Wheat Fertility Management for Yield and Protein

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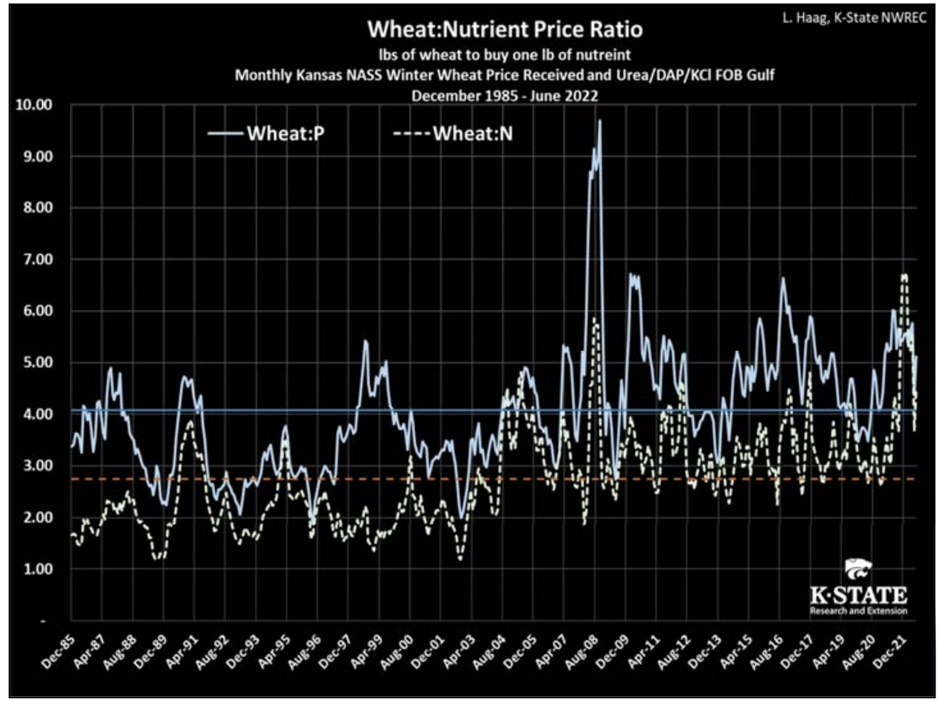
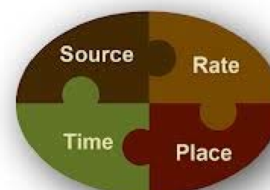


Grain : Nutrient Price Ratios

	Historical	Jun-22
Corn:Nitrogen	**3.42**	**4.87**
Wheat:Nitrogen	**2.75**	**4.51**
Corn:Phosphorus	**5.05**	**5.53**
Wheat:Phosphorus	**4.07**	**5.12**

4R nutrient stewardship?

- Right Source
- Right Rate
- Right Time
- Right Place



4R nutrient stewardship

Phosphorus

- We're going to talk mostly about N this morning
- Anything said about maximizing response to N assumes that we have taken care of P
- Are we aware of our removal rates (e.g. increase of soybeans in NCKS rotations)
- Wheat responds to starter P, especially when late planted or low STP soils
- Recent KSU research would suggest threshold STP may be closer to 25 ppm (Bray1/Mehlich3)

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Phosphorus removal values

Crop	Unit	P_2O_5 (lb)
Corn	bushel	0.33
Grain Sorghum	bushel	0.40
Wheat	bushel	0.50
Sunflowers	pound	0.02
Oats	bushel	0.25
Soybeans	bushel	0.80
Dry Beans	cwt	1.32
Proso Millet	cwt	0.69

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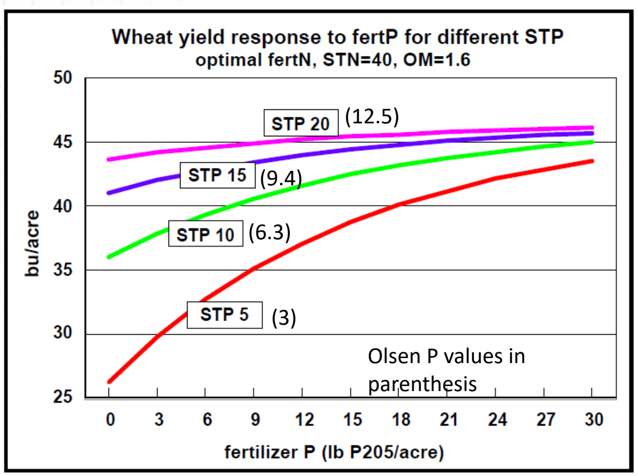
Wheat Response to Soil Test P Level



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Lets talk about the mechanistic approach to N recommendations

- The overall idea is to think about peak plant uptake needs, and then work backwards

Nrec = YG x some factor – credits

Organic Matter, Profile NO_3, PCA

Common misconception is that it's a removal based system…. NOT TRUE!

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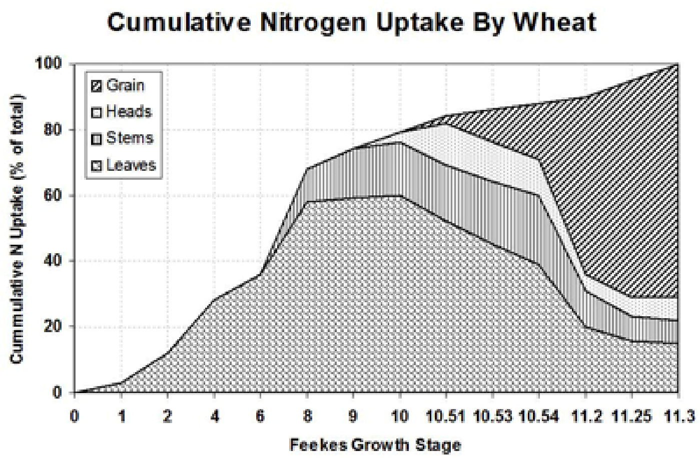

K-State Wheat N Recommendation

Nrec = YG x 2.4 – Profile N – (SOM x 10) – Other Credits

But what about lbs/bu?

"You KSU guys are nuts!
2.4 lb/bu is a ridiculous amount of N!"

- The farm press as well as many producers and consultants want to think in terms of lbs/bu of yield
  - A nice simple number for bragging rights
  - Maybe useful in less dynamic systems in Kansas (e.g. continuous irrigated corn)
- BUT:
  - If you don't know NO_3 at the beginning and end of the season, it's really not that useful of a number

Nrec = YG x 2.4 – Profile N – Soil OM Credit – Other Credits

(65 x 2.4) – 40 lb/ac – (2.5 x 10)

156 – 40 – 25 = 91 lb/ac

N Removal

Lbs of Nitrogen Removed in Wheat Grain, per Bushel

Moisture Content	Protein Content, % 9.00	9.50	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14.00
10.0	0.83	0.88	0.93	0.97	1.02	1.07	1.11	1.16	1.20	1.25	1.30
10.5	0.83	0.88	0.92	0.97	1.01	1.06	1.11	1.15	1.20	1.24	1.29
11.0	0.82	0.87	0.92	0.96	1.01	1.05	1.10	1.14	1.19	1.24	1.28
11.5	0.82	0.87	0.91	0.96	1.00	1.05	1.09	1.14	1.18	1.23	1.28
12.0	0.82	0.86	0.91	0.95	1.00	1.04	1.09	1.13	1.18	1.22	1.27
12.5	0.81	0.86	0.90	0.95	0.99	1.04	1.08	1.13	1.17	1.22	1.26
13.0	0.81	0.85	0.90	0.94	0.98	1.03	1.07	1.12	1.16	1.21	1.25
13.5	0.80	0.85	0.89	0.93	0.98	1.02	1.07	1.11	1.16	1.20	1.25
14.0	0.80	0.84	0.89	0.93	0.97	1.02	1.06	1.11	1.15	1.19	1.24
14.5	0.79	0.84	0.88	0.92	0.97	1.01	1.06	1.10	1.14	1.19	1.23
15.0	0.79	0.83	0.87	0.92	0.96	1.01	1.05	1.09	1.14	1.18	1.22

Prepared by L. Haag. K-State Northwest Research-Extension Center, Colby

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Determining your potential for N loss

- Identify potential N loss mechanisms
  - Runoff or runaround
  - Leaching
  - Denitrification
  - Volatilization
  - Immobilization

Most mechanisms involve water and are impacted by soil properties and temperature

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How can I get the most from my nitrogen?

- Try to estimate how much N you really need.
- Figure out how much N is available in the soil.
- Sort out your potential for N loss and determine the likely N loss mechanism due to:
  - Local rainfall and climate
  - Soils, especially drainage, texture and pH
  - Management/cropping system
- Assess what tools are available to you.

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Nitrogen – management factors

- How do we best utilize our N?
  - Timing – as close to utilization as possible
  - Rate – determine accurate application rates
  - Placement – apply below the soil surface if possible
  - Fertilizer source – AA, UAN, Urea
  - Specialty fertilizers – ESN
  - Fertilizer additives
    - Agrotain – urease inhibitor
    - N-Serve – nitrification inhibitor
    - Super U – urease and nitrification inhibitor

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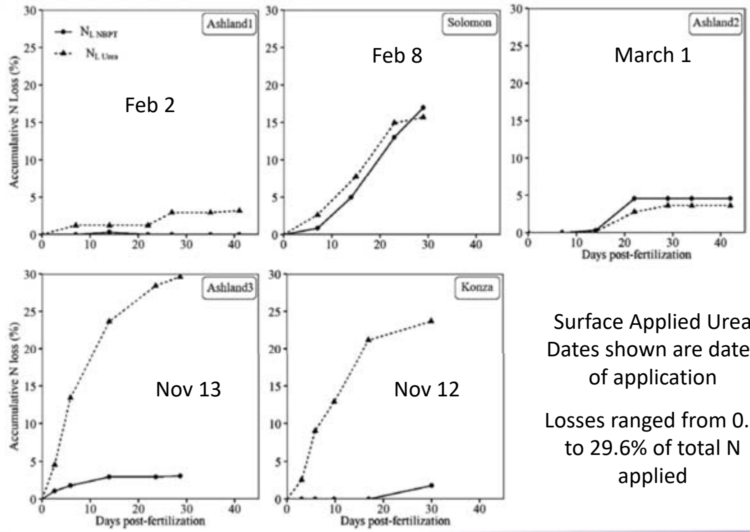
N Loss in Eastern Kansas

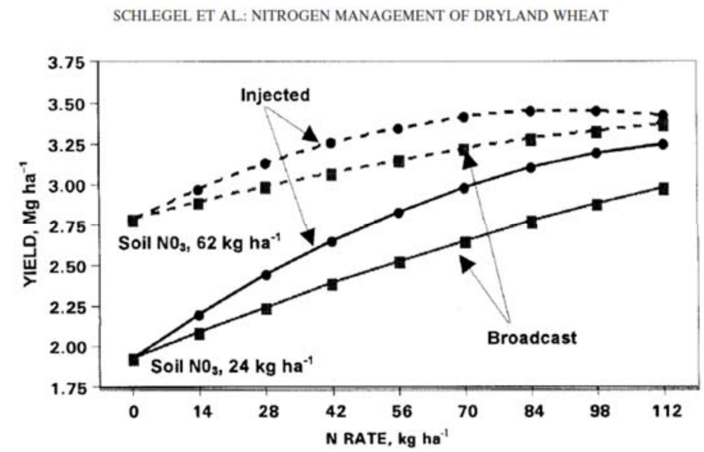


Surface Applied Urea
Dates shown are dates of application

Losses ranged from 0.3 to 29.6% of total N applied

Perin, Santos, Lollato, Ruiz-Diaz, and Kluitenberg, 2020

Injected vs. Broadcast UAN in Western Kansas



Application method of topdress N

N rate (lbs/acre)	Nitrogen Source	Application Method	Yield (bu/acre)
0	NA	NA	46
60	Dry urea	Broadcast	51
60	UAN	Sprayed	47
60	UAN	Streamer bars	56
LSD (0.1)			3

Tucker and Mengel, 2008

Higher probability of significant profile N

- Medium-fine textured soils
- Recent history of excessive N rates
- Previous crop
  - Lower than expected yield
  - Drought affected
  - Previously destroyed stands of alfalfa/clovers
- Manure application
- Warm, late falls and/or early, warm springs

Average soil nitrate levels

Previous crop	Number of samples	Average Profile NO3 lb/acre
Alfalfa	1	103
Corn	11	65
Fallow	12	154
Sorghum	9	70
Soybean	4	84
Wheat	38	65

Fall sampling before wheat, range: 4-313

From a set of 75 samples. Soil testing lab. K-State, 2008

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Other Topdressing Thoughts

- Need to be aware of timing of application. Are we getting it on early enough?
- Pricing of UAN vs. Urea has been very tight at times, UAN has ½ the volatilization potential
- Streaming UAN as opposed to broadcast spray will minimize tie-up and reduce volatilization risk

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In-Furrow Placement of Enhanced Urea Products with Wheat

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Alan Schlegel, Ph.D., Professor and Agronomist-in-Charge
Southwest Research-Extension Center, Tribune

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Department of Agronomy, Manhattan

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Rationale

- Current KSU recommendations allow for 20 - 30 lbs ac^{-1} nitrogen with the seed when in 7.5 – 10” spacing
- However we recommend no seed placed urea
- Research in the Northern Great Plains and Prairie Provinces indicates the use of urea and urea products may be possible

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A moment for clarification…

- This study was not designed to evaluate wheat response to N timing, source or placement
- Our objective was to evaluate potential stand reduction and its effect on yield
- A full nitrogen program was performed in-addition to our use of in-furrow urea

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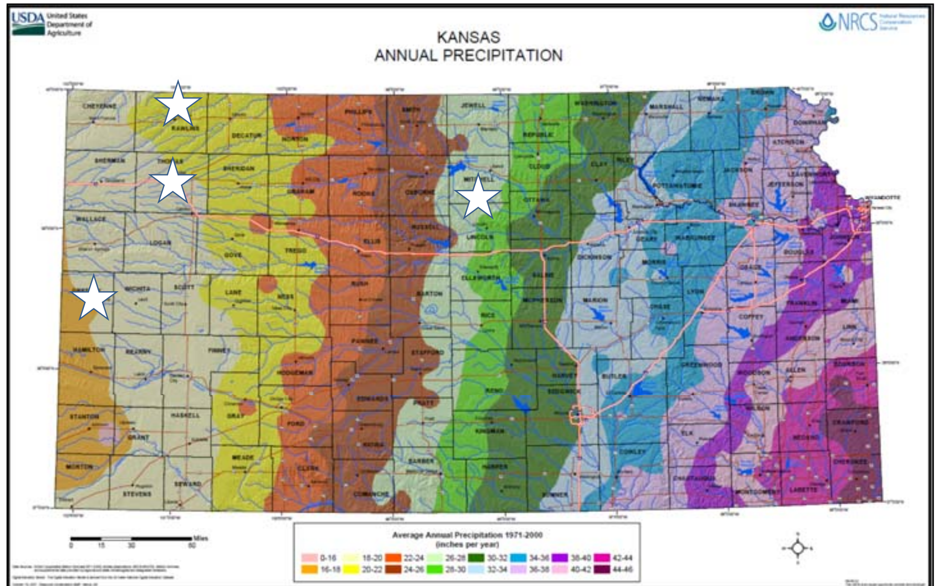

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In-Furrow Urea Materials and Methods

- Western Sites: No-till into chem-fallow, Certified CSU-Byrd, target 1.05 million seeds/ac
- Hunter 2017: No-till into wheat stubble, Certified KSU-Larry
- Treatments were in addition to grower practice Factorial (4 rates x 3 products, plus two controls)
  - 10, 20, 30, 60 lbs/ac N as ESN, NBPT+NPPT (Limus), or Urea
  - MAP to get 10 lbs/ac N (91 lbs/ac of MAP)
  - Control (no in-furrow product)
- Row spacing was 7.5" in 2016 and 2017, 10" in 2018

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Visual – Mitchell Co. 2/9/17

60 lb/ac Urea 60 lb/ac ESN

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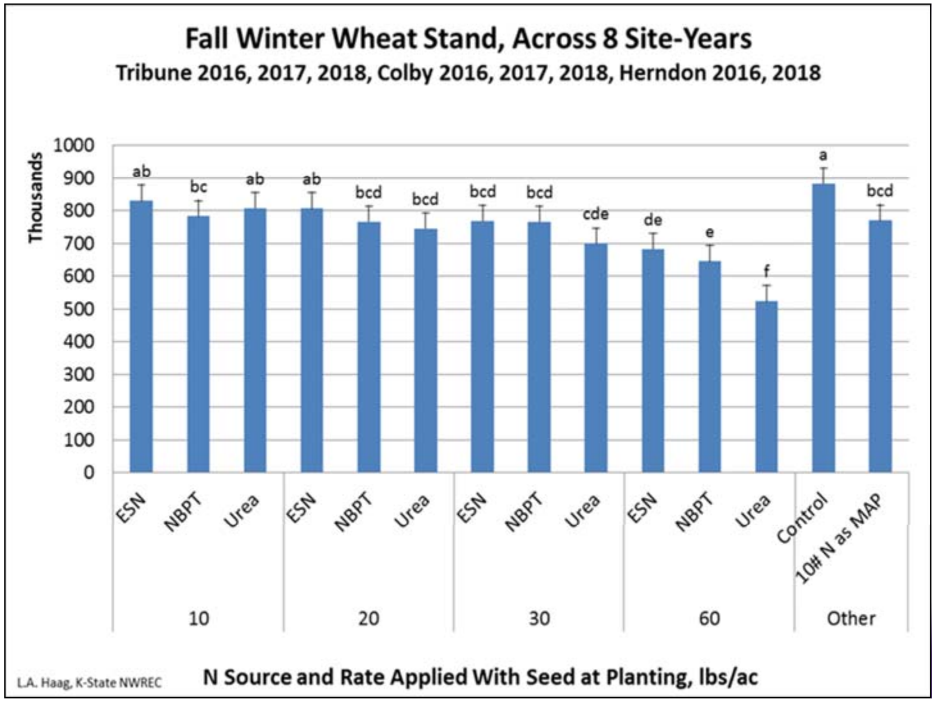
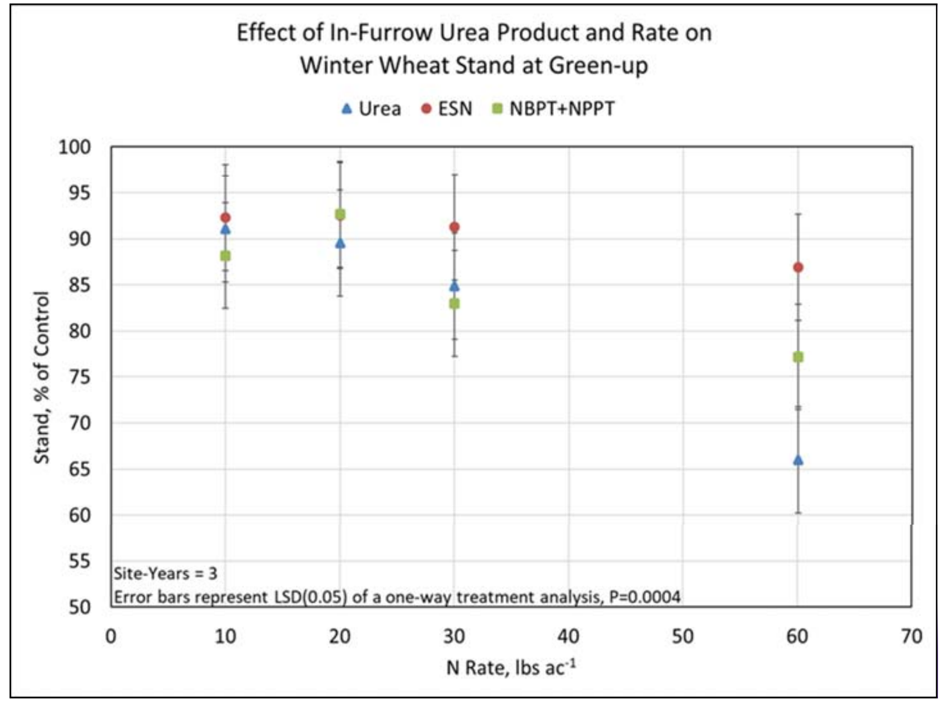
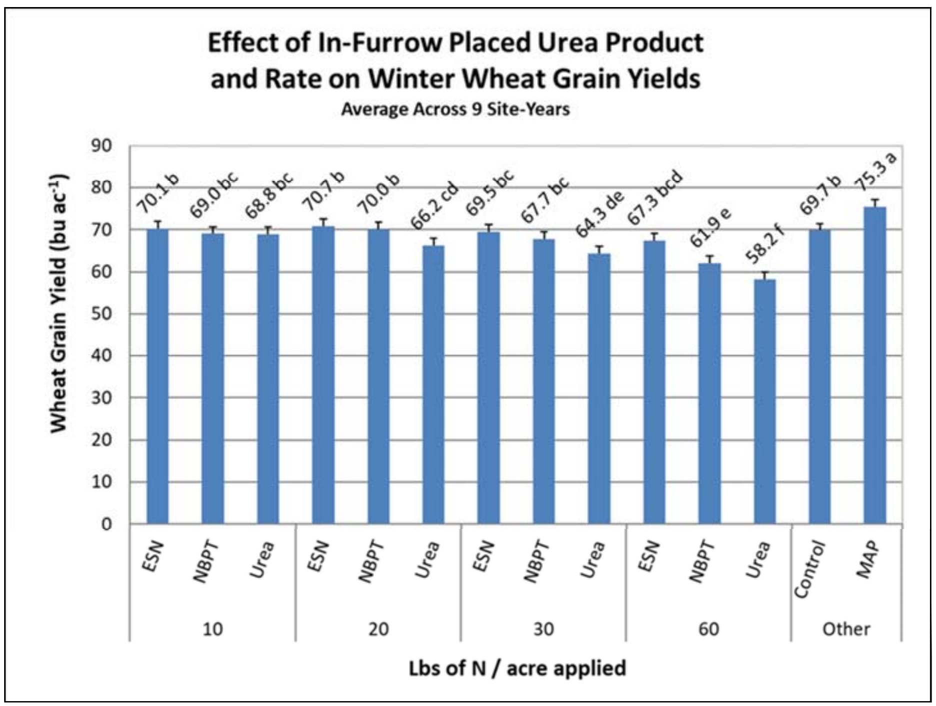
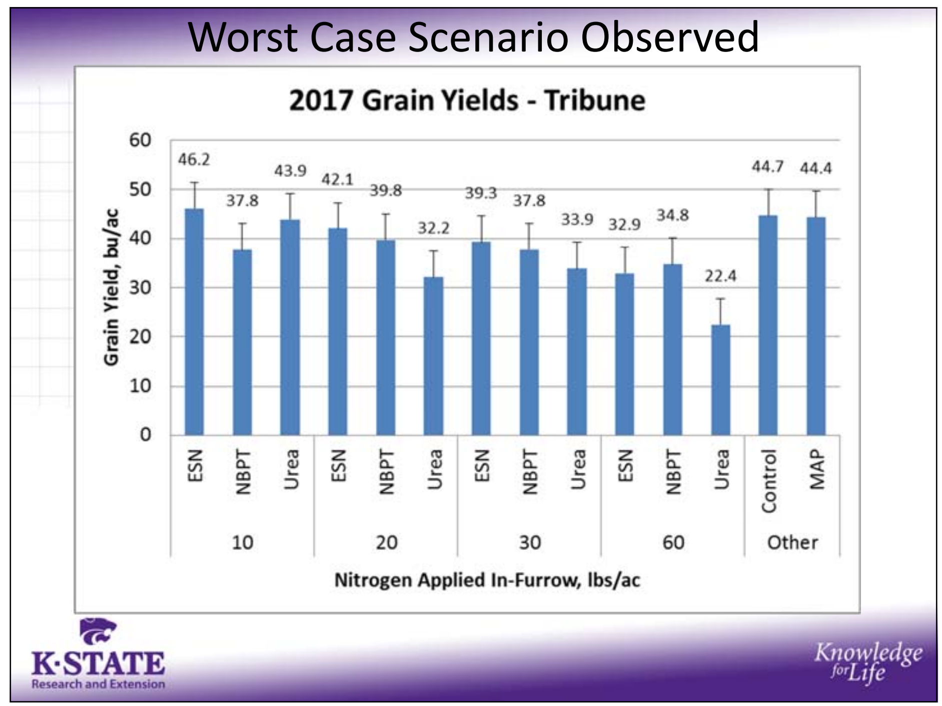

Fall Winter Wheat Stand, Across 8 Site-Years
Tribune 2016, 2017, 2018, Colby 2016, 2017, 2018, Herndon 2016, 2018
Thousands
1000
900
800
700
600
500
400
300
200
100
0
ab
bc
ab
ab
bcd
bcd
bcd
bcd
cde
de
e
f
a
bcd
ESN
NBPT
Urea
Control
10# N as MAP
10
20
30
60
Other
L.A. Haag, K-State NWREC
N Source and Rate Applied With Seed at Planting, lbs/ac


Effect of In-Furrow Urea Product and Rate on
Winter Wheat Stand at Green-up
Urea
ESN
NBPT+NPPT
Stand, % of Control
100
95
90
85
80
75
70
65
60
55
50
Site-Years = 3
Error bars represent LSD(0.05) of a one-way treatment analysis, P=0.0004
0
10
20
30
40
50
60
70
N Rate, lbs ac-1


Effect of In-Furrow Placed Urea Product
and Rate on Winter Wheat Grain Yields
Average Across 9 Site-Years
Wheat Grain Yield (bu ac-1)
90
80
70
60
50
40
30
20
10
0
70.1 b
69.0 bc
68.8 bc
70.7 b
70.0 b
66.2 cd
69.5 bc
67.7 bc
64.3 de
67.3 bcd
61.9 e
58.2 f
69.7 b
75.3 a
ESN
NBPT
Urea
Control
MAP
10
20
30
60
Other
Lbs of N / acre applied


Worst Case Scenario Observed
2017 Grain Yields - Tribune
Grain Yield, bu/ac
60
50
40
30
20
10
0
46.2
37.8
43.9
42.1
39.8
32.2
39.3
37.8
33.9
32.9
34.8
22.4
44.7
44.4
ESN
NBPT
Urea
Control
MAP
10
20
30
60
Other
Nitrogen Applied In-Furrow, lbs/ac
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Summary

- In general our data would suggest we could place up to 10 lb ac^{-1} of urea in-furrow
  - However, at 2 of 9 site-years (Tribune 2016, Colby 2016) yields were reduced by 7 bu ac^{-1}, this was at 95-105 bu/ac yield levels

Across site-years NBPT+NPPT did not reduce yields up to rates of 30 lb ac^{-1}

  - some individual site-years did see reductions, 3 of 9
- Across site-years, ESN at 60 lb ac^{-1} did not reduce yield relative to the control
- ESN was never detrimental at the 30 lb ac^{-1} rate

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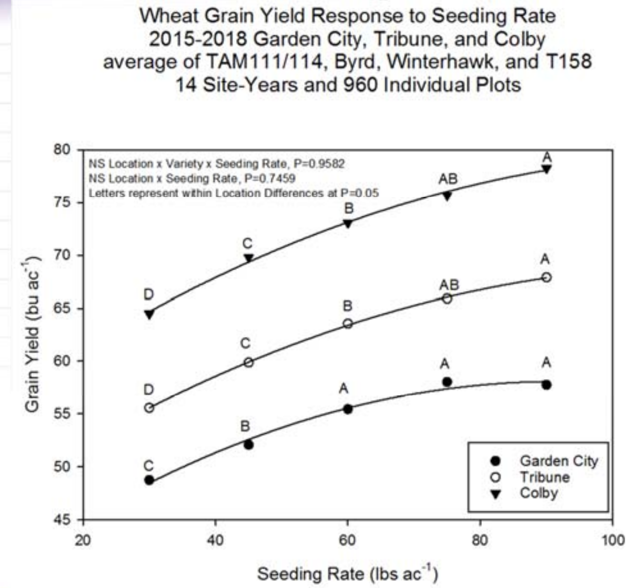
Potential for a seeding rate interaction



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Conclusions

- ESN and NBPT+NPPT coated urea provides some safety over untreated urea when used in-furrow in western Kansas
- Not enough site-years yet to truly evaluate the risk of various levels
- Rates of 10, 20, and 30 lb ac^{-1} for urea, NBPT+NPPT, and ESN appear to be safe in most instances

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Wheat Protein

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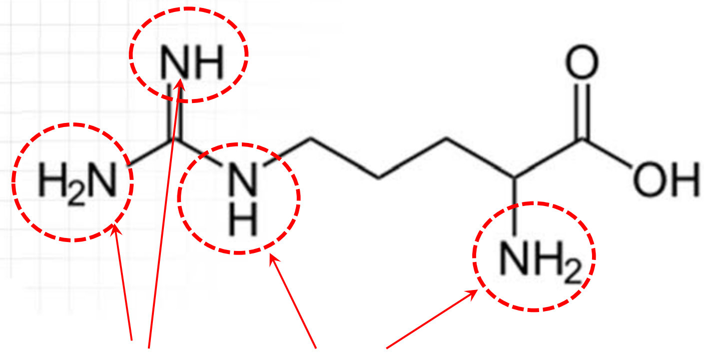
Importance of Protein

- Bread rises because of yeast and gluten
- Gluten – is a "sticky" protein complex
- Proteins are made up of amino acids
- Amino acids are stored in the seed as they are the foundation of plant growth (seedlings)

Amino acid arginine ($C_6H_{12}N_4O_2$)



Amino nitrogen N

32% by weight is N

Making Protein

- Nitrogen is a basic component of amino acids
- Amino acids are the building blocks of plant growth and are stored for seedling development
- The protein in the kernel is generally considered to be laid down first before most of the carbohydrates

Nitrogen Uptake

- Most of the N used by wheat is taken up before flowering and later moved to the kernel during grain fill
- Photosynthesis occurring during grain fill largely determines kernel starch contents

Plant Use of N

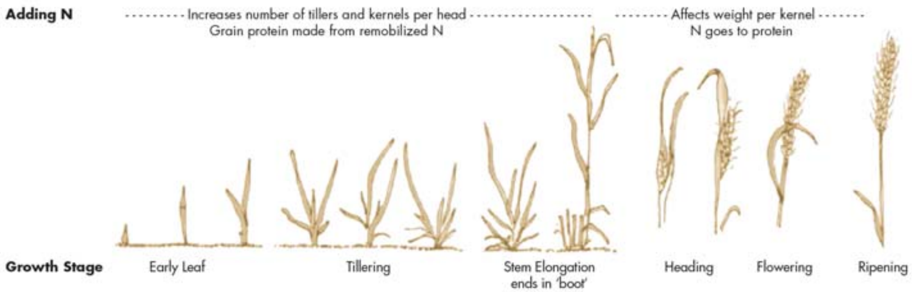


FIGURE 2. Approximate cereal growth stages and N application timing effects on yield and protein. This figure was modified from its original (4).

Jones et al., Montana State Univ. EB0206

N supply effects on Grain Yield and Protein

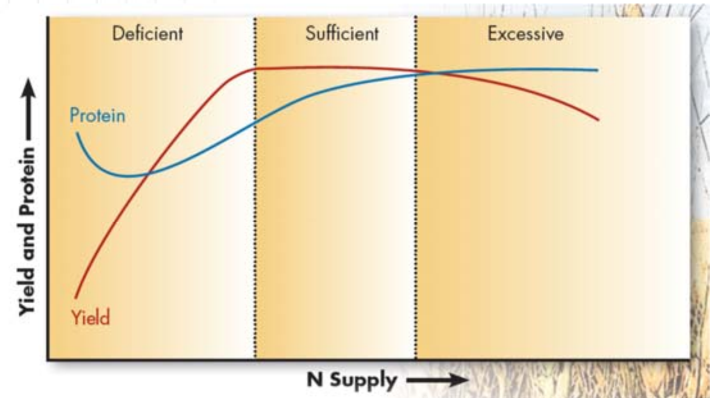
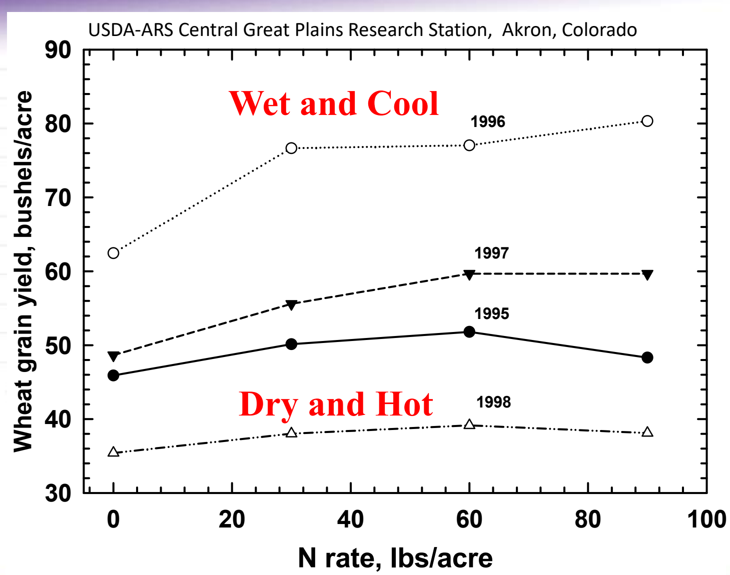
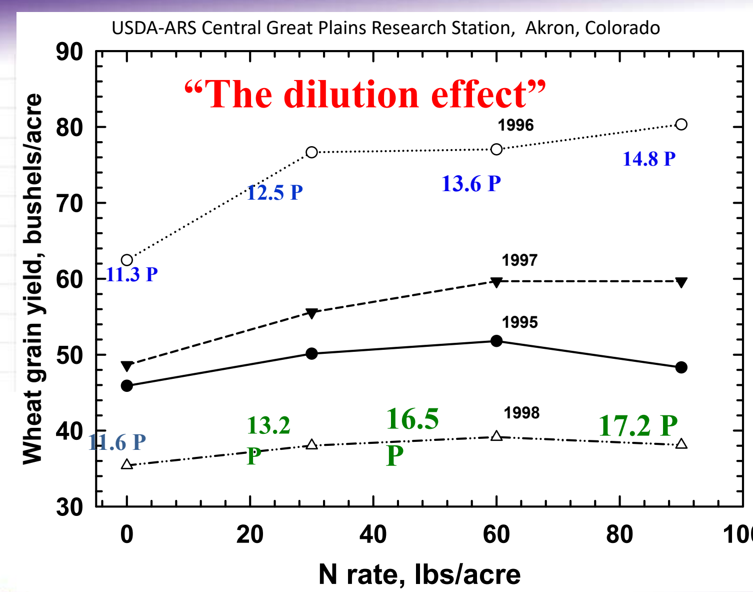
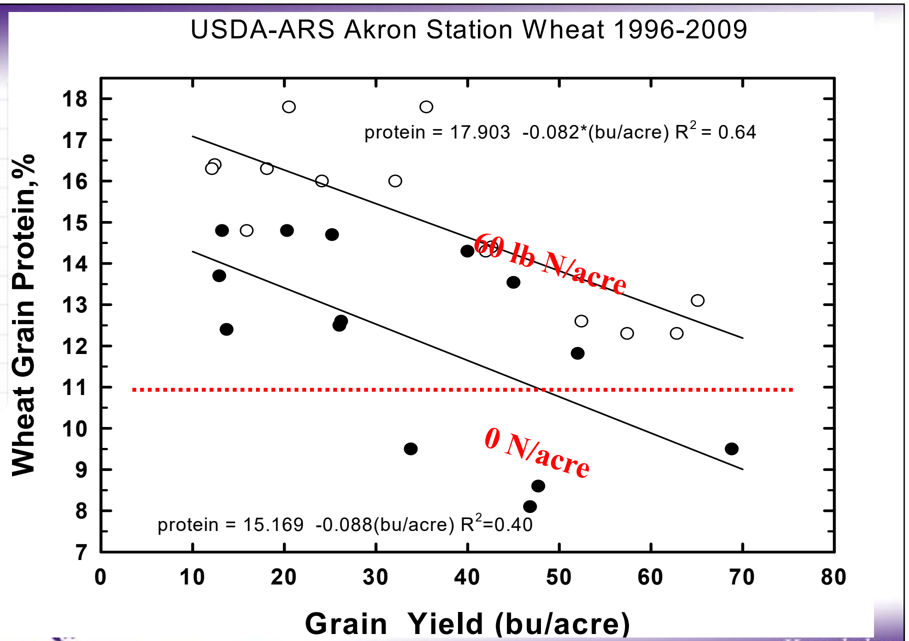


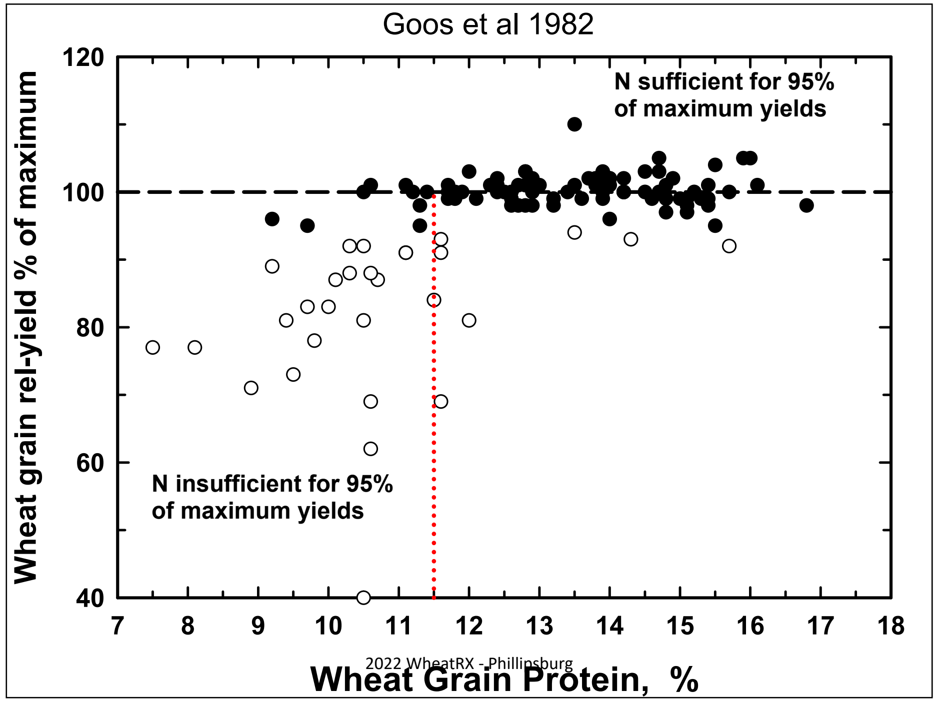
FIGURE 1. The response of wheat yield and grain protein to increasing N (1).

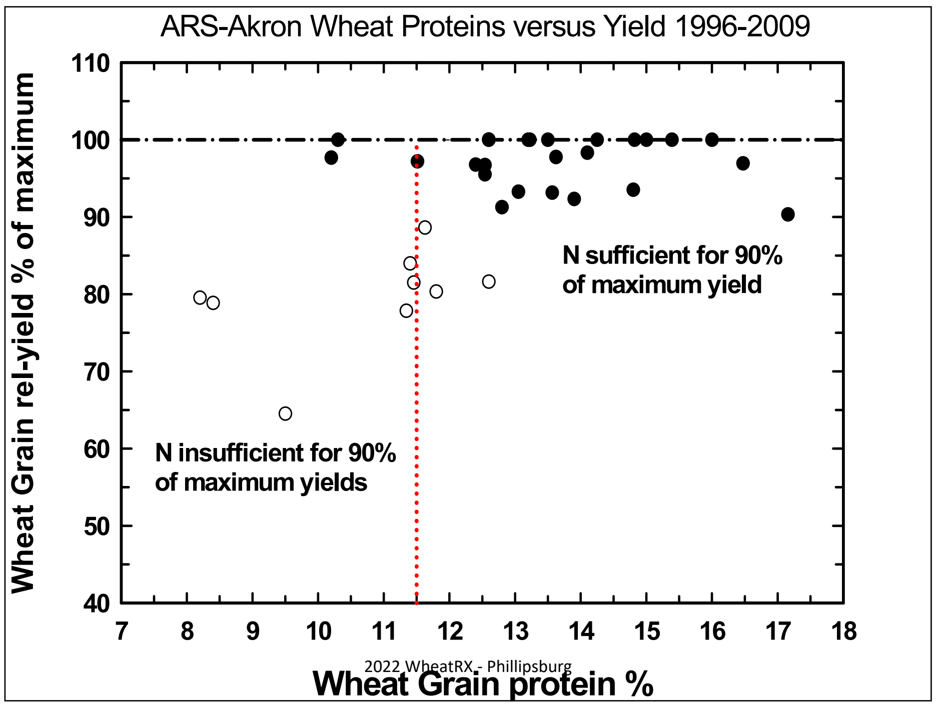
Jones et al., Montana State Univ. EB0206











Increasing Grain Protein

- UNL (NebGuide EC143) recommends an **additional** 20 lbs of spring applied N to increase protein 1% (up to 40 lbs Max)
- CSU (Bulletin 544) recommends an **additional** 20-30 lbs of N to increase protein 1%
- The additional applications will not increase protein if your short of N to maximize yield

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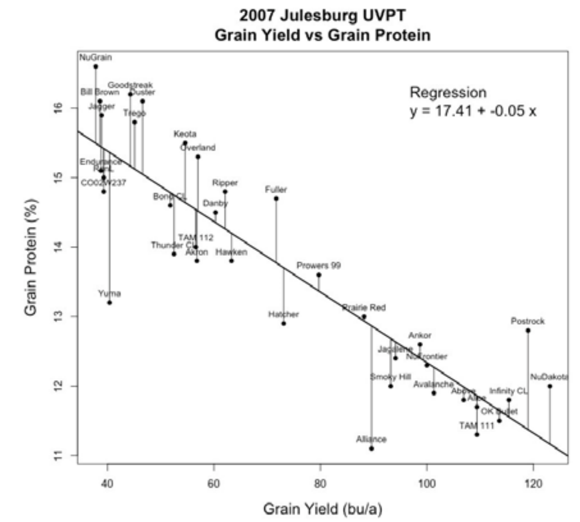
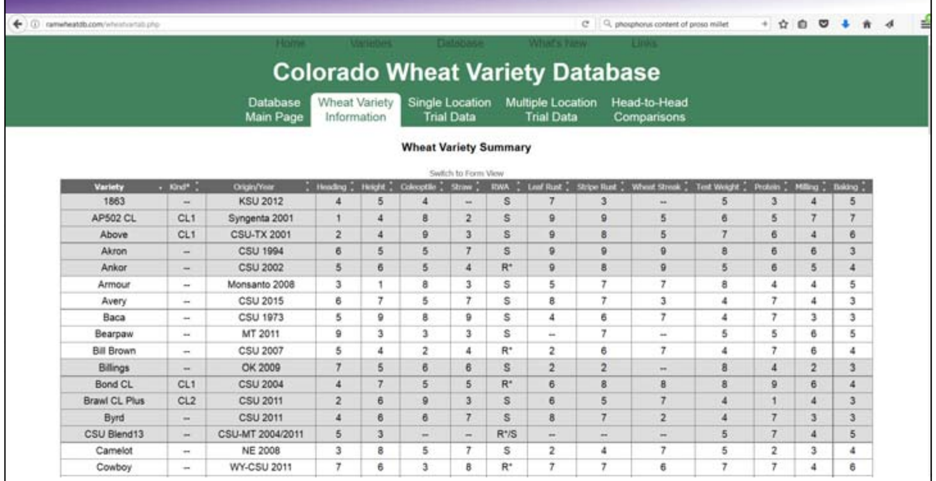
What Role Does Variety Play?

- Anyone who wants to have a conversation about varieties and protein without talking yield isn't really having a conversation
- Varietal differences have been difficult to identify, takes large datasets
- Work by CSU and others has looked at Grain Protein Deviation as a potential indicator

Grain Protein Deviation





Colorado Wheat Variety Database

Database Main Page | Wheat Variety Information | Single Location Trial Data | Multiple Location Trial Data | Head-to-Head Comparisons

Wheat Variety Summary

Switch to Form View

Variety	Kind*	Origin/Year	Heading	Height	Coleoptile	Straw	RWA	Leaf Rust	Stripe Rust	Wheat Streak	Test Weight	Protein	Milling	Baking
1863	--	KSU 2012	4	5	4	--	S	7	3	--	5	3	4	5
AP502 CL	CL1	Syngenta 2001	1	4	8	2	S	9	9	5	6	5	7	7
Above	CL1	CSU-TX 2001	2	4	9	3	S	9	8	5	7	6	4	6
Akron	--	CSU 1994	6	5	5	7	S	9	9	9	8	6	6	3
Ankor	--	CSU 2002	5	6	5	4	R*	9	8	9	5	6	5	4
Armour	--	Monsanto 2008	3	1	8	3	S	5	7	7	8	4	4	5
Avery	--	CSU 2015	6	7	5	7	S	8	7	3	4	7	4	3
Baca	--	CSU 1973	5	9	8	9	S	4	6	7	4	7	3	3
Bearpaw	--	MT 2011	9	3	3	3	S	--	7	--	5	5	6	5
Bill Brown	--	CSU 2007	5	4	2	4	R*	2	6	7	4	7	6	4
Billings	--	OK 2009	7	5	6	6	S	2	2	--	8	4	2	3
Bond CL	CL1	CSU 2004	4	7	5	5	R*	6	8	8	8	9	6	4
Brawl CL Plus	CL2	CSU 2011	2	6	9	3	S	6	5	7	4	1	4	3
Byrd	--	CSU 2011	4	6	6	7	S	8	7	2	4	7	3	3
CSU Blend13	--	CSU-MT 2004/2011	5	3	--	--	R*/S	--	--	--	5	7	4	5
Camelot	--	NE 2008	3	8	5	7	S	2	4	7	5	2	3	4
Cowboy	--	WY-CSU 2011	7	6	3	8	R*	7	7	6	7	7	4	6

www.ramwheatdb.com

CSU Variety Database Protein Ratings for some varieties

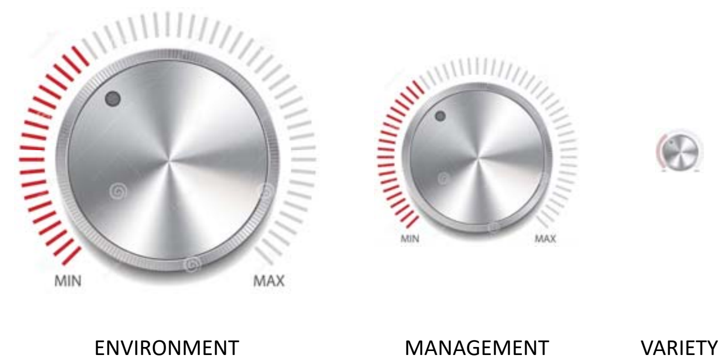
North Central Varieties	Protein Score
Oakley CL	3
SY Wolf	3
Bob Dole	4
KS Dallas	5
T158	5
KS Hamilton	5
SY Monument	5
WB-Grainfield	6
Byrd	7
KS Western Star	7

Relative grain protein content (grain protein deviation), 1=very high to 9=very low

Closing Thoughts on Protein

- Selecting a variety with a good protein score doesn't mean you can get by with less N
- Varieties with a good protein score will still be affected by dilution at high yields
- Protein can be used as a valuable post-hoc evaluation of your N program
  - <u>If protein is consistently less than 11.5% then you are leaving yield on the table!</u>

Protein Control Module



Challenges to Protein Management

- Semi-arid environment
  - Highly variable yield potential, remember N has to make yield FIRST
  - Timing of N is key to maximizing protein response
  - Need moisture to move the N
    - Use of slow release N?
- Are you going to get paid for exporting your nitrogen as protein? The opportunities finally seem to be surfacing…

Questions and Discussion

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Website: www.northwest.ksu.edu/agronomy