Glyphosate Residues, Variety Performance and Protein Variability: Research Results from 2019

EXTENDING KNOWLEDGE ›› CHANGING LIVES

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Features of glyphosate

- Mobile in plants, moves to active sinks
- Deactivated in the soil almost immediately
- Considered one of the safest pesticides from a toxicological perspective (LD_{50} ~5,000 mg/kg)
- Use rates on a per acre basis are relatively high compared to many herbicides
- Glyphosate is metabolized slowly in soil, with a reported half life of 2 to 197 days, 47 days considered typical
- Little metabolism in the plant

Glyphosate residues in wheat

- Though considered safe from a toxicological point of view, claims that it causes cancer has increased scrutiny of residues in food
- Likely sources of glyphosate residues in small grains
  - From pre-harvest applications
  - Drift from nearby fields
  - Uptake from the soil – (minimal?)

Established maximum residue levels

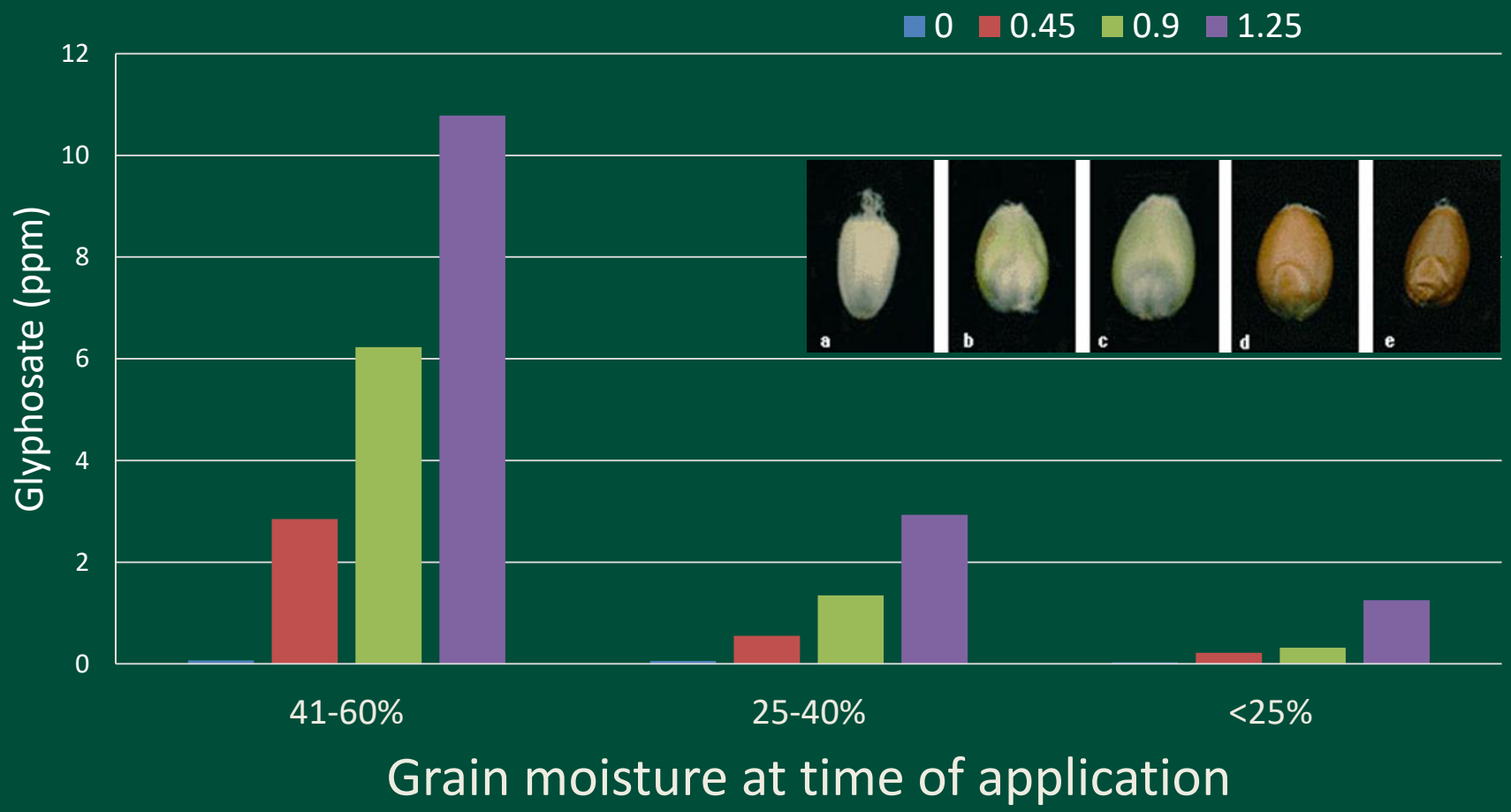
- USA: 30 ppm
- Codex: 30 ppm
- EU: 10 ppm
- Japan, Canada and China: 5 ppm

- Other chemicals for comparison
  - DON = 1 ppm in flour,
  - Atrazine = 0.5 ppm in grain,
  - 2,4-D = 2 ppm,
  - Propiconazole = 0.09 ppm

Current recommendations for glyphosate as a pre-harvest

- Up to 0.75 lb ae per acre rate
- Do not apply to crop intended for seed
- Do not apply to barley for malting
- Can be tank mixed with 2,4-D, dicamba, and saflufenacil
- Apply at hard dough stage or ≤30% moisture
- 7 day pre-harvest interval

Impact of rate and timing on glyphosate residue in spring wheat grain, average of five site/years (adapted from Cessna et al., 1994)



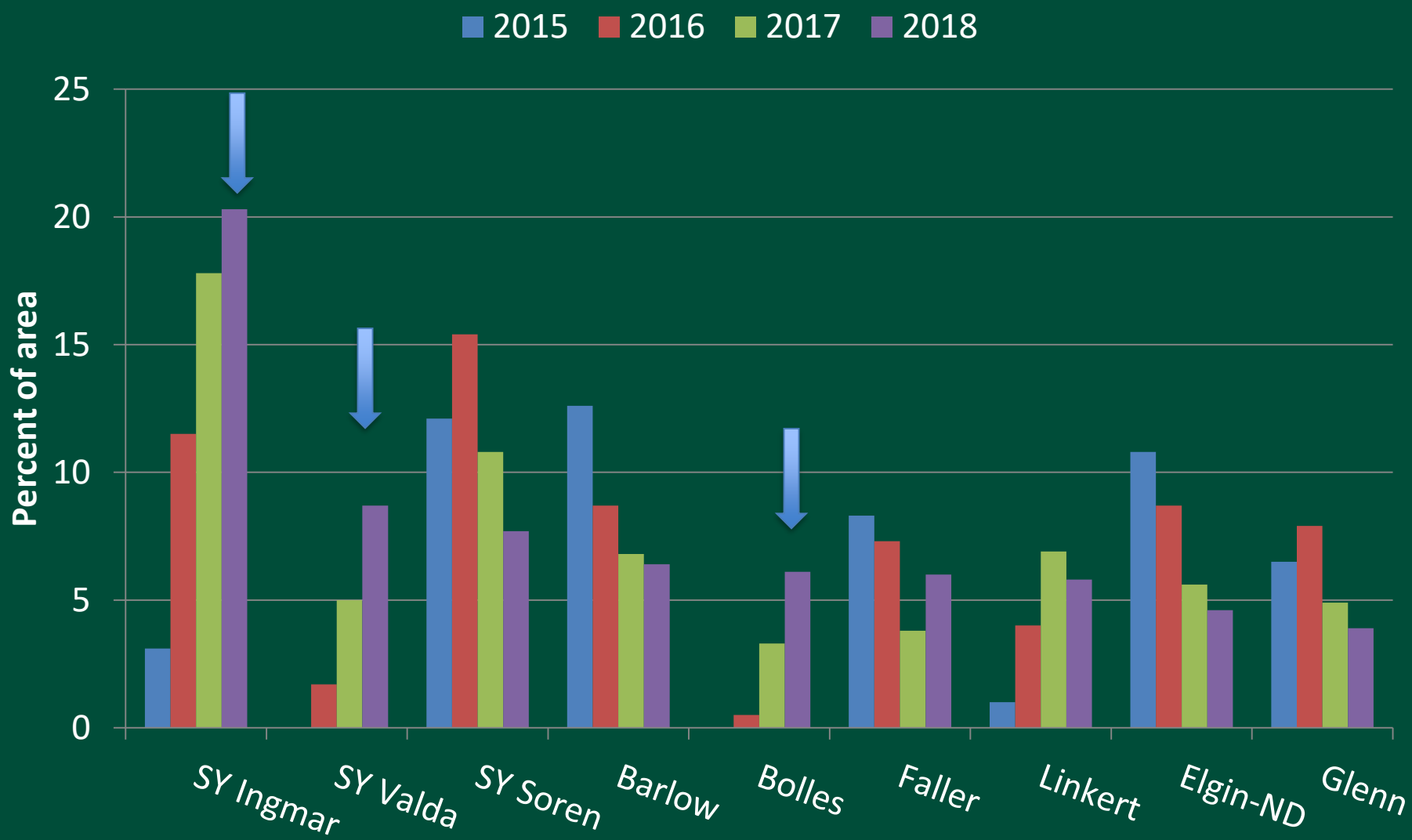
Experience from 2018

- Experiment where glyphosate was applied to the soil
  - All samples of grain were positive including the check, range was 0.021 to 0.054 ppm
  - Soil level in the spring after a fall burndown – 0.04 ppm
  - Soil level in fall in plots receiving spring application – none detected
- Samples from the center of six fields – no detectable amounts

Conclusions

- Detectable levels of glyphosate in the wheat are likely with a pre-harvest application
- Applying too early may result in residue levels that exceed currently accepted limits
- Glyphosate that enters the plant may accumulate in the grain if the plant is still growing
- Drift during the season may result in detectable residues in the grain

Trends in HRSW variety use in ND



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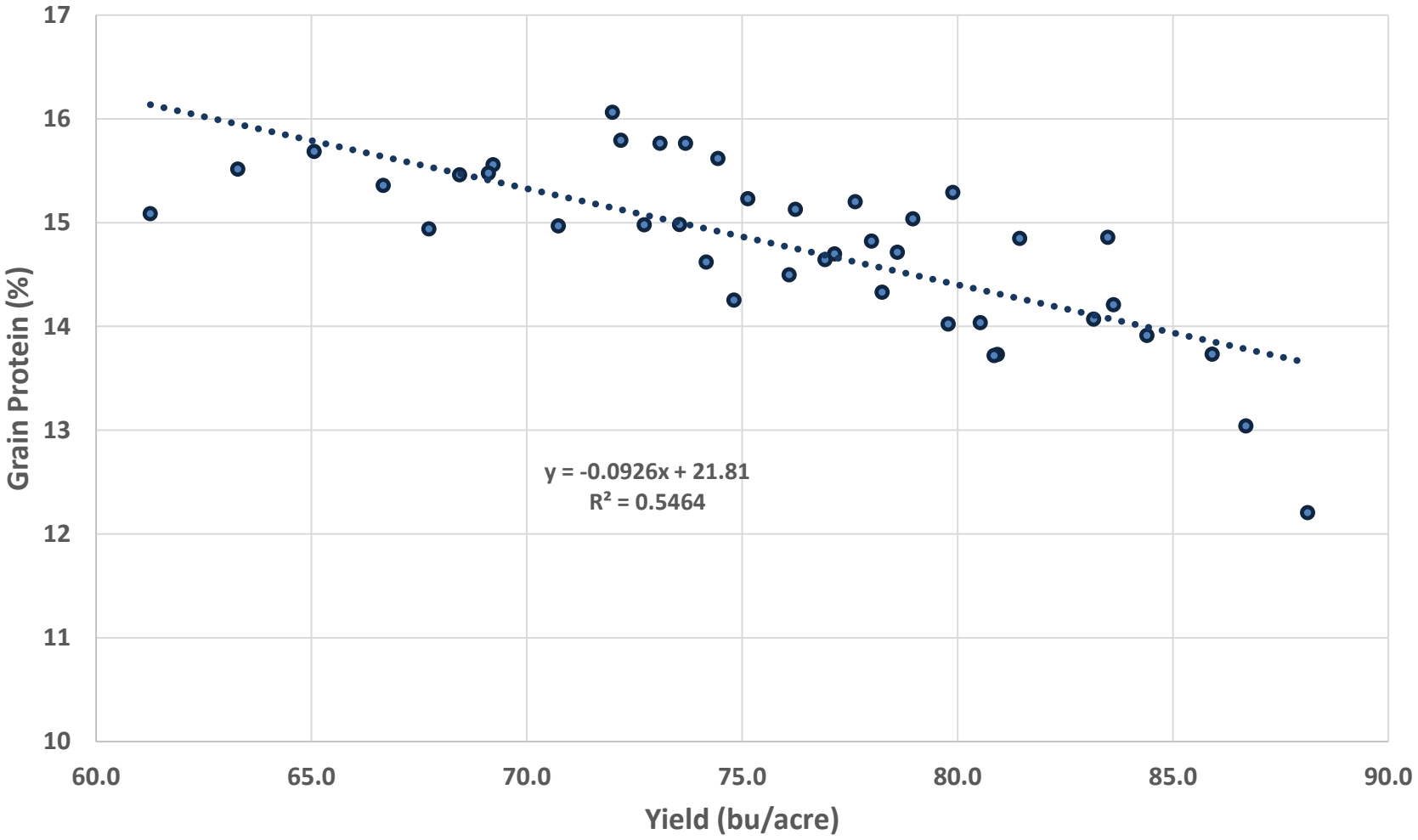
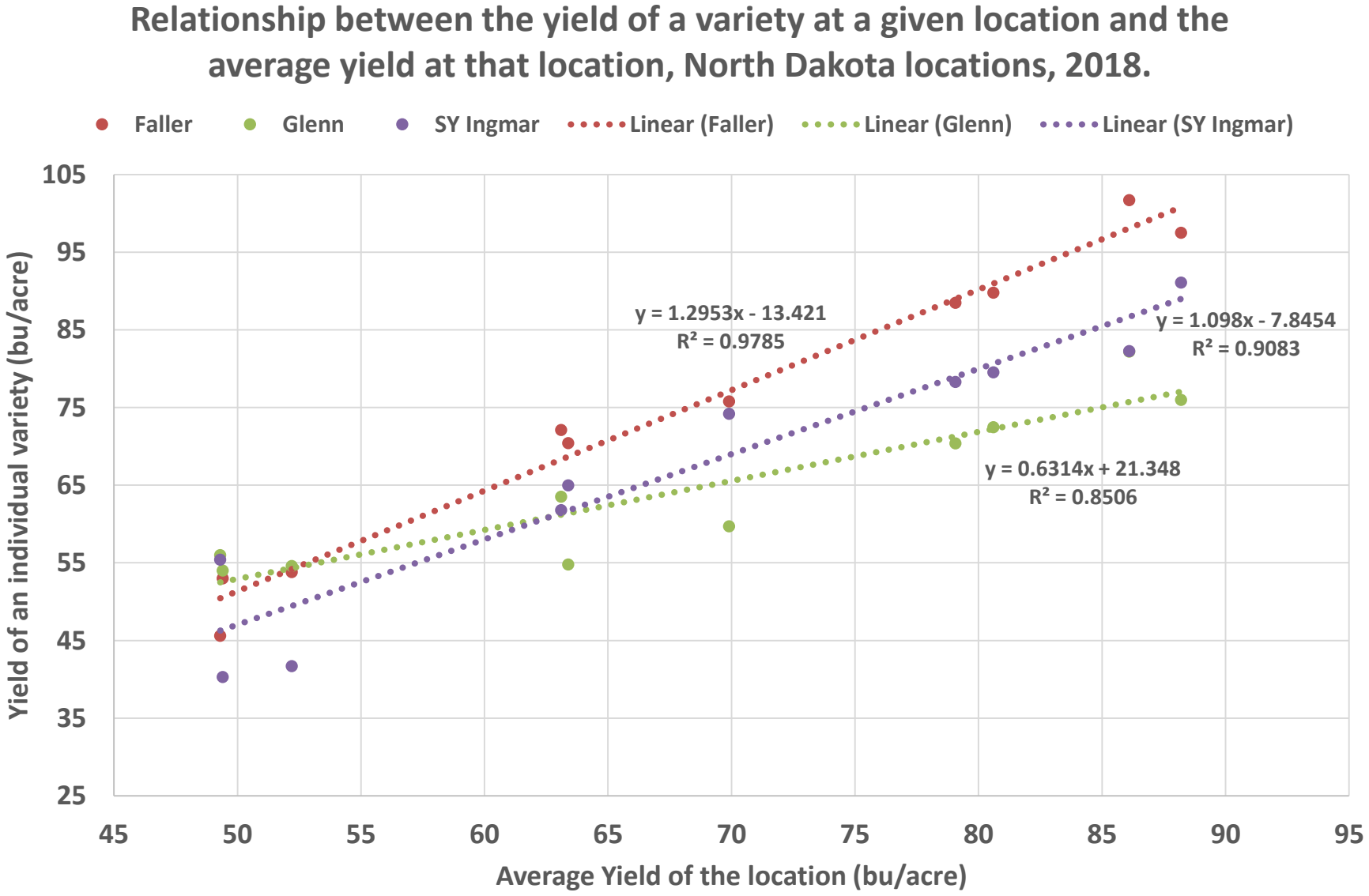
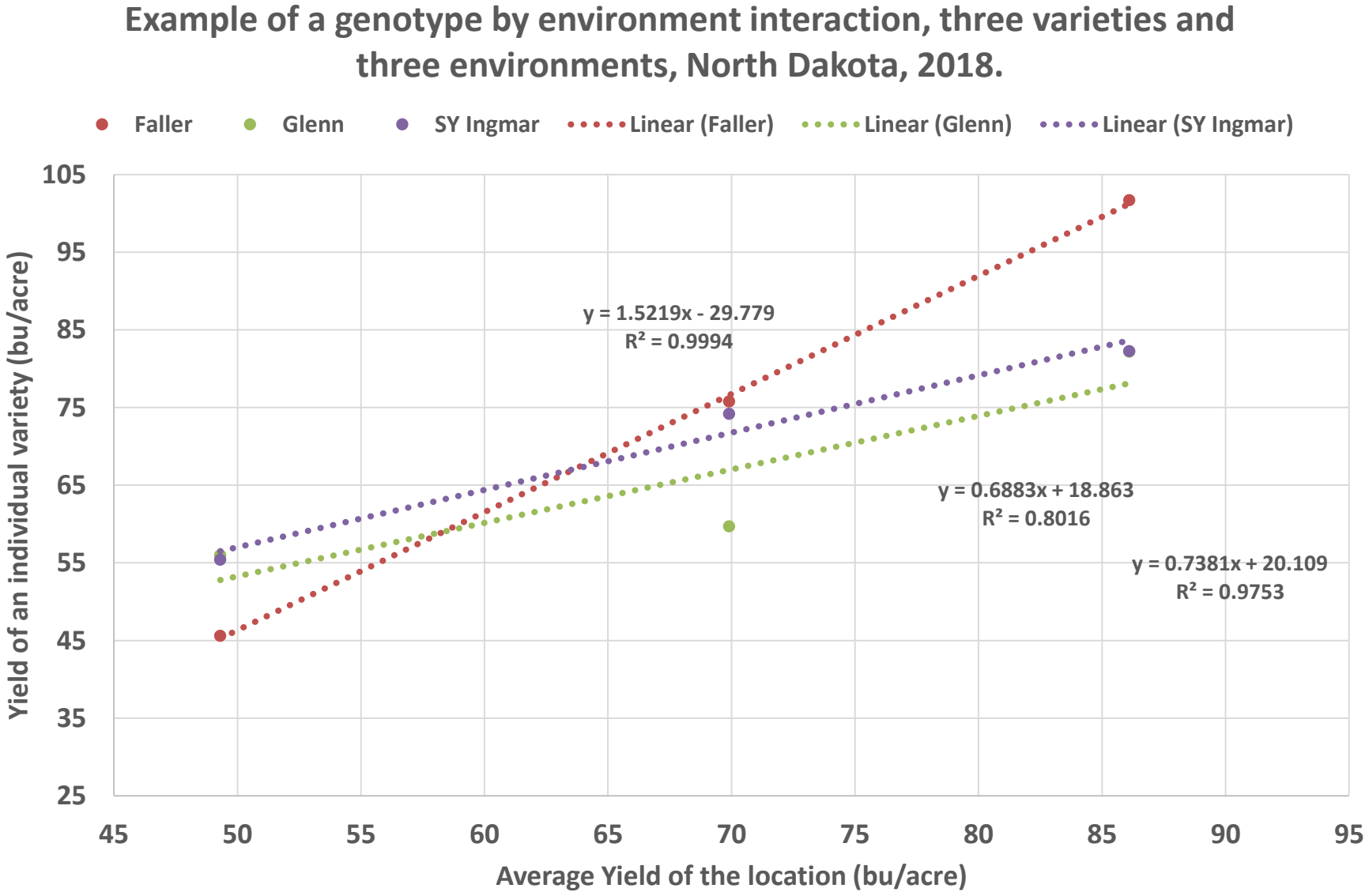
Considerations when using data to select varieties

- Yield and protein content are negatively correlated – need to consider both yield and protein
- Yield stability – a variety that maintains relatively good performance across many environments is a desirable trait
- Genotype by environment interaction – occurs when the ranking in yield of varieties change when environment changes


Relationship between yield and protein content of spring wheat varieties, average of eastern locations, 2018.
Grain Protein (%)
17
16
15
14
13
12
11
10
60.0
65.0
70.0
75.0
80.0
85.0
90.0
Yield (bu/acre)
y = -0.0926x + 21.81
R² = 0.5464

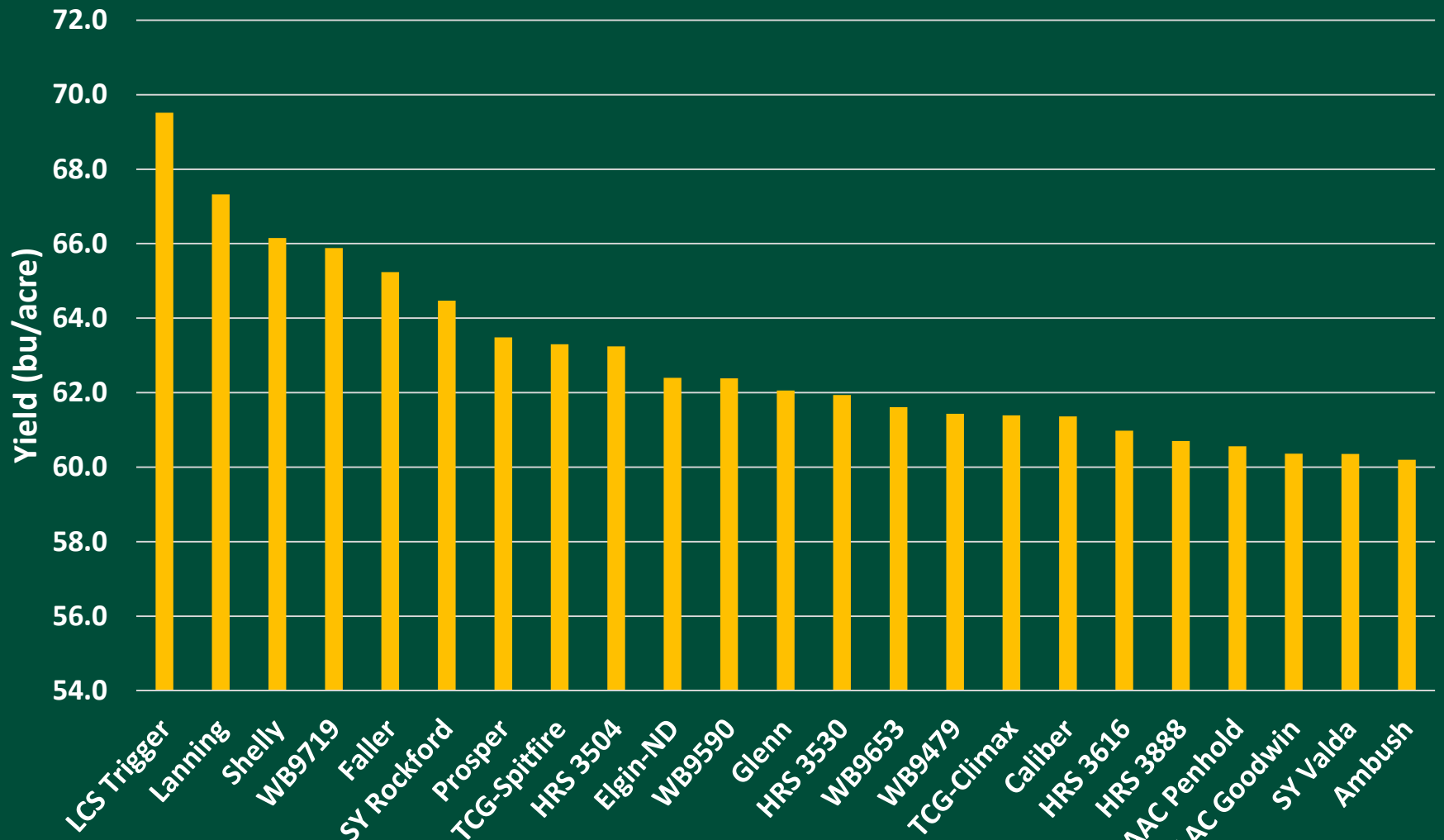

Relationship between the yield of a variety at a given location and the average yield at that location, North Dakota locations, 2018.
Faller
Glenn
SY Ingmar
Linear (Faller)
Linear (Glenn)
Linear (SY Ingmar)
y = 1.2953x - 13.421
R² = 0.9785
y = 1.098x - 7.8454
R² = 0.9083
y = 0.6314x + 21.348
R² = 0.8506
Yield of an individual variety (bu/acre)
105
95
85
75
65
55
45
35
25
45
50
55
60
65
70
75
80
85
90
95
Average Yield of the location (bu/acre)


Example of a genotype by environment interaction, three varieties and three environments, North Dakota, 2018.
Faller
Glenn
SY Ingmar
Linear (Faller)
Linear (Glenn)
Linear (SY Ingmar)
y = 1.5219x - 29.779
R² = 0.9994
y = 0.6883x + 18.863
R² = 0.8016
y = 0.7381x + 20.109
R² = 0.9753
Yield of an individual variety (bu/acre)
105
95
85
75
65
55
45
35
25
45
50
55
60
65
70
75
80
85
90
95
Average Yield of the location (bu/acre)

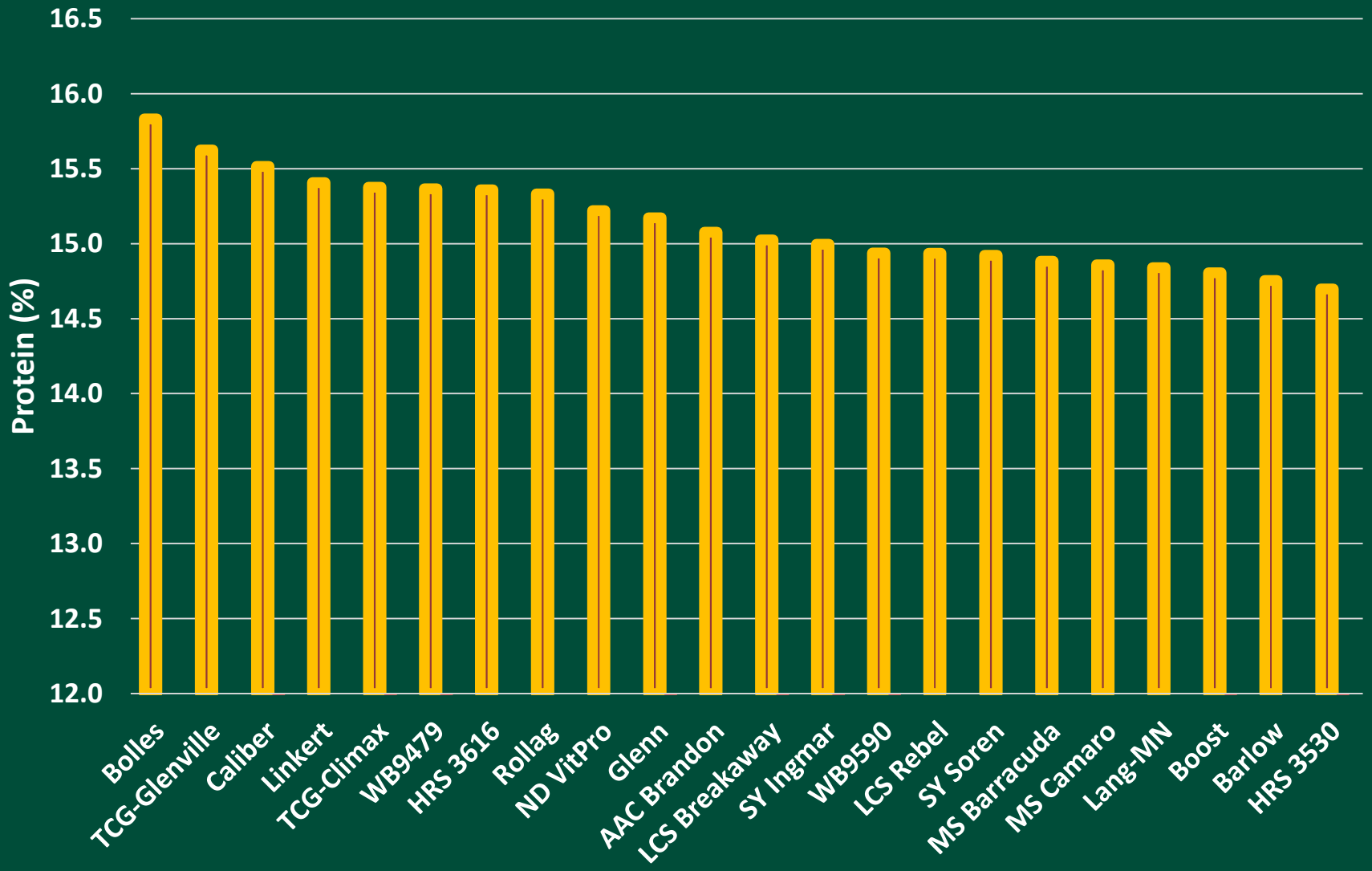
Steps to using data for selecting spring wheat varieties.

1. Rank varieties by yield (averaged over location that are similar to farm, i.e. eastern locations (stability, >confidence)
2. Select the highest yielding with protein values you are comfortable with
3. Look at selected varieties over other locations and look at three year means
4. Examine other important traits (disease resistance, maturity, lodging resistance)

Varieties with yields > mean, western North Dakota, 2018



Varieties with protein > mean, all locations
North Dakota, 2018



Rank of gross income, using average yield and protein of western locations, $5/bu wheat ± premium/discount, 2018			
	$.25 per % ±14%		$.50 per % ±14%
Lanning	$345	Lanning	$353
WB9719	$328	Caliber	$348
Caliber	$327	TCG-Climax	$345
TCG-Climax	$326	Glenn	$341
Shelly	$326	WB9479	$337
Glenn	$326	HRS 3616	$334
SY Rockford	$325	Rollag	$333
LCS Trigger	$324	Elgin-ND	$331
WB9479	$322	WB9590	$330
Elgin-ND	$321	SY Rockford	$328

Rank of gross income, using average yield and protein of eastern locations, $5/bu wheat ± premium/discount, 2018			
	$.25 per % ±14%		$.50 per % ±14%
HRS 3530	$435	HRS 3530	$453
WB9590	$425	WB9590	$451
Surpass	$424	Surpass	$442
WB9653	$424	LCS Rebel	$436
Prosper	$422	SY Ingmar	$435
Faller	$420	Bolles	$434
SY Valda	$417	WB9479	$434
LCS Rebel	$415	AAC Brandon	$432
HRS 3419	$413	HRS 3616	$430
SY Ingmar	$411	Prosper	$427

Optimum Seeding Rates for New Spring Wheat Varieties

J Stanley, NDSU

Joel Ransom, NDSU Extension

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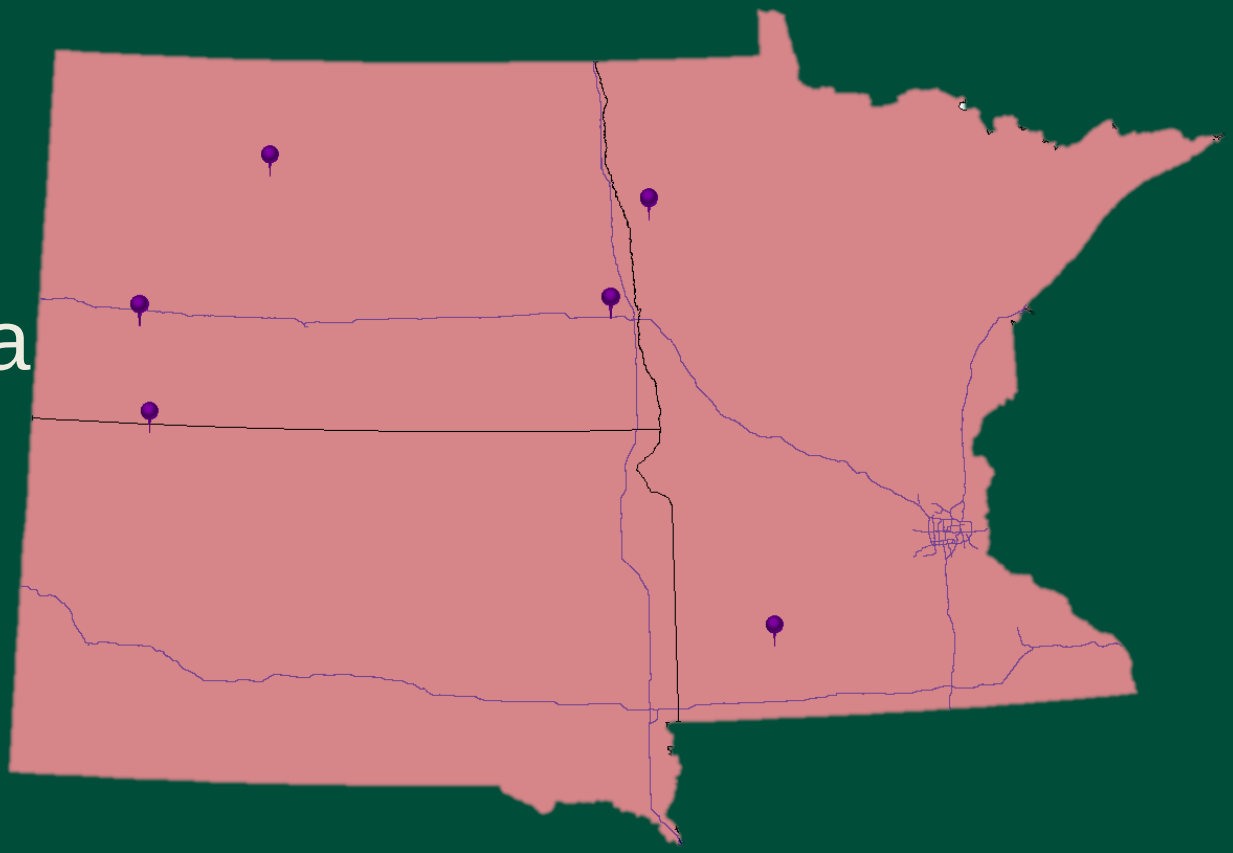
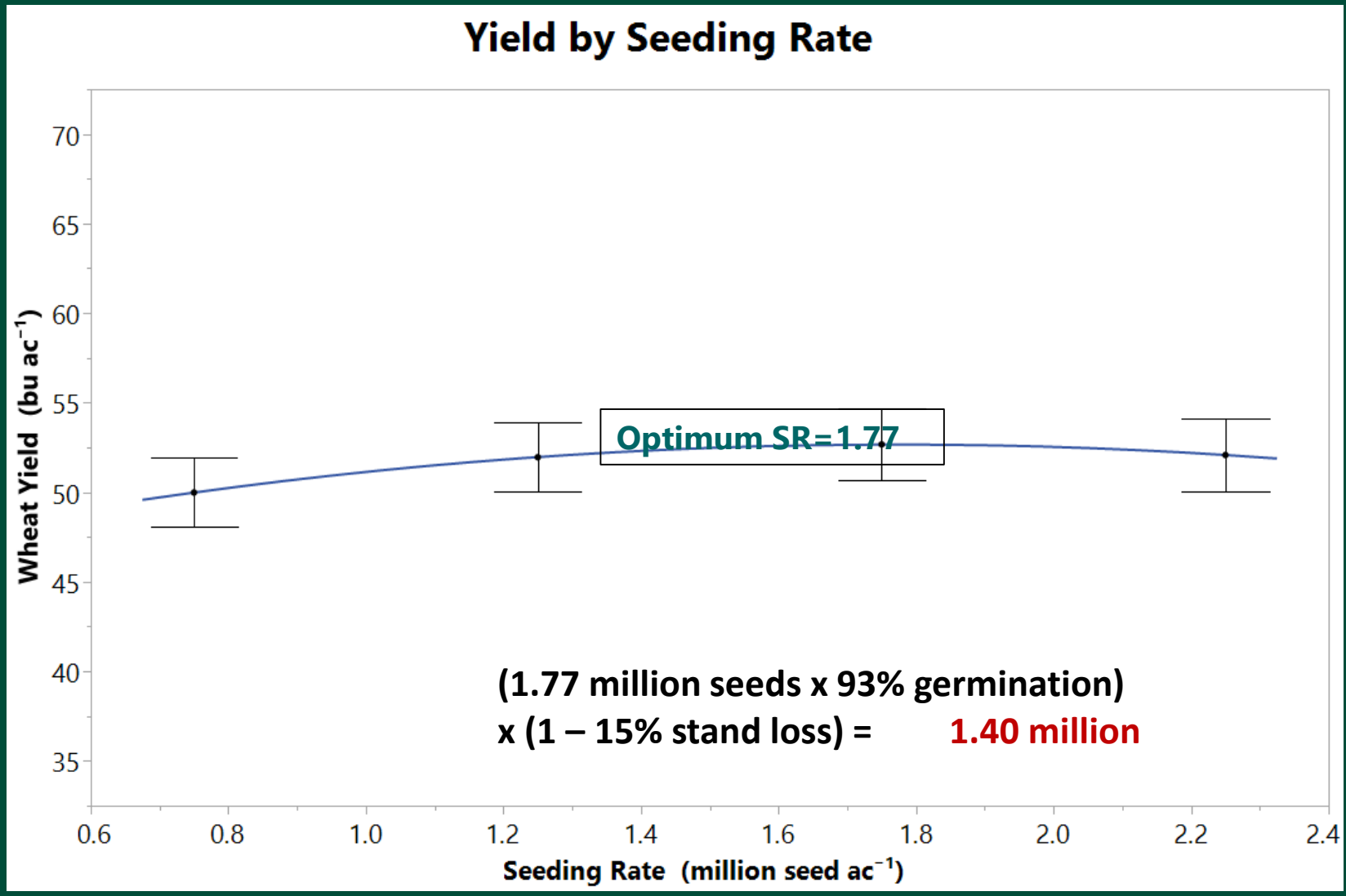
Results from Recent MN/ND Study

- Optimum seeding rate (SR) is variety dependent
  - Derived from SR vs. Yield response curve
- Tillering capacity differs among varieties
  - Increasing seeding rate decreases stems per plant
- Yield models are complicated by environment
  - The SR that is optimum increases as YP decreases
    - Inferences limited as lowest yields were >50 bu ac^{-1}

Experiment Locations

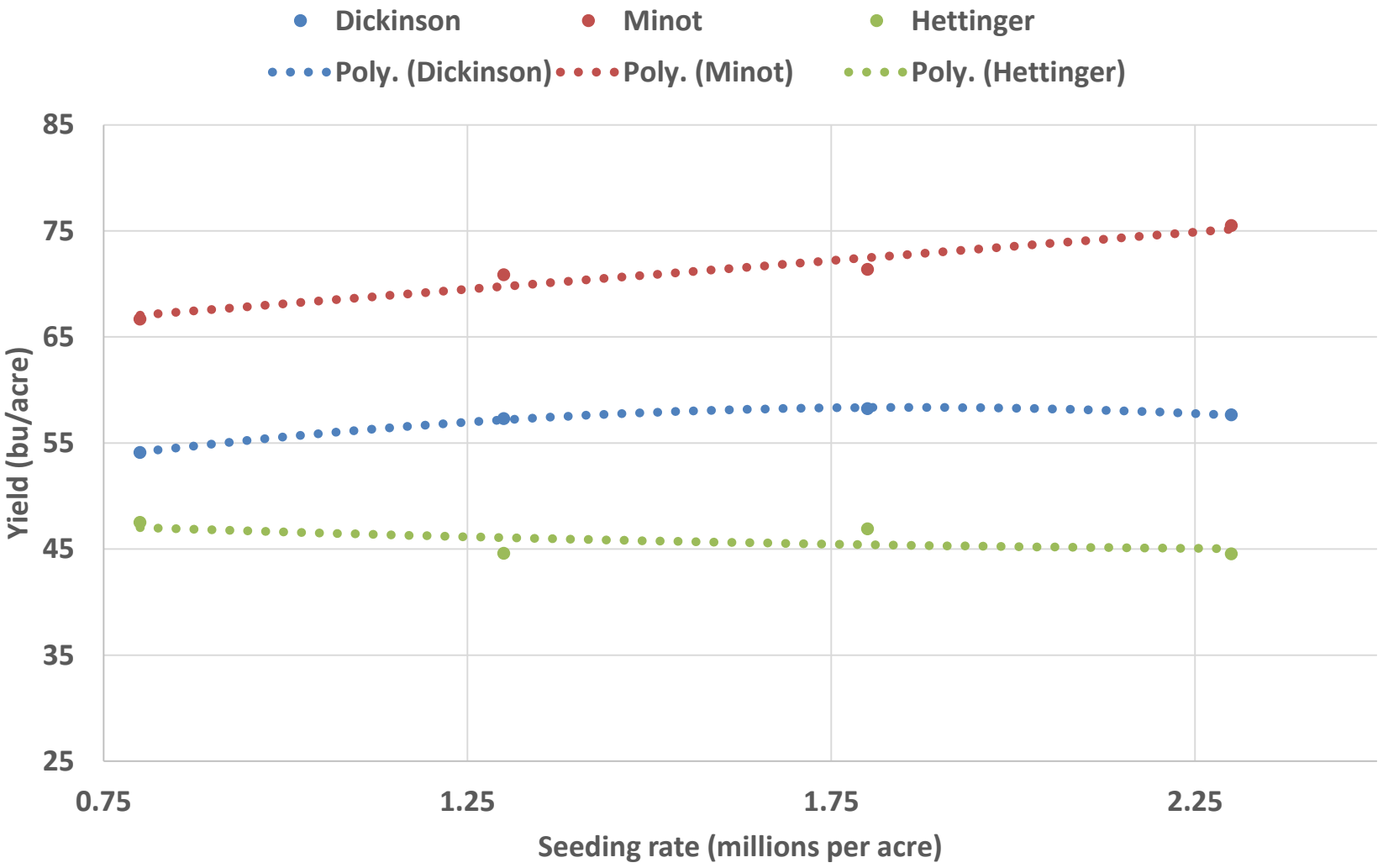
- Minnesota
  - Crookston
  - Lamberton
- North Dakota
  - Prosper
  - Minot
  - Dickinson
  - Hettinger



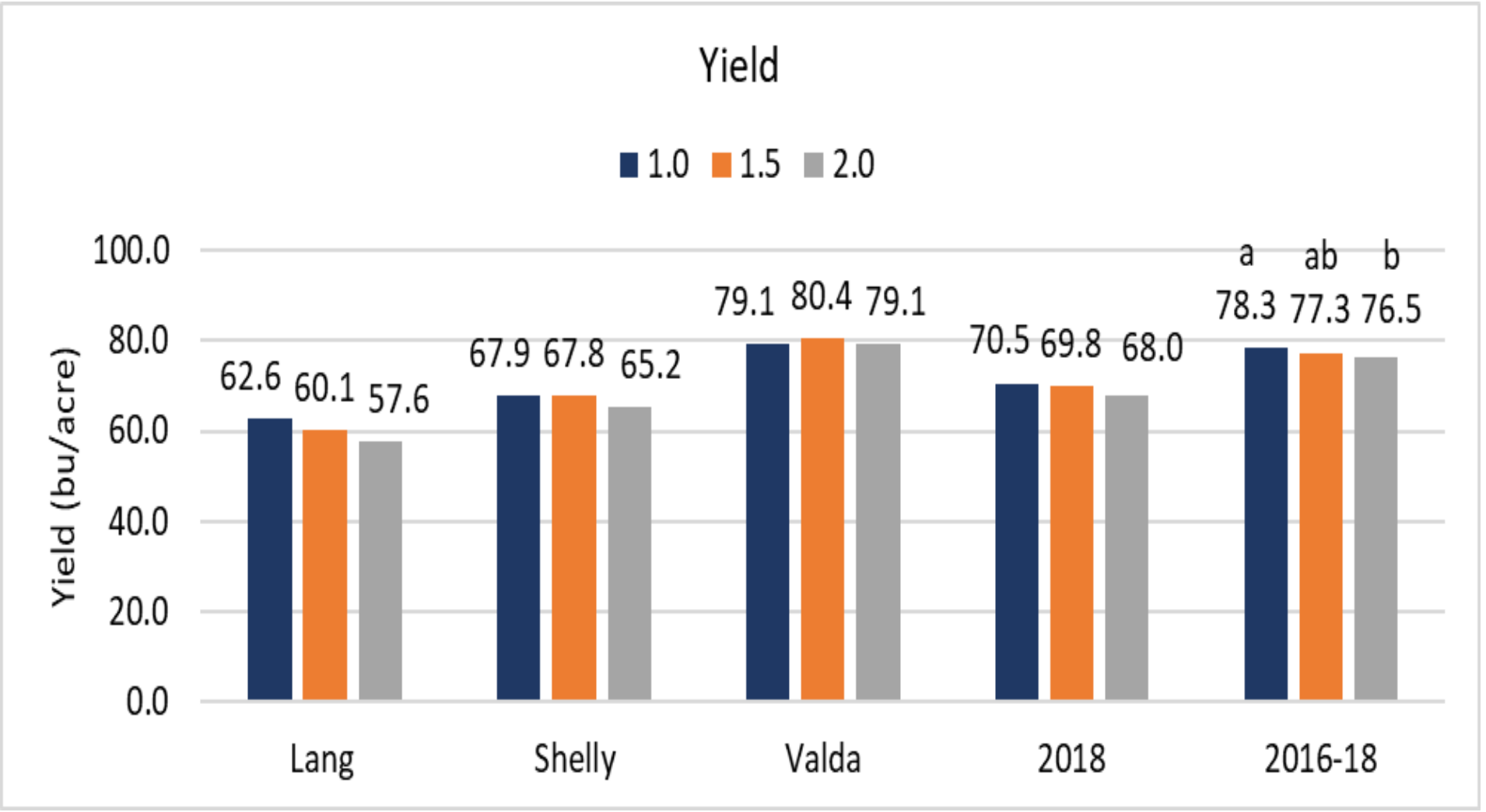


All locations

Response of spring wheat cultivars to seeding rate, average of all varieties, three locations, 2018.



Seeding Rate



ON-FARM RESEARCH NETWORK
MINNESOTA WHEAT

Identifying Causes of Within-Field Protein Variability in Spring Wheat

Melissa Geiszler

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Why Look at Protein Variability?

- Which are the most influential factors influencing protein?
  - H2O and N → OM and soil texture
- Can the causes of variability can be managed?
  - Account for target protein content in VRN application?
  - Can we turn low protein zones into higher protein zones?

How Does it Work?

- Next Instruments: CropScan 3000H

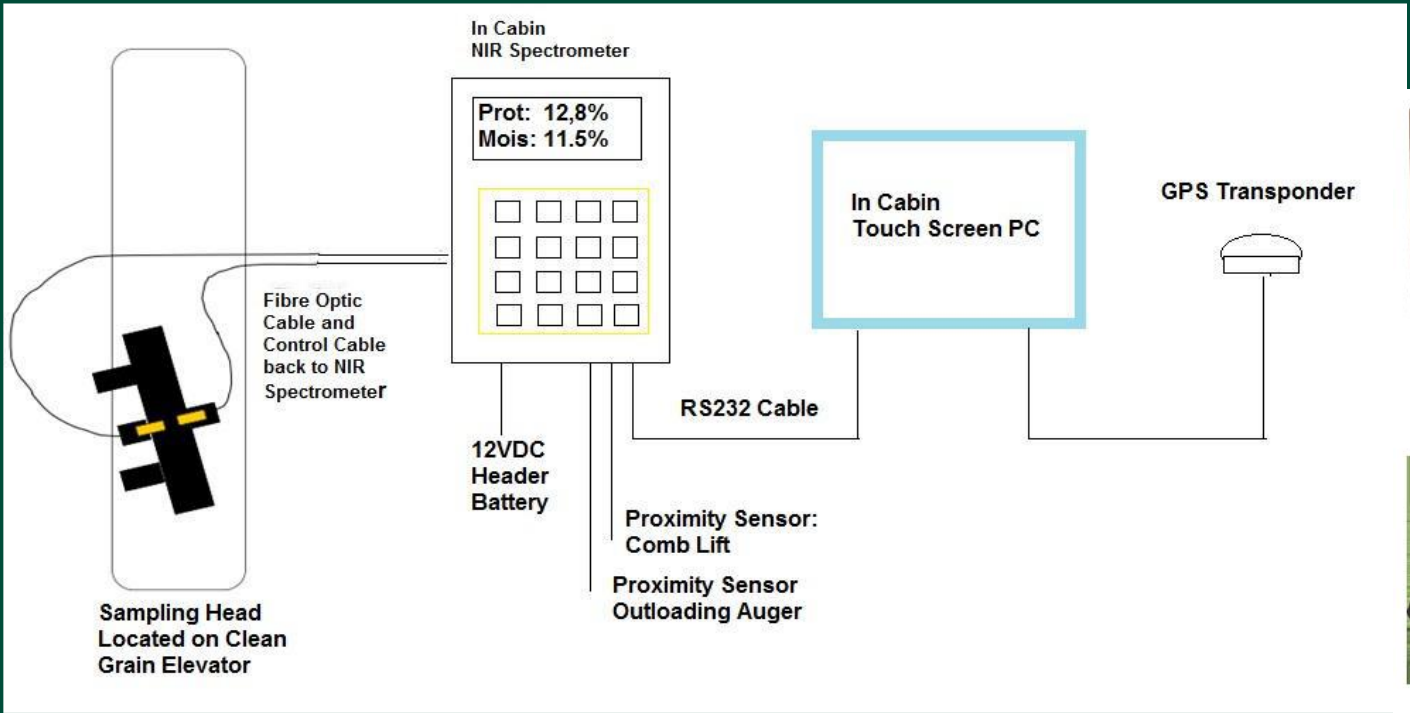
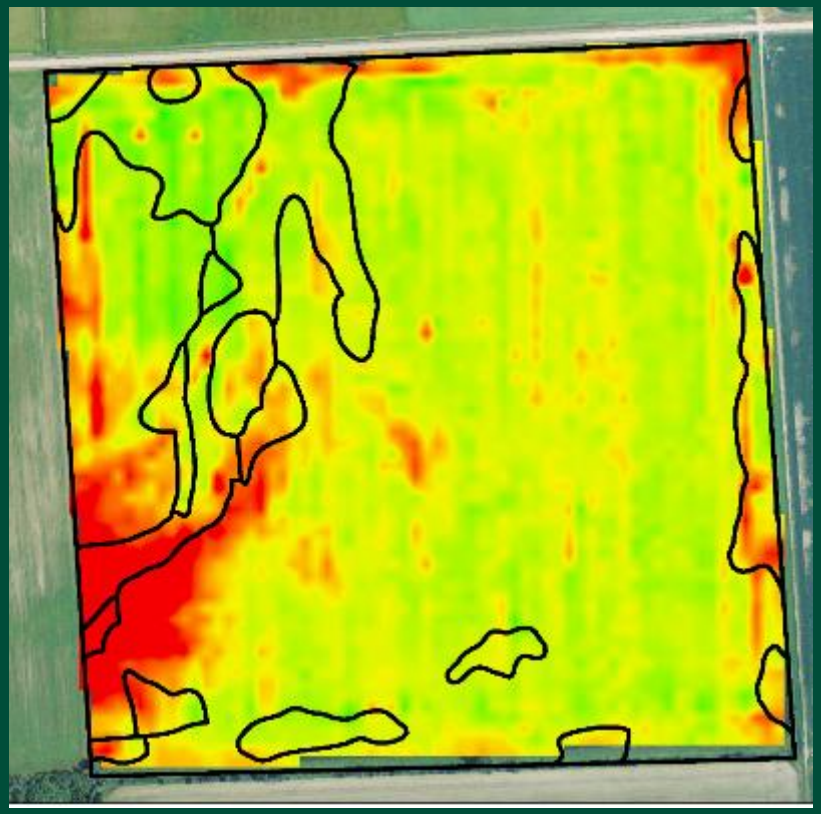
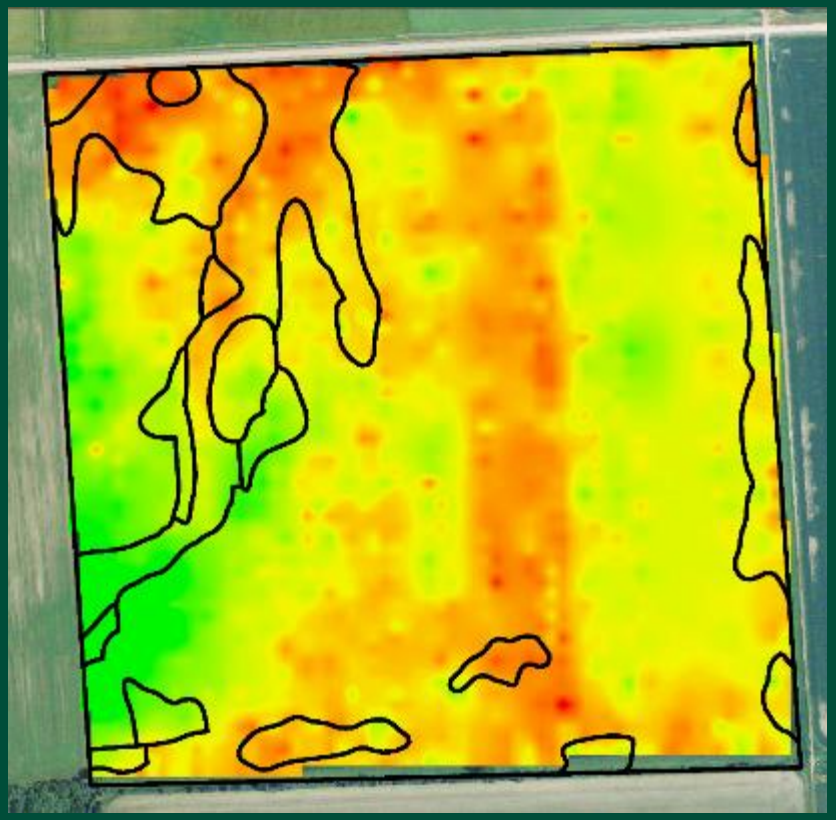


Diagram produced by Next Instruments


Yield
Encirca ERU Soil Unit
High : 137.1
Low : 28.8

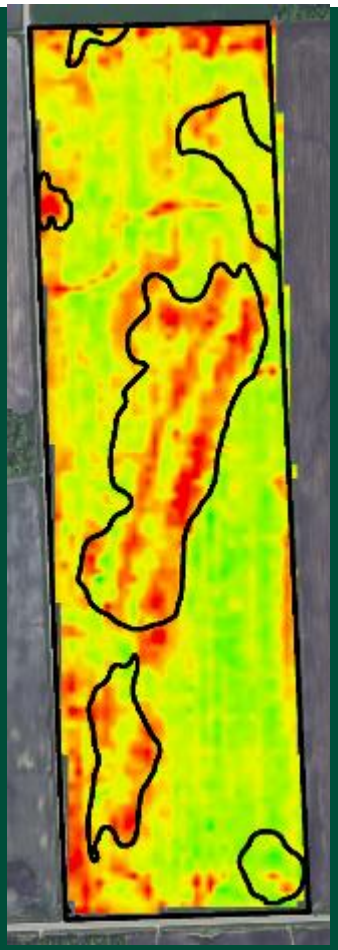

Protein
Encirca ERU Soil Unit
18.9
10.3

Yield

Encirca ERU Soil Unit

High : 136.5

Low : 29.4

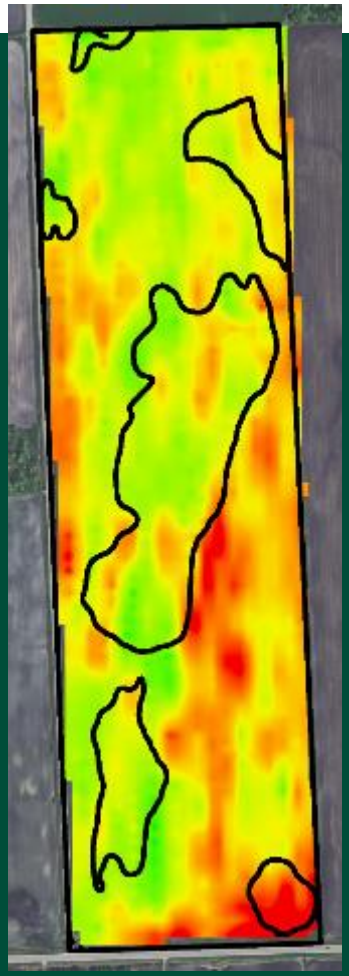


Protein

Encirca ERU Soil Unit

High : 14.5

Low : 10.1

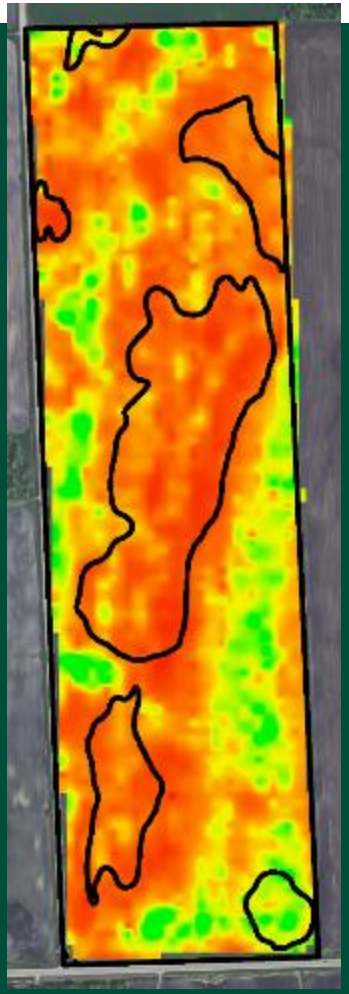


EC

Encirca ERU Soil Unit

High : 26.0

Low : 1.0

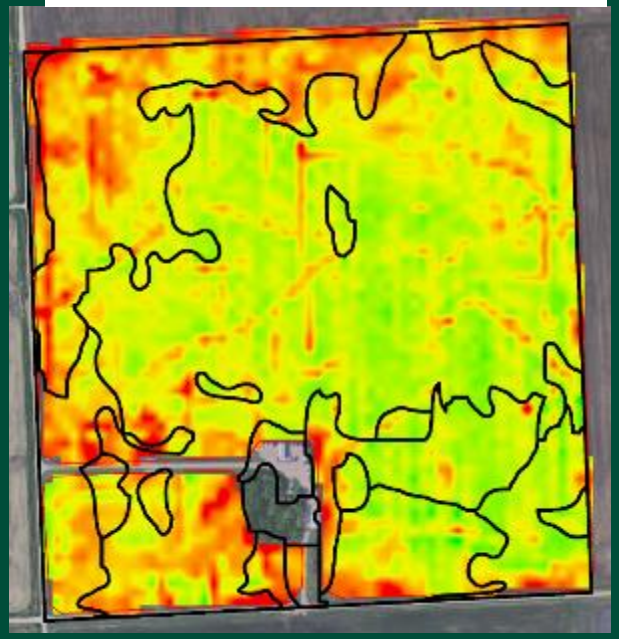


Yield

Encirca ERU Soil Unit

High : 120.9

Low : 53.0

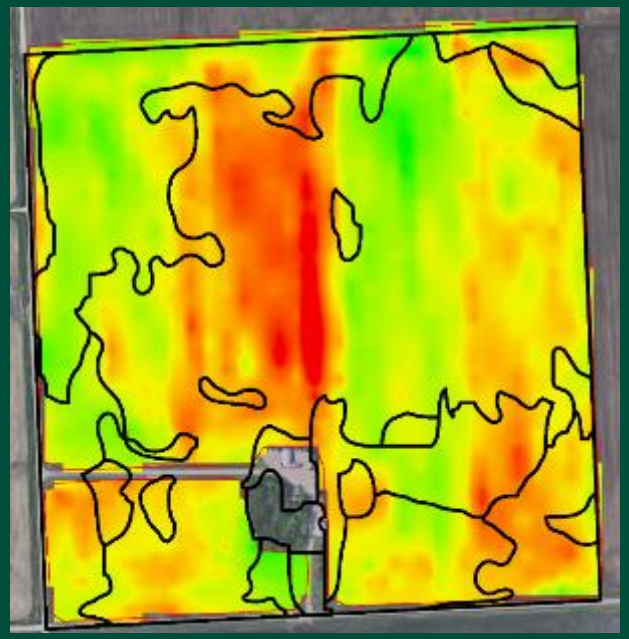


Protein

Encirca ERU Soil Unit

High : 13.9

Low : 10.82

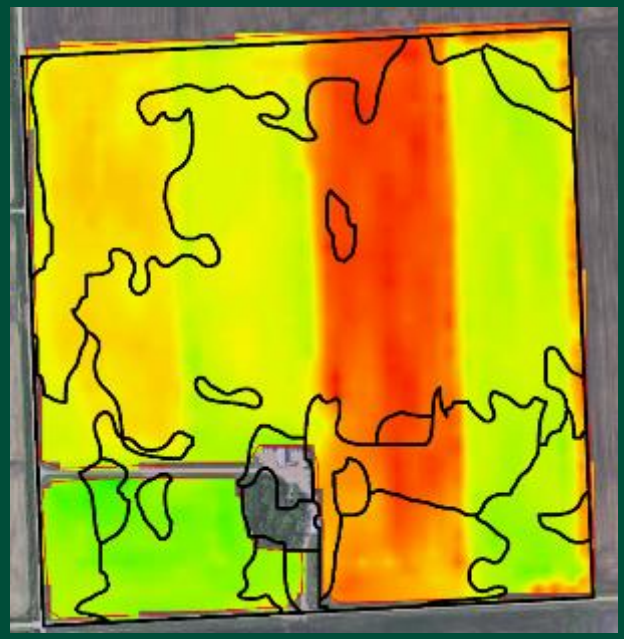


Moisture

Encirca ERU Soil Unit

High : 14.4

Low : 10.8



Conclusions

- Preliminary results show promise in identifying “protein zones” that might benefit from specific management
- Can help quantify the effects of variation in the field and management practices on protein as well as yield
- What are some addition question we should be considering?