THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

P and K fertilizer recommendations in Ohio from on-farm strip trials

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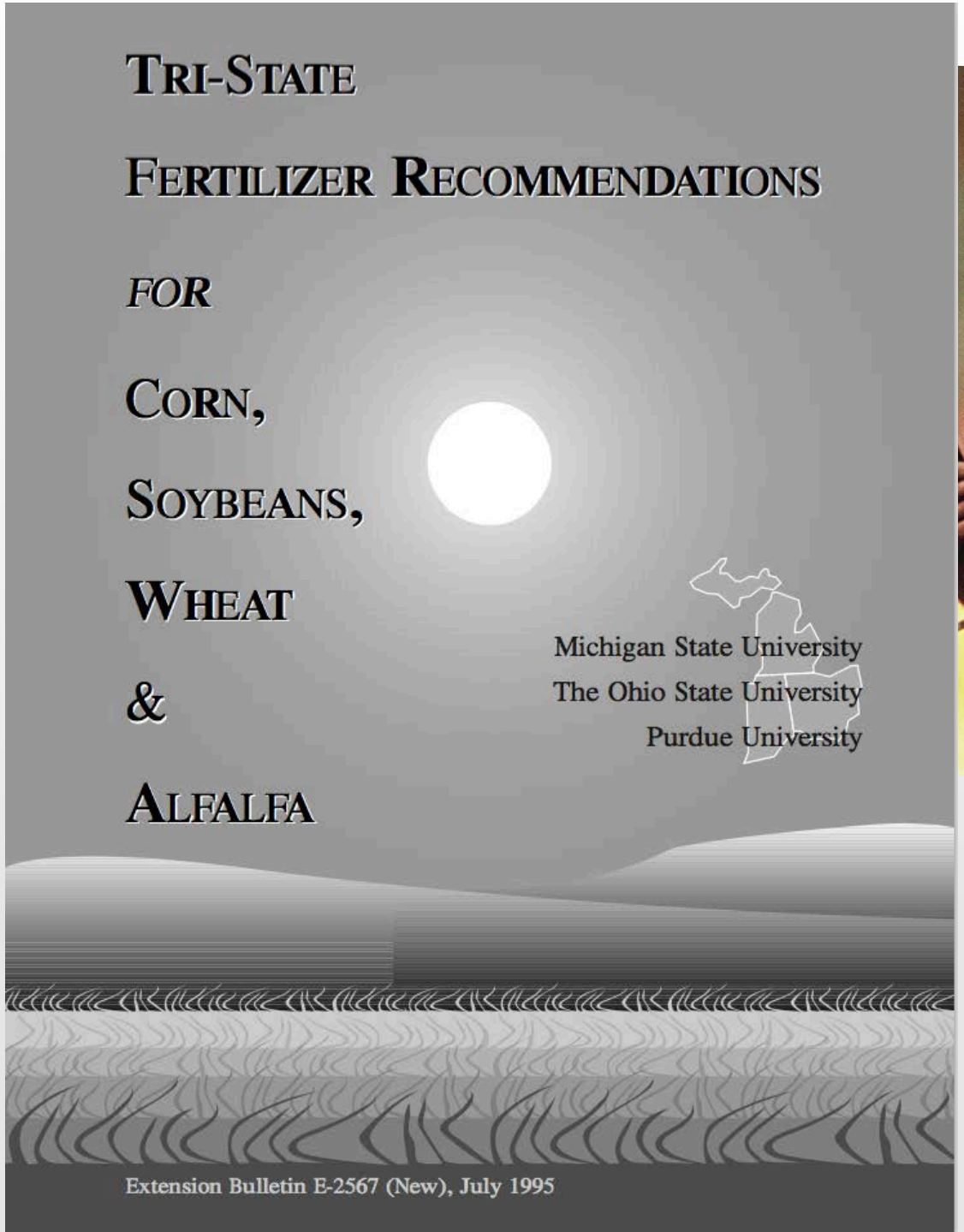
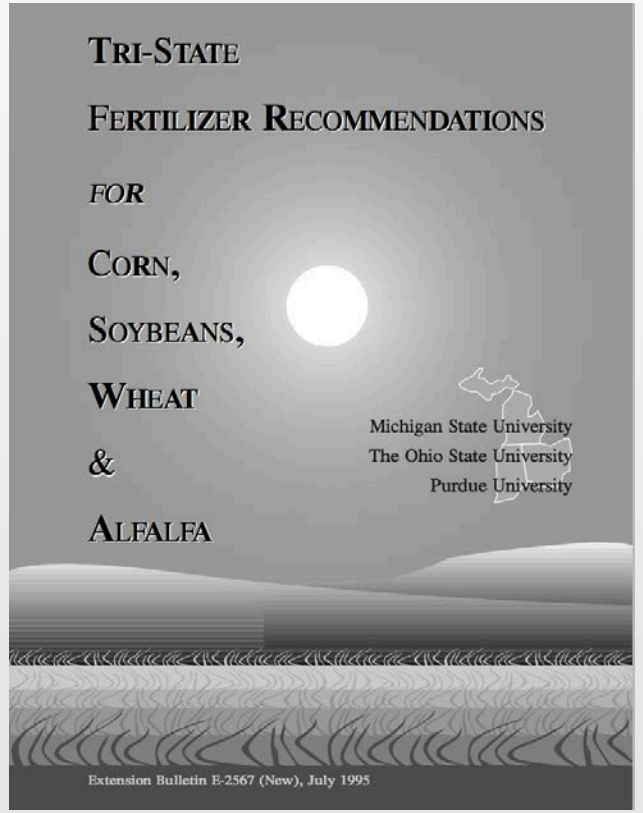
The Year

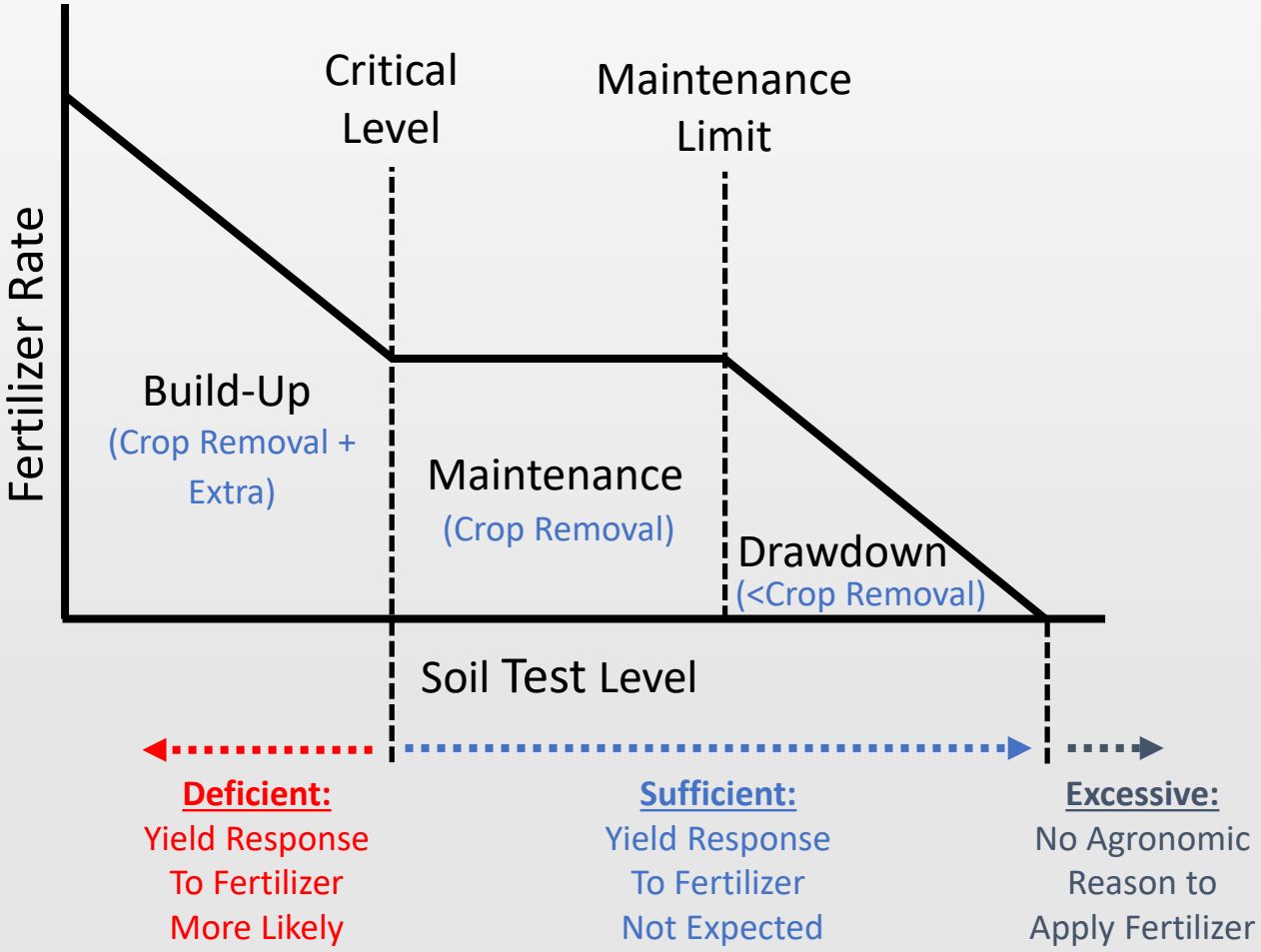

TRI-STATE
FERTILIZER RECOMMENDATIONS
FOR
CORN,
SOYBEANS,
WHEAT
&
ALFALFA
Michigan State University
The Ohio State University
Purdue University
Extension Bulletin E-2567 (New), July 1995

Tri-state Recommendation History

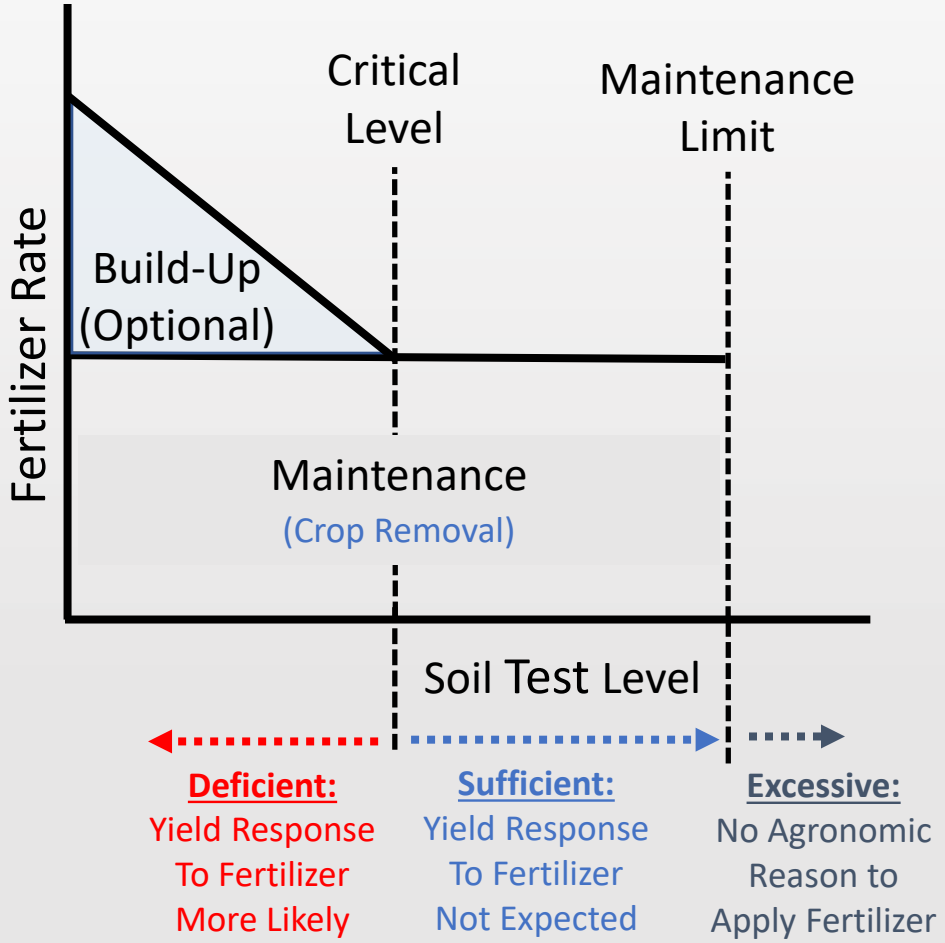
- Ag Retailers wanted a consistent recommendation across a region
- Ohio-Indiana-Michigan
  - (Ohio State – Purdue – Michigan State)
- State fertility specialists came together and created recommendations
- Has been widely adopted and well-received



Old Framework

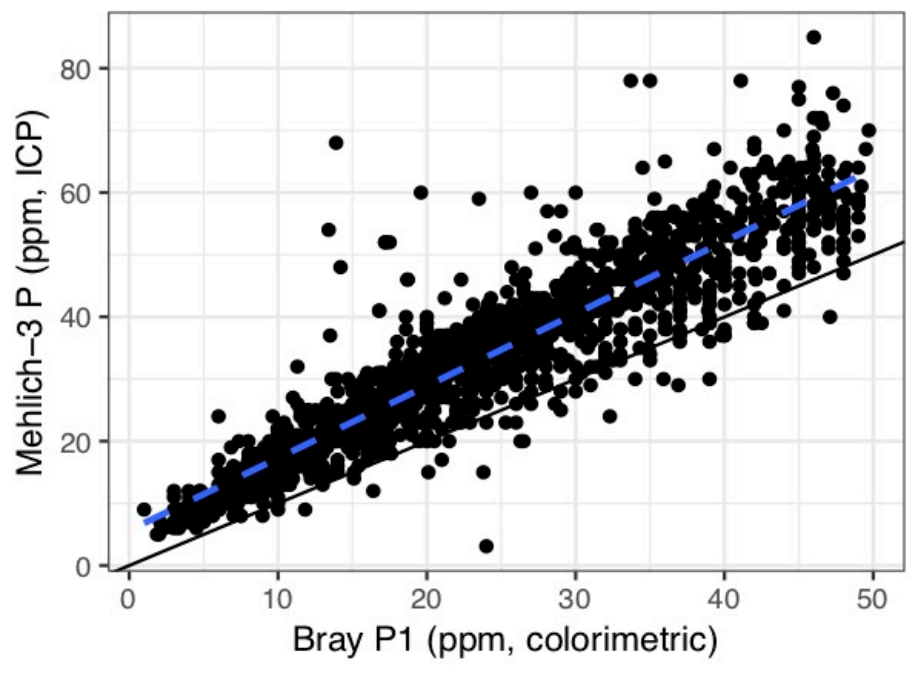


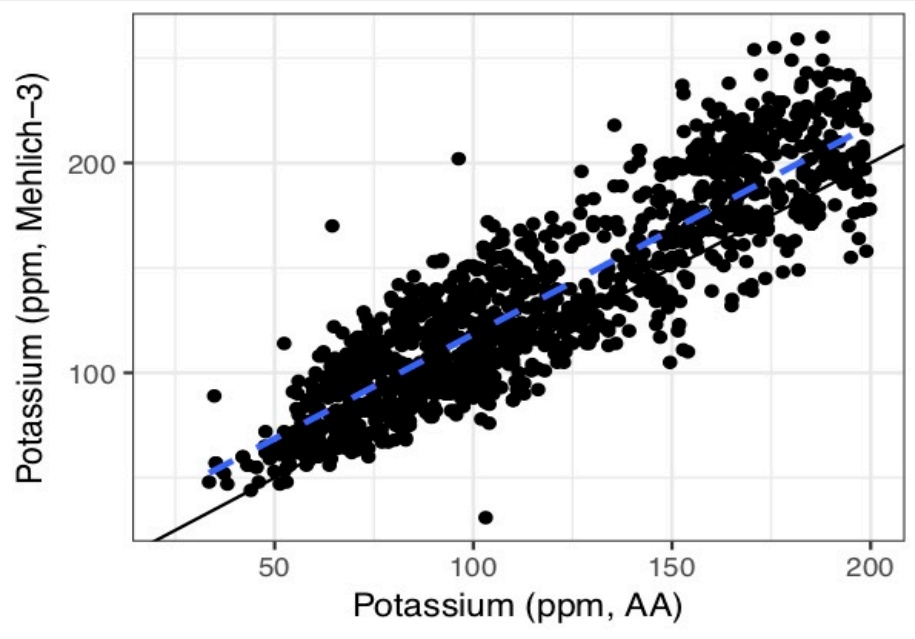
New Framework



Why Change the Framework?

- Simplify recommendations
- As soil sampling densities have increased, uncertainty has decreased
- Majority of cropland in region is rented, economics of build-up
- Provide farmers with more options, flexibility





Moving to Mehlich-3 Extractant

Original Tri-States are based on:

- *Bray P1 for P*
- *Ammonium acetate (AA) for K, Ca, Mg*

New Tri-States will be based on Mehlich-3 for P and K

Bray P to Mehlich-3 P: multiply by 1.35
Mehlich-3 P to Bray P: divide by 1.35.

Bray P 15 - 30 ppm = Mehlich-3 P 20 - 40ppm

AA-K to Mehlich-3 K: multiply by 1.14
Mehlich-3 K to AA-K: divide by 1.14

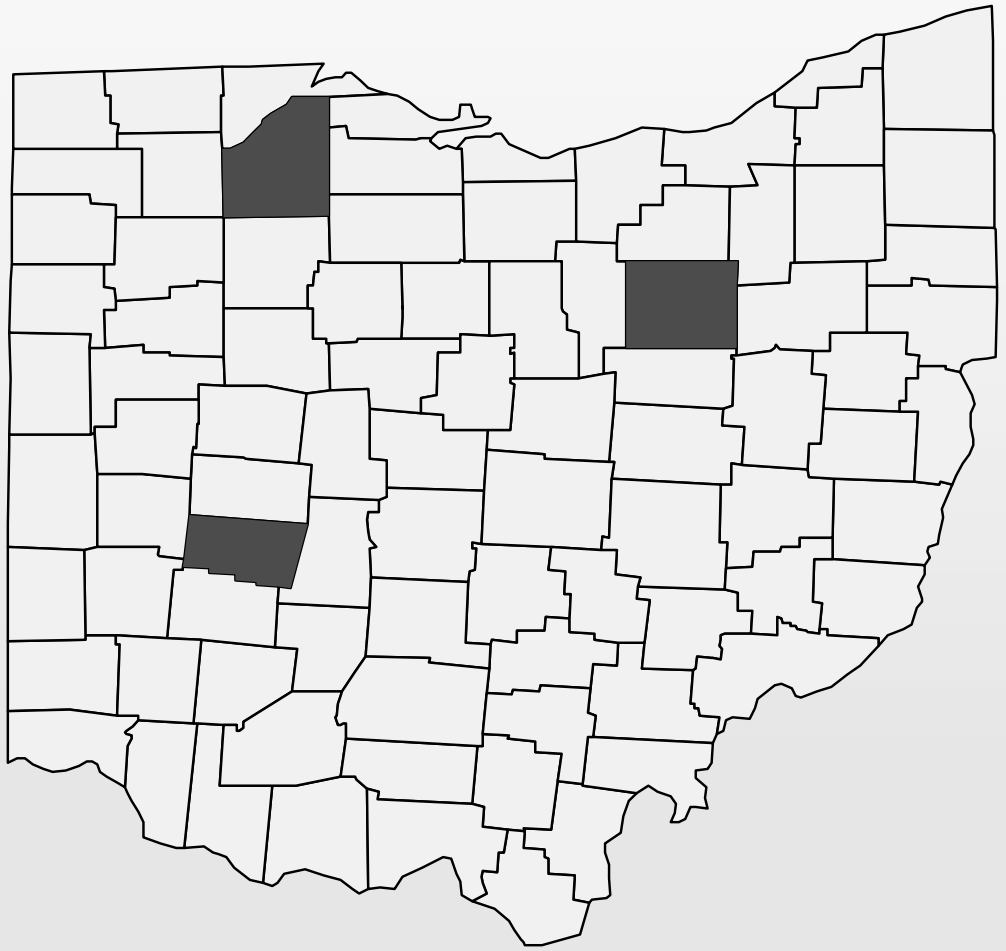
AA K 100 - 150 ppm ≈ Mehlich-3 K 115 – 170 ppm

go.osu.edu/mehlich

Long-term P & K Plots (2006 – 2018)

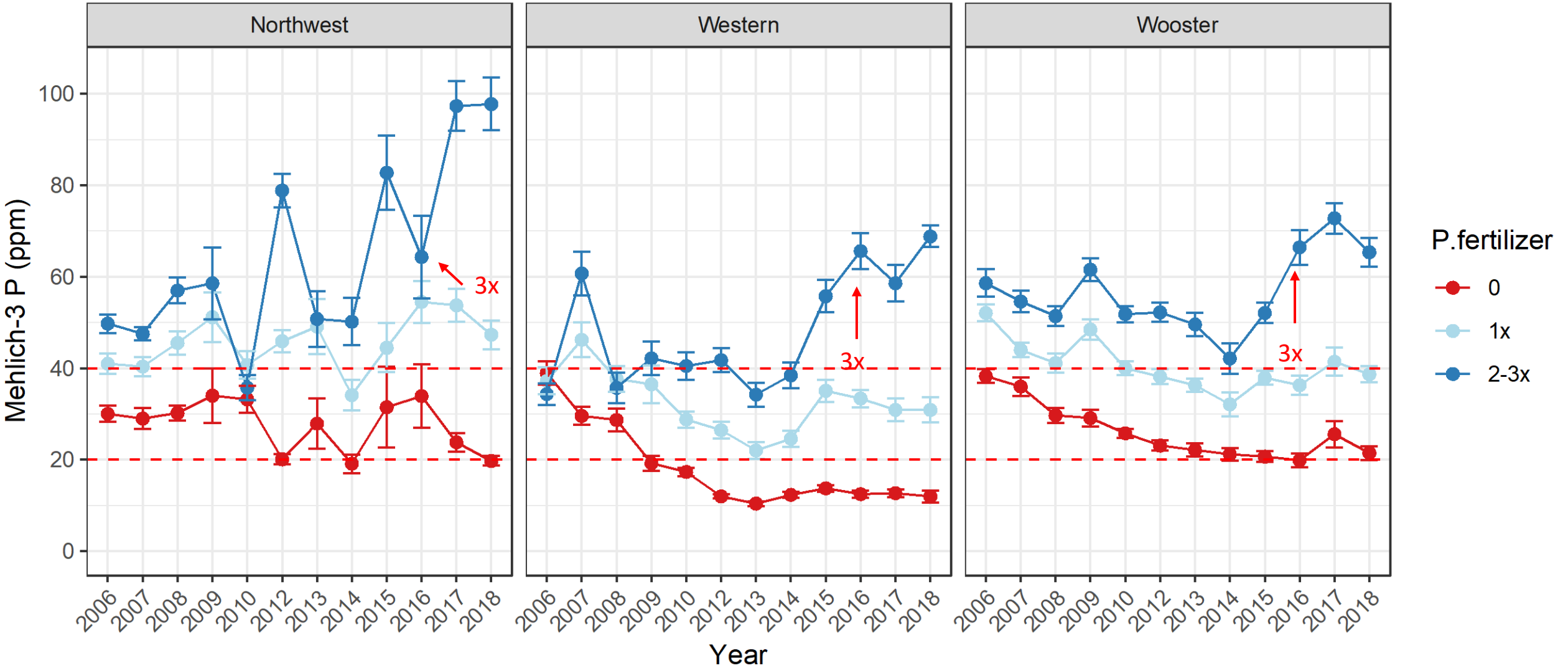
- Clark County
- Wayne County
- Wood County

- Started in 2006
  - P & K Fertilization
    - 3 rates (0, 1x, 2-3x)
  - Corn-soybean rotation



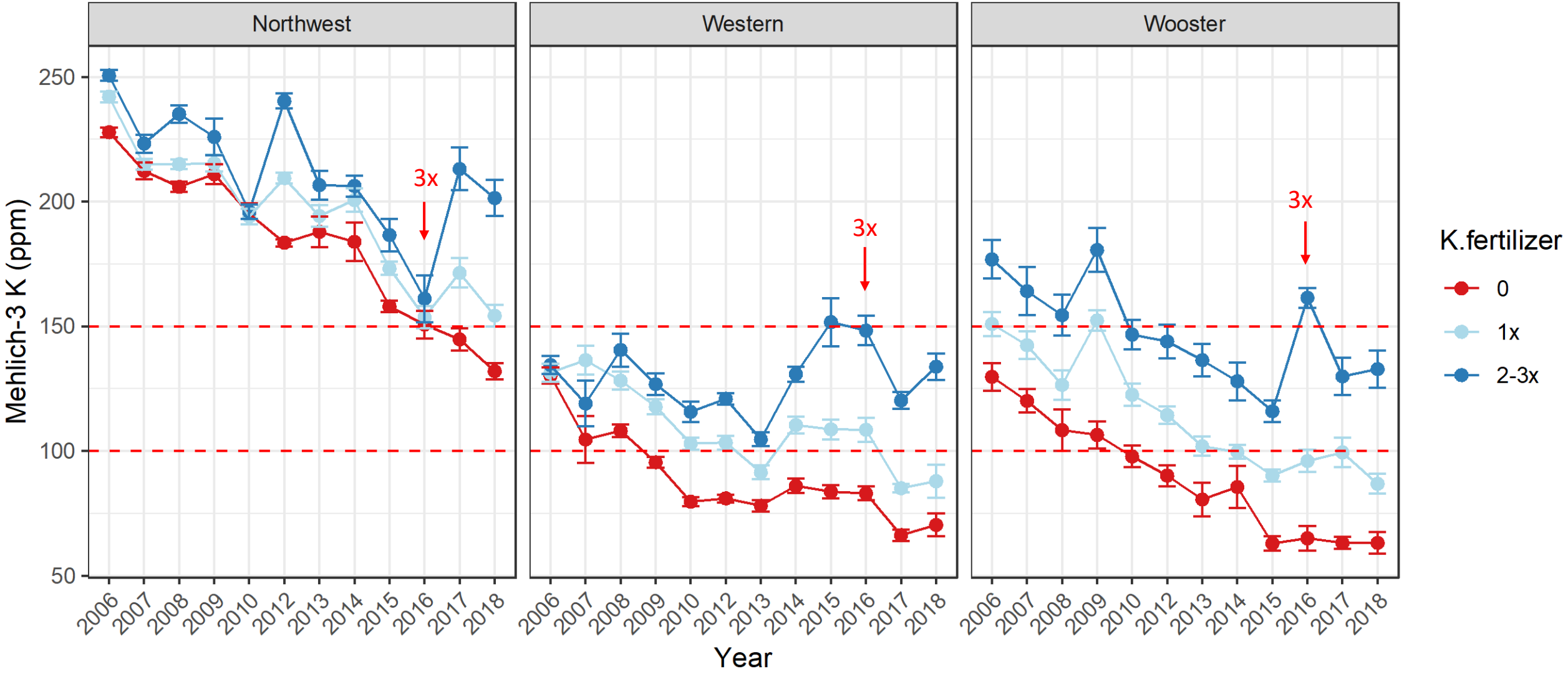
Soil Test P

(red dashed lines = maintenance range: 20-40 ppm M3-P)

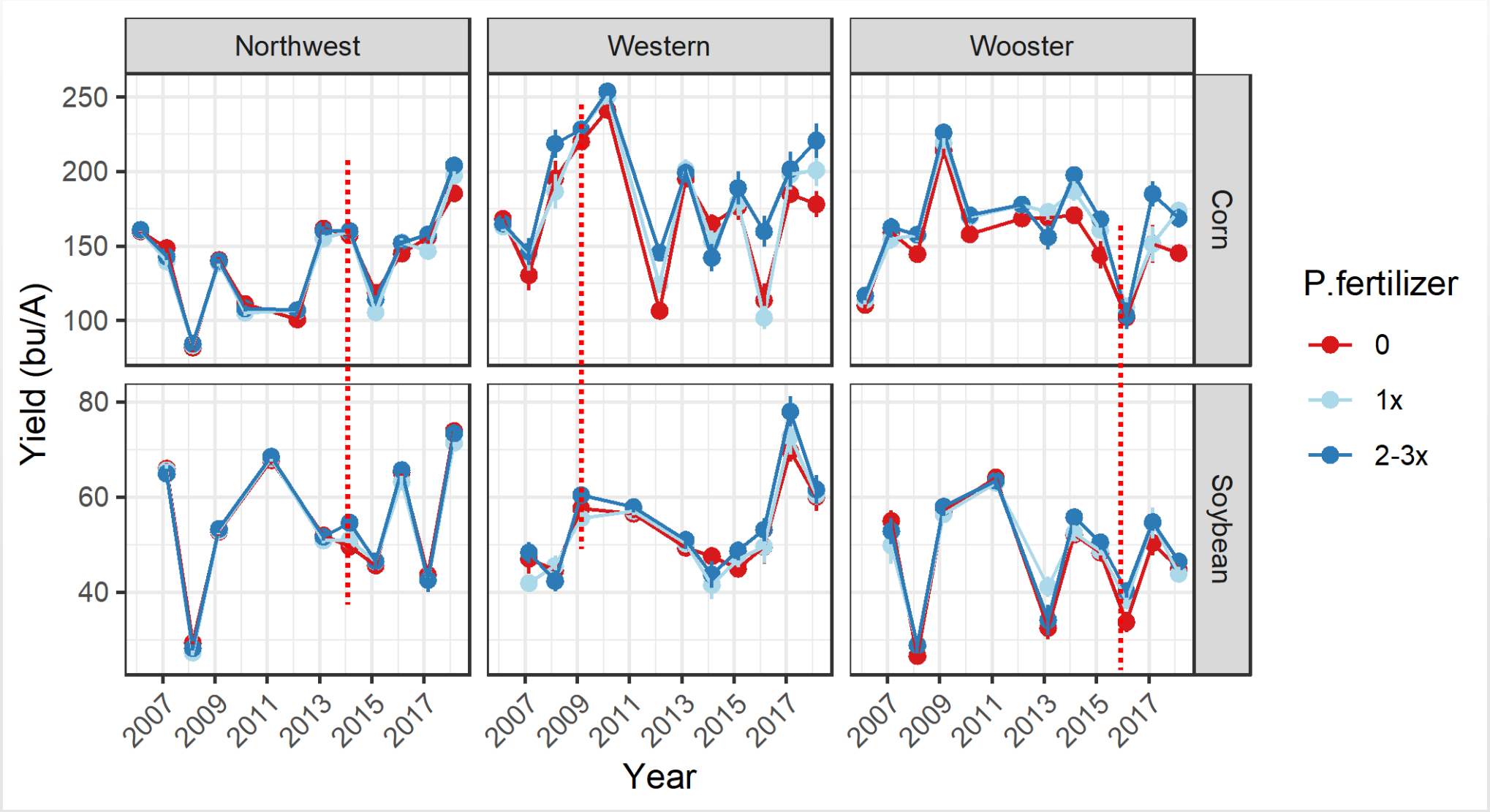


Soil Test K

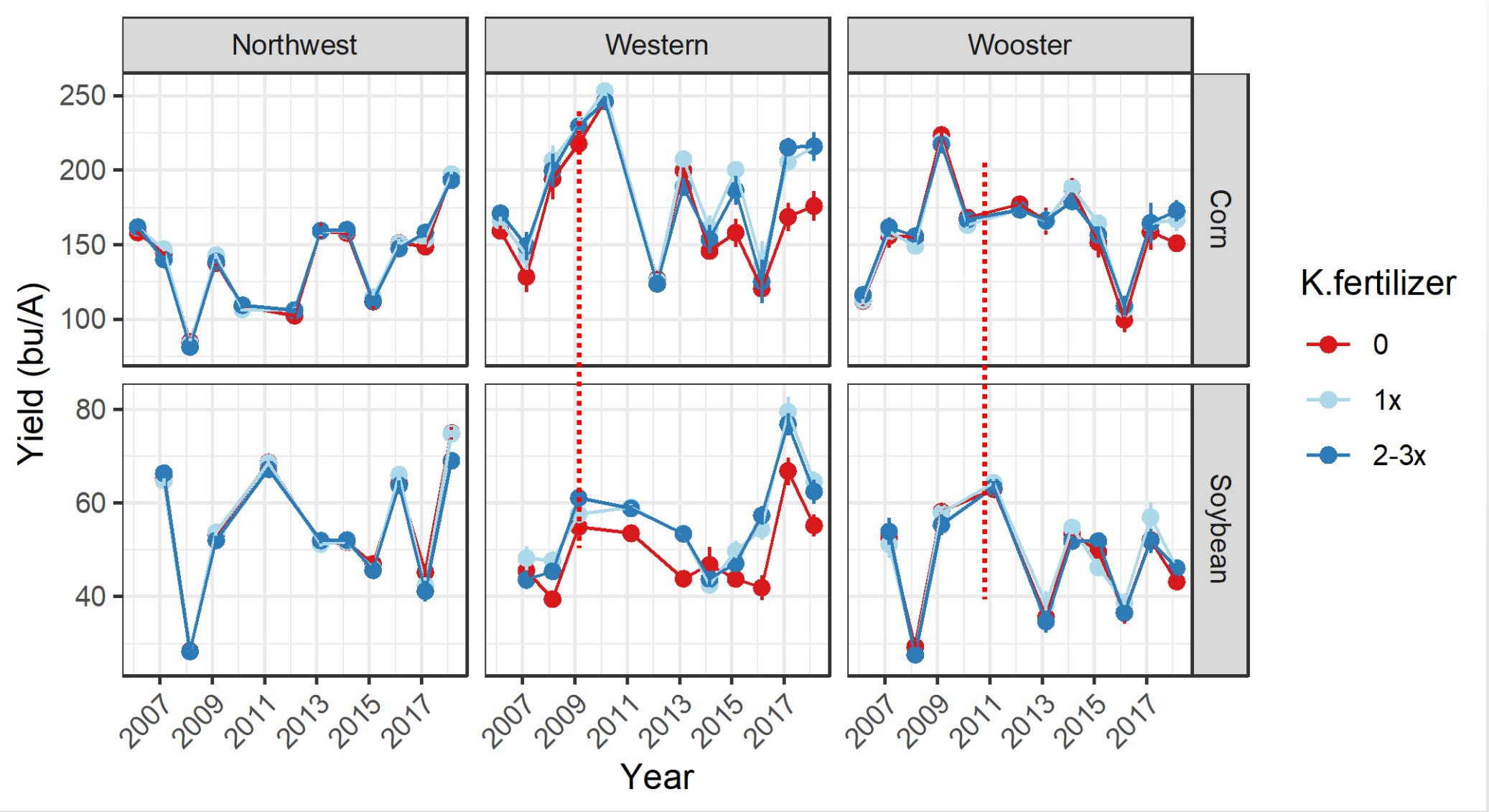
(red dashed lines = maintenance range: 100-150 ppm M3-K)



Phosphorus Trial Grain Yields



Potassium Trial Grain Yields



Applying Fertilizer Increased/ Decreased Yields (P <0.10)

		P trials		K trials	
Crop	**Observations**	**Increase**	**Decrease**	**Increase**	**Decrease**
Corn	108	22	3	8	2
Soybean	90	7	5	15	4

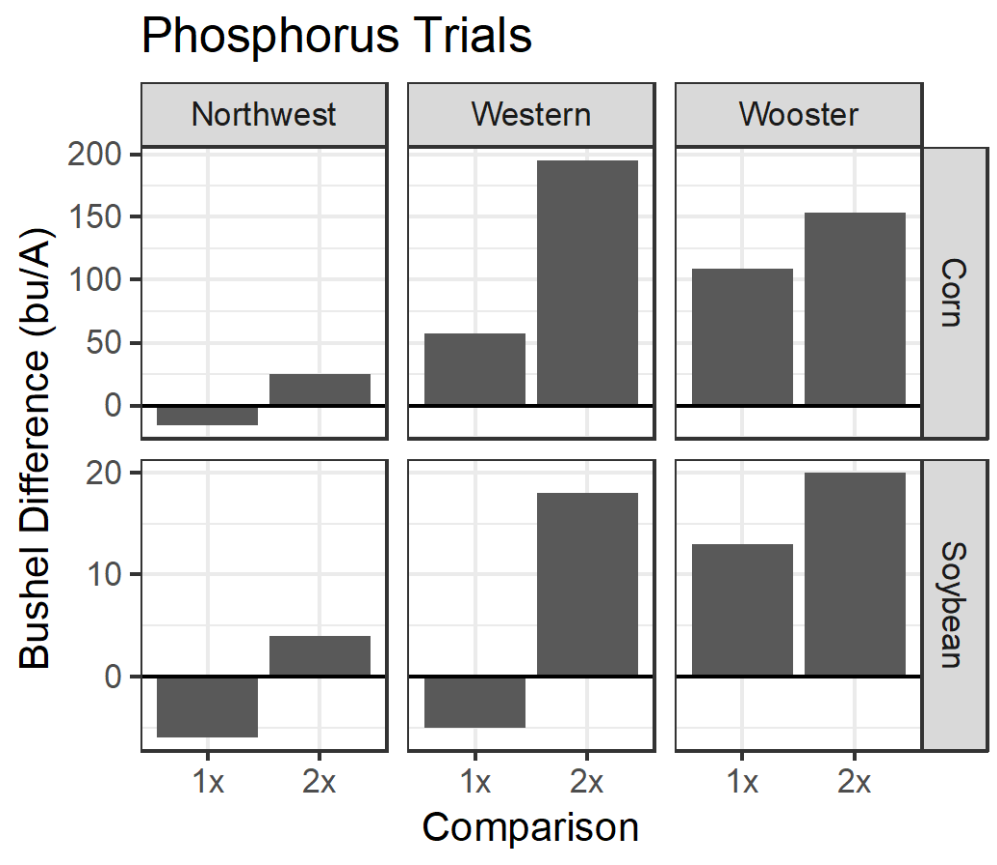
Applying Fertilizer Increased/ Decreased Yields (P <0.10)

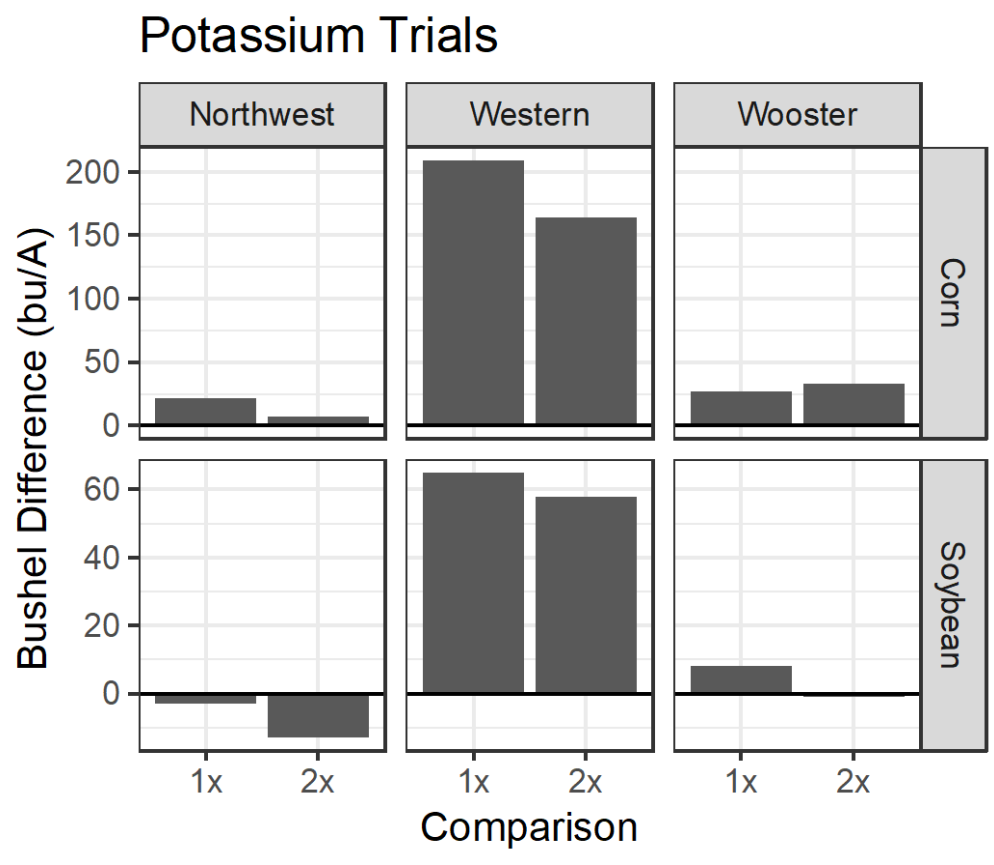
		P trials		K trials	
Crop	**Observations**	**Increase**	**Decrease**	**Increase**	**Decrease**
Corn	108	22 (16, 6)	3 (1, 2)	8 (7, 1)	2 (0, 2)
Soybean	90	7 (4, 3)	5 (1, 4)	15 (12, 3)	4 (0, 4)

(Obs below critical level, obs above critical level)

13 Year Yield Differences: Fertilized – 0

(+ values = bu/A increase with fertilization)



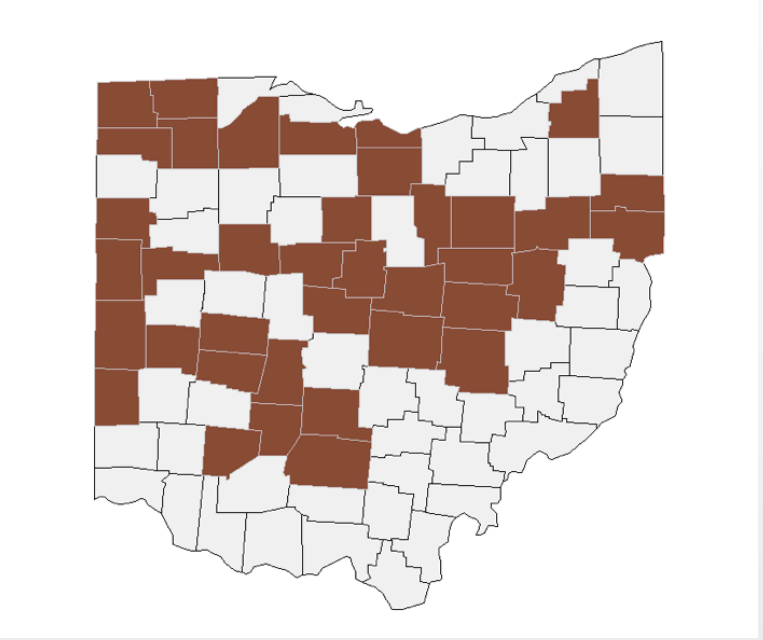


P trials yielded **more** bushels with 2-3x rate vs. 1x rate

K trials yielded **less** bushels with 2-3x rate vs. 1x rate

On-Farm Strip Trials (2014 – 2018)

Recent On-Farm Work



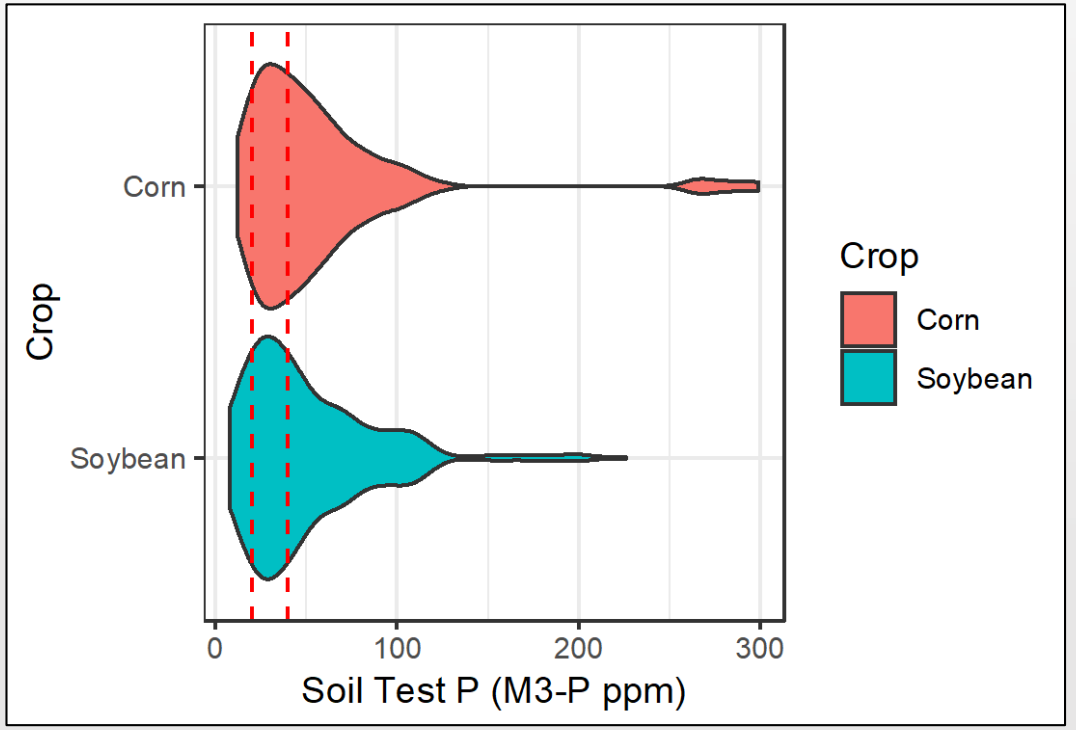
- Corn, soybean and wheat on-farm trials
- N, P, K, S
- Many sites over diversity of soil types and regions in Ohio
- Worked directly with growers, crop consultants, educators, agronomists
- Let farmers choose source, rate, timing, placement
- Soil sampling (0-8”), Leaf tissue (R1), Grain sample and yield, Management survey

P Trial Results

- 102 trials over 5 years (+/- P trt, 3+ reps)
  - 54 in corn, 48 in soybean
  - 34 counties

  - Corn AVG STP = 57 ppm M3
  - Soybean AVG STP = 51 ppm M3

  - Corn AVG Yield = 192 bu/A
    - (61 – 295 bu/A)
  - Soybean AVG Yield = 48 bu/A
    - (5 – 81 bu/A)



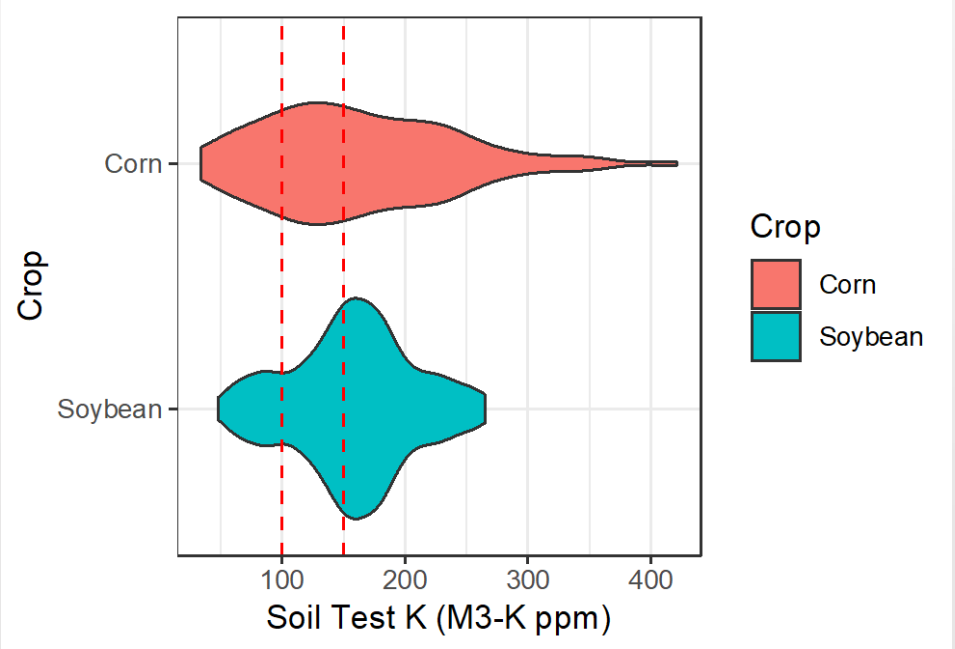
Distribution of STP levels across all trials by crop with red dashed lines indicating critical level (20 ppm M3-P) and maintenance limit (40 ppm M3-P)

P trials

Crop	# of trials	Bushel Increase with Fertilizer (bu/A)	Relative Yield (%)	# Trials Statistically Significant
Corn	54	3.6 (-20.1 – 22.0)	98.0 (86 – 110)	8 increase, 1 decrease
Soybean	48	1.3 (-5.3 – 8.6)	98.0 (77 – 116)	4 increase, 1 decrease

K Trial Results

- 81 on-farm trials over 5 years (+/ - K trt, 3+ reps)
  - 33 in corn, 48 in soybean
  - 32 counties
  - Corn AVG STK = 164 ppm M3
  - Soybean AVG STK = 160 ppm M3
  - Corn AVG Yield = 203 bu/A
    - (53 – 296 bu/A)
  - Soybean AVG Yield = 47 bu/A
    - (7 – 78 bu/A)



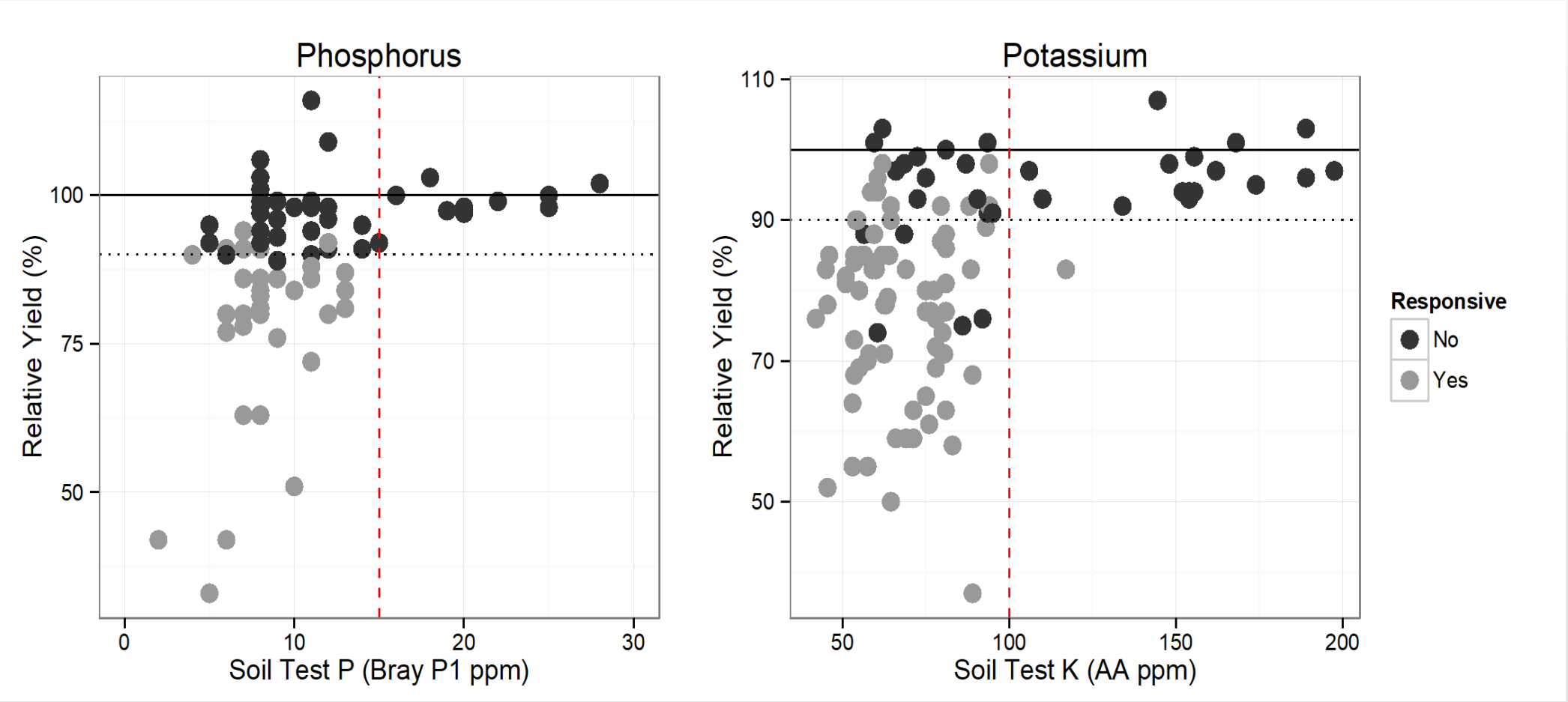
Distribution of STK levels across all trials by crop with red dashed lines indicating critical level (100 ppm M3-K) and maintenance limit (150 ppm M3-K)

K trials

Crop	# of trials	Bushel Increase with Fertilizer (bu/A)	Relative Yield (%)	# Trials Statistically Significant
Corn	33	3.9 (-44.7 – 58.6)	98 (66 – 126)	3 increase, 1 decrease
Soybean	48	-0.6 (-7.1 – 6.7)	102 (68 – 122)	1 increase, 2 decrease

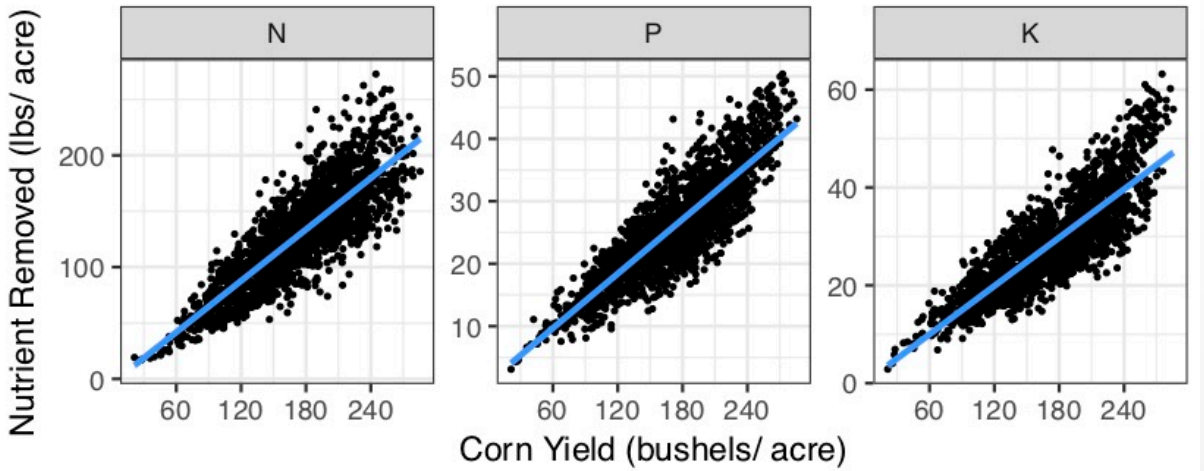
Critical Levels Haven't Really Changed

Original Ohio Tri-State Data (1976-1993)



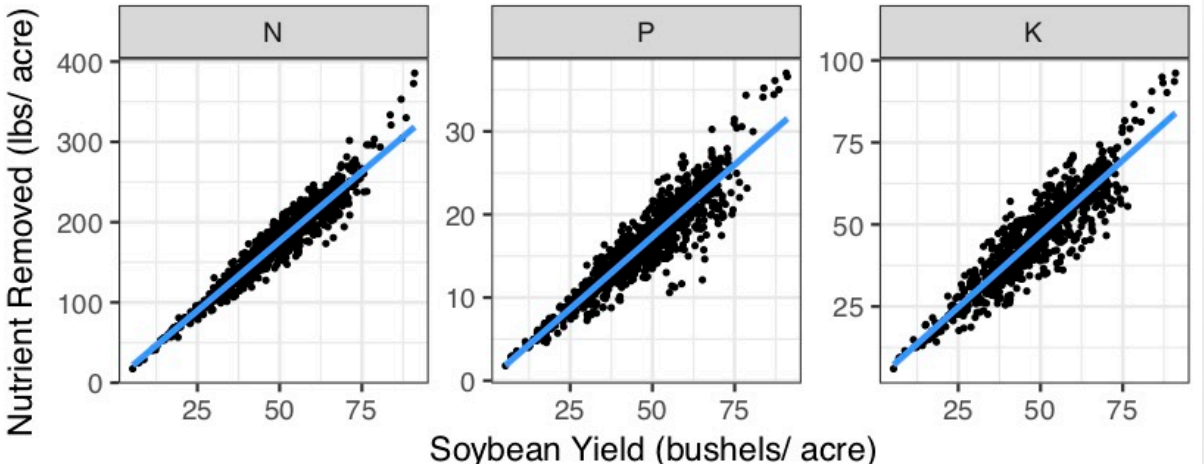
https://ohioline.osu.edu/factsheet/agf-518

Grain Nutrient Removal Rates

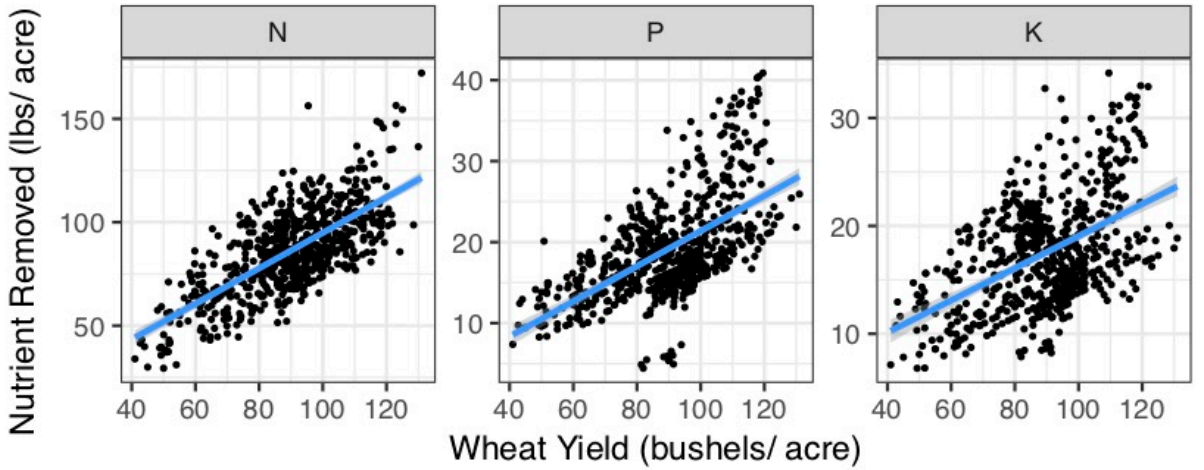


Corn

Nutrient Removal Rate vs. Grain Yield



Soybean



Wheat

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	Grain nutrient removal rates			Total grain nutrient removed at harvest		
	Corn	Soybean	Wheat	Corn (180 bu)	Soybean (60 bu)	Wheat (80 bu)
	(lb of nutrient/ bushel grain)			(lbs of nutrient/ acre)		
N	0.74	3.55	0.96	134	213	77
P_2O_5	0.35	0.79	0.49	62	47	39
K_2O	0.20	1.14	0.24	36	68	19
Ca	0.06	0.22	0.08	11	13	6
Mg	0.05	0.14	0.07	9	8	6
S	0.05	0.18	0.07	9	11	6
B	0.0003	0.0023	0.0003	0.05	0.14	0.03
Cu	0.0001	0.0008	0.0003	0.02	0.05	0.02
Fe	0.0013	0.0054	0.0025	0.24	0.32	0.20
Mn	0.0002	0.0017	0.0022	0.04	0.10	0.18
Zn	0.0010	0.0023	0.0015	0.17	0.14	0.12
Na	0.0003	0.0008	0.0003	0.06	0.05	0.03

Grain Nutrient Removal (lb/bu)

Crop	Nutrient	Tri-State (1995) (lbs/ bushel)	New Data (lbs/ bushel)	Percent Decrease
Corn	P_2O_5	0.37	0.35	5%
	K_2O	0.27	0.20	26%
Soybean	P_2O_5	0.80	0.79	1%
	K_2O	1.40	1.14	19%
Wheat	P_2O_5	0.63	0.49	22%
	K_2O	0.37	0.24	35%

Summary

- Soil test trends
  - STP trends showed both building and drawdown
  - STK failed to substantially build
- Grain yield increases to P and K were not consistent and suggest soil has capacity to supply P and K for years without fertilization
- Critical STP levels were ~20 ppm; Critical STK levels were ~100-120 ppm (or less) – not perfect
- Grain nutrient removal rates decreasing (lb/ bushel)

Conclusions

- No evidence that current Tri-State STP and K levels are too low or need to be raised
- Data suggest that the justification for solely relying on a build and maintenance approach for K is questionable
- Need to look at economics, not just agronomics of yield response
- Working to finalize draft for roll-out

Thank You

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Major Changes

- Corn N rate recommendations updated
- Framework for P and K fertilizer management has been updated/ simplified
- Mehlich-3 is now the default extractant
- Critical P levels for all crops remain unchanged (except now based on M3)
- Critical K levels are simplified into 2 CEC classes.
- Nutrient removal rates per bushel of have decreased, especially with potassium