Using Edge of Field Research to Assess Agricultural Management Practices

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Edge-of-field instrumentation

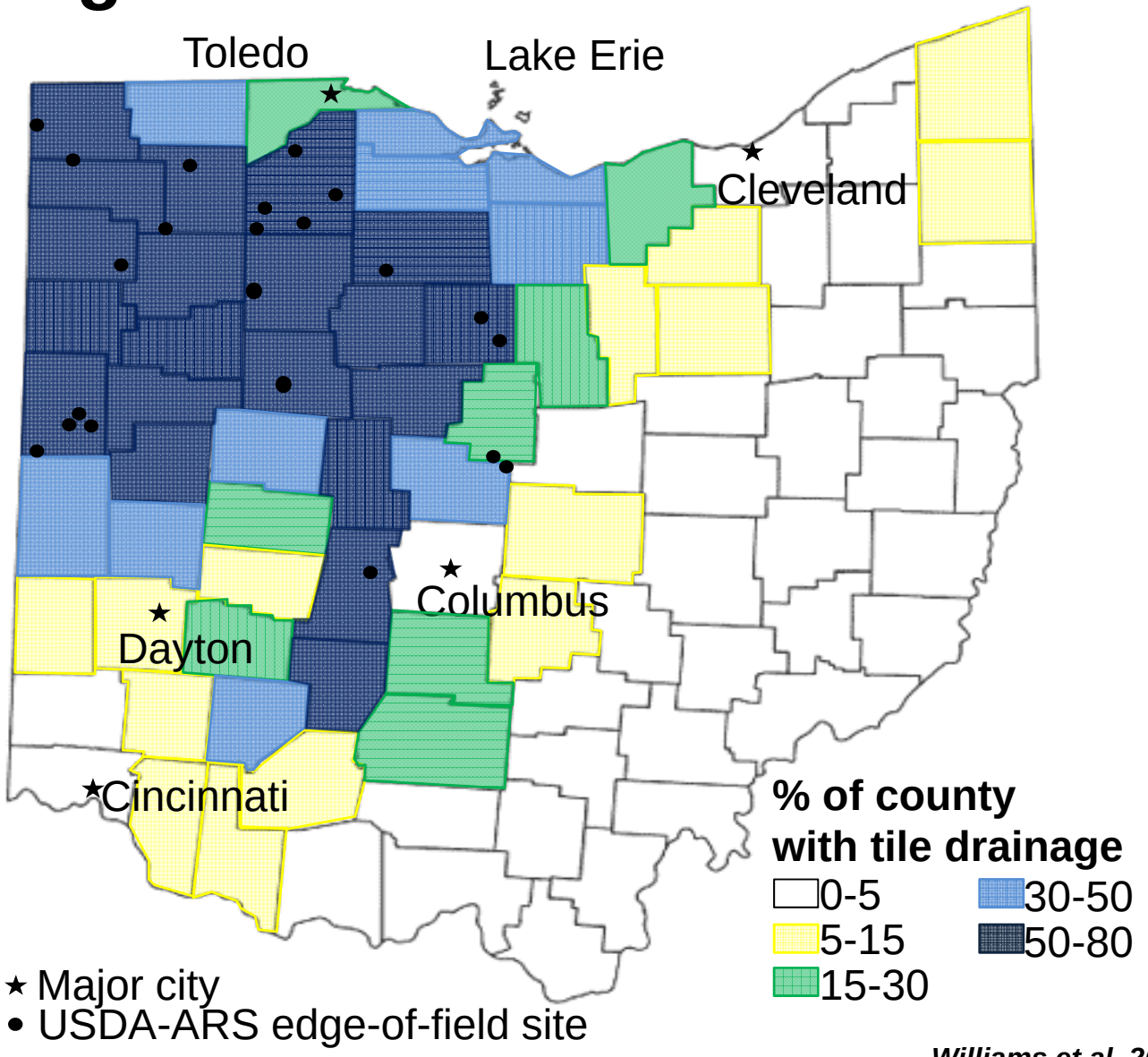
Typical edge-of-field site

Surface runoff

Tile drainage

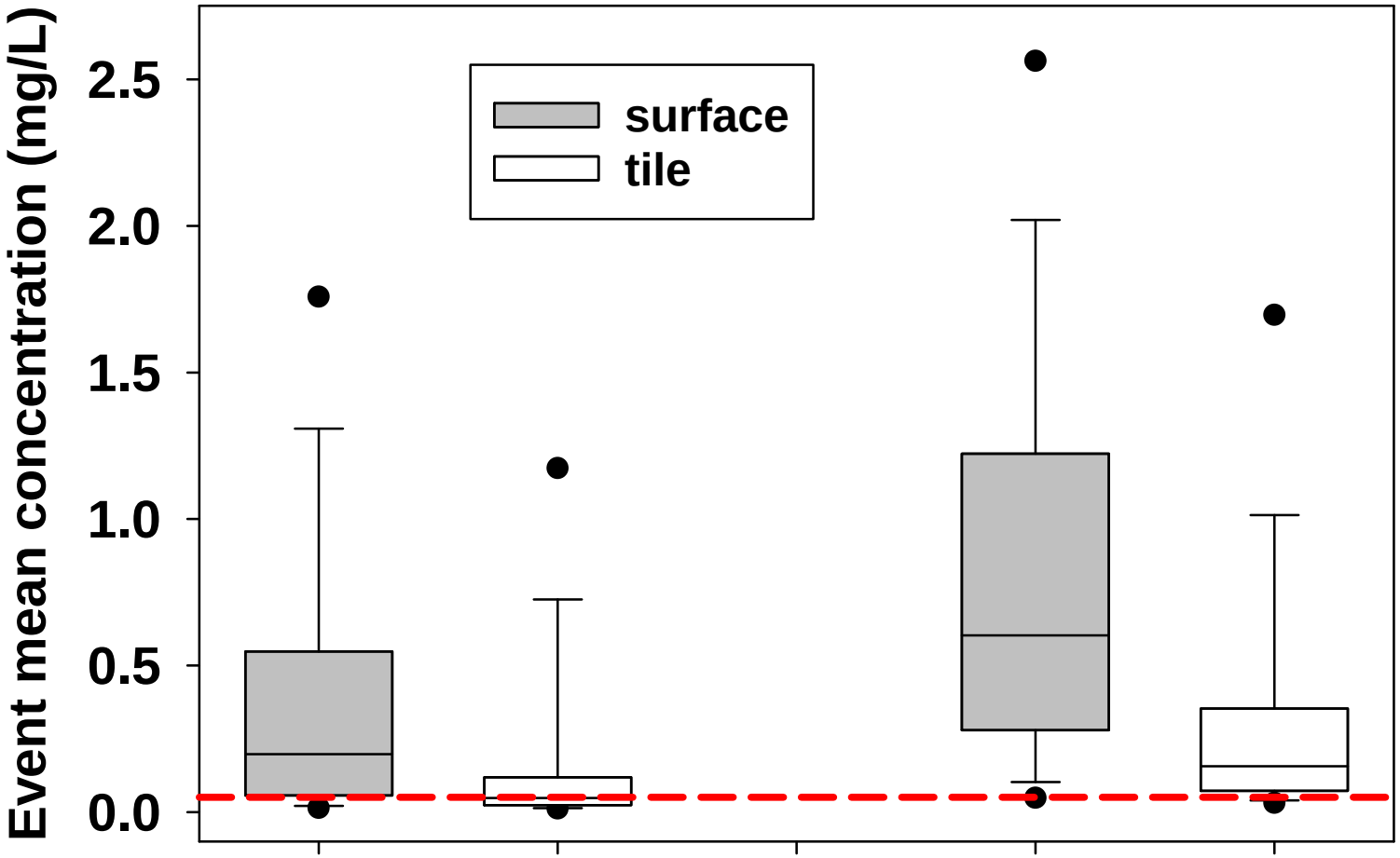
Williams et al. 2016. J. Soil Water Conserv. 71:9-12

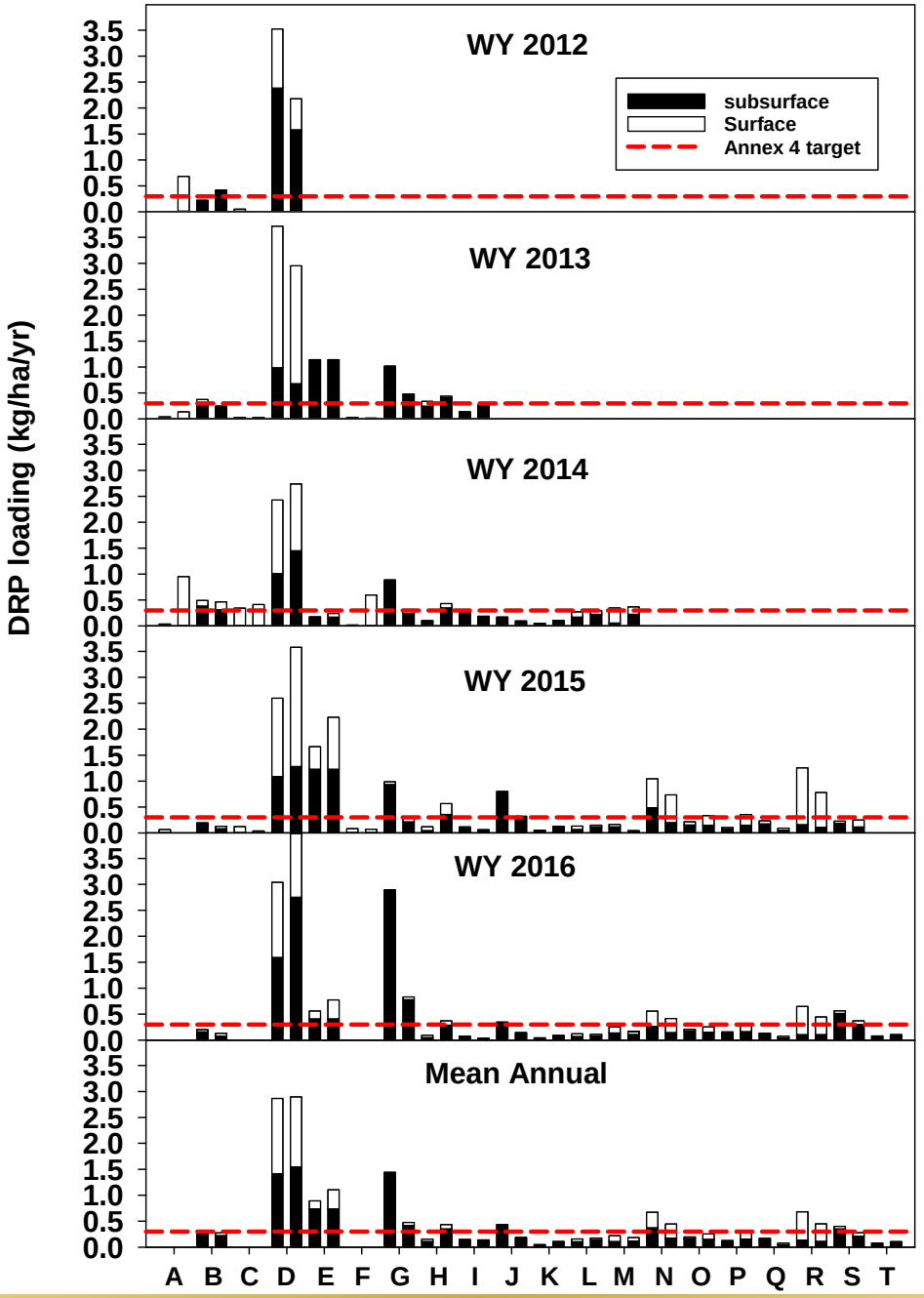
Edge-of-field locations in Ohio



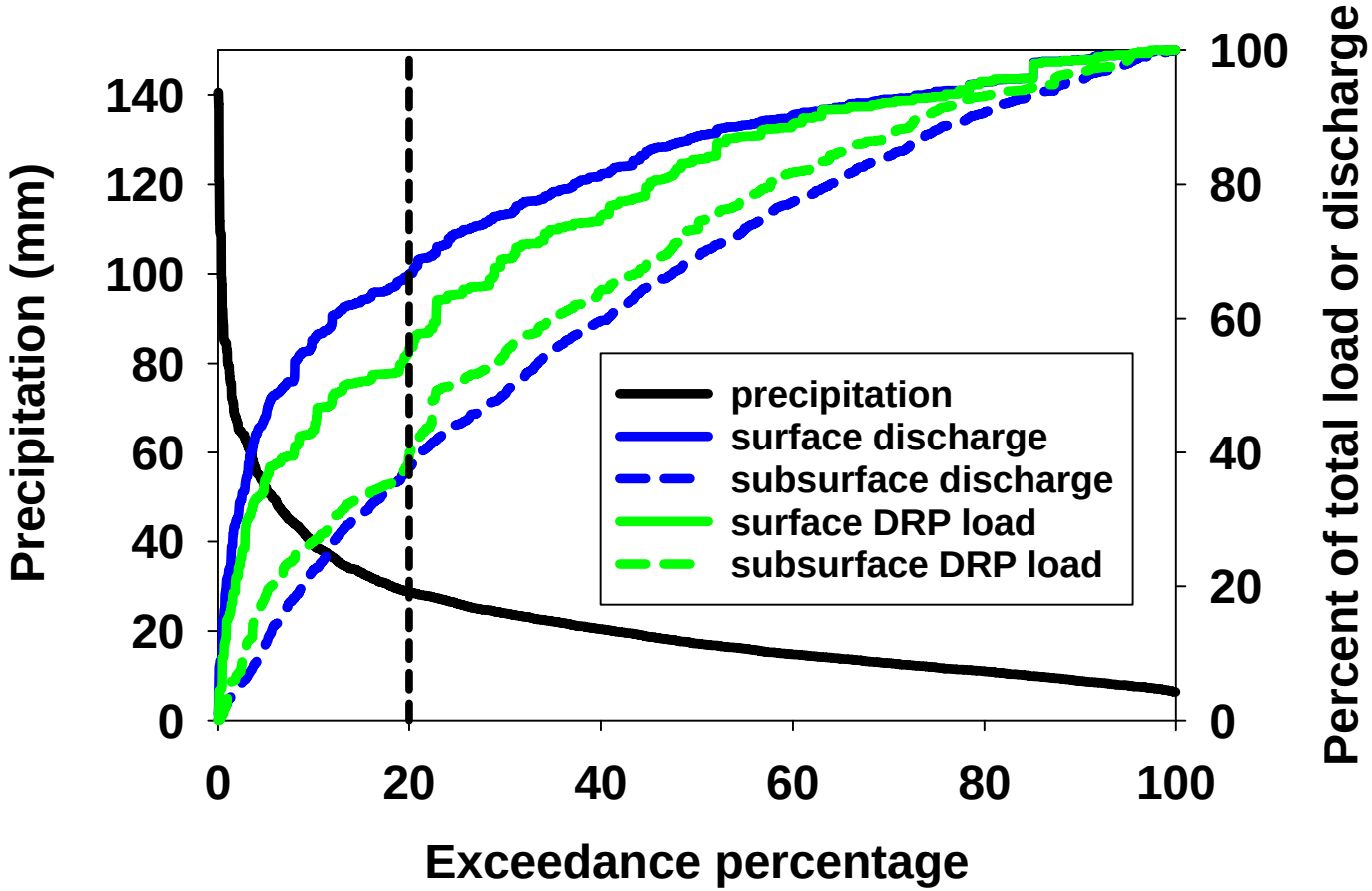
Williams et al. 2016. J. Soil Water Conserv. 71:9-12

Phosphorus Concentrations



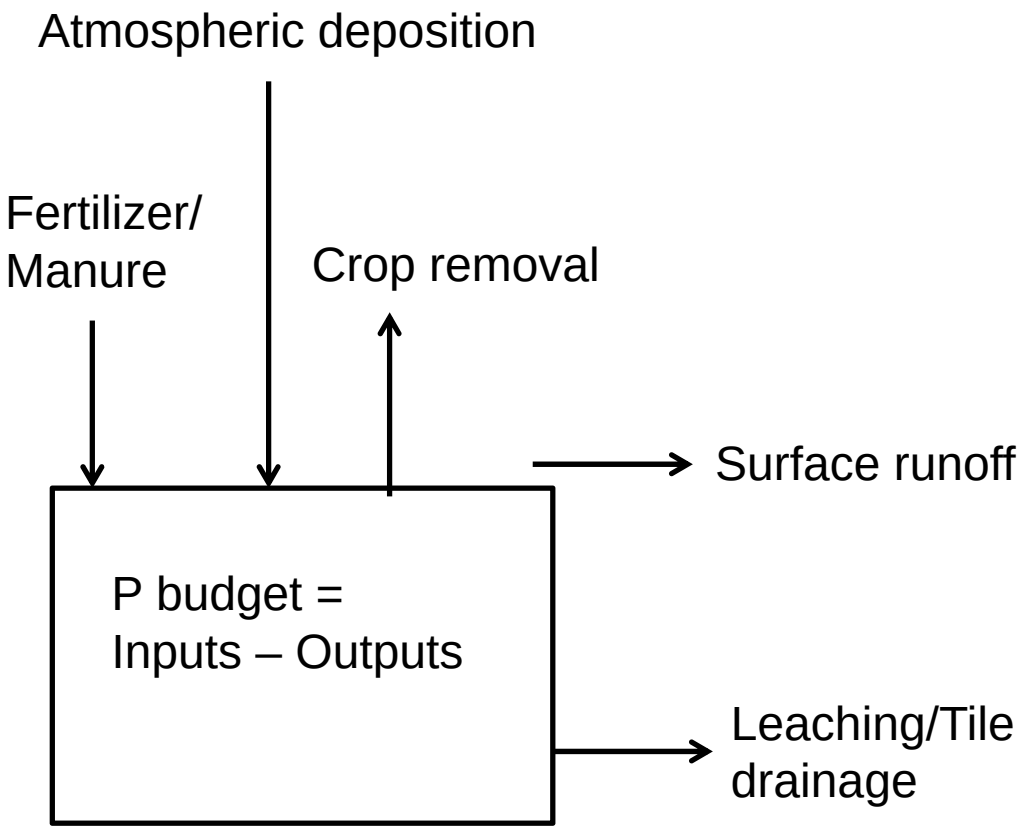

DRP loading (kg/ha/yr)
WY 2012
WY 2013
WY 2014
WY 2015
WY 2016
Mean Annual
subsurface
Surface
Annex 4 target
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
A B C D E F G H I J K L M N O P Q R S T

Weather plays a major role



Are farmers in Ohio doing a good job managing phosphorus?

Phosphorus budget for Ohio fields



All fields regardless of rotation, P source, placement, timing

Inputs

Atmospheric deposition

P applied in precipitation – out of our control

0.13 lb P/ac

Fertilizer and Manure

Average annual P applied to edge-of-field sites

18.9 lb P/ac

Range (0 to 100); Median (14.7)

Total P Inputs

19.0 lb P/ac

Outputs

Crop removal

Actual yield when provided or 160 bu/ac for corn and 45 bu/ac for soybean when not (2 instances) provided

23.1 lb P/ac

Range (0 to 37.5); Median (22.7)

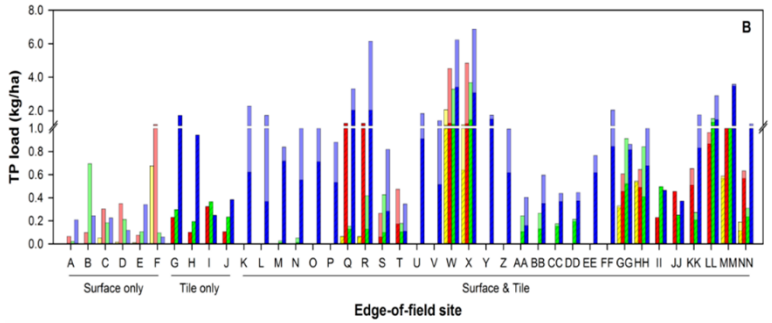
Surface runoff and tile drainage

Average surface runoff loss

0.19 lb P/ac: range (0 to 2.4) Median (0.04)

Average tile drainage loss

0.29 lb P/ac: range (0.03 to 2.6) Median (0.16)



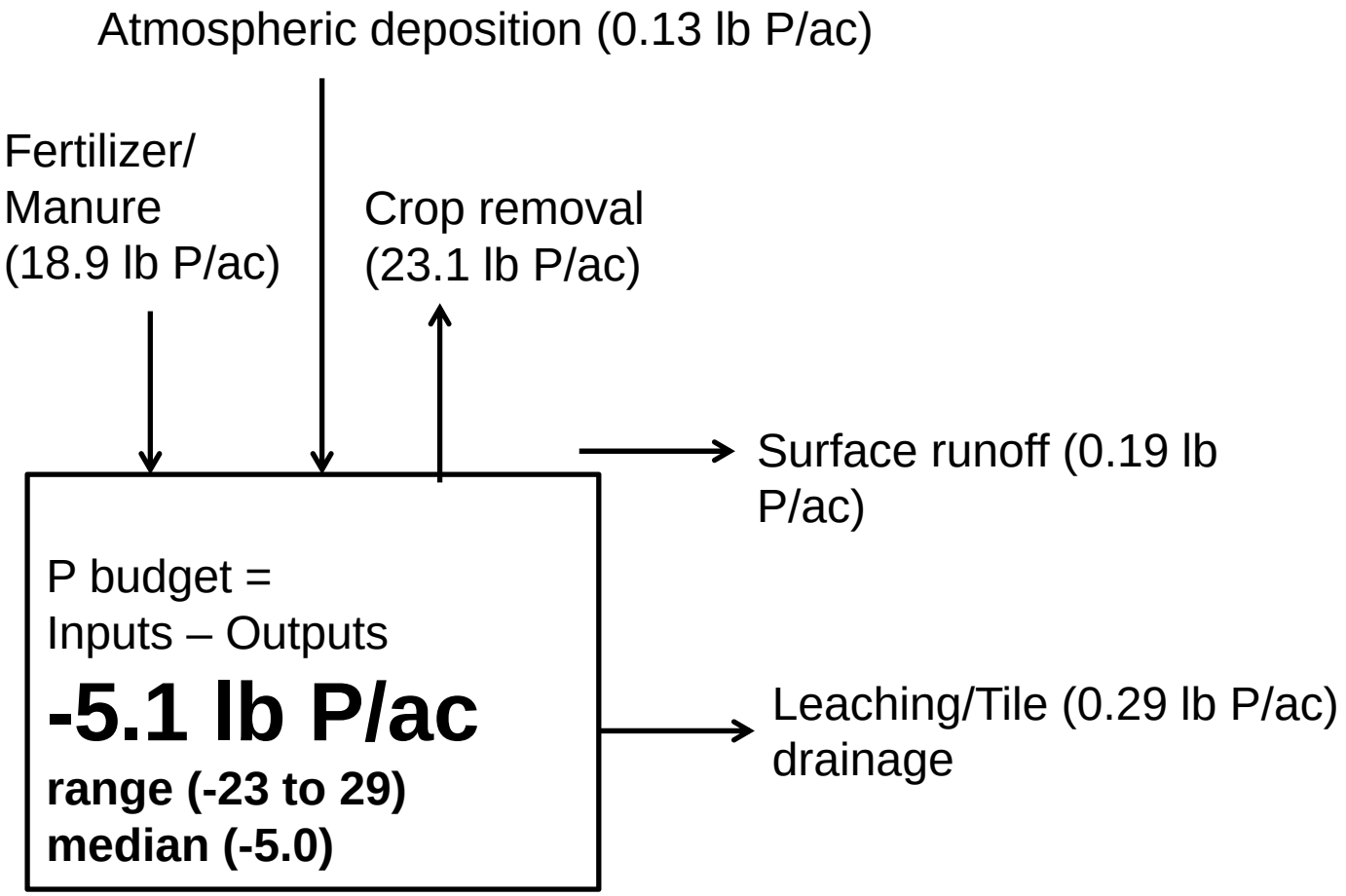
0.48 lb P/ac

Total P Outputs

23.6 lb P/ac

Phosphorus budget for Ohio fields

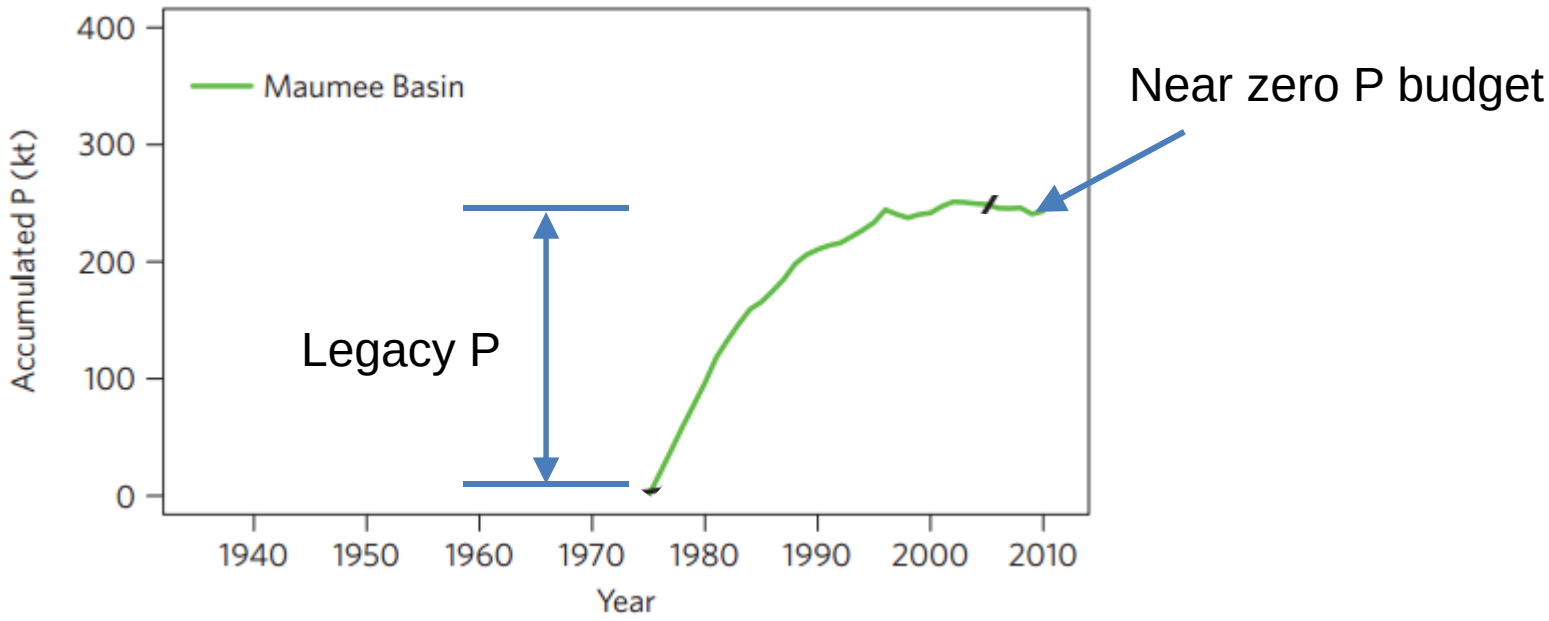
106 site years of data



Are farmers doing a good job managing phosphorus?

- ✓ **Small P losses in surface runoff and tile drainage relative to the amount of P applied**
- ✓ **Average crop removal rates are greater than the average amount of P applied**
- ✓ **P balance near zero (inputs = outputs)**

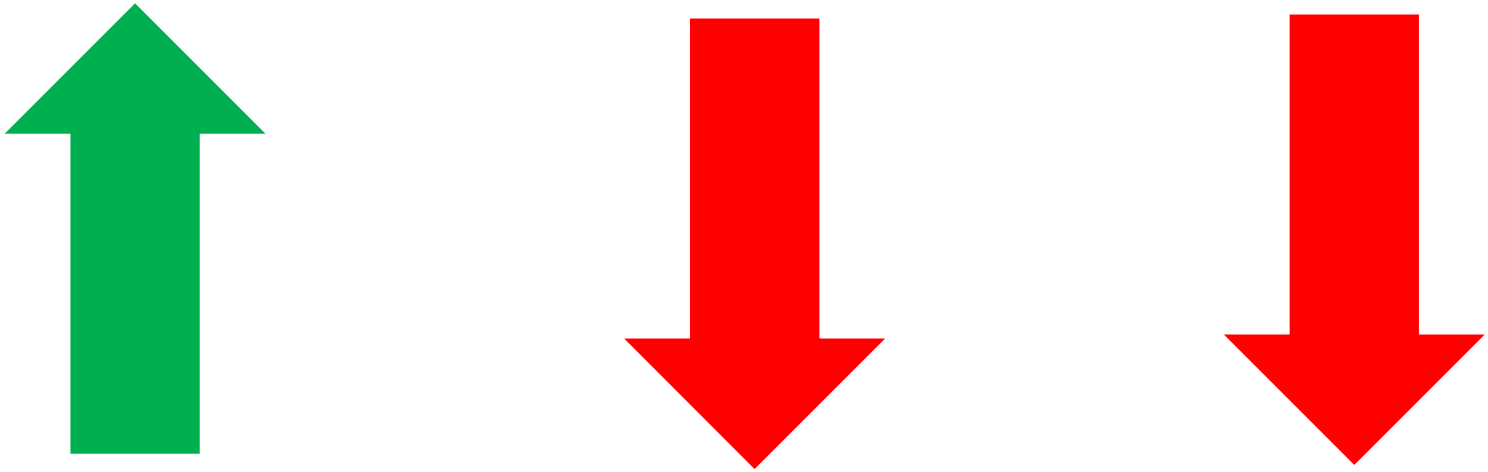
Good may not be good enough



Water quality problems in Lake Erie (and other water bodies) are going to persist due to legacy P

Powers et al. 2016. Nature Geoscience 9:353-357

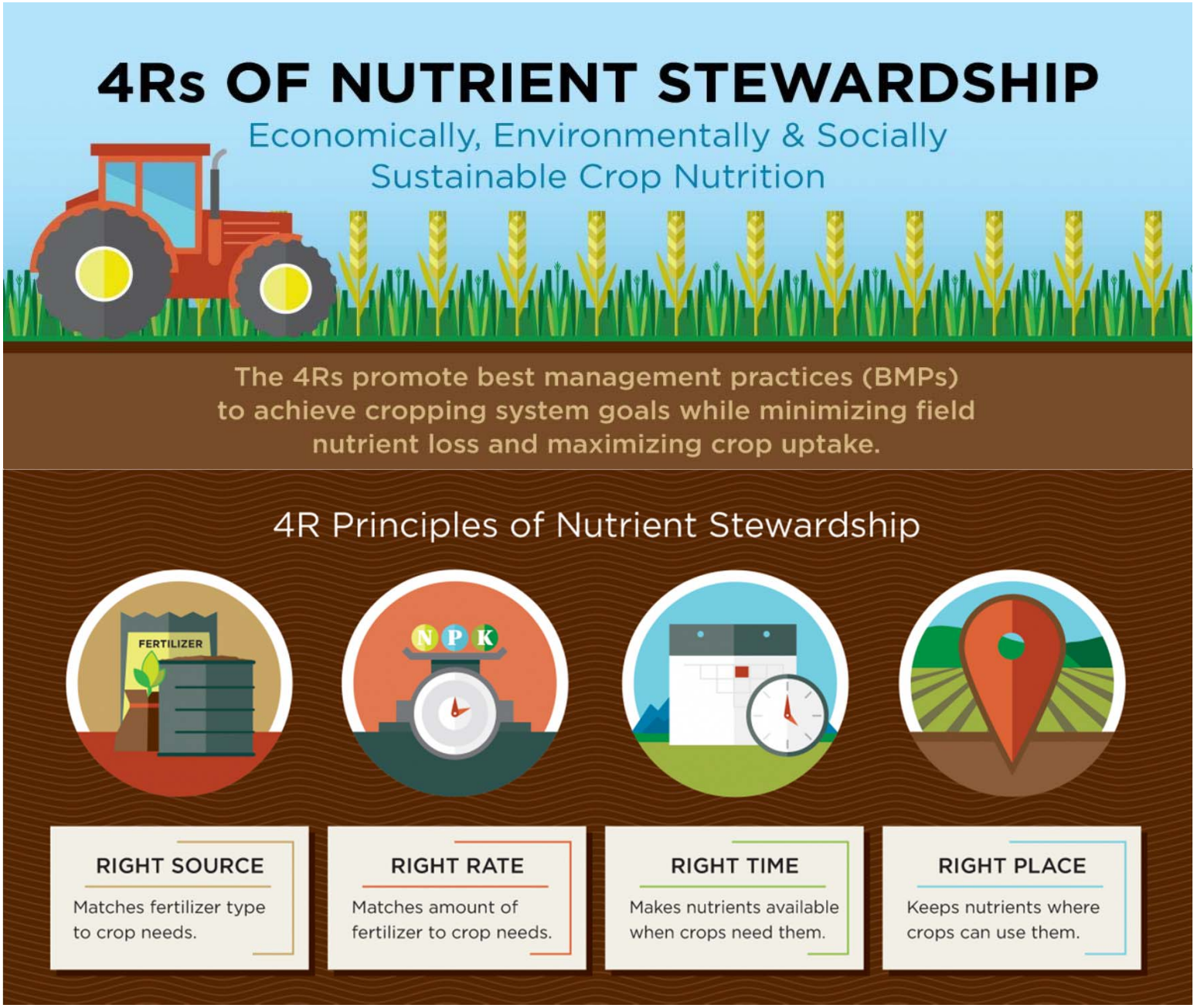
Aspirational phosphorus budget



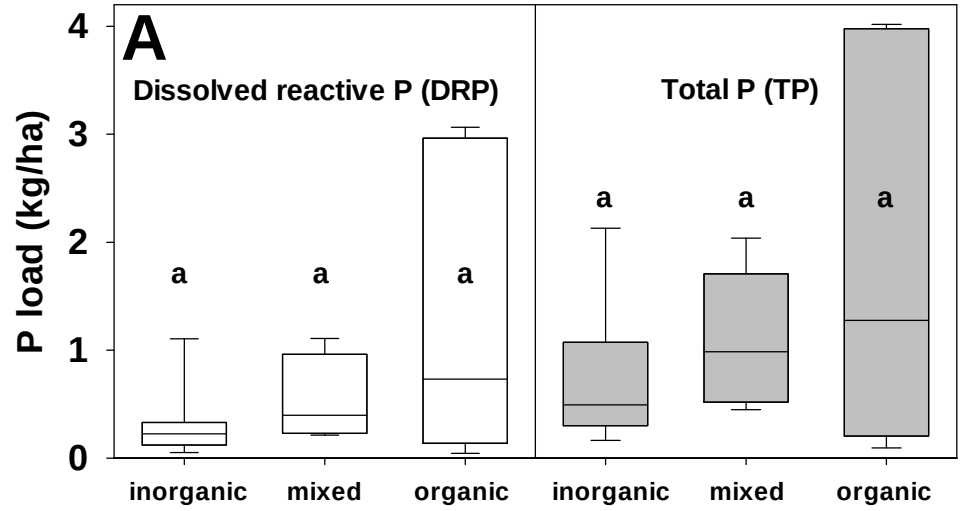
Increased yield

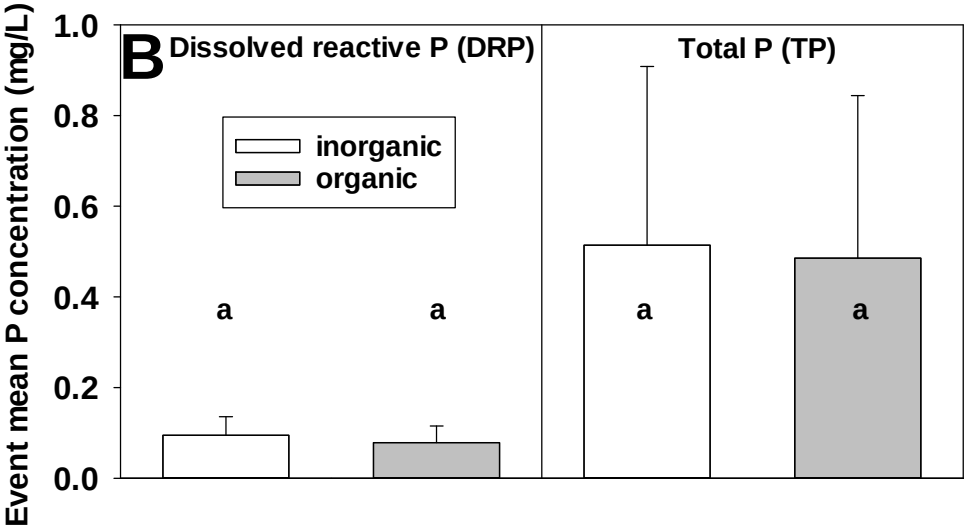
Decreased losses

Decreased P inputs

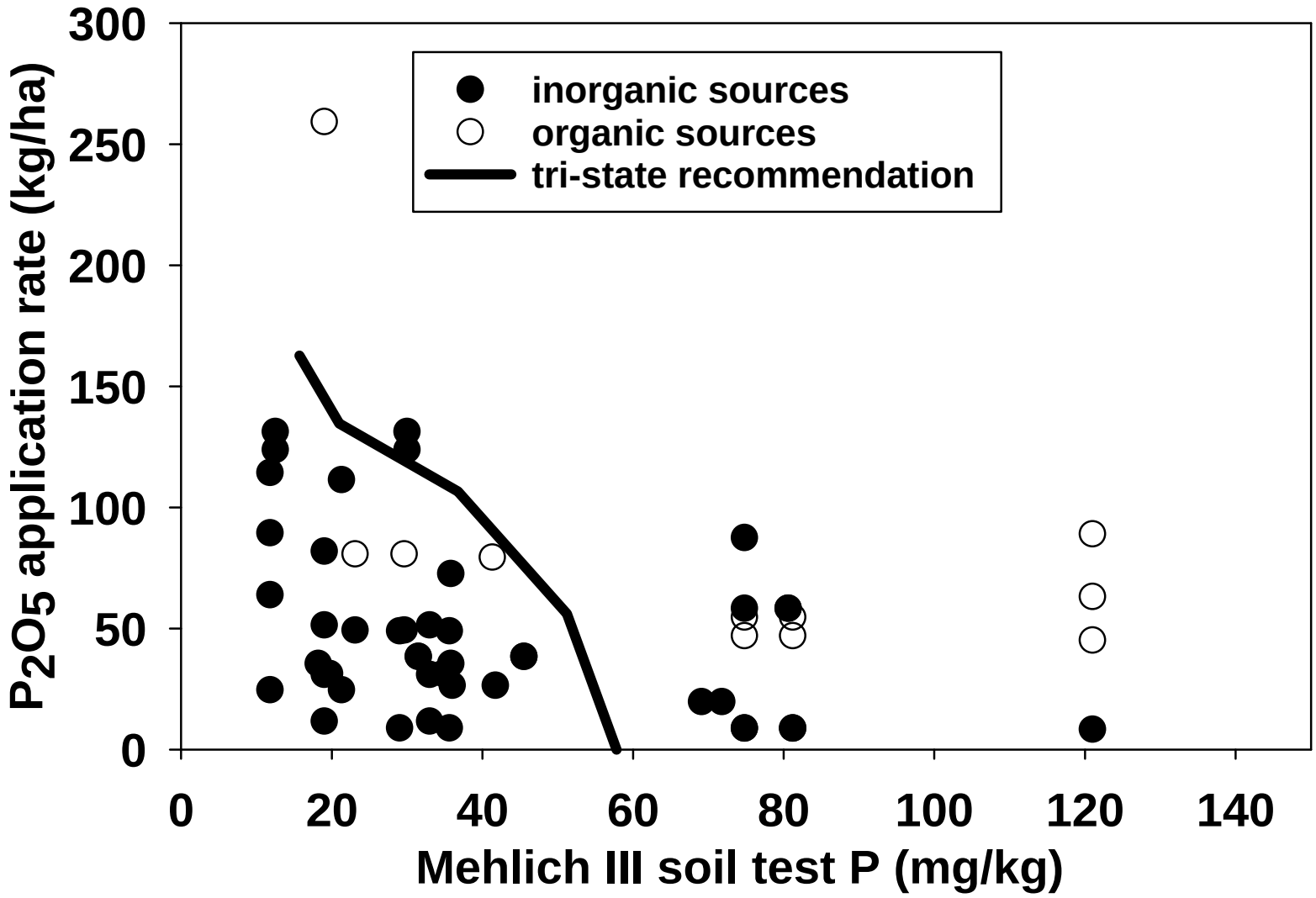

4Rs OF NUTRIENT STEWARDSHIP
Economically, Environmentally & Socially
Sustainable Crop Nutrition
The 4Rs promote best management practices (BMPs)
to achieve cropping system goals while minimizing field
nutrient loss and maximizing crop uptake.
4R Principles of Nutrient Stewardship
FERTILIZER
N P K
RIGHT SOURCE
Matches fertilizer type
to crop needs.
RIGHT RATE
Matches amount of
fertilizer to crop needs.
RIGHT TIME
Makes nutrients available
when crops need them.
RIGHT PLACE
Keeps nutrients where
crops can use them.

P losses and fertilizer source





P application



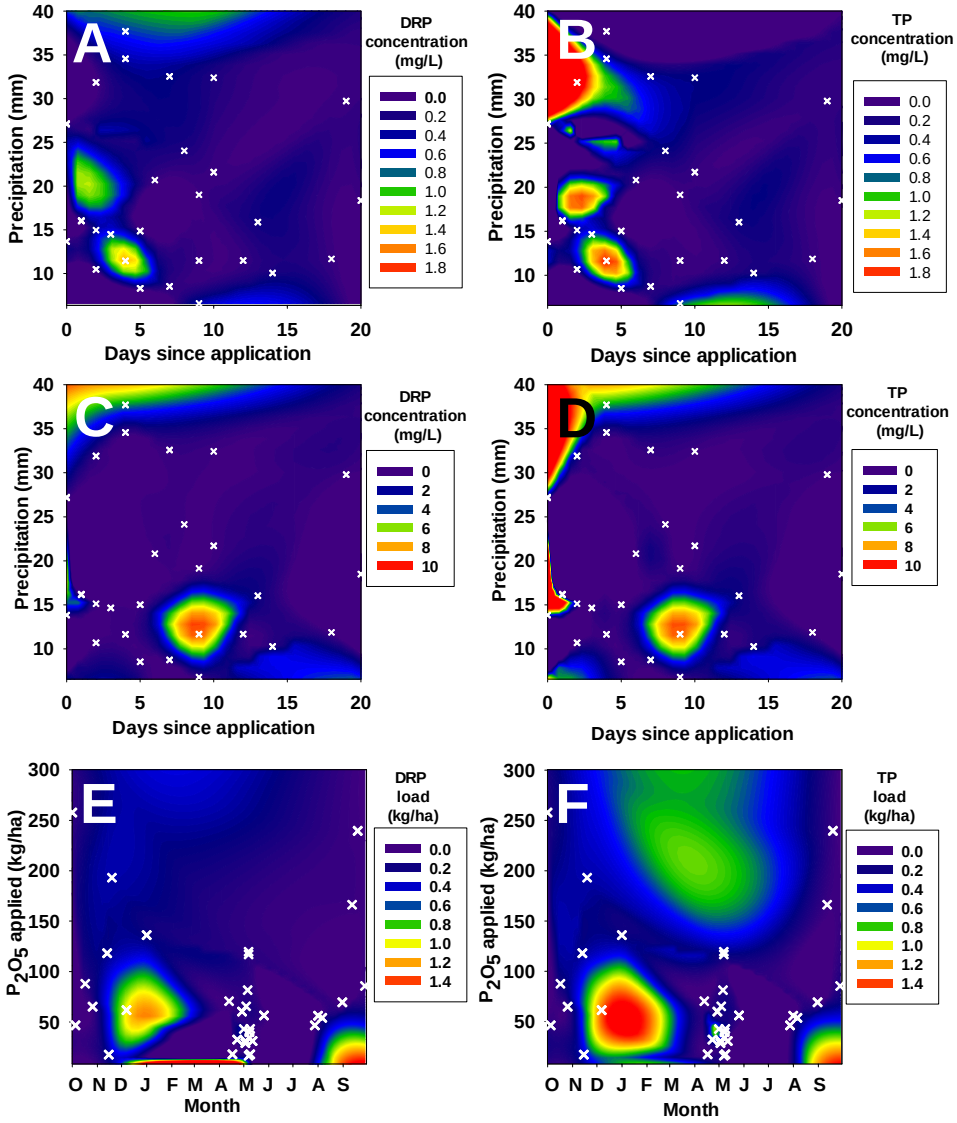
P losses and time of application

With respect to time since application:

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

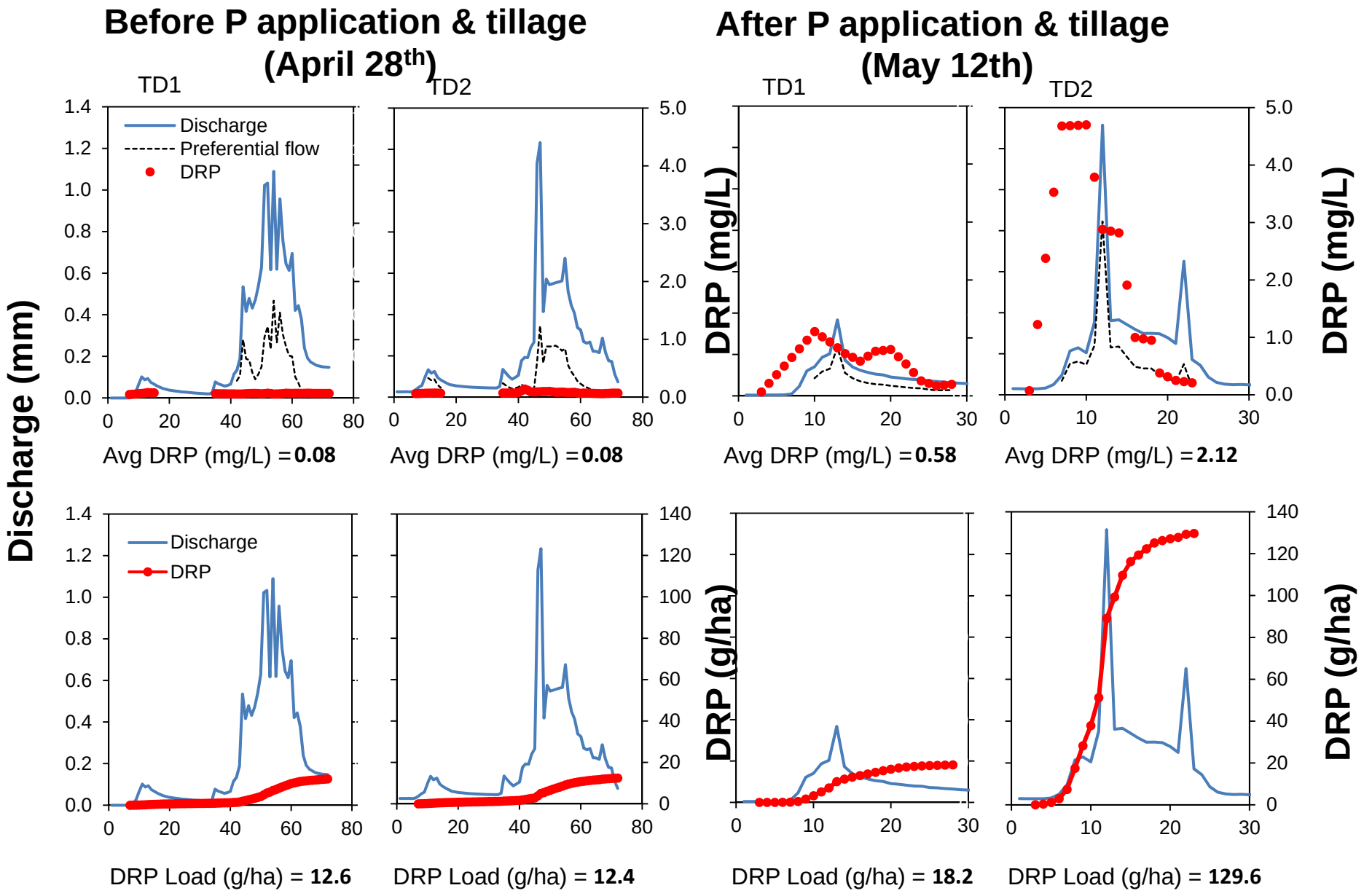
With respect to time of year:

- **Less potential for losses when applied at planting or in summer compared to fall and winter**



P losses and fertilizer placement

Broadcast variable rate application on May 6, 2014

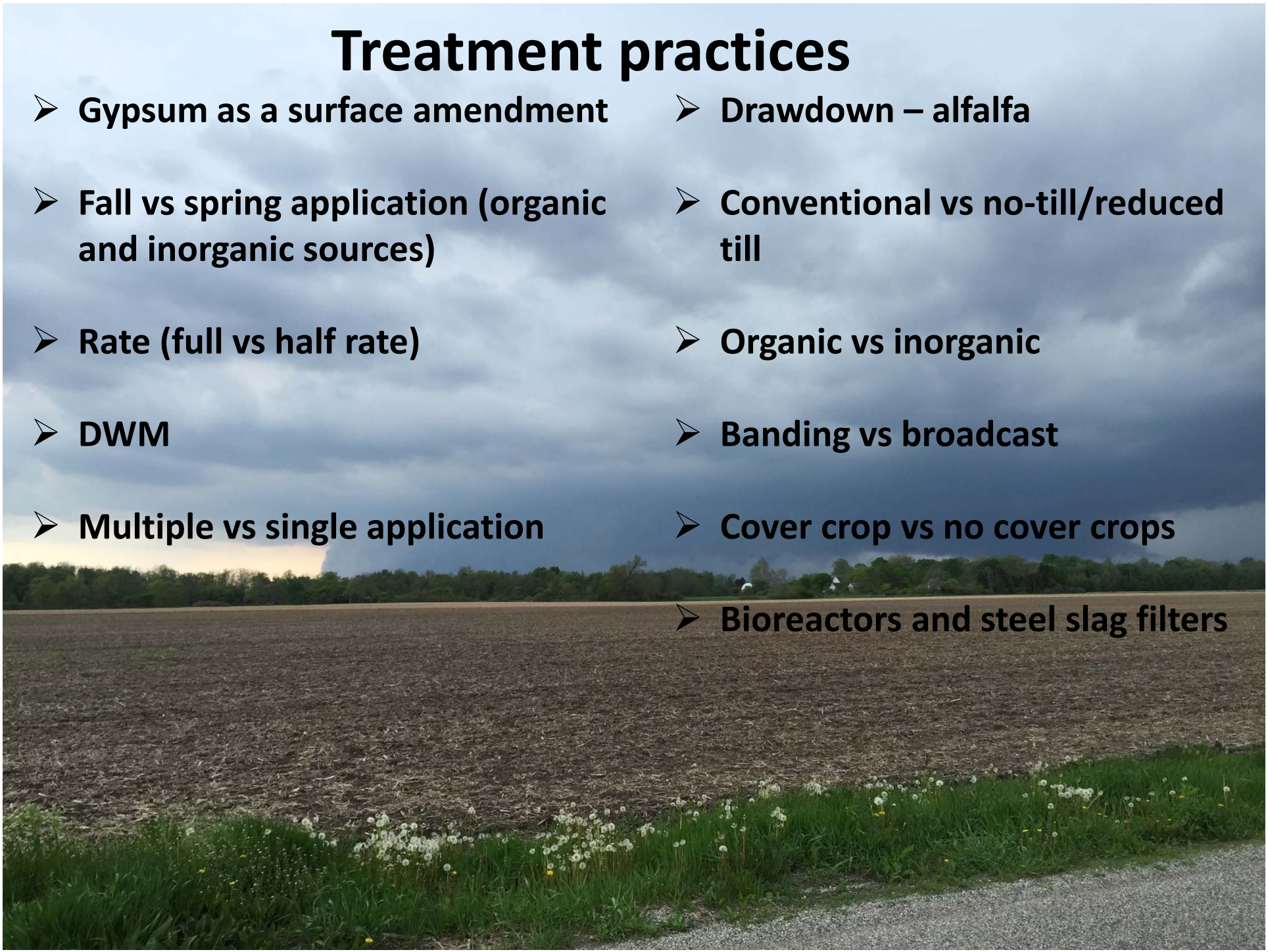

Before P application & tillage
(April 28th)
After P application & tillage
(May 12th)
TD1
TD2
TD1
TD2
Discharge (mm)
DRP (mg/L)
DRP (mg/L)
Discharge
Preferential flow
DRP
Avg DRP (mg/L) = 0.08
Avg DRP (mg/L) = 0.08
Avg DRP (mg/L) = 0.58
Avg DRP (mg/L) = 2.12
Discharge
DRP
DRP (g/ha)
DRP (g/ha)
DRP Load (g/ha) = 12.6
DRP Load (g/ha) = 12.4
DRP Load (g/ha) = 18.2
DRP Load (g/ha) = 129.6

Cover crops and no-till

- Significantly reduce tile drainage discharge
- Significantly reduce NO3-N loss
- No difference in DRP loss
- Can increase organic carbon

Treatment practices

- Gypsum as a surface amendment
- Fall vs spring application (organic and inorganic sources)
- Rate (full vs half rate)
- DWM
- Multiple vs single application
- Drawdown – alfalfa
- Conventional vs no-till/reduced till
- Organic vs inorganic
- Banding vs broadcast
- Cover crop vs no cover crops
- Bioreactors and steel slag filters



Conclusions

- ✓ **No ‘smoking guns’ and no ‘silver bullets’**
- ✓ **Producers generally doing well with P management but improvements can be made**
- ✓ **Due to legacy P, water quality problems in Lake Erie likely persist for a long time**

Conclusions

- ✓ **Accelerated water management as well as P management is essential to addressing algal bloom issues in Lake Erie**
- ✓ **At a minimum every producer should be following 4Rs of nutrient stewardship**
- ✓ **Creating field level P budgets and following 4R practices can help: Increase yield, decrease P losses, and decrease P inputs**

Funding Partners:

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

How it is Possible!!!

Weekly

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

Edge-of-Field Team

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