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

Updating the Tri-State Fertilizer Recommendations

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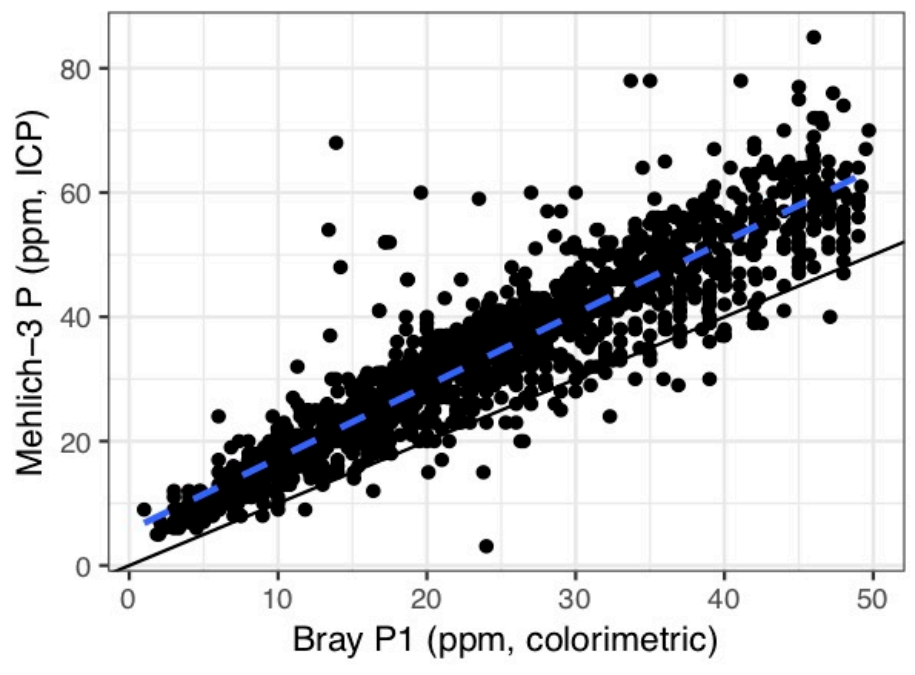
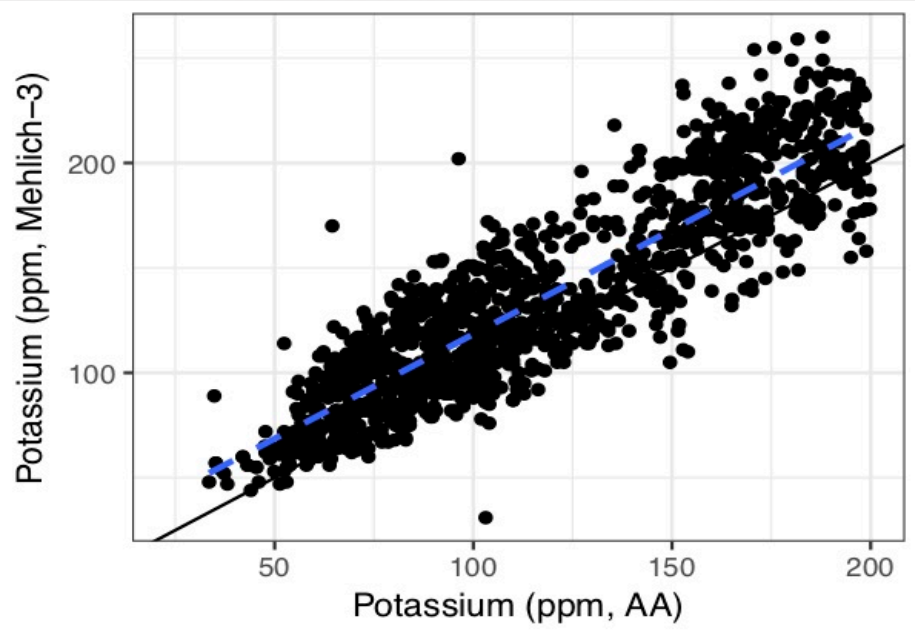
What's Wrong with the Tri-State Fertilizer Recs?

- Based on data from decades ago
- Based on soil test extractants rarely used anymore
- Solely use Build-Up and Maintenance Approach
- Over-sell the precision of soil testing

What's ~~Wrong~~ New with the Tri-State Fertilizer Recs?

- Based on data from decades ago
  - New trials, new data
- Based on soil test extractants rarely used anymore
  - Melhich-3 will become default extractant for STP and STK
- Solely use Build-Up and Maintenance Approach
  - Buildup will be encouraged, but optional,
  - Drawdown will go away
- Over-sell the precision of soil testing
  - More focus on adaptive nutrient management





Moving to Mehlich-3 Extractant

Bray P to Mehlich-3 P: multiply by 1.35

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

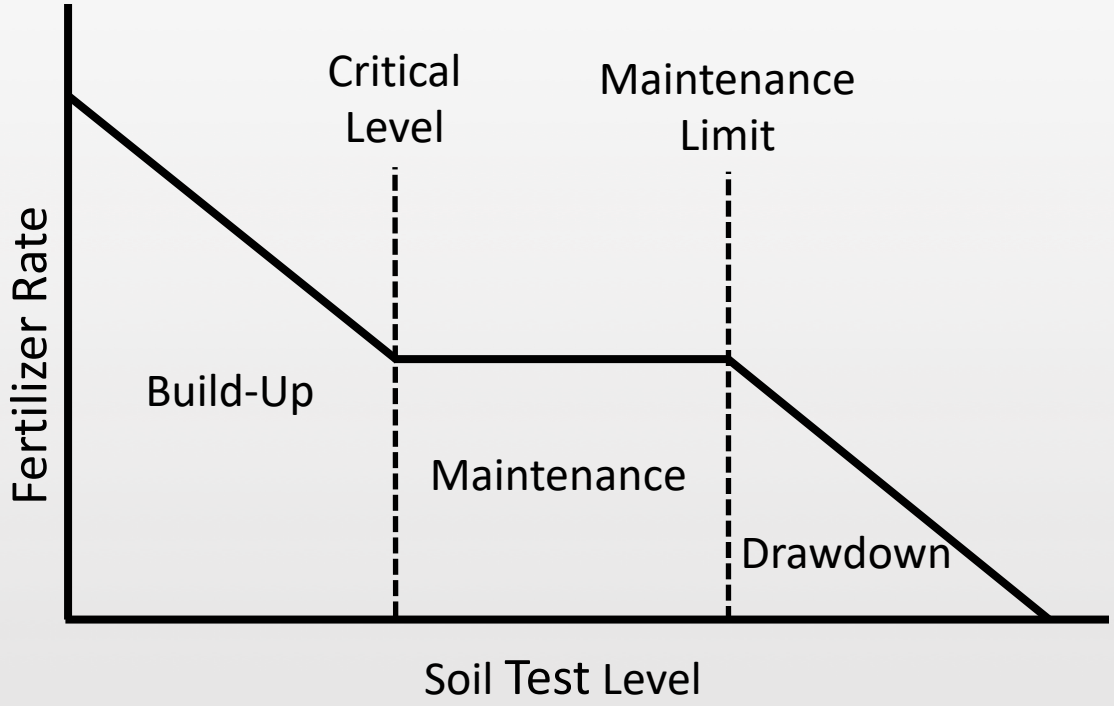
Bray P 15 - 30 ppm = Mehlich-3 P 20 - 40ppm

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

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

go.osu.edu/mehlich

Old Framework



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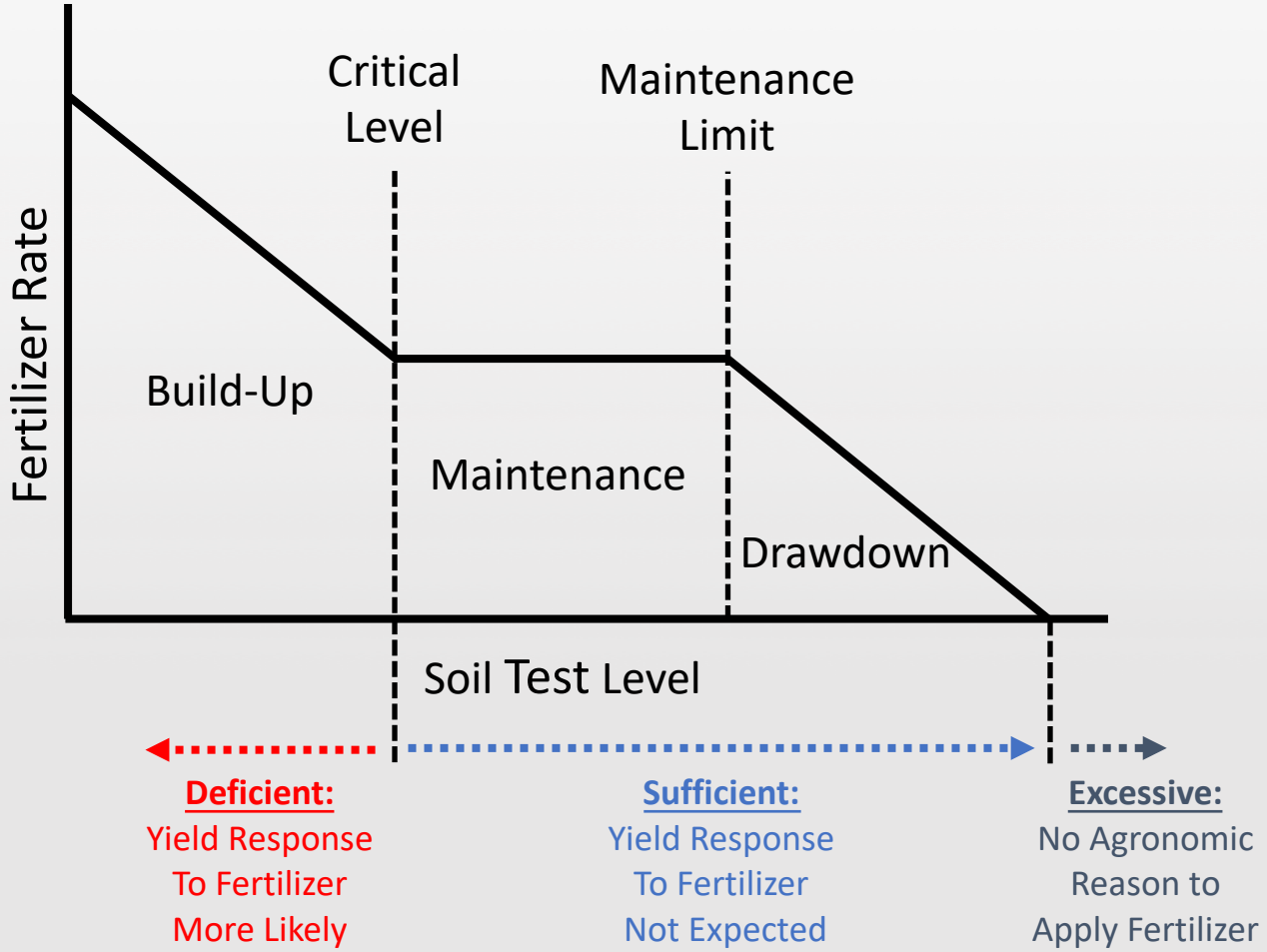

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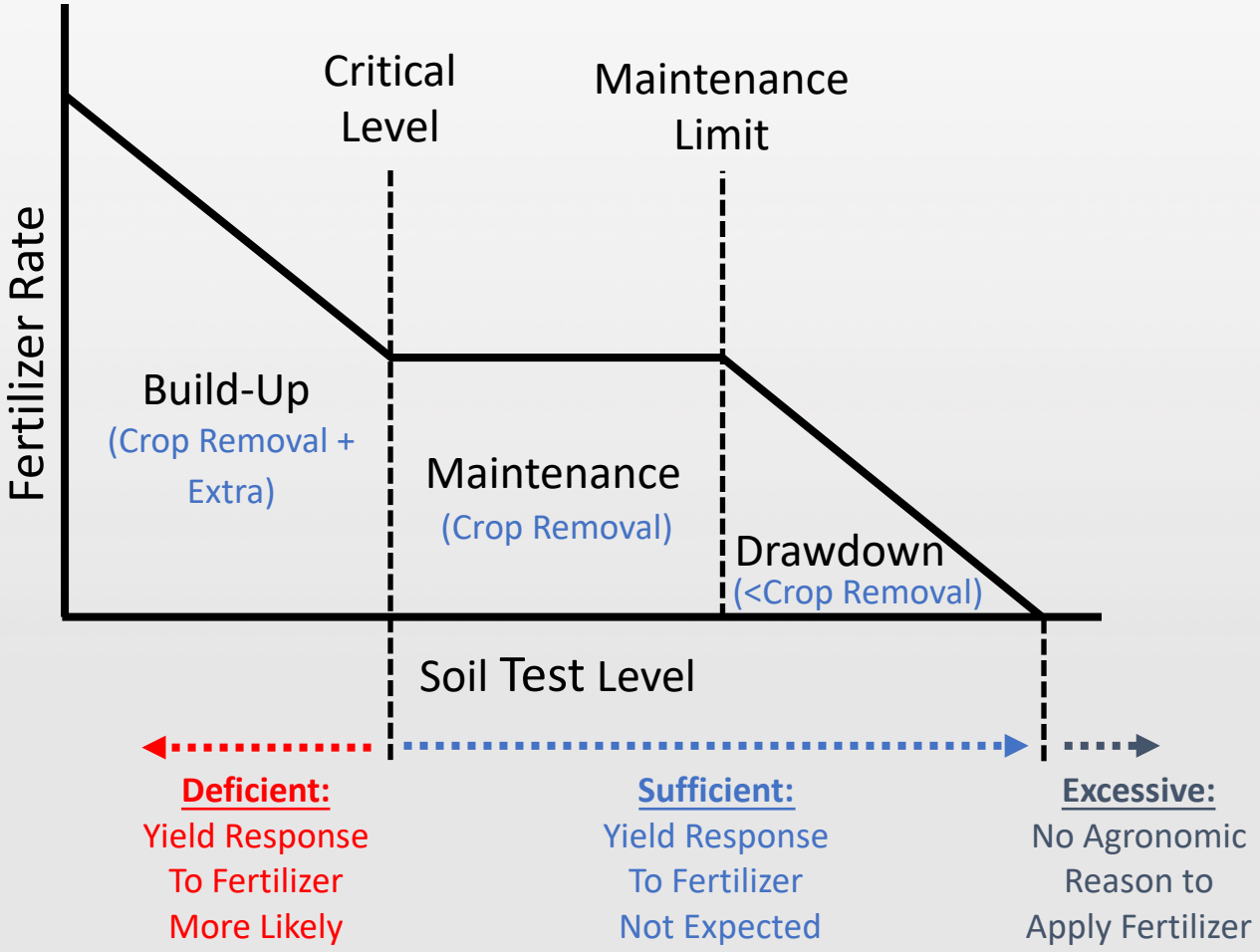
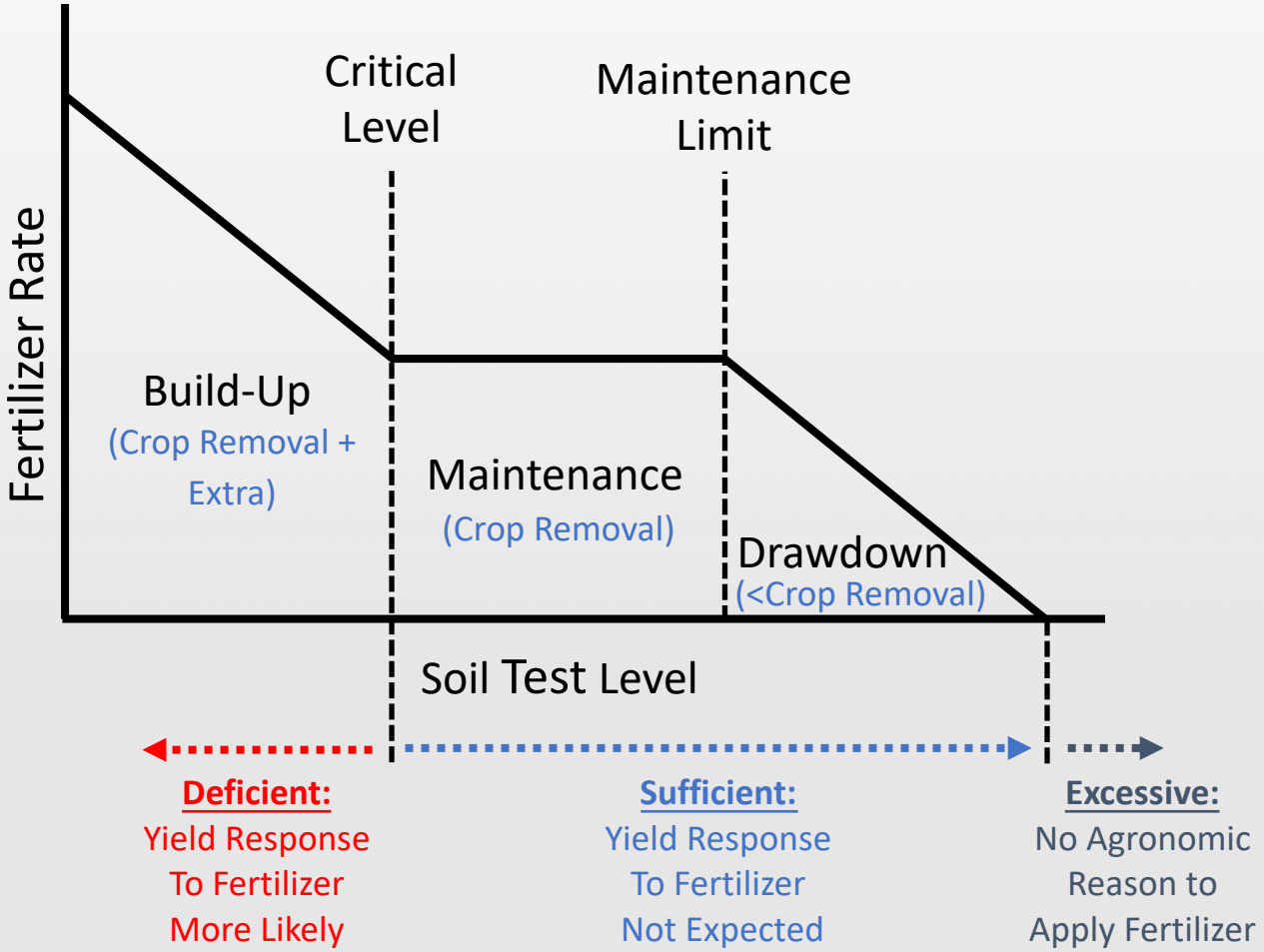
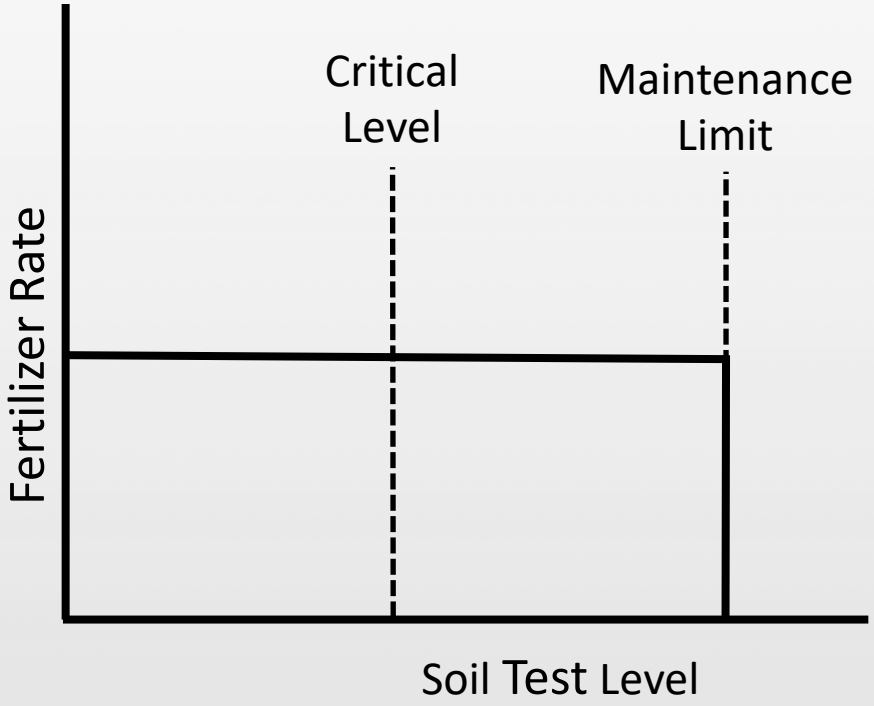


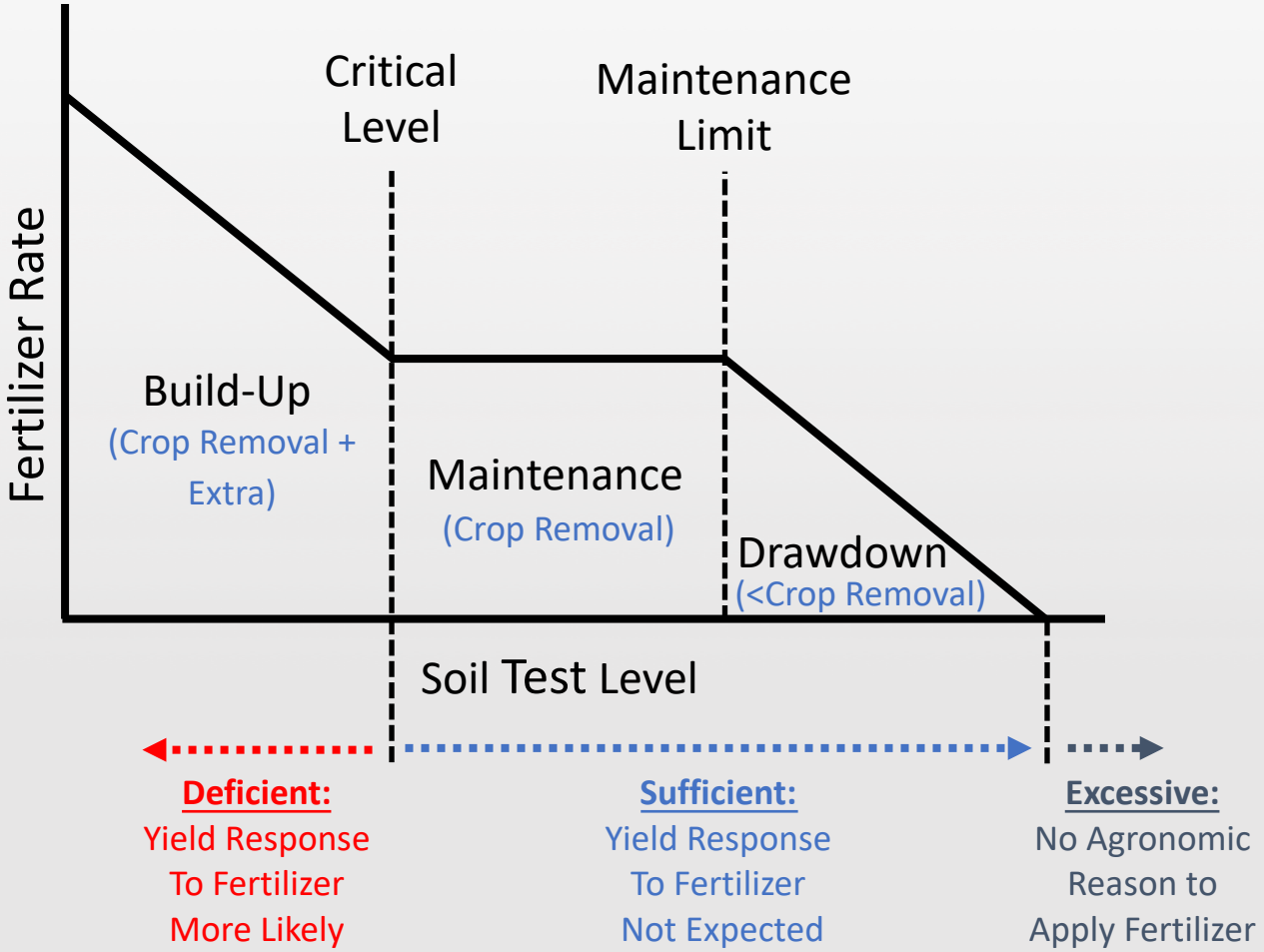
Old Framework



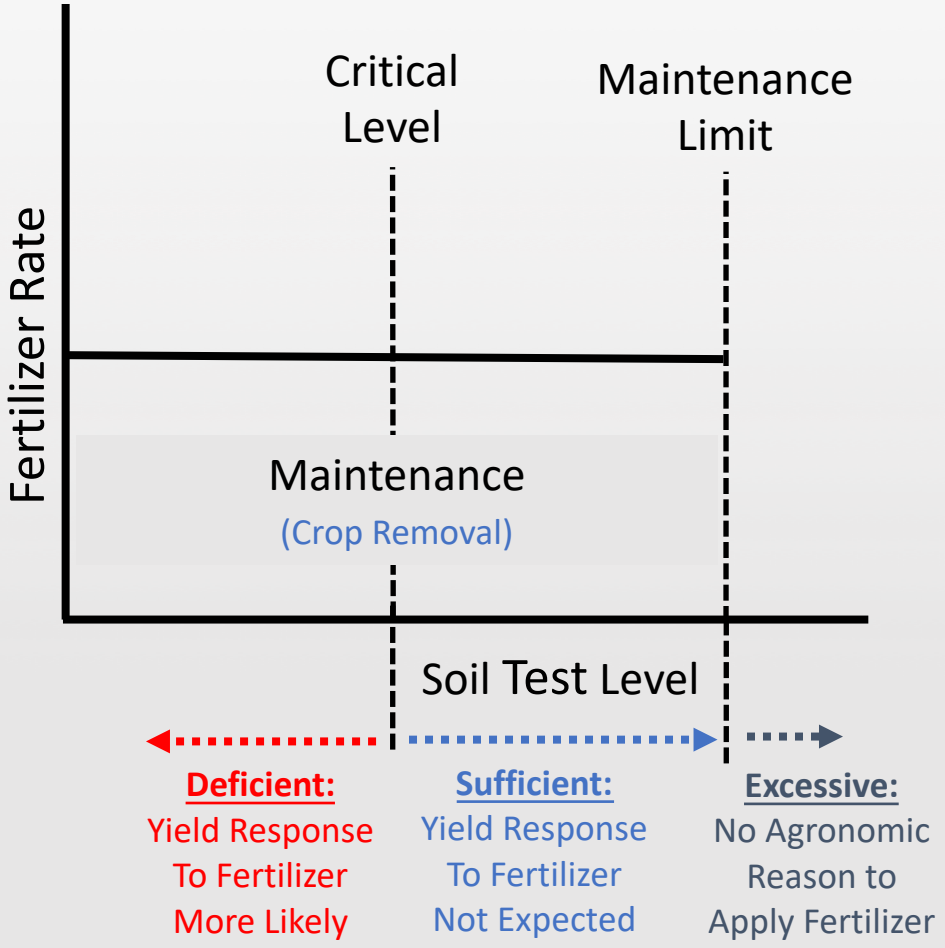
New Framework



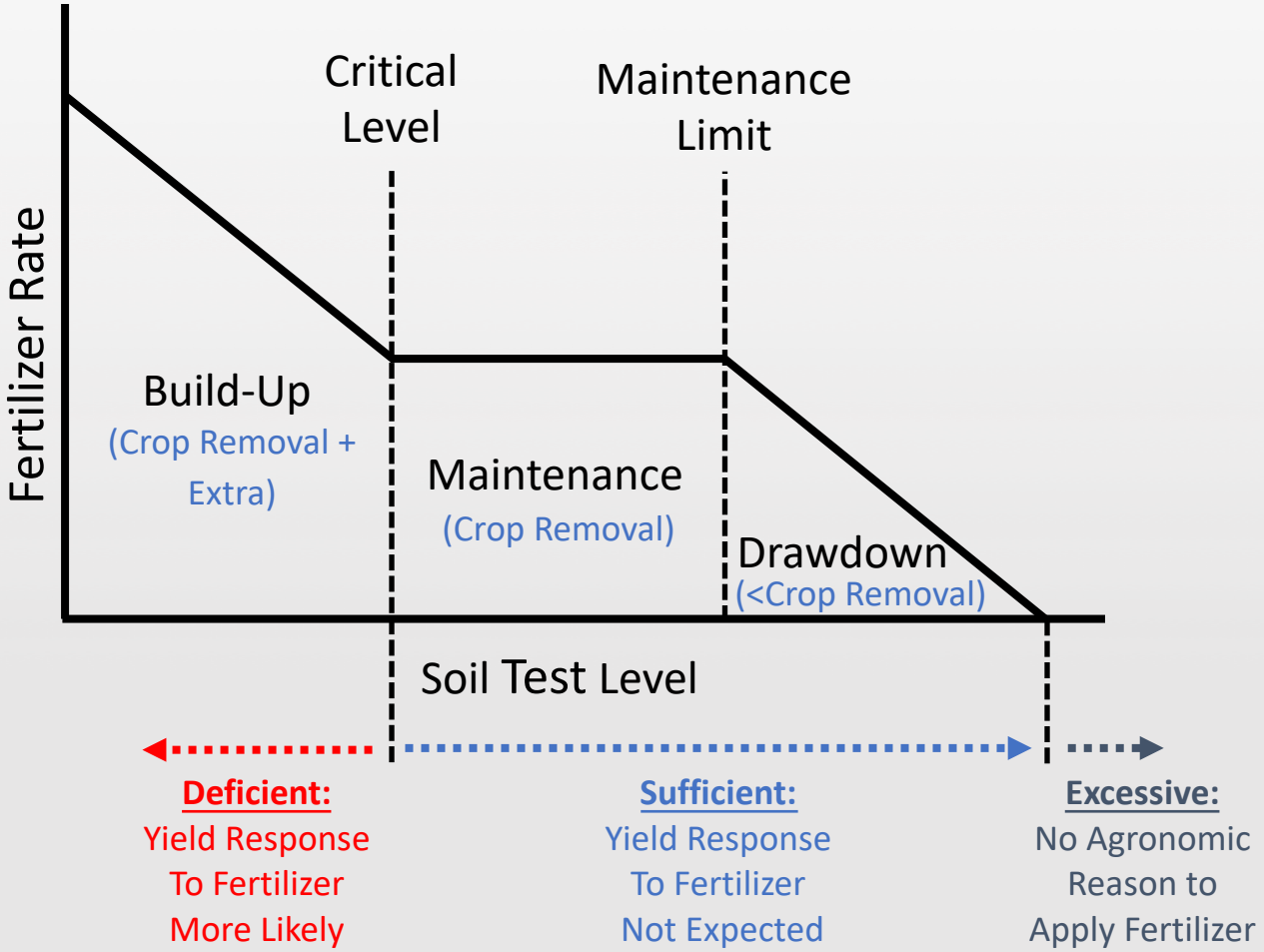
Old Framework



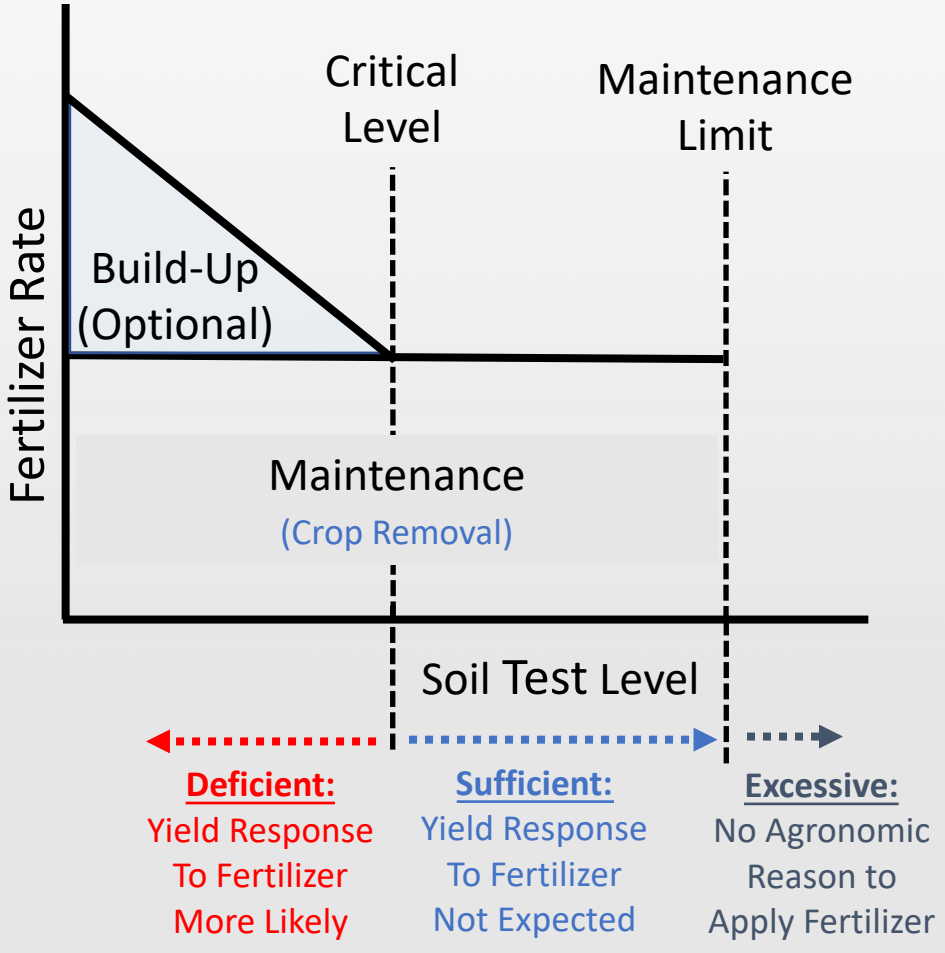
New Framework



Old Framework



New Framework



Why Change the Framework?

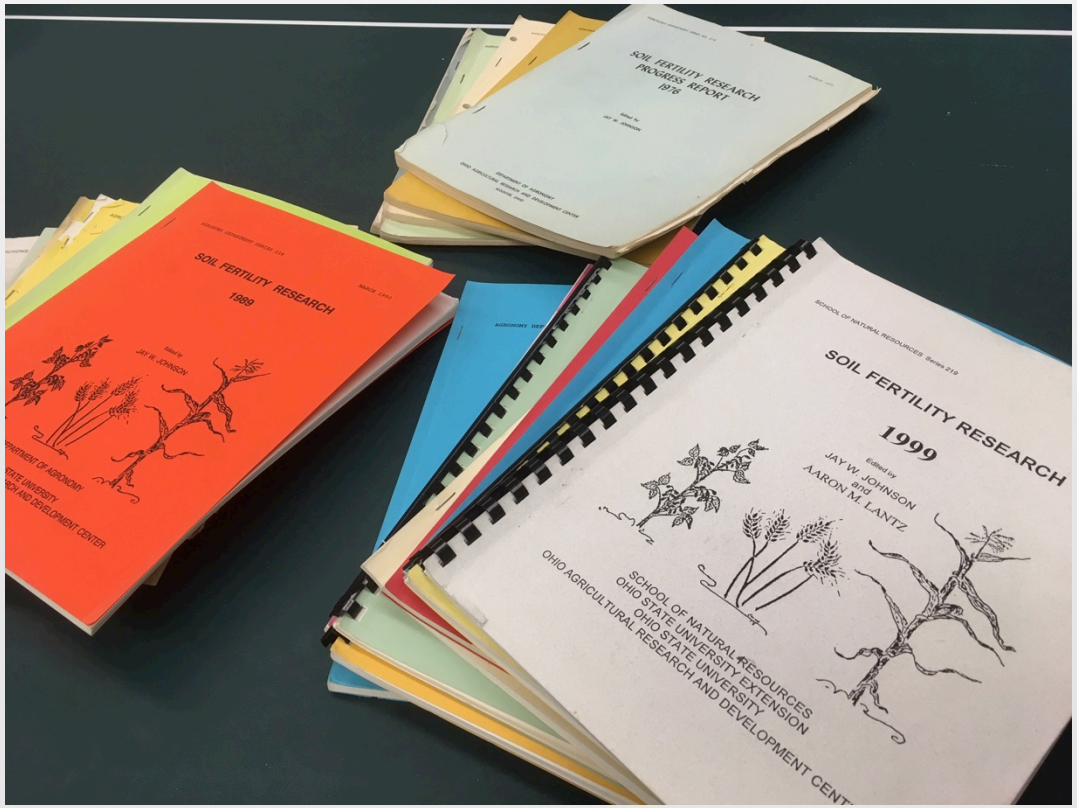
- Simplify recommendations
- As soil sampling densities have increased, uncertainty has decreased
- Majority of cropland in region is rented, economics of build-up
- Provide farmers with more options, flexibility

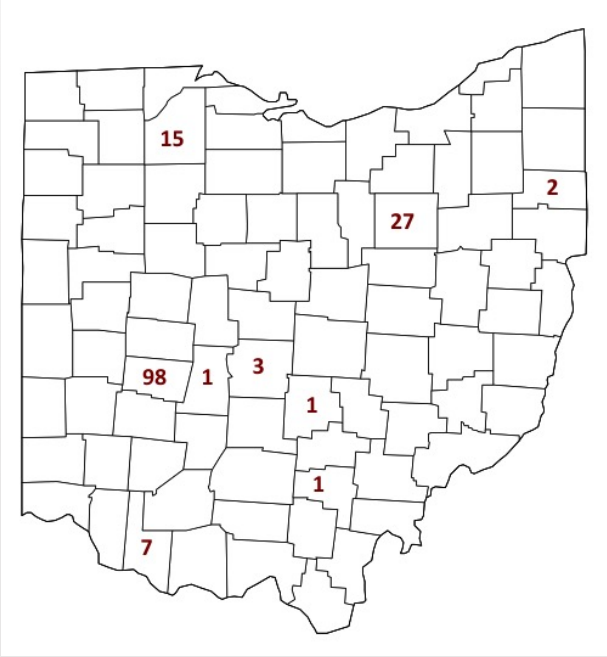
What’s the Basis for Tri-State Recommendations?

Original Ohio Tri-State Data

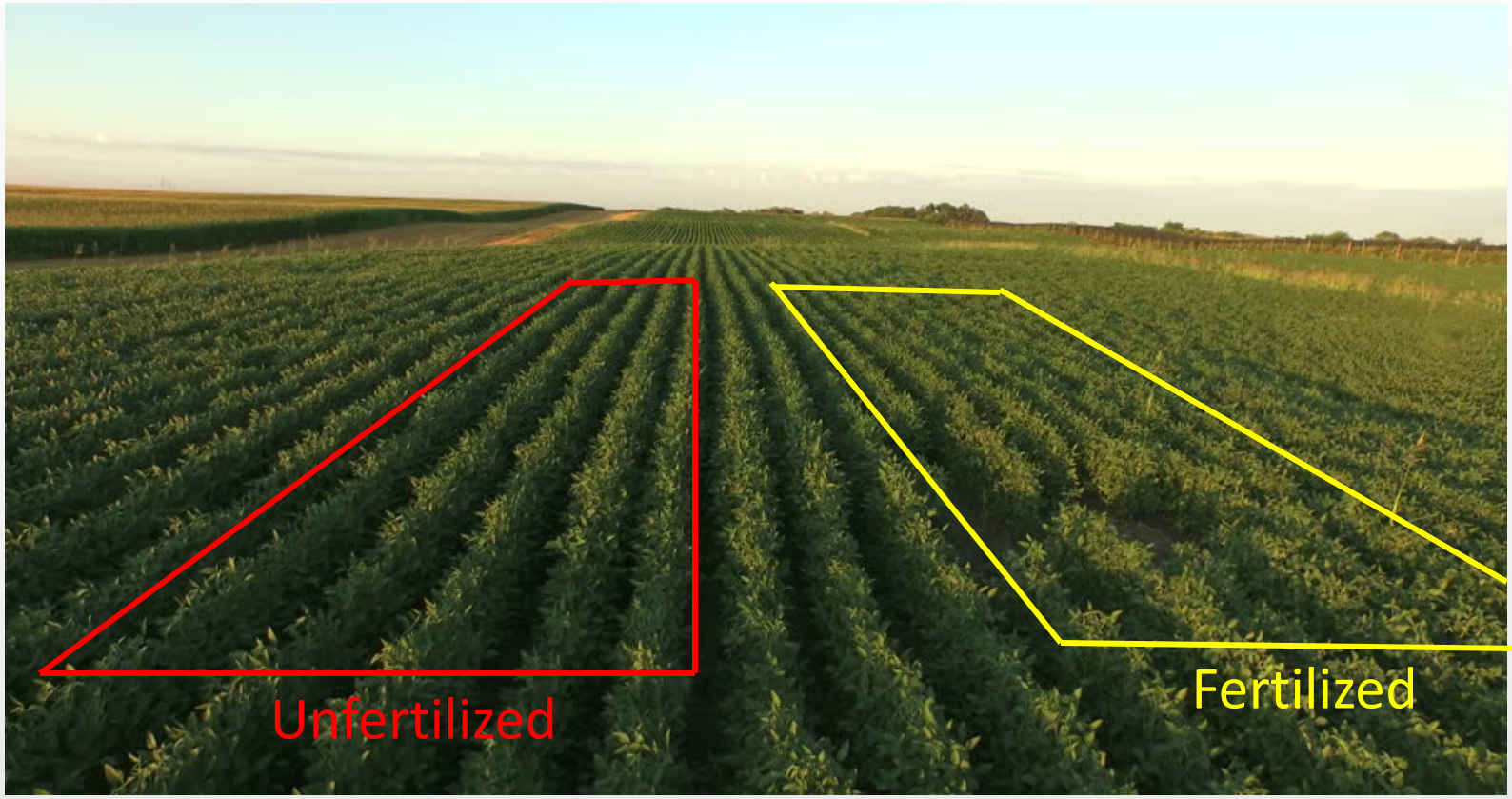
Annual Soil Fertility Reports: 1976 – 1999

- 68 P trials (site-years) conducted
- 92 K trials conducted





9 sites total

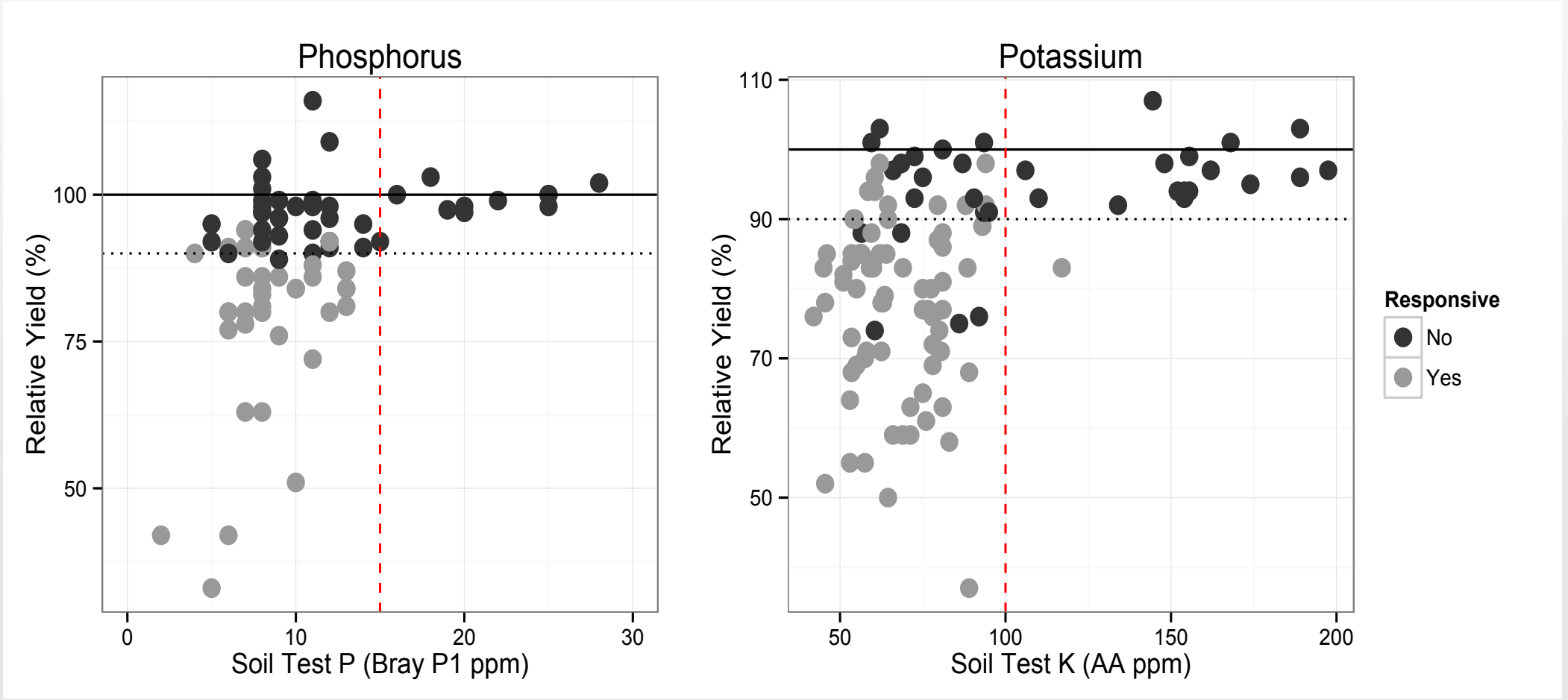


$$\text{Relative Yield} = \frac{\text{Unfertilized}}{\text{Fertilized}} \times 100$$

$$\text{Relative Yield} = \frac{45 \text{ bu/acre}}{50 \text{ bu/acre}} \times 100 = 90\%$$

(10% reduction)

Original Ohio Tri-State Data (1976-1993)
(Corn, Soybean and Wheat)

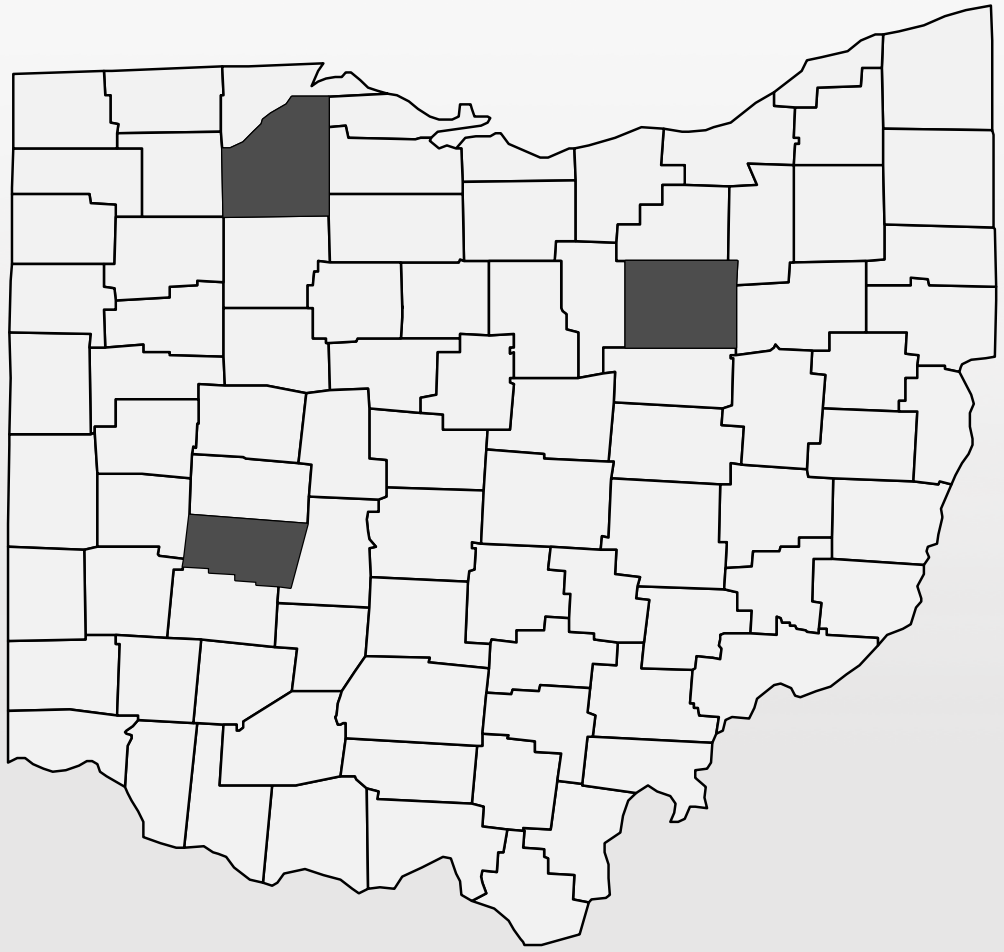


https://ohioline.osu.edu/factsheet/agf-518

Long-term P & K Plots

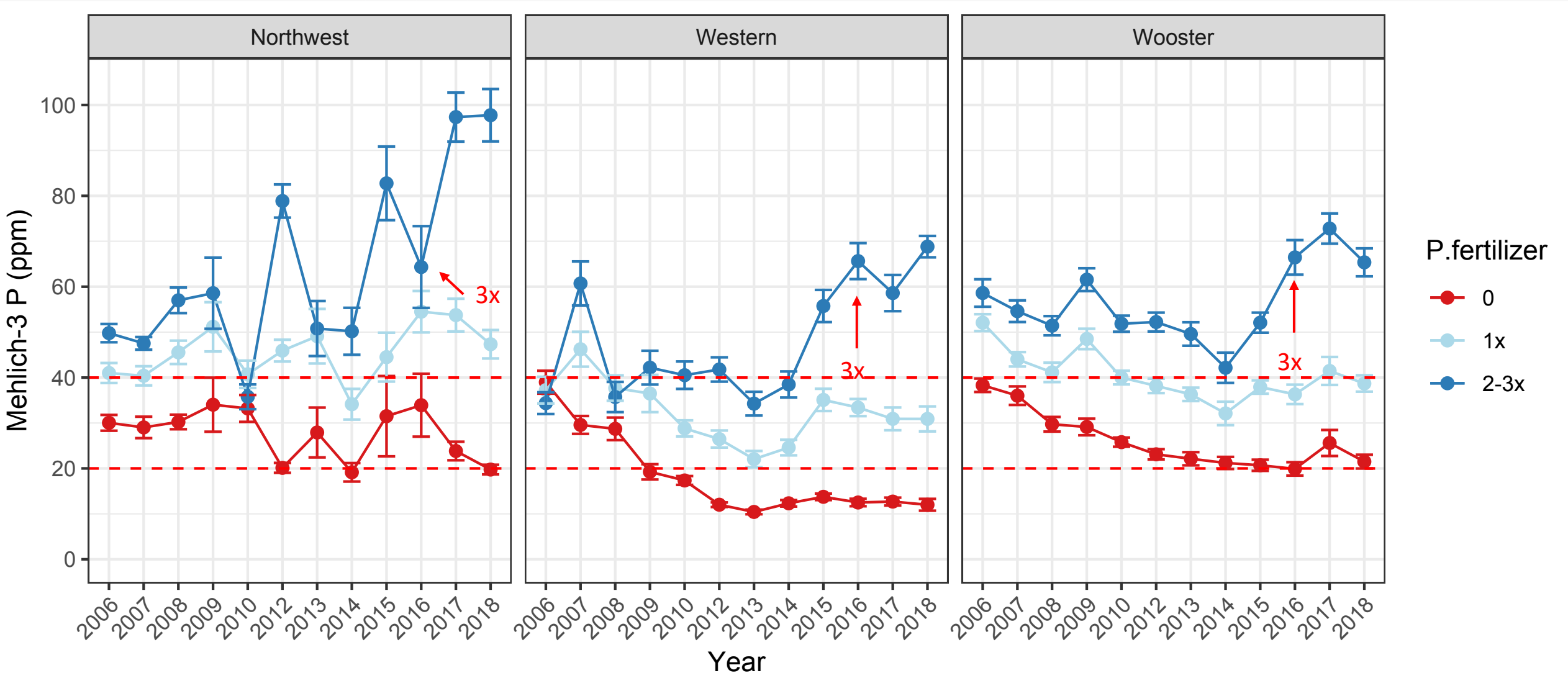
- Clark County
- Wayne County
- Wood County

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



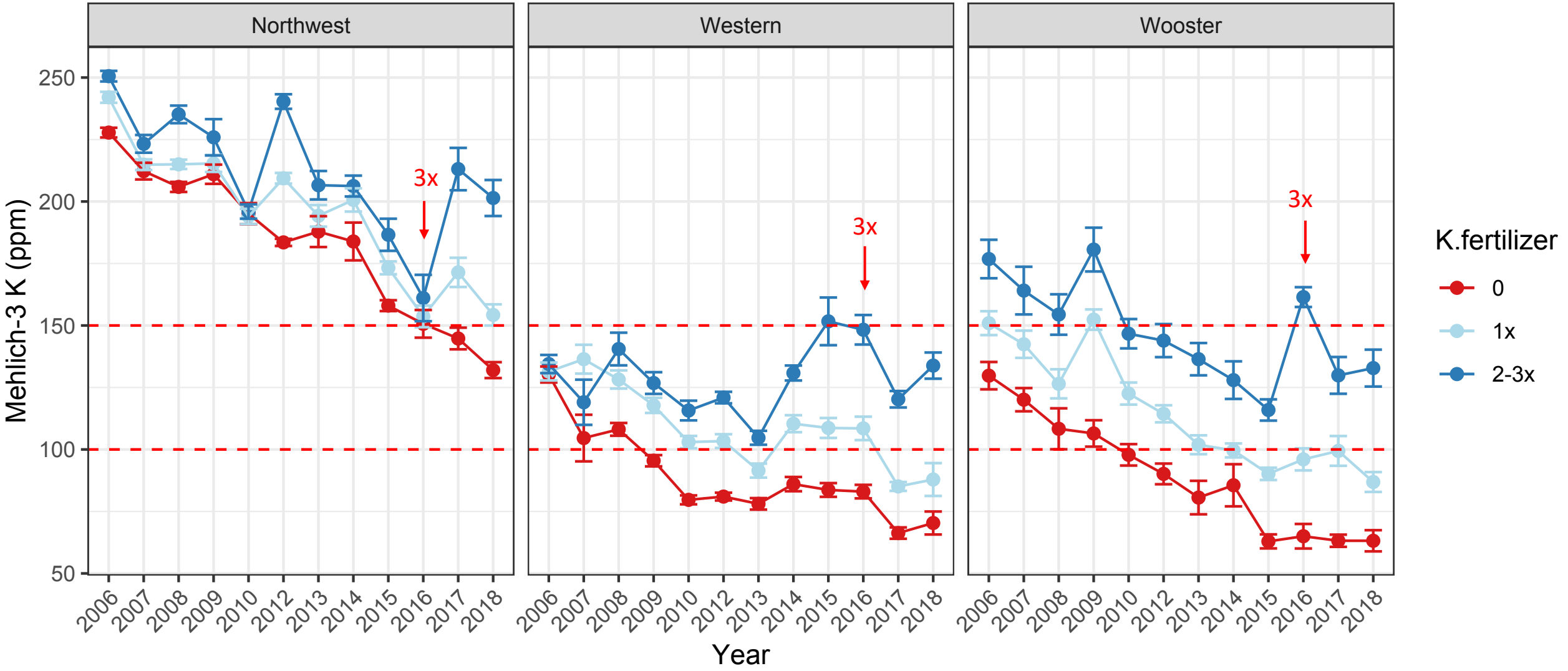
Soil Test P

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



Soil Test K

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



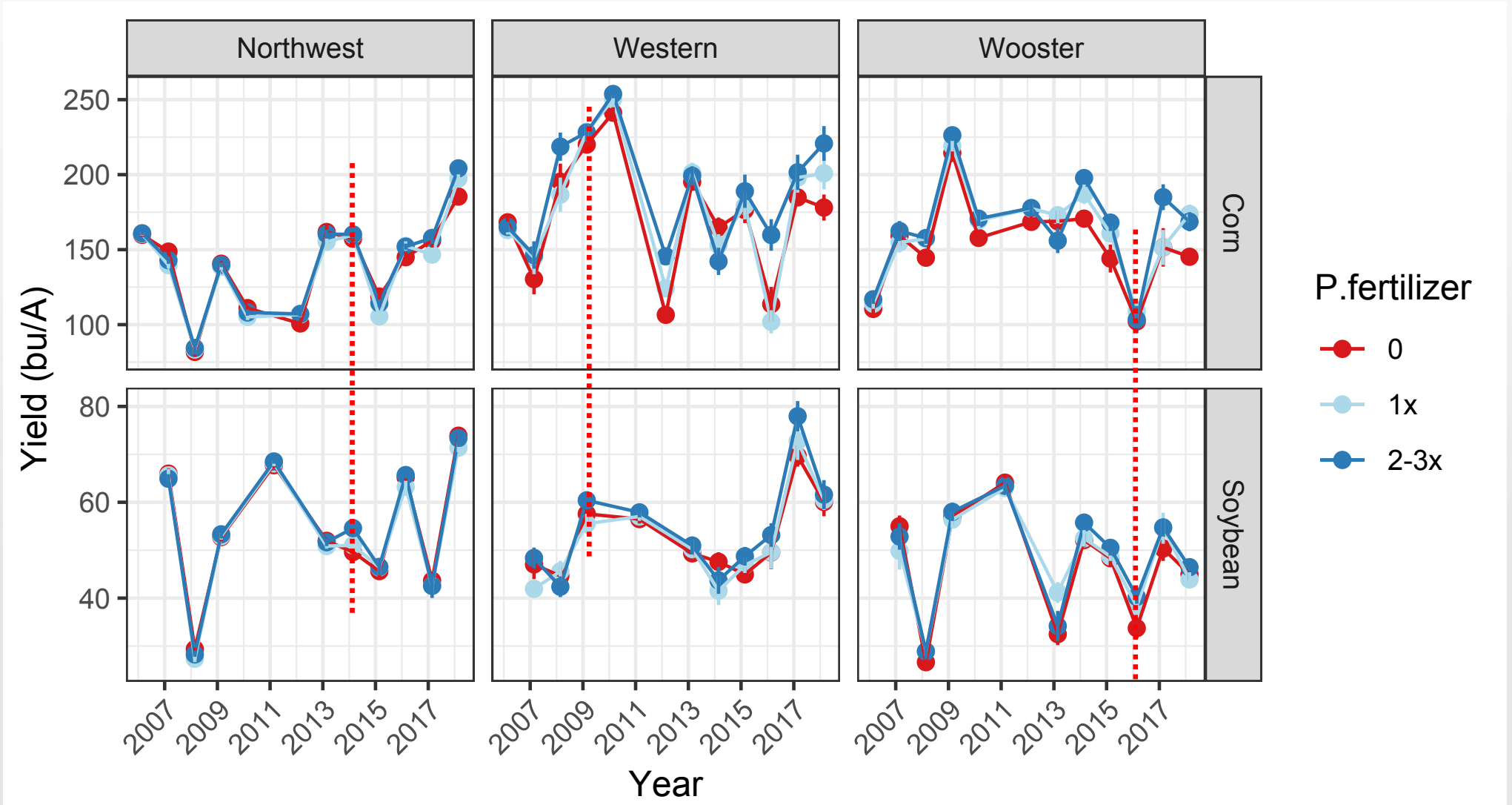
Drawdown Soil Test Rates of Unfertilized Plots (13 yrs)

	CEC (meq/ 100g)	Change in M3P values (ppm) 2006 → 2018	Change in STP/yr (M3-P, ppm)	Change in M3K values (ppm) 2006 → 2018	Change in STK/ yr (M3-K, ppm)
Northwest	22	30 → 20	0.8	228 → 132	7.4
Western	13	39 → 12	2.1	130 → 70	4.6
Wooster	11	38 → 22	1.2	130 → 63	5.2

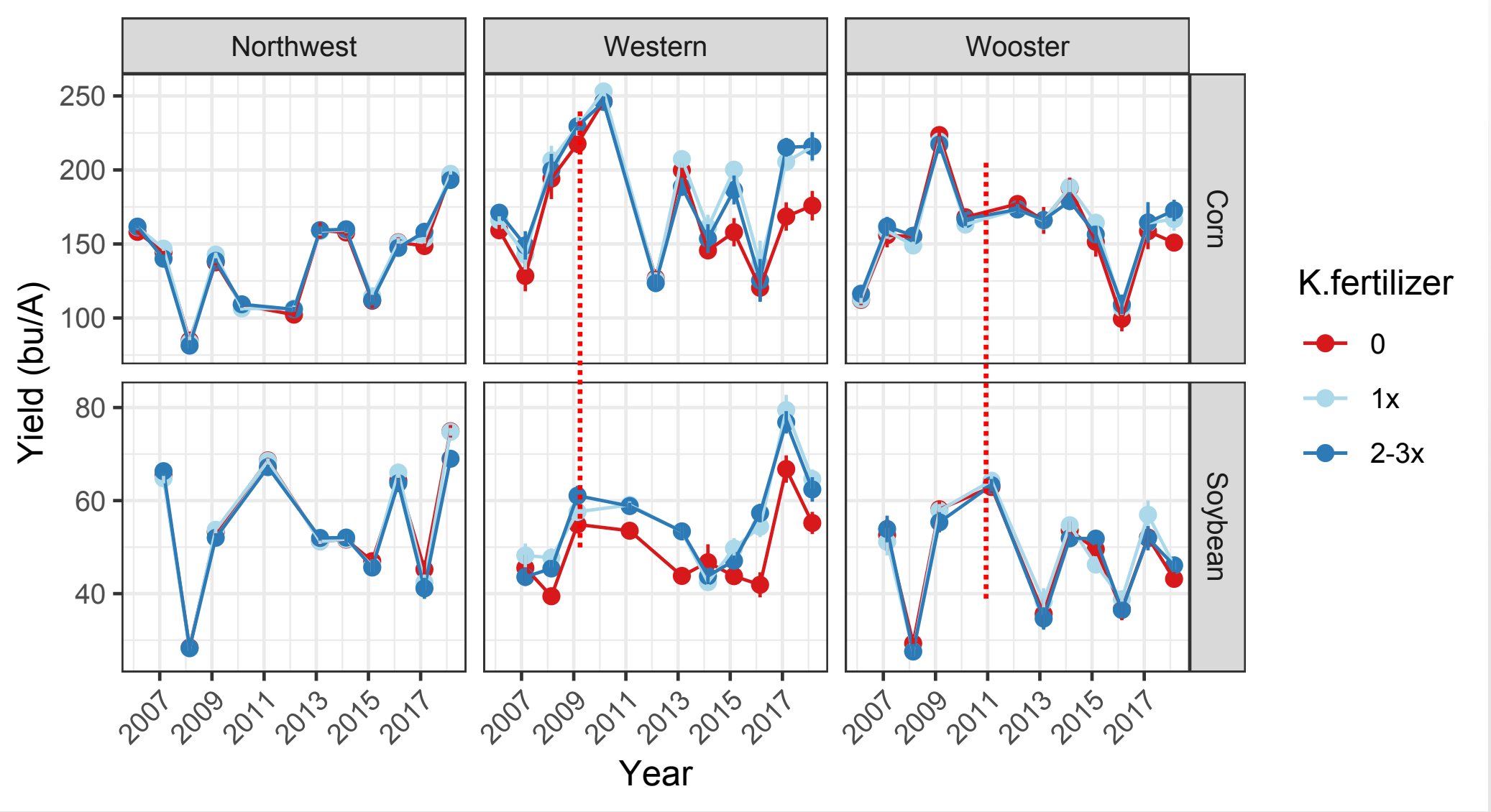
0.8 – 2.1 ppm/yr
in P drawdown

4.6 – 7.4 ppm/yr
in K drawdown

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

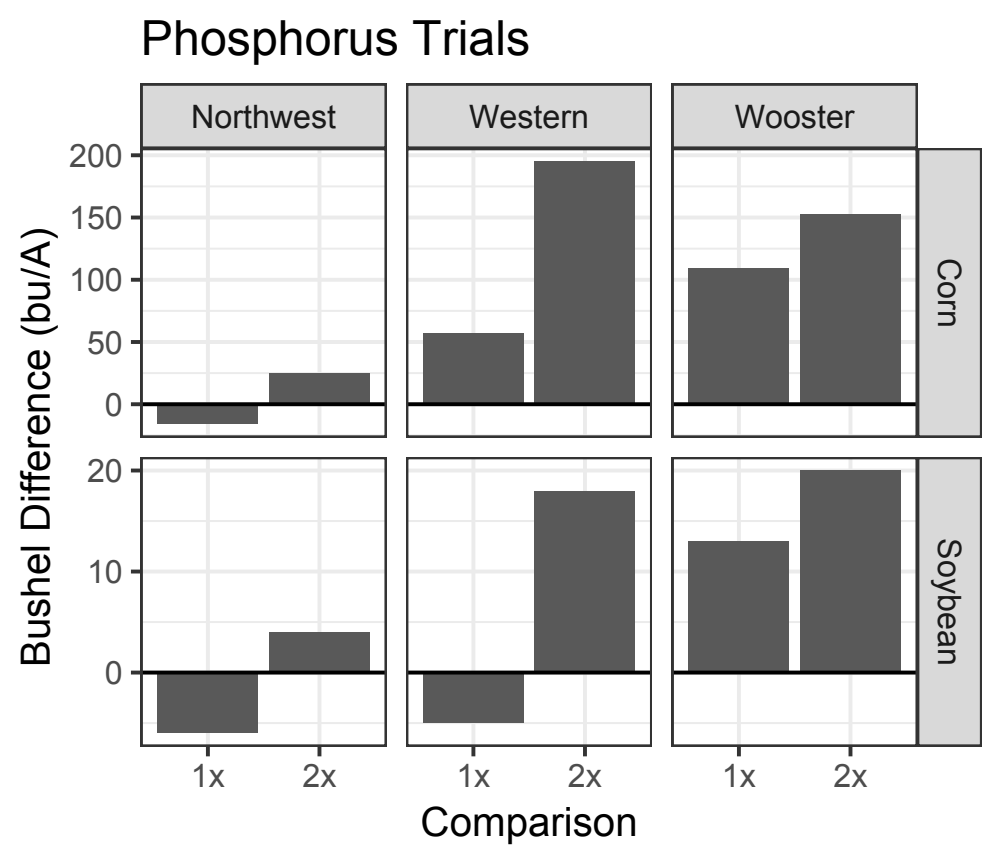
Applying Fertilizer Increased/ Decreased Yields (P <0.10)

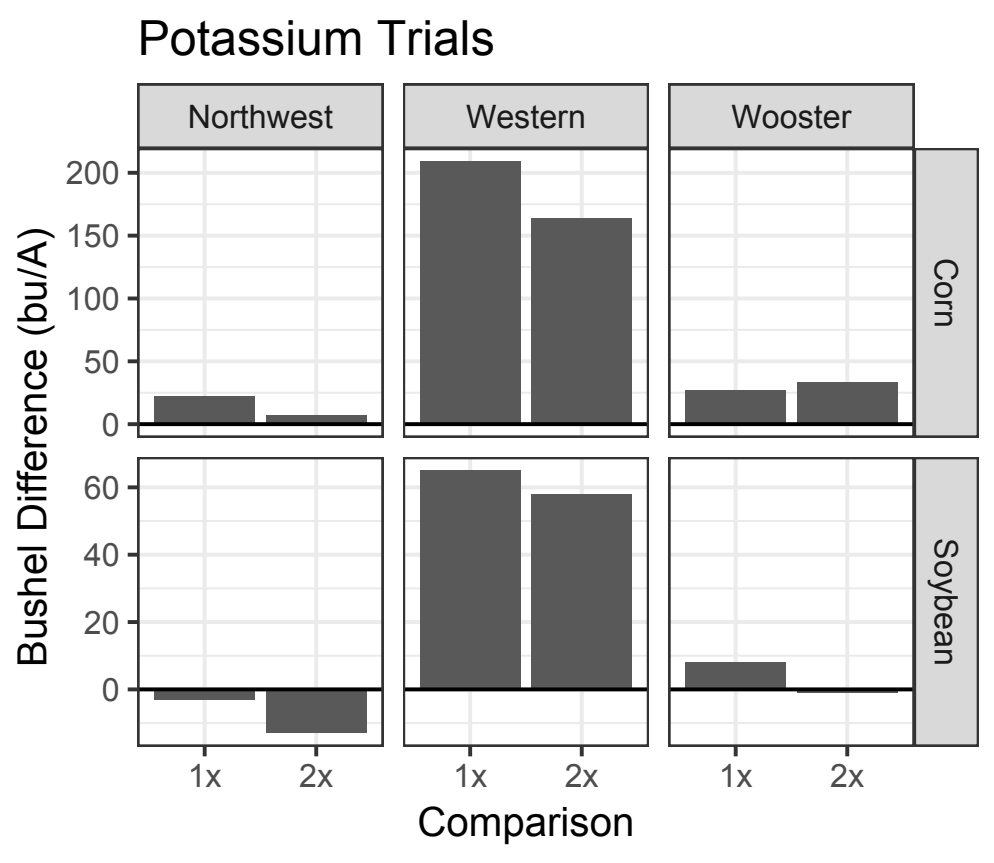
		P trials		K trials	
Crop	**Observations**	**Increase**	**Decrease**	**Increase**	**Decrease**
Corn	108	22 (16, 6)	3 (1, 2)	8 (7, 1)	2 (0, 2)
Soybean	90	7 (4, 3)	5 (1, 4)	15 (12, 3)	4 (0, 4)

(Obs below critical level, obs above critical level)

13 Year Yield Differences: Fertilized – 0

(+ values = bu/A increase with fertilization)



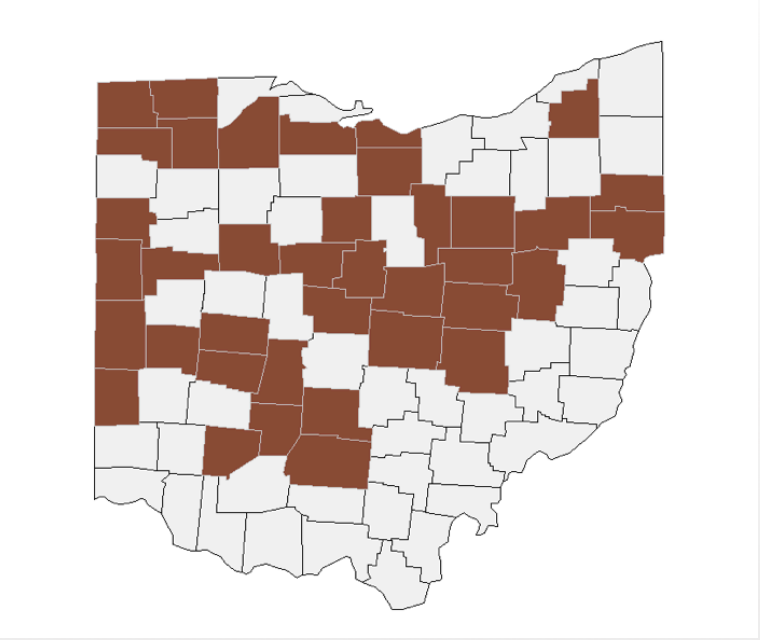


P trials yielded more bushels with 2-3x rate vs. 1x rate

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

On-Farm Strip Trials (2014 – 2018)

Recent On-Farm Work



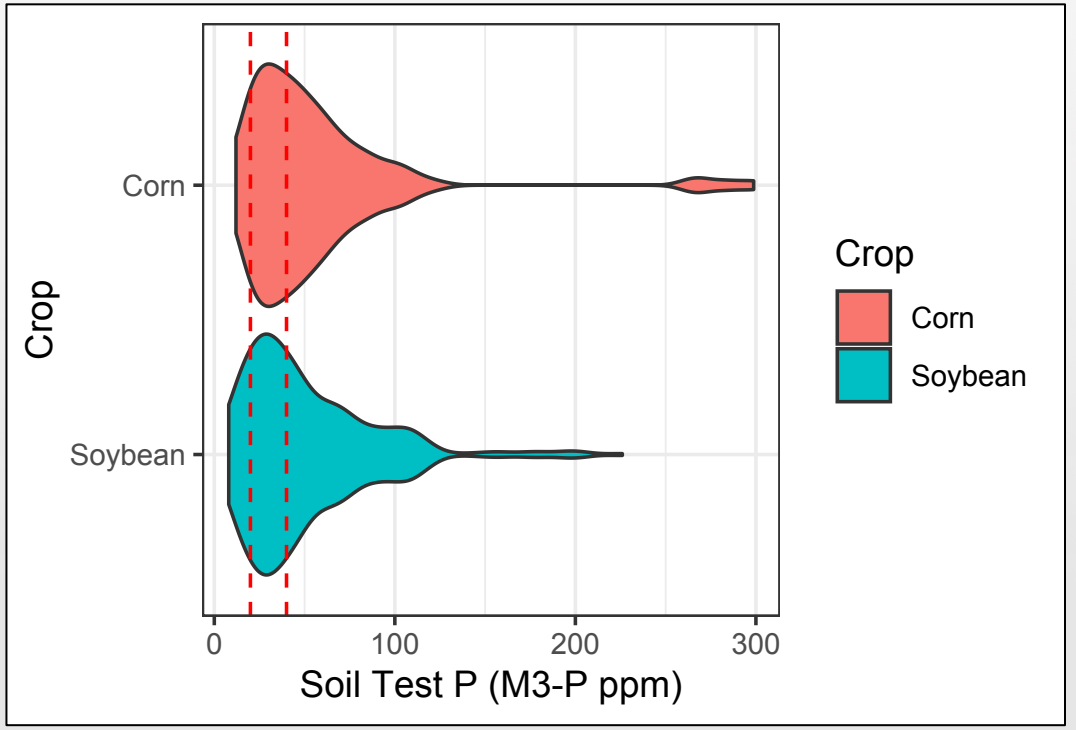
- Corn, soybean and wheat on-farm trials
- N, P, K, S
- Many sites over diversity of soil types and regions in Ohio
- Worked directly with growers, crop consultants, educators, agronomists
- Let farmers choose source, rate, timing, placement
- Soil sampling (0-8”), Leaf tissue (R1), Grain sample and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



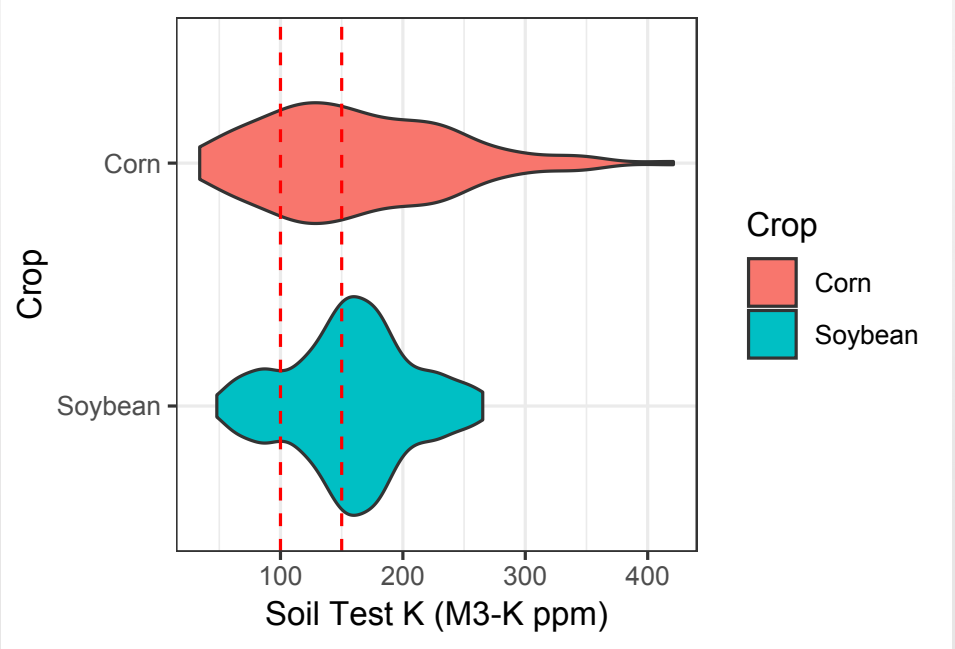
Distribution of STP levels across all trials by crop with red dashed lines indicating critical level (20 ppm M3-P) and maintenance limit (40 ppm M3-P)

P trials – AVG (Min – Max) Across all Trials

Crop	# of trials	Bushel Increase with Fertilizer (bu/A)	Relative Yield (%)
Corn	54	3.6 (-20.1 – 22.0)	98.0 (86 – 110)
Soybean	48	1.3 (-5.3 – 8.6)	98.0 (77 – 116)

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 – AVG (Min – Max) Across all Trials

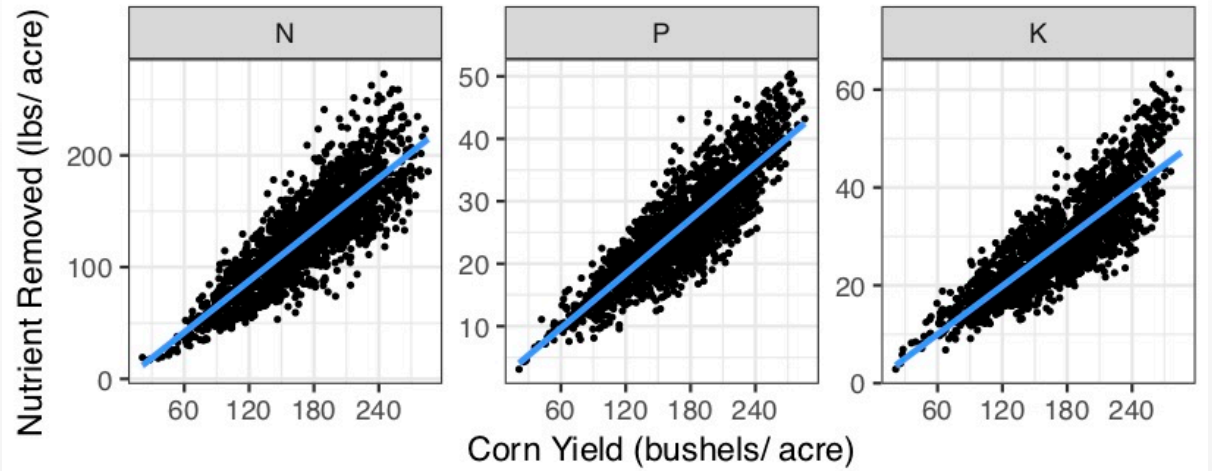
Crop	# of trials	Bushel Increase with Fertilizer (bu/A)	Relative Yield (%)
Corn	33	3.9 (-44.7 – 58.6)	98 (66 – 126)
Soybean	48	-0.6 (-7.1 – 6.7)	102 (68 – 122)

Identifying Critical Levels from PK Trials

		P Trials		K Trials	
		# of trails	**Critical STP Level (x)**	**# of trials**	**Critical STK Level (x)**
On-Station	Corn & Soybean	357	10.2	357	87
	Corn Only	214	22	216	72
	Soybean Only	143	12	141	120
On-Farm	Corn & Soybean	103	18	80	55
	Corn Only	57	26	35	59
	Soybean Only	46	18	45	230
On-Farm + On-Station	Wheat	14	32	14	62

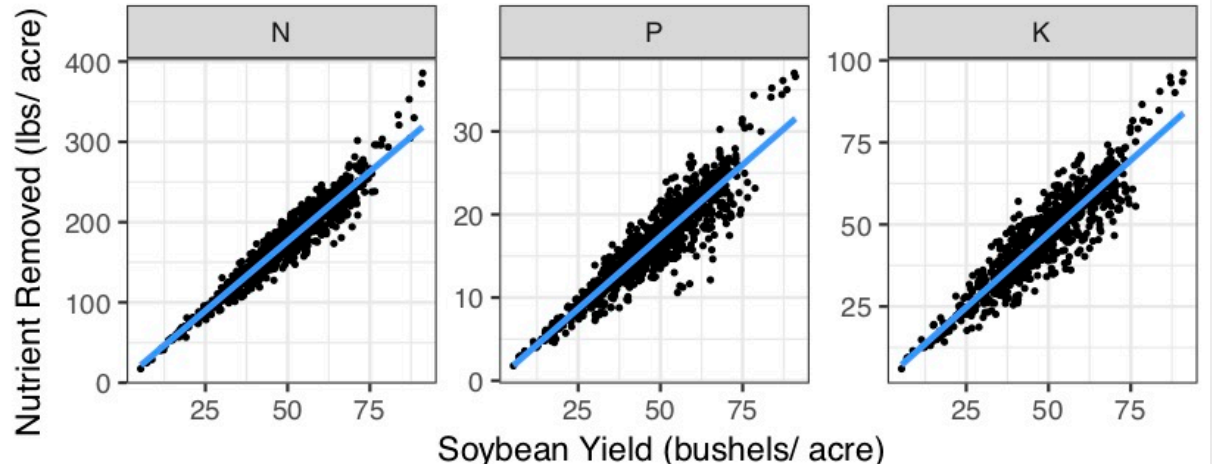
Grain Nutrient Removal Rates

go.osu.edu/grain

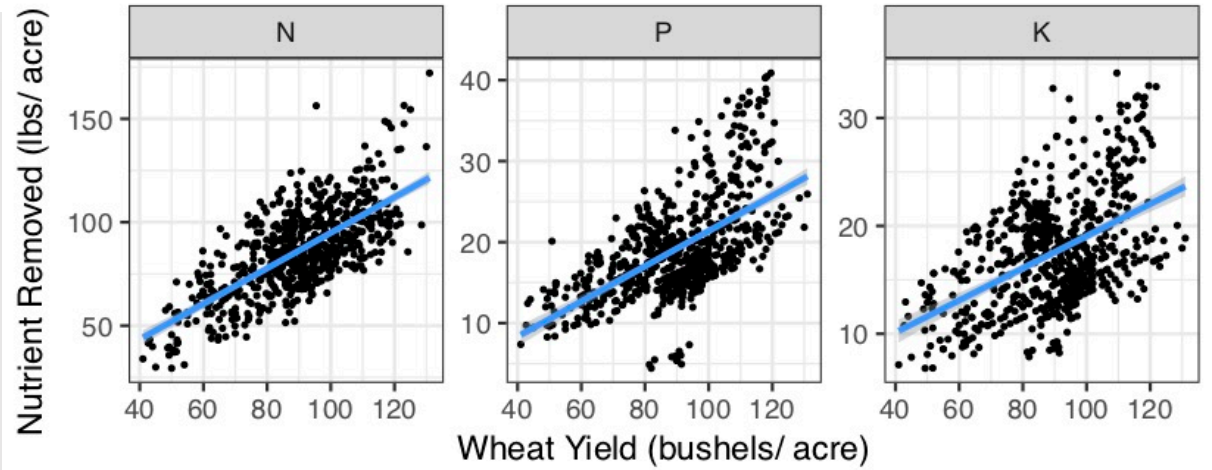


Corn

Nutrient Removal Rate vs. Grain Yield



Soybean



Wheat

	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%

Data Summary

- Soil test trends
  - STP trends showed both building and drawdown
  - STK failed to substantially build
  - Unfertilized soils dropped
    - 1 – 2 ppm M3-P/yr; 5-8 ppm M3-K/yr
- 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 ppm (or less)
- Grain nutrient removal rates decreasing (lb/ bushel), esp. K

Conclusions

- No evidence that current Tri-State 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
  - More work on maintaining K levels is needed
  - Little evidence that we need 4 different CL based on CEC for K

Recap of Major Changes

- 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
- Corn N Rates Updated - MRTN

What has not changed (yet), is consistent with 1995 version

- Lime recommendations
- Wheat N recommendations
- P and K build-up equations
- Leaf tissue sufficiency levels
- Sulfur, calcium and magnesium
- Micronutrient recommendations

Timeline

- Drafts under review
- Release early 2020
- Future Work
  - Wheat N recommendations
  - Leaf tissue sufficiency levels
  - Sulfur response

Thank You

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