Contributions of legacy soil P and P fertilizer to edge-of-field P losses

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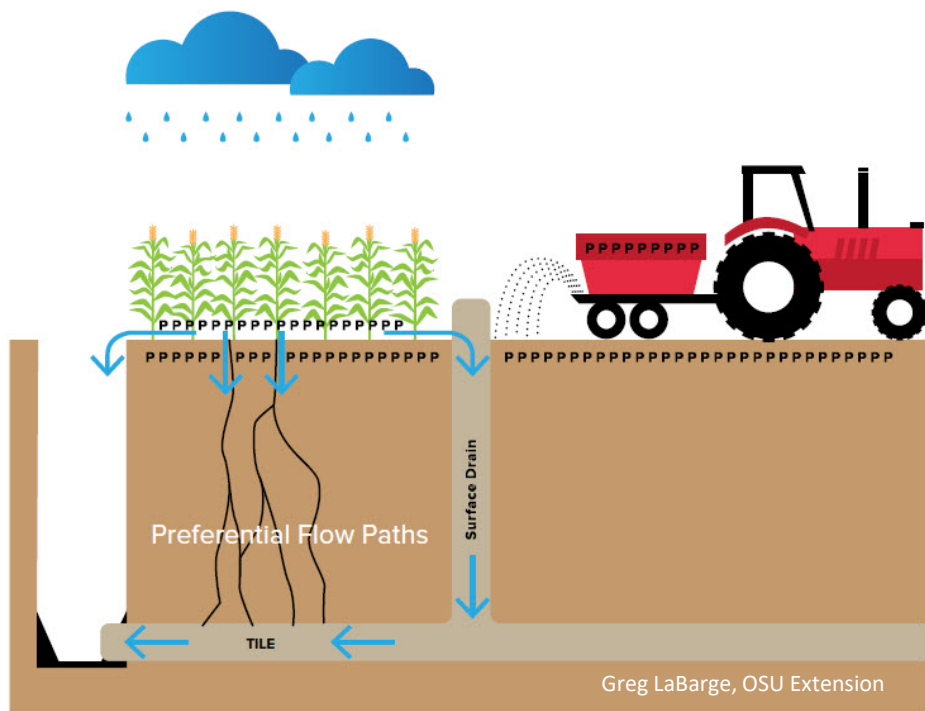[1]USDA-ARS Soil Drainage Research Unit, Columbus OH

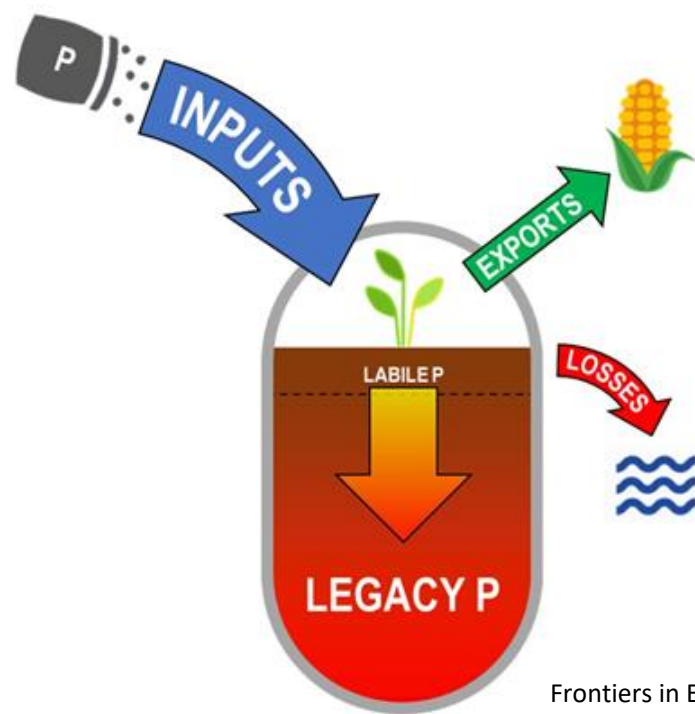[2]The Ohio State University - Department of Food, Agricultural, and Biological Engineering

Sources of agricultural P losses

"New P" (aka incidental, fertilizer P)   **"Old P"** (aka legacy soil P)

Preferential Flow Paths

Surface Drain

TILE

Greg LaBarge, OSU Extension

INPUTS

EXPORTS

LOSSES

LABILE P

LEGACY P

Frontiers in Earth Science

New P vs. Old P

- Relative contributions of new and legacy sources to DRP and TP loads are unknown
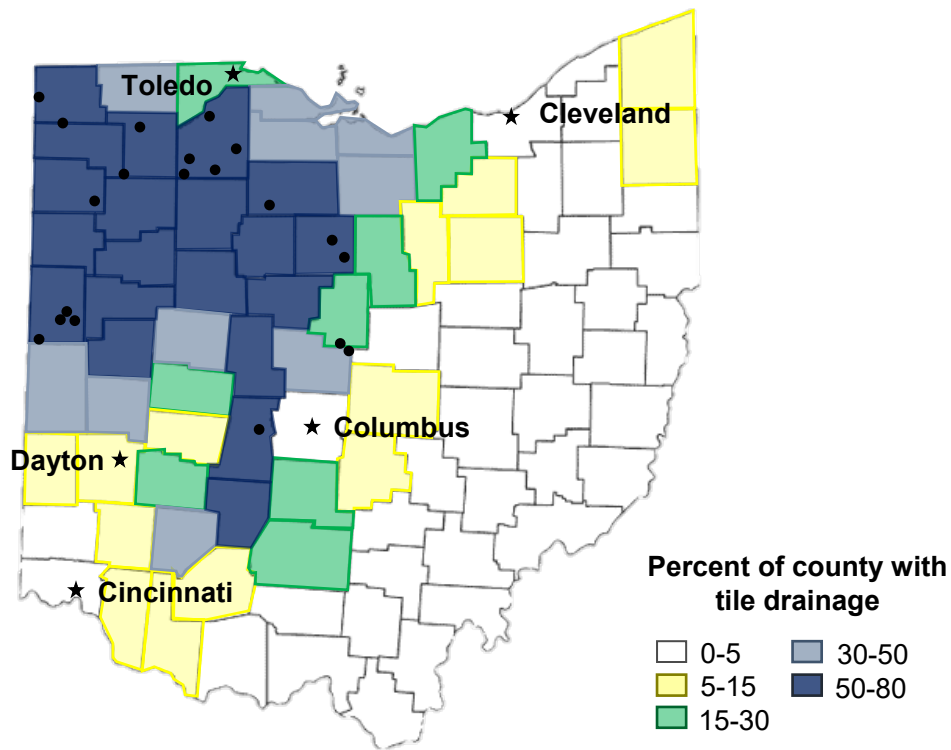
- Mitigation practices differ for "New P" vs. "Old P"

Greg LaBarge, OSU Extension

Blanchard Demo Farms, Ohio Farm Bureau

USDA-ARS edge-of-field water quality network

Percent of county with tile drainage

- 0-5
- 5-15
- 15-30
- 30-50
- 50-80

Toledo
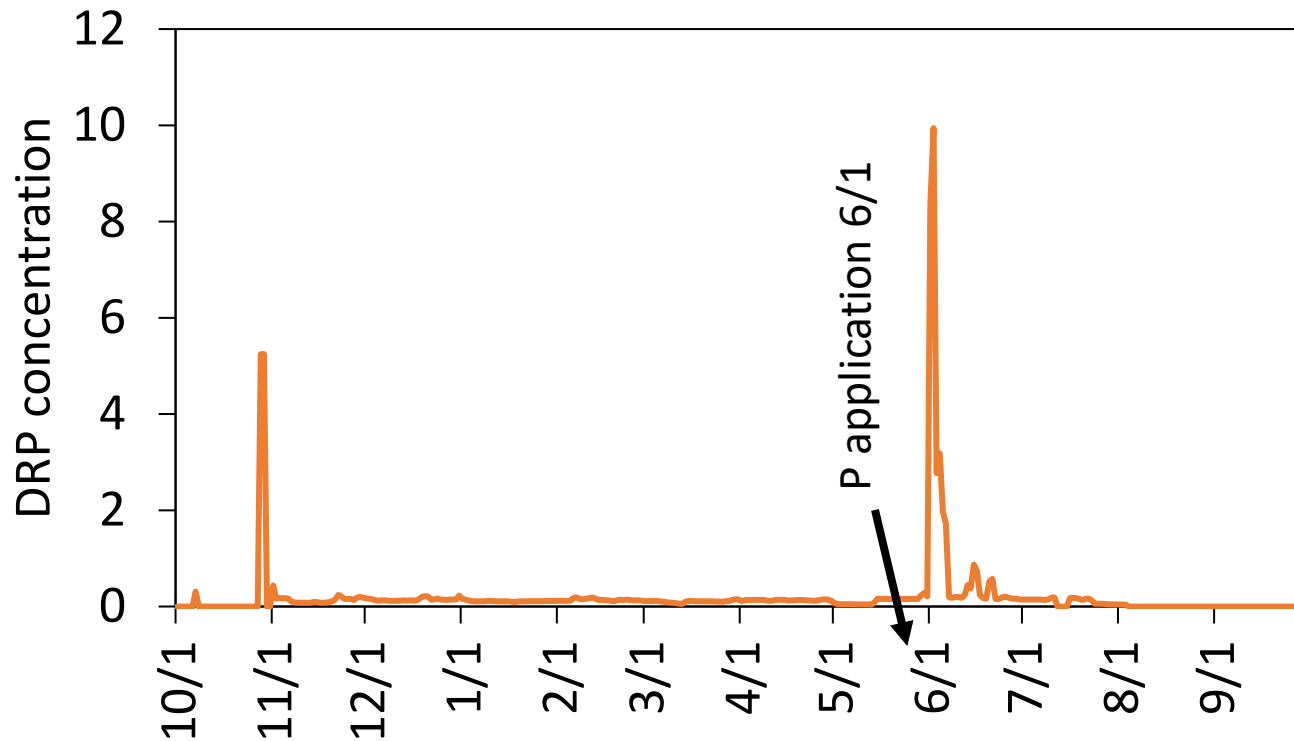Cleveland
Dayton
Columbus
Cincinnati

- USDA-ARS edge-of-field site

- Surface runoff and subsurface tile drainage

- 35 fields

- 192 site-years for surface runoff and tile drain discharge
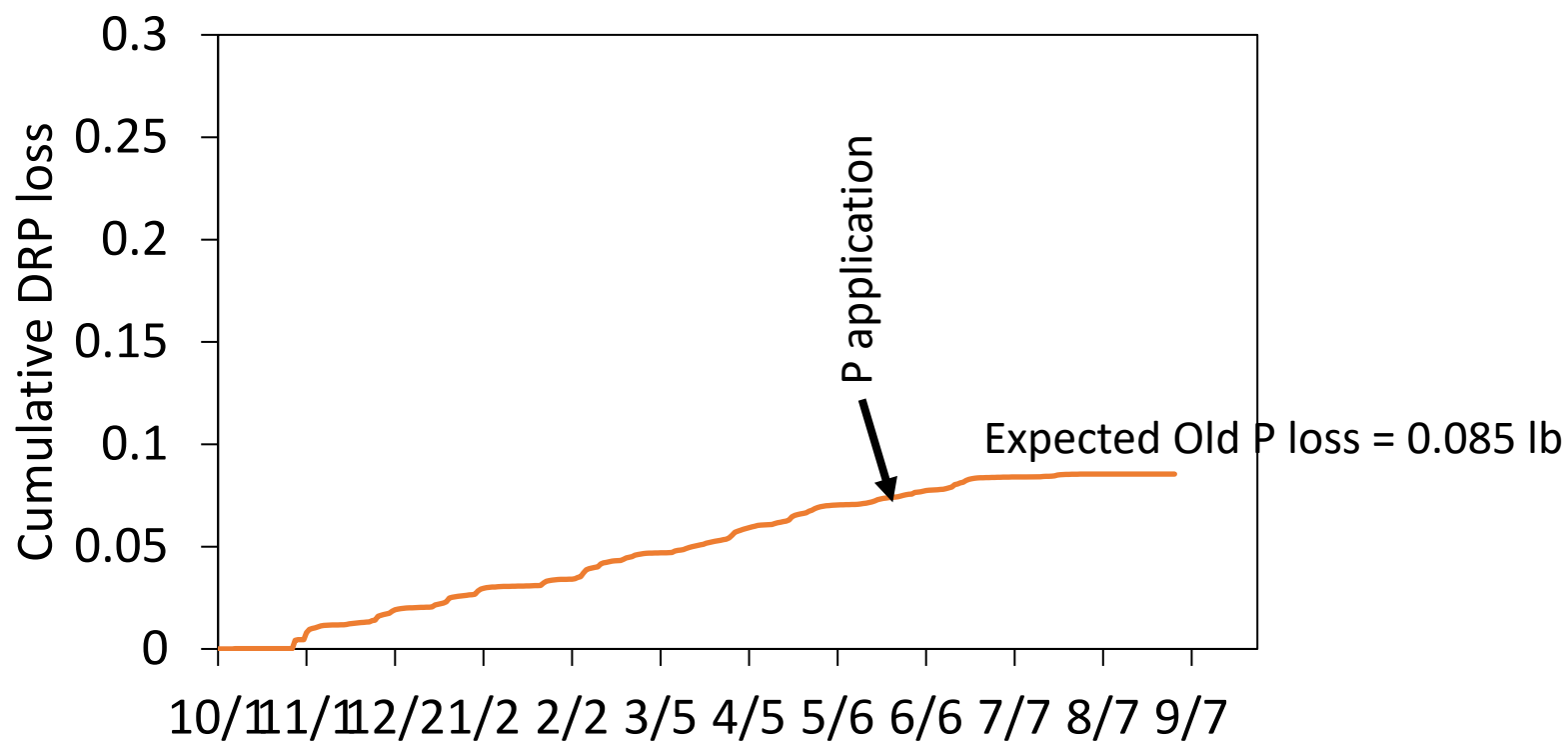
- 102 P fertilizer or manure applications

How can we distinguish new P from legacy P using edge-of-field data?

- Following a P application (3 month risk period for new P loss):
    1. Predict the daily "expected" legacy P load using discharge data measured during the legacy periods (weighted regression)
    2. Subtract the expected P load from the measured load; difference was assumed to be caused by "New P" source

- **New P load** = measured P load – expected legacy P load

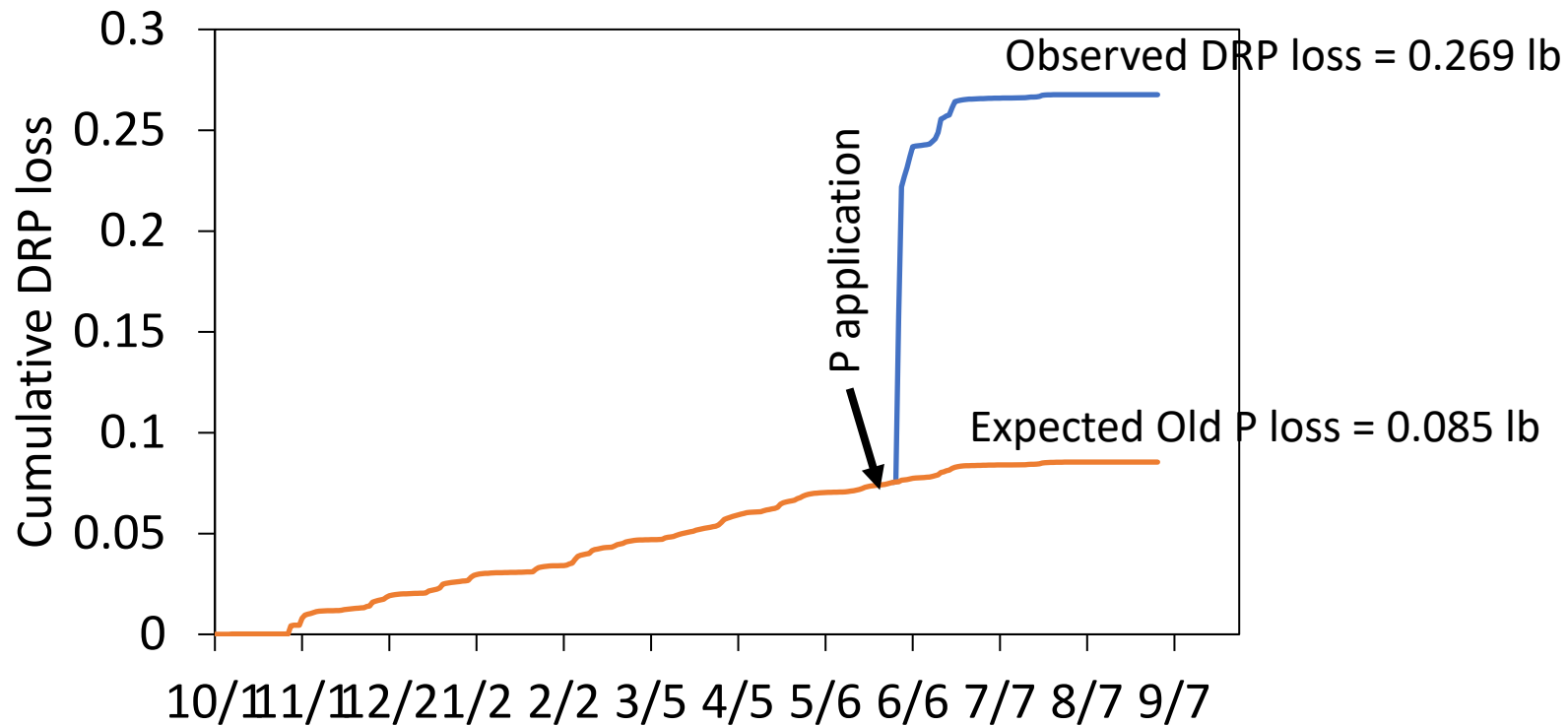- **Legacy P load** = expected legacy P load + full P load from legacy periods

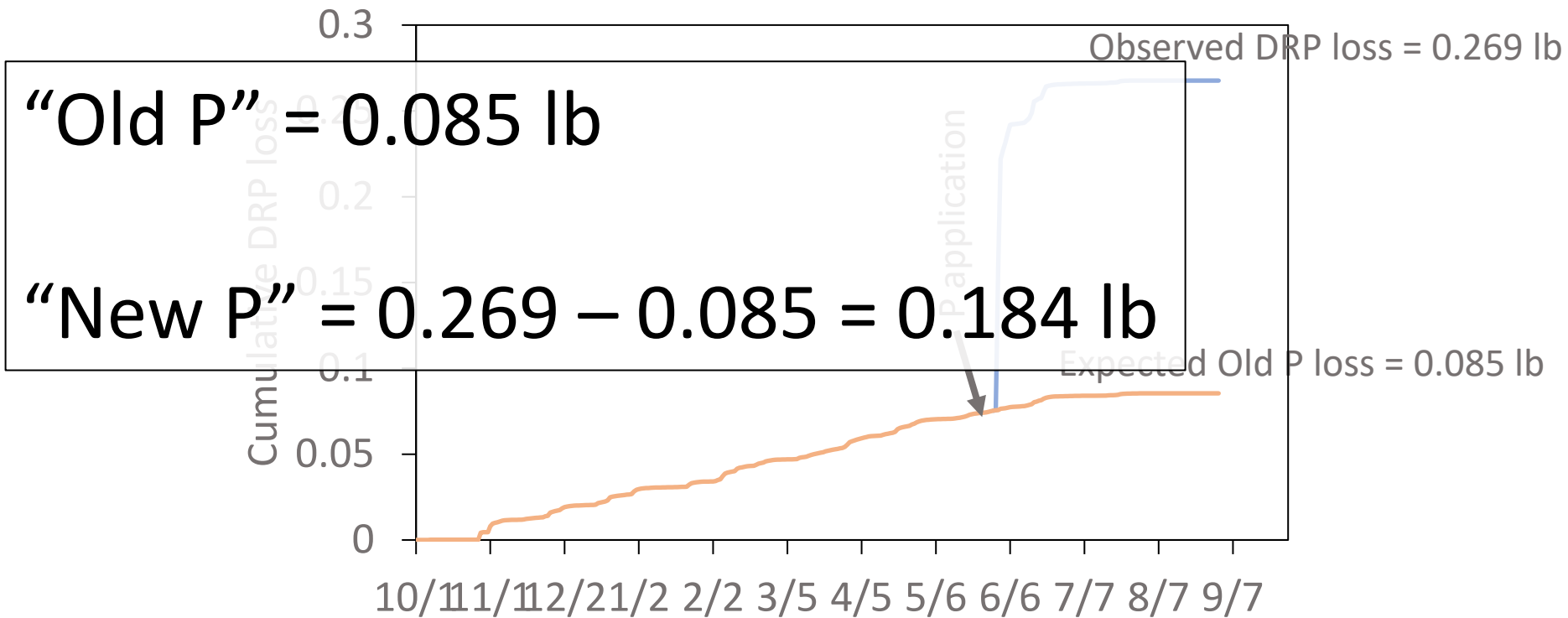# 1 year of dissolved reactive P (DRP) concentrations

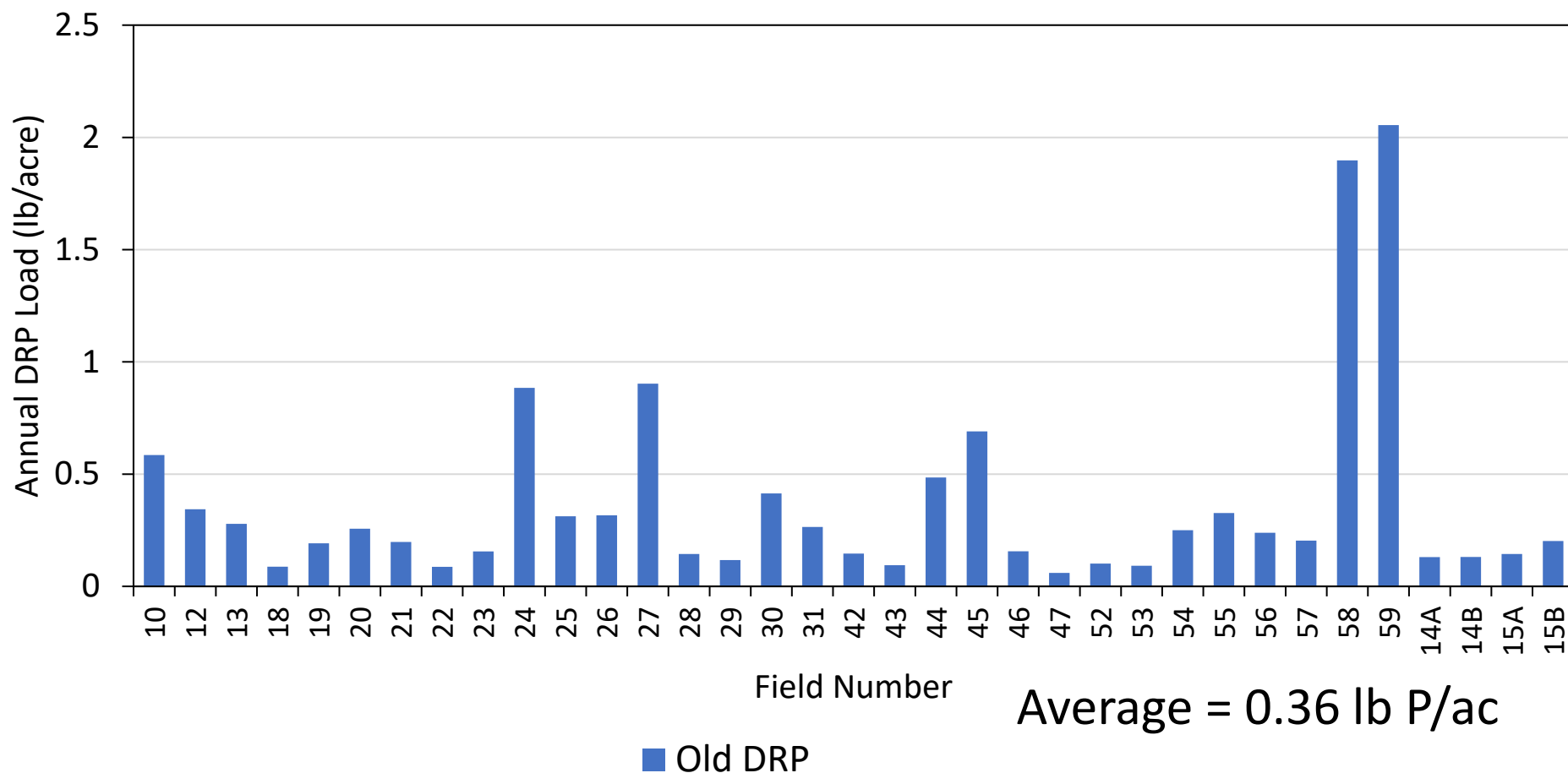# For 3 months after P application, predict the expected "Old P" loss using the discharge data
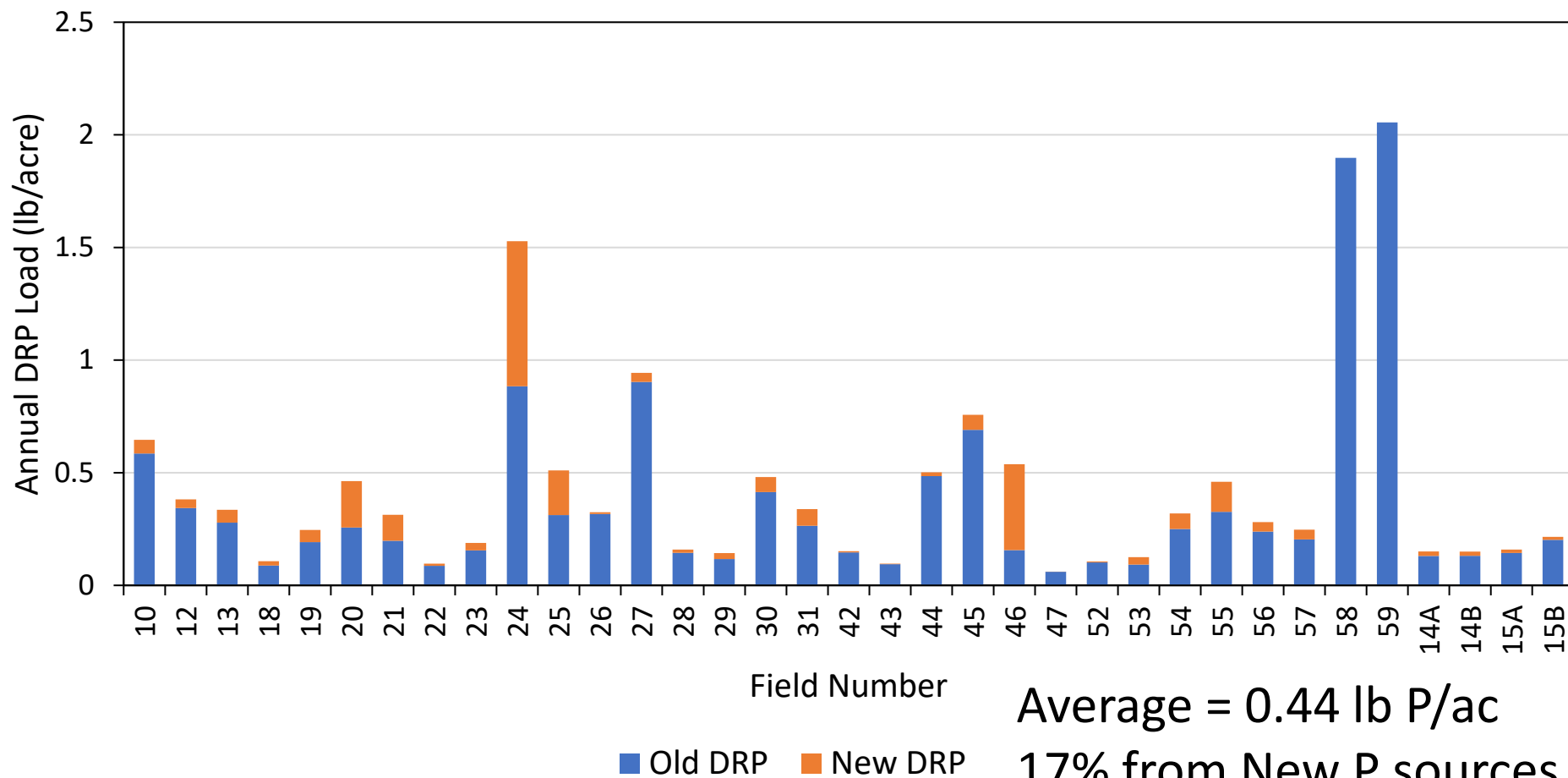
Compare expected "Old P" loss to the observed P loss

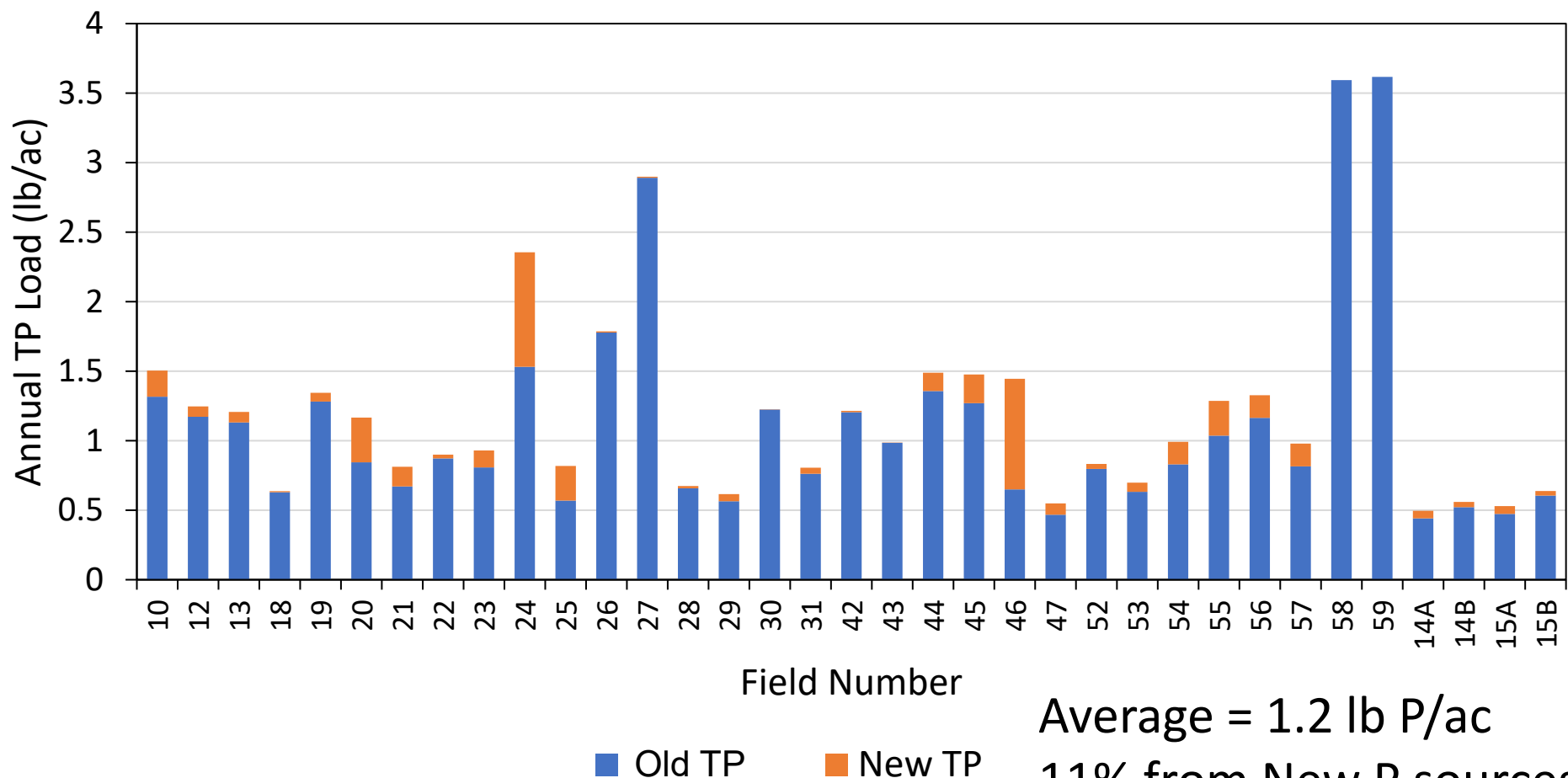# Observed P losses above the predicted "Old P" levels are attributed to the "New P"

"Old P" = 0.085 lb

"New P" = 0.269 – 0.085 = 0.184 lb

Observed DRP loss = 0.269 lb

Expected Old P loss = 0.085 lb

Cumulative DRP loss

P application

0.3
0.25
0.2
0.15
0.1
0.05
0

10/11 11/11 12/21 1/2 2/2 3/5 4/5 5/6 6/6 7/7 8/7 9/7

USDA

Old & New DRP Losses
(Surface + Tile)

Average = 0.44 lb P/ac
17% from New P sources
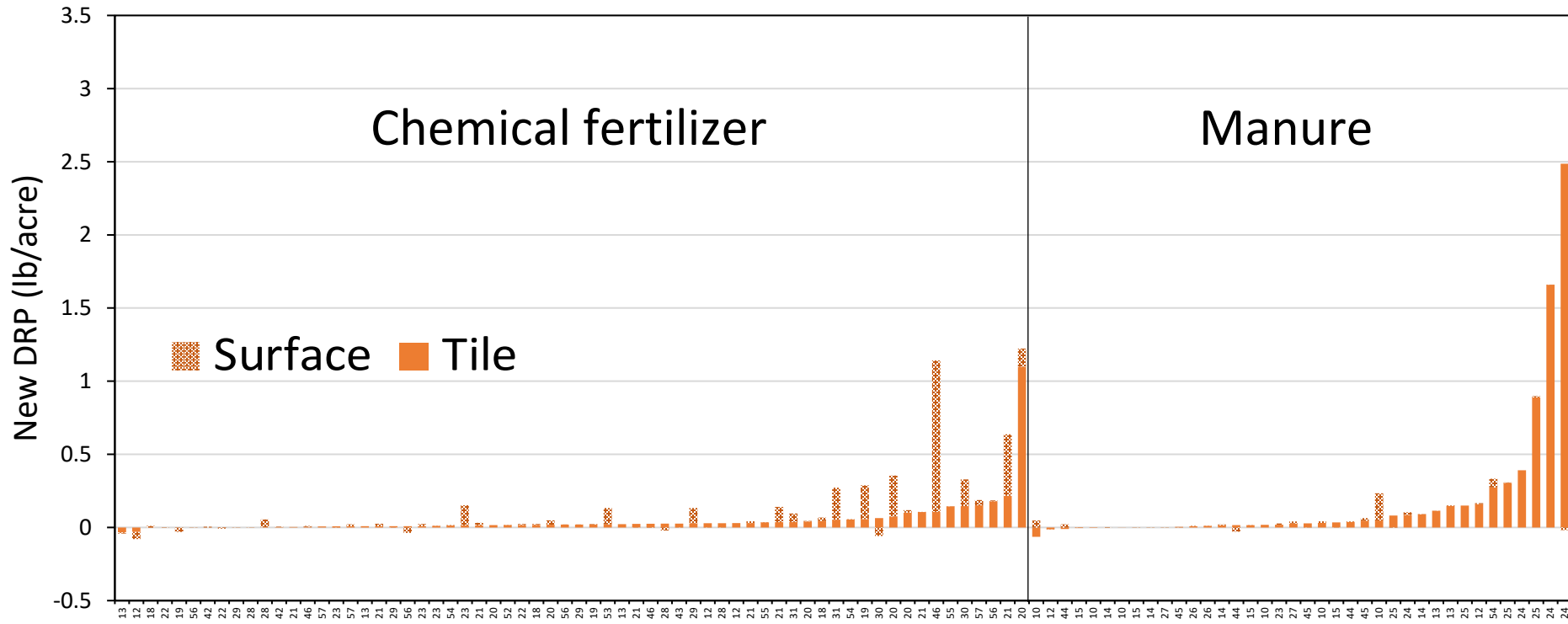
SOIL DRAINAGE RESEARCH UNIT

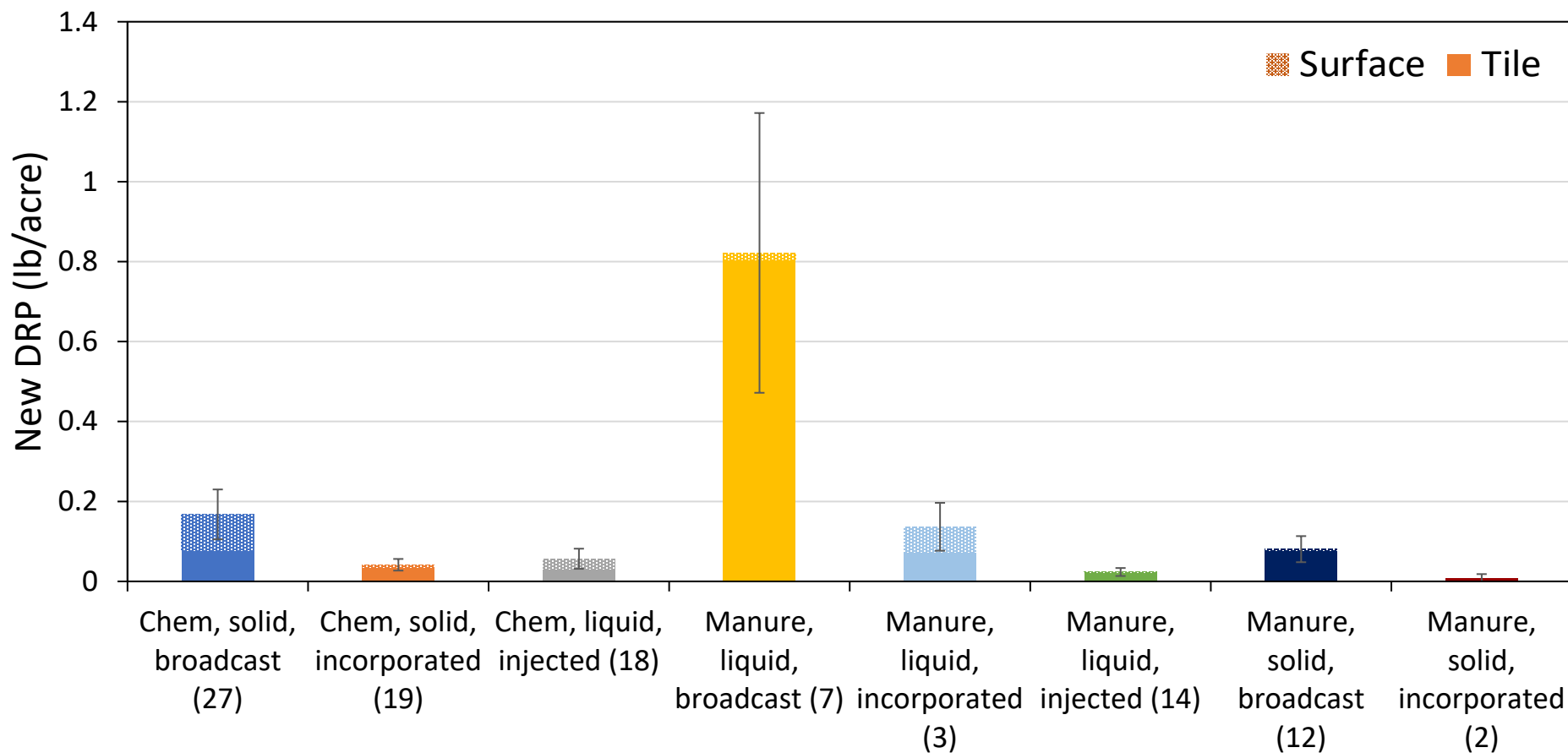# Old & New total P (TP) losses
(Surface + Tile)

Average = 1.2 lb P/ac

11% from New P sources

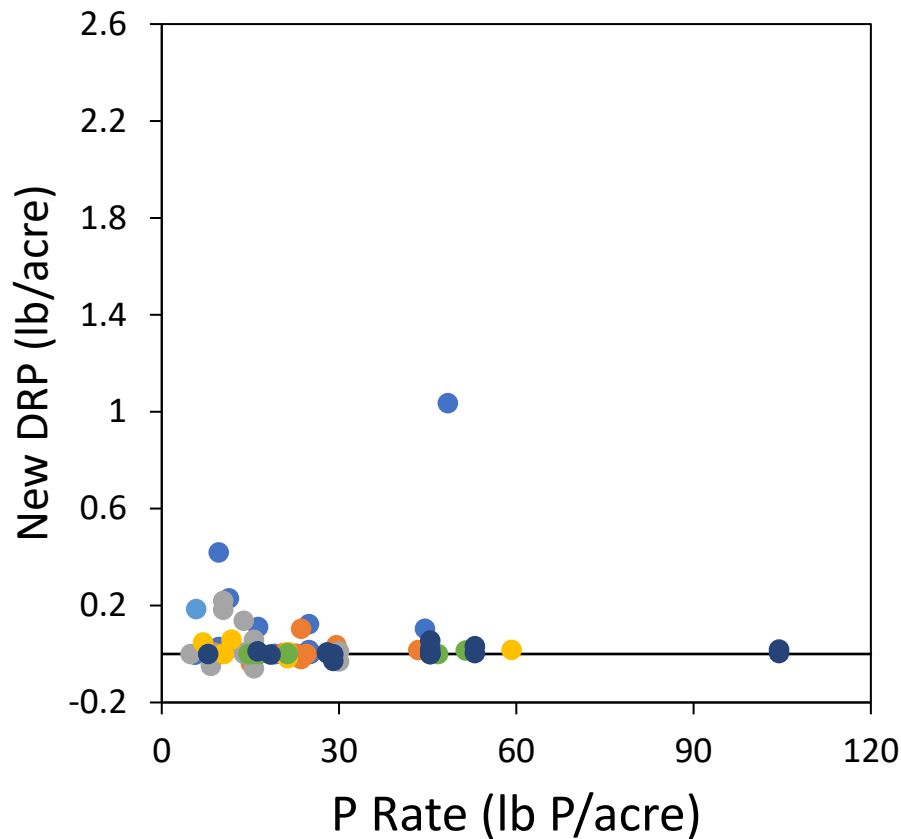# New P – DRP losses from 102 P applications

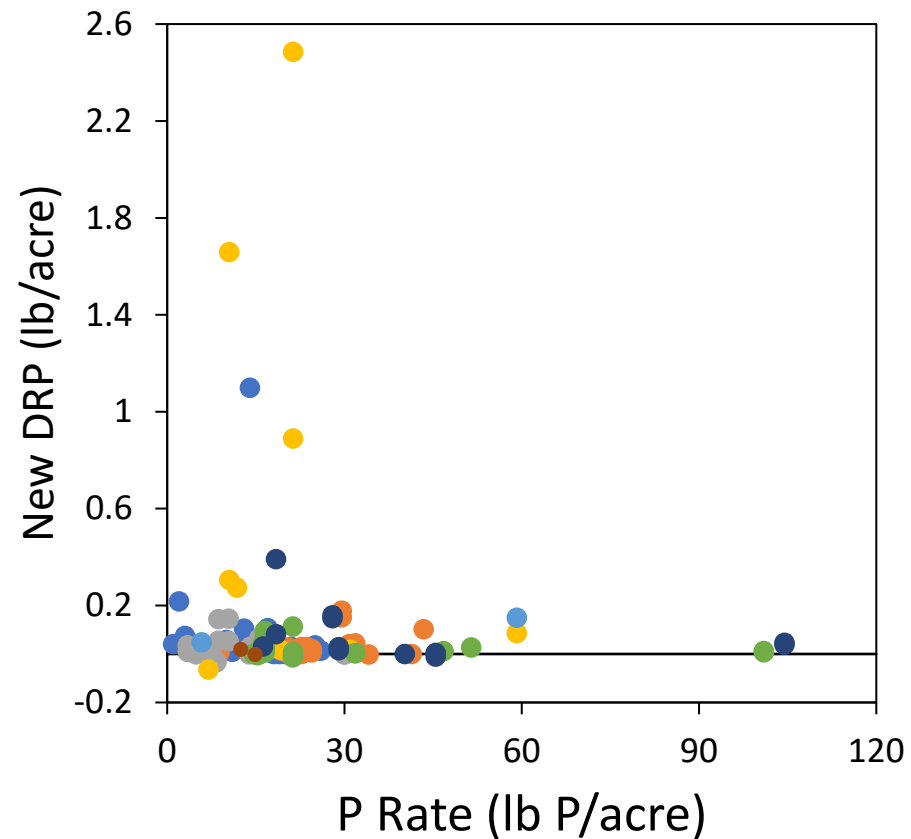# P fertilizer form and placement: New DRP
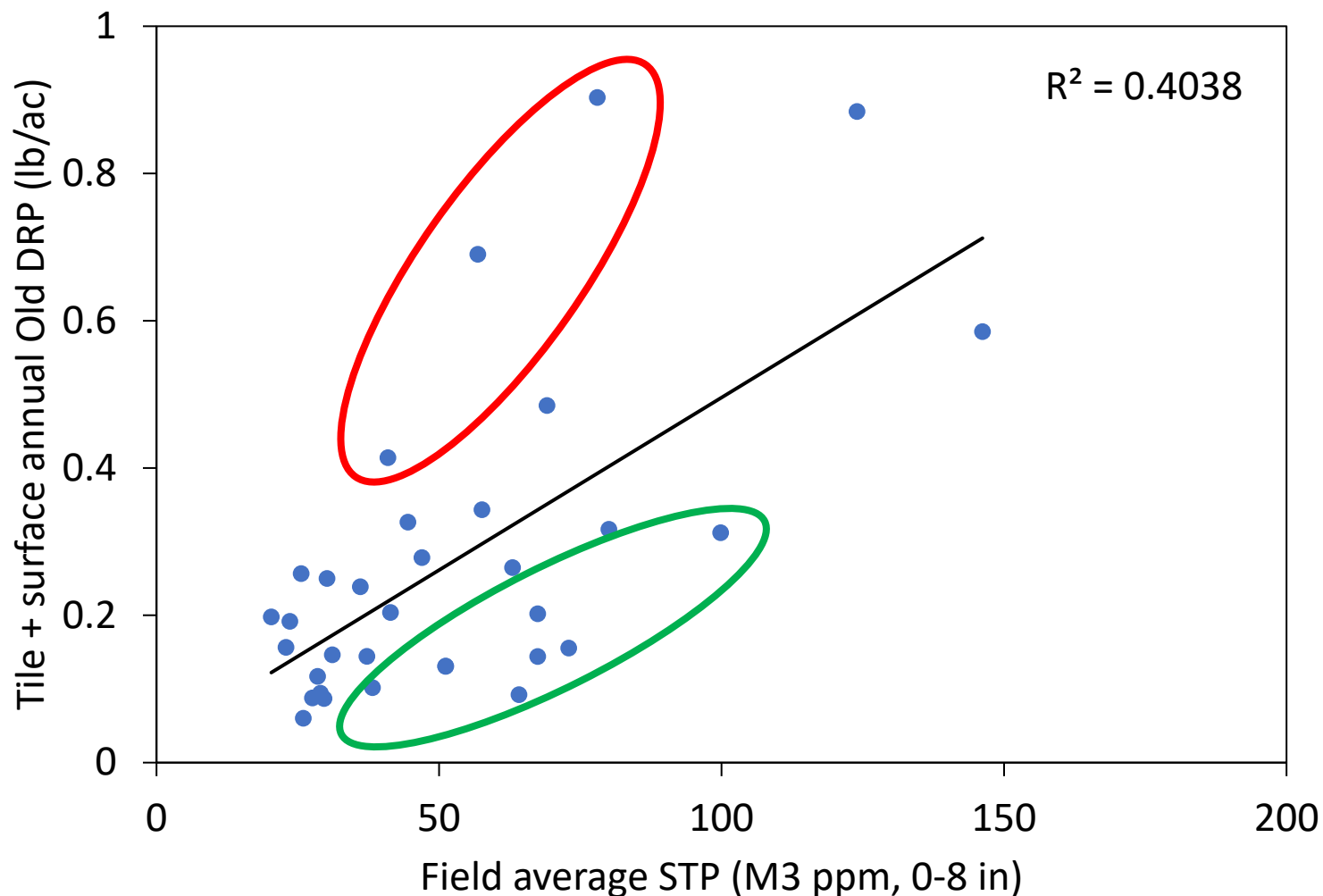(Surface + Tile)

P application rate: New DRP loss

Surface

Tile

Old DRP loss: Influence of soil test P (STP)

$R^2 = 0.4038$

Tile + surface annual Old DRP (lb/ac) vs. Field average STP (M3 ppm, 0-8 in)

Summary of initial findings

- New P contributed only 17% of overall DRP loss and 11% of TP loss, on average

- Riskiest applications were broadcast liquid manure (especially DRP lost through tile drains)

- P rate did not determine the amount of new P loss

- Old P loss is related to STP, but other factors are likely important

Implications

- P fertilizer management (i.e. 4Rs) will have a limited short-term impact on P losses

- Need additional focus on management of old P losses
    - Draw down soil P, but this is a long-term solution
    - Manage hydrology?
    - Manage P stratification?
    - Capture at field edge or downstream?

Acknowledgements

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- Brittany Hanrahan

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    - Ohio Farm Bureau
    - International Plant Nutrition Institute
    - The Nature Conservancy
    - Becks Hybrids
    - Delaware County Soil & Water Conservation District
    - Ohio State University,
    - Ohio Corn and Wheat Growers
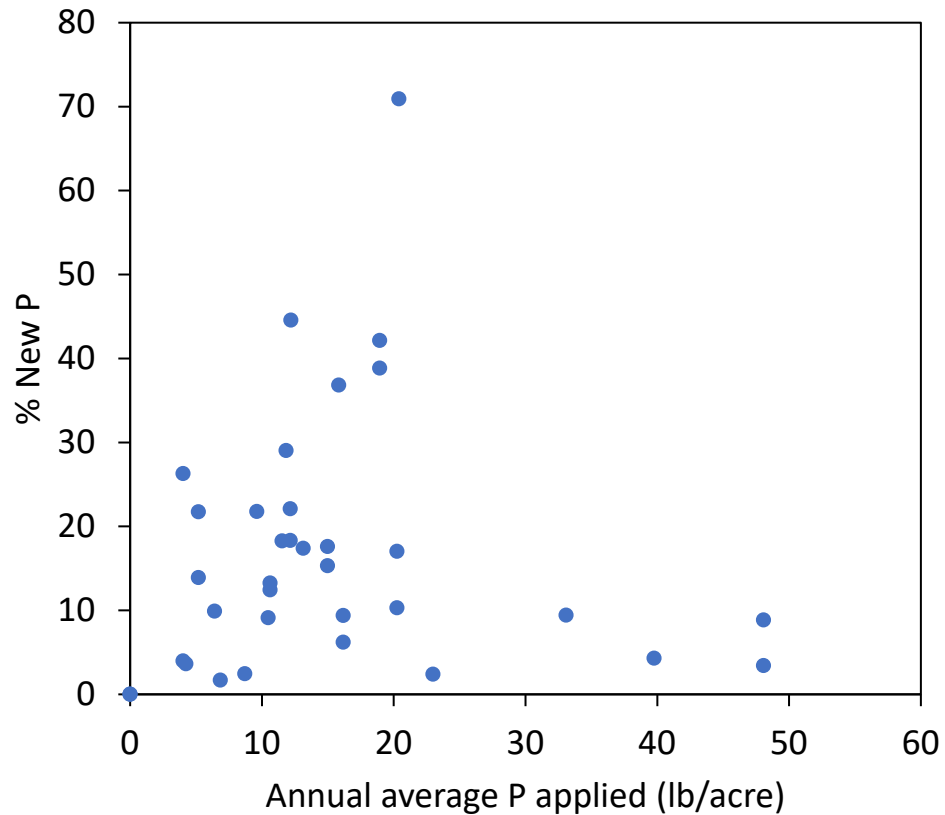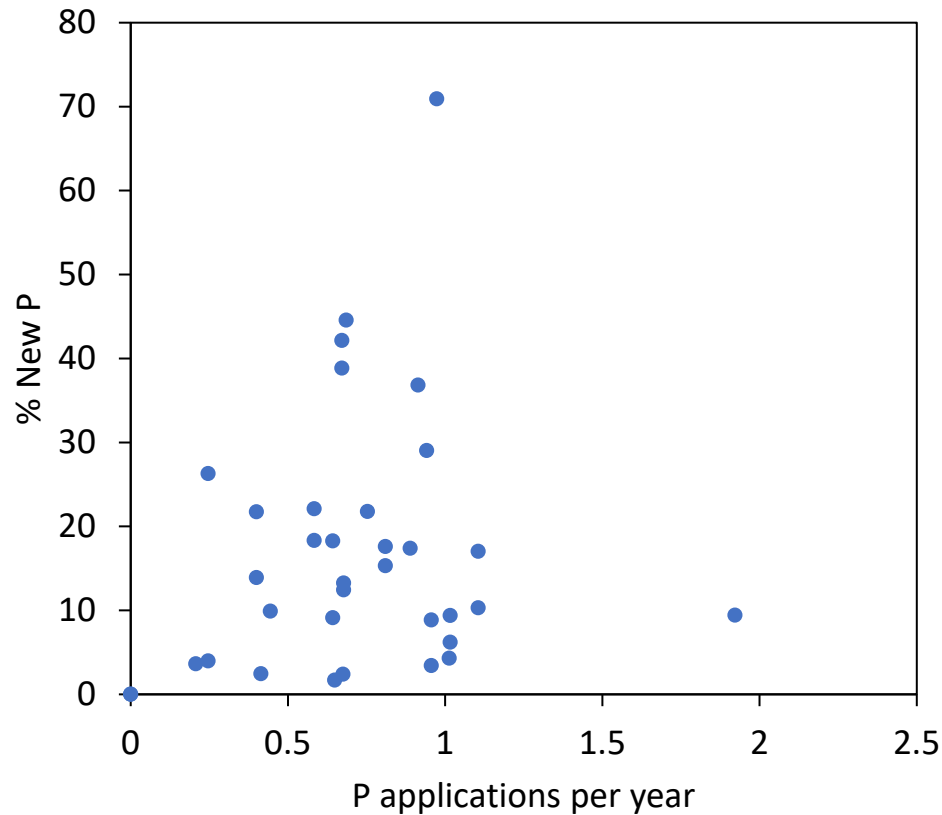   - Ohio Soybean Association

Questions?

General EOF findings

- P concentrations greater in surface runoff than tile drainage

- But ~80% of runoff volume occurs through tile drains
  - Surface runoff: ~35% of P loading
  - Tile drainage: ~65% of P loading

- Dissolved reactive P (DRP) and total P (TP) are important in both pathways

Combined results - P applications

P application timing
(Surface + Tile)