CROP NUTRIENTS FOR EVER-INCREASING YIELDS:

Are current fertilizer recommendations adequate?

Gyles Randall
Univ. of Minnesota, Waseca

Fluid Fertilizer Forum, Scottsdale, AZ 2-15-10

Outline

- **Purpose**
- **Increasing yields**
- **Recent research**
- **Status of current recommendations**
- **Considerations for future recommendations**
- **Nutrient mgmt research to meet future needs.**

Purpose

To discuss challenges facing the fertilizer and nutrient management/research industry as crop yields and potential nutrient demands escalate.

Questions / Challenges

- Adequacy of today's recommendations?
- Will they become yield limiting?
- Is the necessary research in place to meet future needs?
- What are the nutrient/crop priorities?
- Economic and environmental consequences of future production systems.
- Logistics facing the dealer & farmer.
- Will time and placement need re-evaluation?

Increasing Corn Yields

- 1970's – 2000: 1.9 bu/A/yr
- 2000 – 2009: 3 bu/A/yr
- 2030 goal: 250-300 bu/A or
  6 bu/A/yr for next 20 yrs.

Recent Research

Can VERY HIGH Corn Yields be Produced on Low P-Testing Soils?

Univ. of Minn., Waseca

Corn production research on low vs. high to very high P-testing soils

- Location: SROC, Waseca
- Soils: Webster clay loam, tiled 75’
- Soil Test Bray P: 7 ppm (L) vs. 25 ppm (VH)
- Low P site mined with no P or K applied for previous 6 years
- Corn: 2005, 2006, 2007
- Soybean: 2006, 2007, 2008
- Potassium applied at 120-200 lb K_2O/A/yr
- Hybrids, varieties, planting dates, etc same for both L & VH sites each year
- Strip-till corn, No-till soybean

Corn yield as affected by soil P test and P placement

P Treatment		P Test	
Rate	Placement	Low	VH
lb P_2O_5/A		- - - - bu/A - - - -	
0	--	148	193
50/40	Deep-band[1/]	166	186
50/40	Pop-up	166	194
50/40	Broadcast	167	190
50/40	DB + Pop-up	172	189

[1/] 6-7” below soil surface under row.

Soybean yield as affected by soil P test and P placement for previous corn crop

Residual P Treatment		P Test	
Rate	Placement	Low	VH
lb P_2O_5/A		- - - - bu/A/yr - - - -	
0	--	34.5	49.1
50/40	Deep-band	38.5	49.1
50/40	Pop-up	38.2	48.9
50/40	Broadcast	37.1	48.4
50/40	BD + Pop-up	40.8	49.3

Yield and profitability advantage for a VH P-testing soil

Crop	Advantage	
	Yield	Econ Return[1/]
	bu/A/yr	$/A/yr
Corn	25	88
Soybean	10	100
Avg.		94

[1/] Corn @ $3.50/bu and soybean @ $10.00/bu, not counting fertilizer cost.

What did we learn?

- High and profitable corn and soybean yields could not be produced on L P-testing soils even though the P rate used for corn was greater than the UM recommendation.
- There was no advantage to deep-band placement over broadcasting.
- Important to know soil test P when acquiring or renting new land.

STATUS OF CURRENT FERTILIZER RECOMMENDATIONS

- OLD!
  - based on research from the 70's & 80's
  - average corn yields ranged from 80-120 bu/A with 175 bu/A seldom exceeded in research studies
- Recent changes
  - Nebraska, increased STP critical level from 15 ppm to 25 ppm (Bray) for corn after corn
  - Iowa continues to update

Soil Testing Concerns

- Best diagnostic tool we have for making P, K & Zn recommendations
- But it has uncertainties (temporal & spatial)
- Grid sampling and variable rate application
  - Newly acquired land,
  - Geo-referenced
  - Increases potential for higher and more profitable yields and lowers risk of yield loss due to insufficient P or K.

Future Nutrient Recommendations: CONSIDERATIONS

- Land tenure
  - owned vs. rented, length of rental contract
  - long-term vs. short term
- Financial position
  - Strong position vs. cash short
- Risk
  - losing yield due to inadequate fertility
  - economic and environmental*

Effect of Very High Yields on STP

- Uptake amounts will be greater.
- Soil test decline rates will be greater.

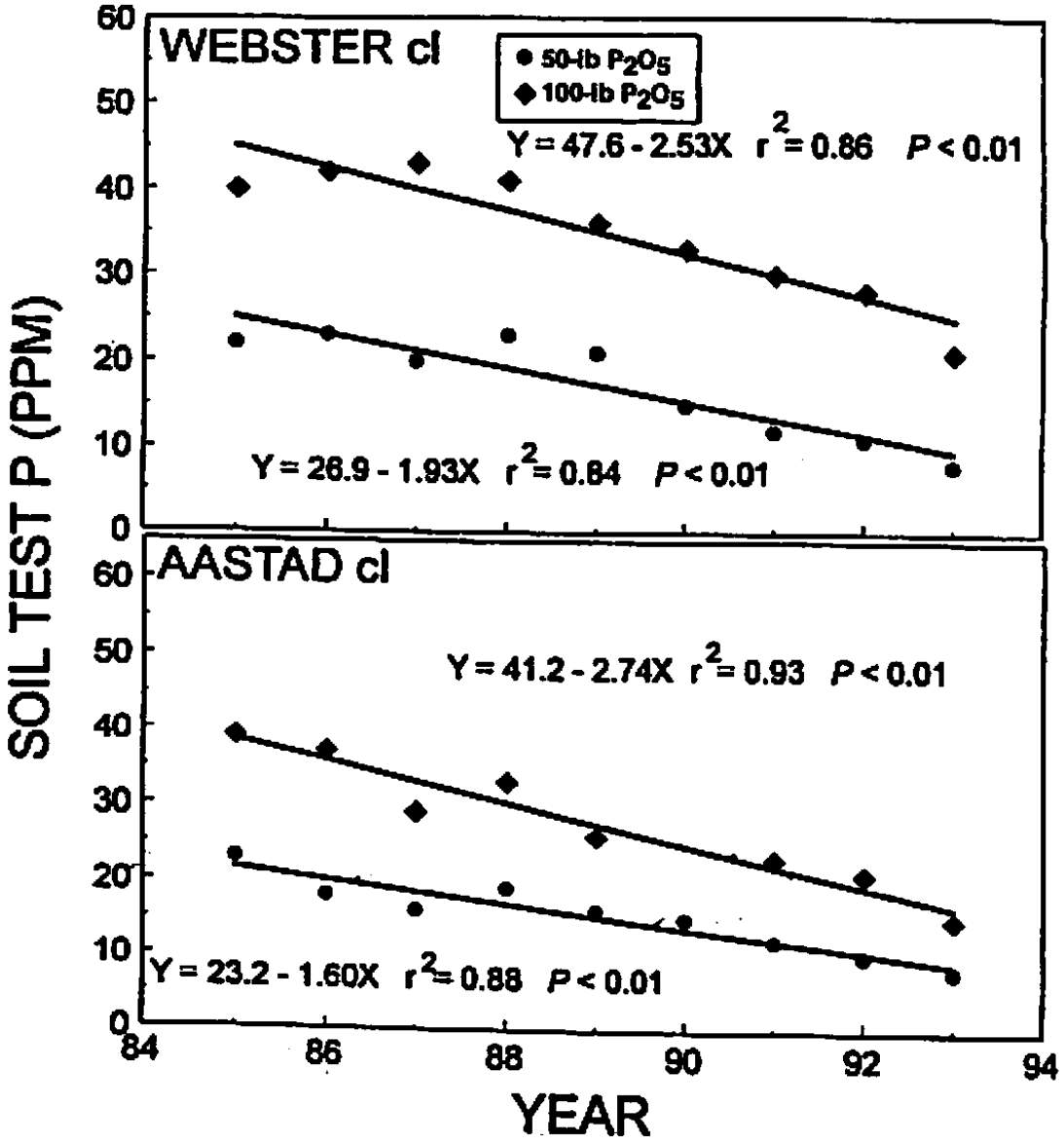


Fig. 3. Decline rates of STP in an 8-yr period when no fertilizer P was added to very high testing soils built up by 50- and 100-lb P_2O_5 rates.

Decline rates for STP during a 8-yr period at Waseca and Morris **(1973-1993).**

Waseca site:

8-yr period ('85–'93)
Starting at 40 ppm
declined about 2.5 ppm/yr
no decline for 4-yrs after long-term annual application

8-yr period ('85–'93)
Starting at 22 ppm
declined about 1.9 ppm/yr

Total P & K Uptake by Very High Yielding Corn & Soybeans[1/]

Crop	Yield	Uptake	
		P	K
	bu/A	lb P_2O_5/A	lb K_2O/A
Corn	308	140	396
Tassel-Maturity (%)		86%	72%
Soybean	101	136	344
Full bloom-Softseed (%)		88%	83%

[1/] Roy Flannery, Rutgers Univ.

Fertilizer Placement

35,000 plants/A in 30” rows = 1 plant/6”
Root zone = 6” x 30” x 48” = 8640 in.^{2}

- Band vs. Broadcast ??
  2” diam. Band = 0.2% of root zone
  3” diam. Band = 0.5% of root zone

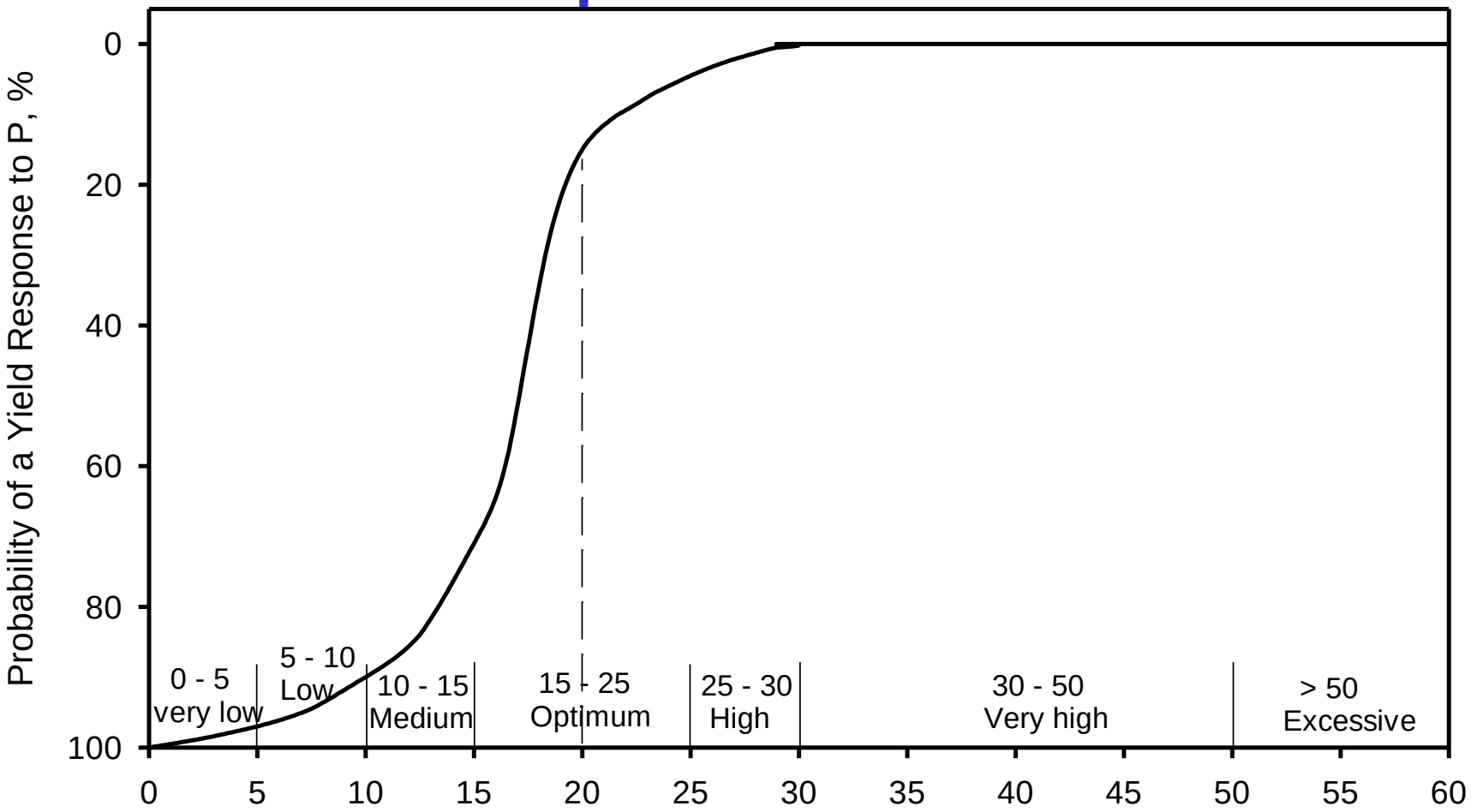
- Soil moisture often limited in top 24” for 1 to 6-week periods in mid-to late season under rainfed conditions.

P and K Recommendations

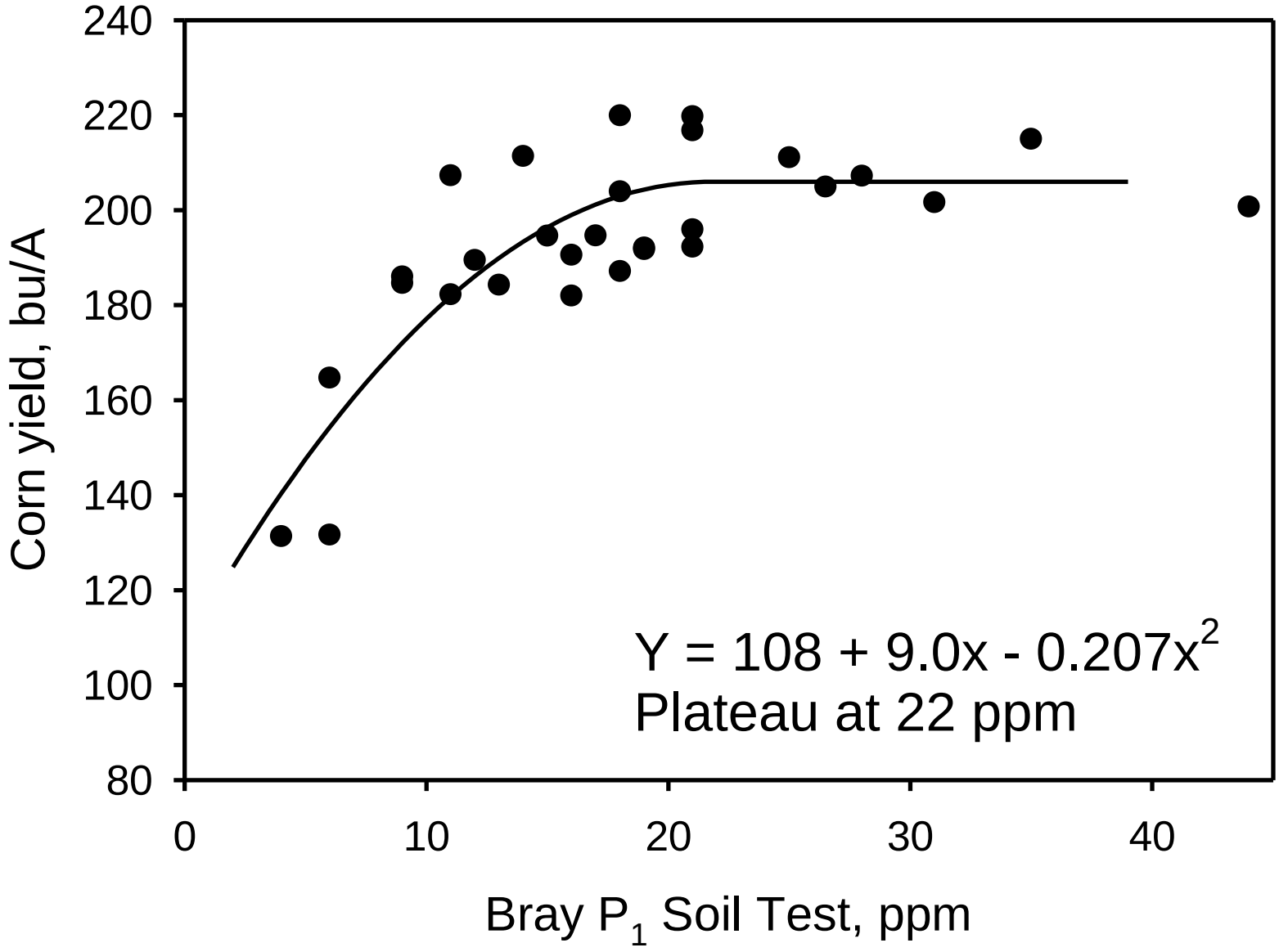
"A Model for the Future"

Proposed

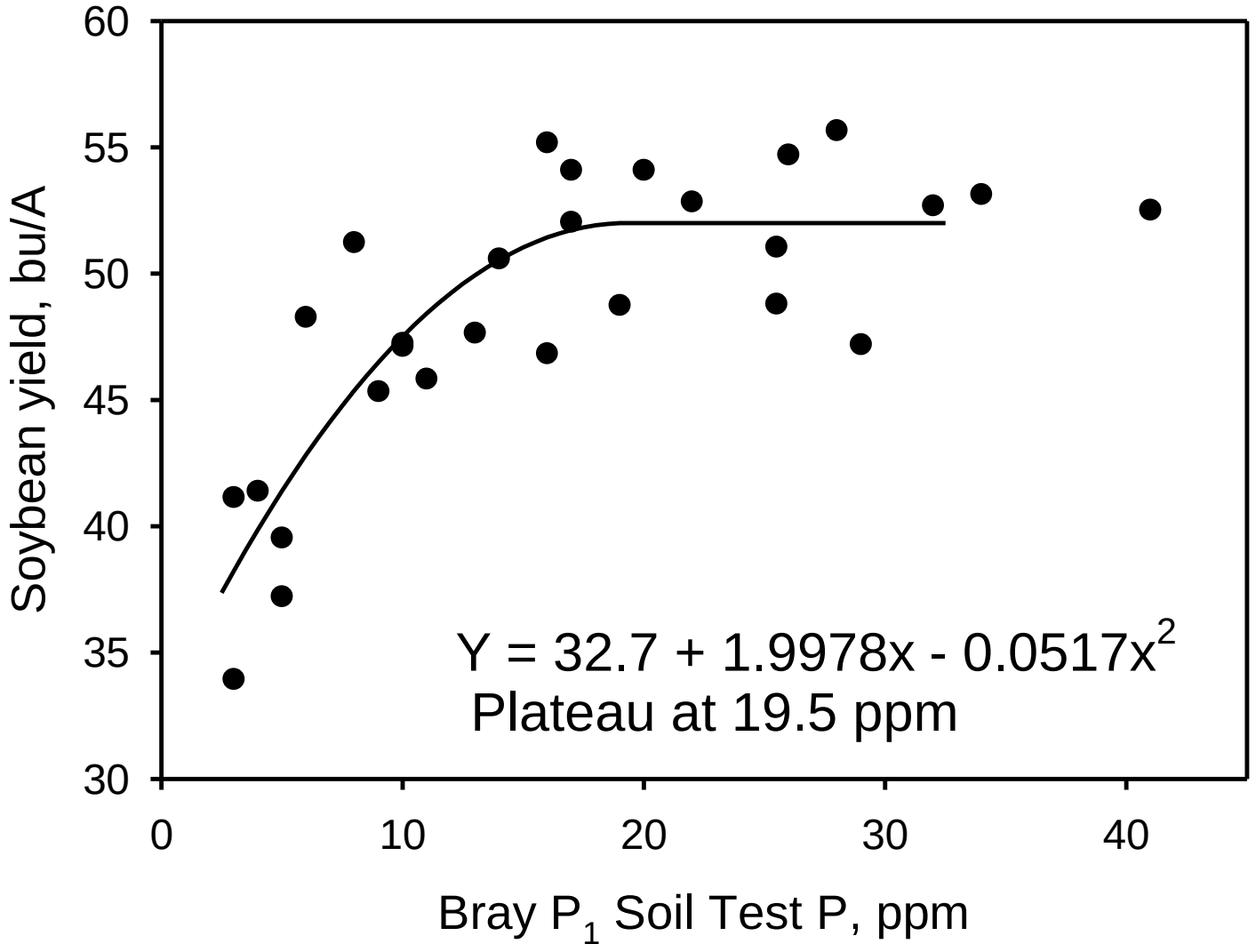
Phosphorus soil test model for Minnesota corn production.



Corn yield response as affected by soil test P (Bray) at Waseca in 2008.

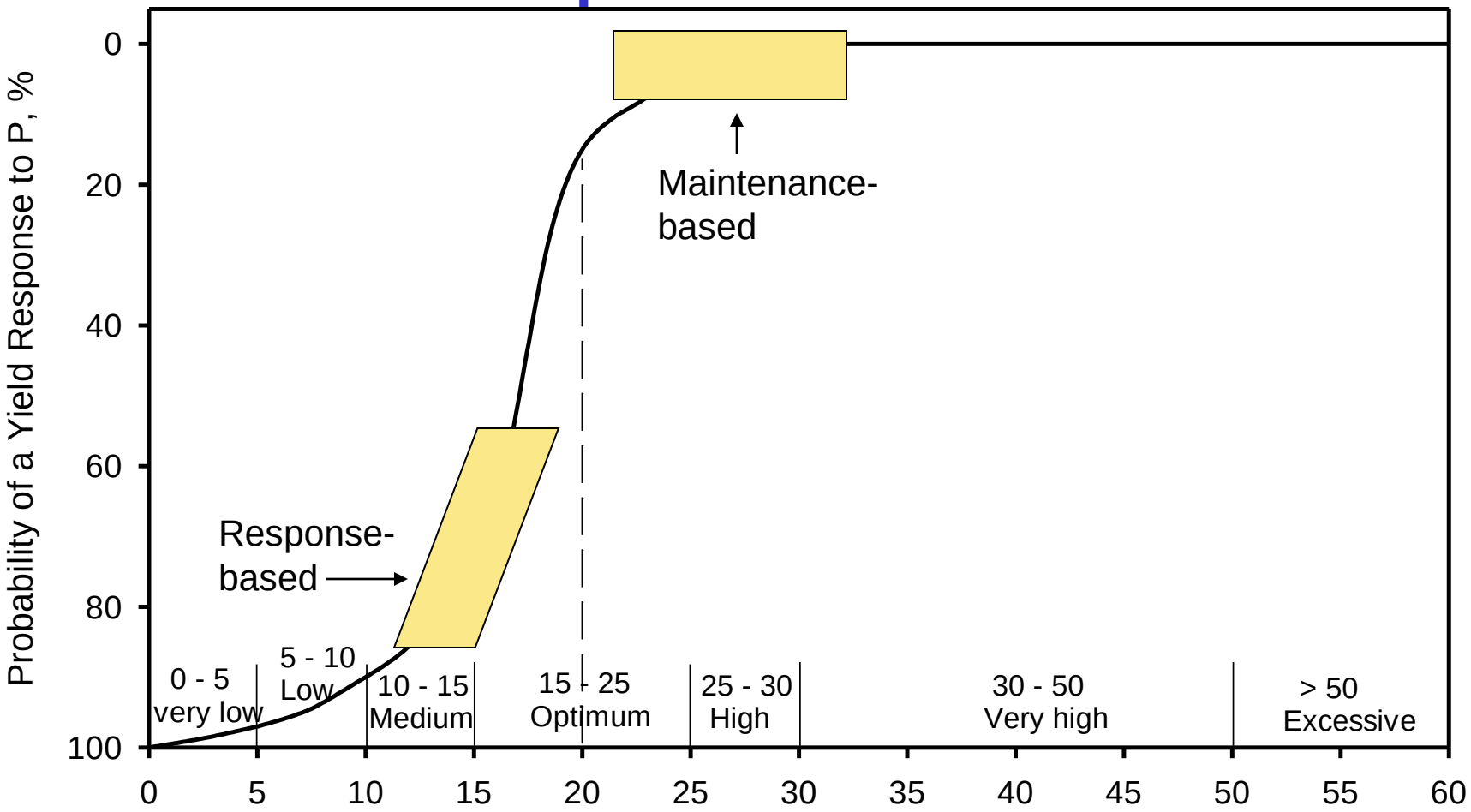


Soybean yield response as affected by soil test P (Bray) at Waseca in 2009.



Proposed

Phosphorus soil test model for Minnesota corn production.



Response-based P Management

- Emphasizes short-term returns
- Requires high accuracy of soil testing, calibrations, and optimum economic fertilizer rates each year.
- Requires frequent soil sampling and careful fertilizer application methods
- Reasonable for “fixing” soils where buildup and maintenance is not practical

Source: A. Mallarino

Buildup/Maintenance-based P Management

- Emphasizes long-term productivity and returns, and reduced risk of yield loss.
- Less sensitive to errors in soil testing and calibration.
- Does not require as frequent soil testing.
- Reasonable for soils with little to moderate “fixation”.
- Suitable when land tenure is secure for at least 2-3 years.
- Suitable for larger farming operations.
- Provides flexibility when fertilizer prices change!

Source: A. Mallarino

Other P Management Issues

- To a large extent, P & K can be “banked”.
- Retention by soil is not necessarily “fixation”.
- Soil testing is not perfect ---uncertainties.
- Use long-term soil test trends to monitor P & K additions and removal.
- Land tenure, farmer’s management philosophy and cash position, and other practical issues should be considered in conversations among farmer, dealer, consultant, and lender.
- What probability of yield response & risk of yield loss is the farmer comfortable with?

Nutrient Mgmt. Research to Meet Future Needs

Is P & K research in place and adequate?

- Marginal, Why?
  1) N has been a priority
  2) Funding has been limited
  3) Number of applied scientists has been declining

What will be needed to meet these demands?

- Calibration research under VH-yield conditions
  - minimize effect of non-controllable yield-limiting factors
  - both small plot and field-size strips
  - intense data collection
- P and K plus S and micronutrients, crop?
- Placement – deep?
- Multiple recommendation options to meet growers tailor-made needs
  - facilitate communication between grower and nutrient supplier, advisor & lender

Are current fertilizer recommendations adequate for ever-increasing yields?

Thanks

Questions?

Gyles Randall

http://sroc.cfans.umn.edu