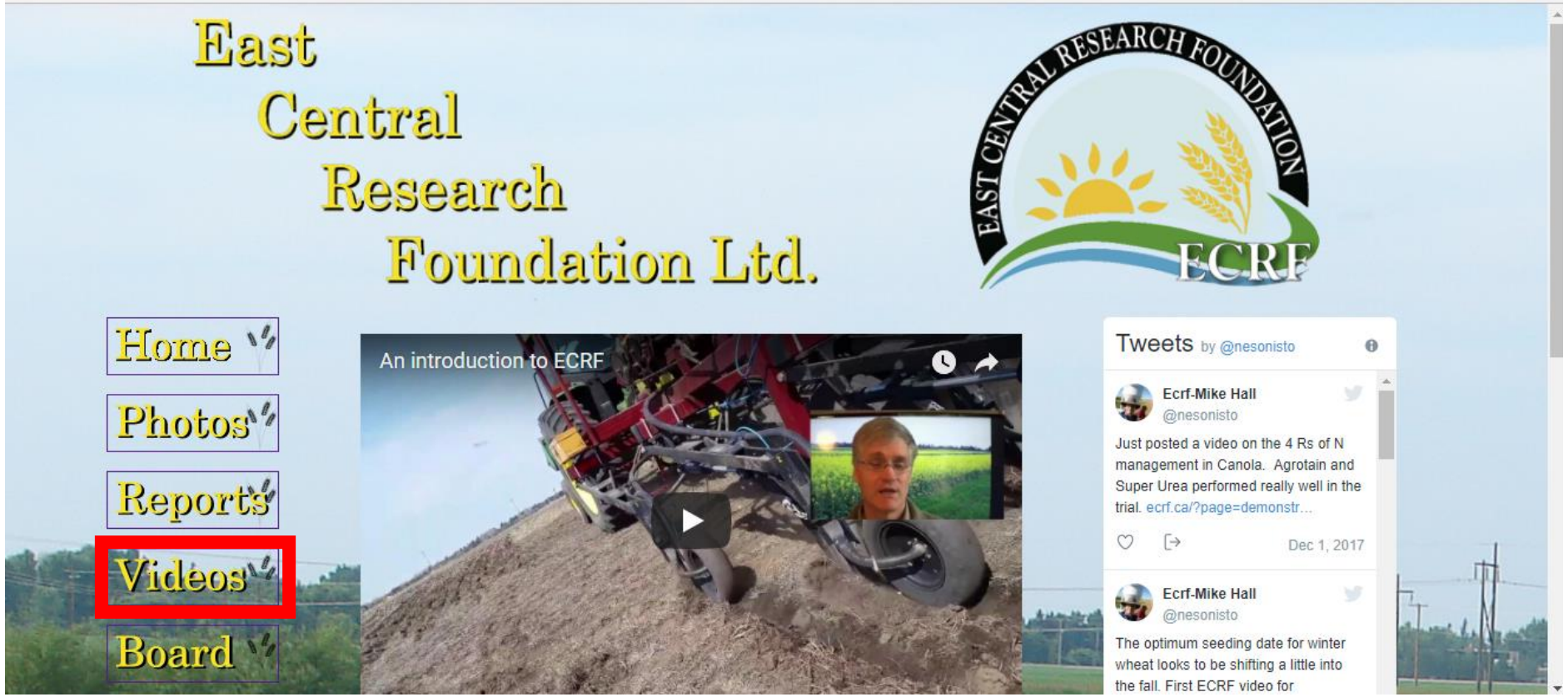
2013

Increasing Protein in Wheat



EAST CENTRAL RESEARCH FOUNDATION ECRF

PARKLAND COLLEGE

Mike Hall
Research
Coordinator
www.ecrf.ca

Increasing Protein in Wheat

Next Field Day is July 12, 2018

E-mail list

Mike Hall
Research Coordinator
www.ecrf.ca

attention to seeding

May produces the best results

BY WILLIAM DEKAY
SASKATOON NEWSROOM

The window of opportunity to seed soybeans is small, but farmers would do well to take it to heart, a researcher involved in a recent study told a people attending Crop Production Week in Saskatoon.

Mike Hall of the Essential Research Foundation and Parkland College in Yorkton, Sask., said farmers will likely get their best results by seeding soybeans in mid to late May.

"Seeding too early runs the risk of cold shock and damage from late spring frosts. Seeding too late reduces yield and increases the chance of fall damage and green seed," he said.

The research foundation conducted several experiments during a five-year program using Northstar Genetics varieties.

A 2013 study demonstrated the importance of seeding soybeans into warm soil to avoid cold shock and improve plant vigour and yield.

Soybeans were planted into 21 C

Seeding too early runs the risk of cold shock and damage from late spring frosts. Seeding too late reduces yield and increases the chance of fall damage and green seed.

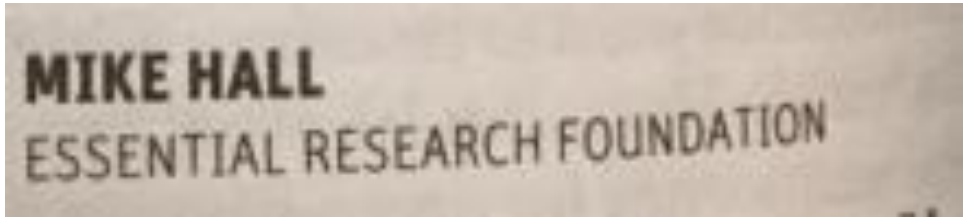
MIKE HALL
ESSENTIAL RESEARCH FOUNDATION

buying planters, for example, he said.

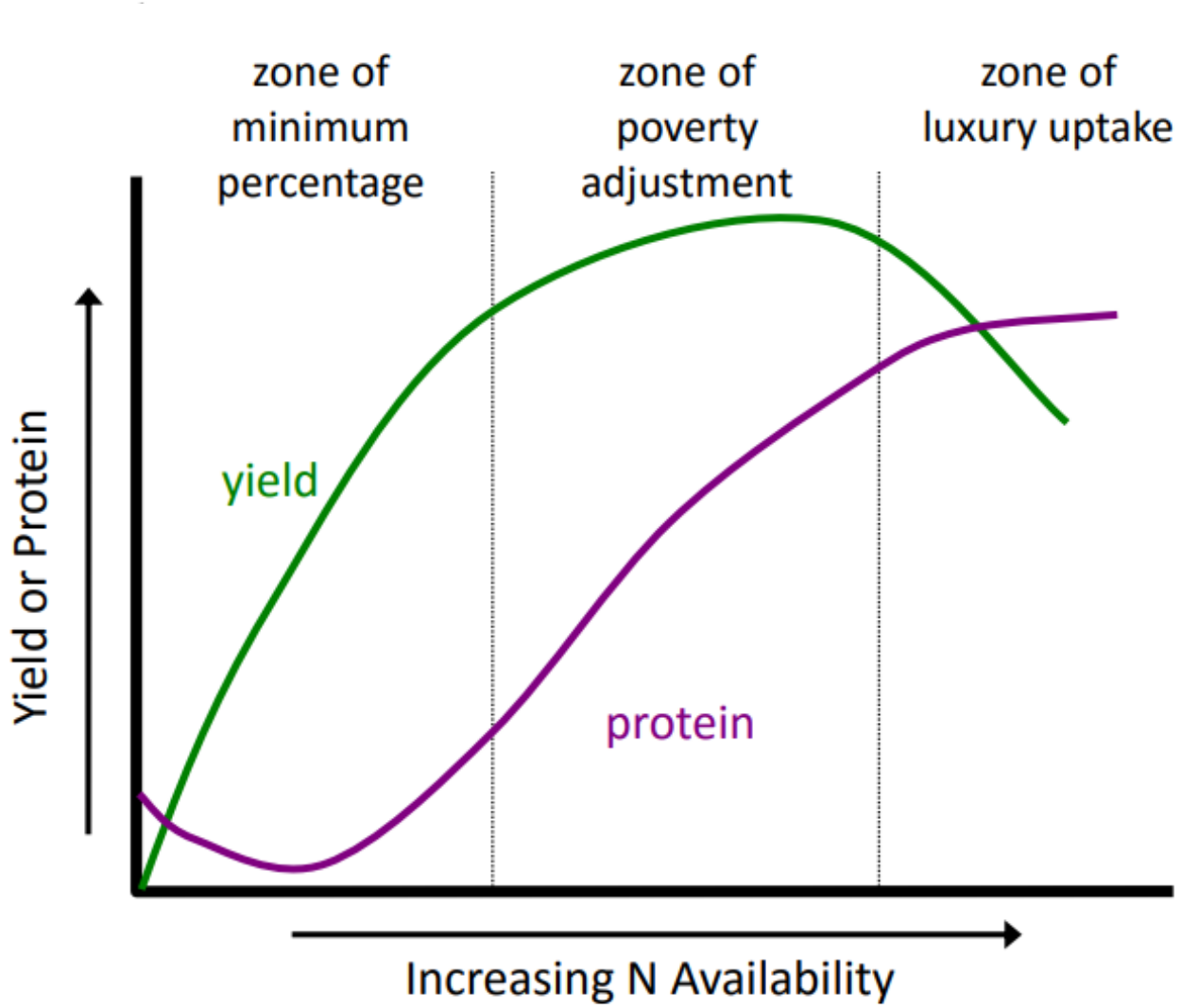
A study in 2016 looked at the influence of fall cultivation and seeding date on soybean production.

Treatment list included soybeans seeded May 5, May 16 and May 24

Hoping this talk will provide us with better exposure than what we received in the Western Producer.

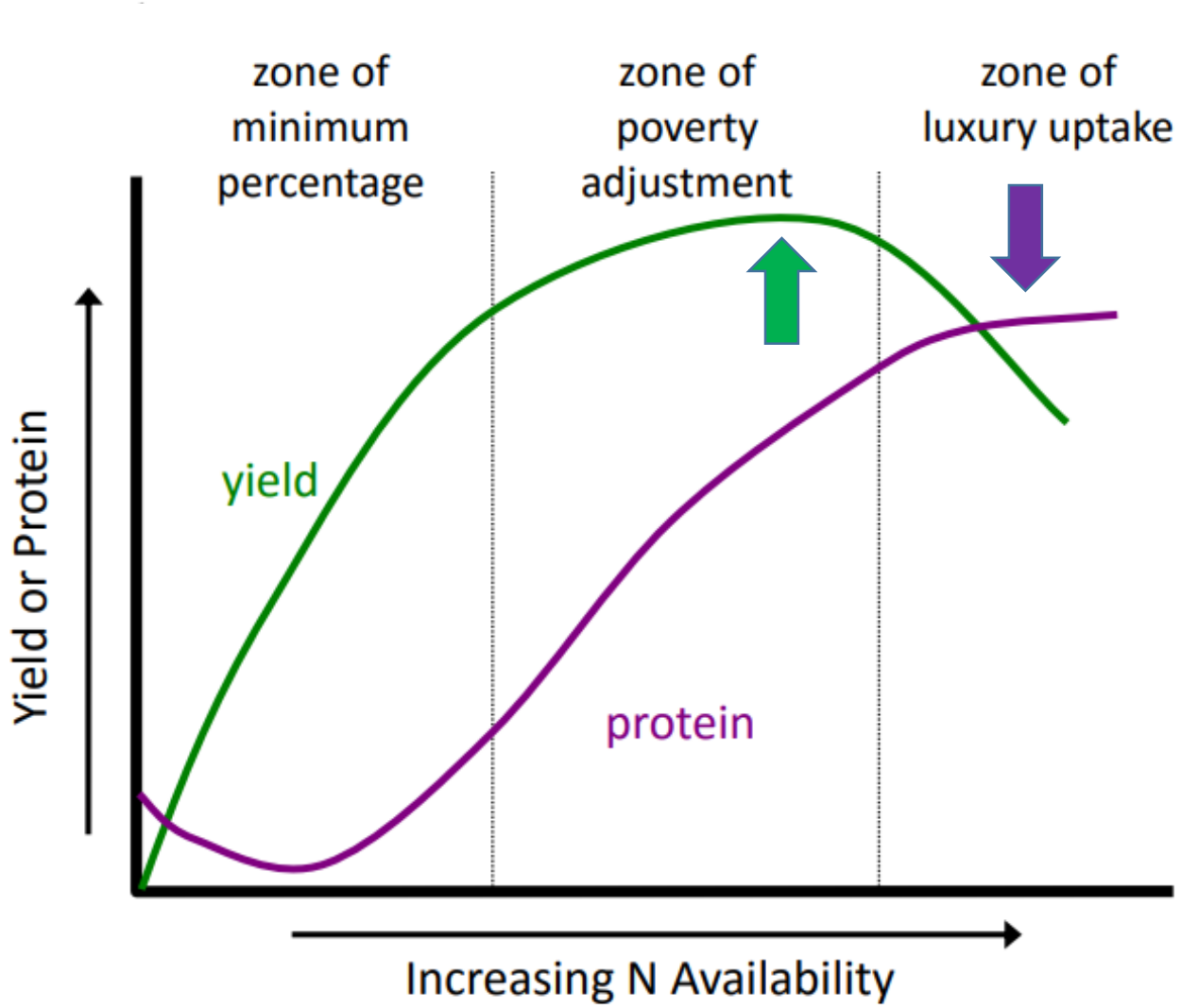


Increasing Protein in Wheat



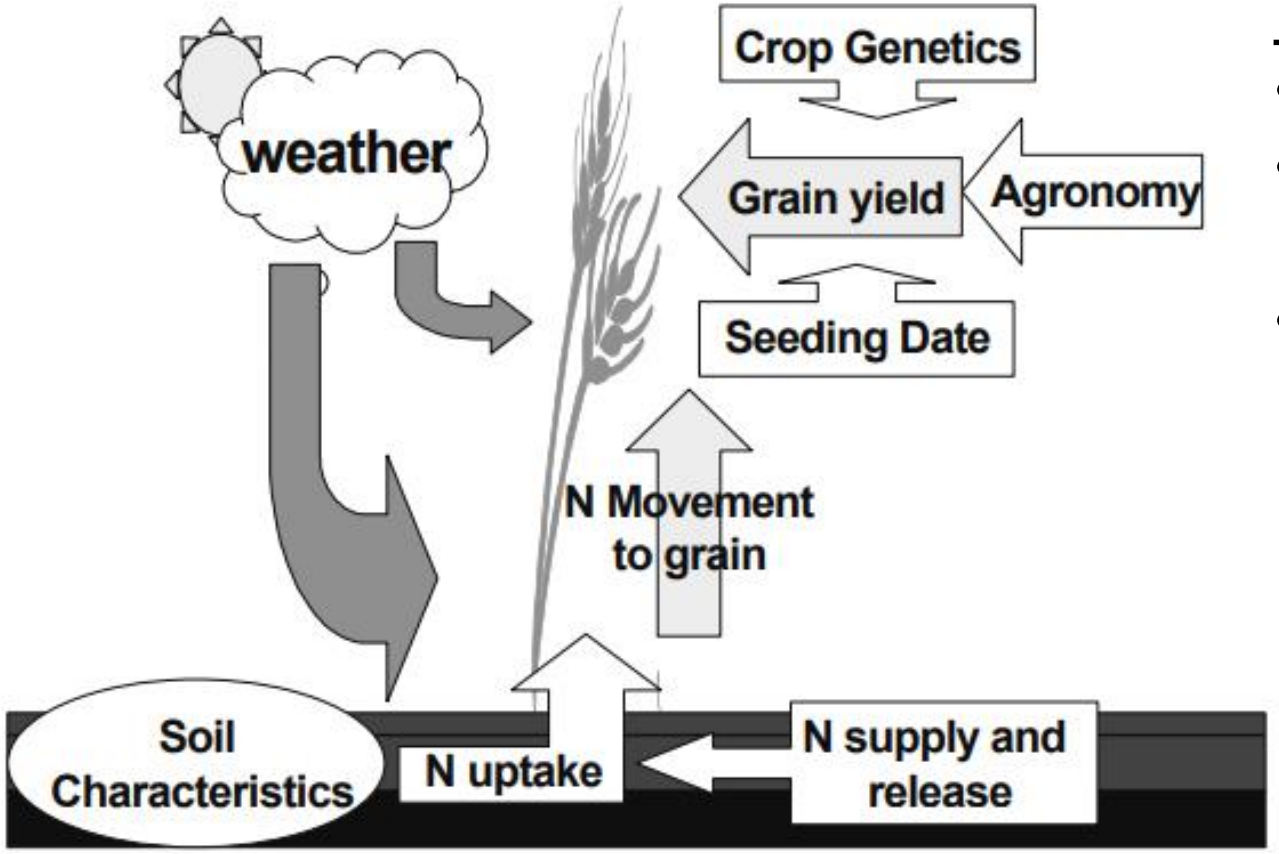
- Premiums for High protein wheat are offered when it is in short supply
- How could the crop have been managed to have higher protein?
- How does increasing nitrogen rate and environment affect wheat protein?

Increasing Protein in Wheat



- The rate a which yield is limited is lower than that of protein. This creates an opportunity for increasing protein

Figure 1: Factors Affecting Protein Content of Wheat



Cindy Grant

Environment impacts Protein

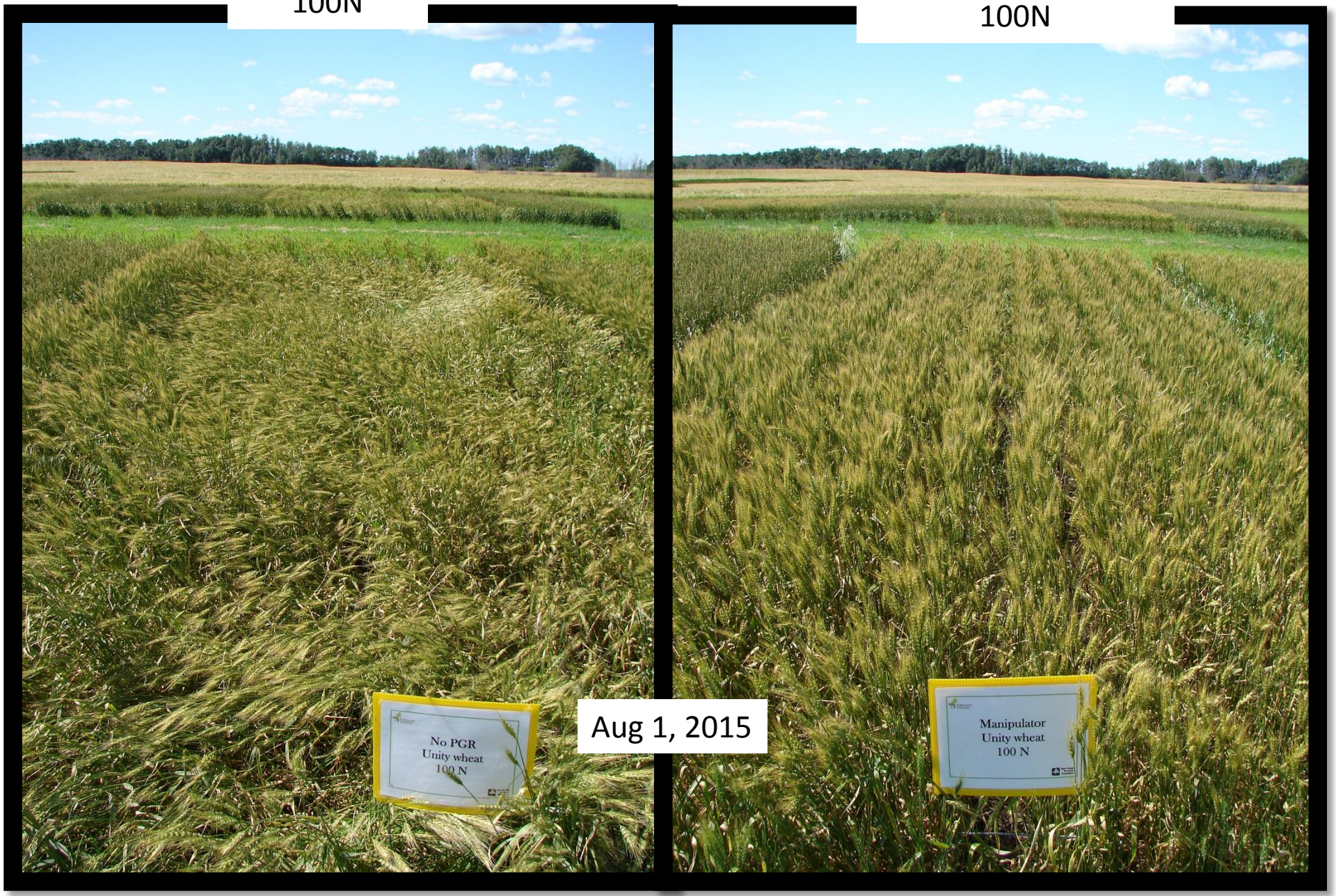
- Drought increases protein
- Good Environmental conditions decrease protein (pie-bald)
- Why low protein in a year with low precipitation?
  - Good soil moisture reserves, low disease and good yields
  - Low mineralization

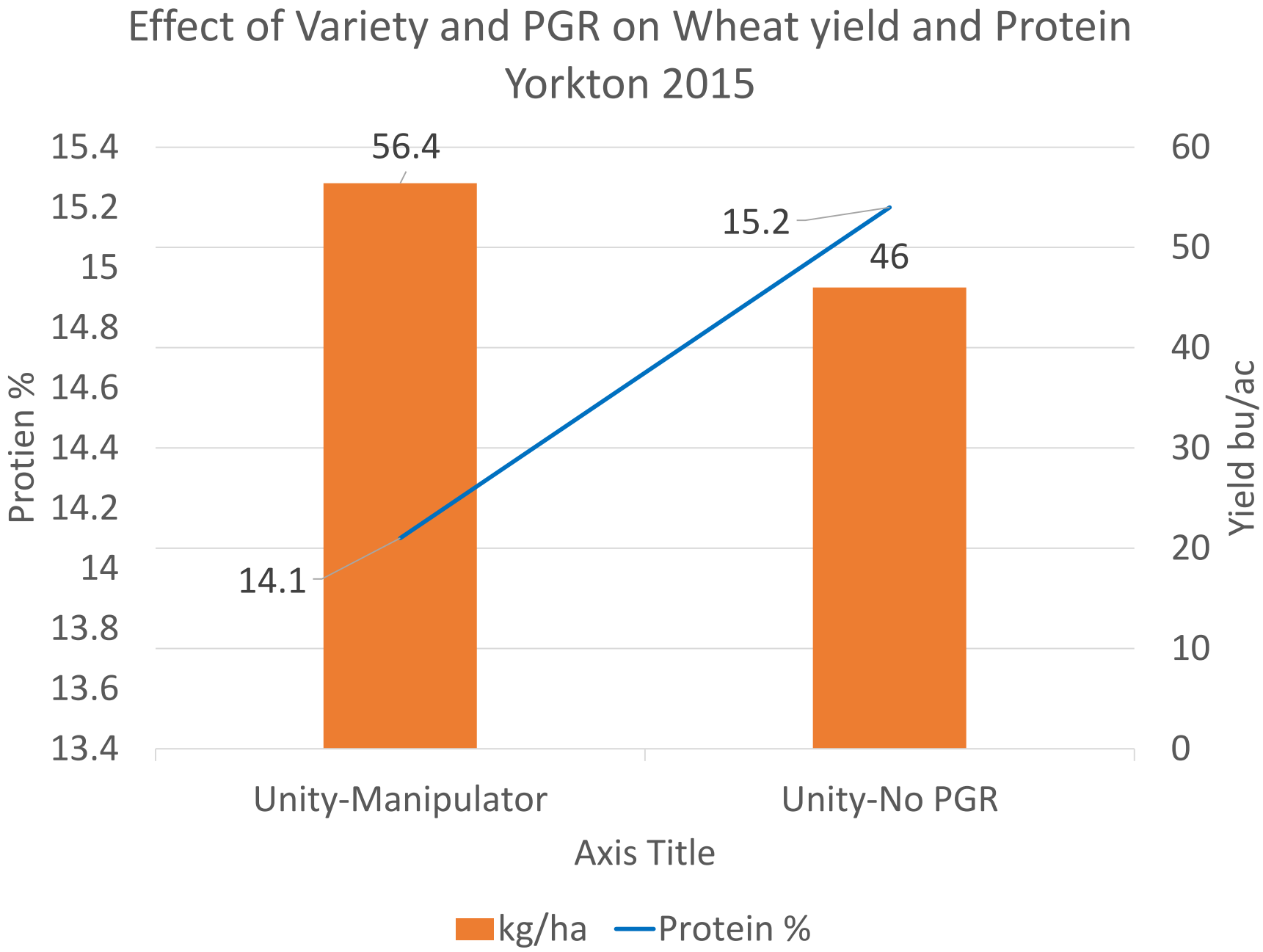
Increasing Protein in Wheat

- Use a high protein variety (protein comparisons in seed guide)
  - High yielding varieties also tend to have lower protein.
  - CNRS varieties Faller and Prosper have -1.9% protein (relative to Carberry)
  - CWRS and CPSR varieties to be moved into the CNRS class (Harvest, Lillian, Unity VB, Conquer VB Aug 1, 2018)
- Grow on manured fields
  - The late season release of nitrogen form the manure will go towards increasing protein.
  - Not an option for most fields
- Grow wheat after a legume
  - Organic matter from legumes is high in nitrogen and is generally released latter in season.
  - Peas (Aphanomyces root rot), Faba beans (limited market)
- Increase applied nitrogen at seeding
  - Generally the approach taken in western Canada
  - Wetter climates such as England use multiple applications because of greater N demands and to reduce leaching and denitrification losses.
  - Could cause lodging issues

No PGR
Unity Wheat
100N

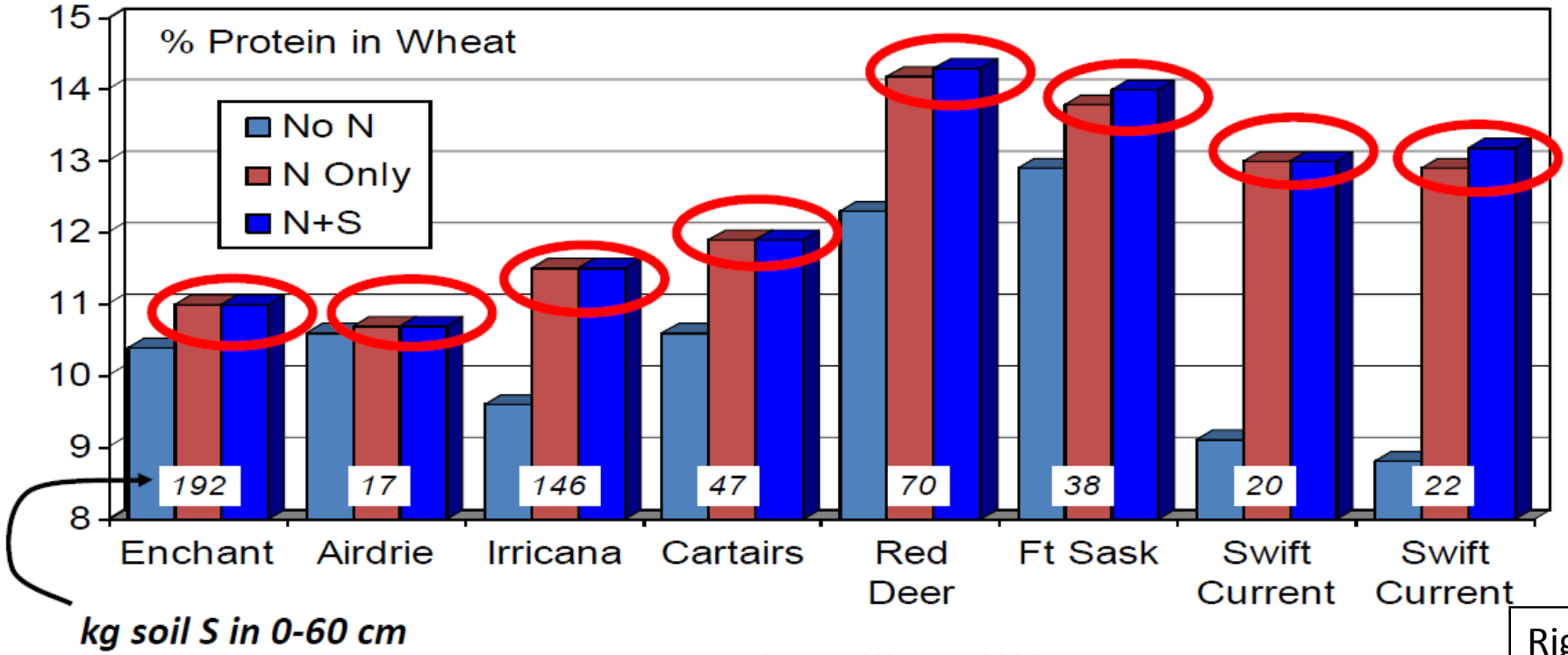
Manipulator @ Zk 31
Unity Wheat
100N




Effect of Variety and PGR on Wheat yield and Protein
Yorkton 2015
15.4
15.2
15
14.8
14.6
14.4
14.2
14
13.8
13.6
13.4
Protien %
60
50
40
30
20
10
0
Yield bu/ac
56.4
46
15.2
14.1
Unity-Manipulator
Unity-No PGR
Axis Title
kg/ha
Protein %

Sulphur Fertilization and Wheat Quality

- **Bread-making wheat requires protein quantity & quality**
- **Protein premiums for wheat reflect the importance of protein in crop quality … <u>but only protein N is measured</u>**
- **As currently measured, S has little effect on % protein**

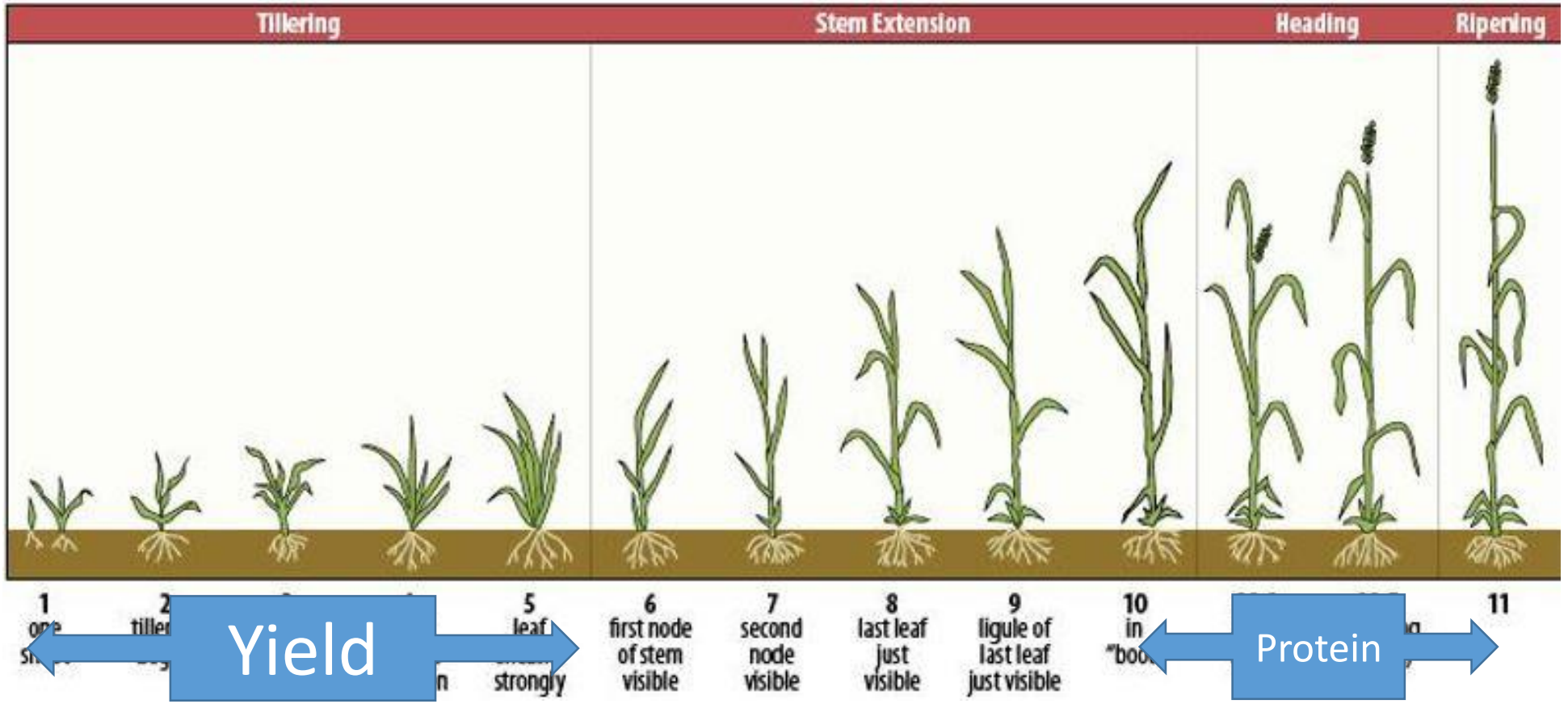


Source; Westco, 1998

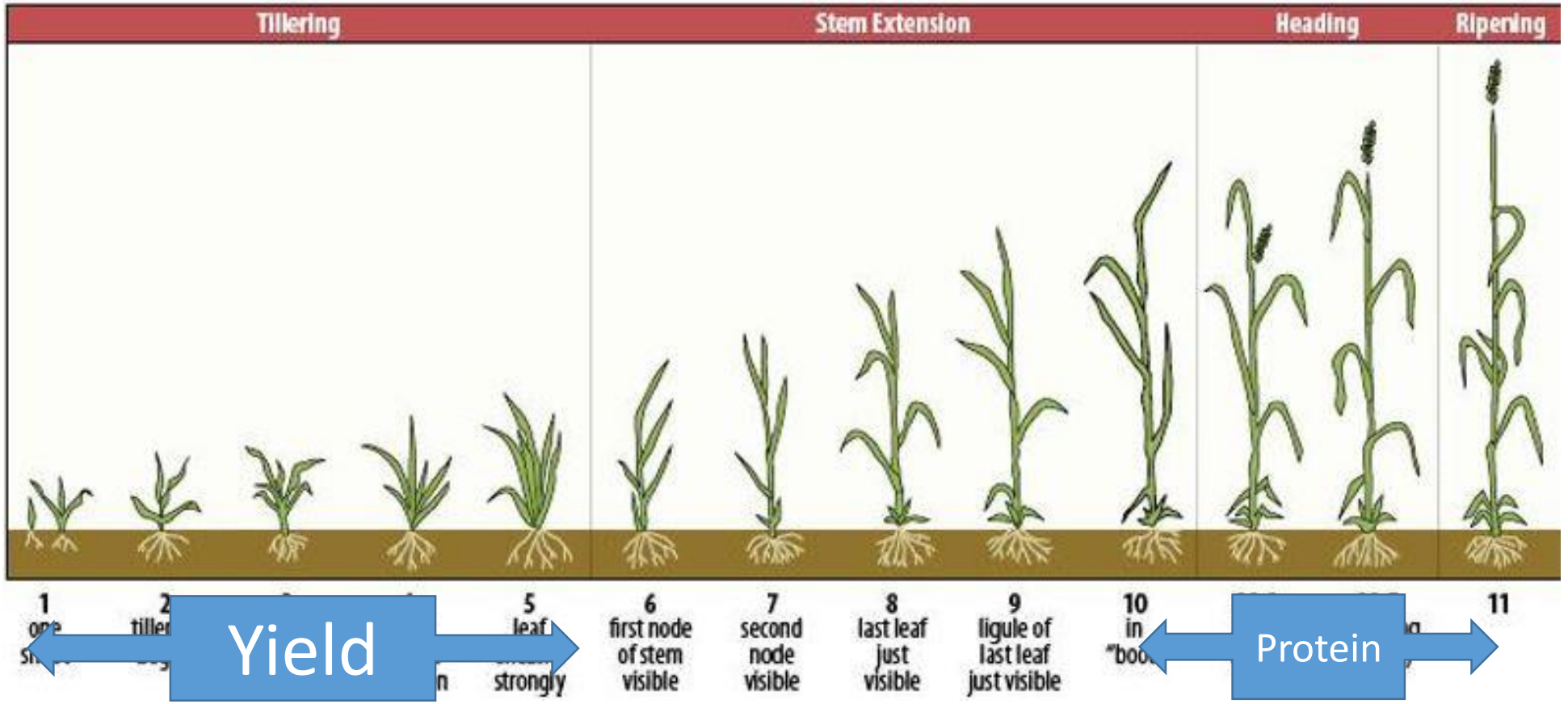
Rigas Karamanos
John Heard slide

Can Post Seeding Applications of Nitrogen increase wheat protein?

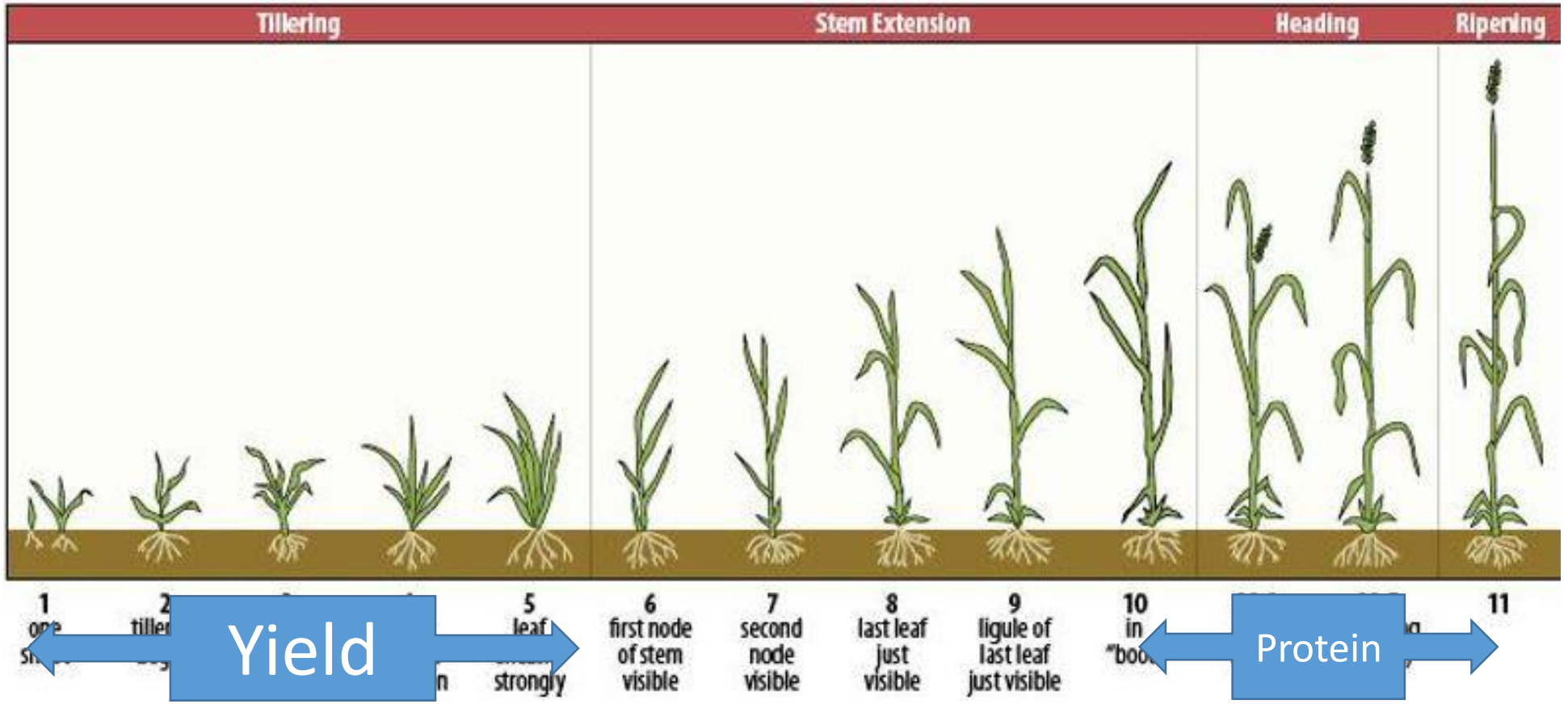
- Post seeding applications?
  - Applications of N prior to 5 leaf stage mostly go towards yield (needs rain)
  - Application of N at boot or after flowering go most towards protein (needs rain)



- Why some consider applying the bulk of N requirement post seeding prior to 5 leaf?
  - Logistic issues at seeding
  - Speed up seeding operations
  - Cheaper nitrogen
  - Yield potential has improved (more rain)

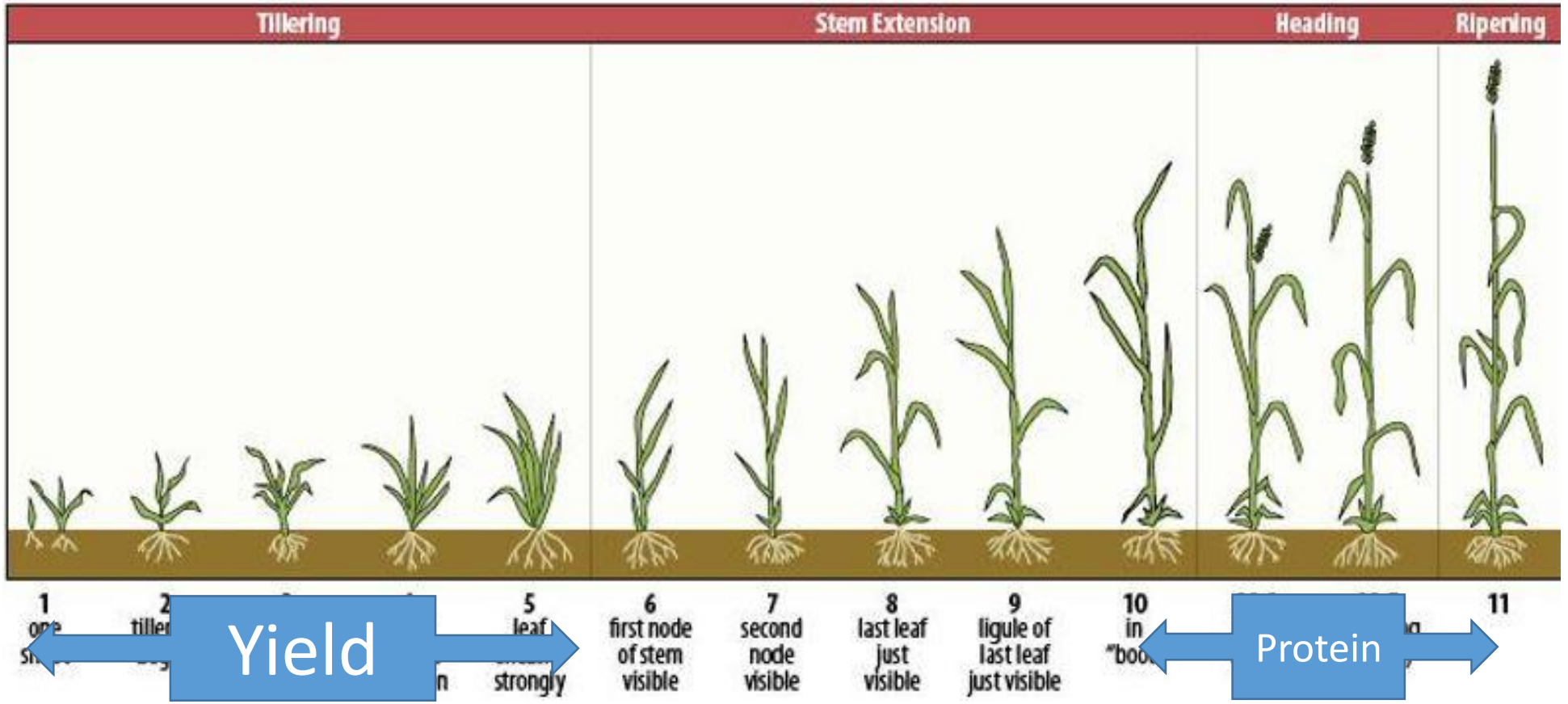


- Risks with Post seeding applications of N prior to 5 leaf?
  - Weather prevents timely application
    - Too much rain to get on field
    - Too dry to leach N into the soil
    - N loss to volatilization
  - Competing with spray operations



A better approach

- Target N rates at or prior to seeding for a high yielding good protein crop.
- If the crop looks exceptional consider late season applications to maintain adequate protein.



Options for post seeding nitrogen

- Ammonium Nitrate (Not an option anymore)
  - Could be broadcast on soil surface without volatilization loss
- Broadcast Urea
  - Volatilization loss- Agrotain can provide some protection for a cost.
- Dribble band UAN
  - Less prone to volatilization loss (25% NO_3 applied as concentrated band)
- Broadcast spray UAN
  - Can result in leaf burn and yield loss

All of these approaches require timely rain. Even broadcast spray UAN

- Research has shown less than five to ten percent of foliar-applied N actually enters the plant through leaf surfaces. To be effective, foliar N needs to be washed off leaves and moved into the soil with rainfall.
- Soil applied tends to be more efficient unless soil conditions are dry. In this case the little N that is absorbed through leaves may prove more beneficial.

Results

What have researchers observed with Post-emergent applications of Nitrogen?

Ross McKenzie-2006

- Research Conducted between 1998 to 2000 (26 site-years mostly in Alberta with a few locations in Saskatchewan and Manitoba)
- Trials applied 15 kg N/ha to a base rate of 60 kg N/ha
  - Broadcast AN or Foliar UAN
  - Applied at Tillering, boot stage or post-anthesis
- Protein increase
  - Average = 0.3%
  - Maximum = 1.3%
  - Latter applications increased protein more
  - No protein increase was observed relative to 75 kg N/ha applied at seeding.
- Increase in grain protein was not economic at most sites.

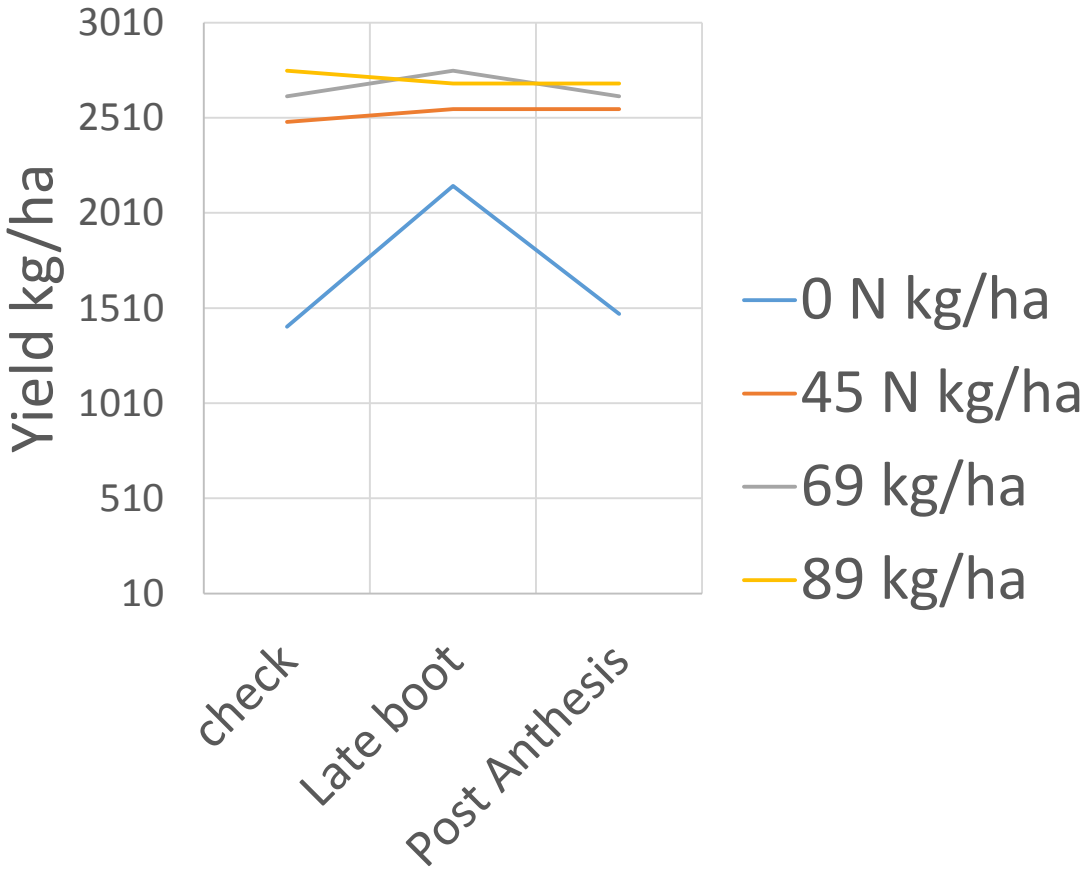
McKenzie, R. H., Bremer, E., Grant, C. A., Johnston, A. M., DeMulder, J. and Middleton, A. B. 2006. In-crop application effect of nitrogen fertilizer on grain protein concentration of spring wheat in the Canadian prairies. Can. J. Soil Sci. 86: 565–572.

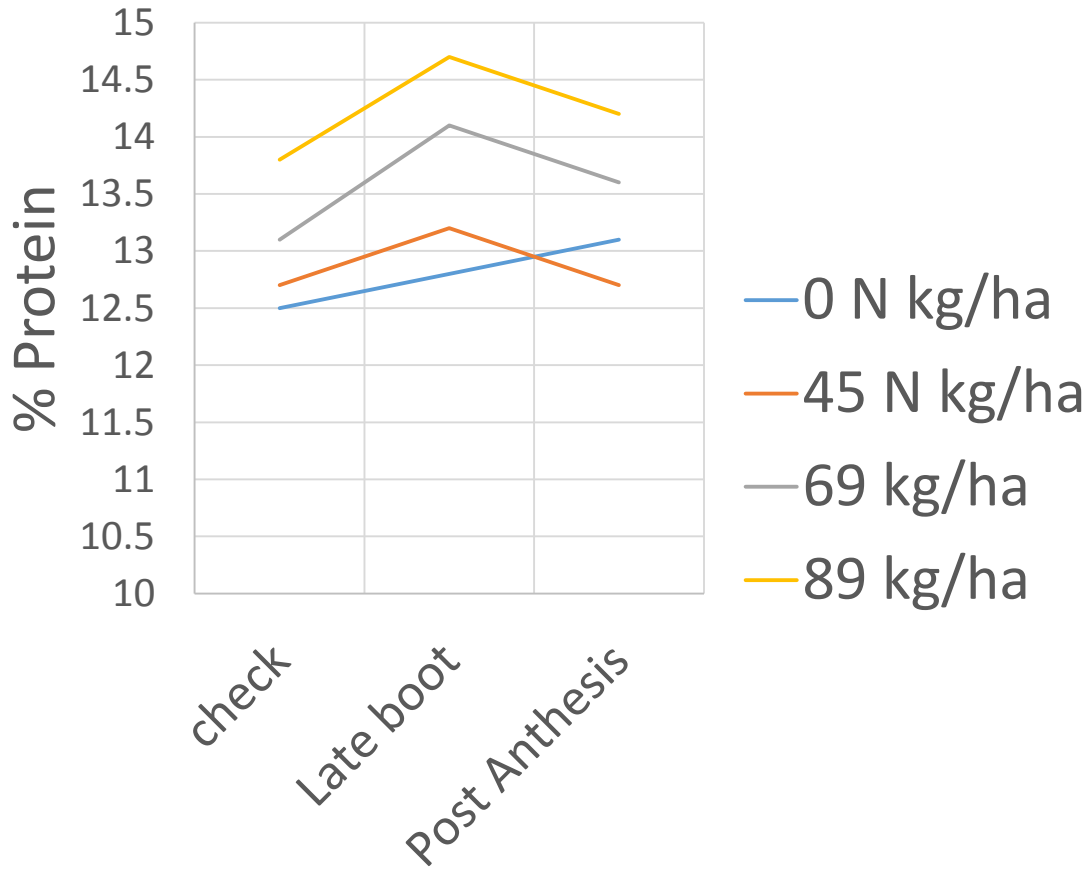
Conclusions

- Western Canadian research has shown in-crop granular and foliar nitrogen applications at tillering, boot and anthesis growth stages do not consistently increase grain protein. Therefore, in-crop applications are less reliable than applying additional N fertilizer at or before seeding.” Ross Mckenzie-retired Soil researcher Alberta Agriculture

Effect of Foliar UAN (15 lbs N/ac) Applied late boot and Post-anthesis on Spring Wheat Yield and Protein.

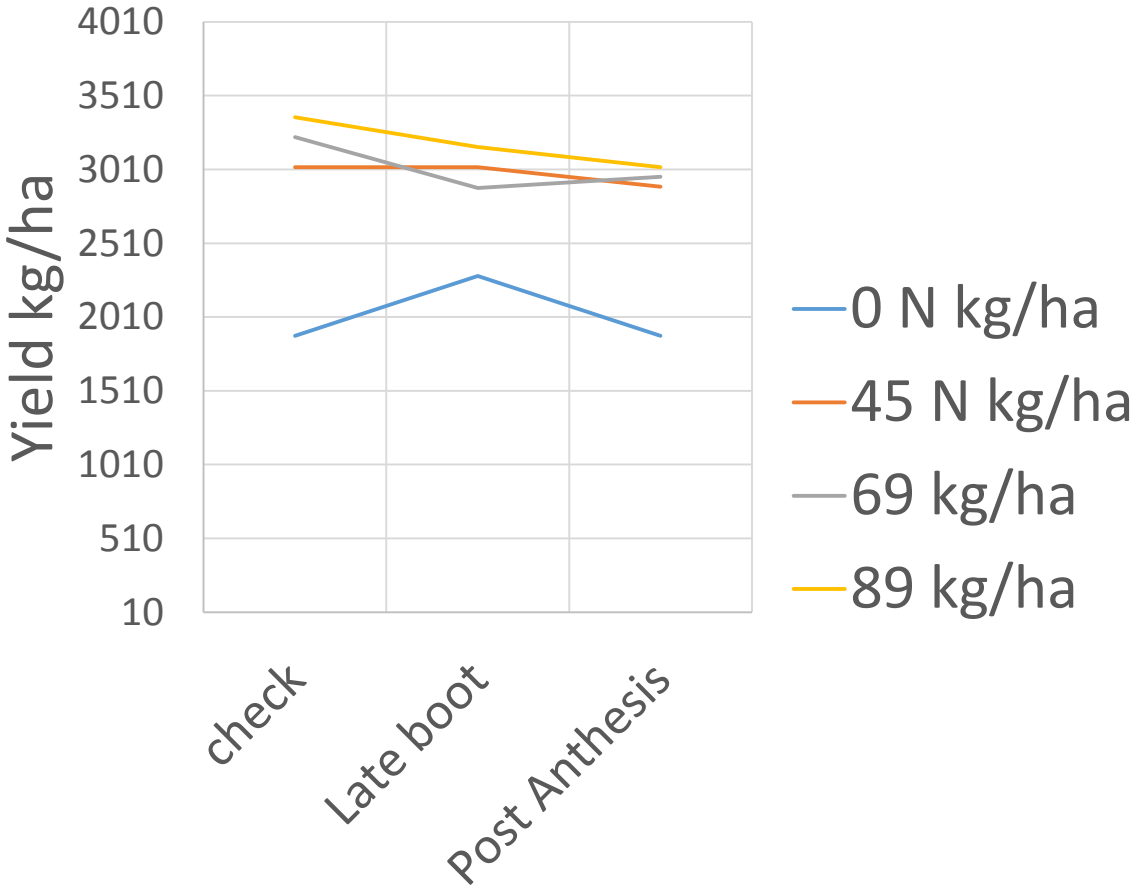
G. Lafond-Heavy Clay Soil 94

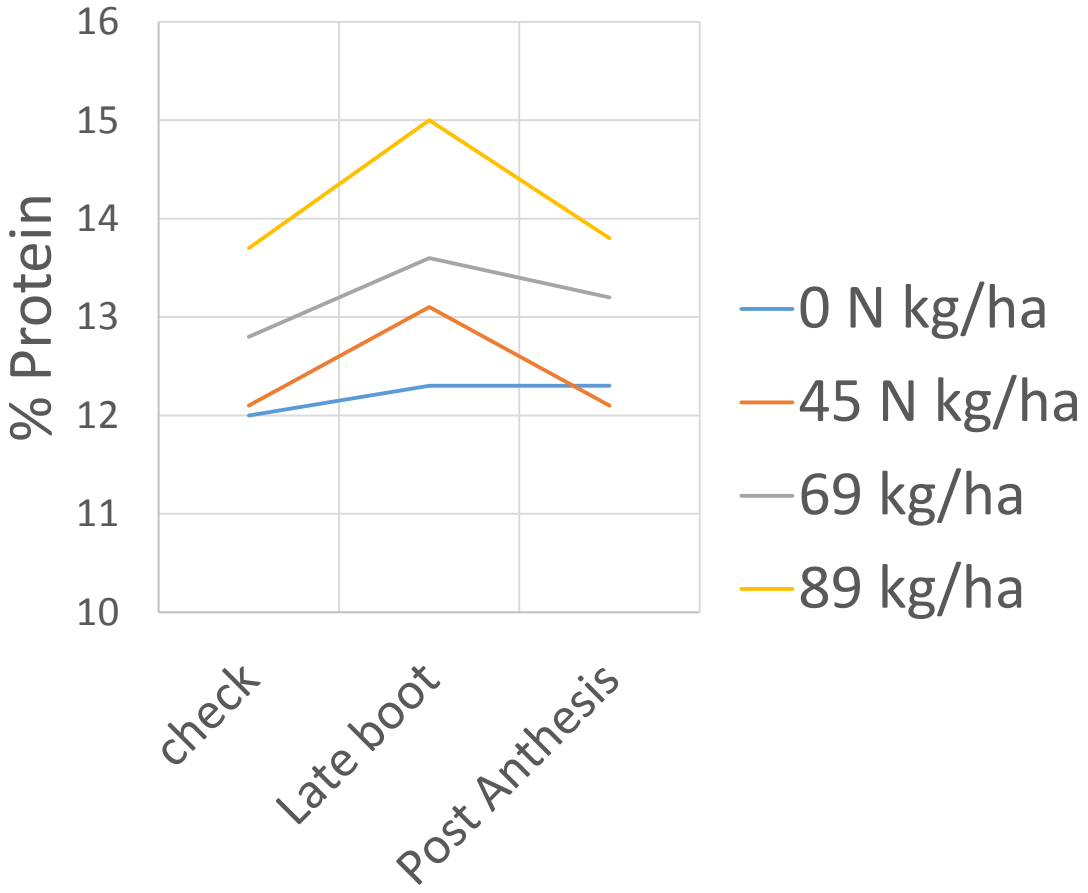




Effect of Foliar UAN (15 lbs N/ac) Applied late boot and Post-anthesis on Spring Wheat Yield and Protein.

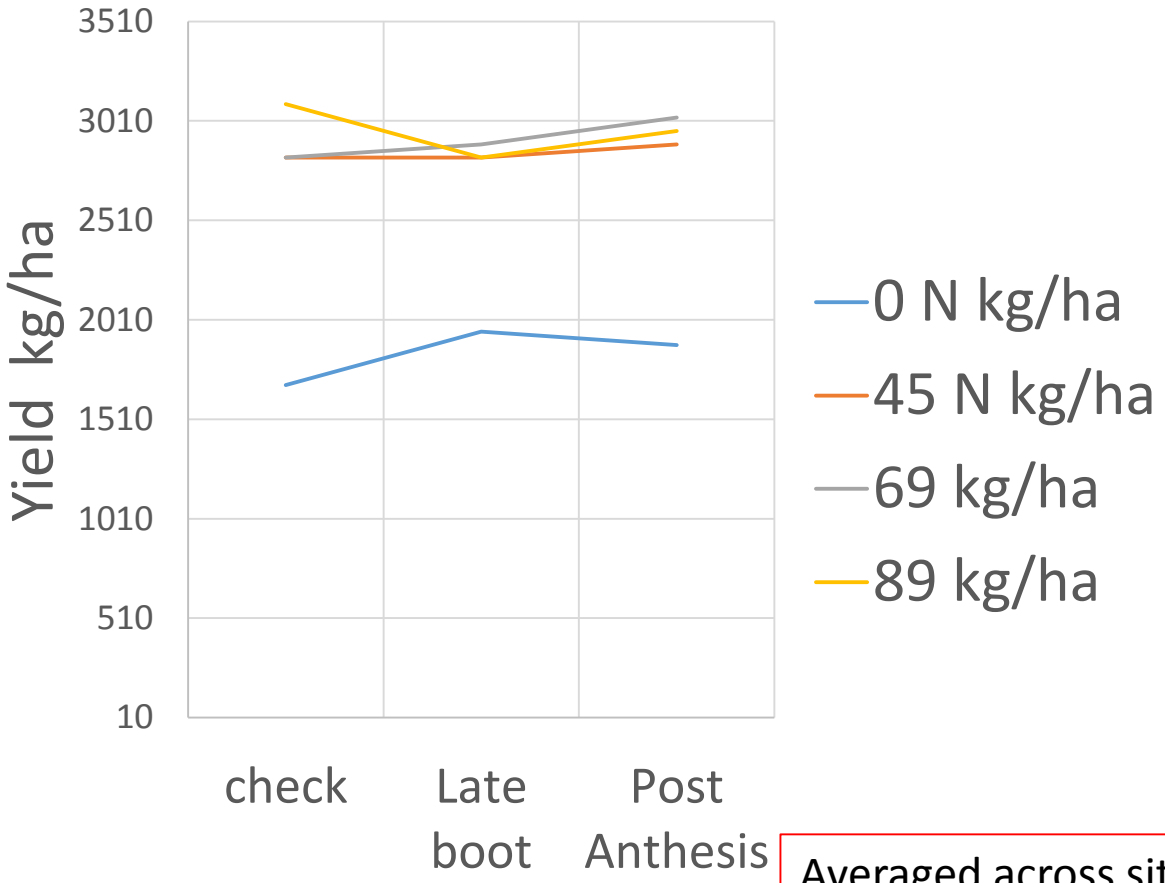
G. Lafond-Oxbow Loam 94

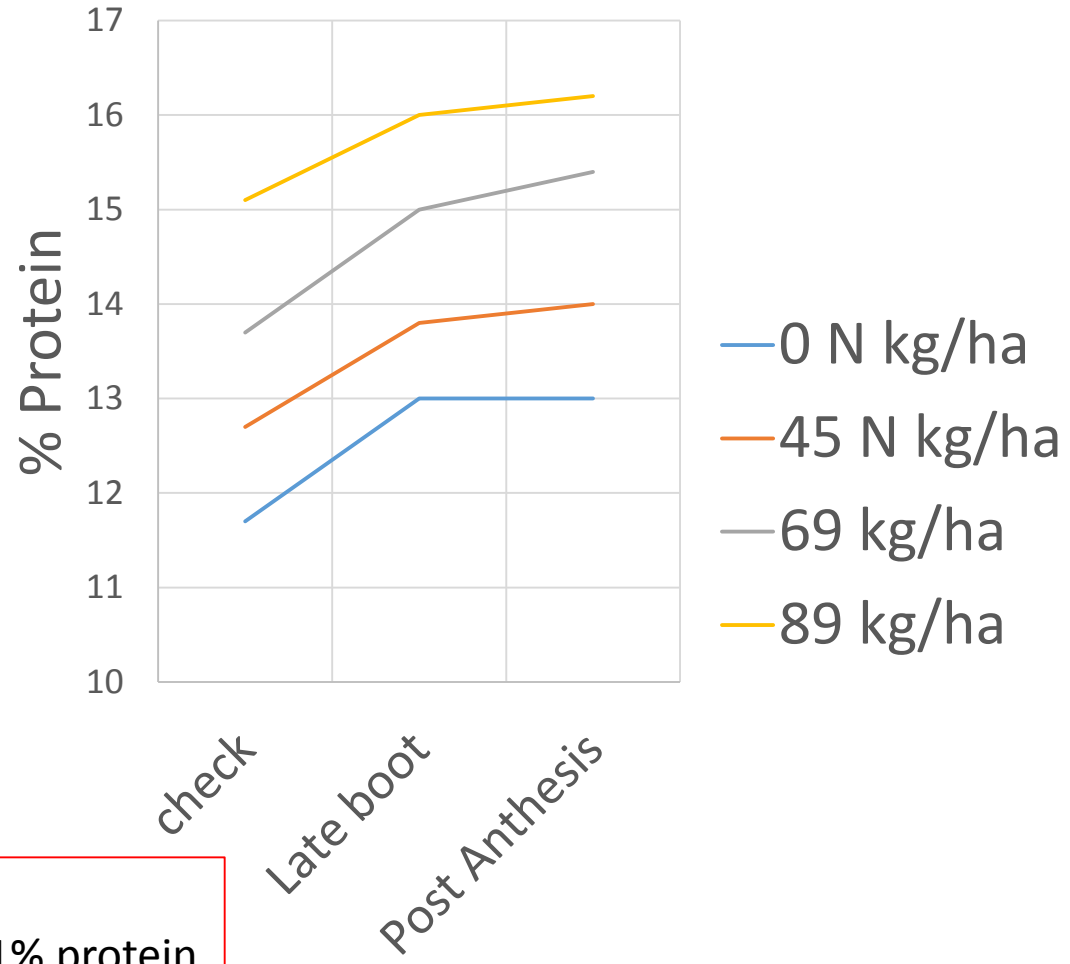




Effect of Foliar UAN (15 lbs N/ac) Applied late boot and Post-anthesis on Spring Wheat Yield and Protein.

G. Lafond-Heavy Clay Soil 95





Averaged across sites:

- Late boot application..+1% protein
- Post-anthesis..+0.7% protein

Foliar N at Boot stage vs Post anthesis

- Guy Lafond (mid-1990s in Indian Head). Practice had merit …. earlier application increased protein more consistently (with occasional increase in yield)….

Top Dressing Nitrogen to Boost Protein

- Flat fan – 10 ga/ac of 28-0-0 (30N/ac) with 10 ga/ac water applied nozzle shortly after anthesis (5-7 days).

Summary of 1995-2000 studies on hard red spring wheat , South Dakota. (Woodard and Bly)		
Treatment	Bu/ac	Protein %
Check	42.5 a	14.2 c
30 lb N/ac at boot	40.2 b	14.4 b
30 lb N/ac post-anthesis	41.2 ab	14.7 a

  - Can cause burn in heat of the day.
  - Not recommended to apply with fungicide for FHB
  - Expect no more than 0.5 to 1.0 percent of a protein boost.

Nitrogen applied post anthesis.

John Heard (Soil Fertility Specialist-Manitoba Agriculture)

- Calls the N. Dakota recipe the 7-10-20-30 Rule
  - 7 days after anthesis
  - 10 ga/ac 28-0-0 with 10 ga/ac water
  - Spray below 20^{o}C.
  - Apply 30 lbs N/ac
- There is more interest in this approach particularly when growing high yielding varieties such a Prosper and Faller.
- He tested this approach (2015-16) with 15 producers using replicated field scale trials.

Base N applied

- 120 lbs/ac (CNHR-Canada Northern Hard Red)
- 82 lbs/ac (CWRS- Canada Western Red Spring)

Post anthesis UAN

- 30 lbs/ac

Effect of Post anthesis N (PAN) on wheat class yield and protein (2015-16)- John Heard

	CNHR (6 sites)	CWRS (7 sites)	CPS (2 sites)
Yield bu/ac			
Base N	80	68	69
Base N + PAN	78	68	65
Protein %			
Base N	13.0	14.2	13.8
Base N + PAN	13.6	14.6	14.1

Protein increase of 0.5% on average, significant at 9/15 sites
Observed 8-15% leaf burn without yield impact.
On instance of mid-day application and 31% leaf burn resulting in 6 bu/ac yield loss

Effect of Post anthesis N (PAN) on wheat class yield and protein (2015-16)- John Heard

Table 10. Economics of PAN applications.

Farm	P	Q	R	S	T	U	V	W	X	Y	Z	a	b	c	d
Variety/Class	Prosper CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Prosper CNHR	Faller CNHR	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Brando n CWRS	Penhold CPS	Penhold CPS
$/bu															
Base	6.35	6.75	6.27	5.52	6.48	6.27	6.61	6.82	6.64	6.79	6.50	6.64	6.8	5.17	5.17
PAN	6.69	6.84	6.57	5.86	6.54	6.39	6.8	6.8	6.75	6.82	6.50	6.79	6.84	5.17	5.17
GR-N															
Base	469.90	418.50	369.93	480.24	430.92	539.22	489.14	549.01	338.64	506.53	383.50	440.23	456.28	369.66	341.22
PAN	488.37	417.24	374.49	503.96	432.95	523.98	537.20	539.24	330.75	525.14	380.90	444.75	464.44	364.49	310.20
R-PAN	-1.53	-21.26	-15.44	3.72	-17.97	-35.24	28.06	-29.77	-27.89	-1.39	-22.60	-15.49	-11.84	-25.17	-51.02

- $/bu = late Feb. 2017 prices with protein
- GR-N = Gross revenue (yield x price/bu) less extra PAN cost of $20/ac @ 30 lb N/ac = $15/ac and $5 application.
- R -PAN= return of PAN above base N rate in $/ac

Only 2/15 sites had positive returns-one with a 5 bu/ac and 1% protein increase (site V) and another with 1.5% protein increase (site S)

The success of boot or post-anthesis applications depends on how well that nitrogen gets into the plant.

How much nitrogen is being absorbed by the leaves?

- University of Manitoba found recovery of foliar applied 15N labelled urea (in solution) was only 4-27% compared to 32-70% with soil application (Growth Chamber Experiments).
- Under field conditions with foliar UAN, most of the uptake occurs after rainfall events wash the N to the soil where it is taken up through roots.
- Under dry soil conditions – this slight uptake through the leaves may be more helpful than N stranded on soil surface

Uptake of foliar or soil application of 15N-labelled urea solution at anthesis and its affect on wheat grain yield and protein. C. D. L. Rawluk1, G. J. Racz2, and C. A. Grant1

Amy Mangin-University of Manitoba (2016-17)

Optimizing Nitrogen Fertilizer Management Strategies for High-Yielding Spring Wheat in Manitoba

Amy Mangin & Don Flaten, University of Manitoba
John Heard, Manitoba Agriculture

University of Manitoba

Manitoba

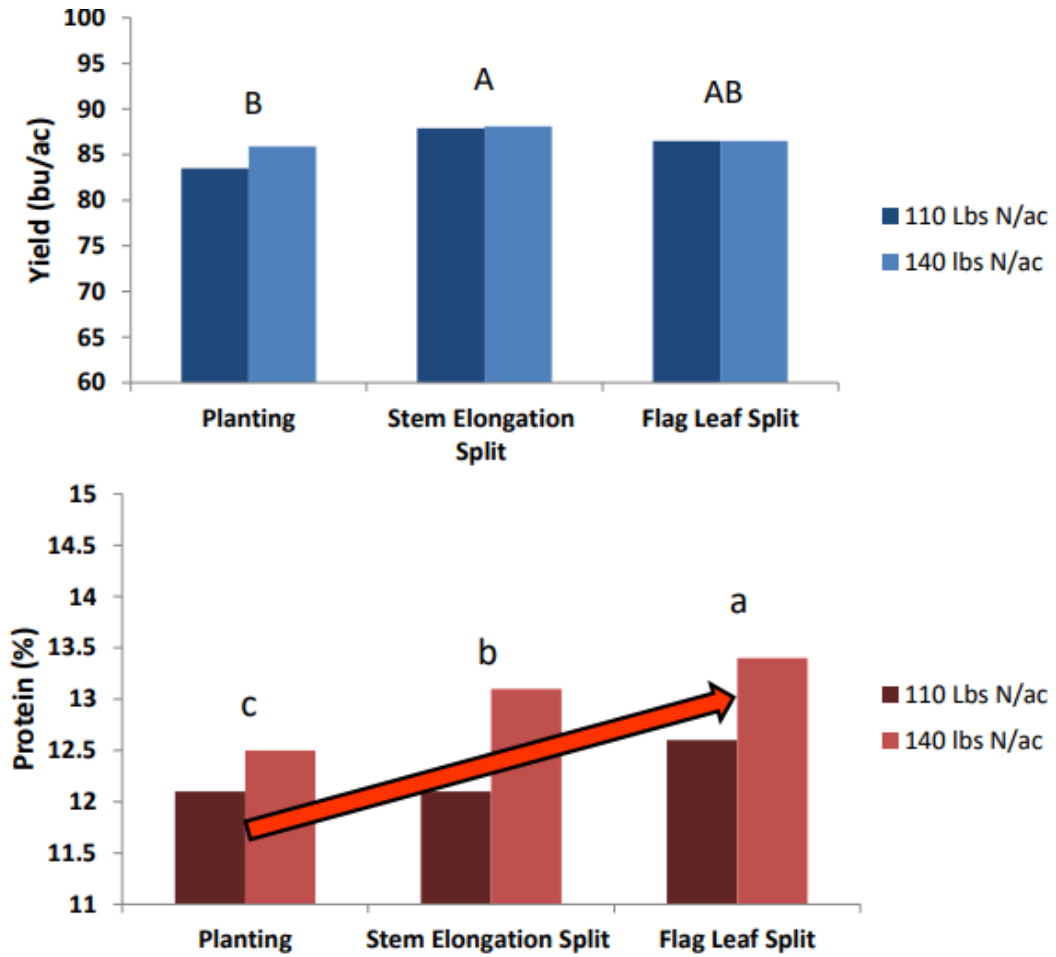
Manitoba Wheat and Barley Growers Association

Methods

- Field trials conducted across MB over the 2016-2017 field seasons (8 site-years)
- Intensive agronomic management to maximize yields
- Factorial Design (Variety X N Treatment) arranged as a RCBD

Intensive “Gold” sites hosted by University of Manitoba. Less intensive “silver” sites managed mainly by Manitoba’s Diversification Centers

Gold Sites:
In Season Splits



Comparing yield and protein

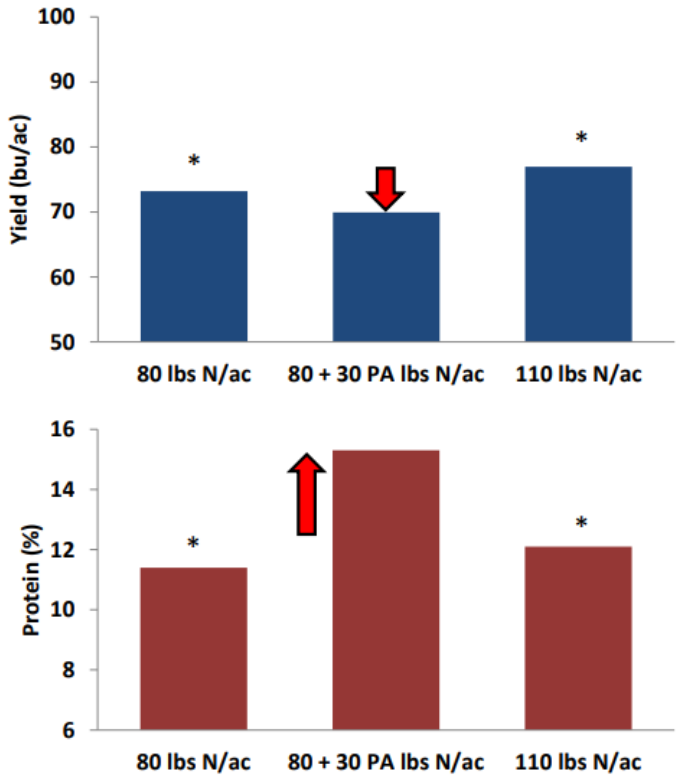
- 110 or 140 lbs N/ac at seeding (midrow banded)
- 80 lbs N/ac at seeding followed by either 30 or 60 lbs N/ac of broadcast Agrotain treated urea.
- Stem elongation split has increased protein and yield.
- Flag split has increased protein protein more and yield less
- Flag leaf split has increased protein
  - 0.5% with 30 N
  - 1% with 60 N

Comparing

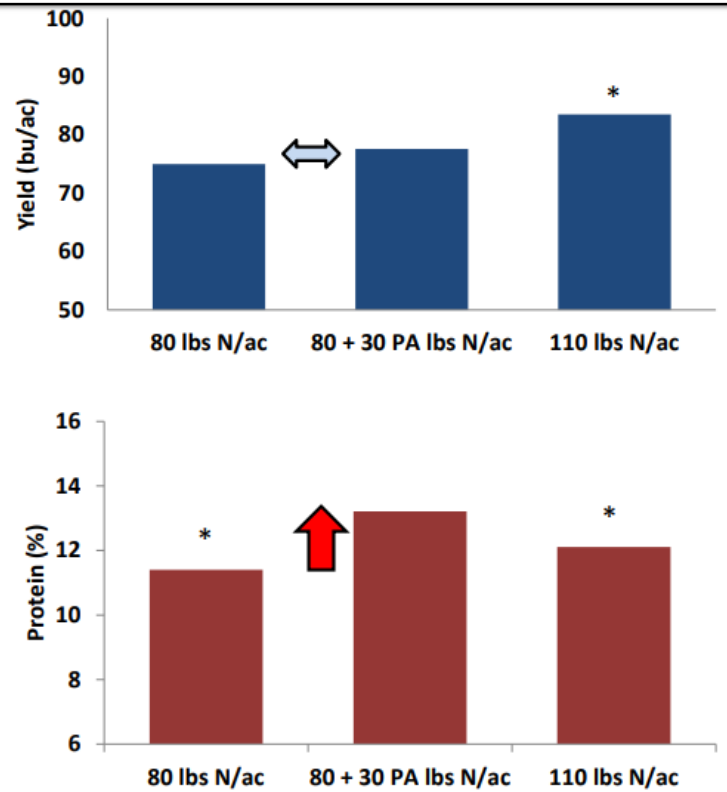
- base rates of 80 and 110 lbs N/ac at seeding
- Base rate 80 lbs N/ac at seeding + 30 lbs N/ac post anthesis (UAN)

- Higher protein with the split, However….
- Yield decrease from leaf burn.
- Putting all the nitrogen down at seeding has better yield

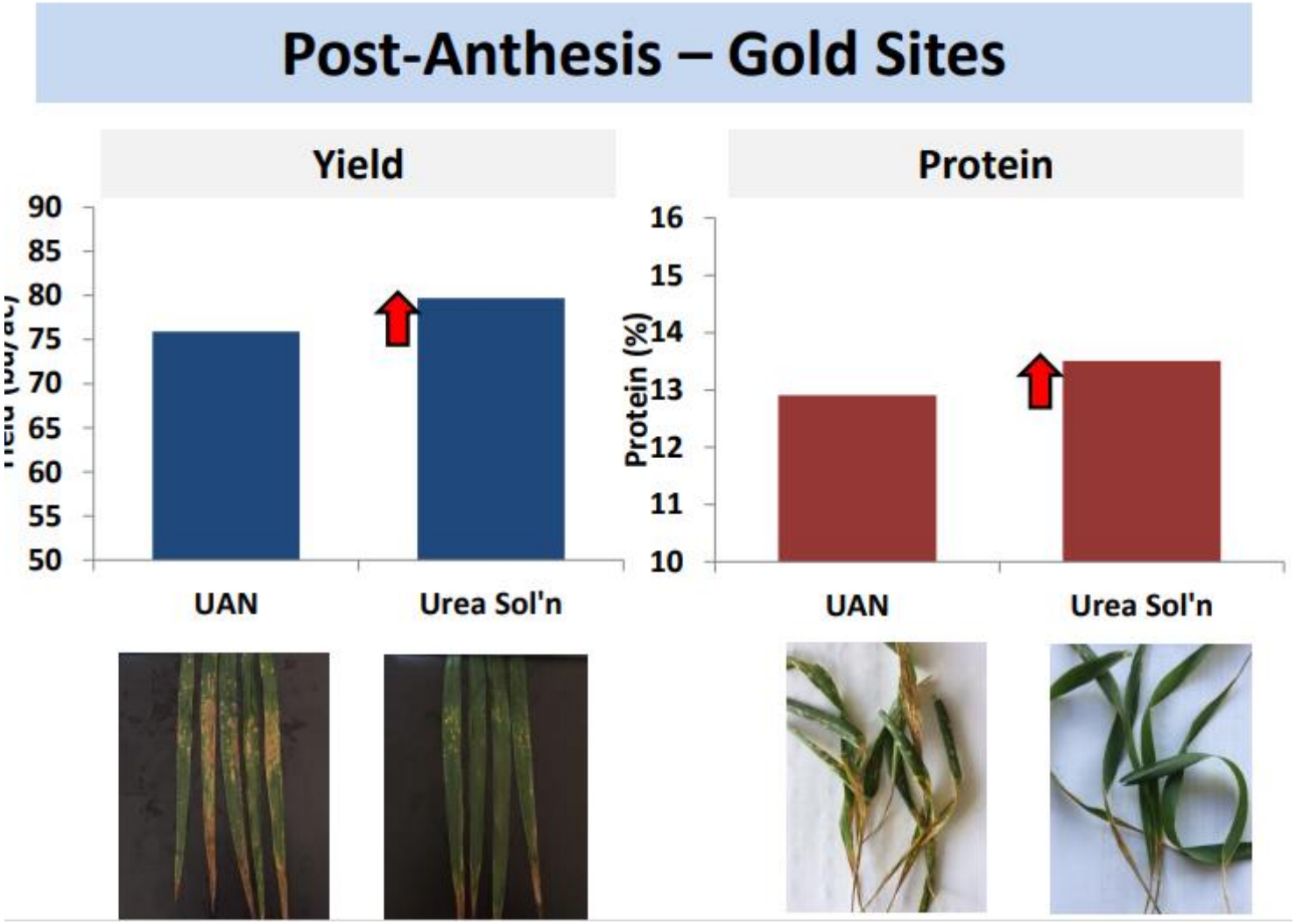
Silver Sites:
Post- Anthesis Application



Gold Sites:
Post- Anthesis Application



Foliar applied urea solution resulted in higher yield and grain protein content compared to UAN



Urea in solution gave a yield and protein gain compared to UAN due to less leaf burn. UAN 14% solution. Urea 9% solution.

Dissolving Urea-Wheat School (Peter Johnson from Ontario) YouTube video

- Used as a standard product in the UK
- In Amy's study 28-0-0 is cut in half with water (14% solution). Dissolved urea was a 9% solution (this is carrying a lot of water).
- Peter says never to put 28-0-0 on with flat fan nozzles (north Dakota recommendation). Use streamer nozzles.
- Factsheet on making dissolved urea
  - Add 4.51 lbs/gal = 21% N
  - Watch out for biuret which is by-product normally taken out of north American production. More than 1% from off-shore urea can burn your crop.
  - Dissolving urea is endothermic. You could freeze a line

Spread (cents/%/bu) required to cover the cost of 30 lbs N/ac of UAN + $5/ac cost of application.

Protein spread 66 cents/%/bu (February 2018)

Crop Yield (bu/ac)	40	50	60	70
Protein Increase (%)	0.5	0.5	0.5	0.5
$N/lbs				
0.3	70	56	47	40
0.35	78	62	52	44
0.4	85	68	57	49
0.45	93	74	62	53
0.5	100	80	67	57
0.55	108	86	72	61
0.6	115	92	77	66
0.65	123	98	82	70

Crop Yield (bu/ac)	40	50	60	70
Protein Increase (%)	1	1	1	1
$N/lbs				
0.3	35	28	23	20
0.35	39	31	26	22
0.4	43	34	28	24
0.45	46	37	31	26
0.5	50	40	33	29
0.55	54	43	36	31
0.6	58	46	38	33
0.65	61	49	41	35

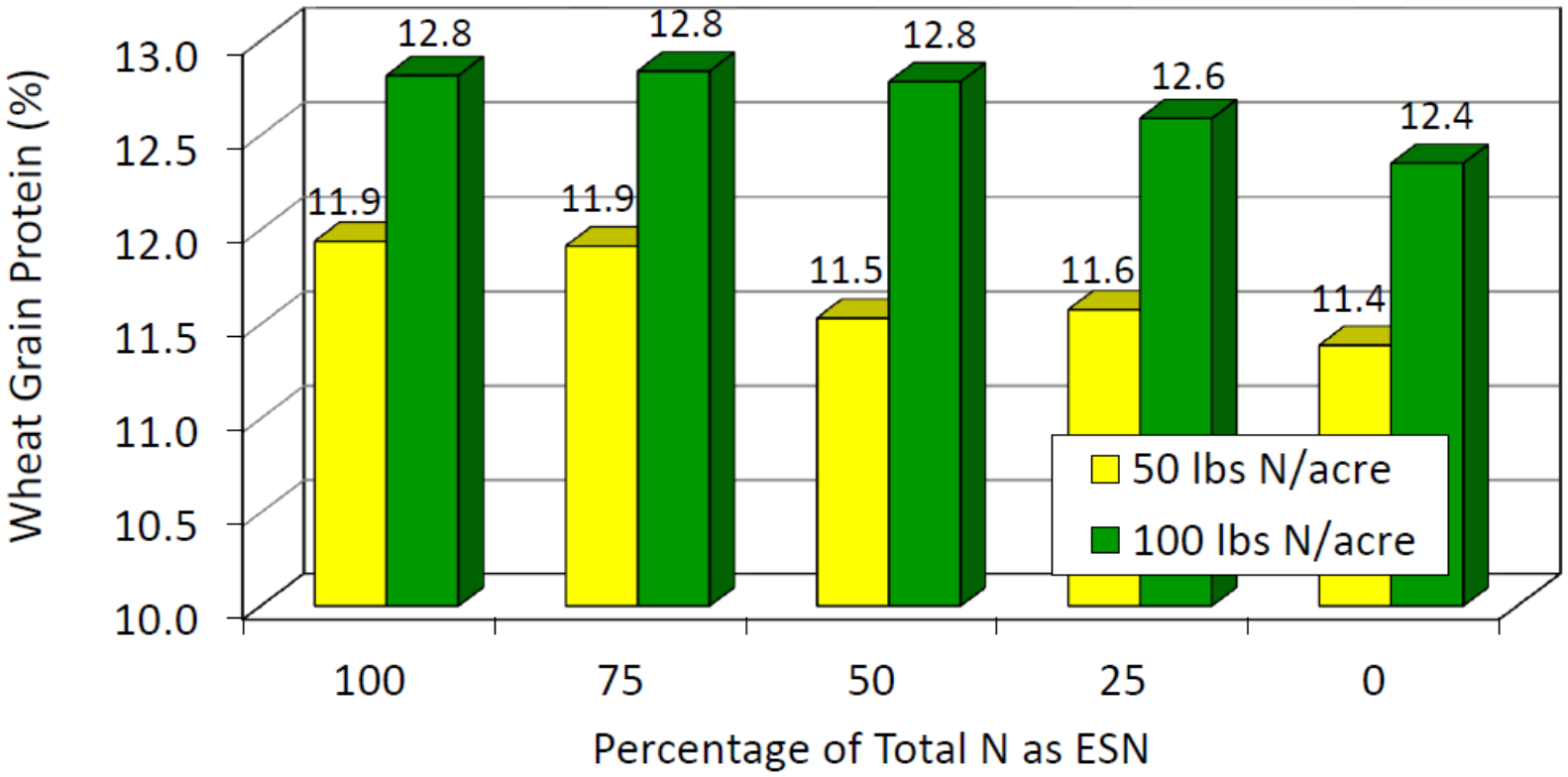
Increasing wheat protein with Controlled Release Nitrogen

- Delayed release of nitrogen should favor protein
- Don’t need to rely on rain to incorporate
- Don’t need to make an extra pass on the field

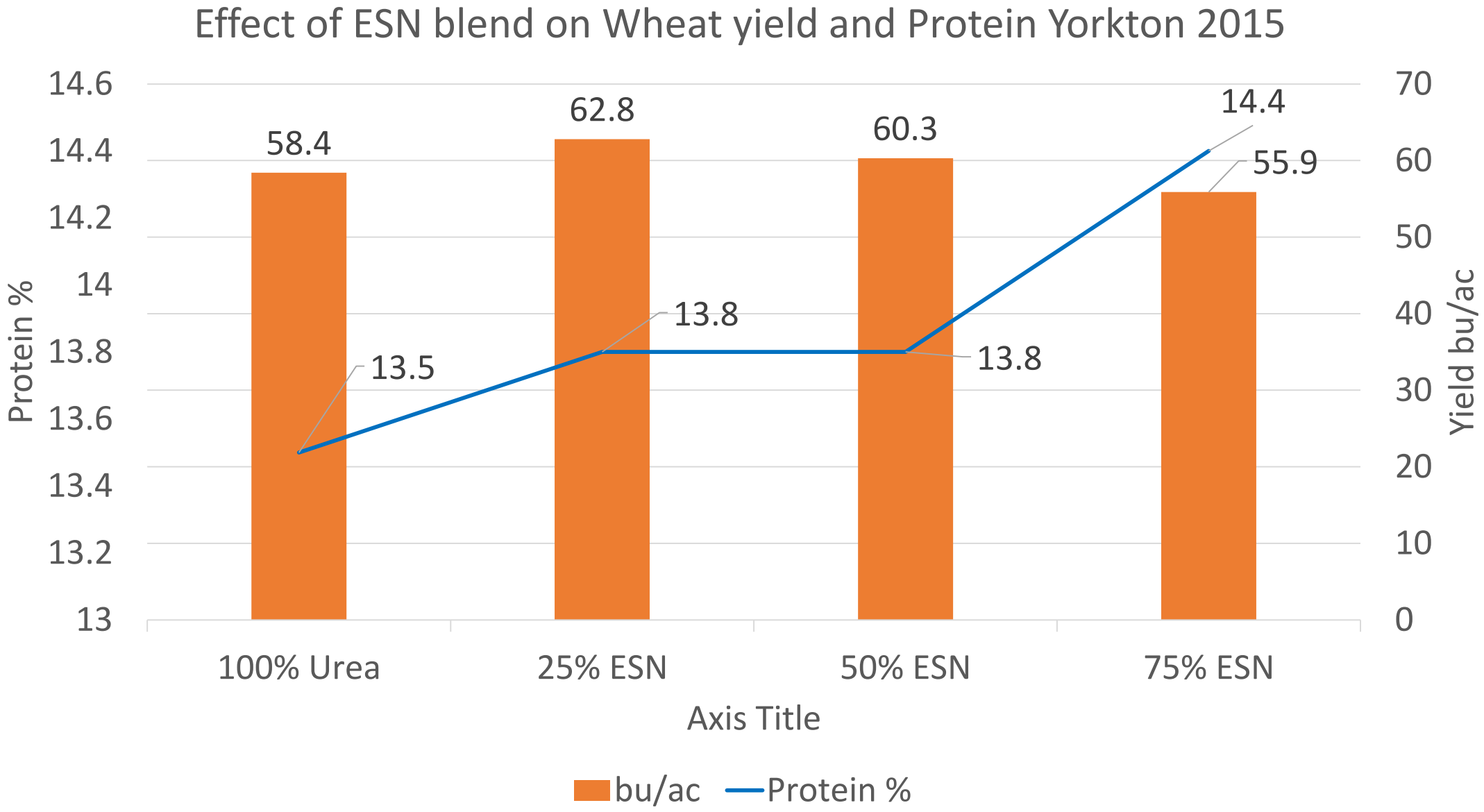
Environmentally Smart Nitrogen (ESN-Agrium)

- Urea with a polymer coating that regulates how quickly the dissolved fertilizer can move into the soil solution.
- Recommended blends with urea at seeding
  - 50:50
  - 75 ESN: 25 urea

ESN Increases Spring Wheat Protein

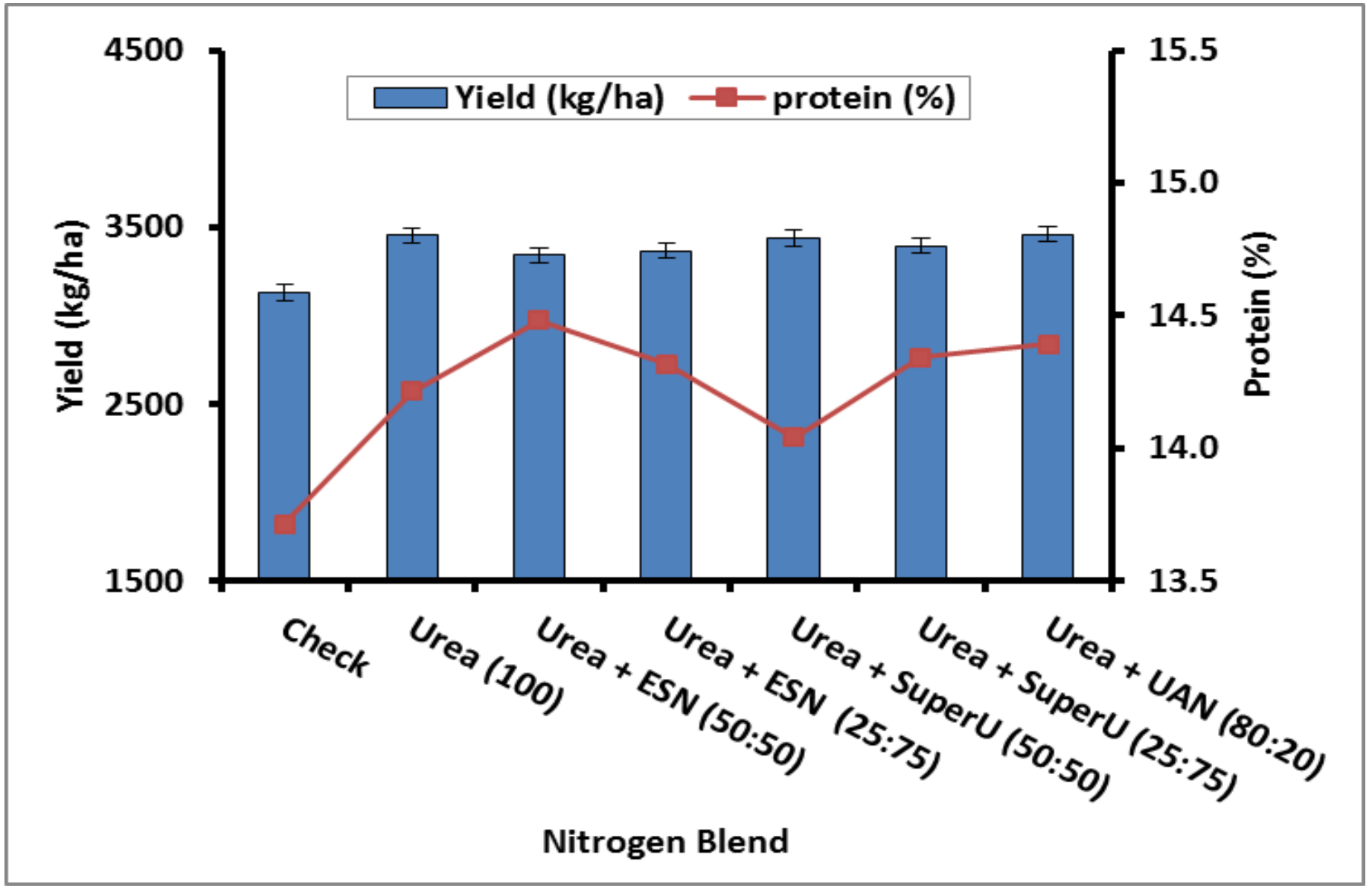


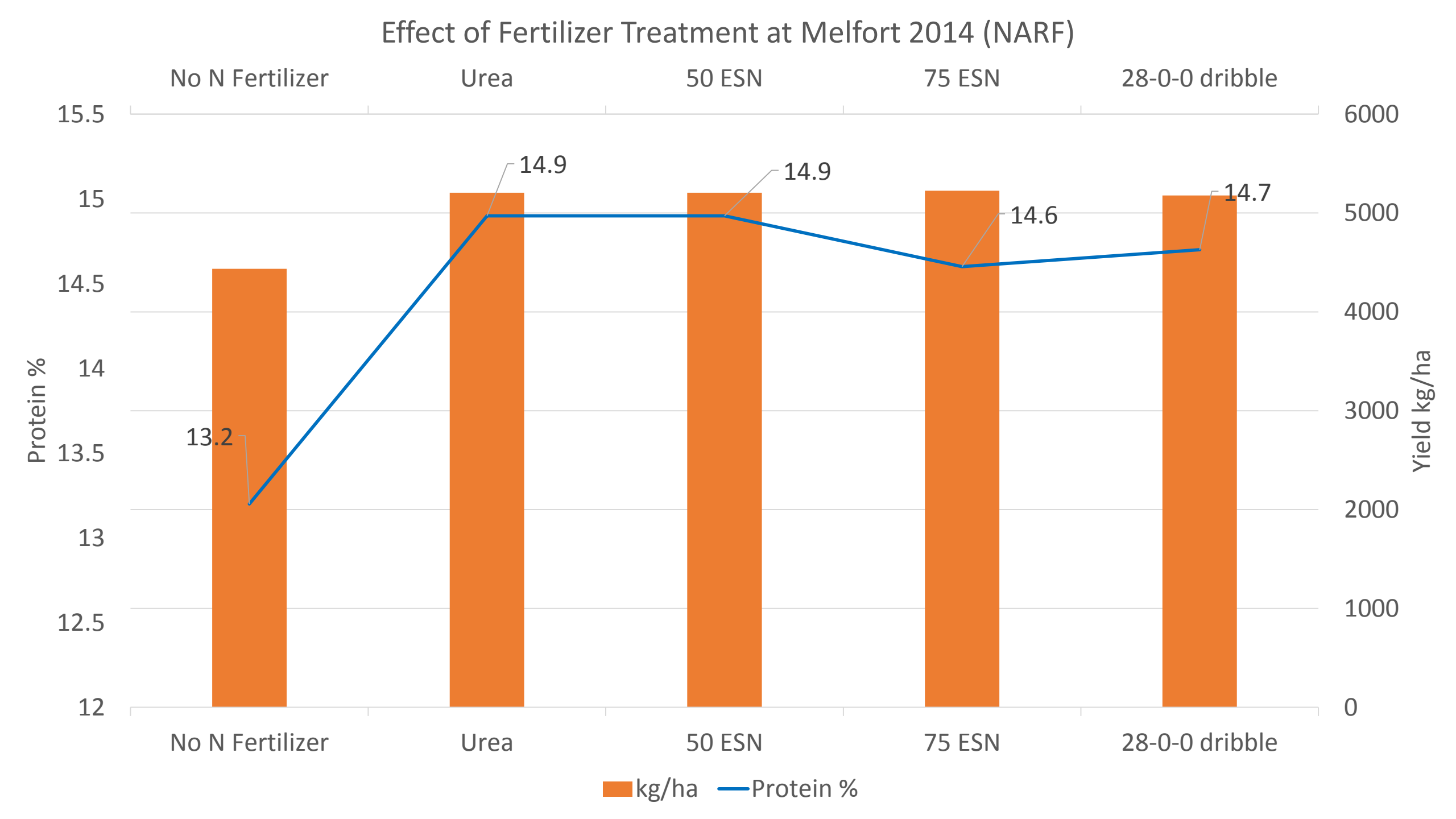
Agrium presenting University of Minnesota data shows a protein increase of 0.5% when esn constitutes 75% of the blend with urea

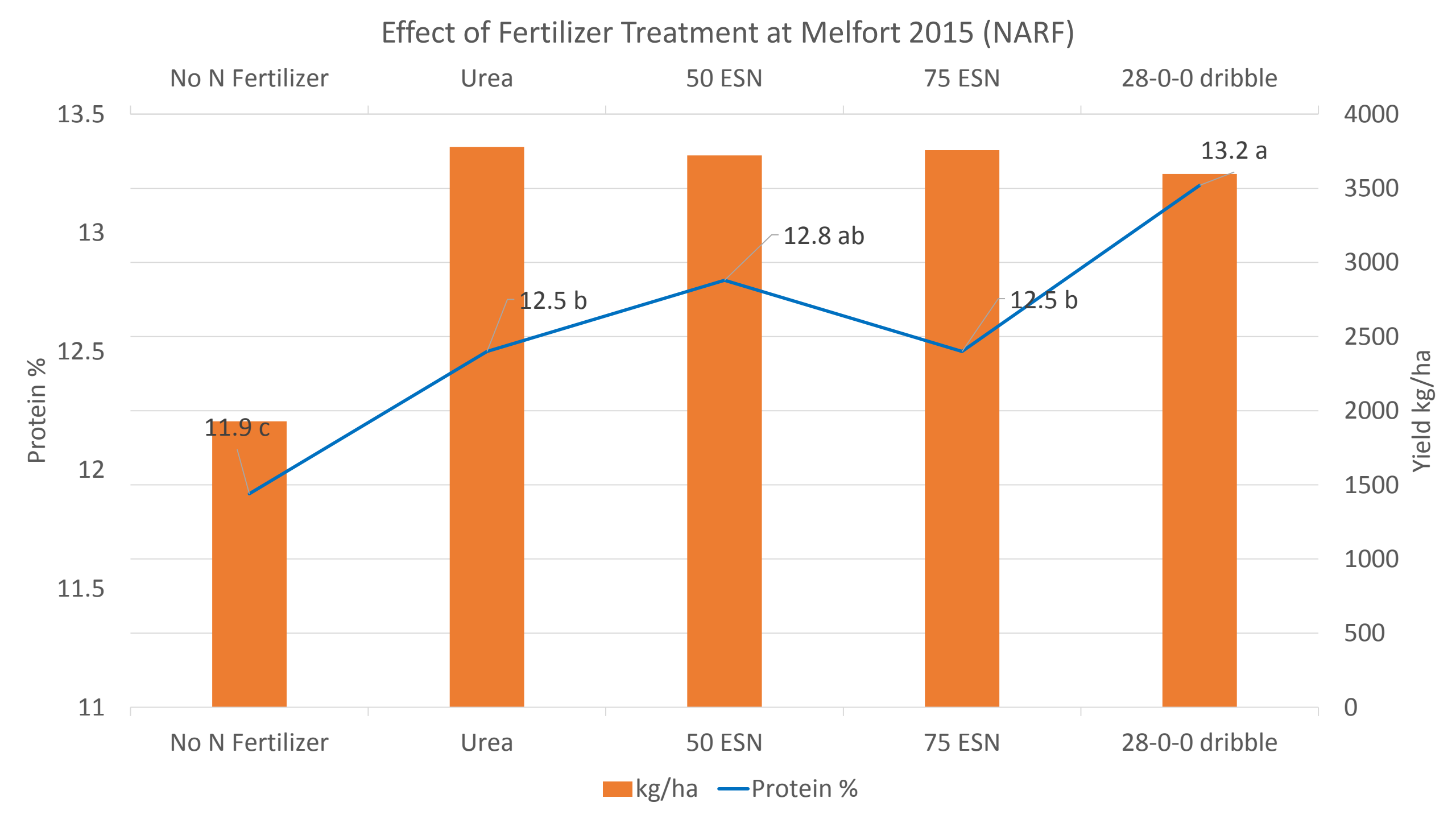


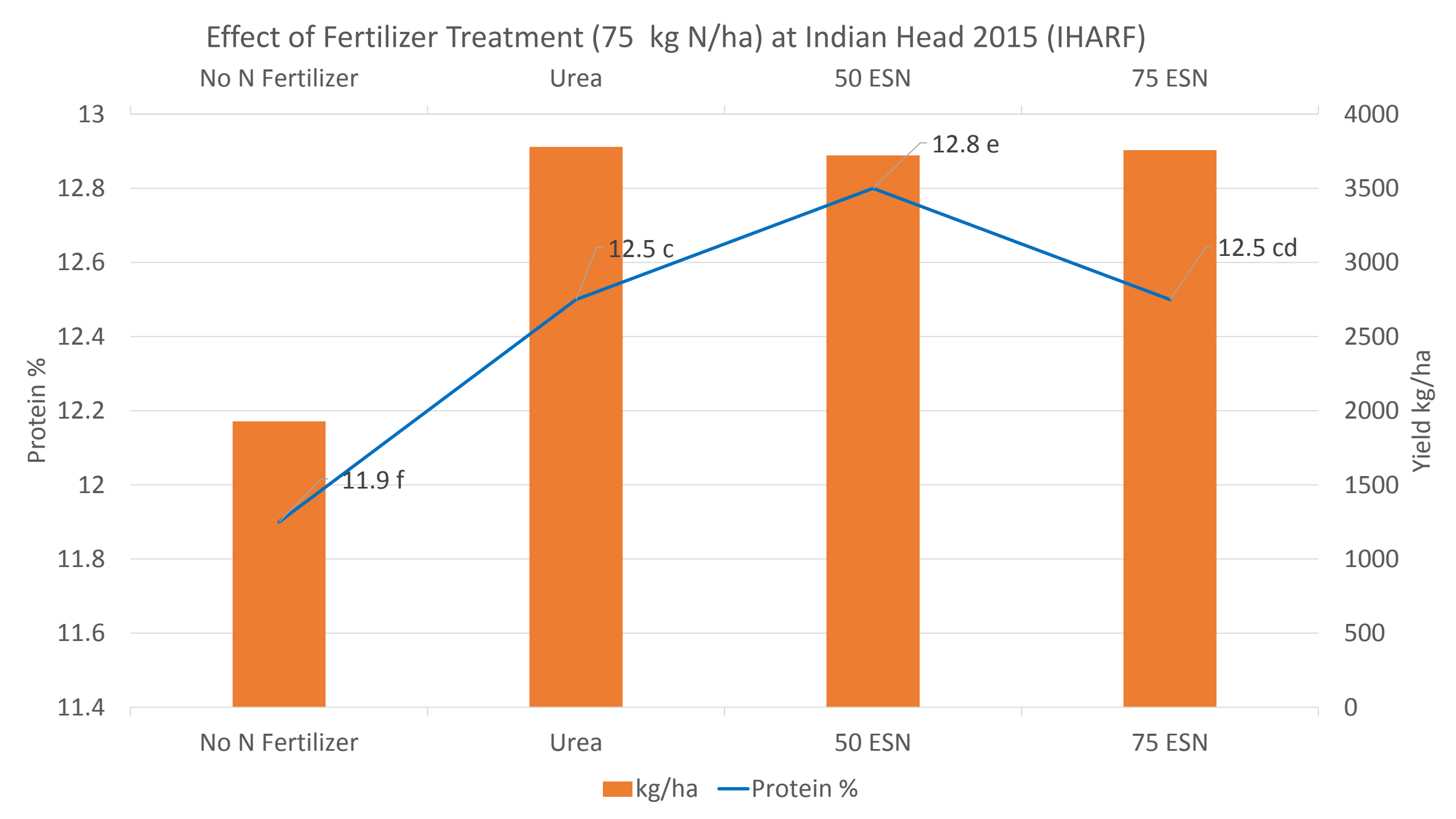
- 75% ESN increased protein but it also decreased yield
- Most Economical treatment was 25% ESN for my trial (yield + protein)

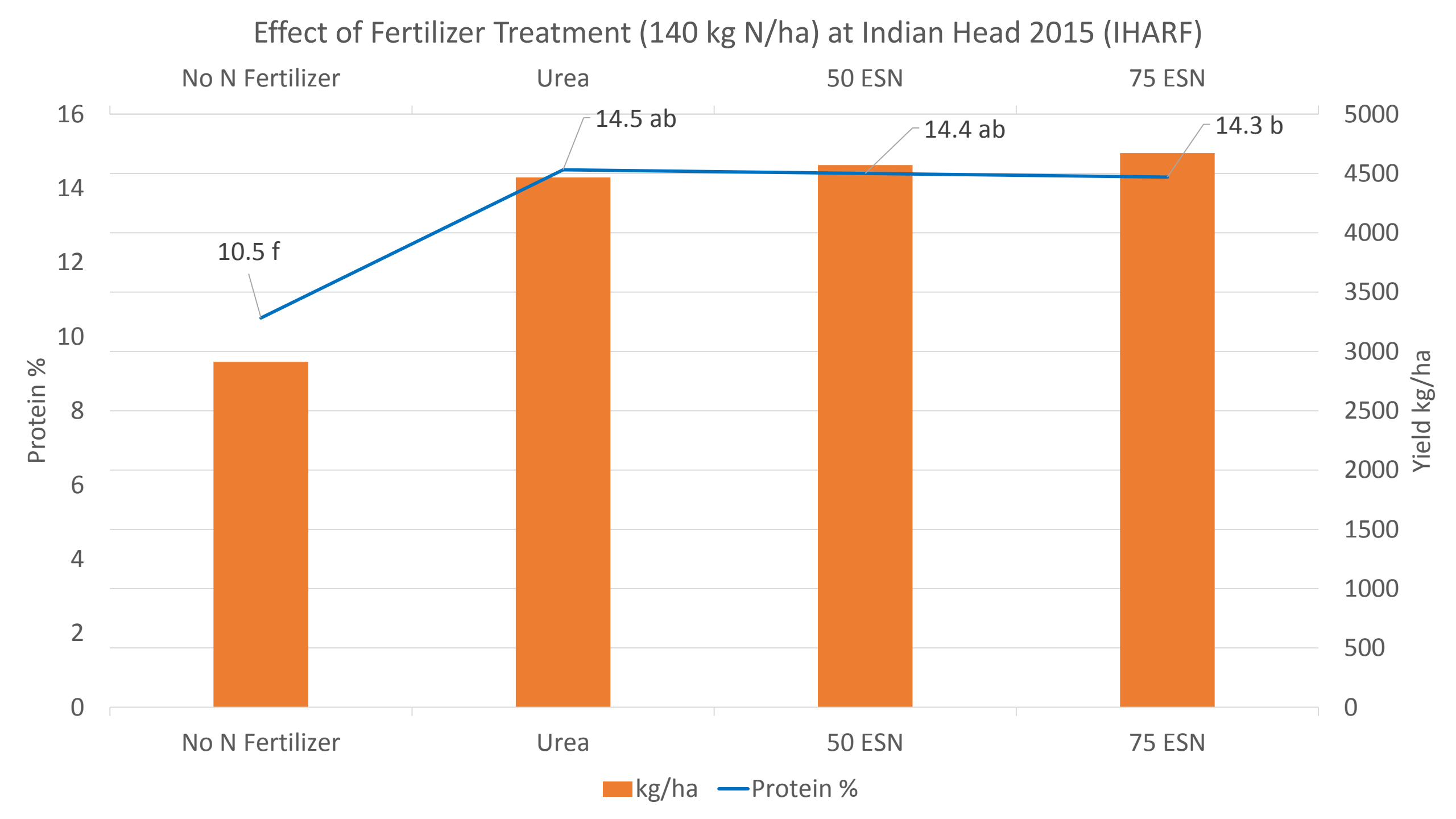
WARC-2015 (Scott)




Effect of Fertilizer Treatment at Melfort 2014 (NARF)
No N Fertilizer
Urea
50 ESN
75 ESN
28-0-0 dribble
15.5
15
14.5
14
13.5
13
12.5
12
Protein %
6000
5000
4000
3000
2000
1000
0
Yield kg/ha
13.2
14.9
14.9
14.6
14.7
kg/ha
Protein %


Effect of Fertilizer Treatment at Melfort 2015 (NARF)
No N Fertilizer
Urea
50 ESN
75 ESN
28-0-0 dribble
13.5
13
12.5
12
11.5
11
Protein %
4000
3500
3000
2500
2000
1500
1000
500
0
Yield kg/ha
11.9 c
12.5 b
12.8 ab
12.5 b
13.2 a
kg/ha
Protein %


Effect of Fertilizer Treatment (75 kg N/ha) at Indian Head 2015 (IHARF)
No N Fertilizer
Urea
50 ESN
75 ESN
13
12.8
12.6
12.4
12.2
12
11.8
11.6
11.4
Protein %
4000
3500
3000
2500
2000
1500
1000
500
0
Yield kg/ha
11.9 f
12.5 c
12.8 e
12.5 cd
No N Fertilizer
Urea
50 ESN
75 ESN
kg/ha
Protein %


Effect of Fertilizer Treatment (140 kg N/ha) at Indian Head 2015 (IHARF)
No N Fertilizer
Urea
50 ESN
75 ESN
10.5 f
14.5 ab
14.4 ab
14.3 b
Protein %
Yield kg/ha
0
2
4
6
8
10
12
14
16
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
kg/ha
Protein %

Using ESN as a portion of base N rate (John Heard)

- Attempts to better match N supply with grain protein accumulation and to minimize lodging.

Farm	Base N rate	Total N	N: ESN blend	Base N Yield bu/ac (% Protein)	ESN blend yield (% Protein)	Economic Benefit of ESN ($/ac)
M	130	147	Urea65: ESN65	78 (13.7)	79.7 (13.9)	0.3
N	98	115	UAN49: ESN49	84.6 (12.4)	86.9 (12.5)	10.7
O	160	205	NH3100: 60ESN	66.5 (13.1)	70 (13.5)	17.6

The use of ESN produced positive returns, more from yield increase than protein increase.

Manitoba Wheat and Barley Growers Association

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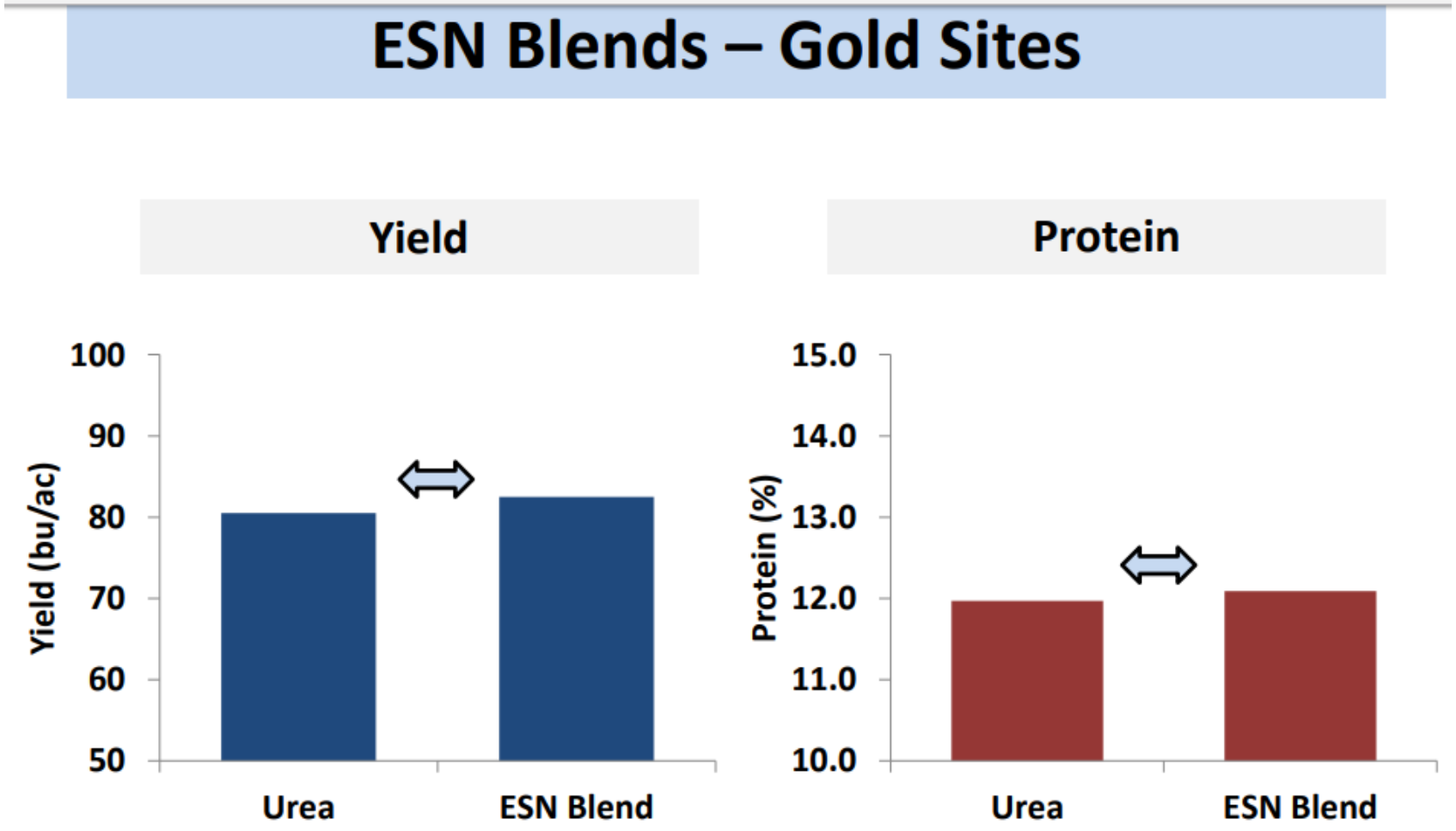
Growing Forward 2
A federal-provincial-territorial initiative

Manitoba

Amy Mangin-University of Manitoba

- ESN blends produced yield and protein content similar to conventional urea (Manitoba 2016-2017)



Would ESN pay?

- Currently
  - Urea $470/tonne
  - ESN $625/tonne
- ESN costs $0.16/lb actual N
- 40 N of ESN costs = $6.40/ac
- 0.3 % more protein = 50 bu/ac * $0.65/%/bu * 0.3% = $9.75/ac
- Net return = $3.35/ac

Conclusions

- Grow higher protein varieties (the lower yield will likely cost you more)
- Grow wheat in rotation with legumes.
- The bulk of nitrogen requirement should be applied at seeding.
- Post seeding applications of N to increase protein may be worthwhile if:
  - The projected yield potential of the crop has increased
  - Fertilizer is cheap and protein premiums are likely to be high
- Don’t expect better than a 0.5 to 1% increase in protein
  - Results are variable and the practice is frequently uneconomical.
  - In-crop applications are less reliable than applying additional nitrogen fertilizer at or before seeding.

Conclusions

- Applications made late in the year (flag to post anthesis) will favour protein over yield
  - Broadcast urea prone to volatilization (Agrotain)
  - Dribble banded UAN (less prone to volatilization)
  - Broadcast spray UAN (leaf burn risk- 7-10-20-30 rule helps)
  - Broadcast spray liquid urea (potential to reduce leaf burn)
- ESN (50:50) blend
  - Results are hit and miss.
  - Increases in protein were modest (0.3%)
- Could we have increased our protein last year?

THE END