Fluids and P Management to Minimize Loss to Surface Waters

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Overview

- The Issue
  - Transport of different P fractions (soluble and sediment-bound)
- Managing Loss Pathways (Source and Placement)
  - How does source impact transport?
  - How does placement impact transport?

P Transport and The Issue in Ohio

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Generalized Model

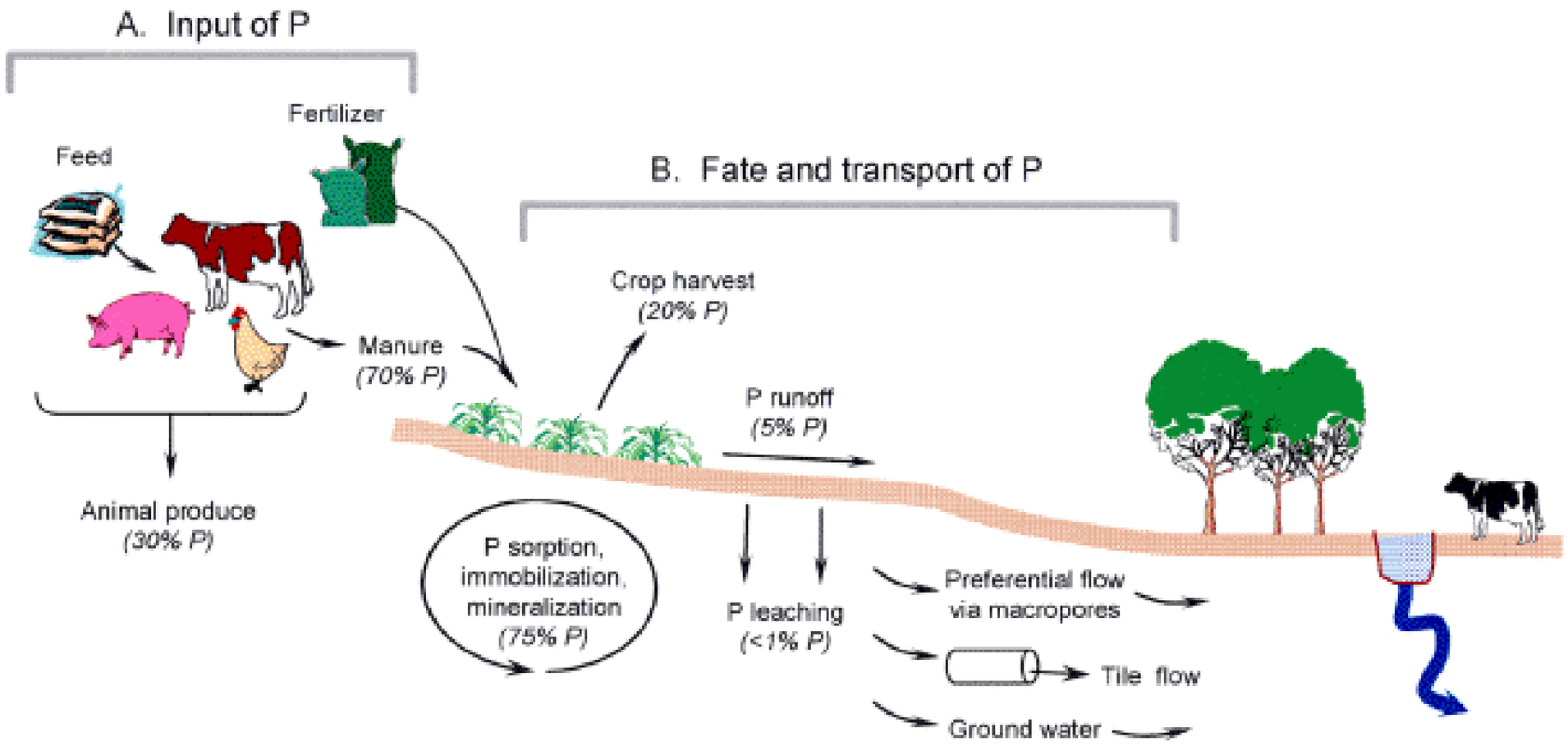
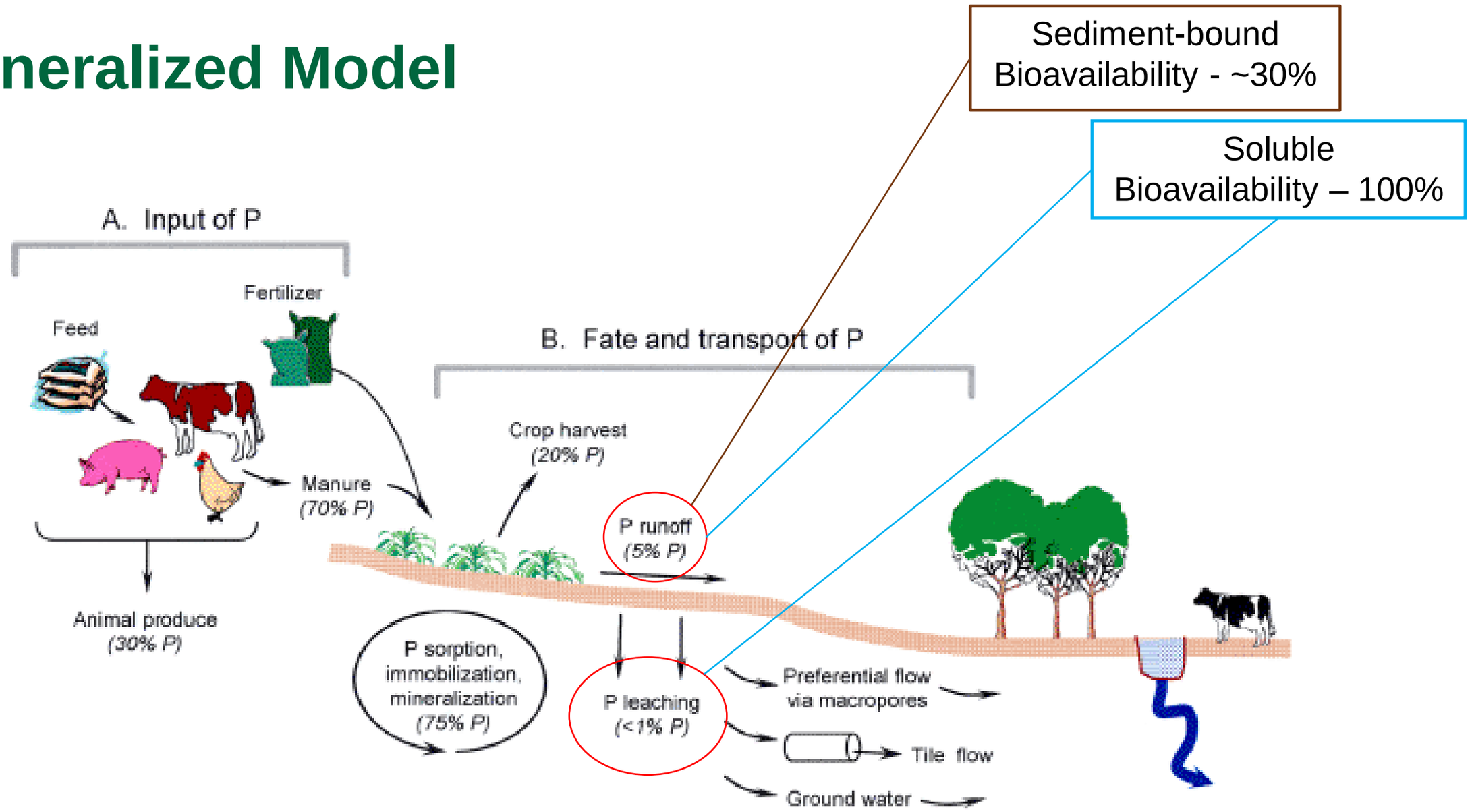


Figure 4 - Factors affecting the input, fate, and transport of P in agricultural systems. Numbers in parentheses are based on approximate farm inputs of P in animal feed and fertilizer and output in animal produce (A) and manure and fate in soils, crops, and transport in runoff (B). Adapted from Howarth et al. (2000) and Sims and Sharpley (2005).

Generalized Model



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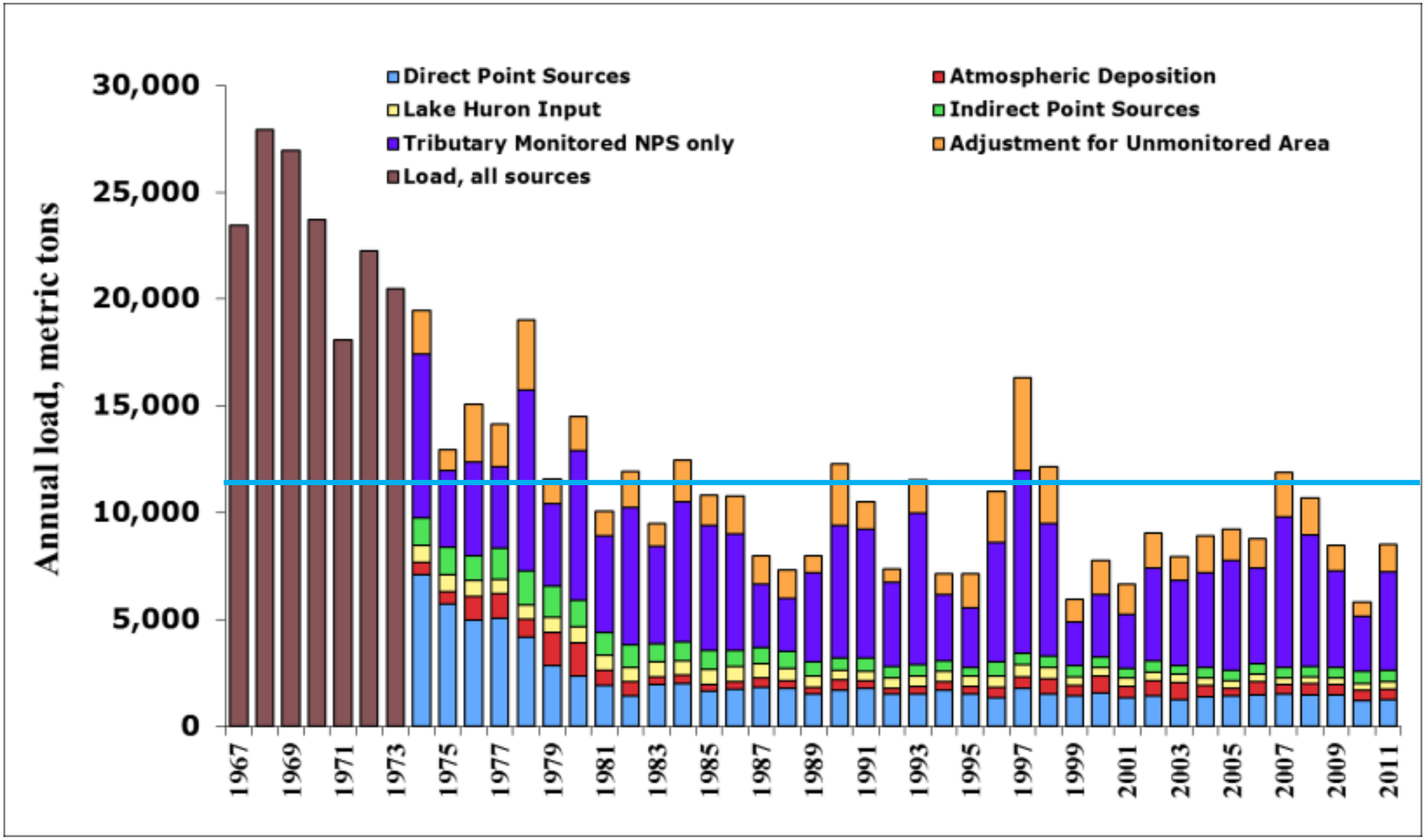
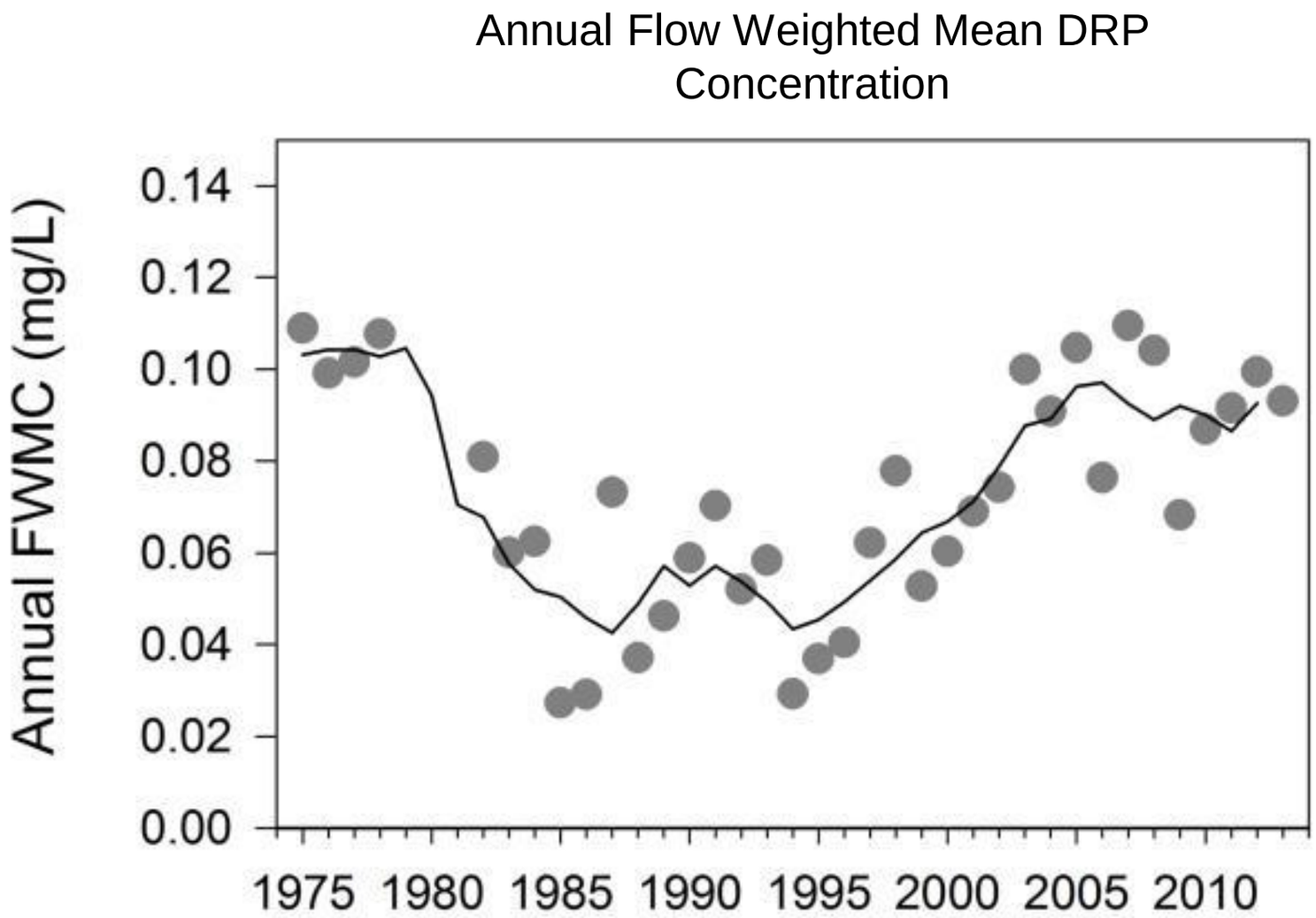
Lake Erie (A Very Brief History)



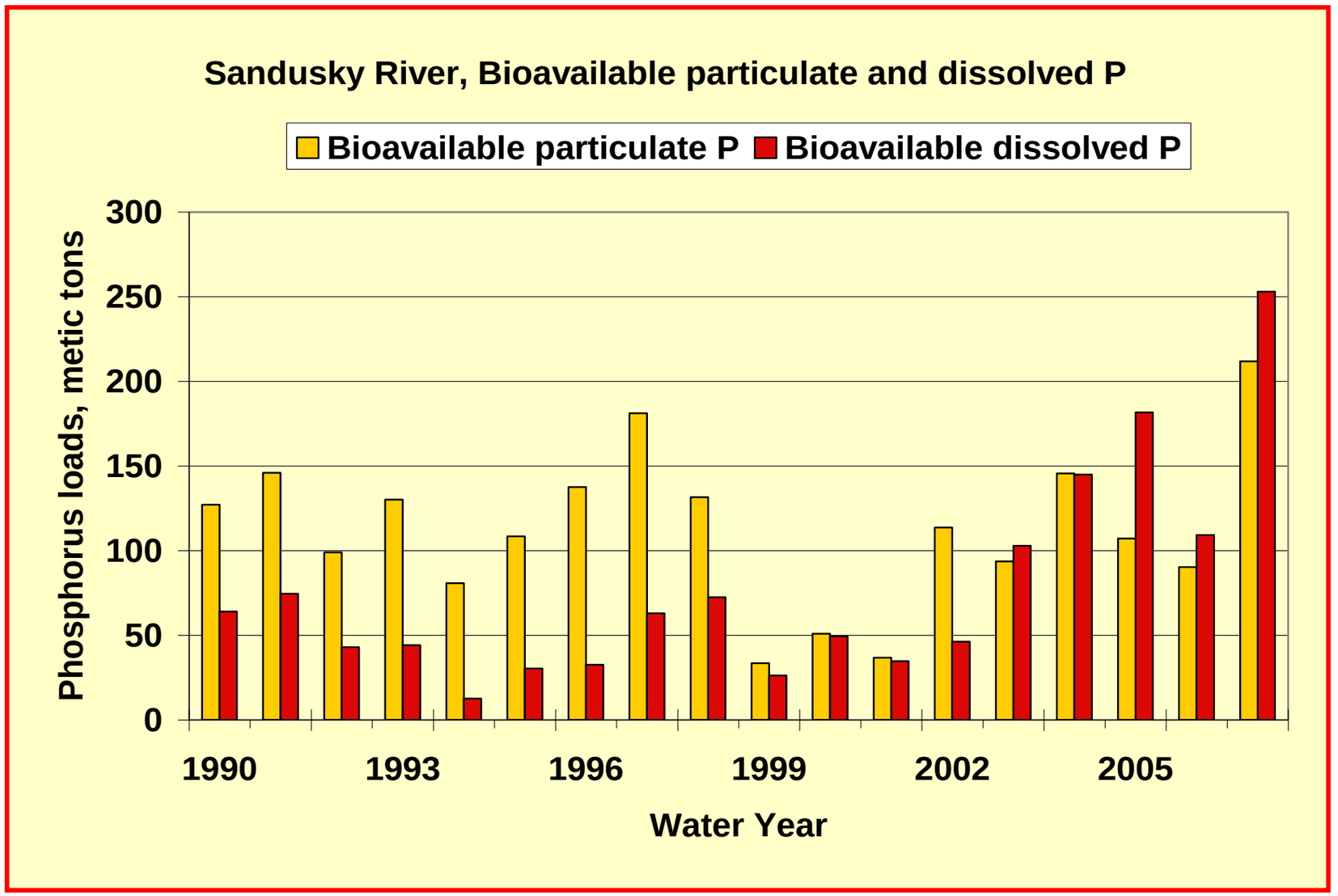
Target total P load of 11,000 metric tons per calendar year set by International Joint Commission in early 70s

Changes in Phosphorus Loading



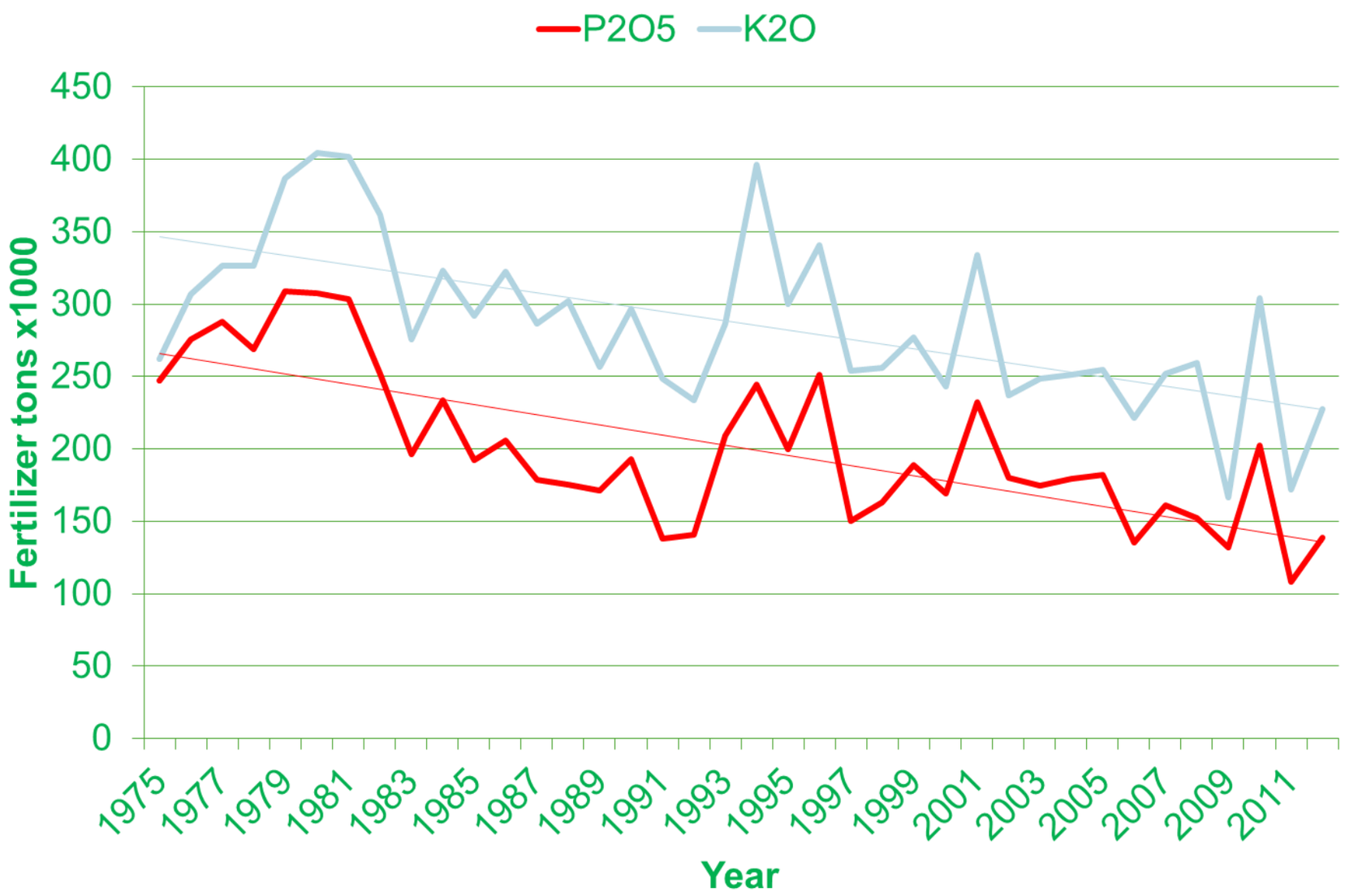
Data from Heidelberg University, 2015

Loading of DRP



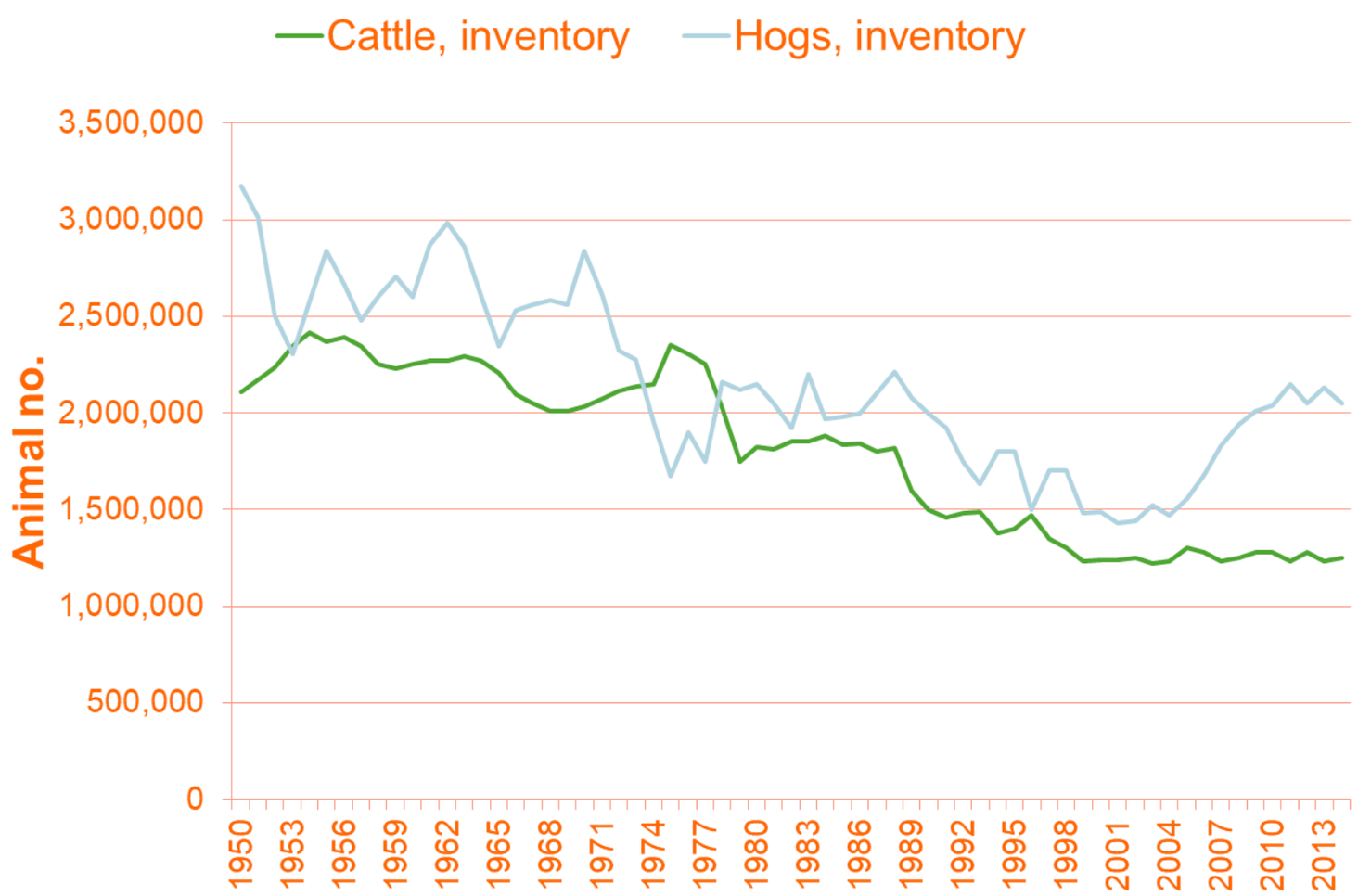
Source: Baker, Heidelberg University

Ohio Potassium and Phosphorus Consumption



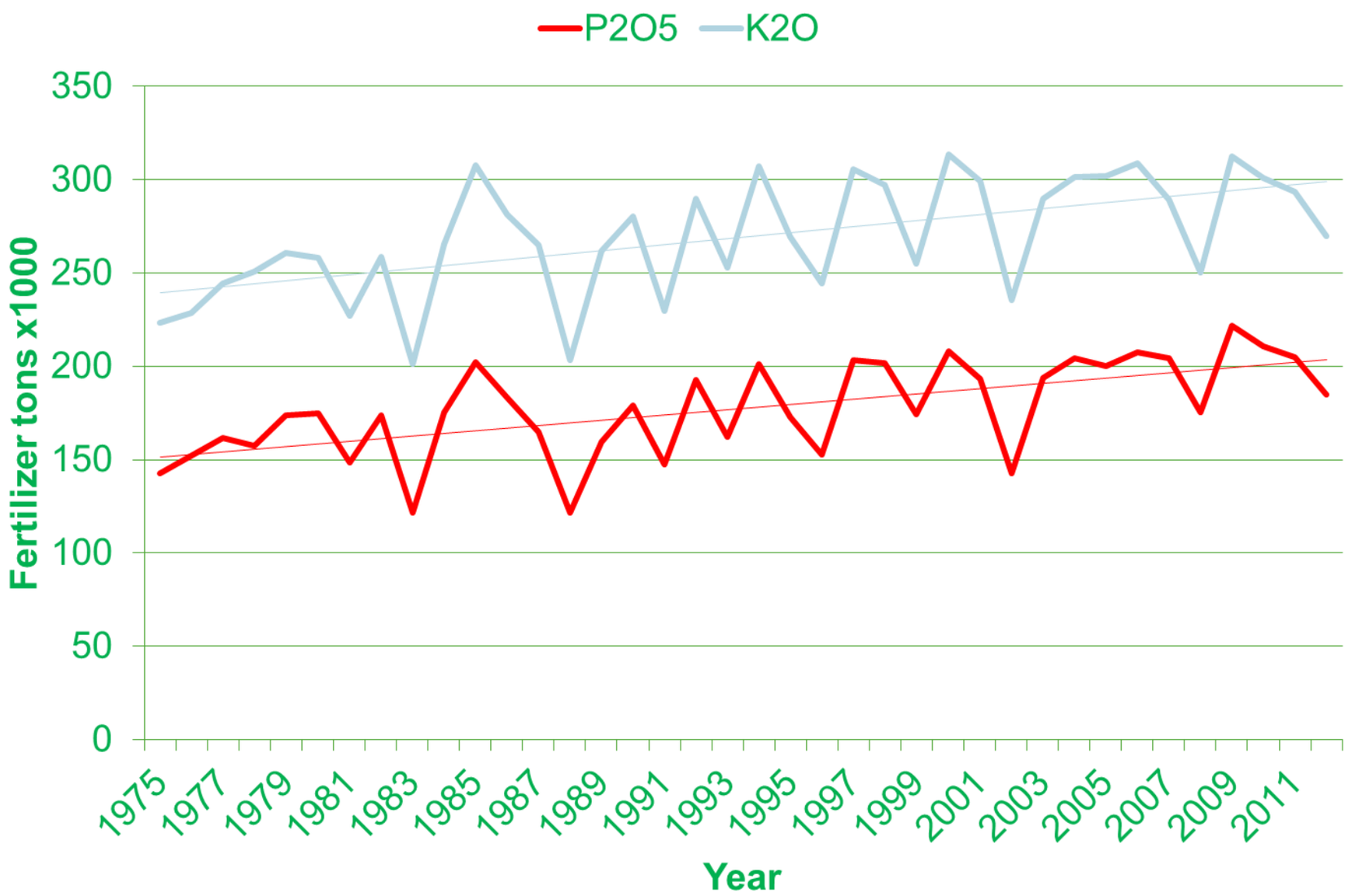
Source: AAPFCO

Animal Numbers in Ohio



Source: USDA

Ohio Potassium and Phosphorus Removal



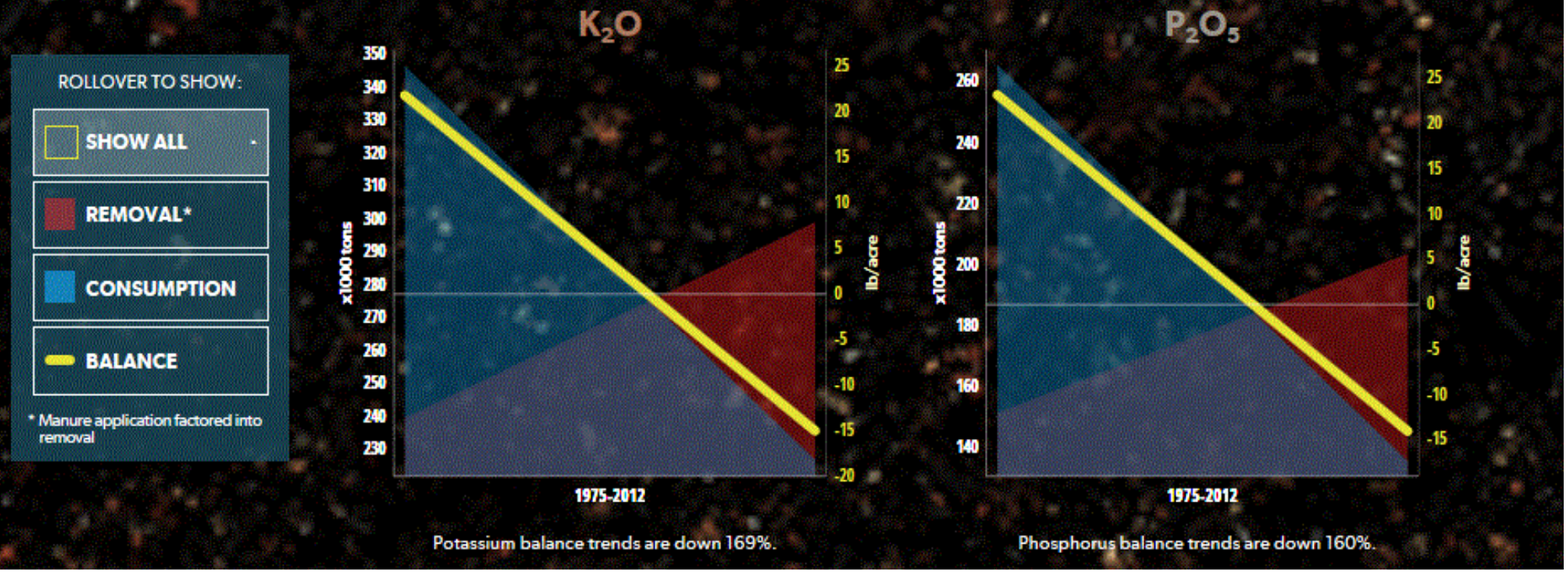
Source: USDA, IPNI

Phosphorus Balance in Ohio (1975-2012)

Percentage of Soils Below the Critical Level

	2005	2010	2015
K	23%	36%	35%
P	42%	42%	48%

Nutrient Balance Data



Potassium balance trends are down 169%.

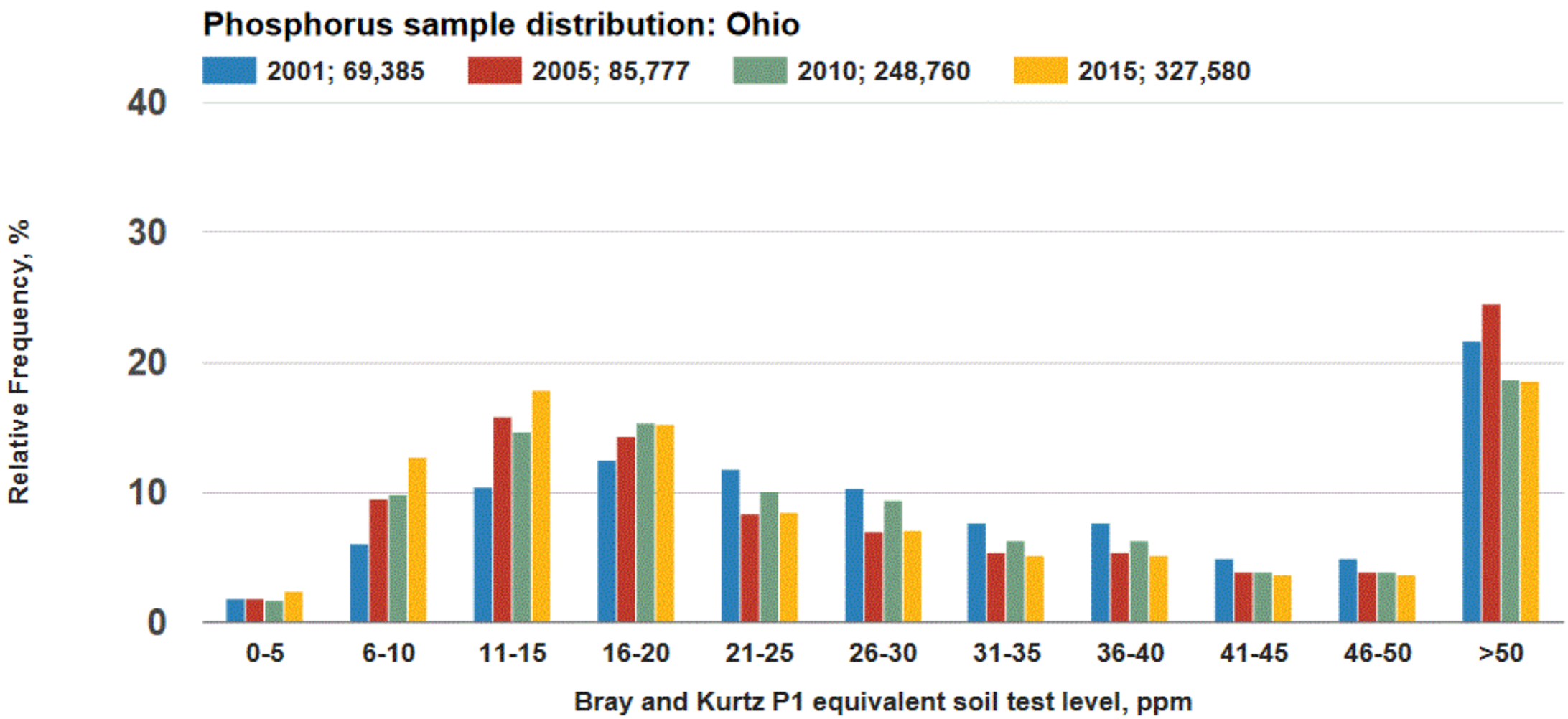
Phosphorus balance trends are down 160%.

Source: eKonomics

Soil Test Changes Over Time

- Are soil test levels too high?

73% of soils less than 40ppm



Source: IPNI

The Issue

- Still not clear what the central, driving 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
  - Delayed incorporation of fertilizer applications? Maybe
  - Sins 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

Managing Loss Pathways – Source/Placement

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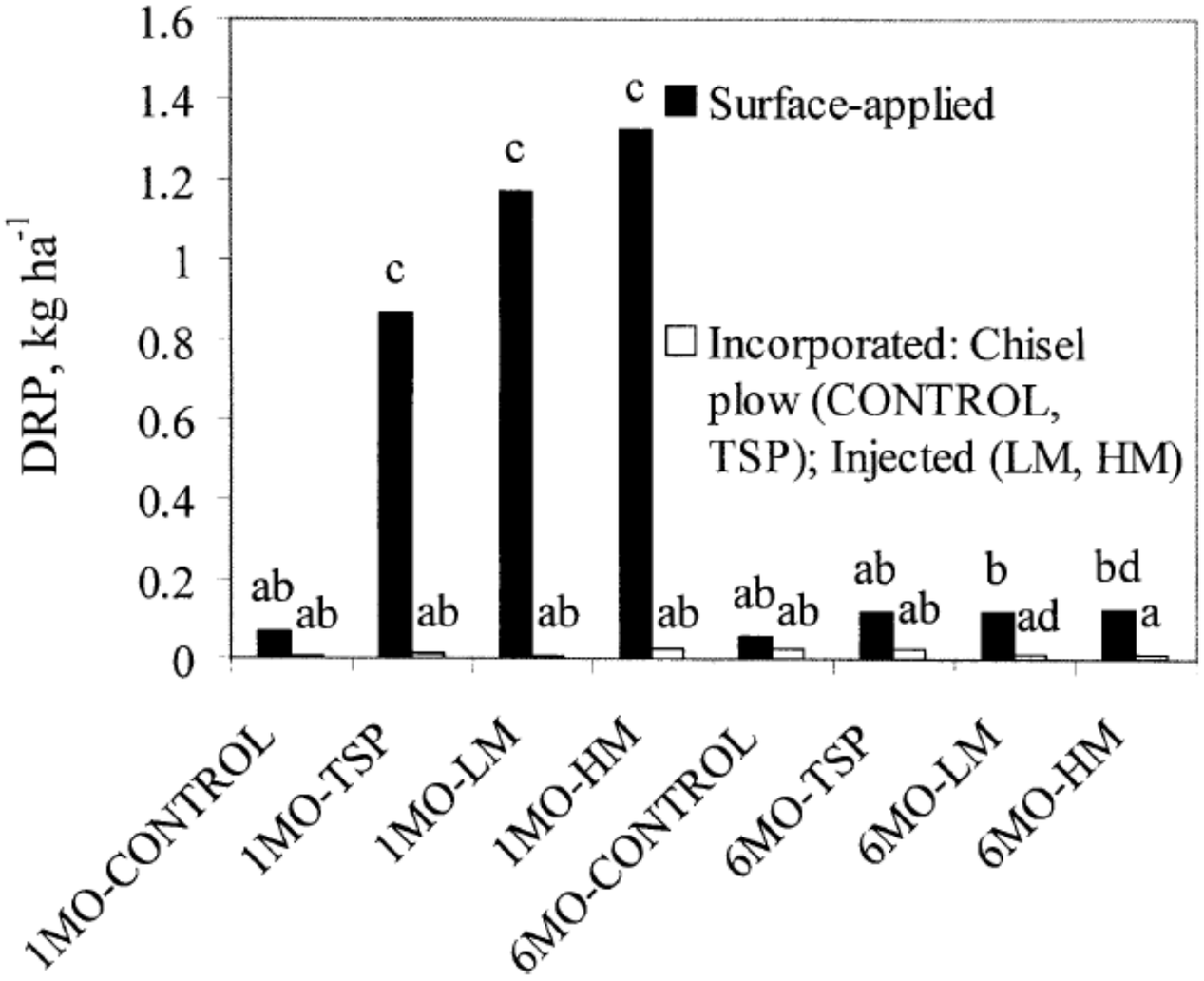
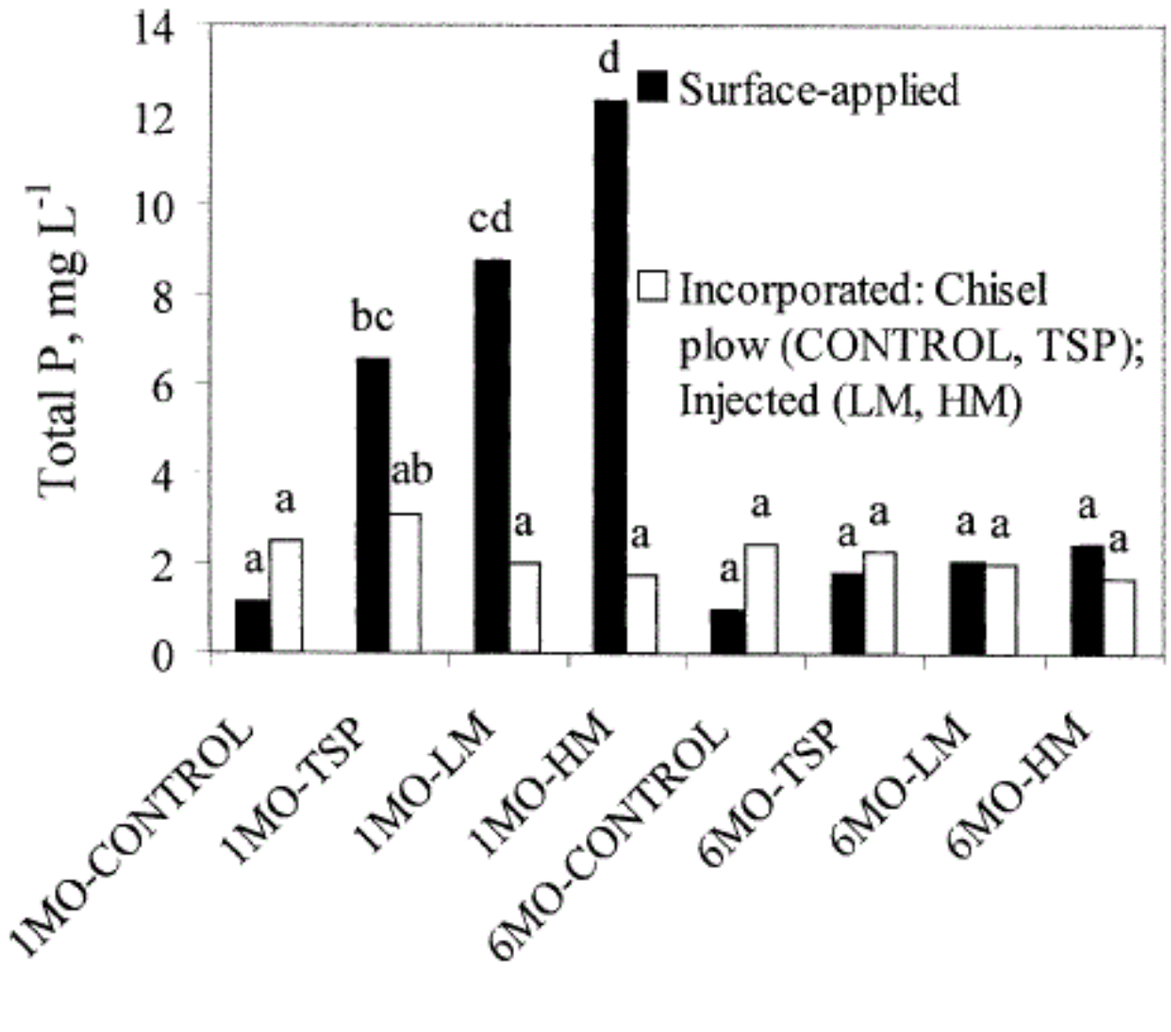
Phosphorus Loss

- Incorporation versus surface application

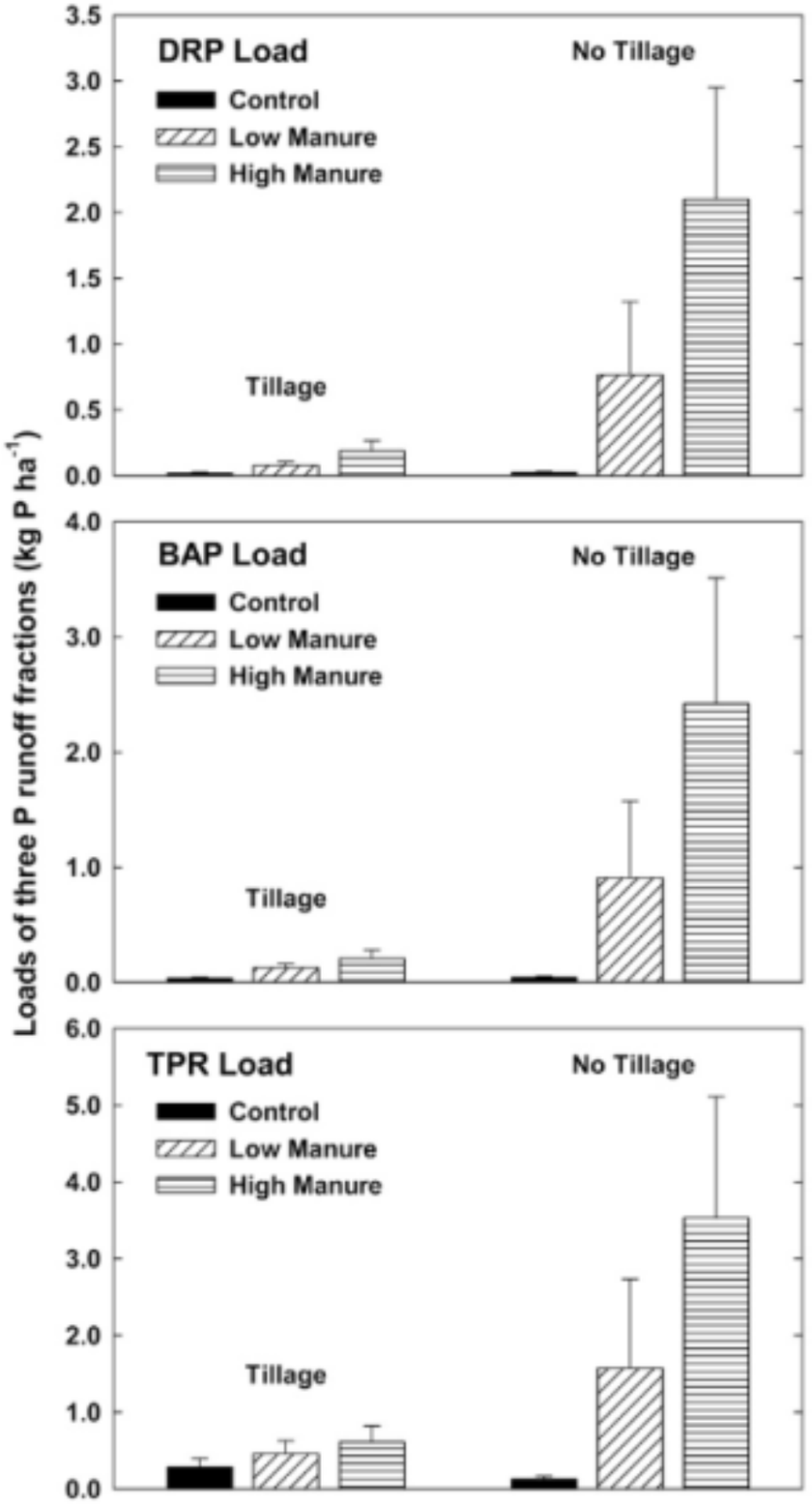




Source: Daverede et al., 2004. Journal of Environmental Quality 33:1535-1544.

Phosphorus Loss

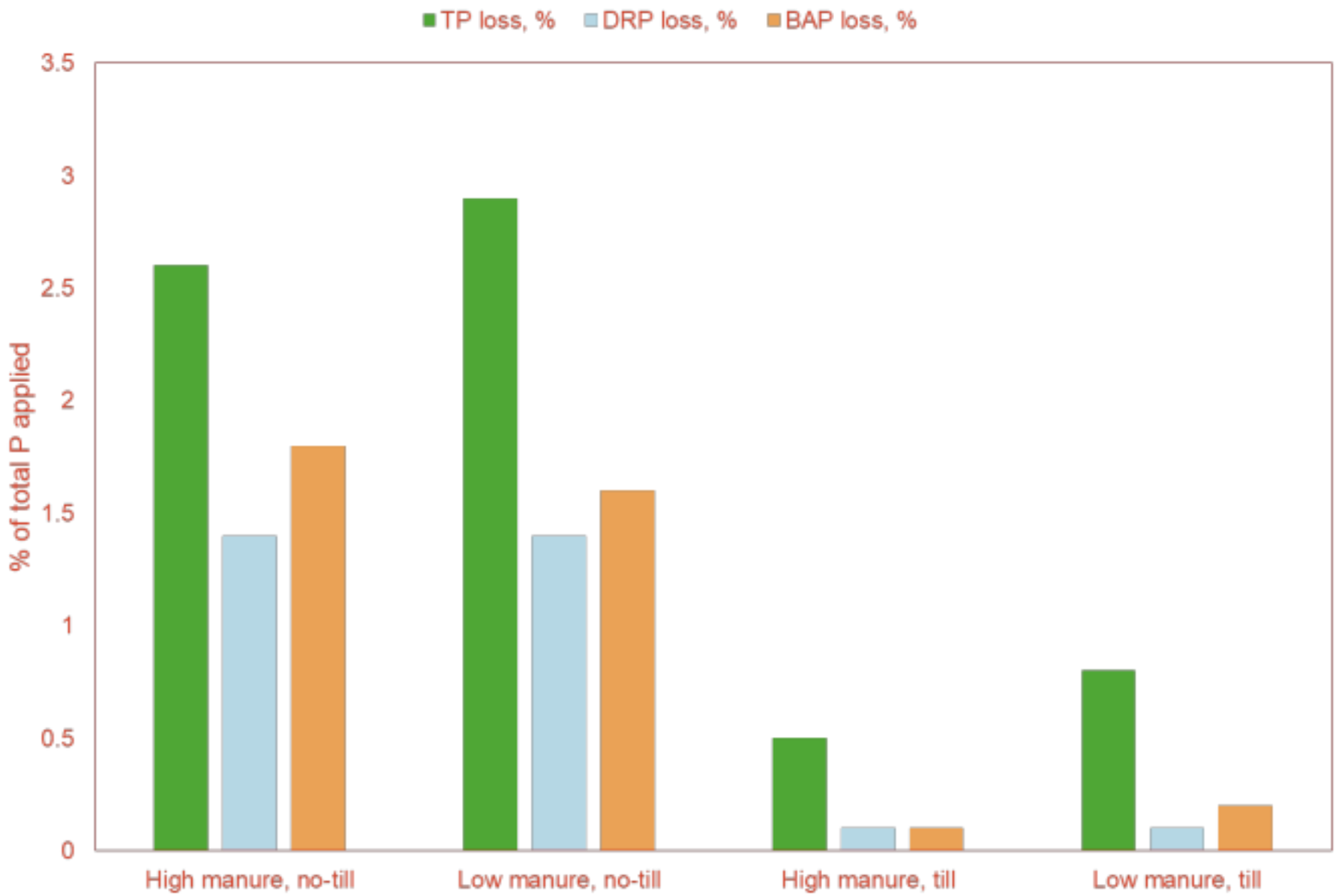
- Incorporation of manure versus surface application
  - Tillage done with disk harrows (3 locations), chisel plow (1 location), and rotary tiller (4 locations)



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

Phosphorus Loss

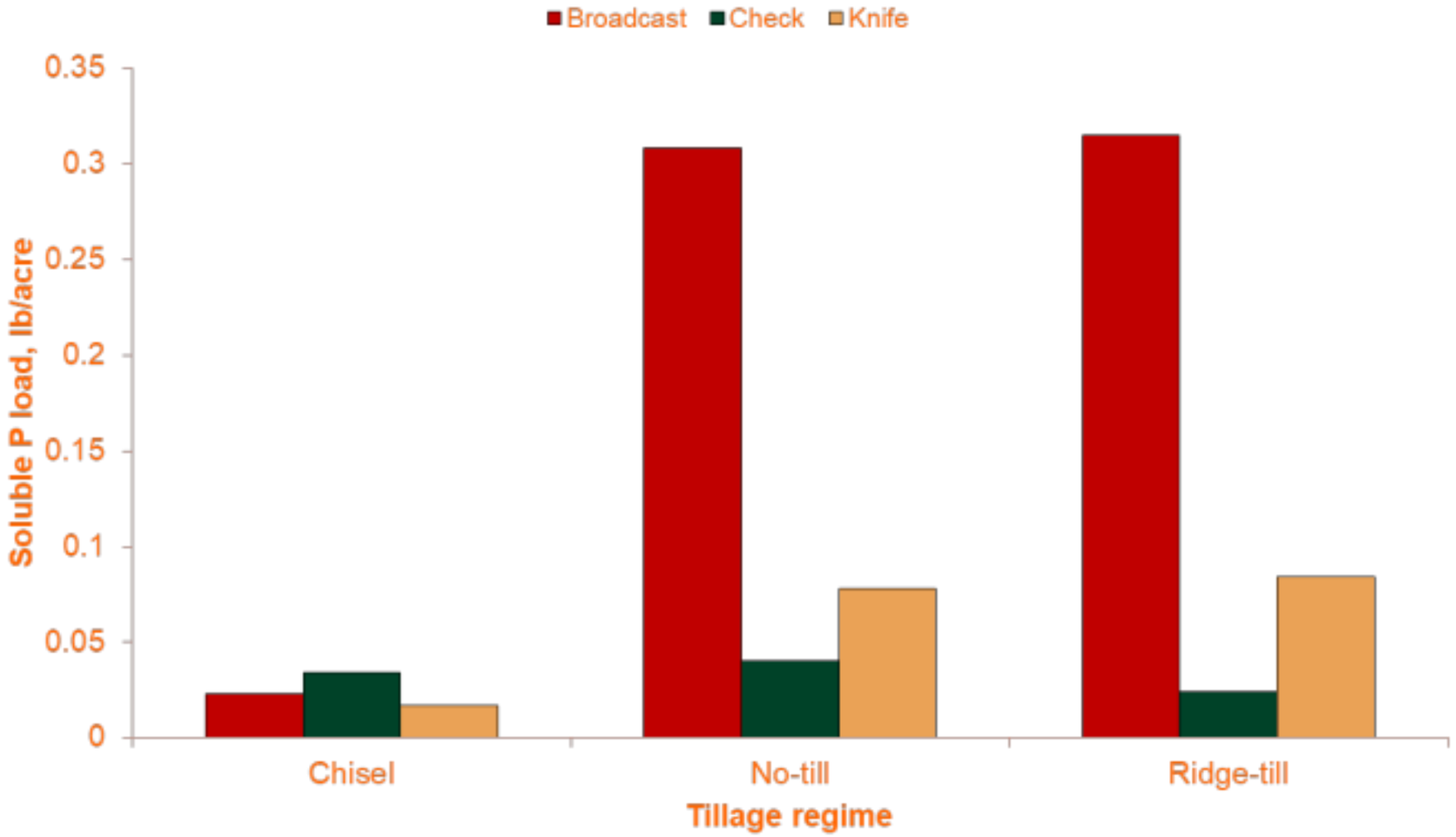
Looking at the previous study another way



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.

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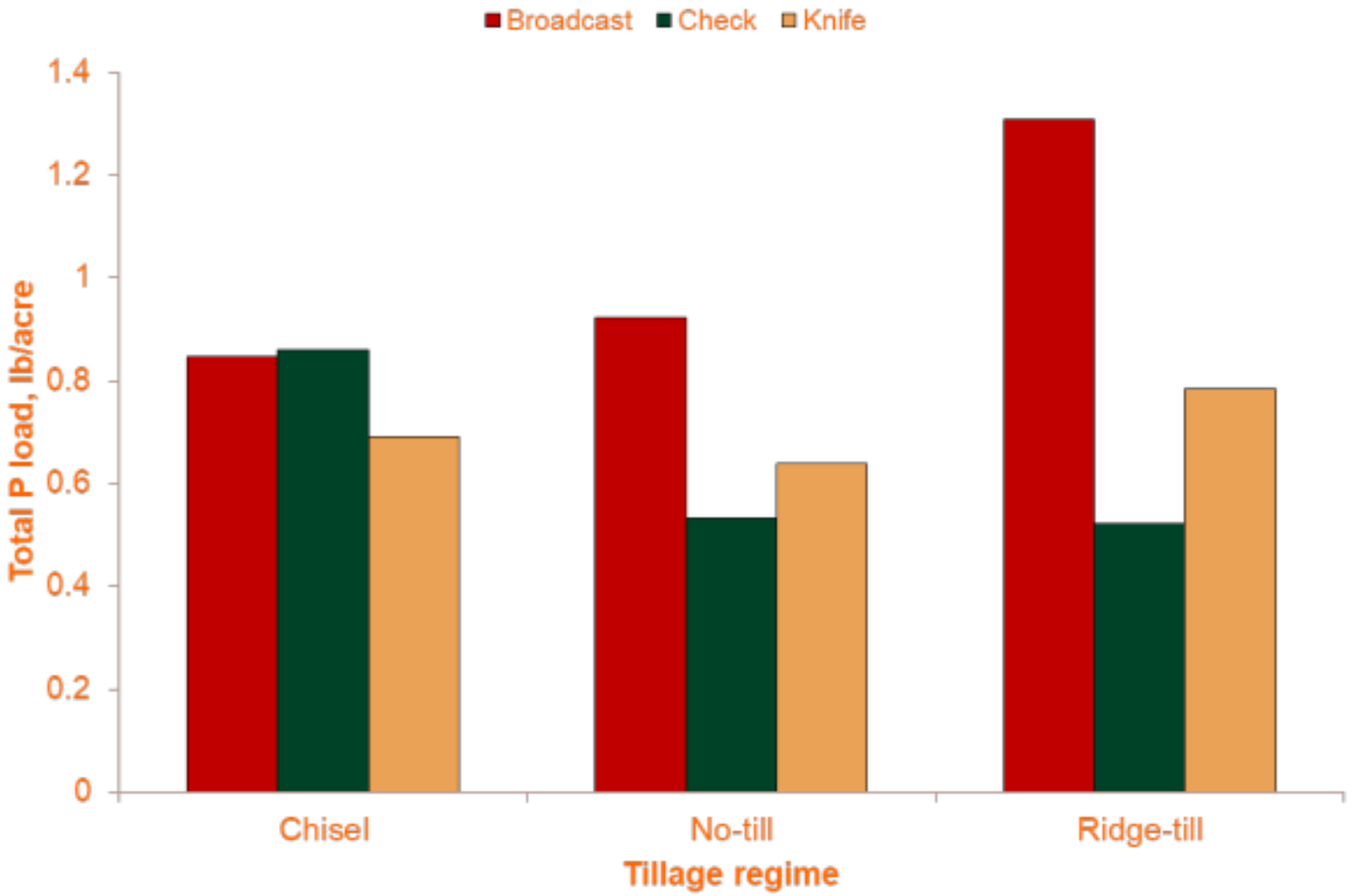
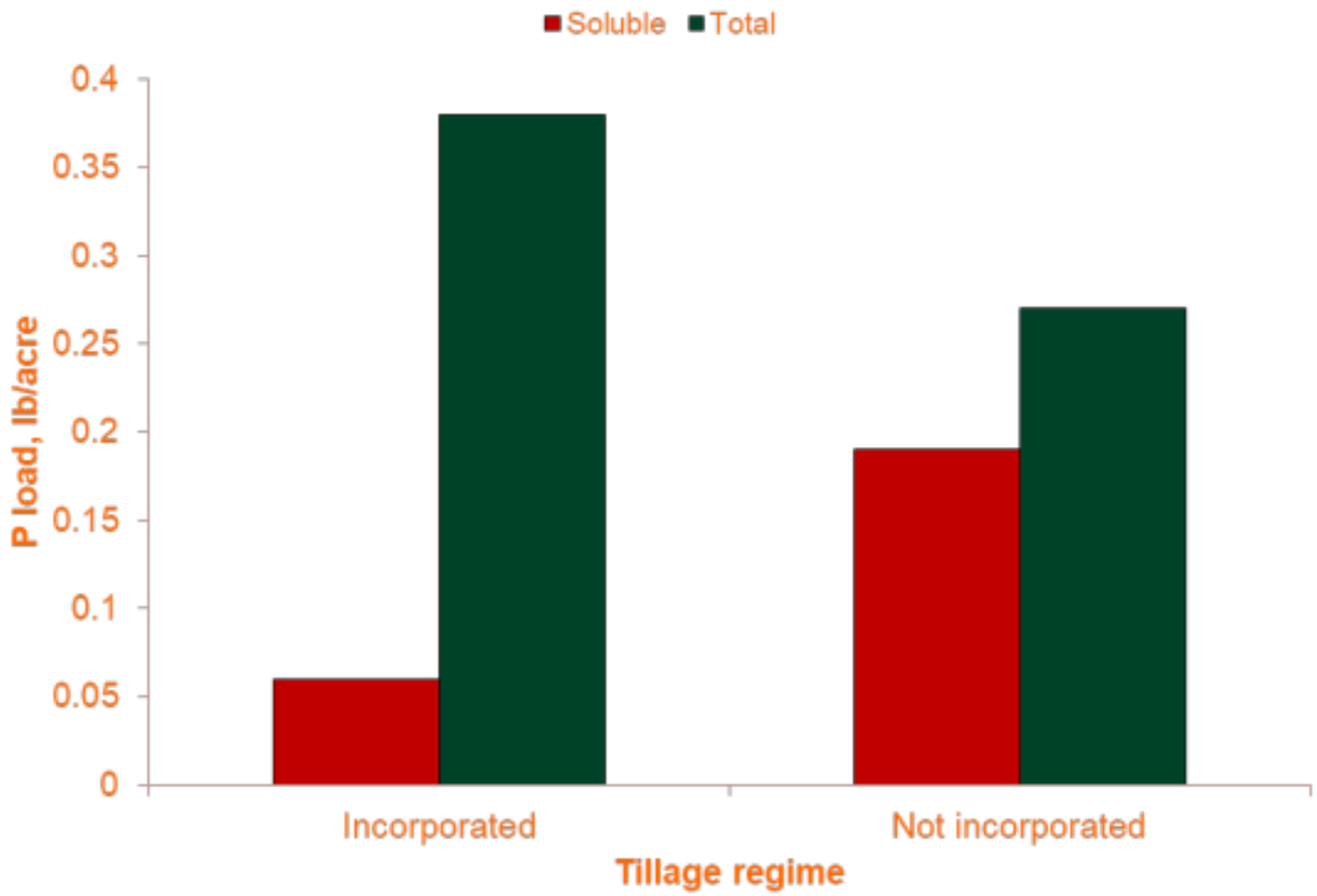


Source: Kimmel et al., 2001. Journal of Environmental Quality 30:1324-1330.

Phosphorus Loss

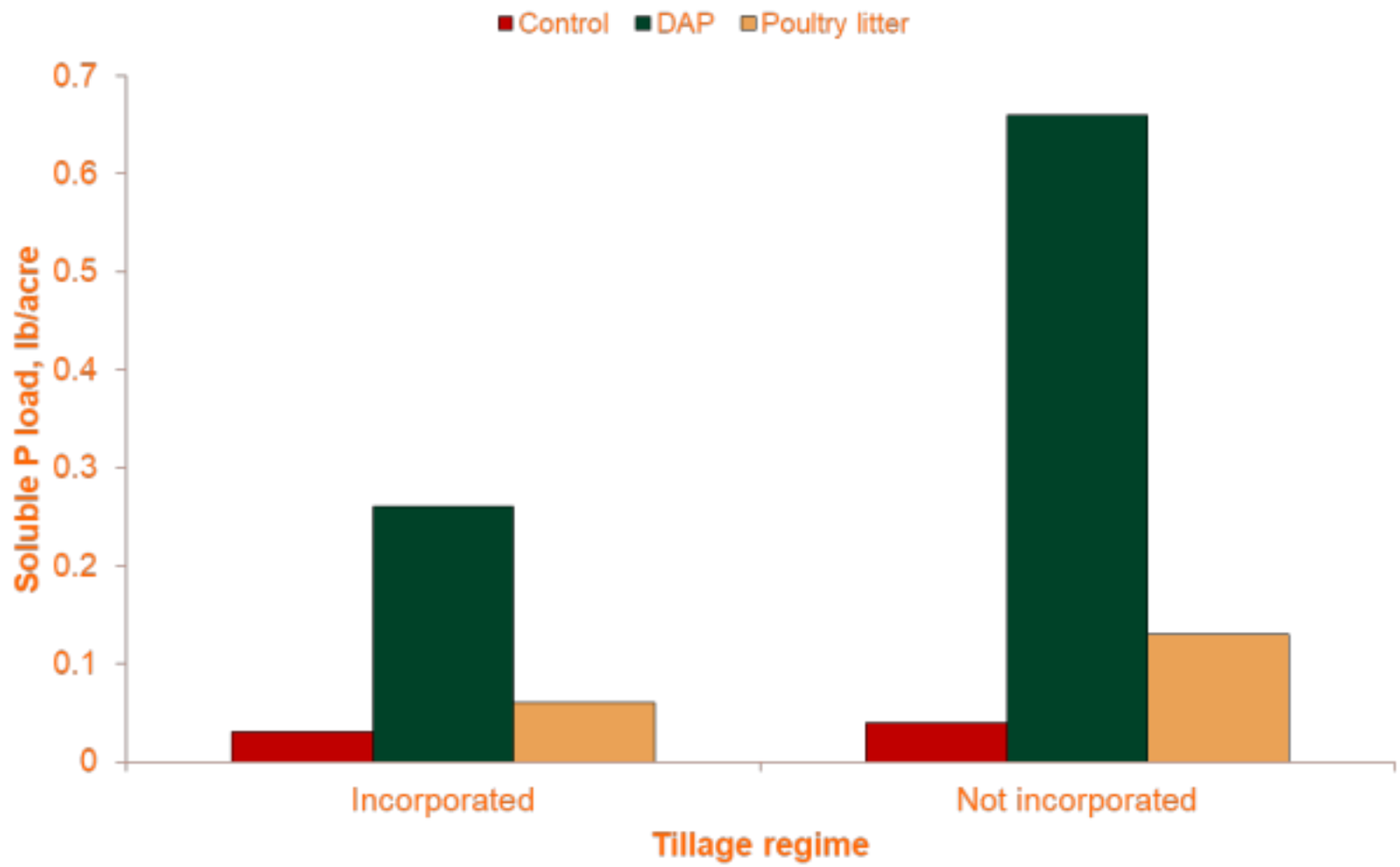
- Incorporation versus surface application
  - Two fertilizer materials (commercial and poultry litter) (conducted in Wauseon)



Source: Ohio State field research

Phosphorus Loss

- Incorporation versus surface application
  - Conducted at NWARS



Source: Ohio State field research

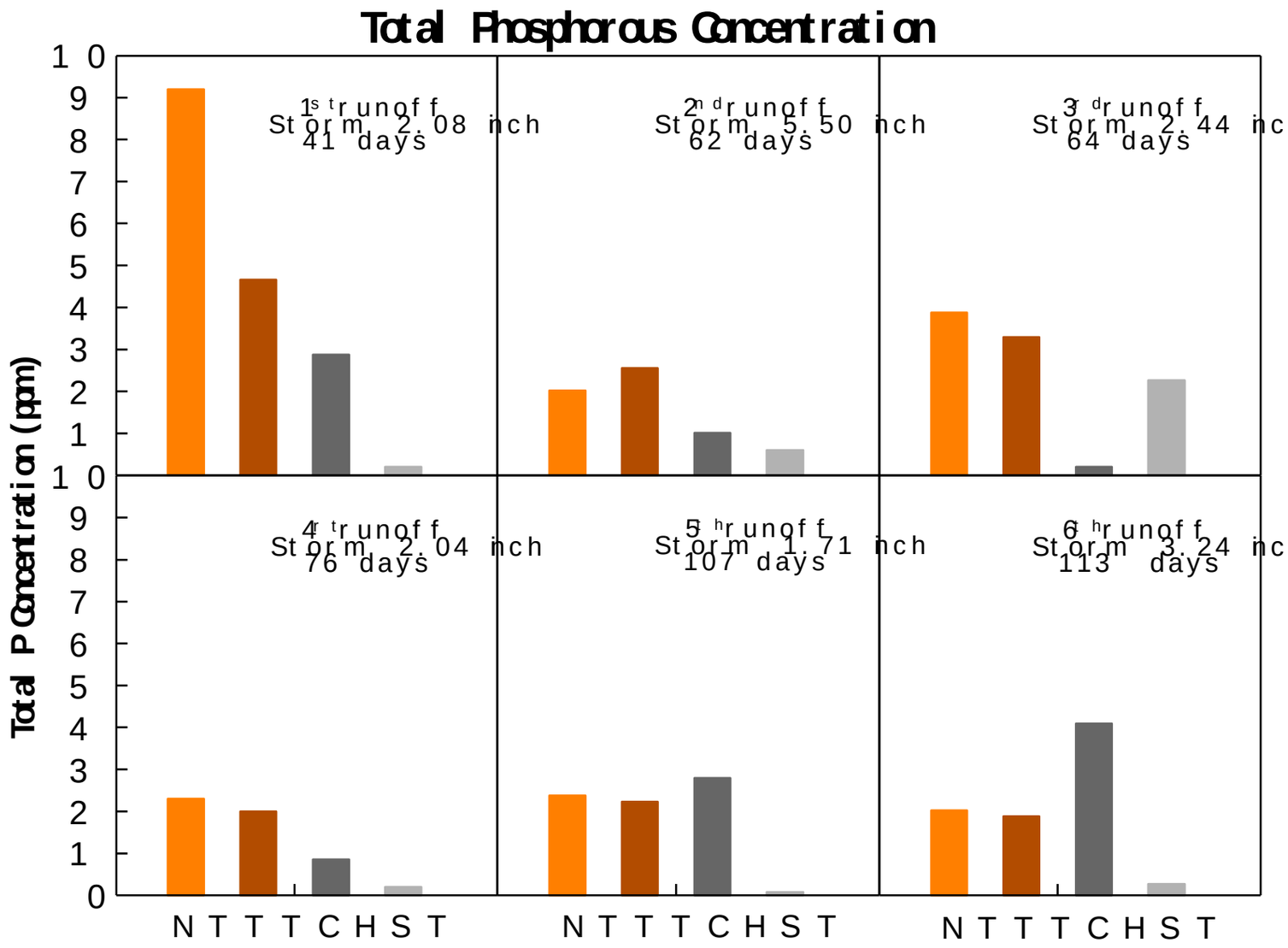
Phosphorus Loss

Table 1. Fertilizer treatments used for rainfall simulations, including the rate of each fertilizer applied, soluble P (SP) lost, and relative loss compared with applied.

Fertilizer source	Placement	Nomenclature	Rate	SP load	Relative loss
			kg ha^{-1}	mg	%
Monoammonium phosphate	Surface	MAP	112	89.3 a	17.4 a
Diammonium phosphate	Surface	DAP	127	84.6 a	16.5 a
Triple super phosphate	Surface	TSP	127	97.3 a	19.0 a
Polyammonium phosphate	Surface	Poly	172	2.1 d	0.17 d
Single super phosphate	Surface	SSP	324	66.8 b	13.0 b
Bone meal	Surface	Bone	417	8.6 d	1.45 d
Rock phosphate	Surface	Rock	1945	3.0 d	0.37 d
Poultry litter	Surface	PL	1459	25.5 c	4.80 c
Unfertilized control	–	Unfert	–	1.2 d	–
MAP	Banded	Sub/MAP	112	1.8 d	0.13 d
Poly	Banded	Sub/Poly	172	1.5 d	0.07 d
PL	Banded	Sub/PL	1459	4.0 d	0.57 d

Source: Smith et al., Ag & Environ. Letters, 2016.

Importance of Intensity of Rainfall Events



Source: Josh McGrath, University of Kentucky (research he did in Maryland)

Summary

- Managing two different fractions
- Particulate P
  - Conservation tillage keeps soil in place
  - Manages particulate P transport quite well

Summary

- Dissolved P (as a result of fertilization)
  - Surface applications without incorporation (except maybe liquid sources – at least poly?) can increase dissolved P transport because fertilizer has less interaction with soil
  - Applications that place fertilizer material below soil surface are preferred
  - Knife/injection will decrease transport potential (at least for surface flow), but this can create other issues (soil testing specifically)

Thank you

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