Nitrogen management on sandy soils

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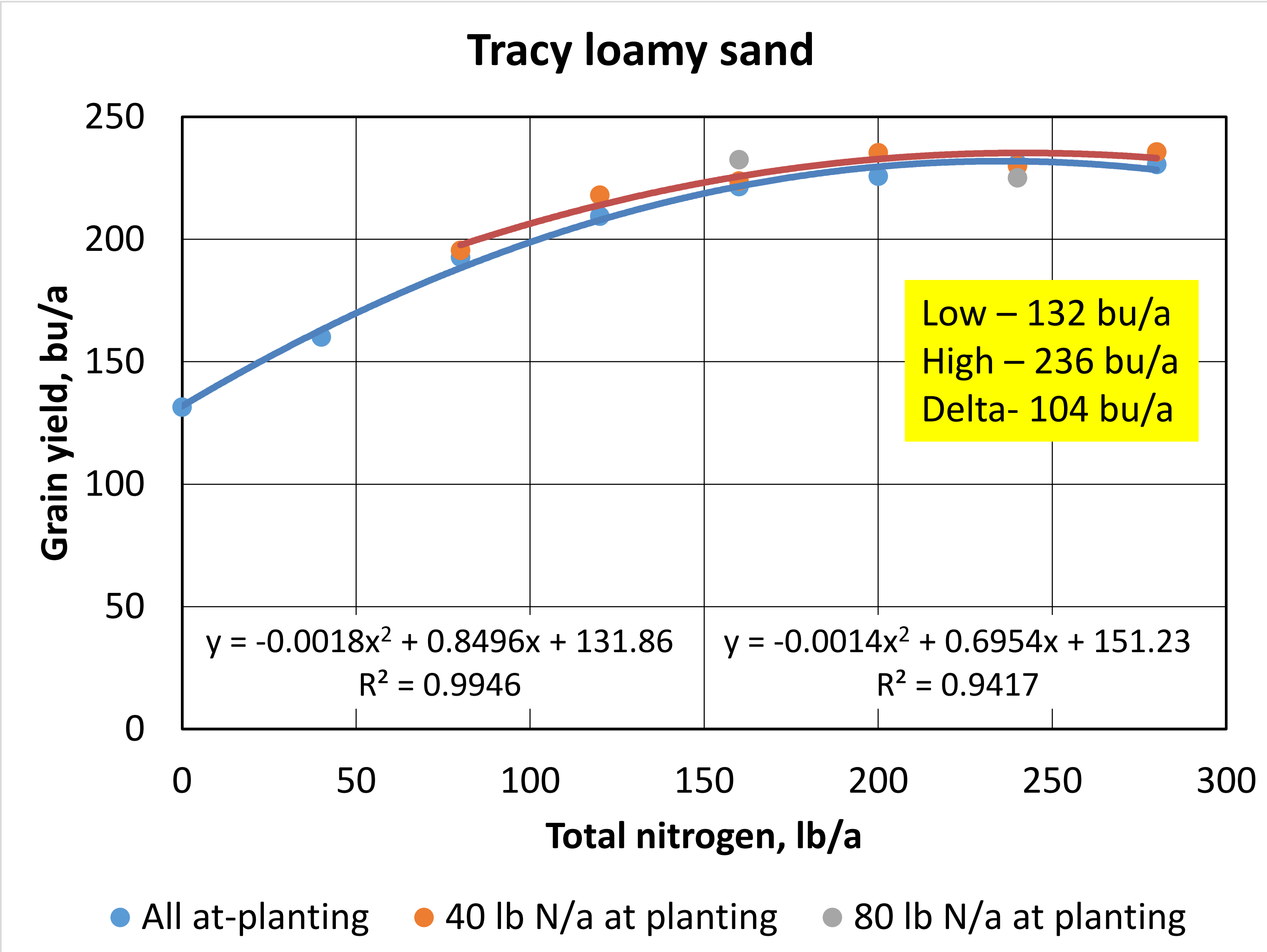
Nitrogen rate response trials

- Purdue and farmer fields
- 4-6 N rates replicated 4-6 times
- Calibrated yield monitor
- Yield response fit with equation to determine opt. N rate and yield



Tracy loamy sand
Grain yield, bu/a
Total nitrogen, lb/a
250
200
150
100
50
0
0
50
100
150
200
250
300
Low – 132 bu/a
High – 236 bu/a
Delta- 104 bu/a
y = -0.0018x2 + 0.8496x + 131.86
R² = 0.9946
y = -0.0014x2 + 0.6954x + 151.23
R² = 0.9417
All at-planting
40 lb N/a at planting
80 lb N/a at planting

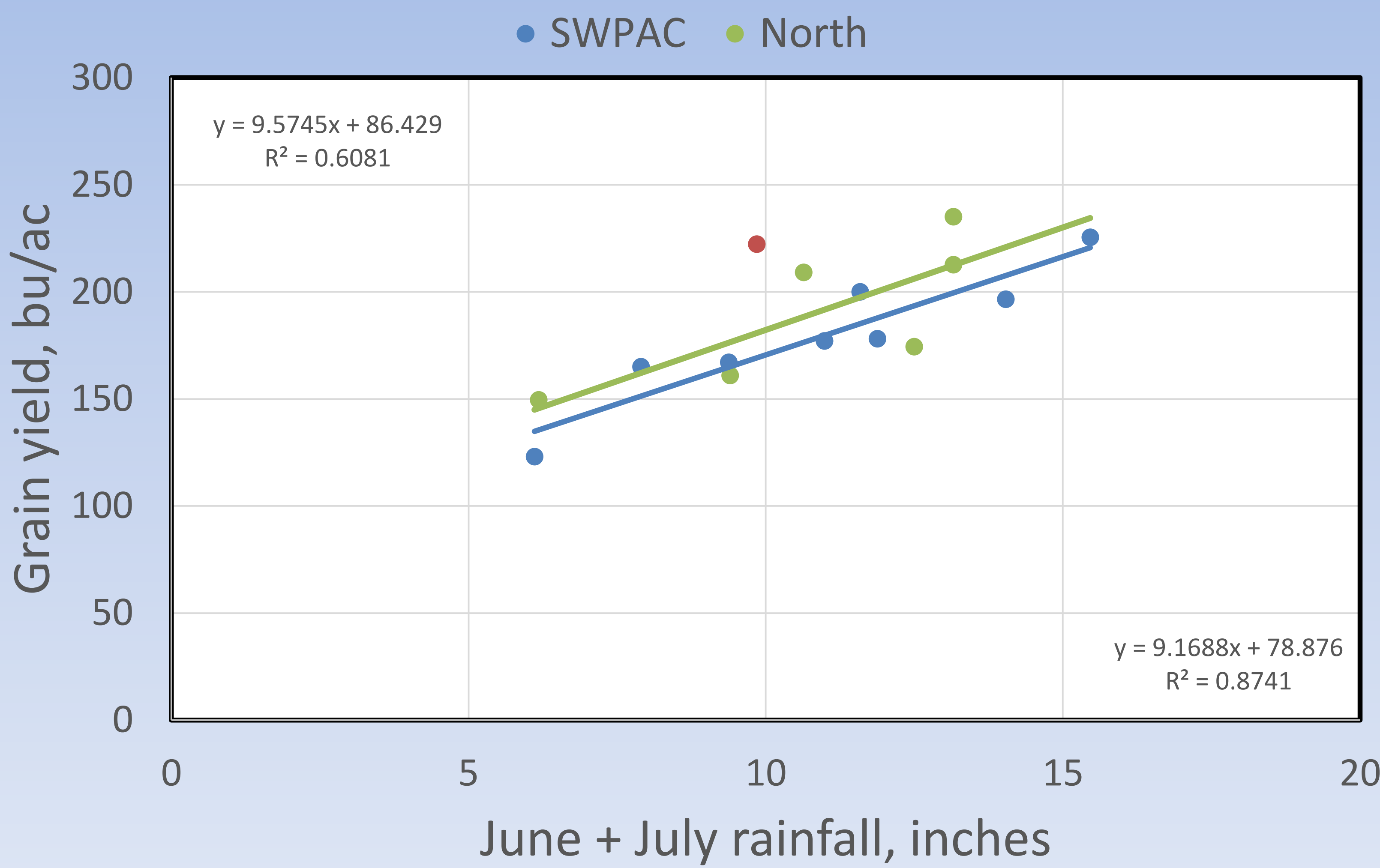
Table 3. Range of economic optimum N rate (EONR) values (lbs/ac applied N) for corn following soybean as influenced by nitrogen cost per lb. N (Table 8) and grain price per bushel based on yield response data summarized **throughout Indiana on sandy, non-irrigated soils**. The average agronomic optimum N rate for these sandy, non-irrigated soils is approximately 184 lbs N/ac.

Sandy non-irrigated soils

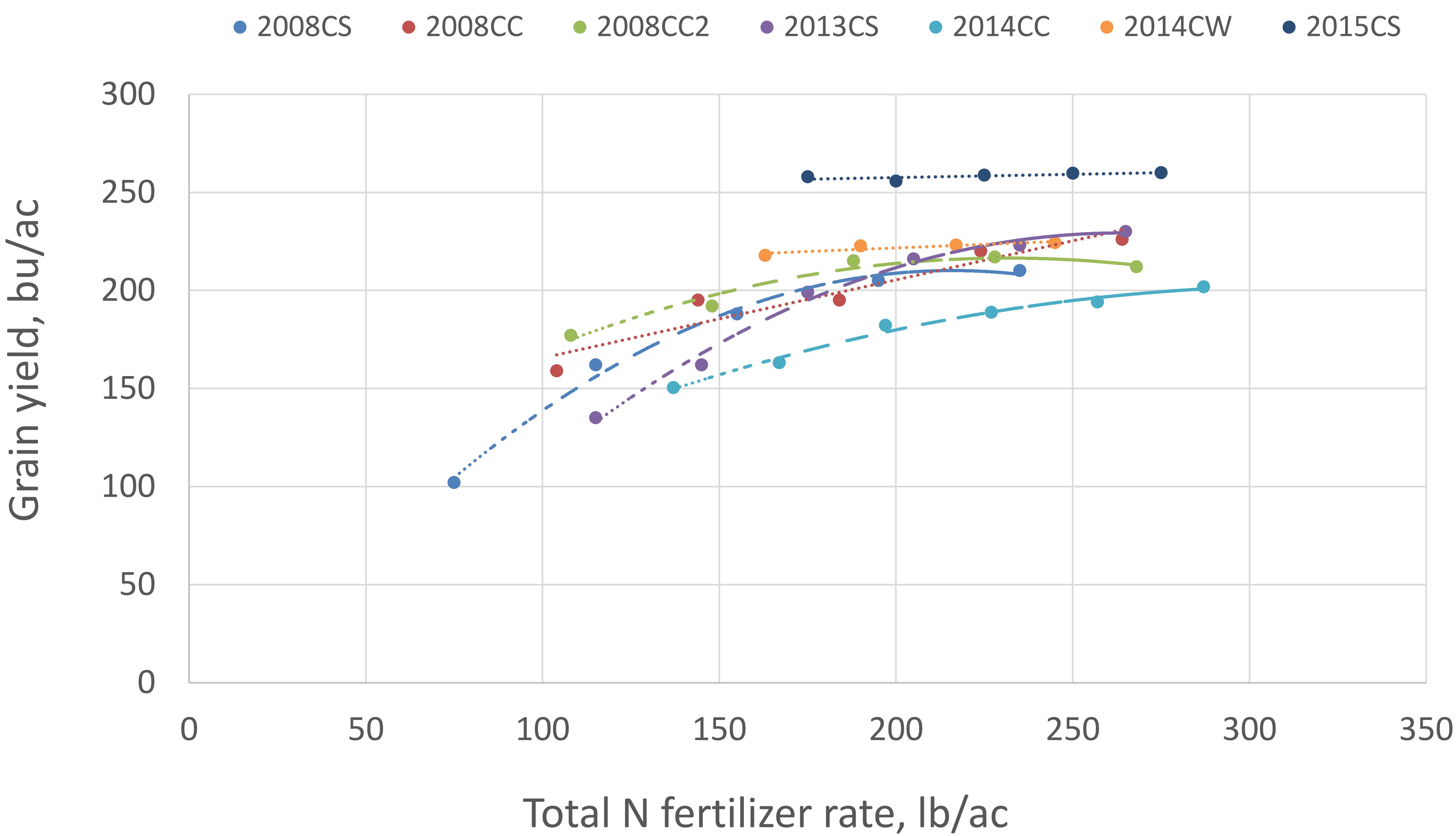
	Grain price						
N cost	**$2.50**	**$3.00**	**$3.50**	**$4.00**	**$4.50**	**$5.00**	**$5.50**
$0.30	166	169	172	173	174	175	176
$0.40	160	164	167	169	171	172	173
$0.50	154	159	163	166	168	169	171
$0.60	148	154	159	162	164	166	168
$0.70	142	149	154	158	161	163	165
$0.80	136	144	150	154	158	160	163

Based on 14 field-scale trials conducted 2006-2014. These rates assume N management practices that minimize the risk of N loss prior to plant uptake.

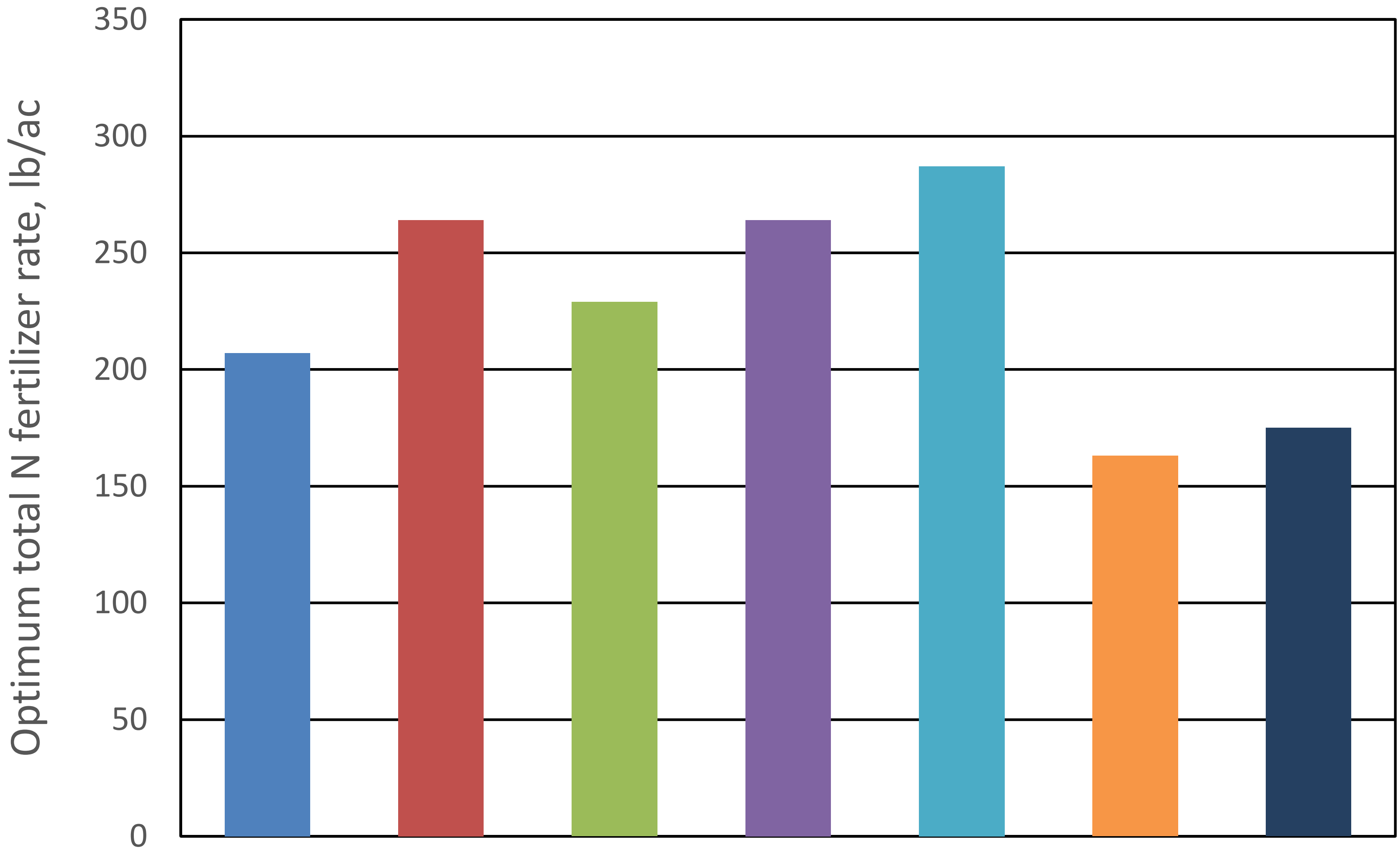
June and July rain is positive



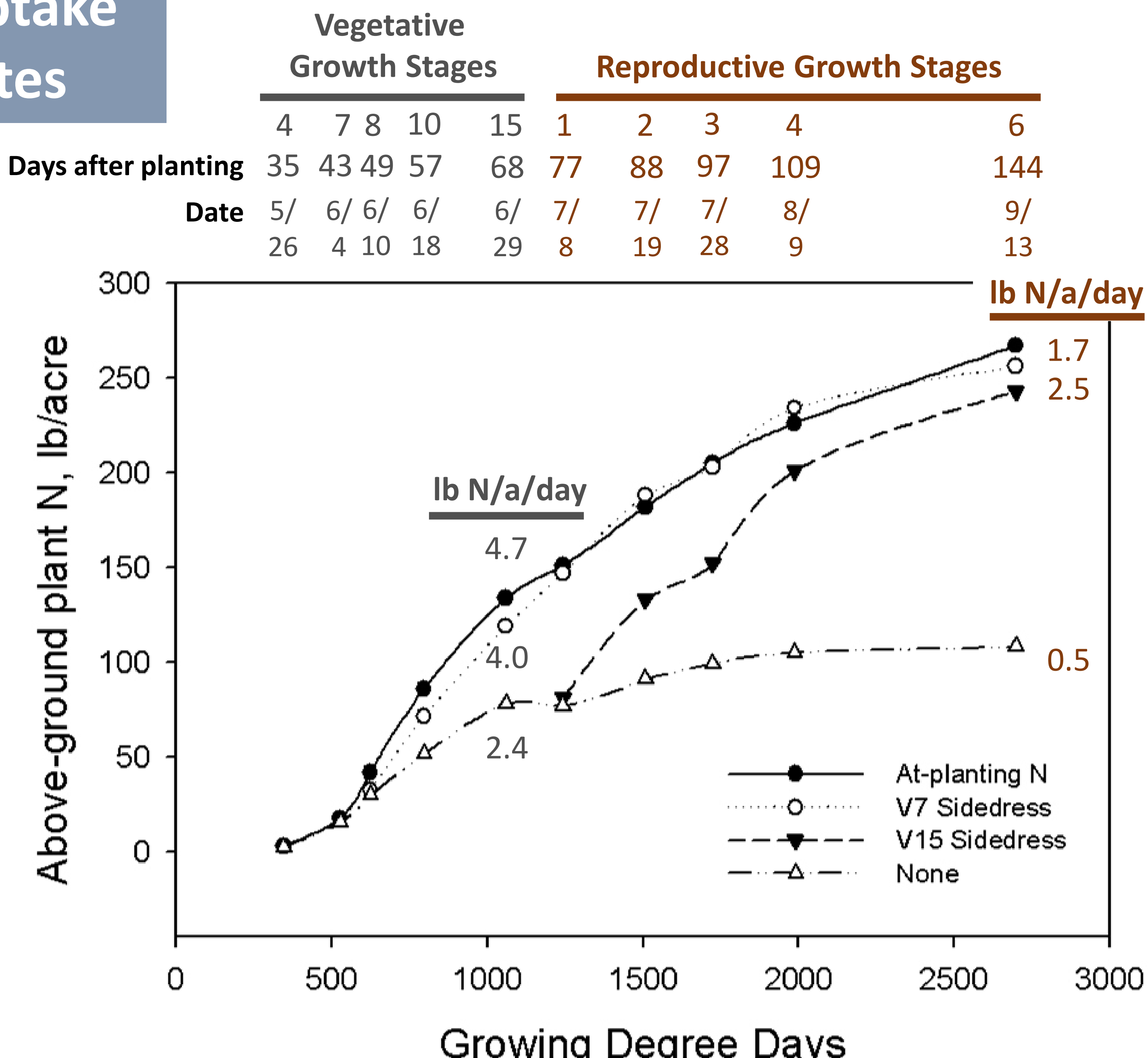
Irrigated corn response to N



Optimum N rate varies



N uptake rates



Miller, Nielsen, Camberato, 2010

Nitrogen fertilization to feed the crop

- Provide N early
  - N accumulated rapidly during vegetative growth, about 5 lb N/ac/day
  - Normally 2/3 of total
- Ensure N availability late
  - N accum. at similar rate per GDD as during veg. growth
  - Normally about 1/3 of total
  - Crop can accum. N faster if crop is N deficient

Nitrogen fertilizer forms

- Anhydrous ammonia
  - dissolves in water to form ammonium
- Urea ammonium nitrate
  - Urea (at application) and nitrate are leachable, but not ammonium
  - Urea is rapidly converted to ammonia/ammonium (1-3 d)
  - If left on surface ammonia loss can occur
- Ammonium is converted to nitrate in a few days to weeks

Nitrogen fertilizers

- Banding and urease inhibitors (NBPT, NPPT) reduce ammonia loss from surface-applied urea
- Banded fertilizers convert more slowly to nitrate (AA slower than UAN)
- Nitrification inhibitors (nitrapyrin, DCD) slow conversion of ammonium to nitrate

Irrigated corn N suggestions

- pH, P, K, S, and micronutrients and everything else provided at sufficient levels
- Minimize preplant N
- Use starter N – 25-40 lb N/ac, 10-15 lb P_2O_5/ac, plus S or Zn if needed (K?)

Irrigated corn N suggestions

- If 3 or more applications are planned
  - Sidedress V4-V7 to target N rate minus 30-50 lb N/ac
  - include strip at target +30 in several fields
- Apply remainder of N with irrigation by V12-V14

Potential tools for estimating N requirement

- Soil sampling for nitrate
- Sensors – SPAD, Greenseeker, OptRx, aerial photography
- Computer models – Climate Corp. N advisor, Pioneer Encirca, Agron. Tech. AdaptN

Soil N sampling and handling

- Soil N is quite variable, choose representative areas and take a lot of soil cores
- Keep samples cool until they can be dried by spreading thinly and air drying or dry in an oven at less than 250 ^{o}F
- Ship to laboratory

Soil N sampling suggestions

- 1-2’ in addition to 0-1’ when early-season rainfall may have moved some nitrate deeper in the soil (sandy soils)
- Ammonium-N (NH_4^+) in addition to nitrate (NO_3^-) if soil temperatures have been cooler than normal or recent N application

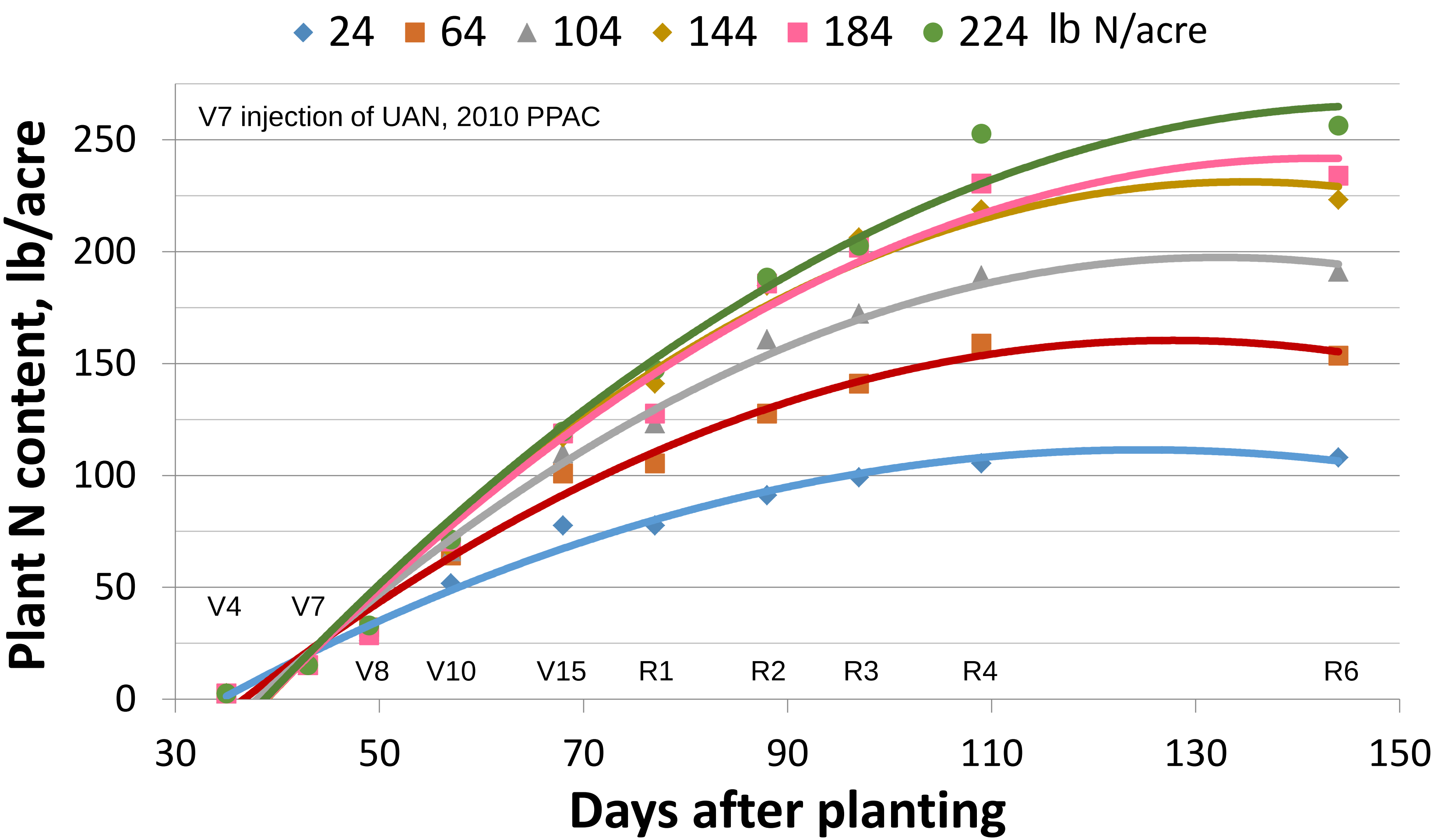
Assessing N loss with soil sampling

Expected level of NO_3-N or (NO_3-N + NH_4-N) in a 1 foot soil sample at different fertilizer application rates

Fertilizer N applied prior to rains	Nitrogen analysis: Expected N levels, ppm	
	NO_3-N	NO_3-N + NH_4-N
lb/acre	*	**
130	30	36
140	31	37
150	33	39
160	35	41
170	36	42
180	38	44
190	40	46

Apply 10 lb N/acre for every 2 ppm below expected level

Adjustment for plant N uptake



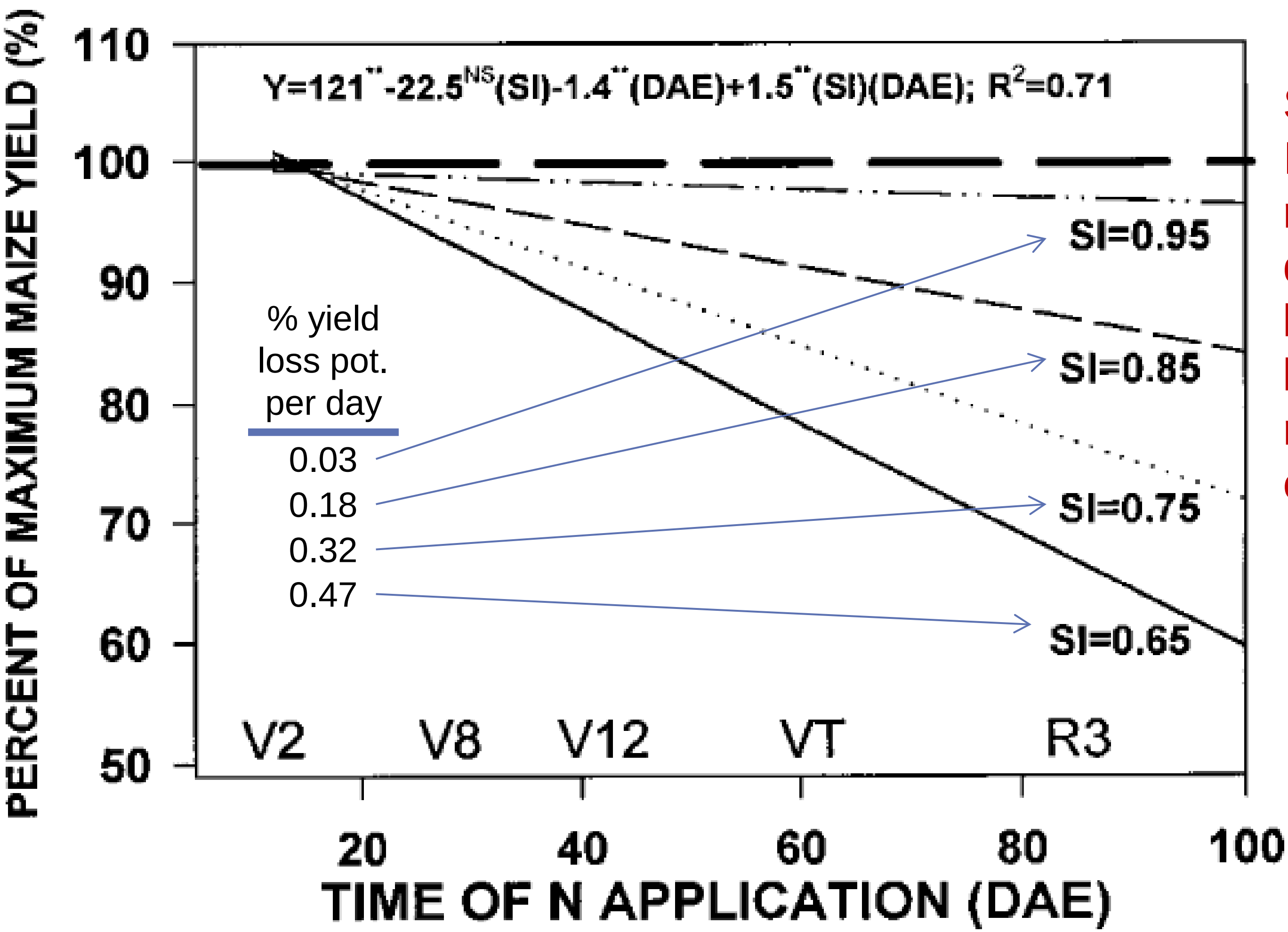
Adjustment for plant N uptake

- Plant N content / 4 = soil NO_3-N in ppm in upper 1' of soil
- At V10 plant N content will be about 40-80 lb N/acre and will have reduced soil NO_3-N about 10-20 ppm

Sensing and imagery

- Requires a reference strip for each hybrid in each field
- Differences are not normally detectable early, if they are yield may be lost
- Best utilized for rescue or perhaps for variable rate application of supplemental N

The greater and later the stress the greater the decrease in yield



SI, Sufficiency Index - SPAD readings of deficient leaf/sufficient leaf (most recently collared leaf)

Binder et al., 2000. Agron. J. 92:1228–1236

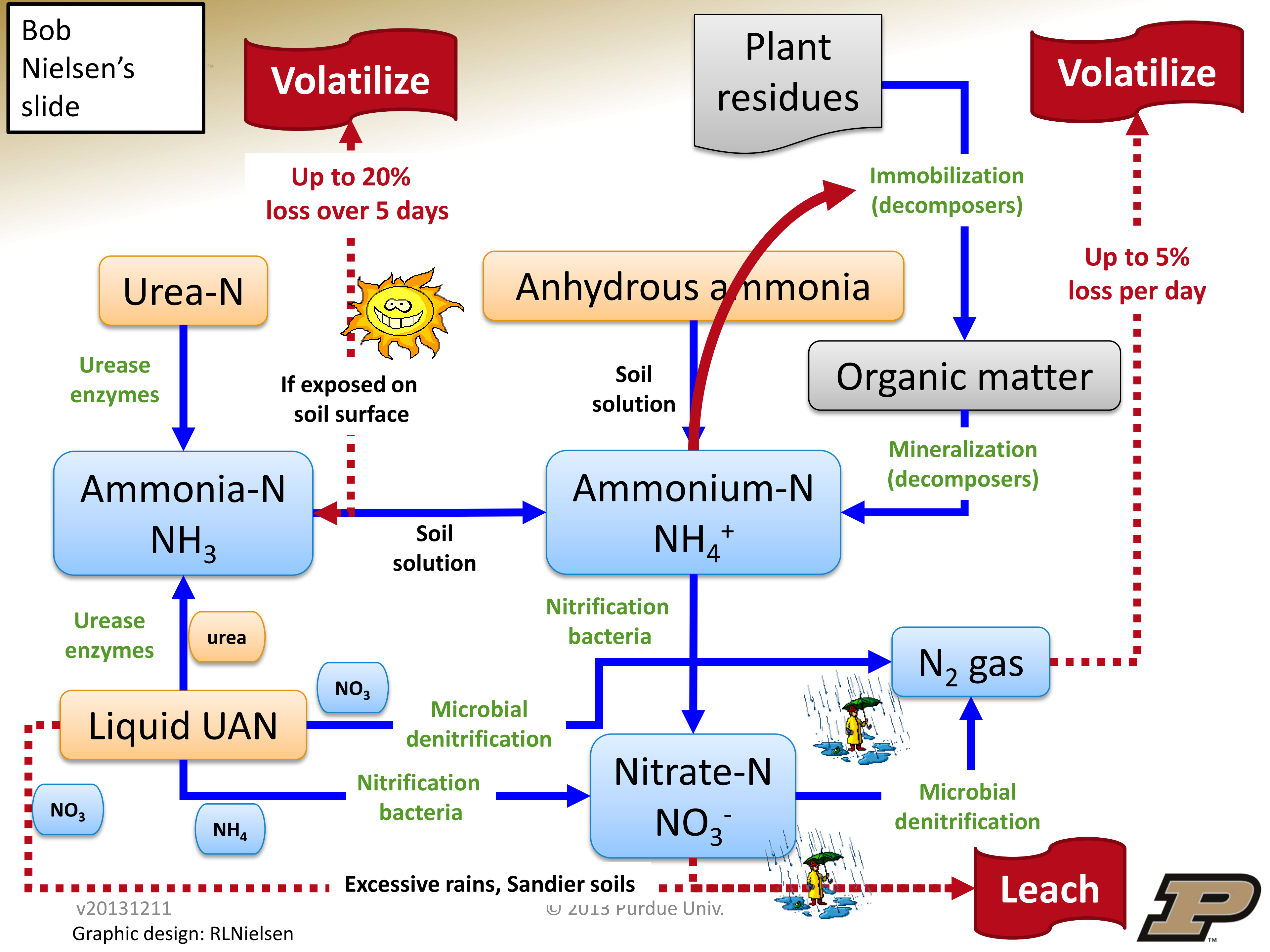
Yield loss with N stress

Sufficiency Index	Yield loss with delayed N application, bu/ac
0.65	1.24
0.75	0.67
0.85	0.30
0.95	0.13

Binder et al., 2000. Agron. J. 92:1228–1236

Computer models

- Pioneer – Encirca Yield Nitrogen Management Service
- The Climate Corporation – Field Pro Nitrogen Advisor
- Agronomic Technology Corp. - AdaptN



Bob Nielsen's slide
Volatilize
Up to 20% loss over 5 days
Plant residues
Volatilize
Immobilization (decomposers)
Up to 5% loss per day
Urea-N
Anhydrous ammonia
Organic matter
Urease enzymes
If exposed on soil surface
Soil solution
Mineralization (decomposers)
Ammonia-N
NH_3
Soil solution
Ammonium-N
NH_4^+
Nitrification bacteria
Urease enzymes
urea
NO_3
N_2 gas
Liquid UAN
Microbial denitrification
Nitrification bacteria
Nitrate-N
NO_3^-
Microbial denitrification
NO_3
NH_4
Excessive rains, Sandier soils
Leach
v20131211
Graphic design: RLNielsen
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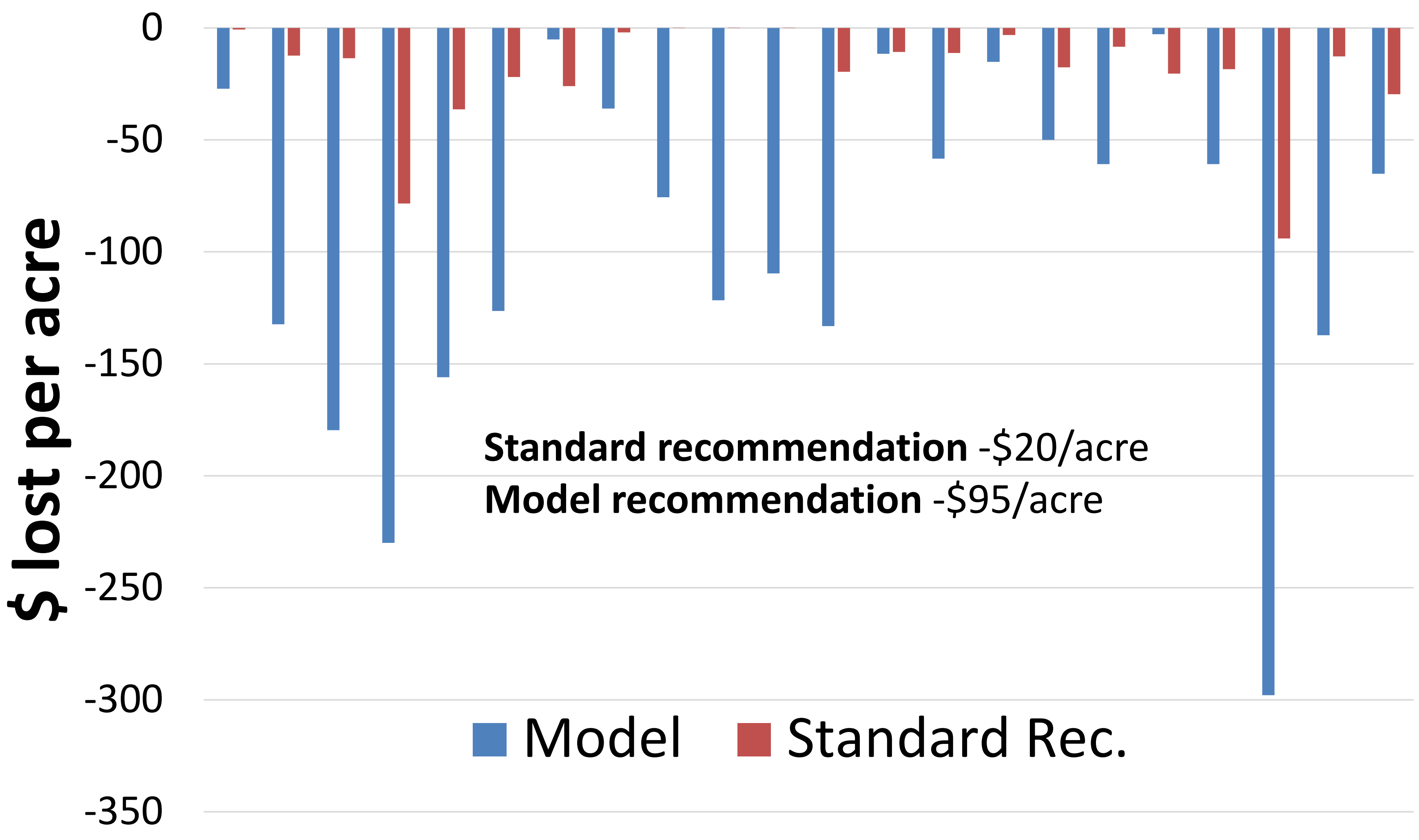
Computer models utilize some or all of these factors

- Anticipated yield and corn growth/N uptake models
  - Typically assume 1 lb N/bu yield
- Soil properties
  - Enhanced soil maps based on landscape parameters, sampling and analysis

Computer models utilize some or all of these factors

  - Estimate and predict soil N mineralization and loss of soil and fertilizer N
- Actual and historical weather
- N application amounts and dates, tillage, CRM, planting date, etc.

One model vs. std. rec. across 22 IN locations



Improving computer models

- All are yield based – Can we predict yield accurately? For different hybrids?
- N rec. is based on yield x N/bu factor of about 1.0
  - Research reveals N/bu factor can range from 0.8 to 1.6 lb N/bu
  - For 200 bu/acre corn the N demand would vary from 160 – 320 lb N/acre!!!!!!!!!!!!!!
- Is variation in the lb N/bu factor a result of hybrid x env. x management interaction? How do we predict it?

Improving computer models

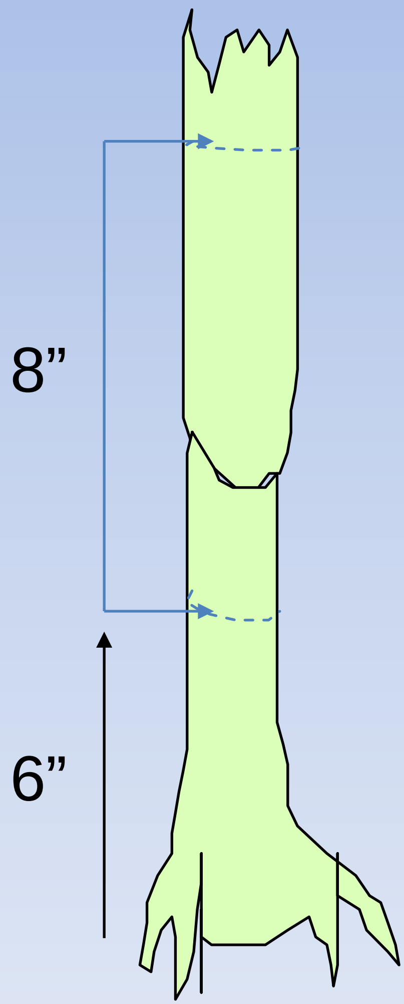
- The conversion of ammonium to nitrate determines the potential for N loss………….
- this process differs among soils and is dramatically slowed by banding
- How accurately can this be predicted for a given field area, N source, application timing?

Improving computer models

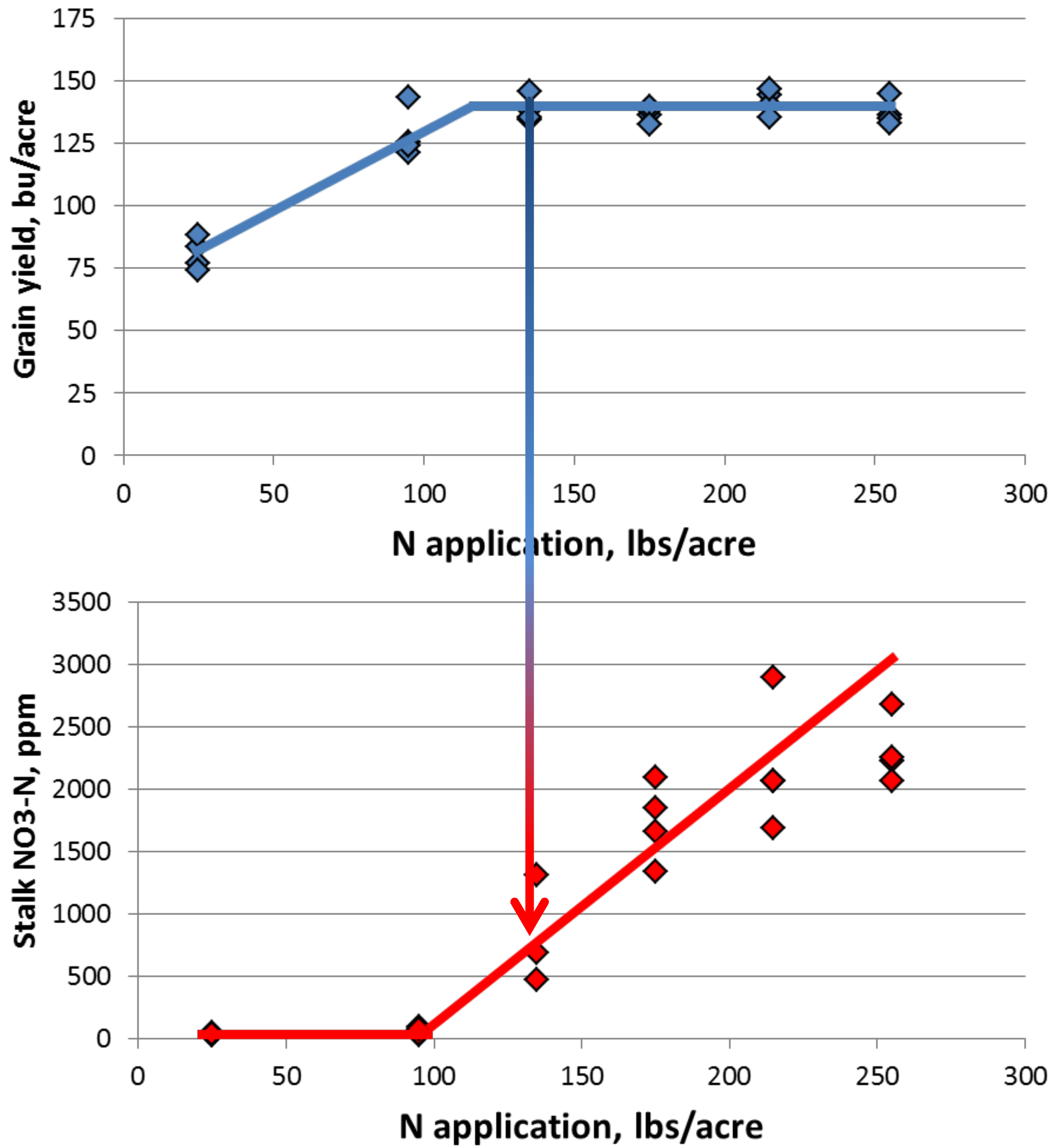
- Each model needs to be independently evaluated to determine its accuracy in making N recommendations

End-of-season cornstalk nitrate test

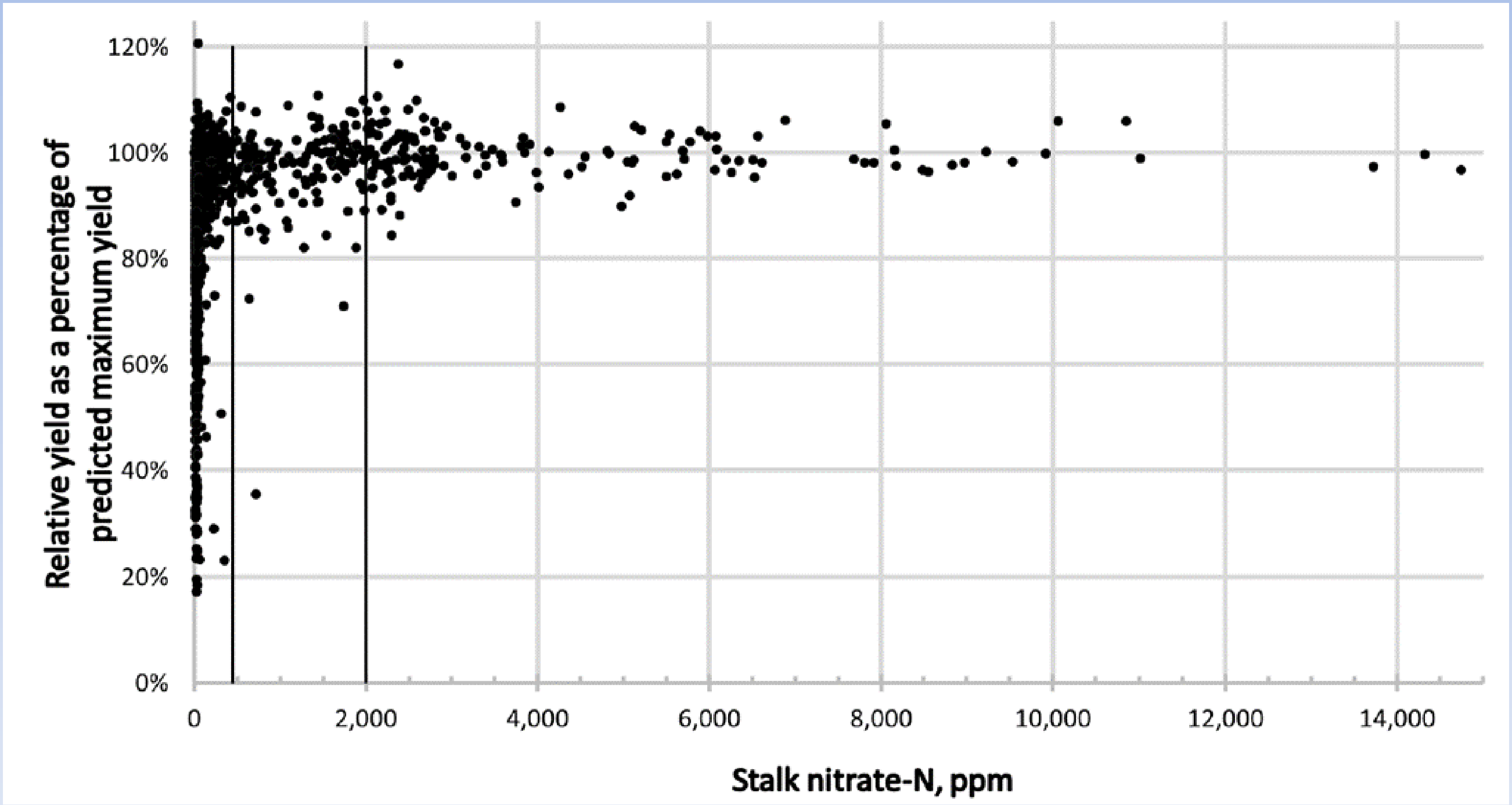
- Sample from ¼ milk line to 2 to 3 weeks after blacklayer
- Collect 8” segment from undamaged stalks 6” to 14” above the soil
- 15+ segments per sample, remove leaf sheaths
- mail to lab in paper bag (refrigerate, not freeze, samples if stored for more than a day)



Lower stalk NO_3-N accumulates often when N rate exceeds that needed for maximum yield



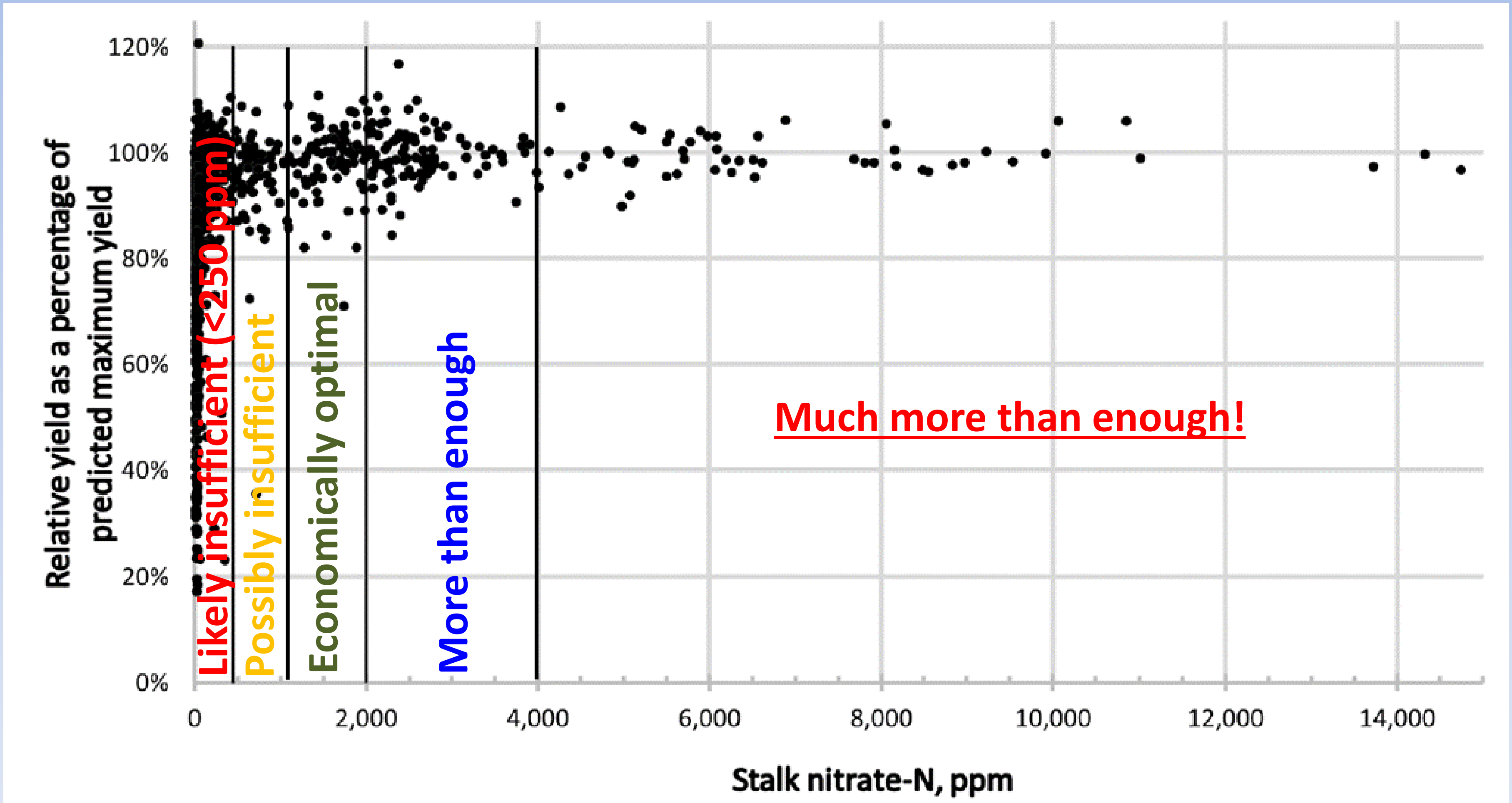
Cornstalk nitrate relationship to yield



Sufficiency of N supply according to end-of-season cornstalk nitrate

Corn stalk NO_3-N, ppm	Relative % yield	N deficit (-) or excess (+), pounds per acre
≤ 250	81	-92
251 - 500	96	-27
501 – 1,000	96	-24
1,001 – 1,500	98	-9
1,501 – 2,000	99	5
2,001 – 4,000	100	33
4,001 – 8,000	99	53
> 8,000	100	77

Cornstalk nitrate assessment



Cornstalk nitrate summary

- Multiple-season evaluations of cornstalk nitrate are suggested before modifying a N management plan
- Cornstalk nitrate is a good indicator of sufficient to more than enough N
- Low cornstalk nitrate levels do not necessarily indicate insufficient N supply
- Consider strip trials if <250 ppm or >4,000 ppm to determine adjustment to N rate


Questions?