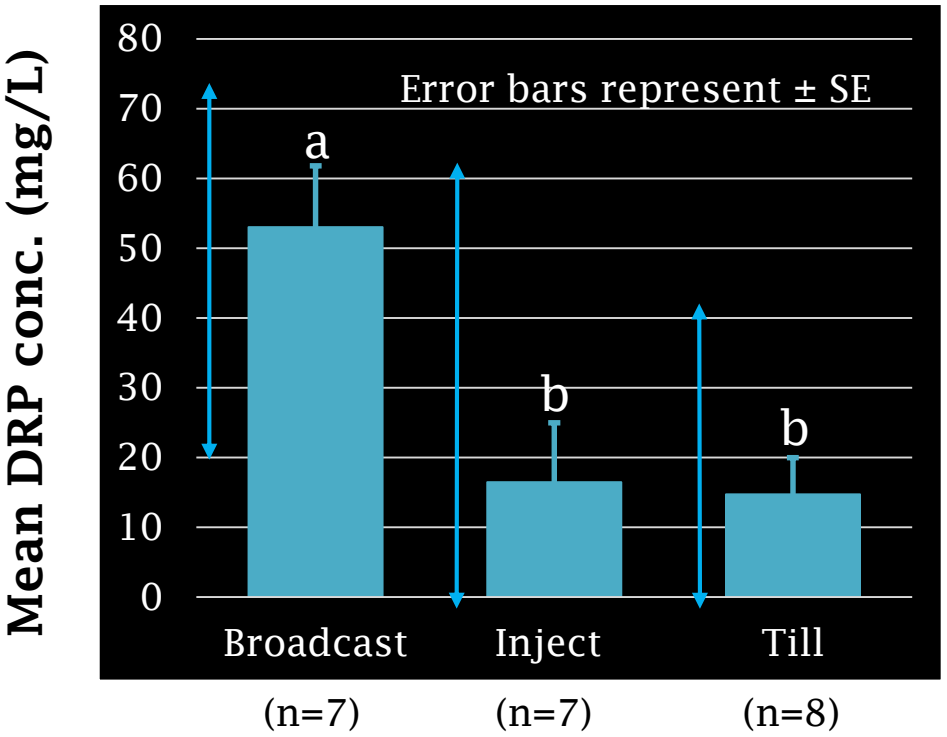
Surface runoff



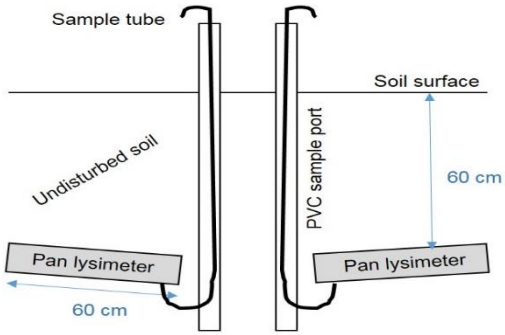
- **Greater potential for losses when application is followed shortly by precipitation**

King et al., 2018

P losses and fertilizer placement



Variability among lysimeters



Williams et al., 2018

Cover/catch Crop x Rate study

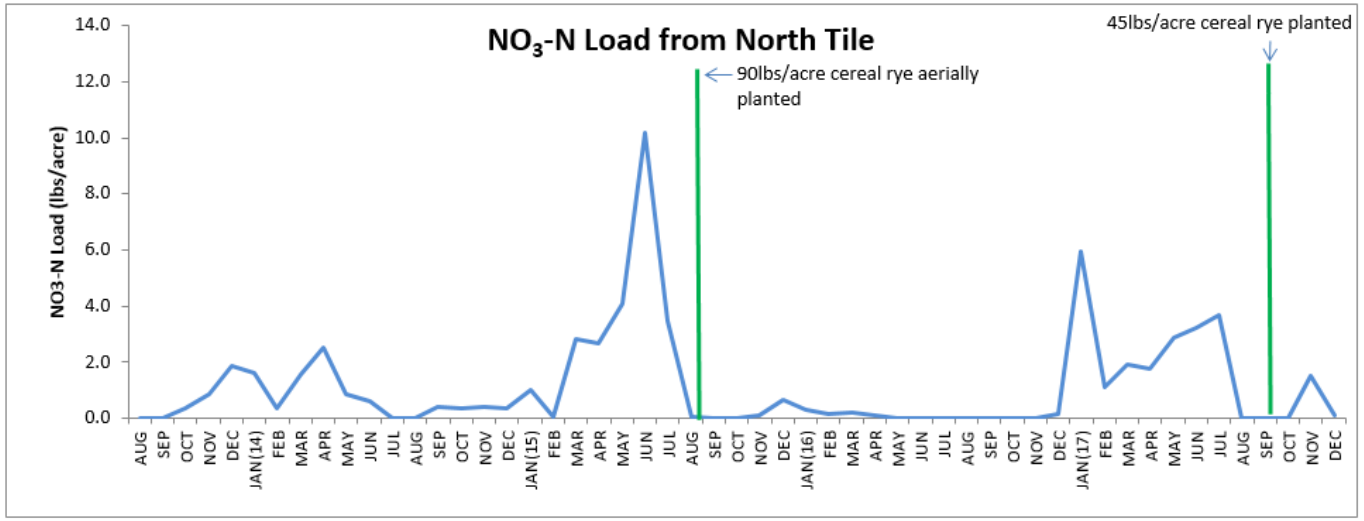
7/6/2017: 7000 gal/ac liquid dairy manure (15.3,5.4,13.5)

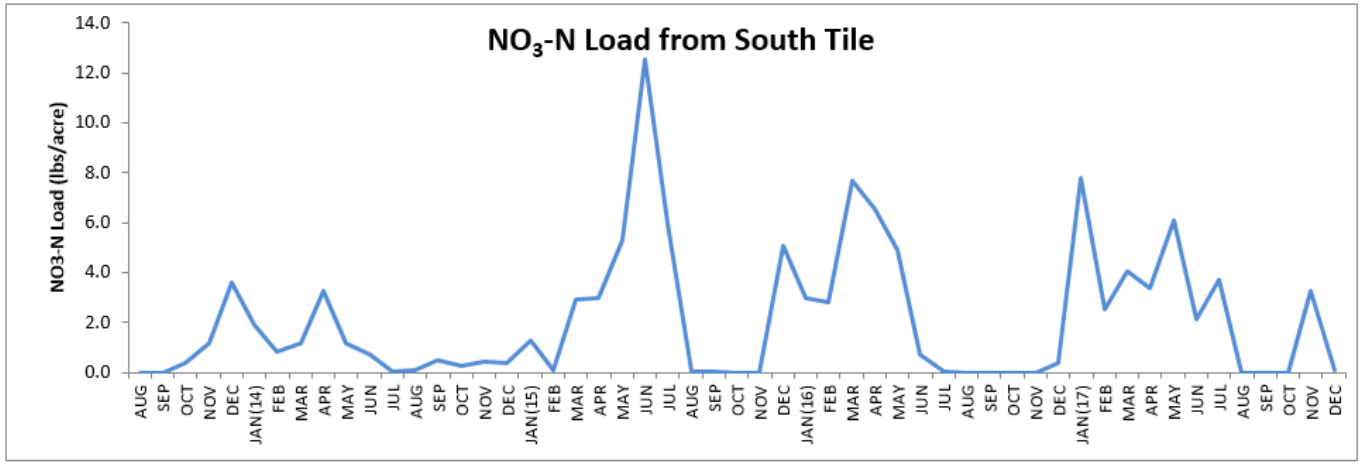
7/31/2017: 7000 gal/ac liquid dairy manure (15.3,5.4,13.5)

	Precipitation (inches)	Discharge (inches)	NO3-N (lbs/ac)	DRP (lbs/ac)	Discharge (inches)	NO3-N (lbs/ac)	DRP (lbs/ac)	Discharge (inches)	NO3-N (lbs/ac)	DRP (lbs/ac)	Discharge (inches)	NO3-N (lbs/ac)	DRP (lbs/ac)
Oct	2.94	0.84	4.32	0.01	0.20	1.33	0.00	0.25	1.21	0.00	0.09	0.26	0.00
Nov	5.87	1.74	12.06	0.02	0.70	1.35	0.01	1.83	25.35	0.03	1.18	2.50	0.02
Dec	0.32	0.19	0.63	0.00	0.08	0.02	0.00	0.05	0.12	0.00	0.20	0.03	0.00
Total	9.13	2.77	17.01	0.03	0.98	2.70	0.01	2.12	26.68	0.03	1.47	2.80	0.02

Preliminary data suggests: Rate and cover crop have a significant impact on NO3-N tile drainage losses but little effect on DRP

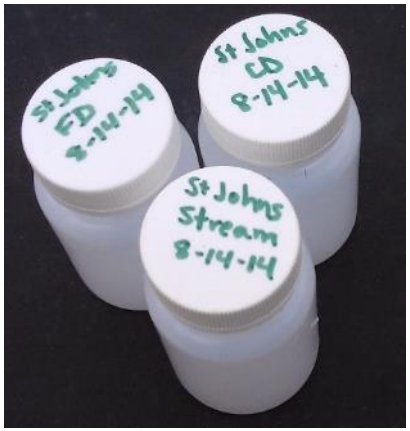
Cover crops

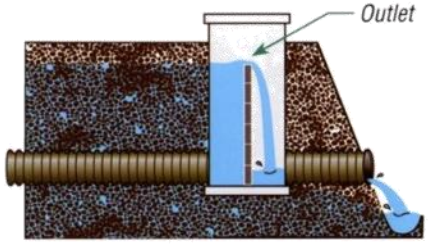

NO_3-N Load from North Tile
90lbs/acre cereal rye aerially planted
45lbs/acre cereal rye planted
NO3-N Load (lbs/acre)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
AUG SEP OCT NOV DEC JAN(14) FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN(15) FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN(16) FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN(17) FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC


NO_3-N Load from South Tile
NO3-N Load (lbs/acre)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
AUG SEP OCT NOV DEC JAN(14) FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN(15) FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN(16) FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN(17) FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

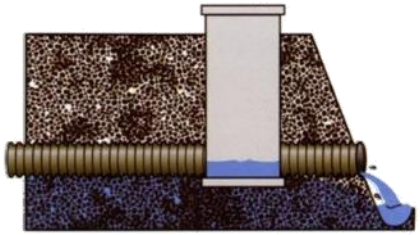
Edge of Field Practices

Drainage Water Management (DWM)

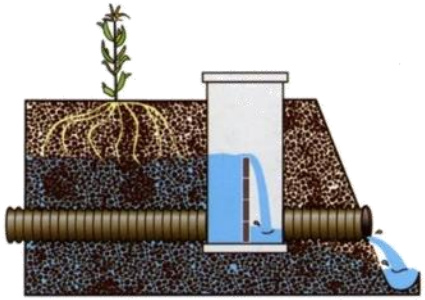




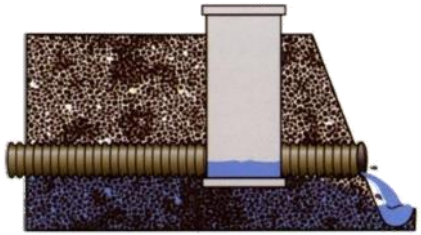
Non-Growing Season



Planting

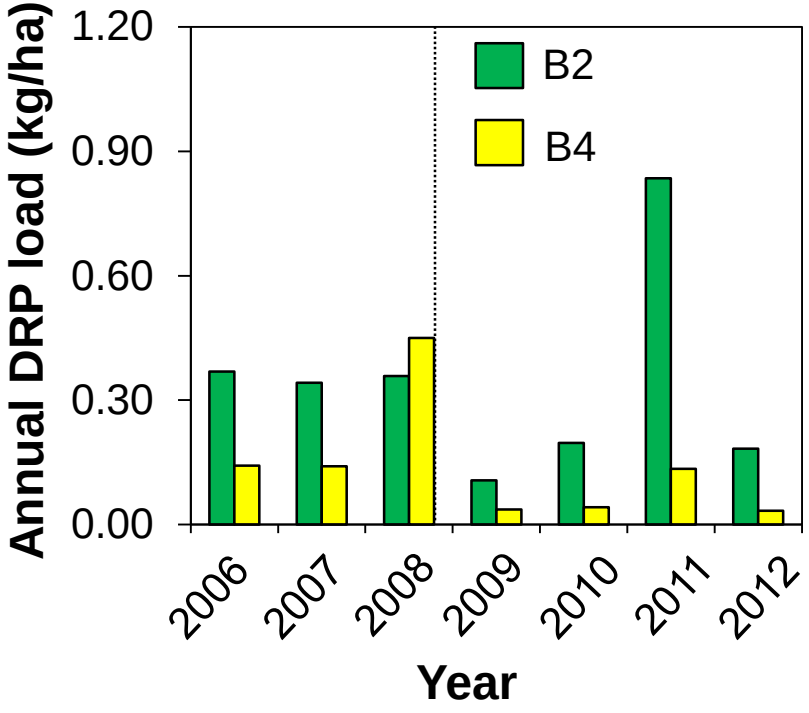


Growing Season



Harvest

DWM - Case Study

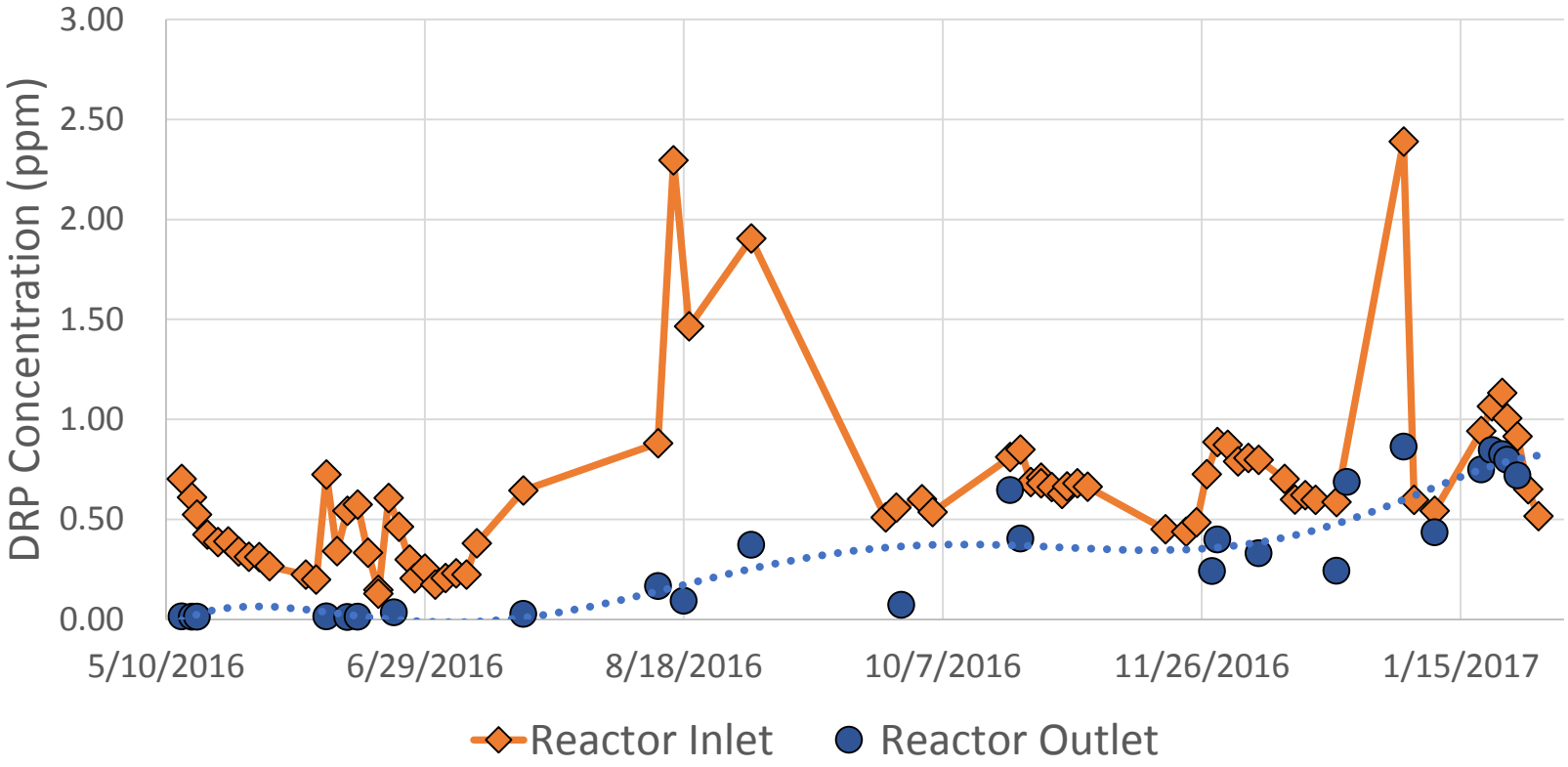


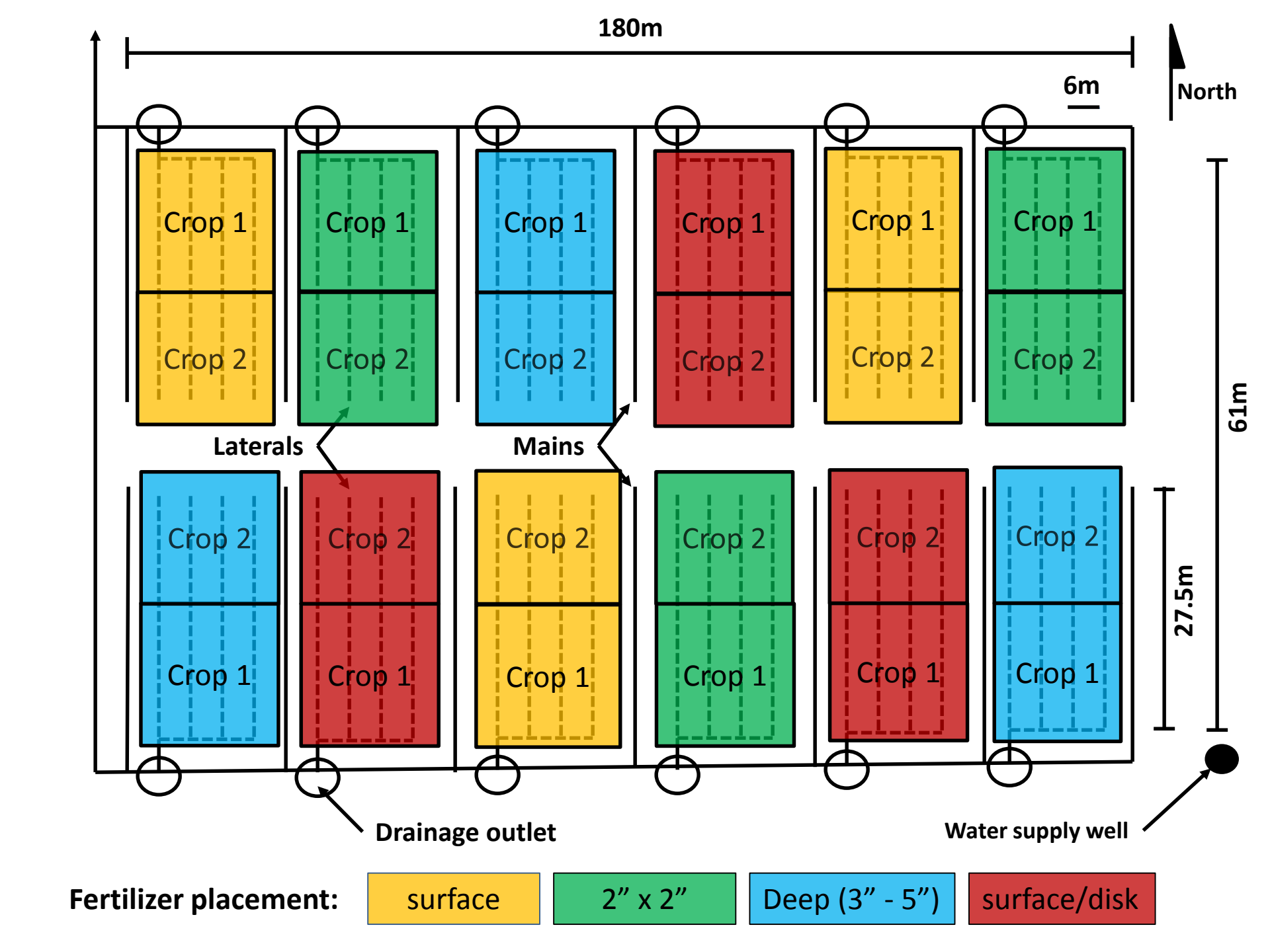
B2 – free drainage
B4 – drainage water management

- **Annual discharge reduction:**
  17% to 73% across sites
  41% on average
- **Daily discharge reduction:**
  50% on average during management
  (*Gunn et al. 2015*)
- **DWM did not significantly affect DRP concentration**
- **8-40% reduction in annual DRP load with DWM**

Phosphorus Removal Structures

DRP Concentration Reduction

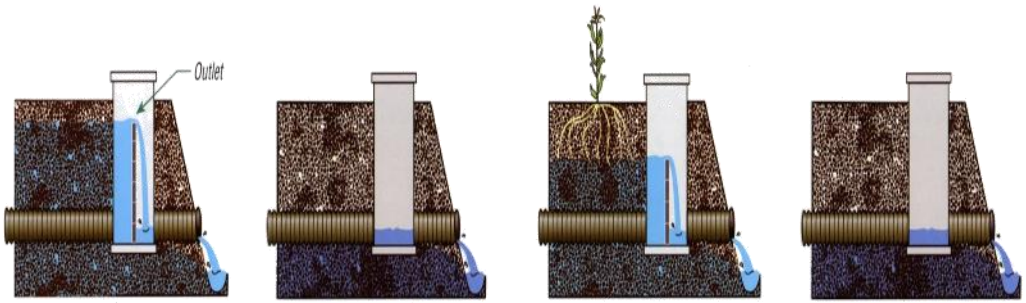



180m
6m
North
61m
27.5m
Crop 1
Crop 2
Laterals
Mains
Drainage outlet
Water supply well
Fertilizer placement:
surface
2” x 2”
Deep (3” - 5”)
surface/disk

Directionally Correct Practices

- 4Rs of nutrient management (Right source, rate, time, placement)

- Disconnecting hydrologic pathways (DWM, blind inlets, linear wetlands, water storage/increased OM)



- Do not increase erosion potential (subsurface placement)

How it is Possible!!!

Weekly

- 19 counties
- 1200 to 1300 miles per week
- 300 to 400 water samples (10000 +annually)

Edge-of-Field Team

- Brittany Hanrahan, PhD
- Emily Duncan, PhD
- Vinayak Shedekar, PhD
- Jed Stinner, PhD
- Katie Rumora, MS
- Phil Levison, MS
- Sara Henderson, MS
- Eric Fischer, MS
- Marie Pollock, MS
- Michael Maybury
- Mark Day

Funding Partners:

- NRCS (2003-present)
  - CEAP - Conservation Effects Assessment Project
  - MRBI: Mississippi River Basin Initiative
  - 201/202 EOF activities
- USDA-Agriculture Research Service
- Ohio Farm Bureau (2017-2020)
- 4R Research Fund (IPNI and Fertilizer Industry) (2014-2019)
- The Nature Conservancy (2013-2018)
- Becks Hybrids/Ohio State University (2016-2020)
- Ohio Agri-Businesses (2013-2015)
- Ohio Corn and Wheat Growers (2013 – 2015)
- CIG: 69-3A75-12-231 (OSU) (2013-2015)
- CIG: 69-3A75-13-216 (Heidelberg University) (2014-2017)
- Ohio Soybean Association (2013-2015)
- EPA: DW-12-92342501-0 (2011-2013)

Contact Information

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Rotational till

Conventional till

Rotational till

Strip till (20+ yrs)

Rotational till

No till w/ cover crop

Wheat or alfalfa (rotational till)