Phosphorus Management to Minimize Loss to Surface Waters

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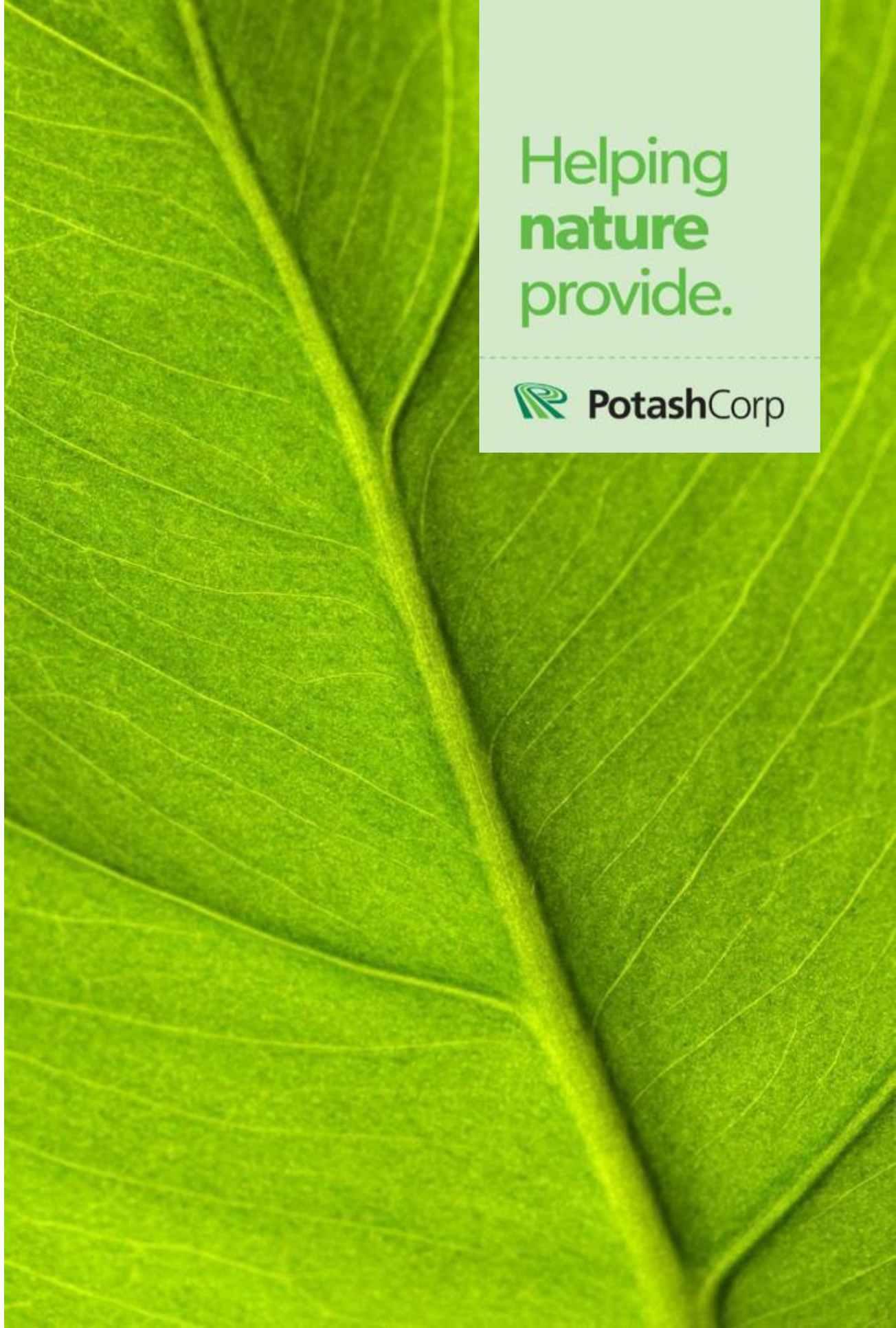
Fluid Fertilizer Technology Workshop

December 9, 2015



PotashCorp.com

Overview

- Lake Erie Issues
  - What is going on?
  - Any ideas as to what is contributing to what we see?
- How do we minimize phosphorus transport risk?
  - Opportunities for fluid fertilizers

Lake Erie Issues

Regulation/Legislation

- Remember these headlines

Tap Water Ban for Toledo Residents

By EMMA G. FITZSIMMONS AUG. 3, 2014

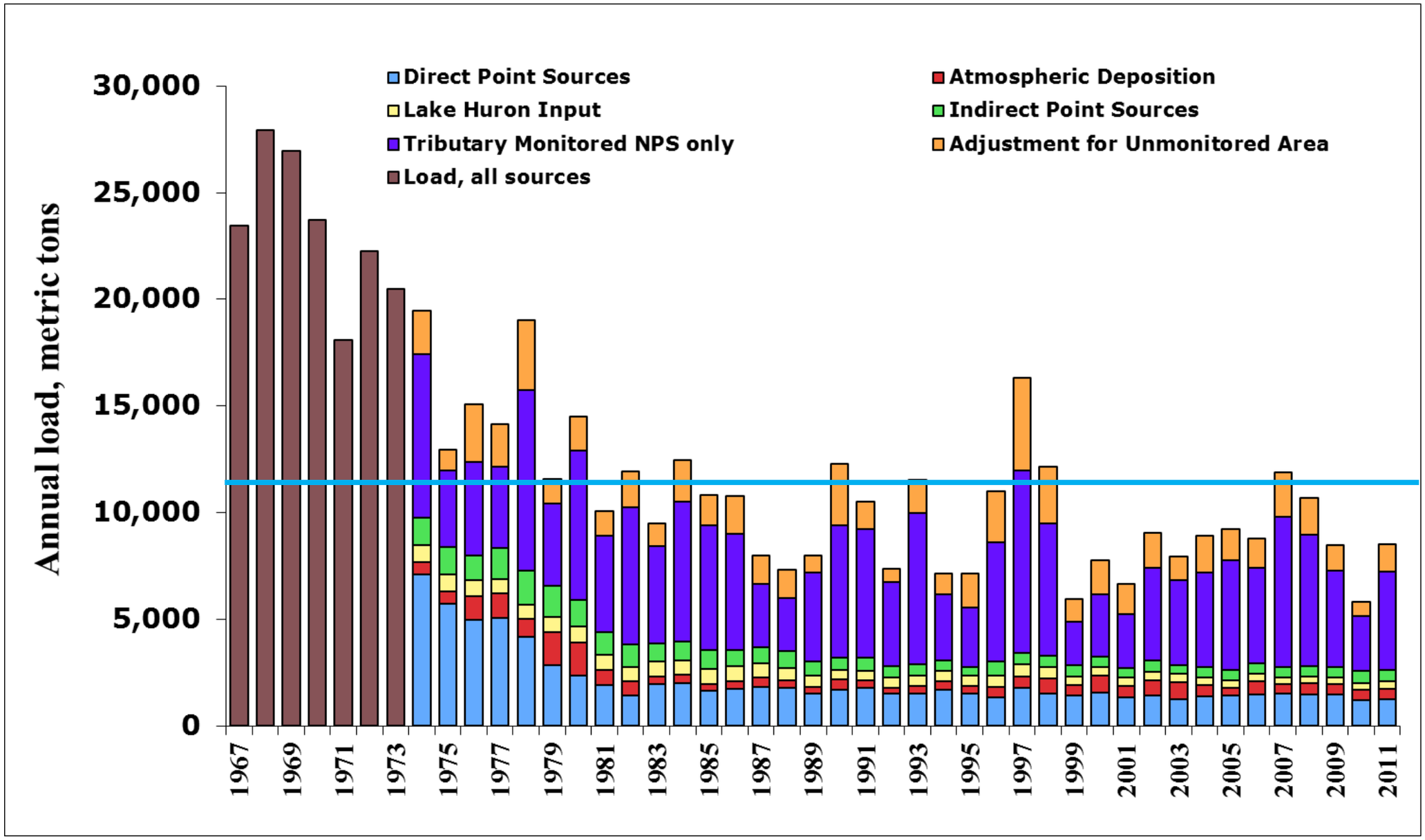
The discovery of high toxin levels in water from Lake Erie had residents in Toledo, Ohio, relying on bottled water while local supplies were being tested. Joshua Lott/Reuters

Source: New York Times

Regulation/Legislation

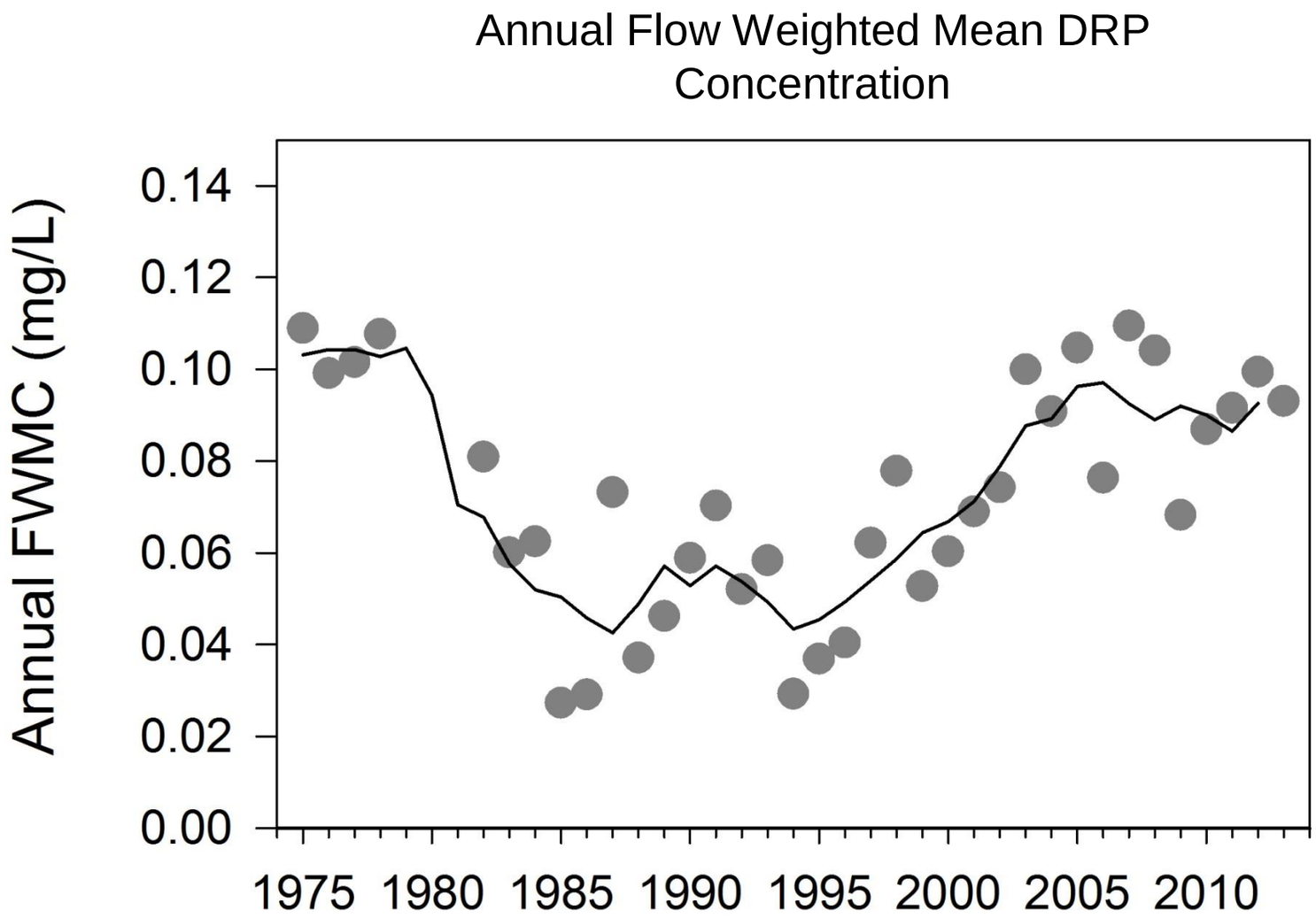
- Remember – Never let a good crisis go to waste.
- Comments in the public sphere (actual article from CBC News on Lake Erie – quoting a water quality specialist – published in August 2014)
  - More livestock farming and greater application of their waste to fields
  - Higher applications of fertilizers in general
  - An increase in corn farming to meet ethanol demand
  - (No mention of unusual north winds and cool fronts, no mention of the age of the wastewater treatment facility and its disrepair, no mention of the early trigger by the city to issue the ban on consumption)

Lake Erie (A Very Brief History)



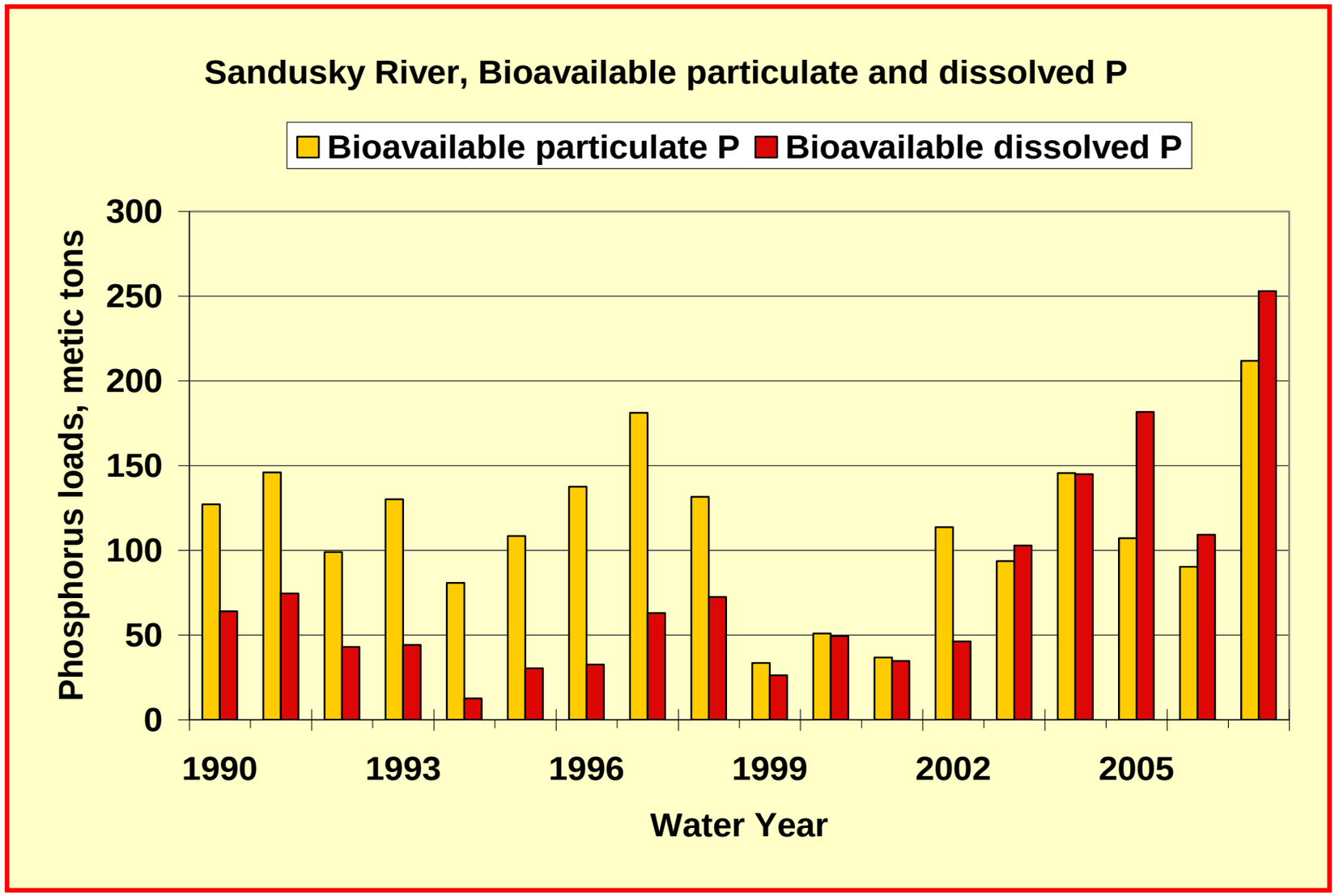
Target total P load of 11,000 metric tons per calendar year set by International Joint Commission in early 70s

Changes in Phosphorus Loading



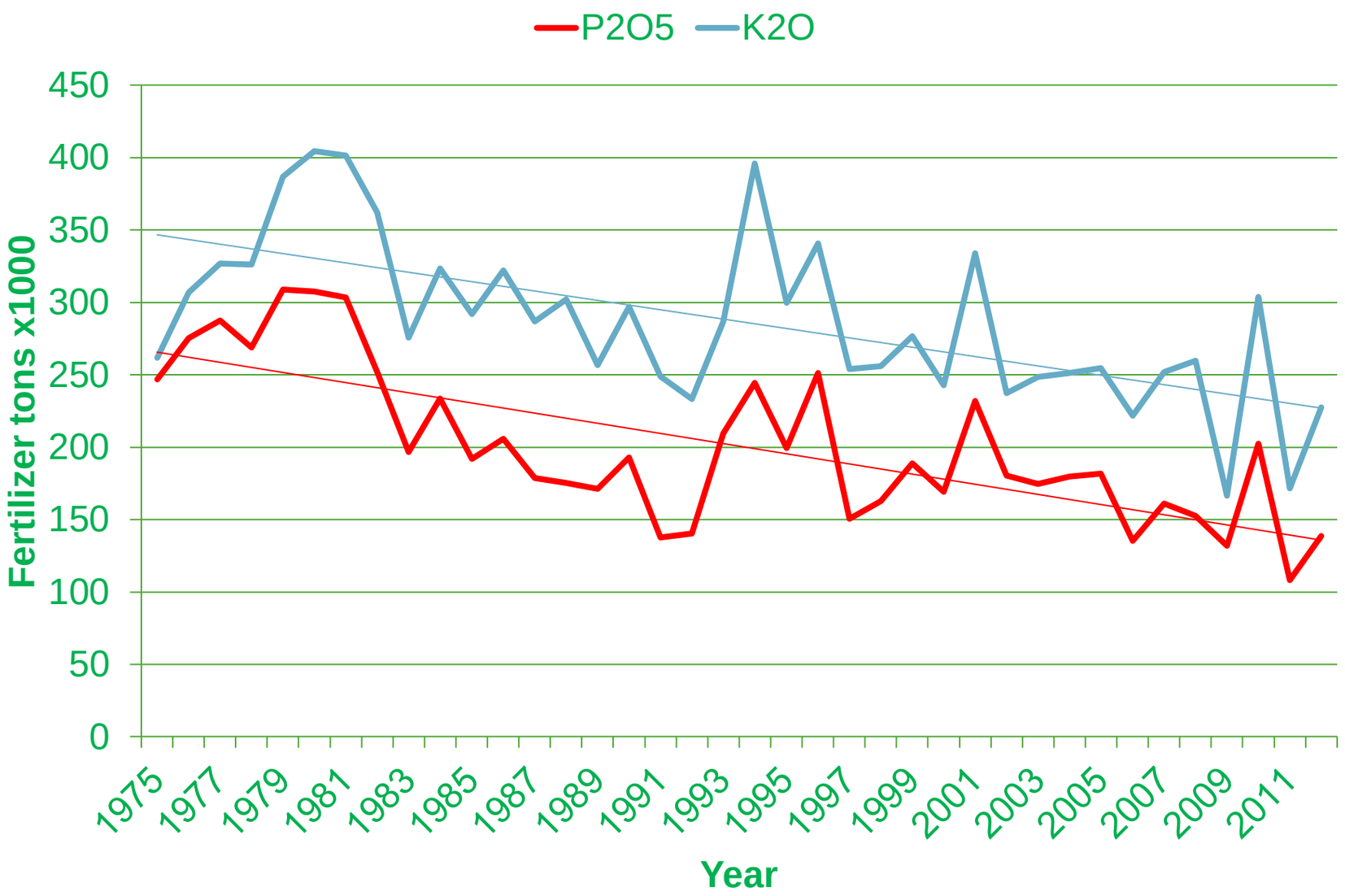
Data from Heidelberg University, 2015

Loading of DRP



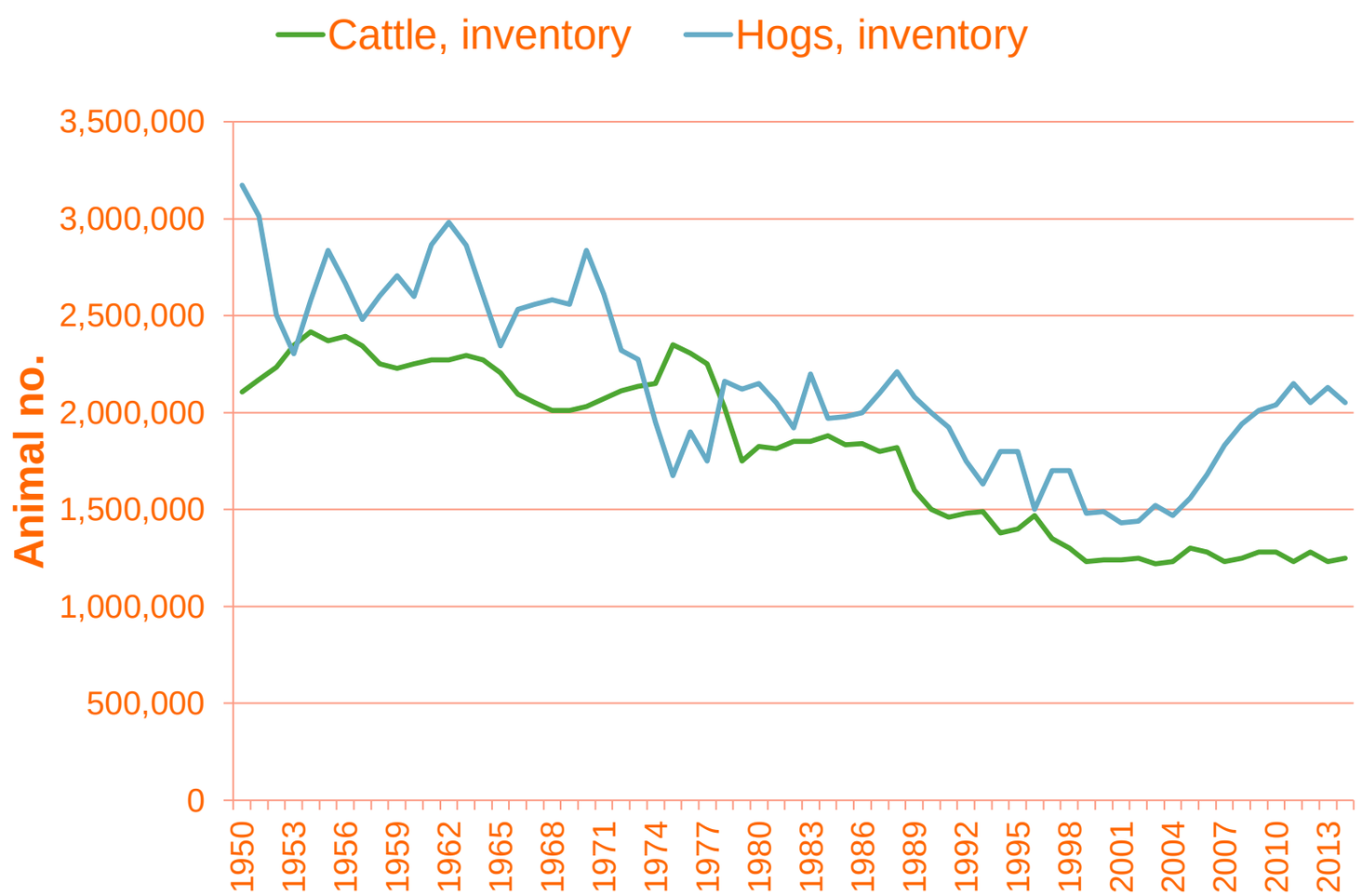
Source: Baker, Heidelberg University

Ohio Potassium and Phosphorus Consumption



Source: AAPFCO

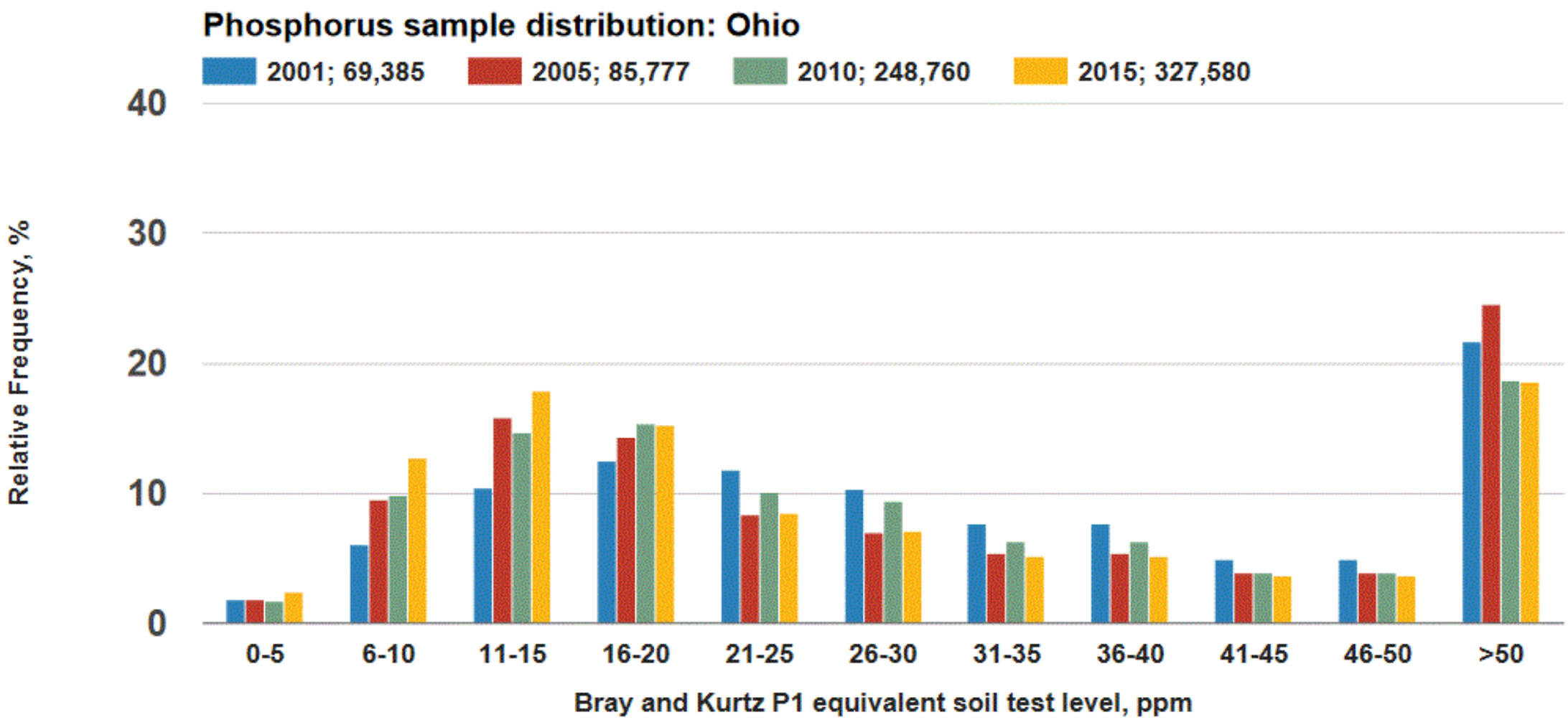
Animal Numbers in Ohio



Source: USDA

Soil Test Changes Over Time

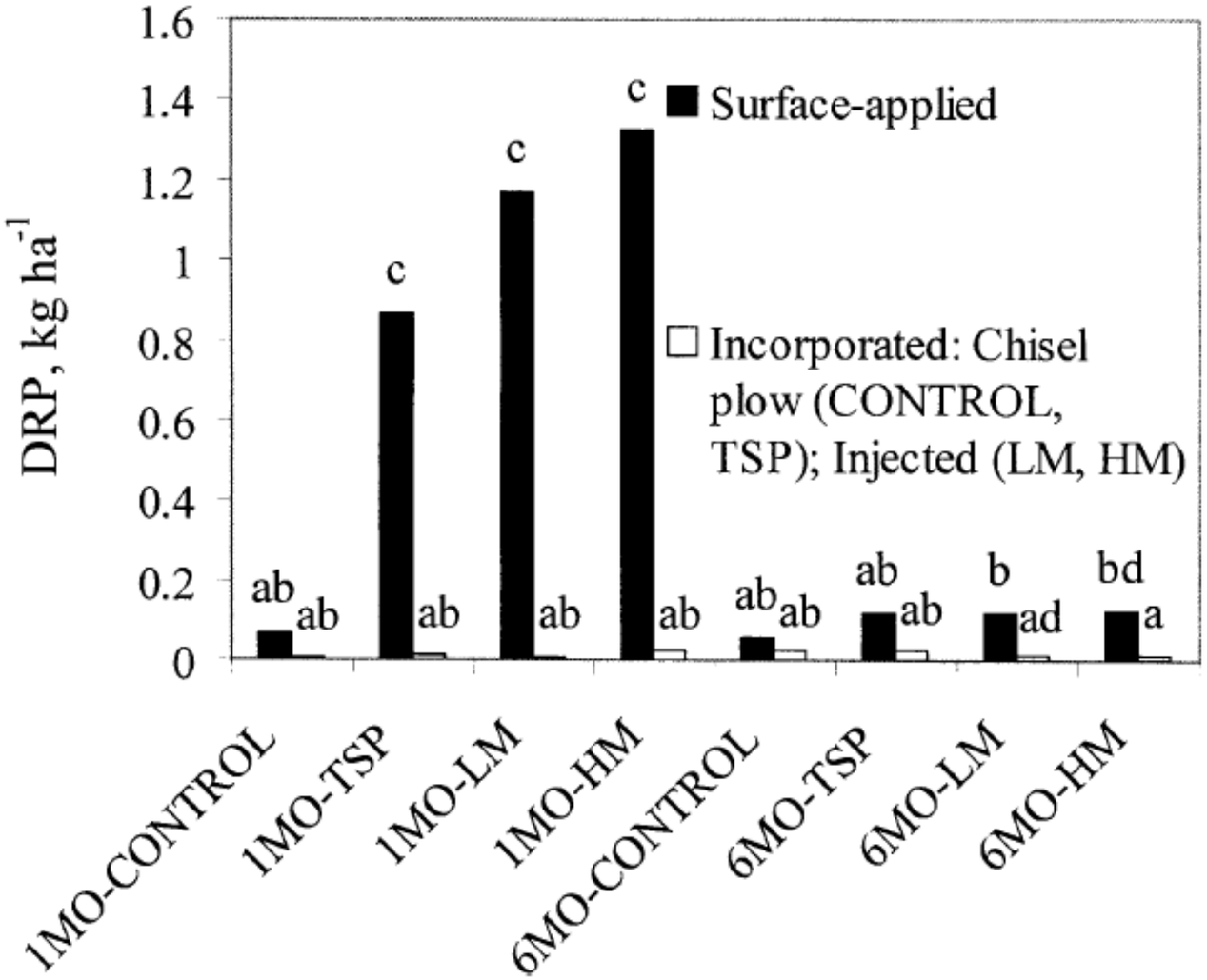
- Are soil test levels too high?

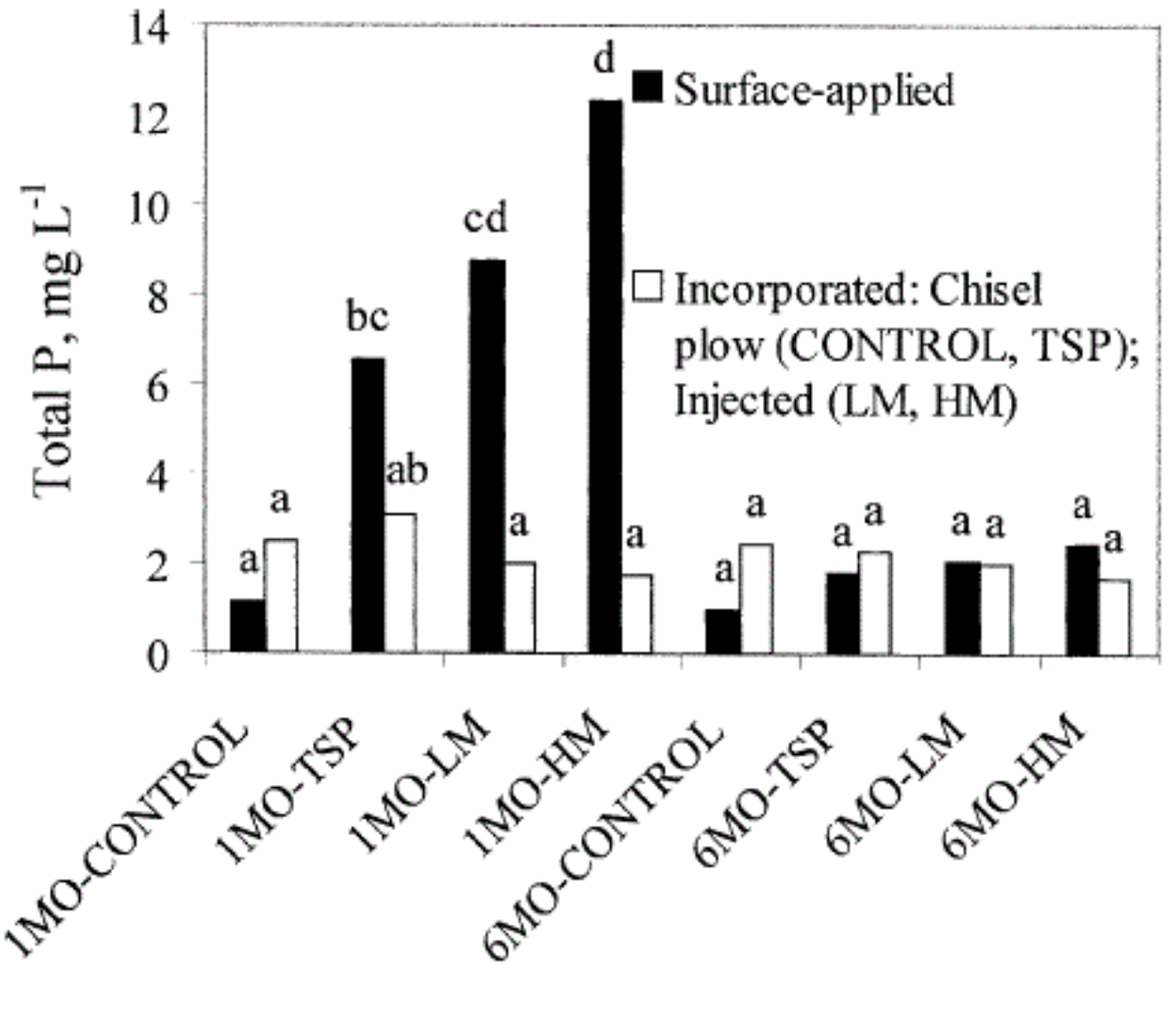


Source: IPNI

Phosphorus Loss

- Incorporation versus surface application

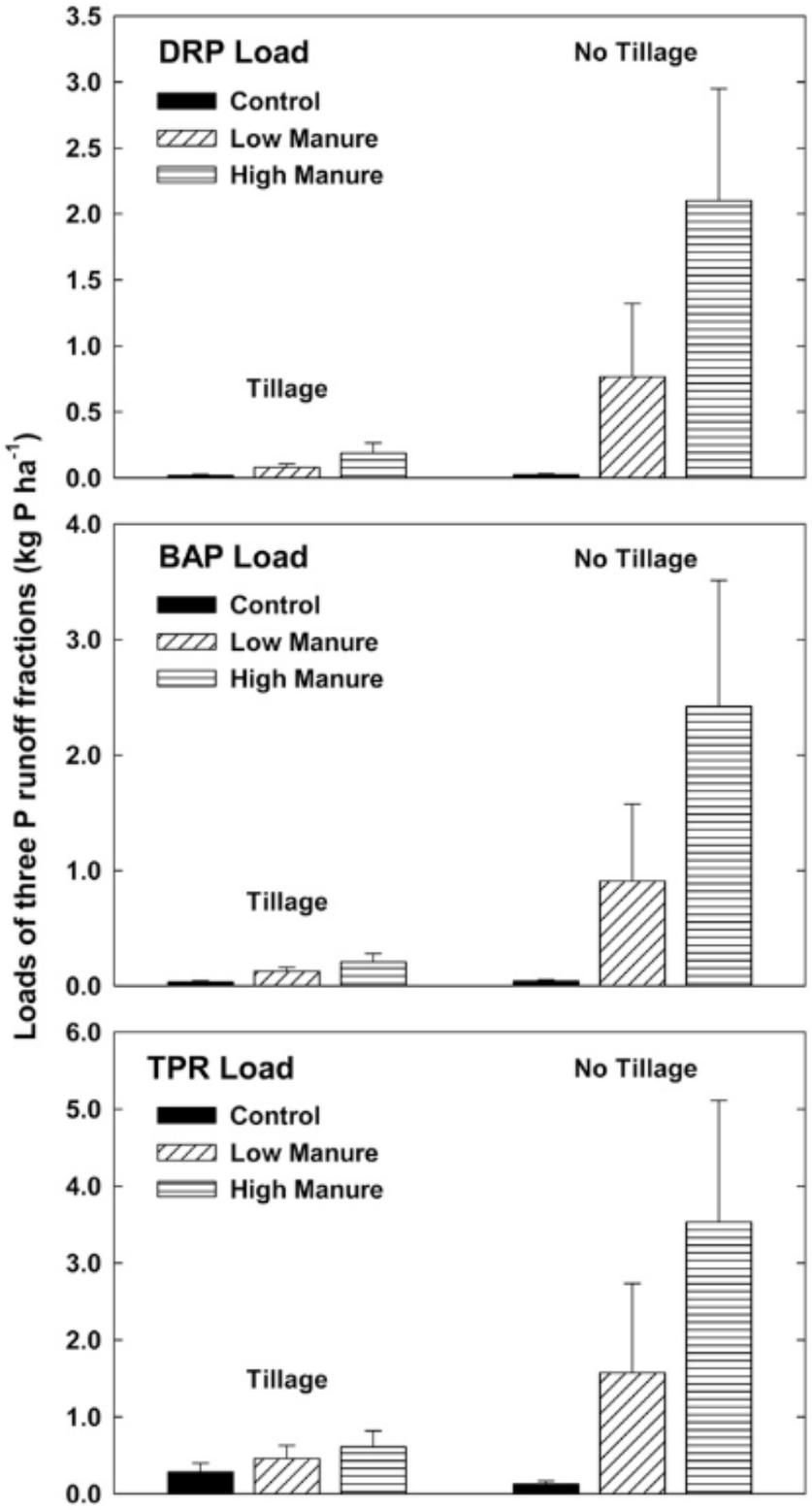




Source: Daverede et al., 2004. Journal of Environmental Quality 33:1535-1544.

Phosphorus Loss

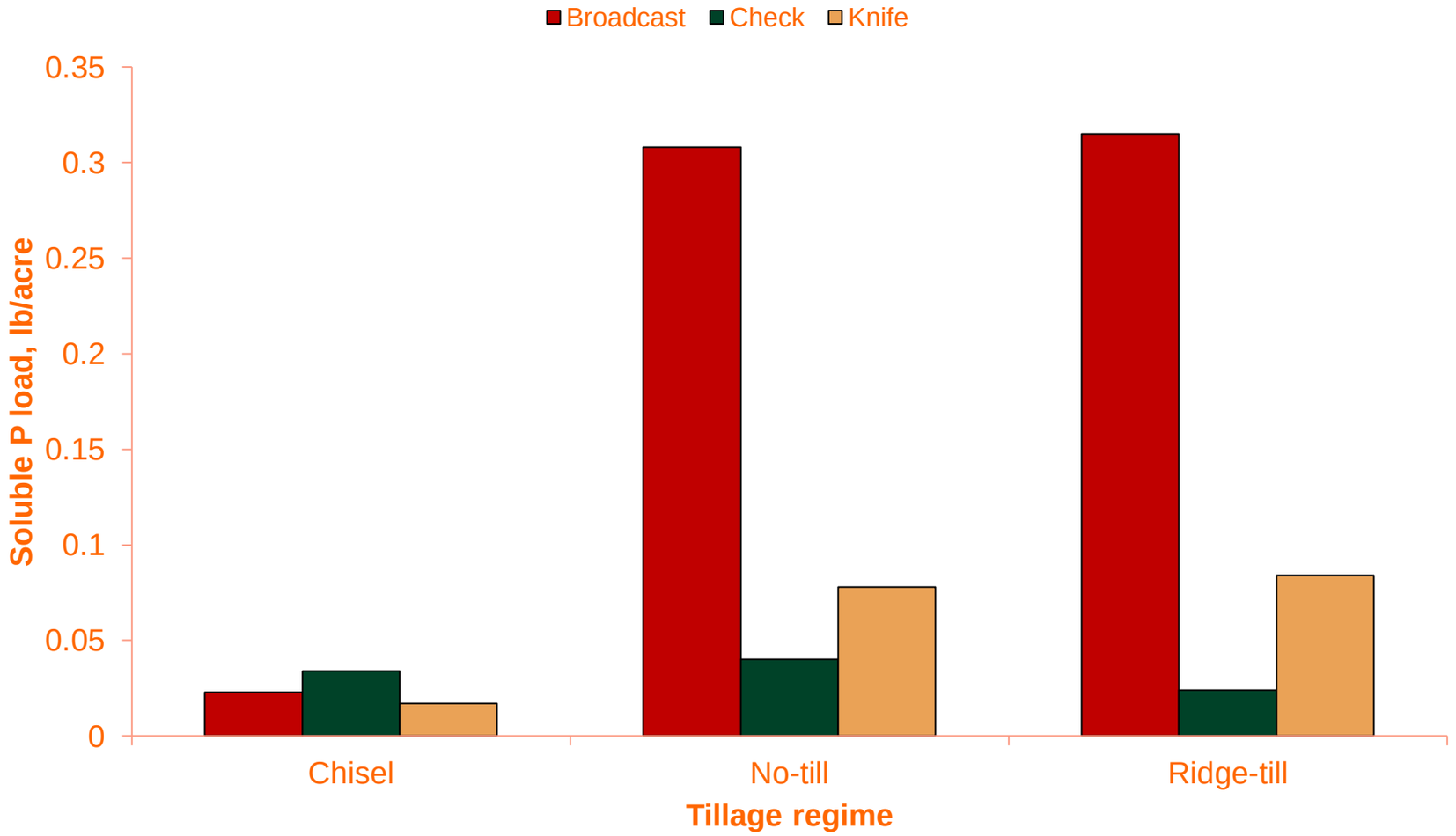
- Incorporation of manure versus surface application



Source: Kaiser et al., 2009. Journal of Environmental Quality 38:299-308.

Phosphorus Loss

- Incorporation versus surface application over a rotation (cumulative load over 2-years)



Source: Kimmel et al., 2001. Journal of Environmental Quality 30:1324-1330.

Phosphorus Loss

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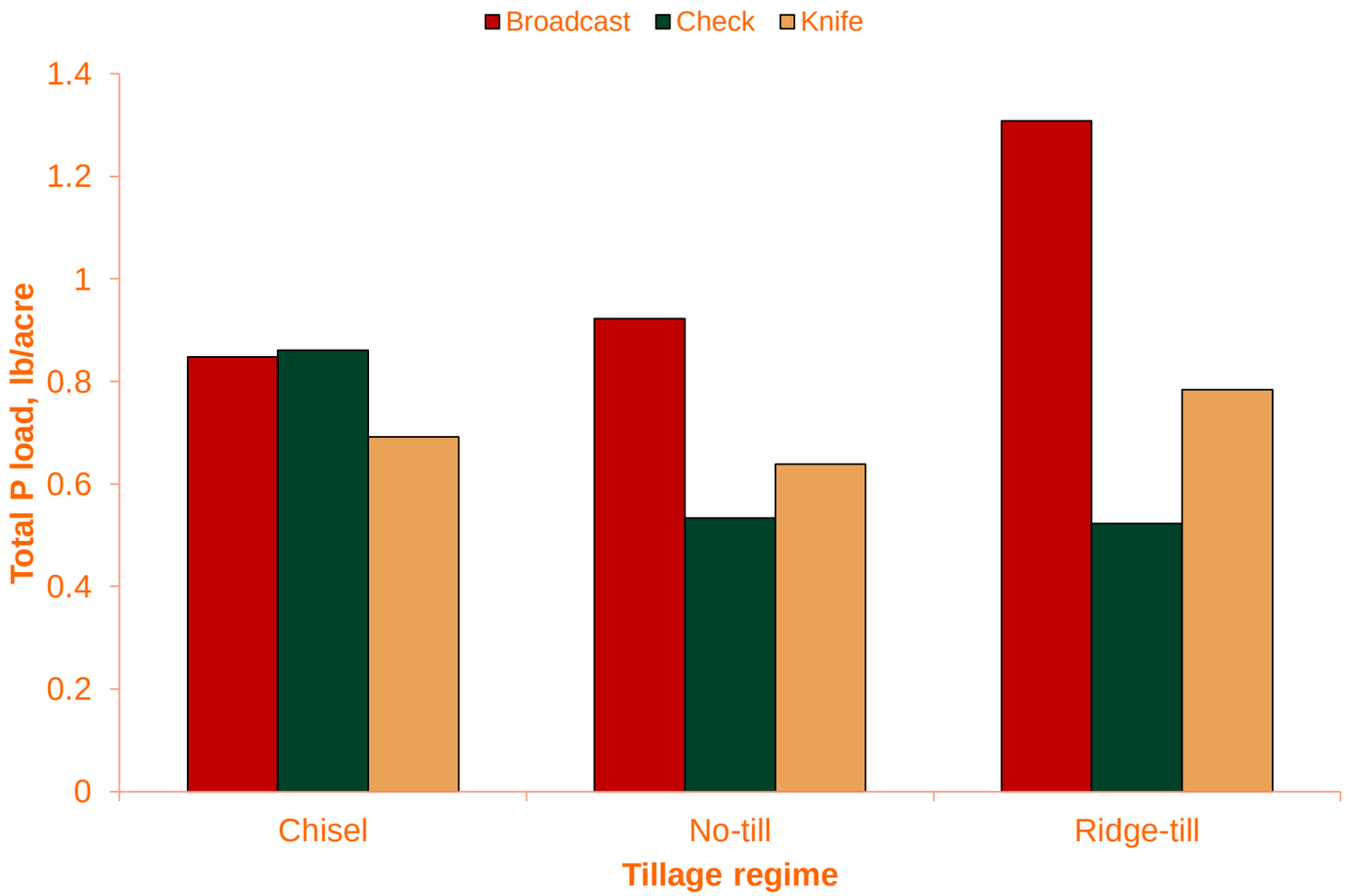
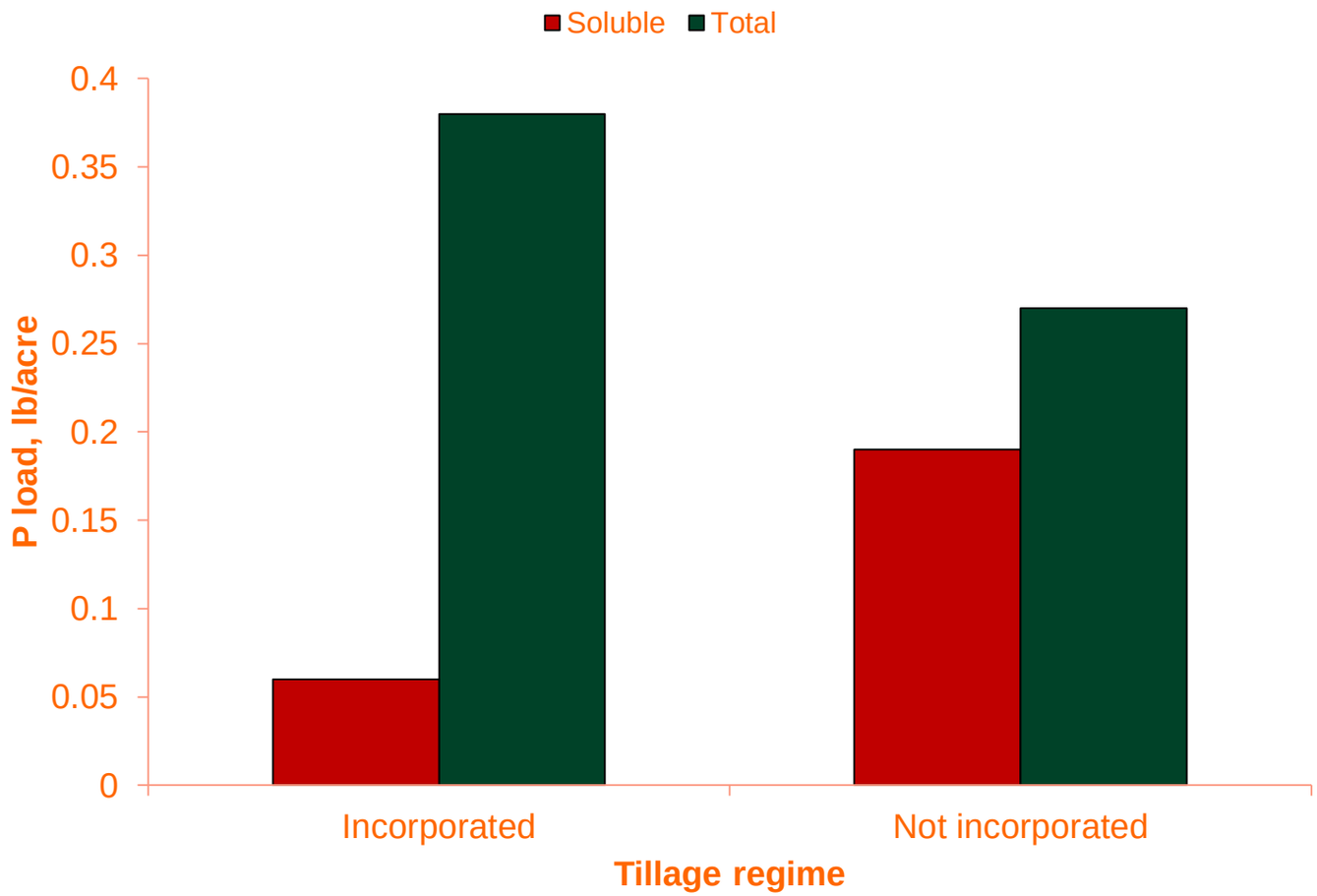


Source: Kimmel et al., 2001. Journal of Environmental Quality 30:1324-1330.

Phosphorus Loss

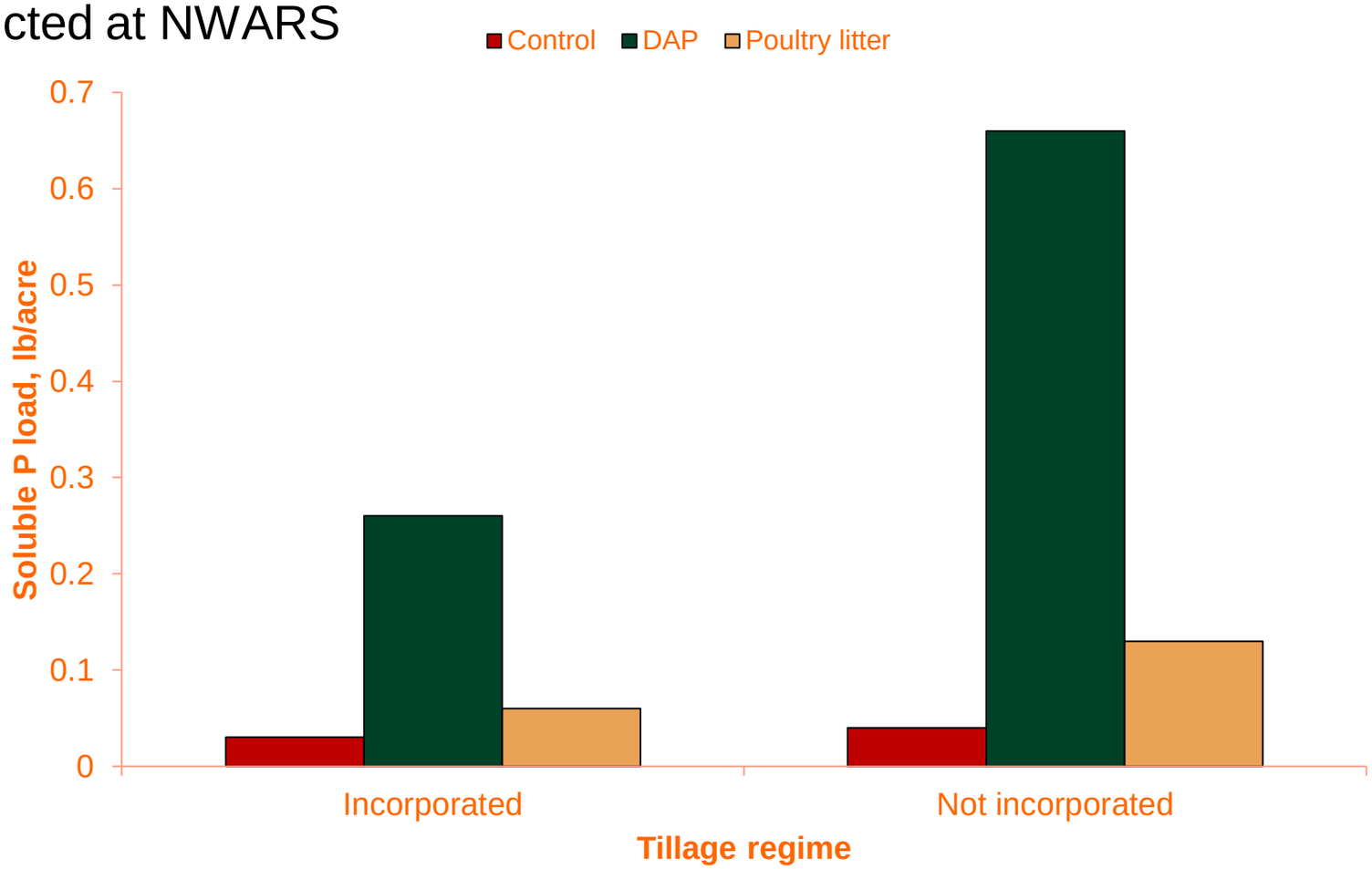
- Incorporation versus surface application
  - Two fertilizer materials (commercial and poultry litter) (conducted in Wauseon)



Source: Ohio State field research

Phosphorus Loss

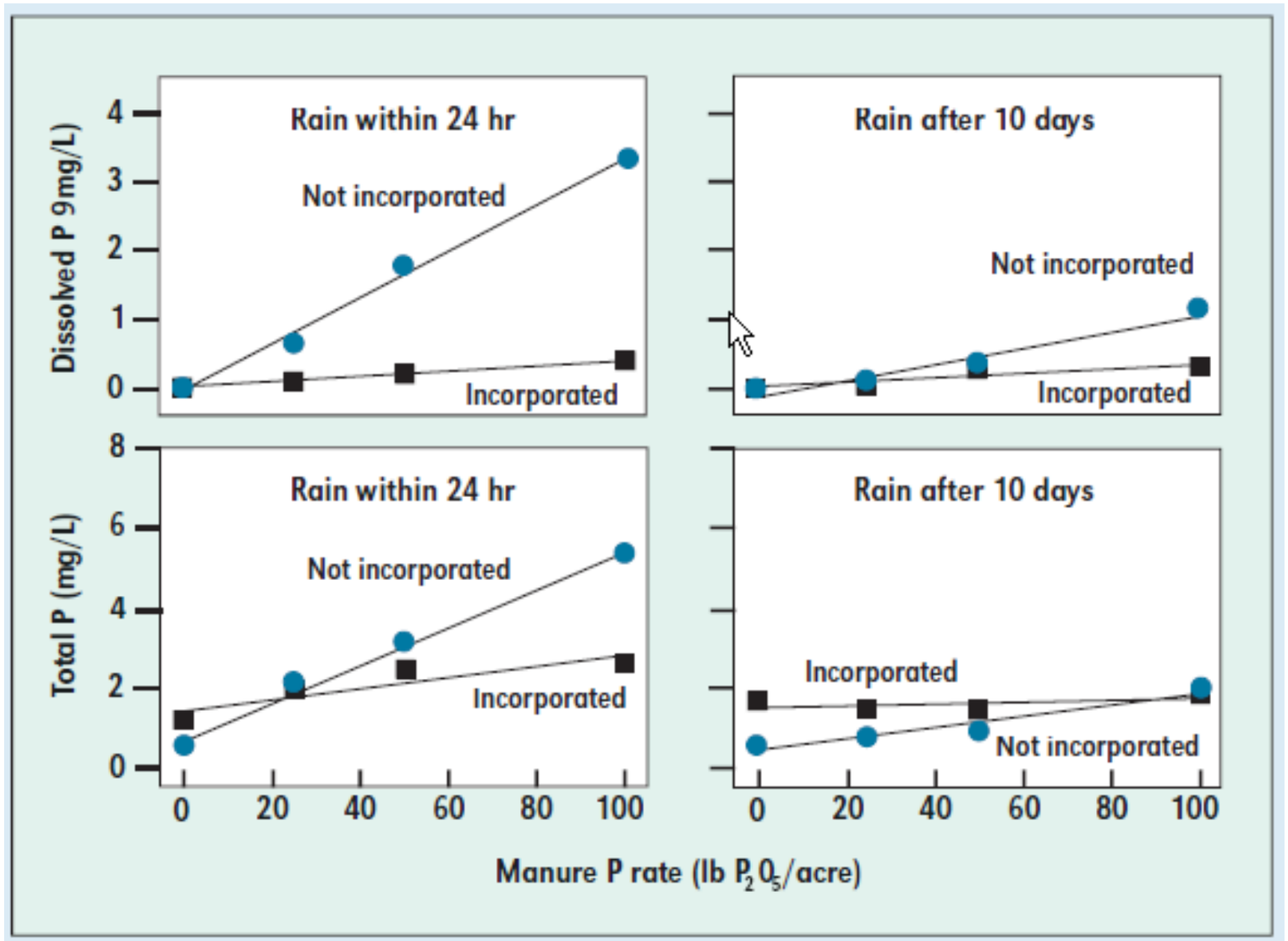
- Incorporation versus surface application
  - Conducted at NWARS



Source: Ohio State field research

Phosphorus Loss

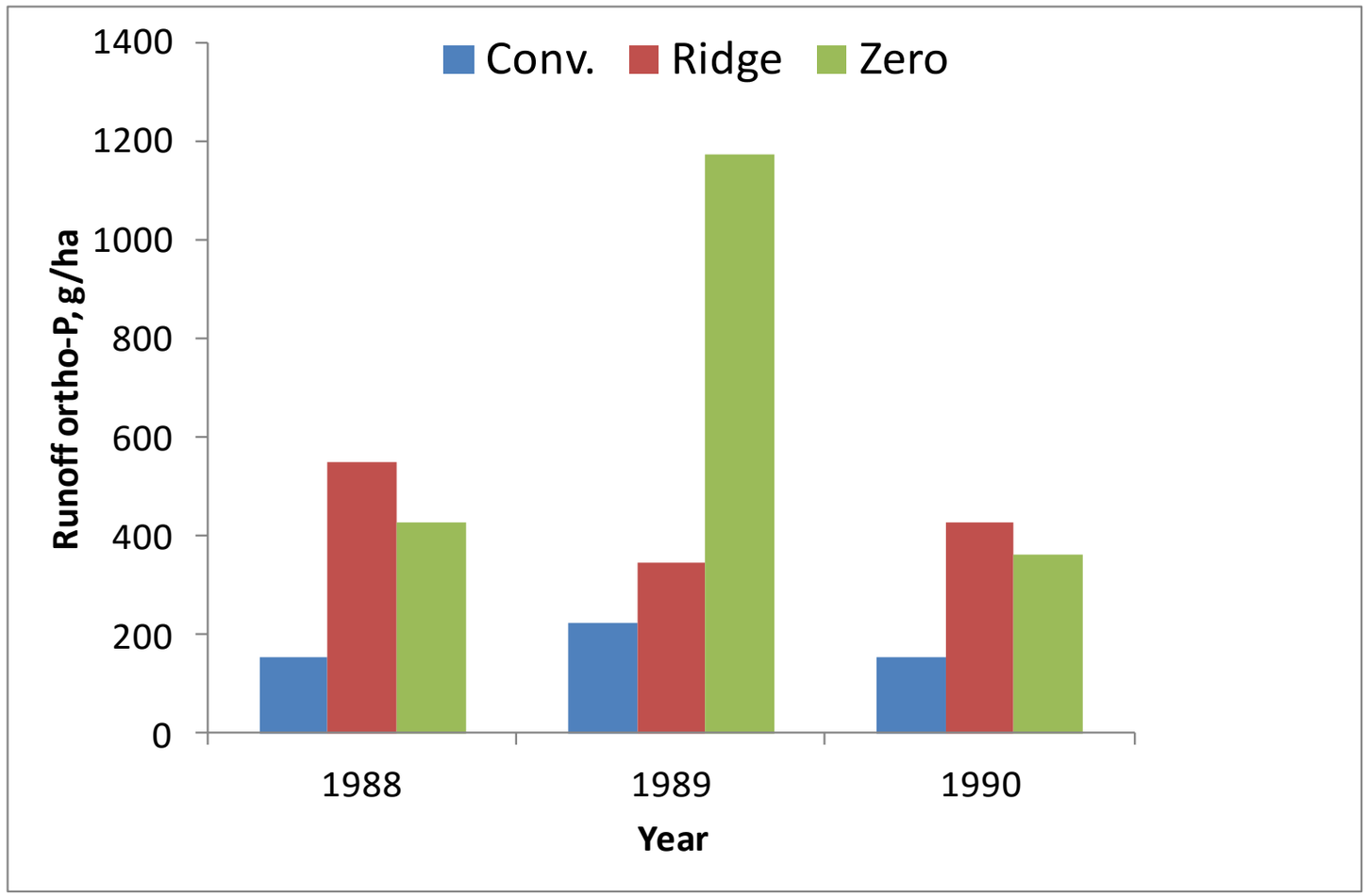
- Rain-free period matters (at least rainfall that generates runoff)



Source: Allen et al., Iowa State University

Phosphorus Loss

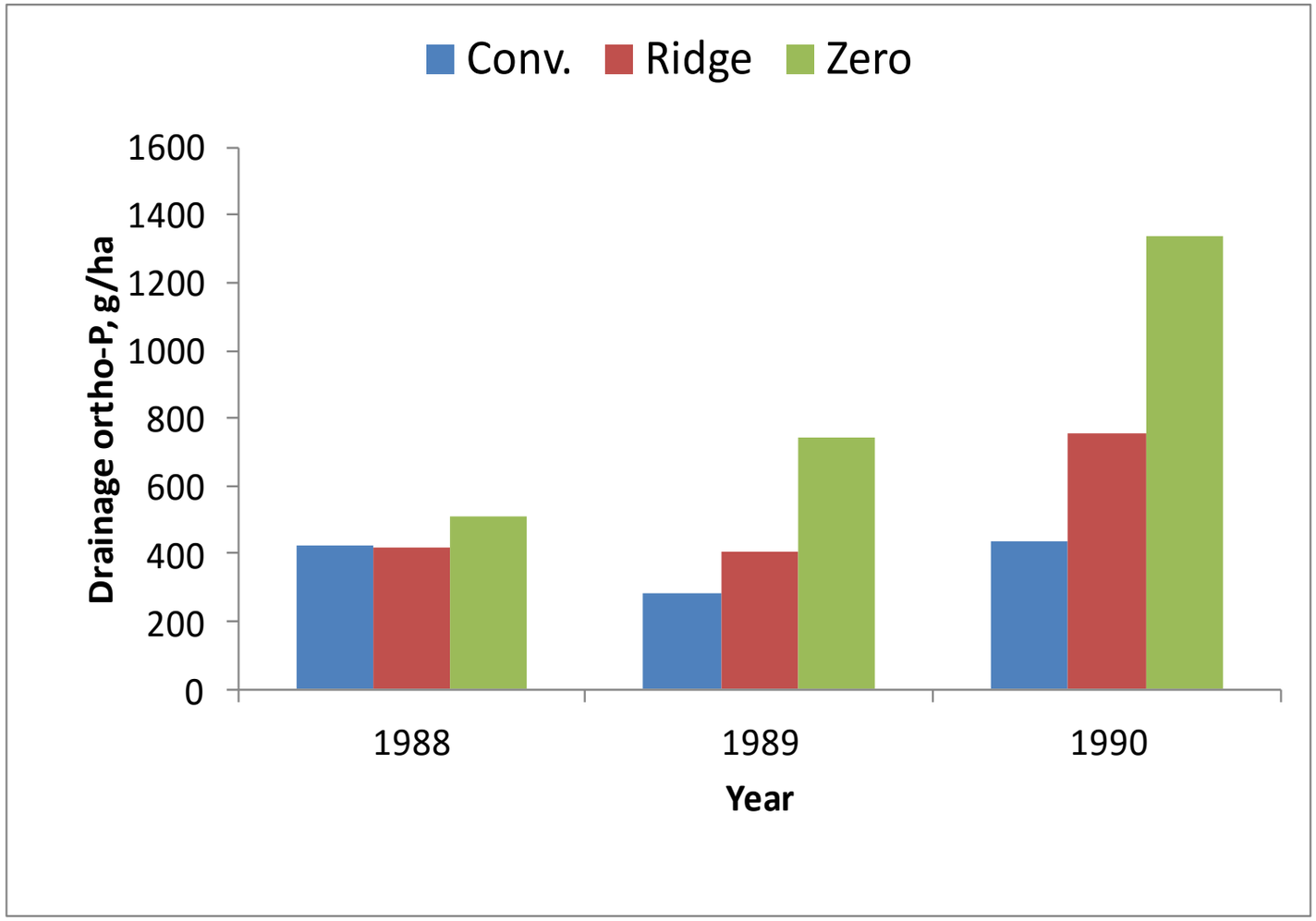
- More evidence that tillage is beneficial for mitigating ortho-P losses (surface runoff)



Source: Gaynor and Findlay, 1995

Phosphorus Loss

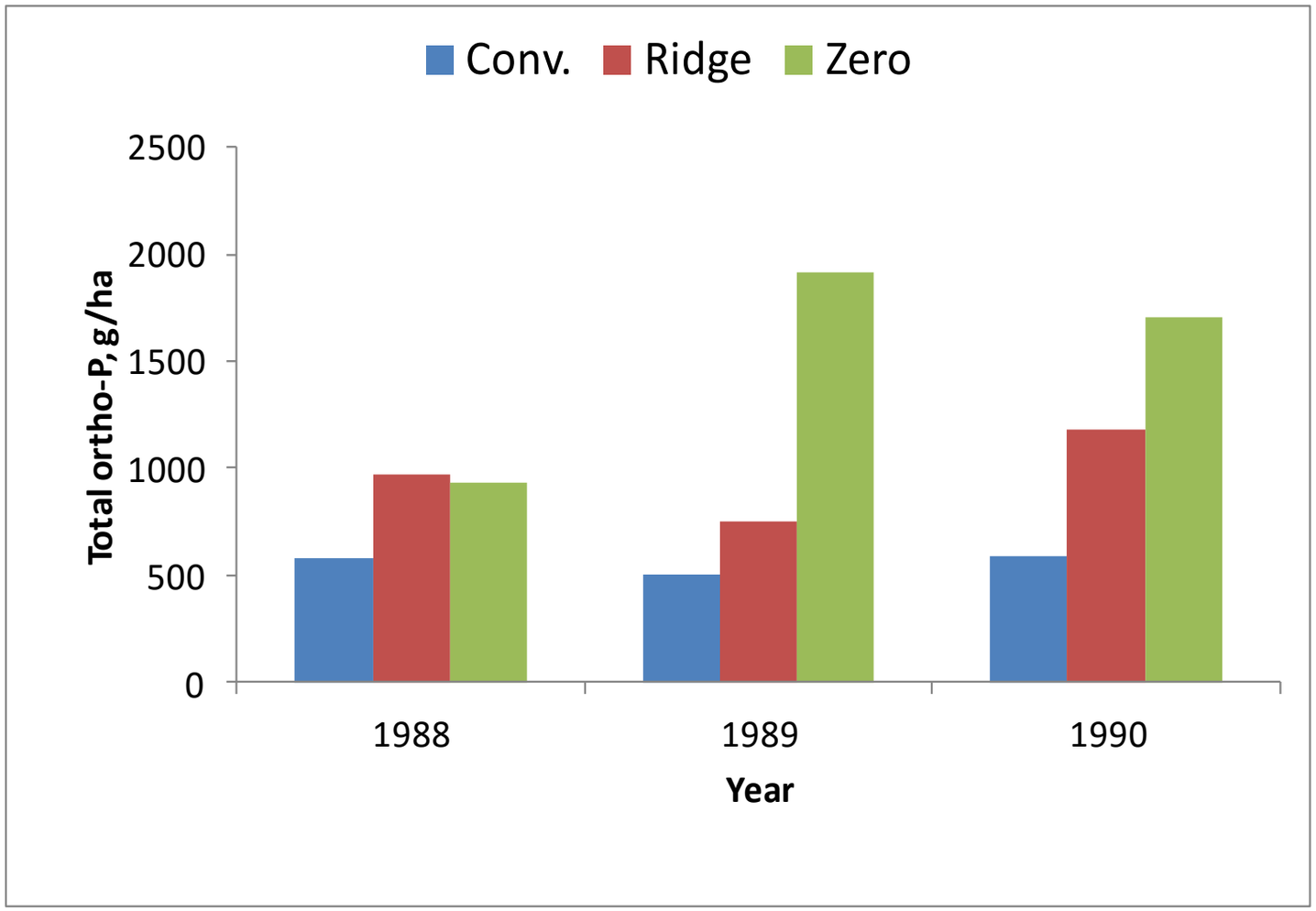
- More evidence that tillage is beneficial for mitigating ortho-P losses (drainage)



Source: Gaynor and Findlay, 1995

Phosphorus Loss

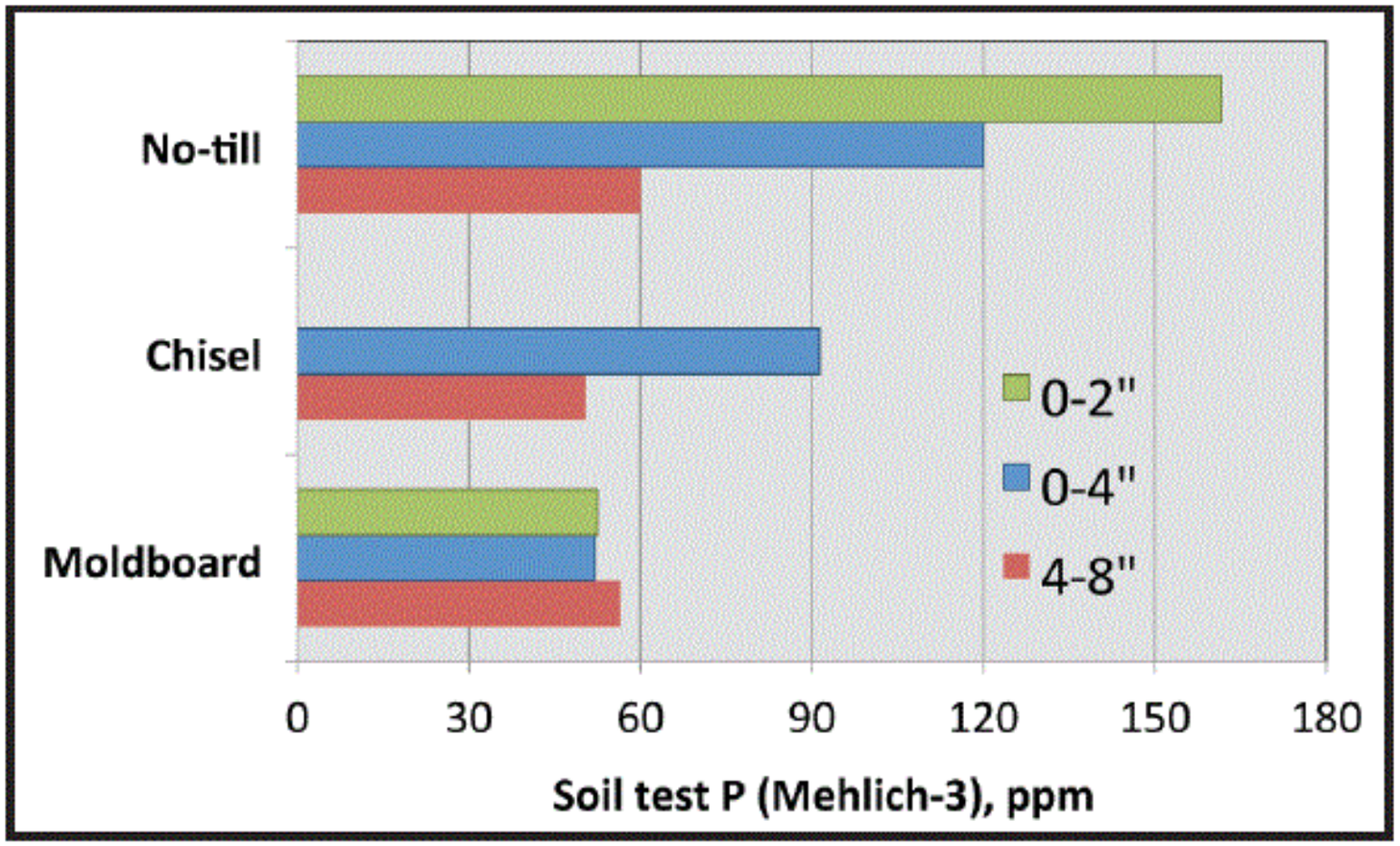
- More evidence that tillage is beneficial for mitigating ortho-P losses (total)



Source: Gaynor and Findlay, 1995

Phosphorus Loss

- Is this a stratification issue?



Source: Bruulsema et al., 2012

Lake Erie Issue

- Not clear what the issue is
  - Increased loading of phosphorus to the lake? - No
  - Increased loading of dissolved reactive phosphorus? (blamed on conservational tillage and increased use of drainage tile) – Maybe (stratification?)
  - Increased use of tile risers? Unknown.
  - Increase in invasive quagga and zebra mussels in the lake? – Maybe (recent research in Michigan points here as a possible contributor)
  - Sin of the past, sediment loaded with P occupying intermittent streams that gets resuspended during rainfall events? – Maybe
  - Shunting of historic retention areas to avoid flooding of cities? - Maybe

Lake Erie Issue

- So…what about a solution?
  - Still no smoking gun, so go after the lowest hanging fruit available
  - Ban frozen ground applications
  - Avoid applications of fertilizer materials close to predicted rainfall events
- What if this is the result of phosphorus stratification, will changing application rates and timing dramatically effect Lake Erie water quality?

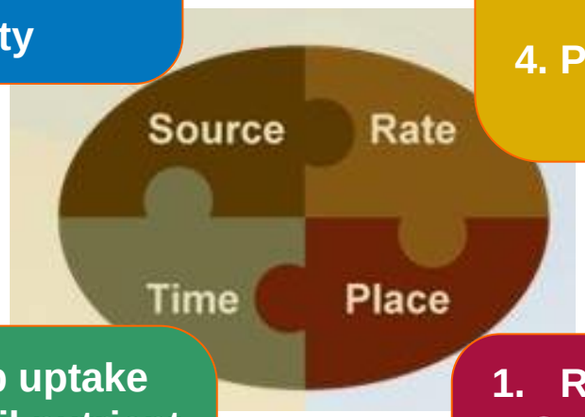
Source: USDOC, Piers

4R Nutrient Stewardship

The basics

1. Supply in plant available forms
2. Suit soil properties
3. Recognize synergisms among elements
4. Blend compatibility

1. Appropriately assess soil nutrient supply
2. Assess all available indigenous nutrient sources
3. Assess plant demand
4. Predict fertilizer use efficiency

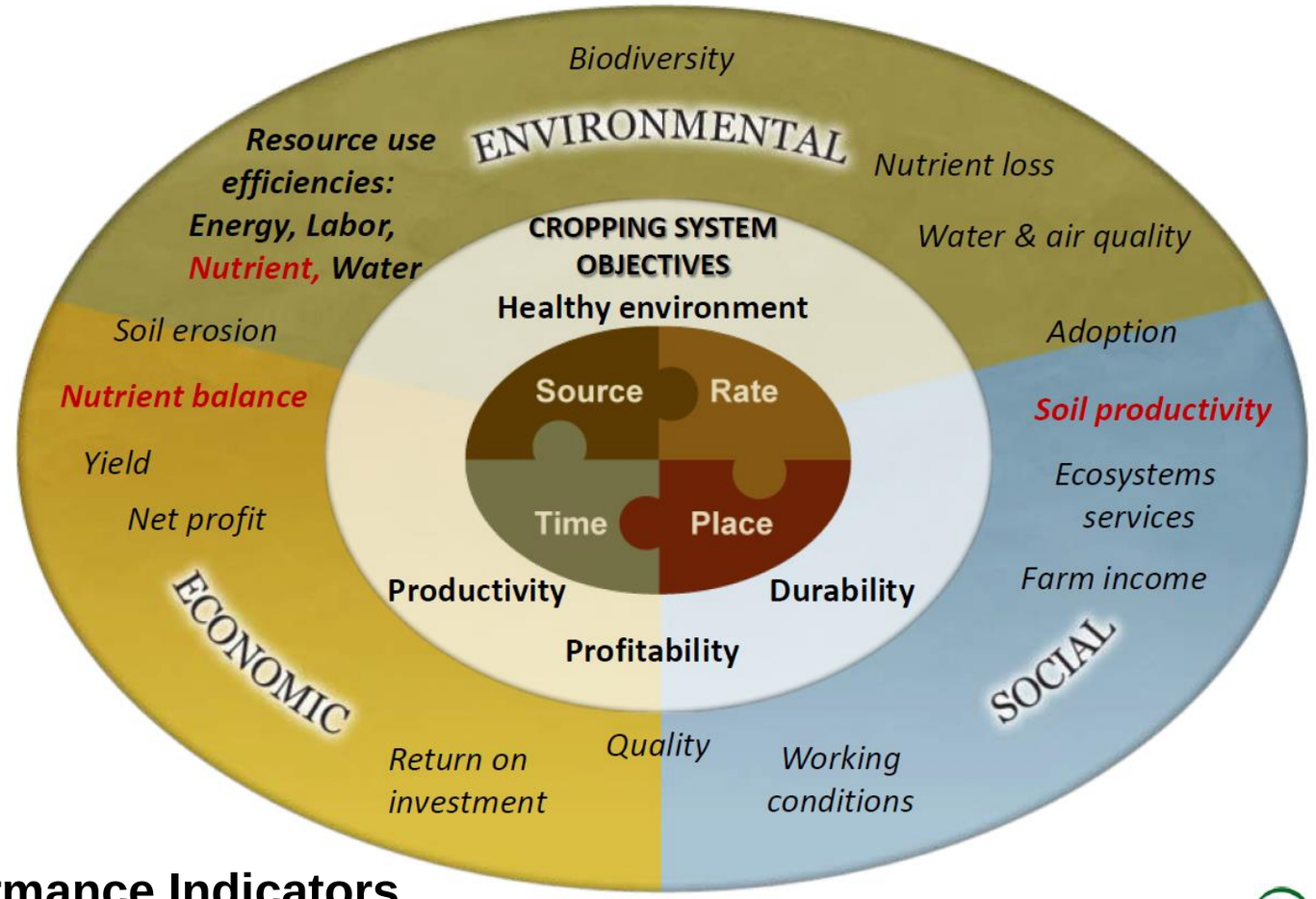


1. Assess timing of crop uptake
2. Assess dynamics of soil nutrient supply
3. Recognize timing of weather factors
4. Evaluate logistics of operations

1. Recognize root-soil dynamics
2. Manage spatial variability
3. Fit needs of tillage system
4. Limit potential off-field transport

4R Nutrient Stewardship

Advanced



Performance Indicators

Putting 4R To Work

P Application Practice	Advantages	Limitations
OPTION 1 S – MAP or DAP R – removal rate for rotation T – fall after soy before corn P – broadcast	• Minimal soil compaction • Allows timely planting in spring • Lowest-cost fertilizer form • Low cost of application	• Risk of elevated P in runoff in late fall and winter • Low N use efficiency
OPTION 2 S – MAP or DAP R – removal rate for rotation T – spring before corn P – broadcast	• Minimal soil compaction • Better N use efficiency • Low-cost fertilizer form • Low cost of application	• Risk of elevated P in spring runoff before incorporation • Potential to delay planting • Retailer spring delivery capacity
OPTION 3 S – MAP or fluid APP R – removal rate for crop T – spring P – planter 2" x 2" band	• Best N efficiency • Low risk of elevated P in runoff • Less soil P stratification	• Cost and practicality of planting equipment with fertilizer capacity • Potential to delay planting • Retailer delivery capacity • Cost of fluid versus granular P
OPTION 4 S – MAP or DAP R – removal for crop or rotation T – fall after soy before corn P – zone placement in bands	• Low risk of elevated P in runoff • Better N and P efficiency • Maintain some residue cover • Allows timely planting in spring • Less soil P stratification	• Cost of RTK GPS guidance • Cost of new equipment • Requires more time than broadcast
OPTION 5 S – fluid APP R – removal for crop or rotation T – fall after soy before corn P – point or spoke injection	• Low risk of elevated P in runoff • Better N and P efficiency • Maintain good residue cover • Allows timely planting in spring • Less soil P stratification	• Cost of RTK GPS guidance • Cost of new equipment • Cost of fluid versus granular P • Requires more time than broadcast

Source: Bruulsema et al., 2012

Thank you

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