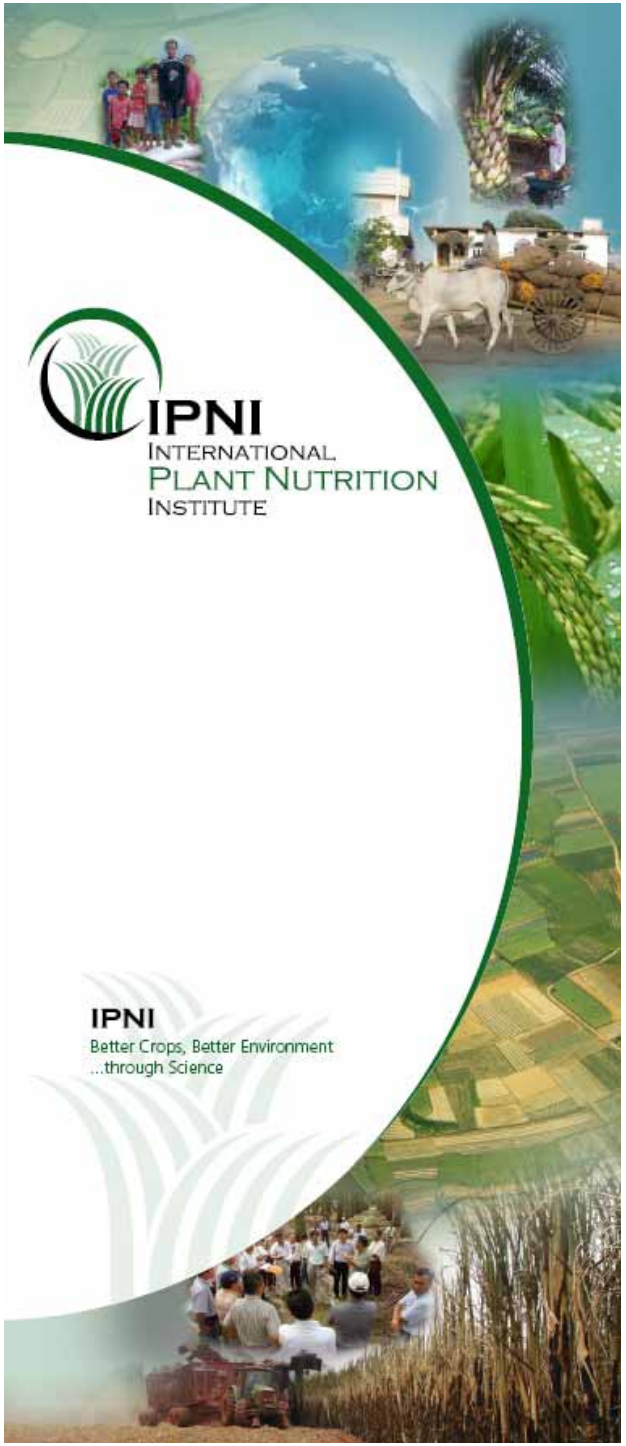
Economic Use of Immobile Nutrients

T. Scott Murrell
Director, North American Programs

8th Annual Nutrient Management Conference, Morton, MN. 9 Feb. 2016.



Outline

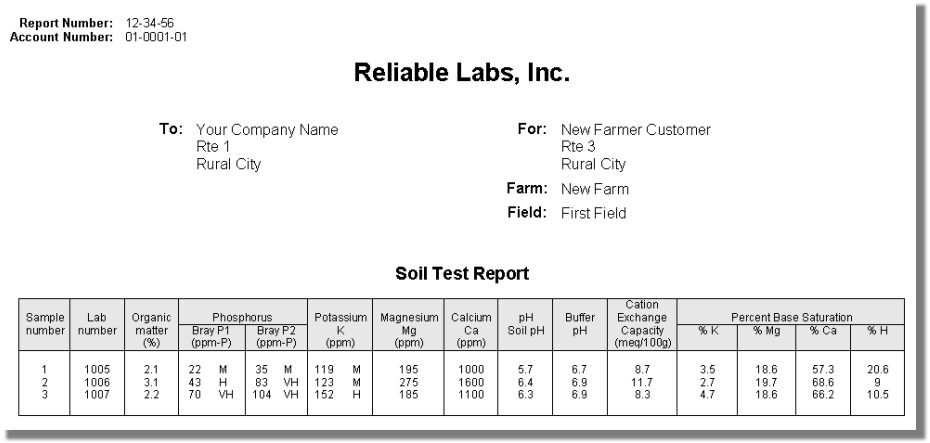
- What are the risks if I skip an application?
- What will happen to soil tests if I skip an application?
- How can I get the most from banded P applications?

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

What are the risks if I skip an application?

What information does a soil test provide?

- An index of the amount of plant-available nutrients in the soil



Report Number: 12-34-56
Account Number: 01-0001-01

Reliable Labs, Inc.

To: Your Company Name
Rte 1
Rural City

For: New Farmer Customer
Rte 3
Rural City

Farm: New Farm

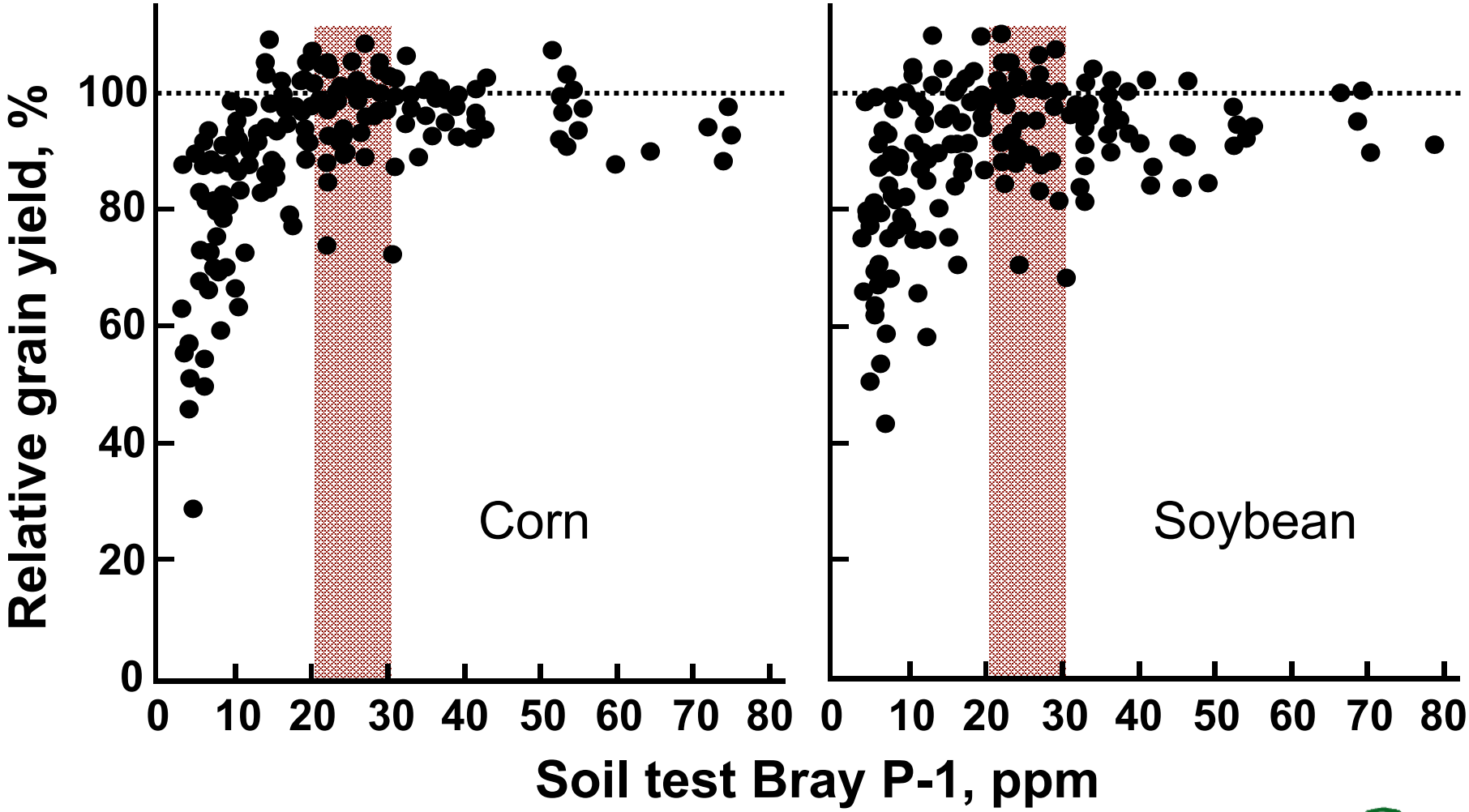
Field: First Field

Soil Test Report

Sample number	Lab number	Organic matter (%)	Phosphorus Bray P1 (ppm-P)	Phosphorus Bray P2 (ppm-P)	Potassium K (ppm)	Magnesium Mg (ppm)	Calcium Ca (ppm)	pH Soil pH	Buffer pH	Cation Exchange Capacity (meq/100g)	Percent Base Saturation % K	% Mg	% Ca	% H
1	1005	2.1	22 M	35 M	119 M	195	1000	5.7	6.7	8.7	3.5	18.6	57.3	20.6
2	1006	3.1	43 H	83 VH	123 M	275	1600	6.4	6.9	11.7	2.7	19.7	68.6	9
3	1007	2.2	70 VH	104 VH	152 H	185	1100	6.3	6.9	8.3	4.7	18.6	66.2	10.5

- This index must be correlated to yield response:
  - Examine responses to nutrient additions at various soil test levels
  - Conduct studies across a wide range of soil test levels and environmental conditions

Examples of Correlation to Yield Response:
Corn and Soybean in Iowa



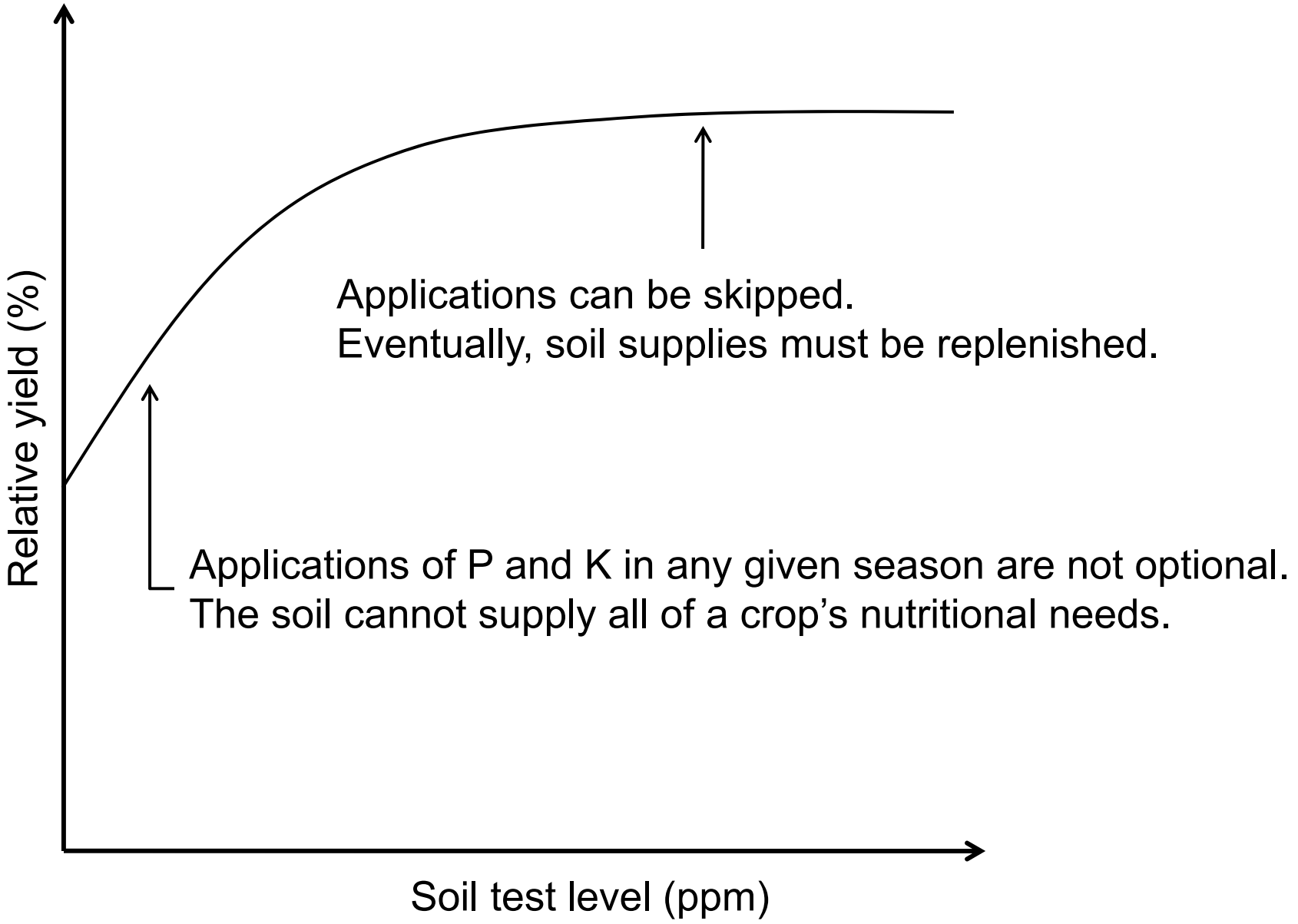
Mallarino, 1999

Probability of Crop Response:
First season after application

Soil test category	Iowa	North Dakota	South Dakota	Wisconsin
	---------- (Probability of response, %) --------			
Very low	80	> 80	> 80	> 90
Low	65	50 - 80		60 - 90
Medium/Optimum	25	20 - 50	40 - 60	30 - 60
High	5	10 - 20		5 - 30
Very high	< 1	< 10	< 20	2 - 5

Iowa: Mallarino et al. 2013. Iowa State Univ. Coop. Ext. Bull. PM 1688.
North Dakota: Franzen, D. 2013. North Dakota State Univ. Coop. Ext. Bull. SF882 (Revised).
South Dakota: Gerwing, J. and R. Gelderman. 2005. South Dakota State Univ. Coop. Ext. Bull. EC750.
Wisonsin: Laboski et al. 2006. Univ. Wisconsin Coop. Ext. Bull. A2809.

IPNI


Relative yield (%)
Applications can be skipped.
Eventually, soil supplies must be replenished.
Applications of P and K in any given season are not optional.
The soil cannot supply all of a crop's nutritional needs.
Soil test level (ppm)

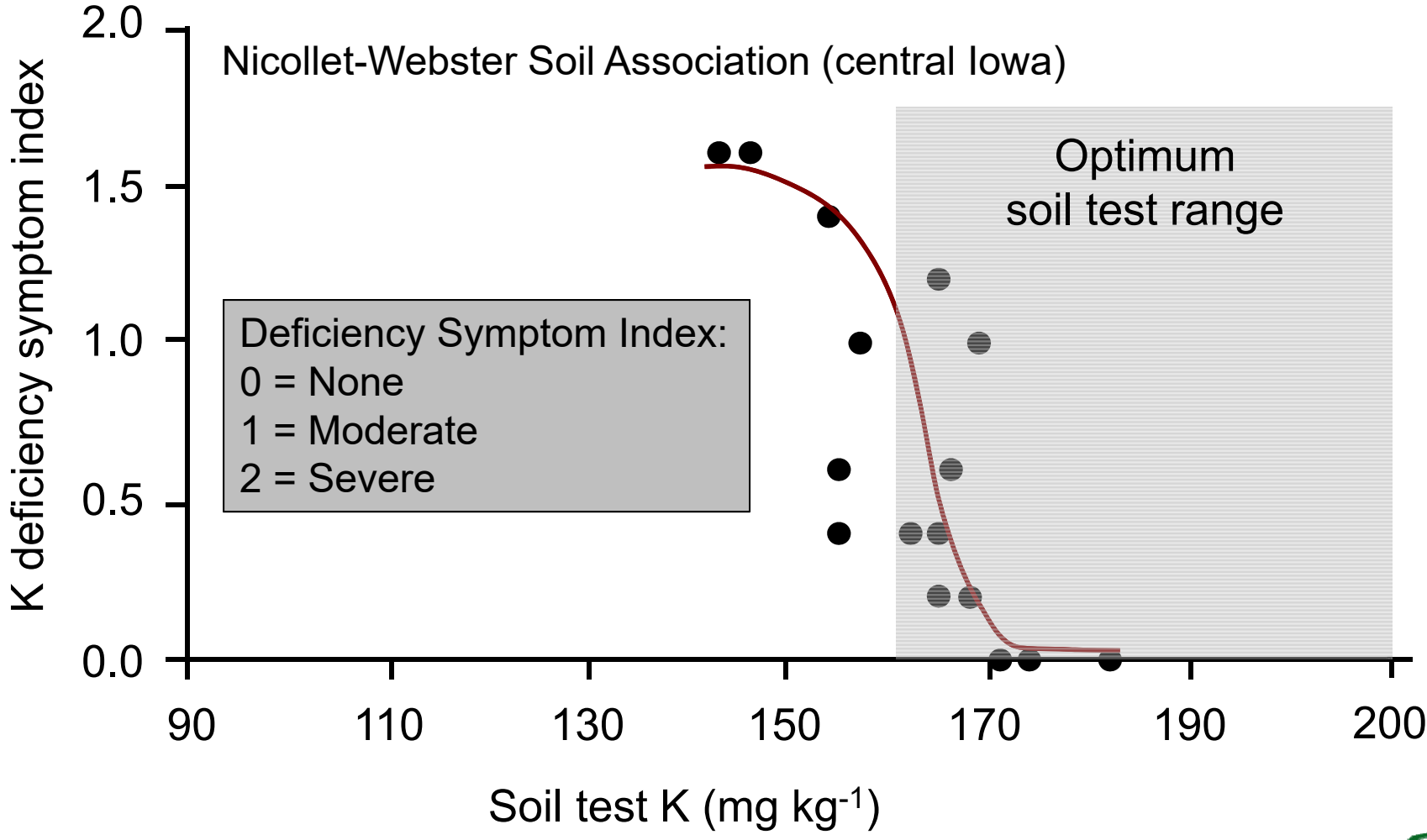
Variable Target Soil Test Levels (ppm)

	Duration of land use (years)		
Capital	1	4	More than 8
Very limited	4	14	20
Limited	6	16	21
Available	9	18	22

Based on PKMAN modeling approach with a visual interpretation of the Iowa State Univ. calibration data for corn

Symptoms of K deficiency:
Marginal chlorosis / necrosis on lower leaves

Iowa: Soil test interpretations are consistent with visual evidence

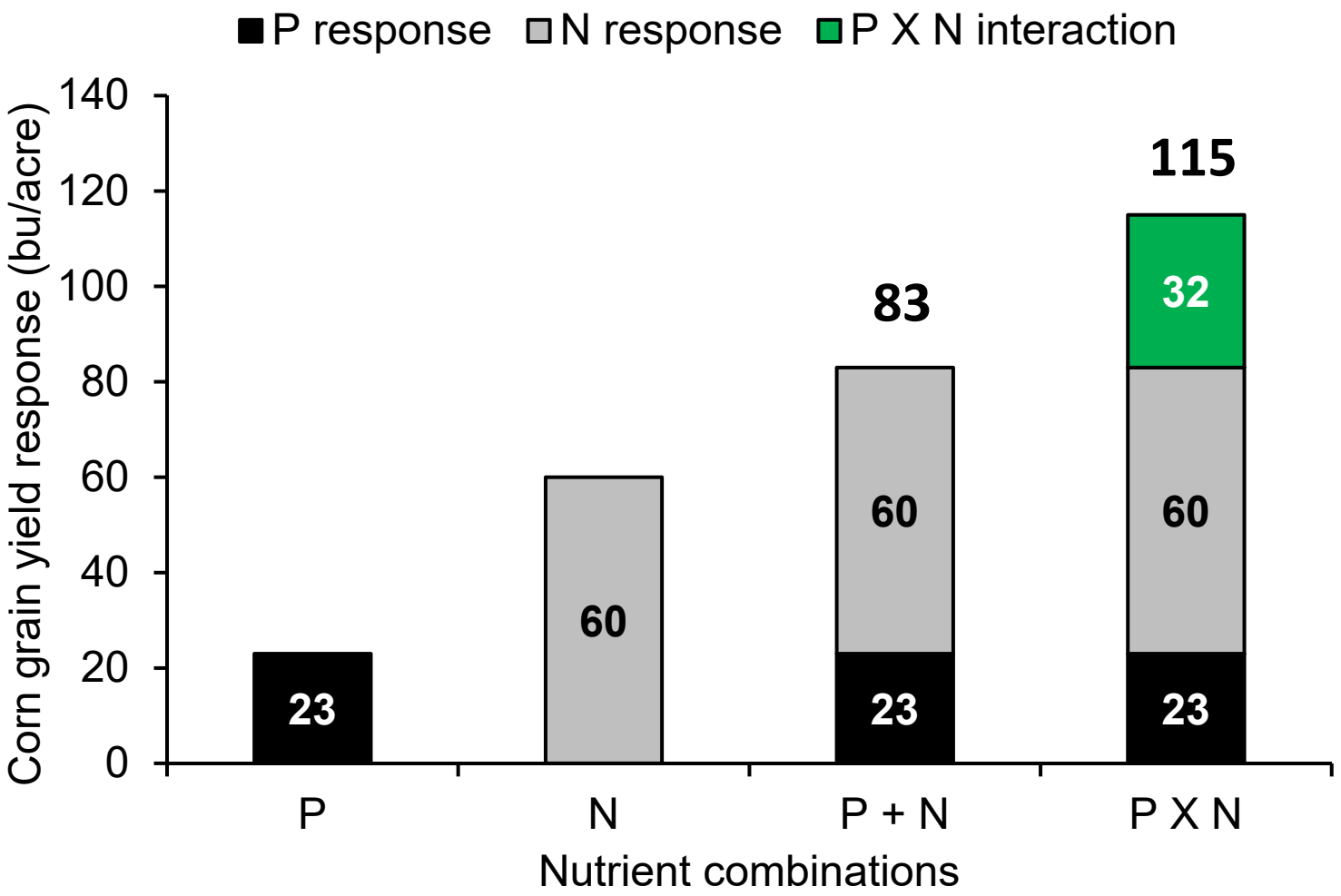


Wittry and Mallarino, Iowa State University

“An interaction takes place when the response of two or more inputs used in combination is unequal to the sum of the their individual responses.”

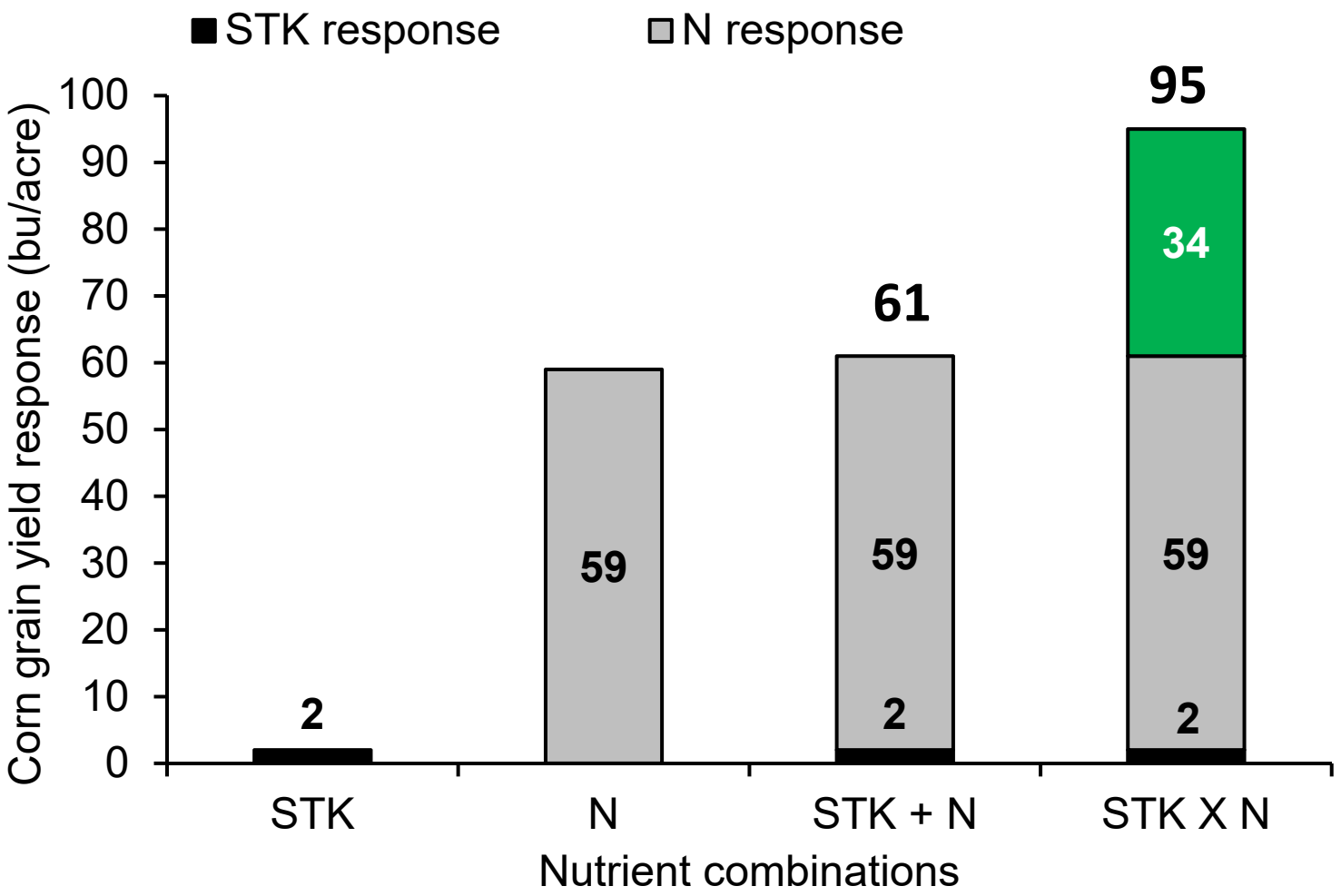
Tisdale, S.L., W.L. Nelson, and J.D. Beaton. p. 52. Soil Fertility and Fertilizers. 4th ed. Macmillan Publ. Co., New York.

Data are from 30th year of a long-term, irrigated study in Kansas
N: 161 lb/acre
P: 40 lb P_2O_5/acre



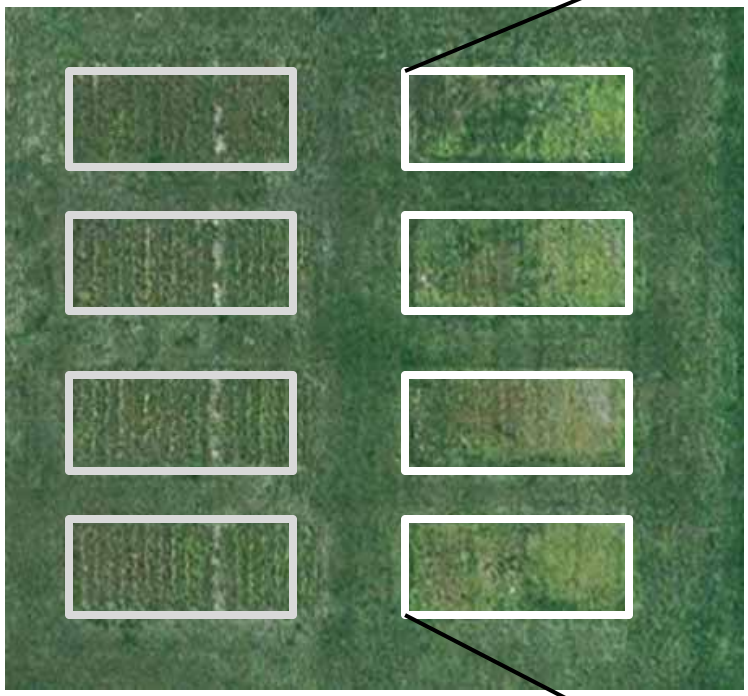
Schlegel et al. 1996. J. Prod. Agric. 9:114-118.

Data are from a 4-yr. rain-fed study in Ohio
Soil test K (STK) was increased from 80 ppm to 116 ppm
N: 240 lb/acre



Johnson et al. 1997. Better Crops 97:3-5.

Experimental design needed to measure the interactive effect of two nutrients



0 N
0 K_2O

Rec. rate of N
0 K_2O

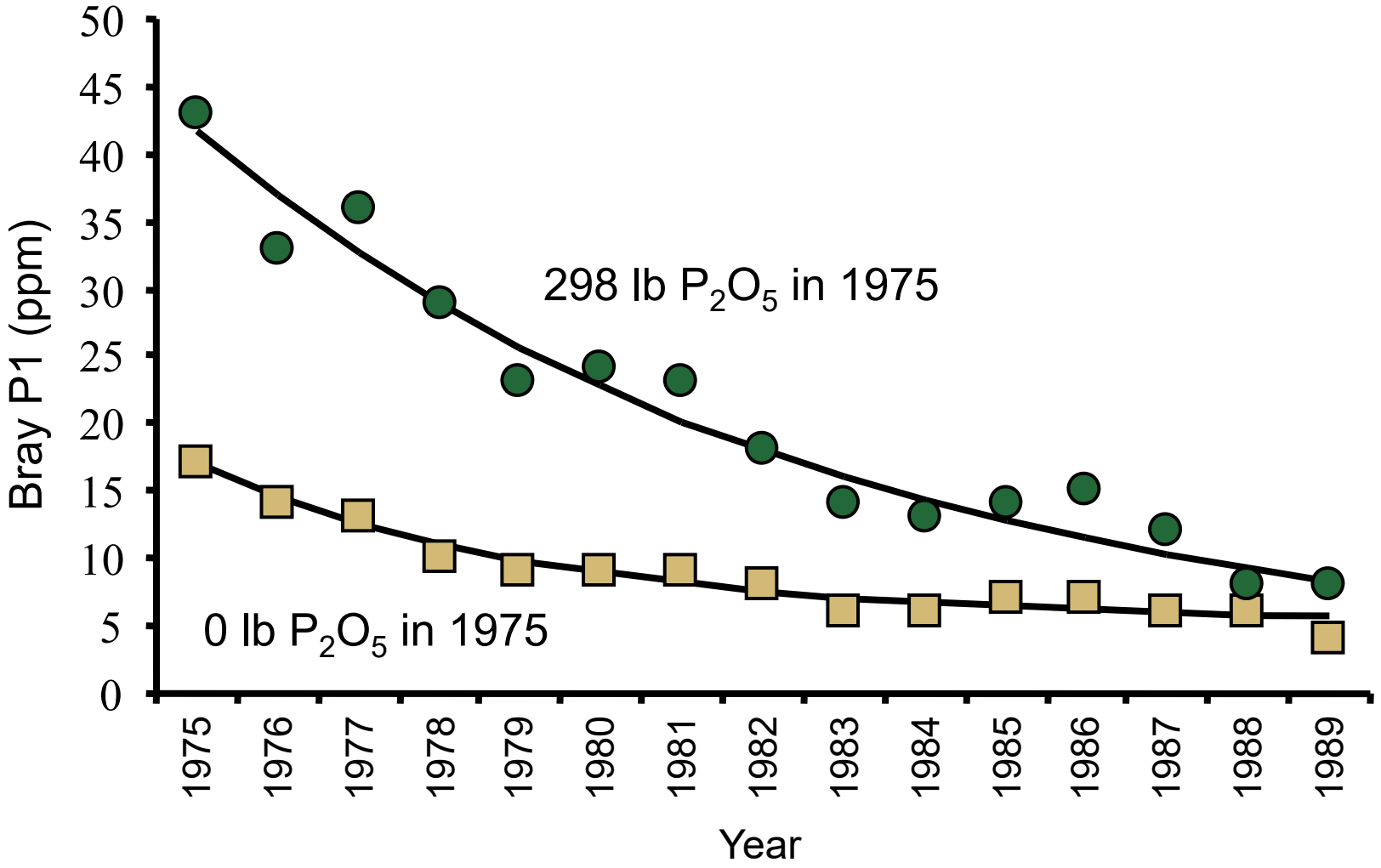
0 N
Rec. rate of K_2O

Rec. rate of N
Rec. rate of K_2O

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

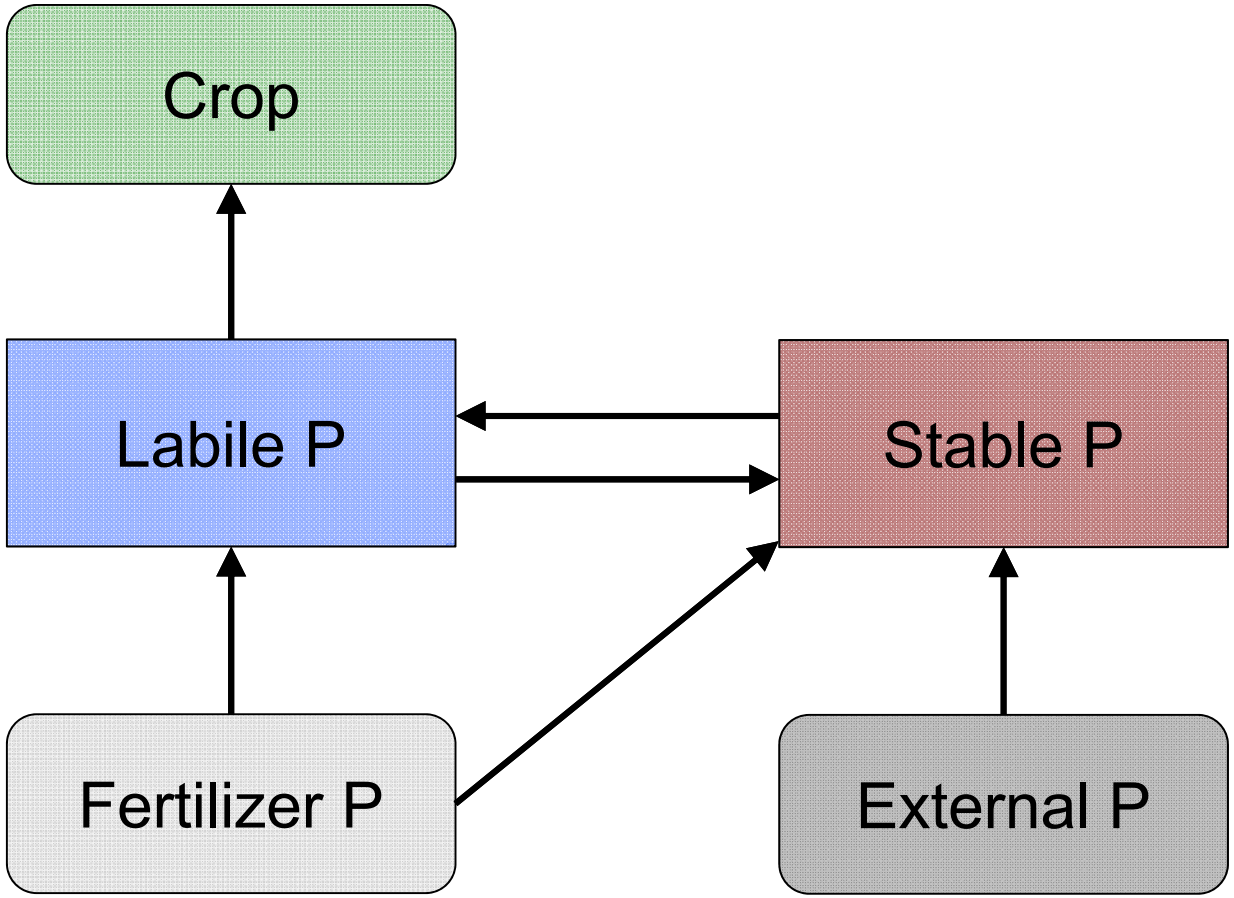
What will happen to soil tests if I skip an application?

How do soil tests change with no applications?



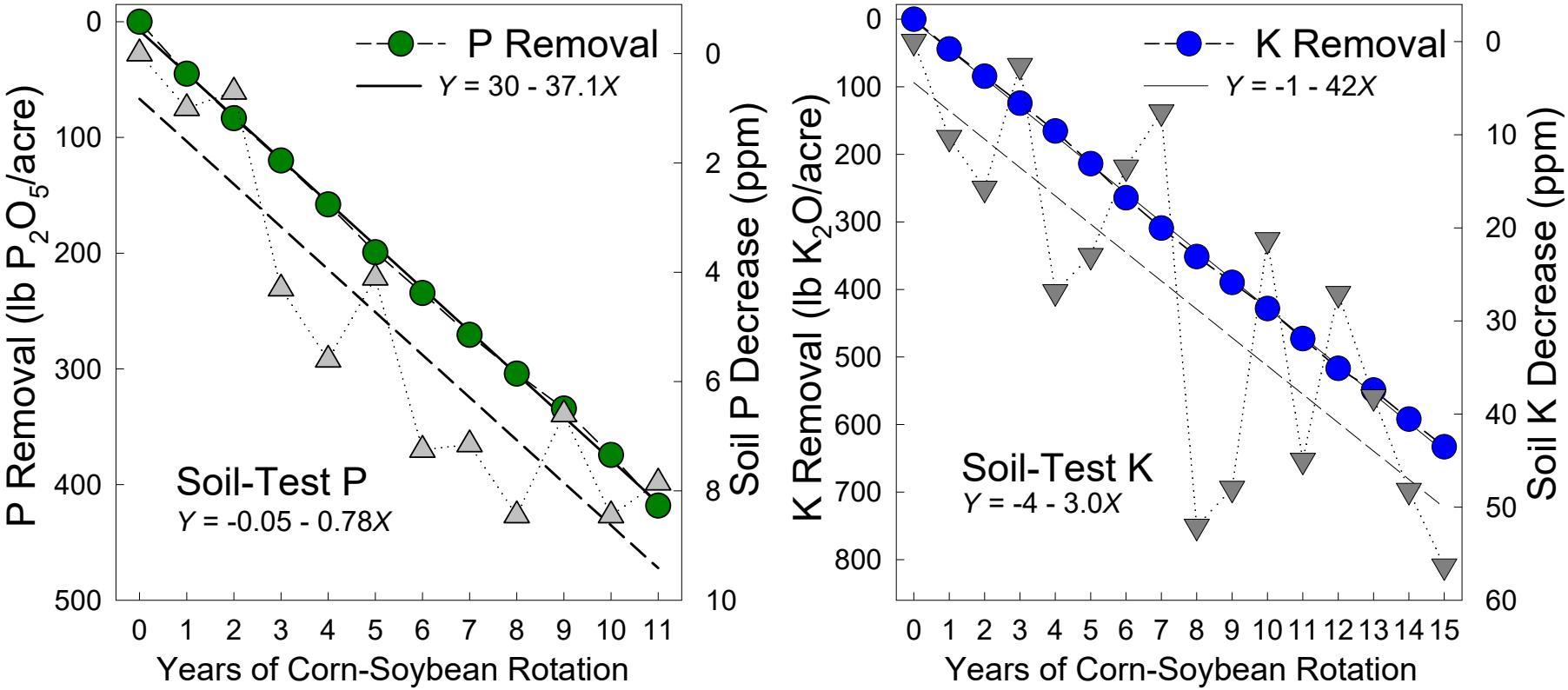
Webb et al., 1992 (Iowa)

Labile and Stable Forms of Phosphorus



Wolf, J. et al. 1987. Agron. J. 79:445-451.

How do soil tests change with no applications?



Villavicencio and Mallarino, 2011

What are the best uses for soil test P information?

—Estimating **average** probabilities of crop response

—Examining changes in levels over time

—Estimating **average** relative yield response

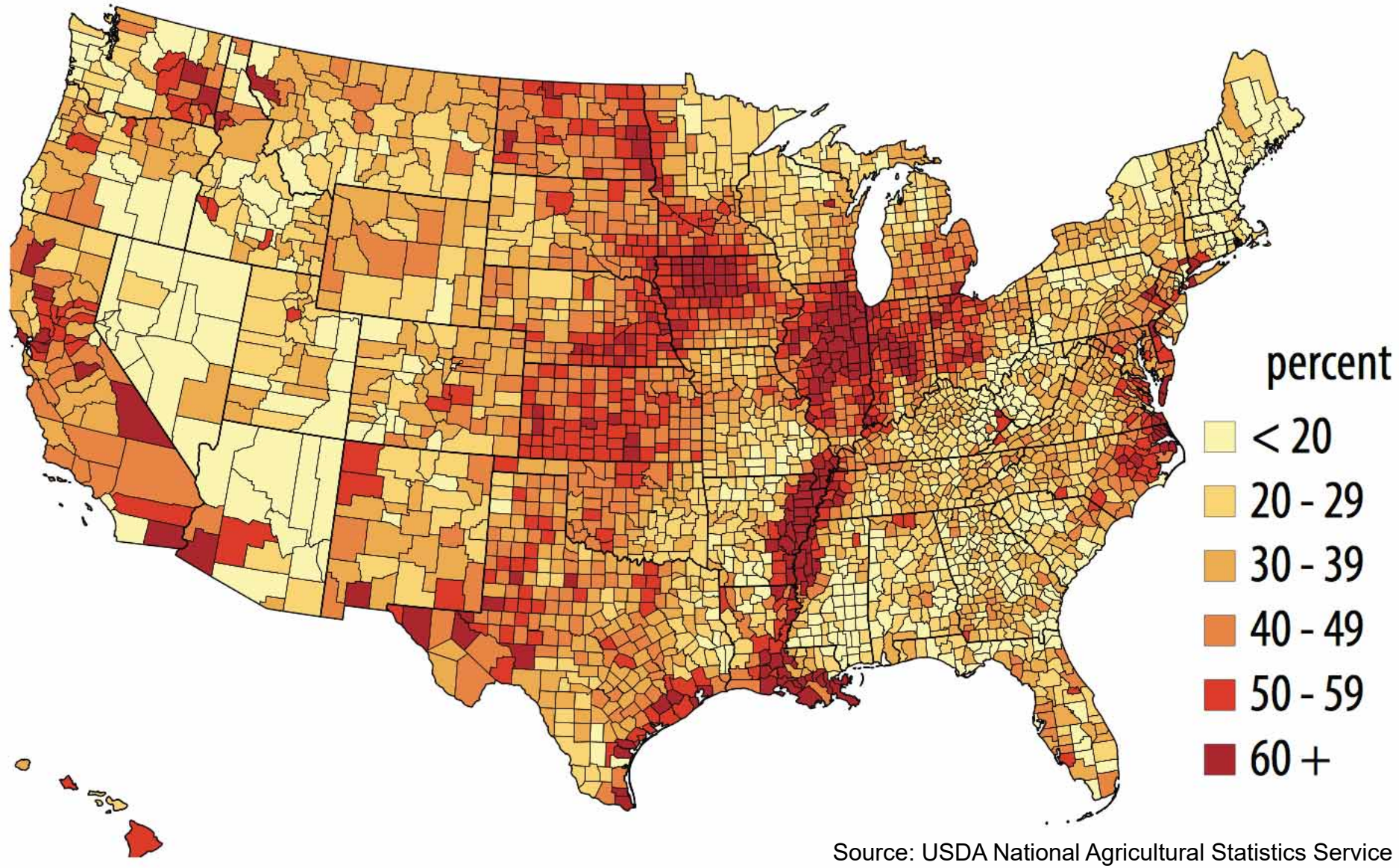
—Estimating a **specific** probability of response for a given site and year

—Estimating a **specific** relative yield response at a given site and year

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

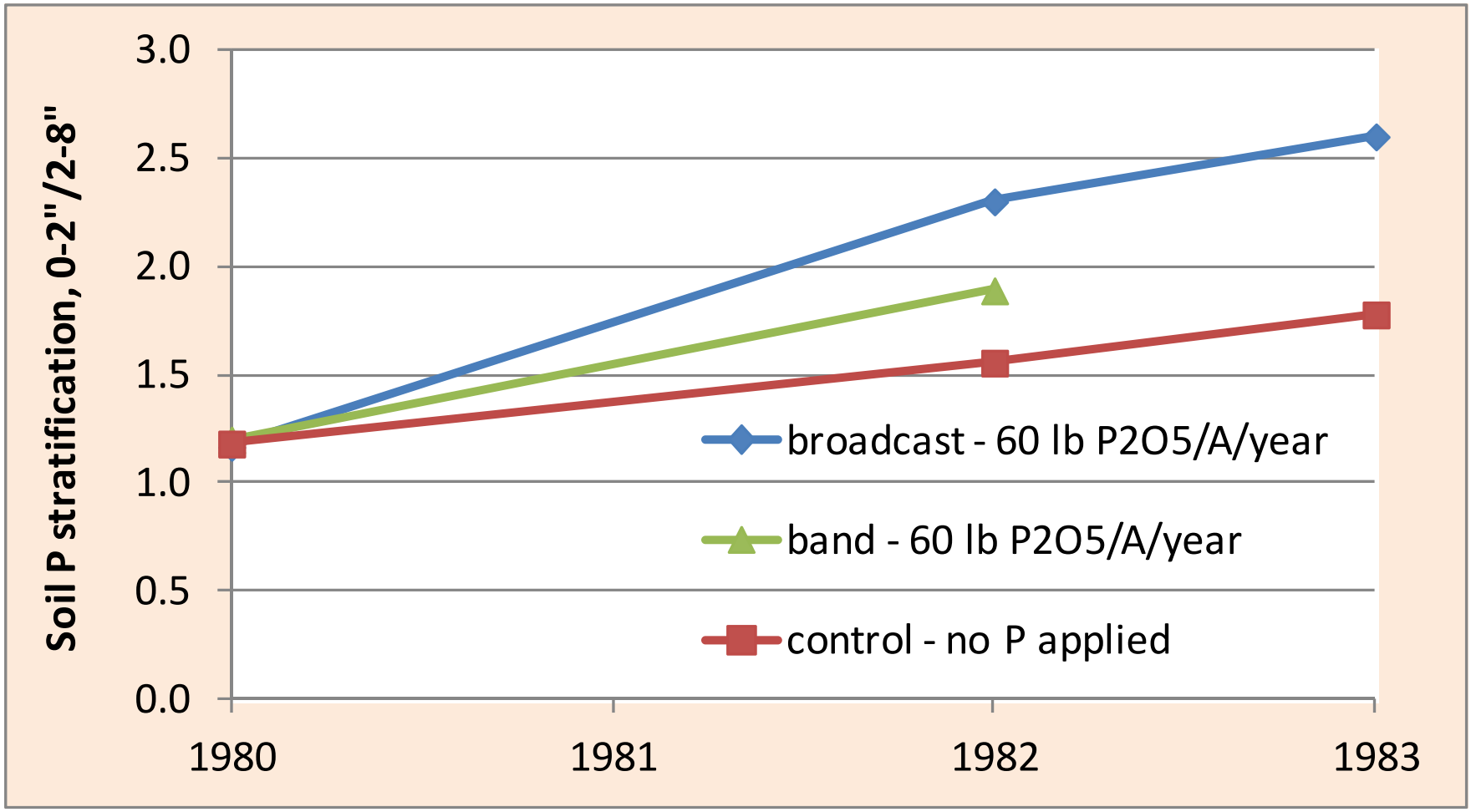
How can I get the most from banded P applications?

Percent of Farmland Rented or Leased
(2012 Ag Census)



Source: USDA National Agricultural Statistics Service

Banding Reduces Soil Test P Stratification



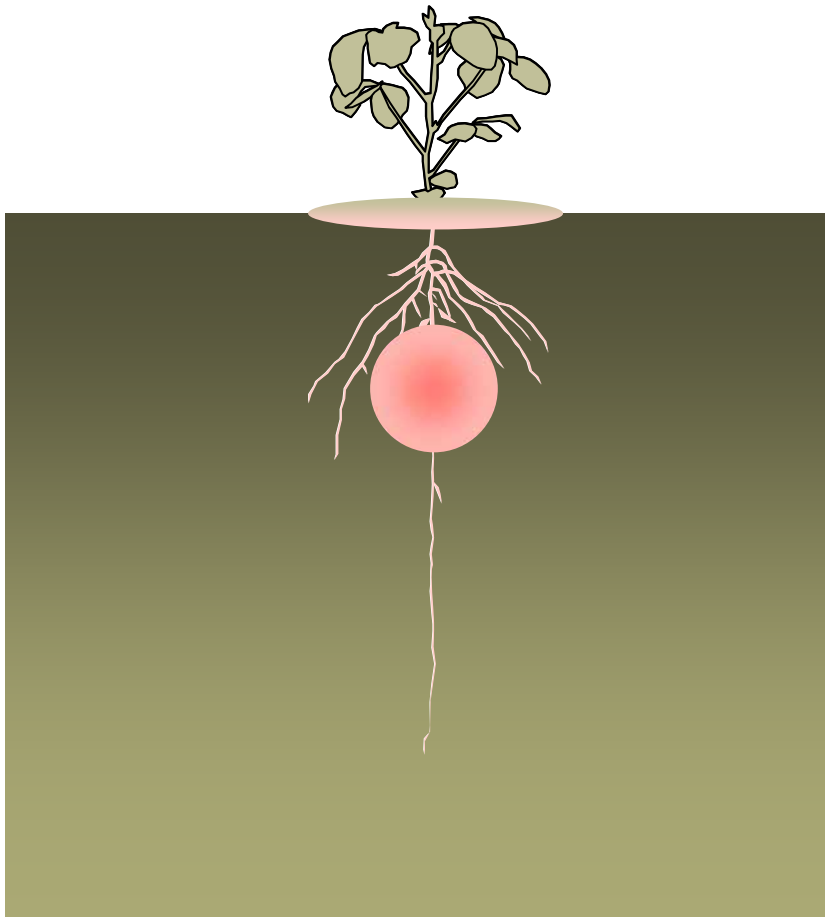
Eckert and Johnson (1985)

Transport of Banded Nutrients

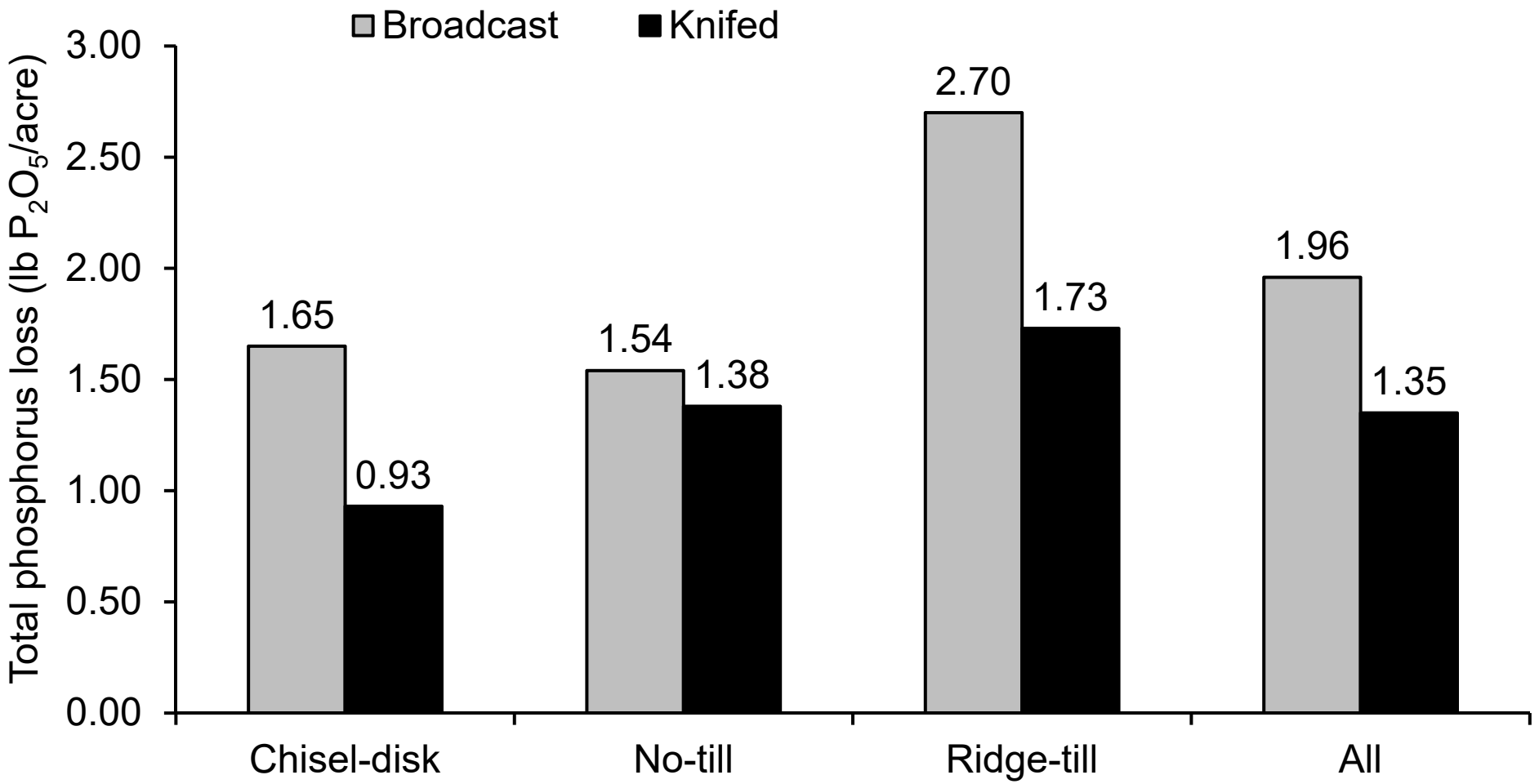
Nutrient uptake

Deposition and leaching

Diffusion



Banding Reduces P Runoff Losses

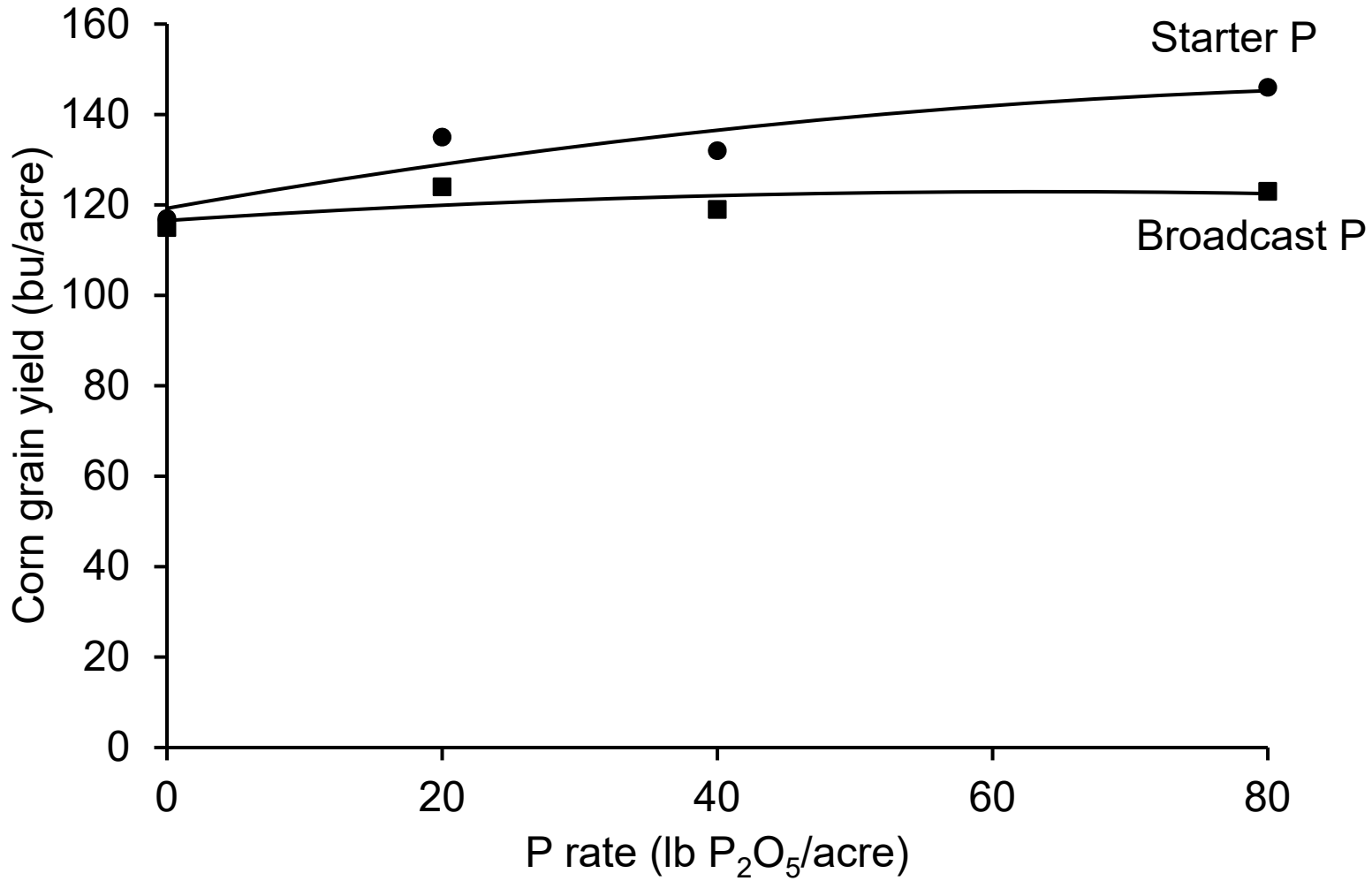


Kimmel et al. 2001. J. Environ. Qual. 30:1324-1330.

Flooding affects next year's P placement decision

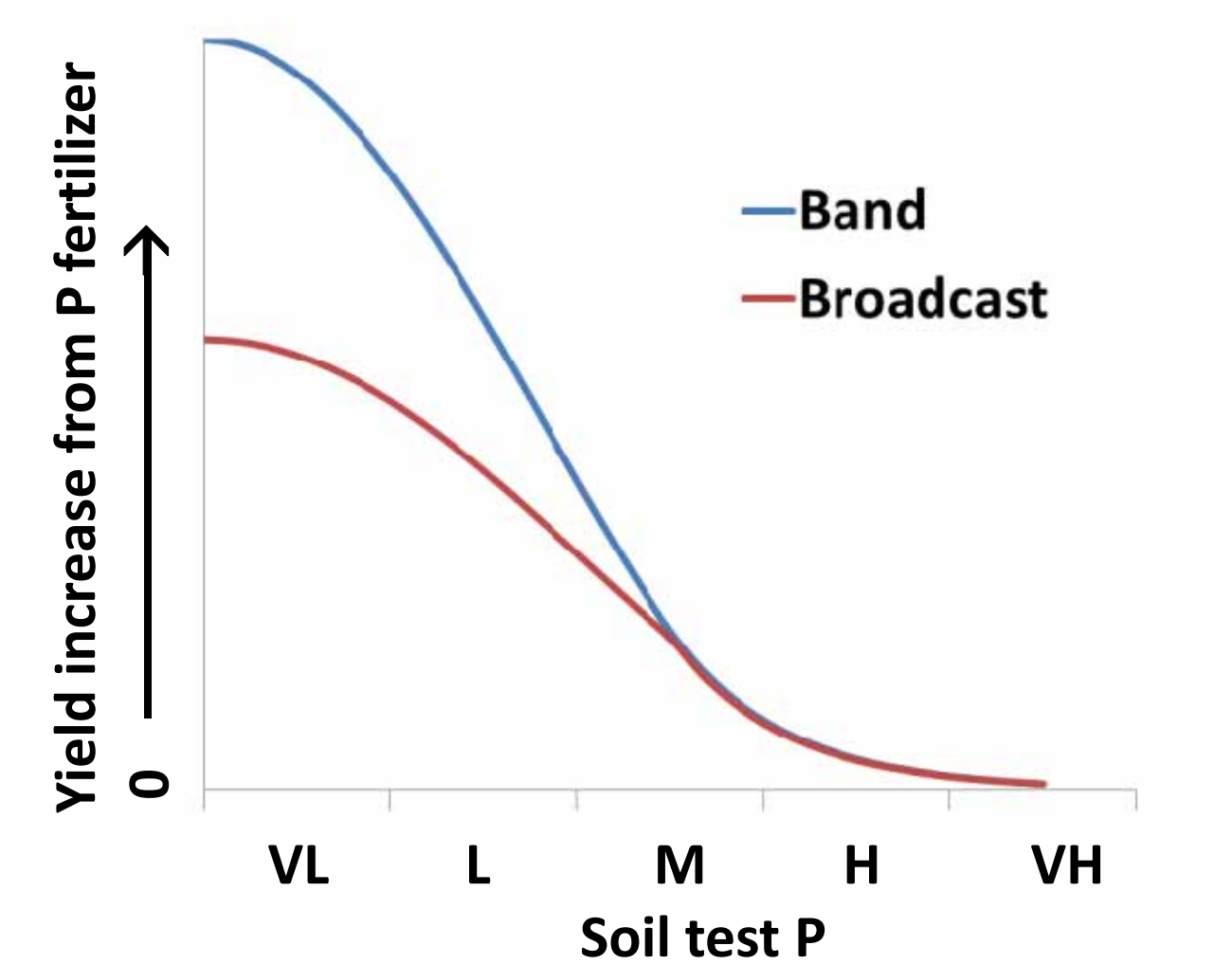
Photo: Keith McCall (NRCS)

Banding Increases Yields after Flooding or Fallow



Fixen et al. referenced by Wetterauer, D.G. and R.J. Killorn. 1996. J. Prod. Agric. 9:39-41.

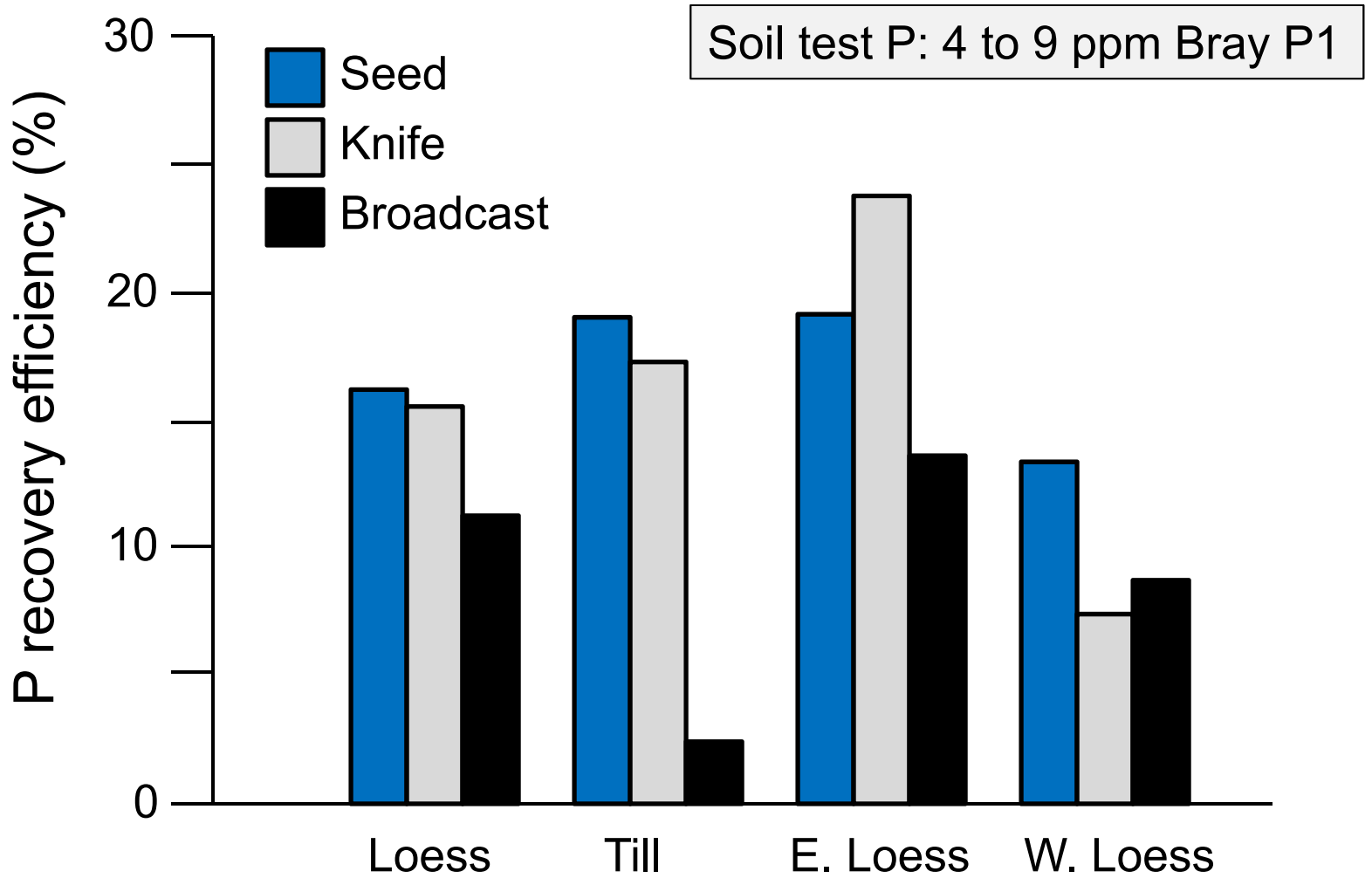
Idealized effect of placement on crop response



Randall and Hoeft, 1988

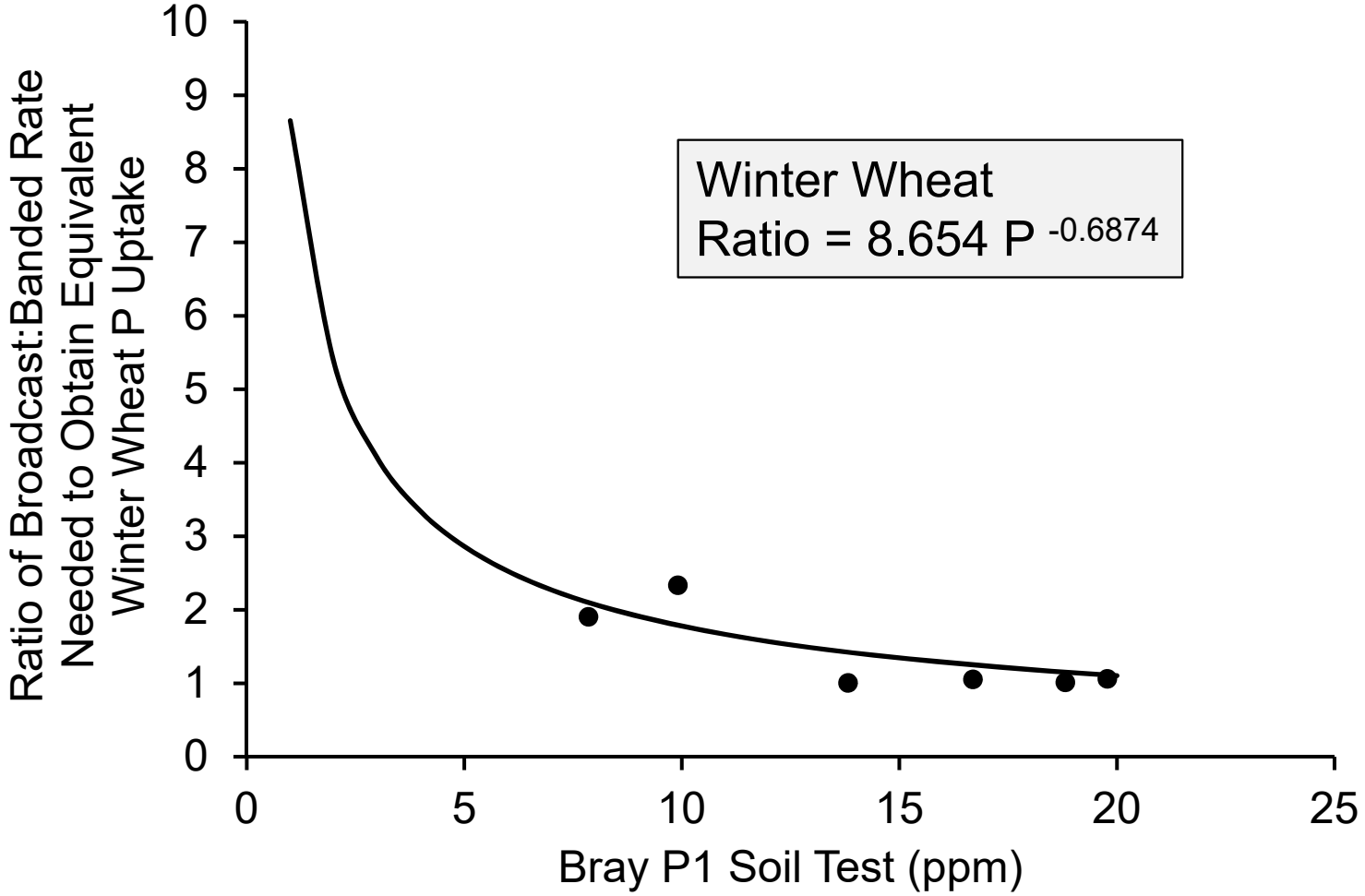
P recovery efficiency:

An example for winter wheat



Sander, D.H. et al. 1991. Soil Sci. Soc. Am. J. 55:1474-1479.

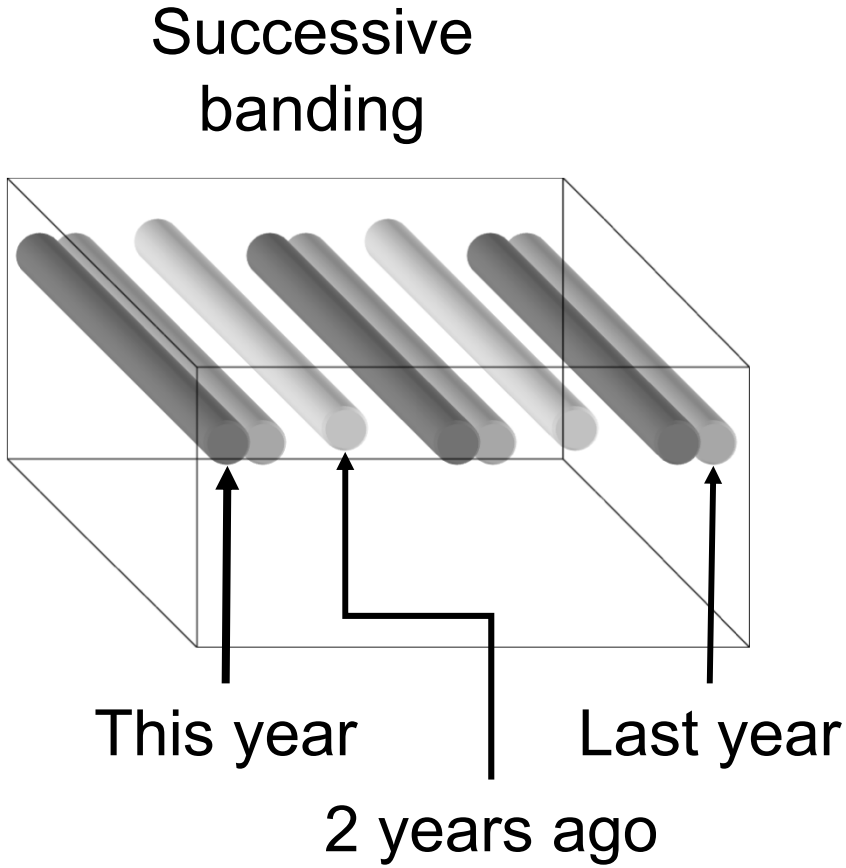
Statistically modeled relationship of broadcast and banded rate comparisons



Peterson, G.A. et al. 1981. Agron. J. 73:13-17.

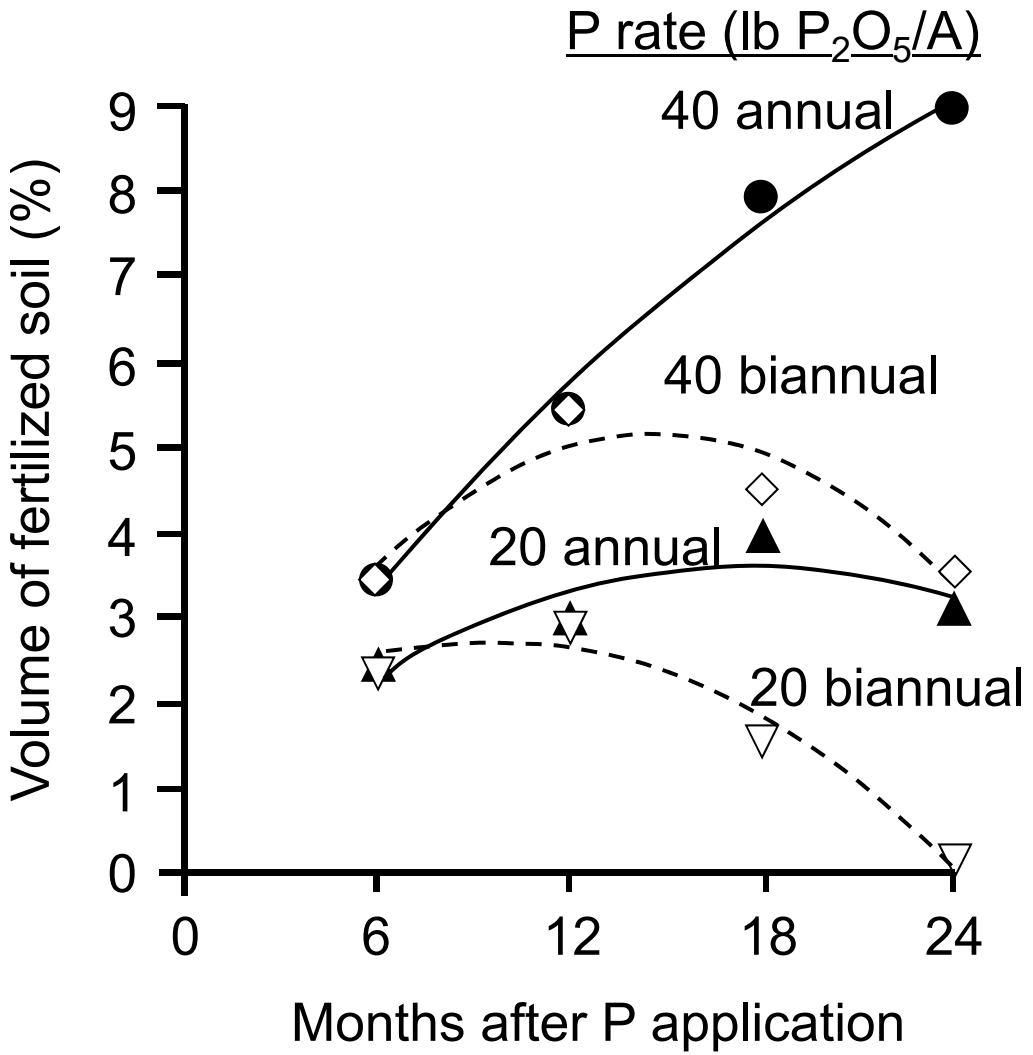
Effects of successive banding

- Effects include:
  - Increasing fertility
  - Positional availability



Impact of successive banding

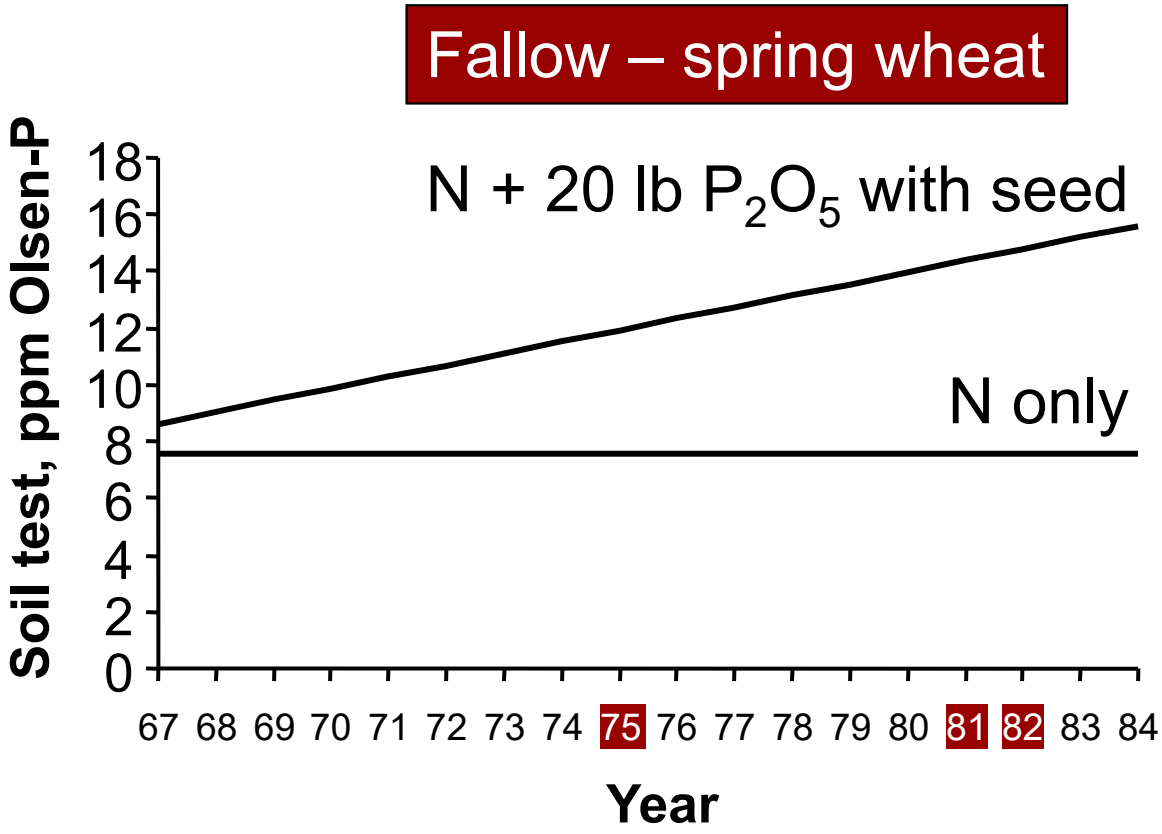
- Mexico silty clay loam soil
- Single 20 lb/A band fertilizes 2.6% of soil volume
- Volume assumed to be additive
- Annual applications stay ahead of volumetric reductions of specific bands over time



Stecker et al., 2001

Residual effects of successive banding

18-yr average wheat yield increase from P banded with the seed was 11.5%



yr = No yield increase from added P

Zentner et al., 1993; Zentner and Campbell, 1988

Summary

- Risks to skipping an application:
  - Economic losses from yield reductions are more likely at lower soil test levels
  - Skipping a P or K application at lower soil test levels may result in a lowered effectiveness of an N application
- What happens to soil test levels if I skip an application?
  - Higher soil test levels decline more rapidly over time than lower soil test levels

Summary

- How can I get the most from banded P applications?
  - Use when soils are low testing
  - Use during unfavorable economic conditions
  - Use after fallow or flooding
  - Use where there are risks of surface runoff
  - Apply in different places over time to fertilize a greater soil volume
  - Apply every season to build fertilized soil volume (increase fertility)