N management for high yield wheat and protein

John Heard, CCA

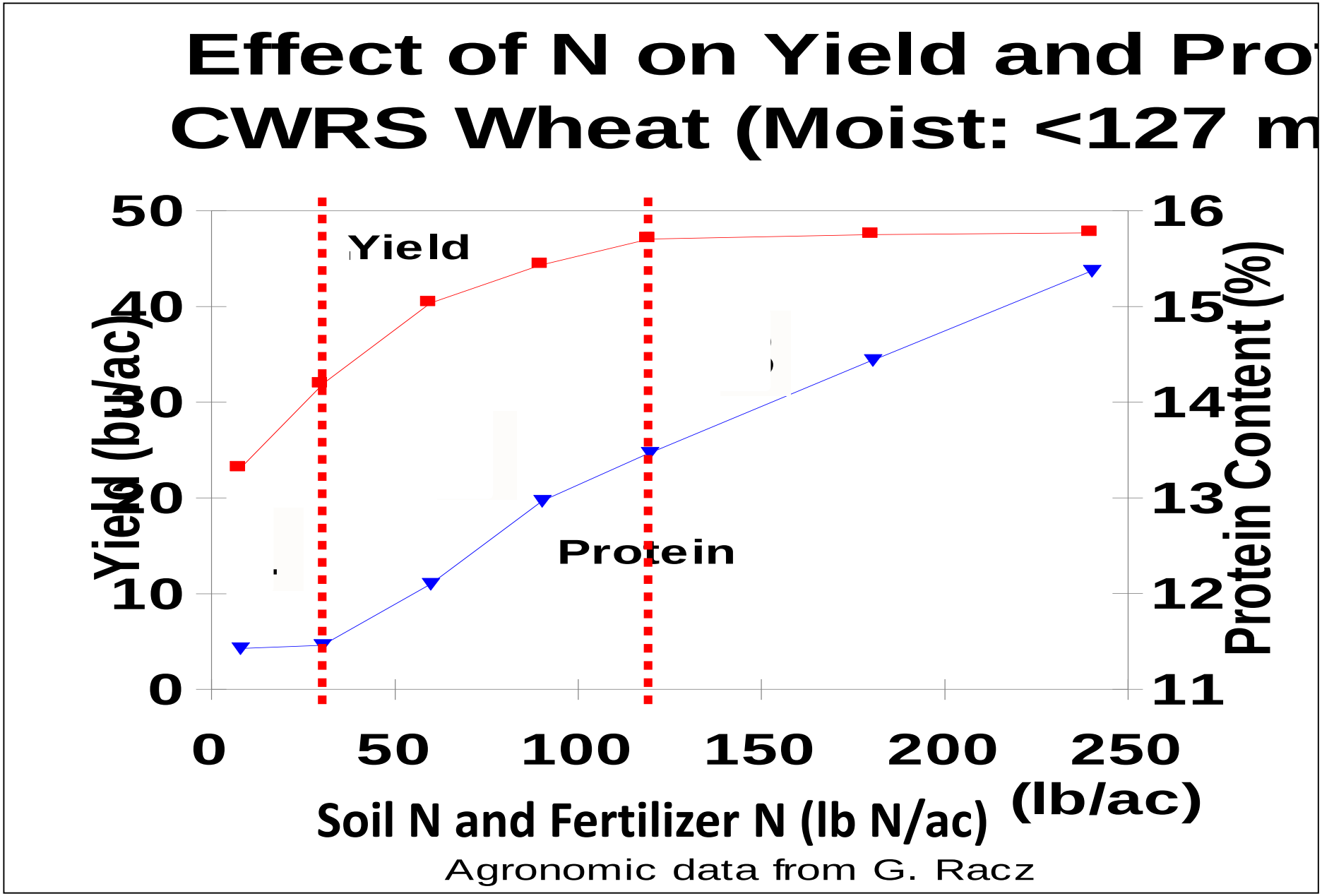
Overview

- Our dilemma
- Past guidelines – MB, NDSU, Montana
- Wheat N Uptake
- 4R Approach
  - Rate
  - Source, time, placement
- On-Farm-Testing

Dilemma

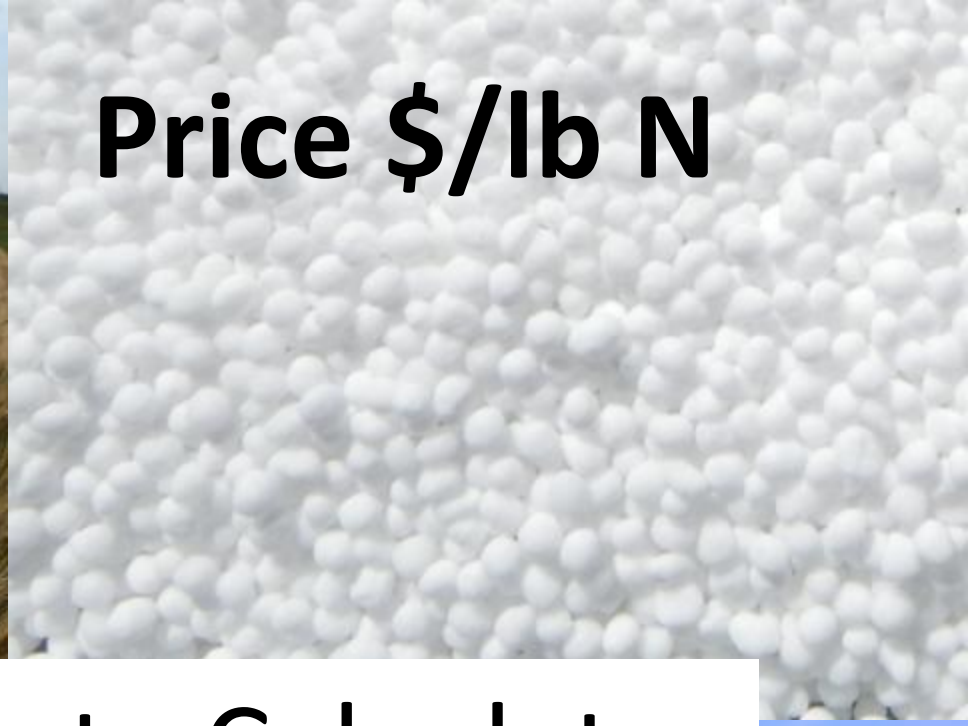
- High yields of milling wheat (80-100 bu/ac)
- Insufficient protein for market
- Price discounts

- Solutions

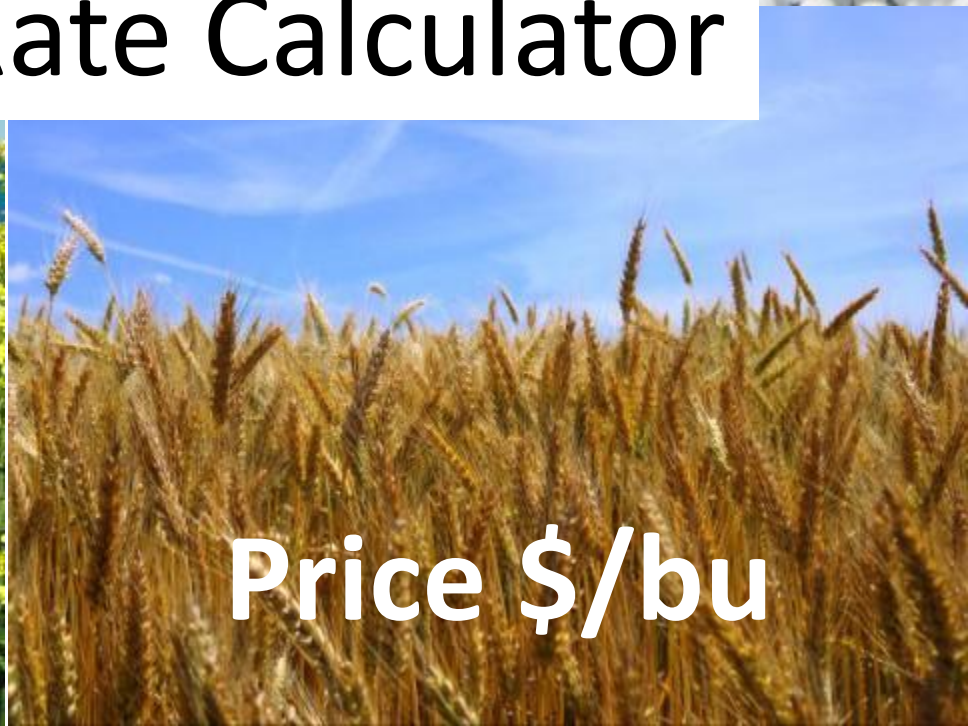


1. 13.5% protein

2. 2.5 lb N/bu



MAFRD N Rate Calculator



Nitrogen Rate of Return Calculator
Wheat, Barley, Canola & Hybrid Canola
Manitoba

Fertilizer N data	
Fertilizer Type	UREA
Cost/tonne	$600
%N	46
Cost/Unit of N	$0.59
Fertilizer N increment	10
Crop price increment, $	$0.50
Soil test N (0-24") lb N/acre	24
Fertilizer price increment, $/tonne	$50
Yellow Cells Can be Modified	

Crop and Economic data	Current N Rate (lb N/acre): Moist	Dry	Arid
CWRS Wheat	110	95	90
Barley	110	90	80
Canola	125		
Canola (hybrid)	145		
Expected prices ($/bushel):			
CWRS Wheat	$6.00		
Barley	$3.70		
Canola	$10.00		
Canola (hybrid)	$10.00		

Google Manitoba Nitrogen Rate Calculator

Nitrogen $ Rate of Return Calculator

Manitoba (Moist)

Go to Marginal Revenue Chart | Go to Fertilizer Price as variable | Return to Data Entry

N Rate	Average yield	Yield Increase from 0 lb. N*	Go to Total Net Return Below	Expected CWRS Wheat Price						
				$4.50	$5.00	$5.50	$6.00	$6.50	$7.00	$7.50
				Net Return ($/ac.)**						
				CWRS Wheat:N Price Ratio						
(lb./acre)	(bu./ac.)	(bu./ac.)		7.6	8.4	9.3	10.1	11.0	11.8	12.7
70	57.6	21.9		$57.2	$68.1	$79.1	$90.0	$101.0	$112.0	$122.9
80	59.5	23.9		$59.9	$71.8	$83.8	$95.7	$107.6	$119.6	$131.5
90	61.1	25.5		$61.3	$74.1	$86.8	$99.6	$112.3	$125.1	$137.8
100	62.5	26.8		$61.4	$74.8	$88.2	$101.6	$115.0	$128.5	$141.9
110	63.5	27.9		$60.1	$74.0	$88.0	$101.9	$115.8	$129.7	$143.7
120	64.2	28.6		$57.5	$71.8	$86.1	$100.4	$114.6	$128.9	$143.2
130	64.7	29.0		$53.5	$68.0	$82.5	$97.0	$111.5	$126.0	$140.5
140	64.8	29.1		$48.2	$62.7	$77.3	$91.9	$106.5	$121.0	$135.6
150	64.6	29.0		$41.5	$56.0	$70.5	$84.9	$99.4	$113.9	$128.4

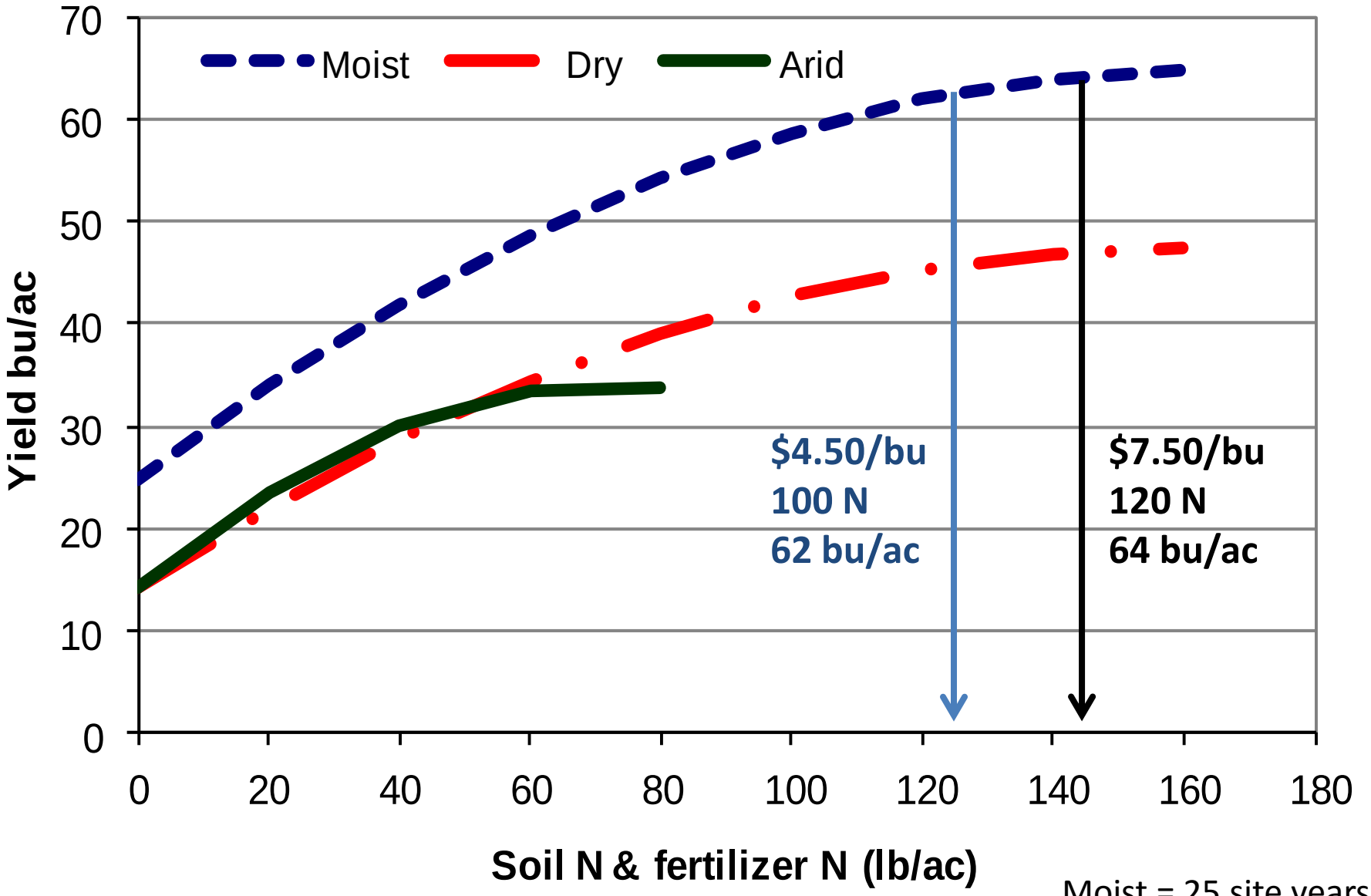
*Yield responses are averages from 25-site years

Current N rate from your soil test report or common practice

**Net Return = (wheat price x yield increase) - (N price x N rate)

Net return in blue represents maximum ± $0.50 for the CWRS Wheat:N Price Ratio range in this table and in Orange

CWRS Wheat Response to Nitrogen



Moist = 25 site years

Welcome to the

North Dakota Wheat Nitrogen Calculator

You will need to know the location of the farm, the general productivity of the soils, the price you contract for wheat, the cost per pound of N, the soil test nitrate-N to a depth of 2-feet, and the previous crop.

Please select the location of the farm. The map of North Dakota on this site will help you determine the region of the farm. ***Click on the map for a detailed view.***

- ○ Eastern North Dakota
- ○ Western North Dakota
- ◉ Langdon Region

Low productivity is defined in the Langdon area as historical yields below 40 bushels per acre

Medium productivity is defined in the Langdon area as historical yields from 41 to 60 bushels per acre

High productivity is defined in the Langdon area as historical yields over 60 bushels per acre

http://www.ndsu.edu/pubweb/soils/wheat/

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- ( ) Langdon Region

Low productivity is defined as Pealers ND av. bu/acre/ yield, below 40 bu/ac. per acre

Medium productivity is defined as Pealers ND av. bu/acre/ yield, from 41 to 60 bu/ac. per acre

High productivity is defined as Pealers ND av. bu/acre/ yield, over 60 bu/ac. per acre

Please select the historical productivity of the farm from the options below.

- (•) Low Productivity
- ( ) Medium Productivity
- ( ) High Productivity

Select Nearest Wheat Price ($/bushel) $0.00

Select Nearest N Cost ($/lb N) $0.00

Nitrogen Recommendation Before Credits: 72

Please indicate the amount of nitrates in the soil. (Enter the analysis result in the box.)

Soil test for Nitrogen analysis (lbs/acre 2-ft depth) Input OK

Please indicate the crop previously planted in the field.

- (•) No Nitrogen-supplying crop
- ( ) Soybean, Field Pea, Dry Bean, Lentil, Chickpea, or Harvested Sweet Pea
- ( ) Sugarbeet with yellow-green leaves
- ( ) Sugarbeet with green leaves
- ( ) Harvested Alfalfa or unharvested Sweet Clover (< 2 plants/sq-ft)
- ( ) Harvested Alfalfa or unharvested Sweet Clover (2-4 plants/sq-ft)
- ( ) Harvested Alfalfa or unharvested Sweet Clover (>4 plants/sq-ft)
- ( ) Harvested Alfalfa or unharvested Sweet Clover (< 1 plants/sq-ft)

Nitrogen provided by previous crops: 0

Please indicate the previous tilling method used in the field.

- (•) Is the field area conventionally tilled (plowed and/or disc, and/or field cultivator or glen)?
- ( ) Has the field been in fallow for 1 to 2 years?
- ( ) Has the field been in fallow for more than 2 years?

Nitrogen recommendations assume conventional tillage and no adjustment in N rates are made.

Please indicate the percent of organic matter in the soil. (Enter the percentage in the box.)
(If soil organic matter exceeds 5.9%, please type in the soil organic matter value. If 5.9% or less, please leave blank.)

Organic matter 0.0 % Input OK

Input OK

Nitrogen recommendation: 72 plus/minus 30 lbs. N

The final Nitrogen recommendation is the average optimal rate. Growers may choose to apply up to 30 lb N/acre more or less than the calculated N rates due to protein traits of a variety, special soil condi not be most efficient or historical experiences from the field or part of a field that may influence N uptake and efficiency. For wheat after small grains, we assume about 2,000 lb/acre of straw residue. For e

Site designed by Matt Kerbaugh for Dr. Dave Franzen, NDSU Department of Soil Science. Created August 2008. Last revised November 2008.

Page visits since 31 March 2013: 3,047

http://www.ndsu.edu/pubweb/soils/wheat/

A) Langdon area – behaves like MB

Nitrogen recommendation: 111
plus/minus 30 lbs. N

The final Nitrogen recommendation is the average optimal rate. Growers may choose to apply up to 30 lb N/acre more or less than the calculated N rates due to protein traits of a variety, special soil conditions such as susceptibility to spring denitrification, application techniques that may not be most efficient or historical experiences from the field or part of a field that may influence N uptake and efficiency. For wheat after small grains, we assume about 2,000 lb/acre of straw residue. For every 2,000 lb/acre straw greater than this, add 30 lb N/acre.

B) Eastern ND – high N losses

Nitrogen recommendation: 176
plus/minus 30 lbs. N

The final Nitrogen recommendation is the average optimal rate. Growers may choose to apply up to 30 lb N/acre more or less than the calculated N rates due to protein traits of a variety, special soil conditions such as susceptibility to spring denitrification, application techniques that may not be most efficient or historical experiences from the field or part of a field that may influence N uptake and efficiency. For wheat after small grains, we assume about 2,000 lb/acre of straw residue. For every 2,000 lb/acre straw greater than this, add 30 lb N/acre.

Montana Guidelines

Historical average AVAILABLE N rate guideline: when soil organic matter = 2%

- Dryland winter wheat
  2.6 lb N/bu ⟶ 40 bu/ac @ 12.5% protein

- Spring wheat
  3.3 lb N/bu ⟶ 40 bu/ac @ 14% protein

- MSU N rate calculation tool takes into account fertilizer costs, grain prices, and protein discounts to optimize net revenue.
  http://www.msuextension.org/econtools/nitrogen/index.html

C. Jones, Montana

Nitrogen Rate Summary

1. Soil test
2. Use existing N rate calculator for modest yielding wheat varieties
3. Consider scaling up rates with “thumb rule” of 2.5 lb N (soil & fert)/bu x Yield goal

- 80 bu/ac = 200 lb soil & fert N
- 100 bu/ac = _____

2.5 lb N (soil & fert)/bu ?

Very high N rates for high yield varieties

- Financial risk – high $ outlay
- Agronomic risk – lodging
- Environmental risk – excess soil N

Better ways than brute force (high N) approach?

Lafond, AAFC

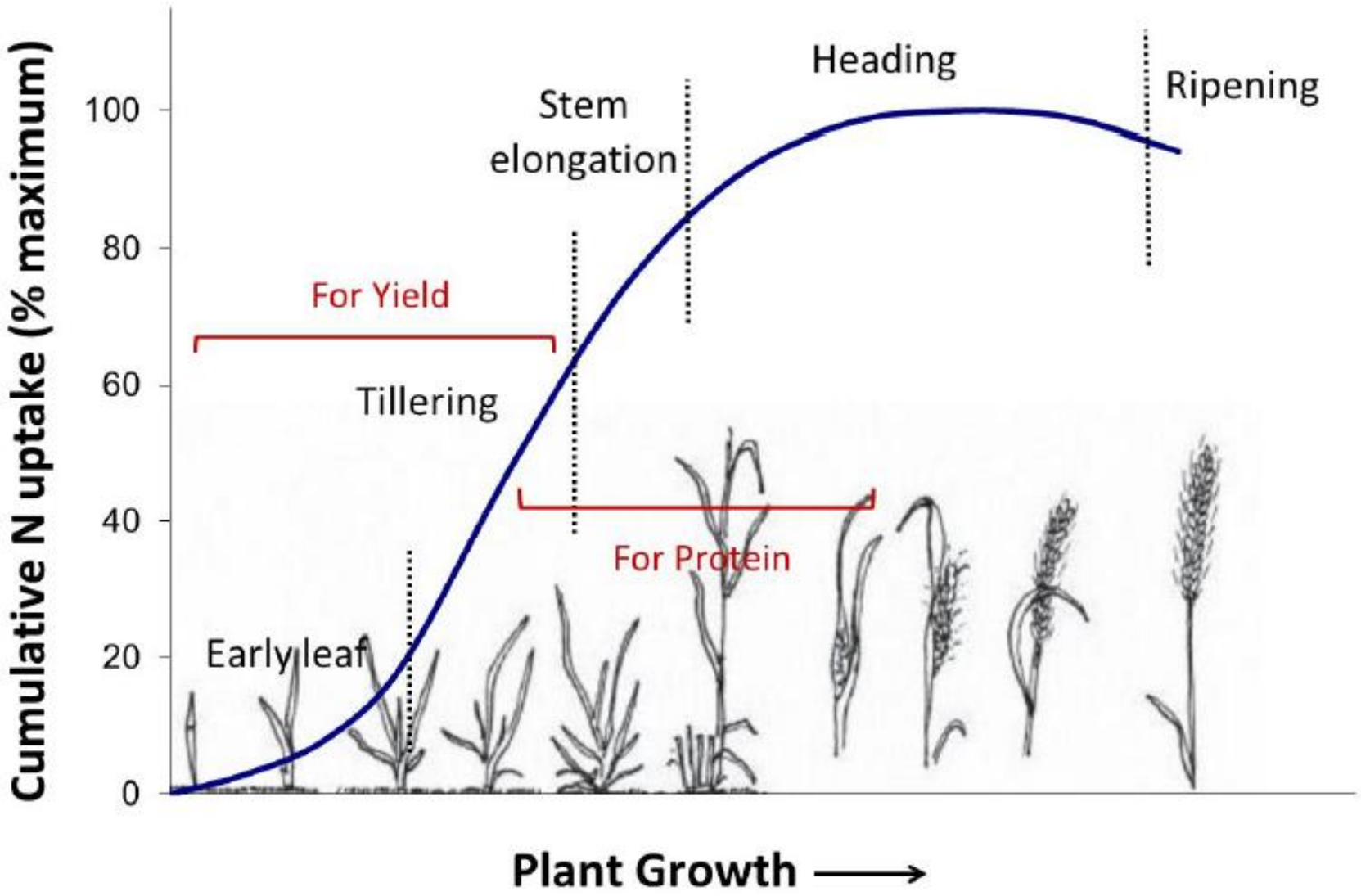
Wheat lodging – management or weather?

Manage to increase protein

- Timing
- Source
- Placement

- Scouting techniques? Time to assess yield potential before investing all N$

N uptake by wheat for yield and protein



Jones, Montana State University

A top-up strategy?

1. **Apply base rate N for modest yield & protein**
2. **Assess crop in June**

- ☑ Excellent yield potential
- ☒ Enough N supplied (2.5 lb N/bu expected)?
- Make up shortfall
- At tillering, stem elongation, boot.
- More important to get incorporation with > ½ ” rain event than “correct” timing

How to apply in crop

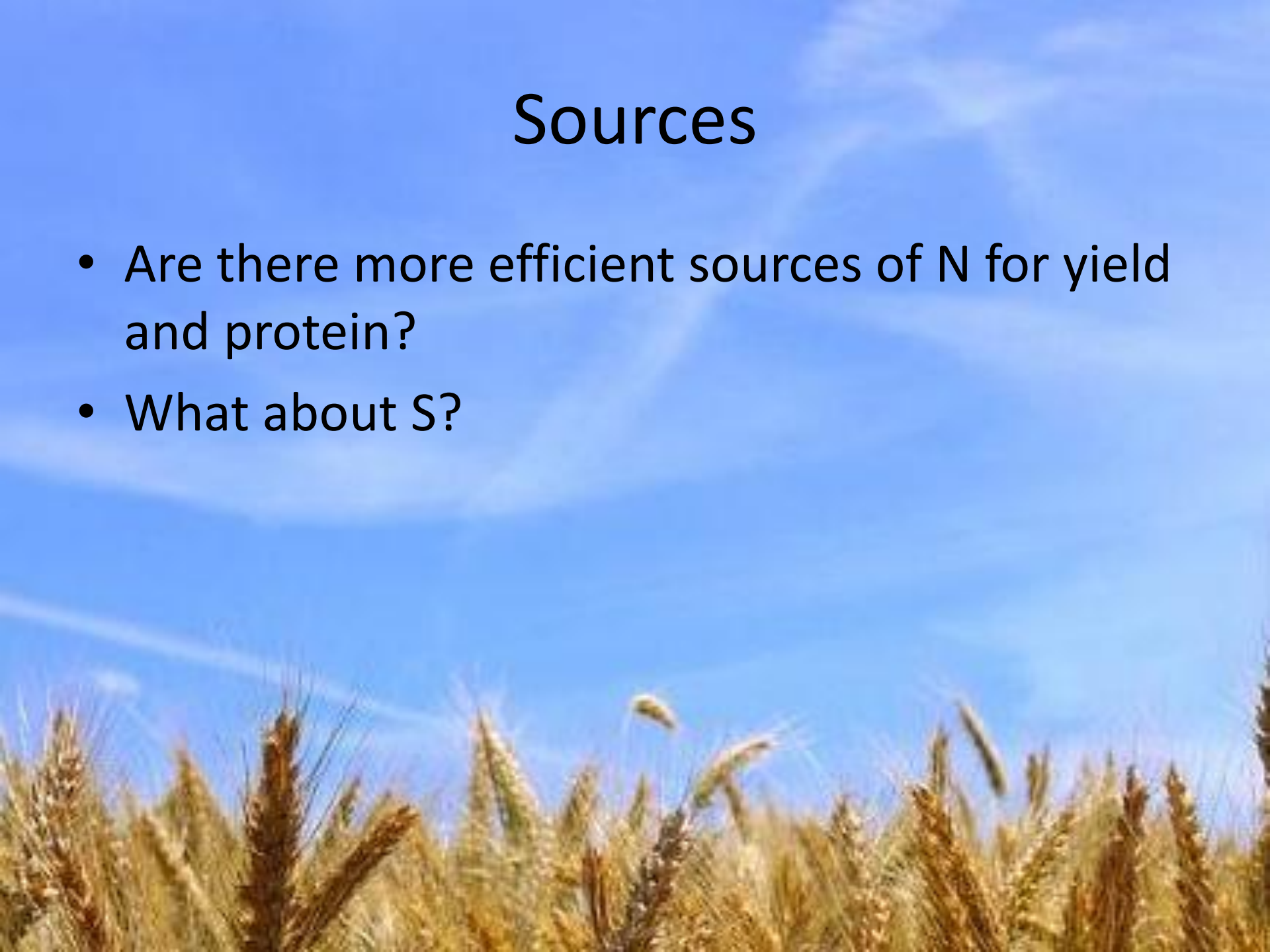
- Dribble banded UAN
- Broadcast urea (& Agrotain to minimize volatilization)

Lafond, AAFC

Jones, Montana State University

Sources

- Are there more efficient sources of N for yield and protein?
- What about S?

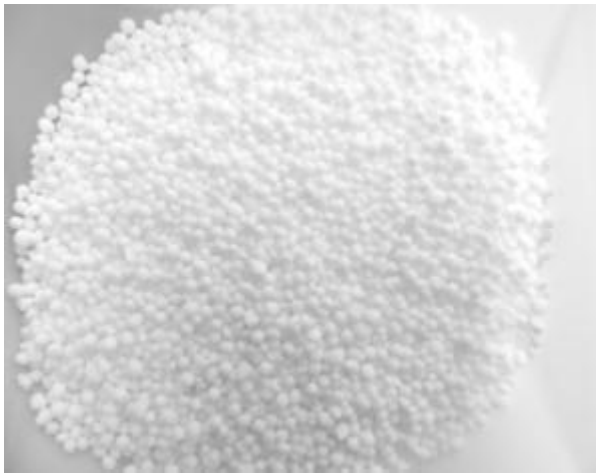


Sure fire ways to make wheat protein

Manure and Alfalfa:

High N and continued release of N

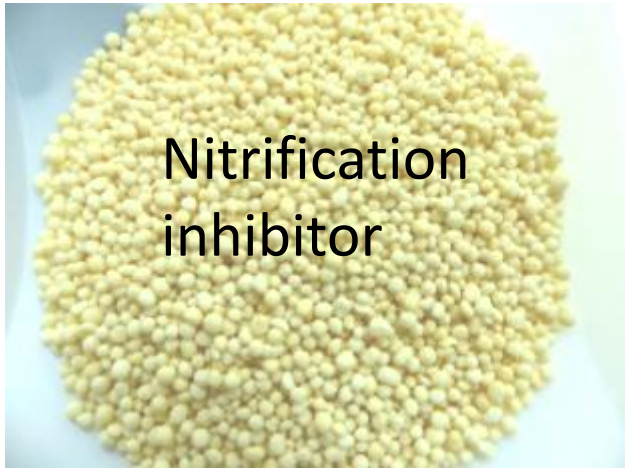
Many new enhanced efficiency additives to improve efficiency through reduced losses



Urea 46-0-0

ESN 44-0-0

SuperU 46-0-0



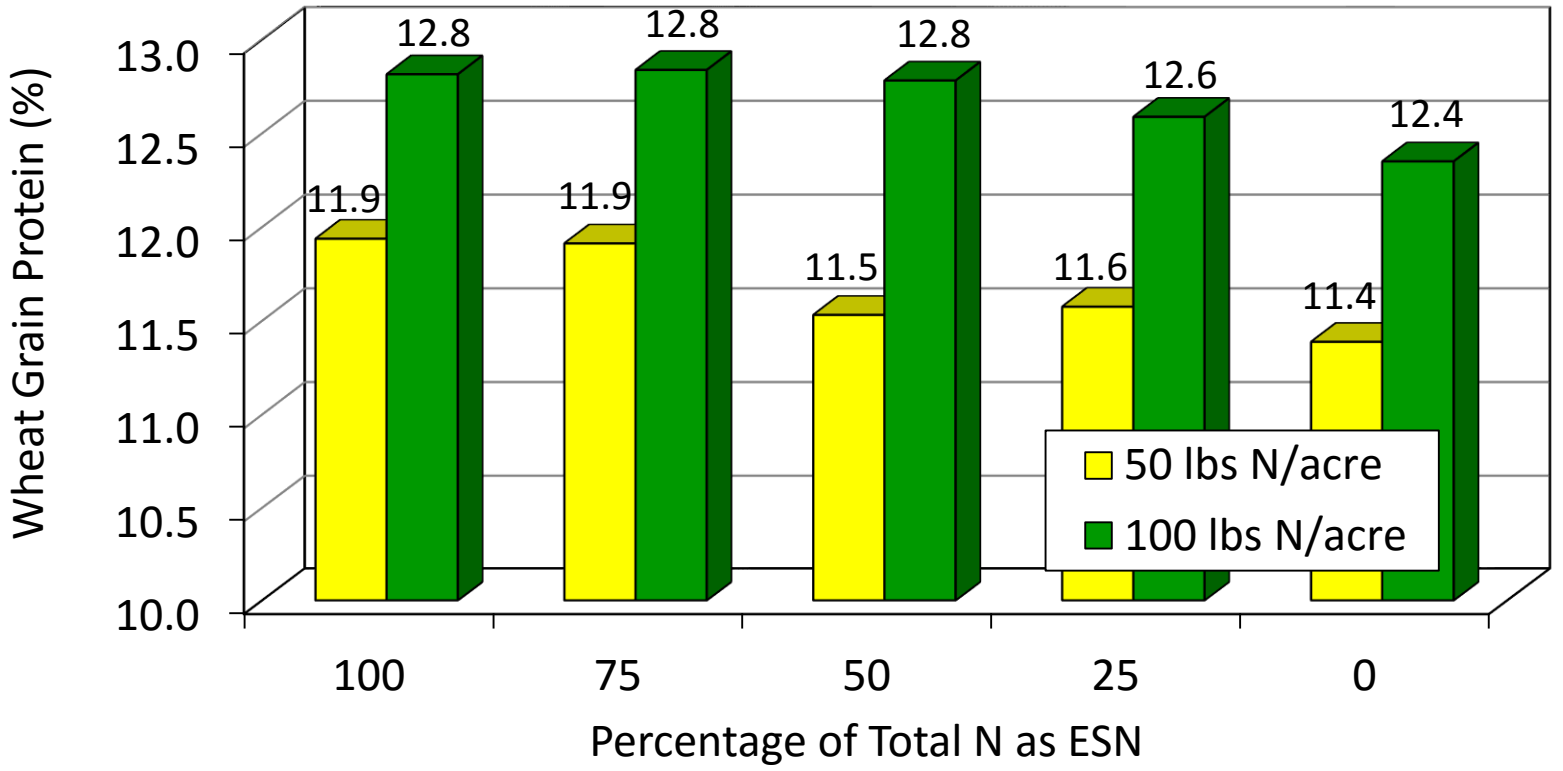
Urea + eNtrench

Urea + Agrotain Ultra

Different N Sources have different loss potential versus urea

Source	POTENTIAL LOSS VS UREA		
Conventional	Volatilization	Leaching	Denitrification
Ammonium nitrate	**Less**	**More**	**More**
Ammonium sulphate	**Slightly less**	**=**	**=**
UAN 28-0-0	**Less**	**More**	**More**
Enhanced efficiency			
Urease inhibitors (Agrotain)	**Less**	**=**	**=**
Nitrification inhibitors (DCD, N-Serve, eNtrench)	**=**	**Less**	**Less**
Combinations (SuperU, Agrotain Plus & UAN)	**Less**	**Less**	**Less**
Controlled release polymer coat (ESN)	**Less**	**Less**	**Less**

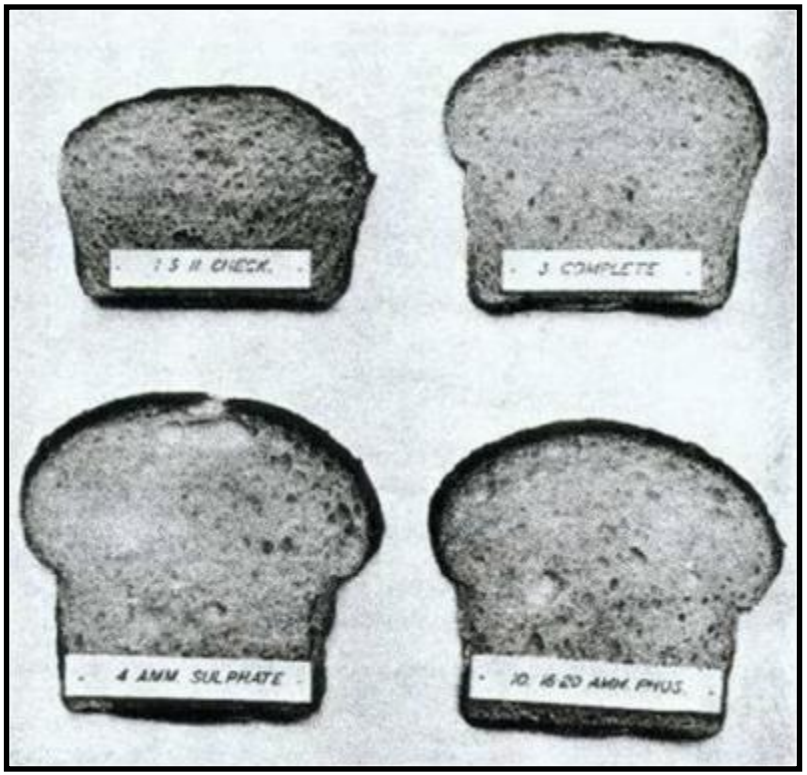
ESN Increases Spring Wheat Protein

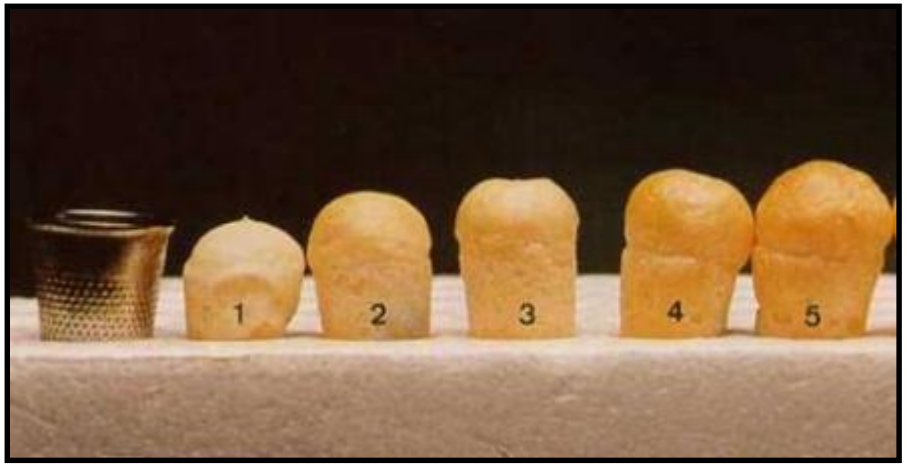


Data are means of four site years. All N applied at planting
Yield did not differ significantly among treatments. Average yield was 109 bu/acre.
Source: Dr. A Sims, Univ of Minnesota-NWROC, Crookston, MN, 2008-09

Sulphur has a large effect on protein quality

- **N and S are both required for protein production**
- **S-containing amino acids are important for high quality flour, dough, and gluten to enable proper loaf volume**

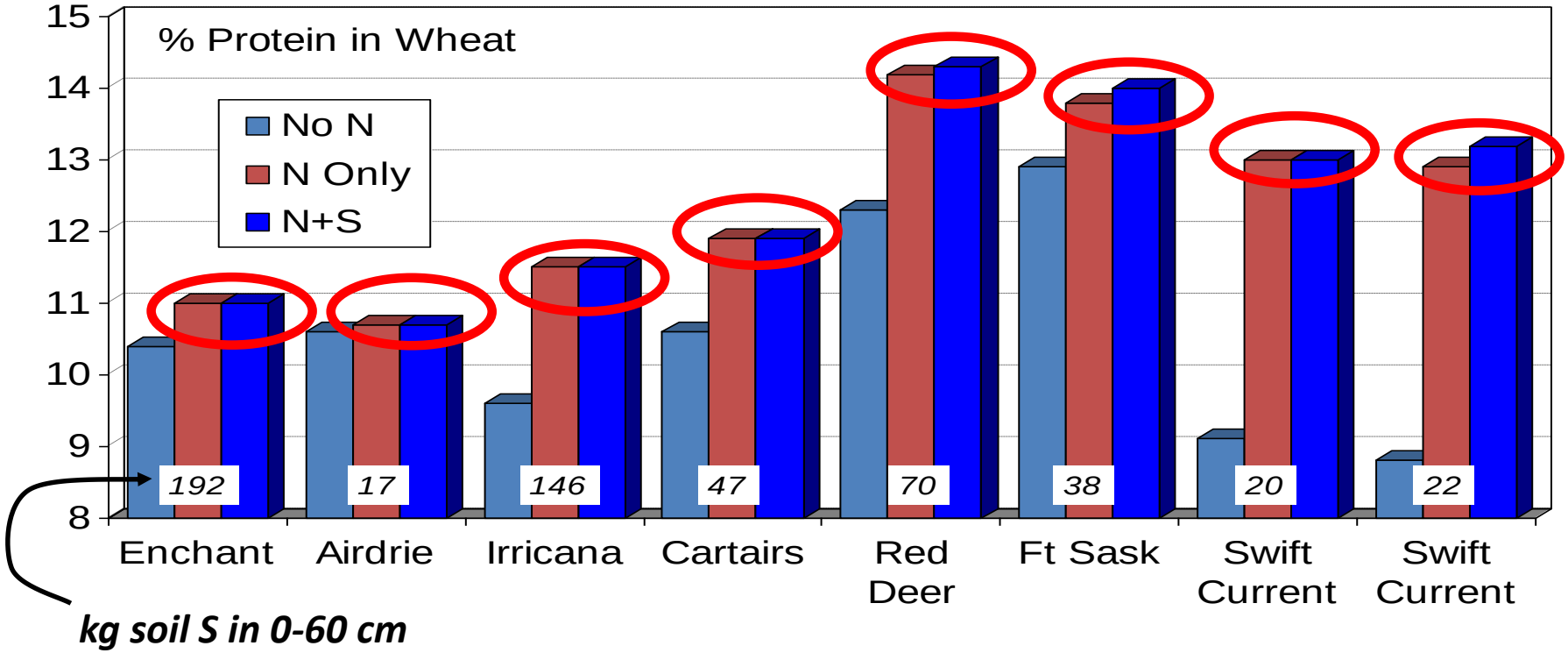




Wheat grown after legumes on Breton Plots 1938 (Univ. of Alberta Ext. Bull. 21)

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**



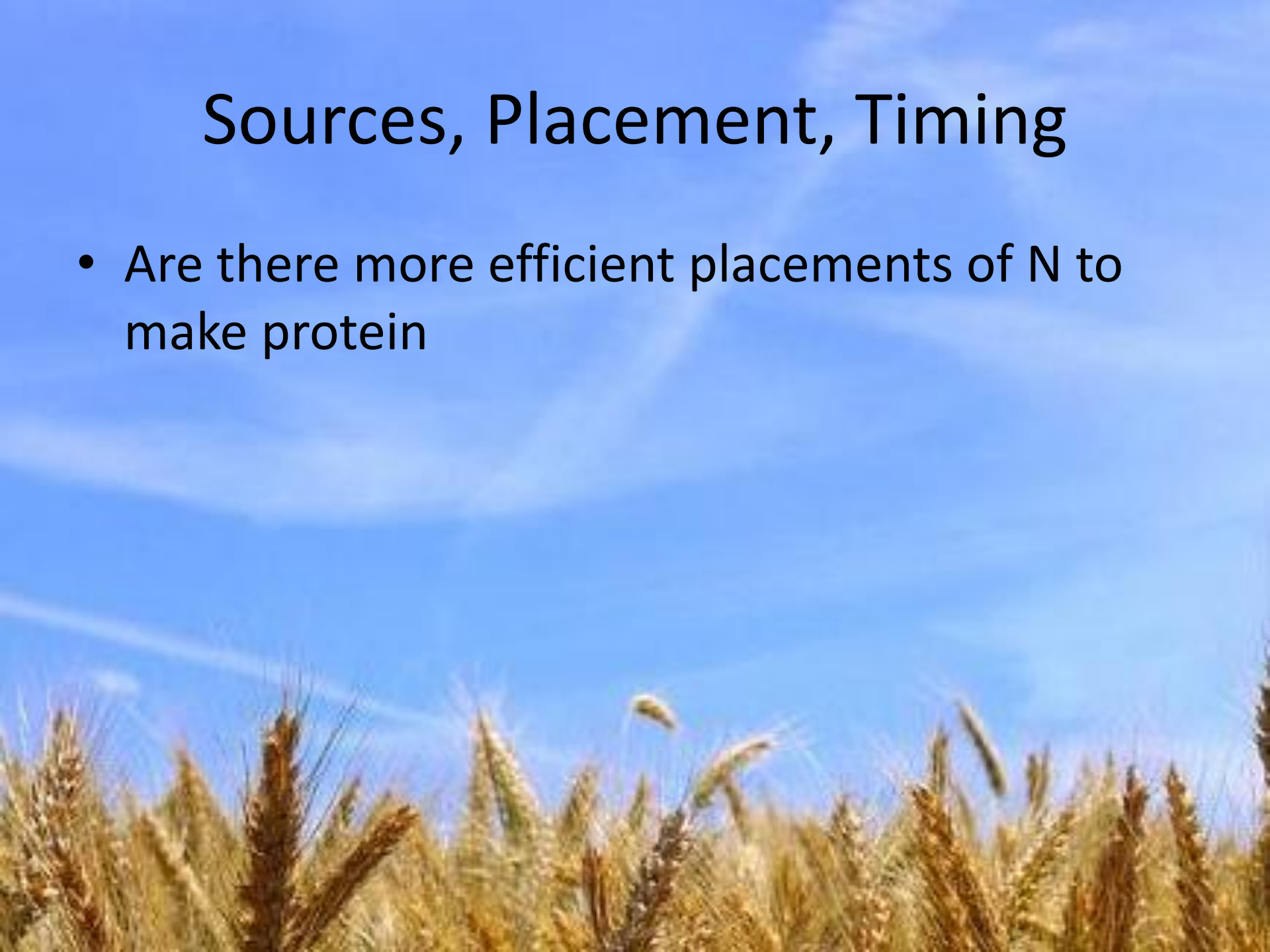
Source; Westco, 1998

Wheat yield response to S at Melfort in 1999

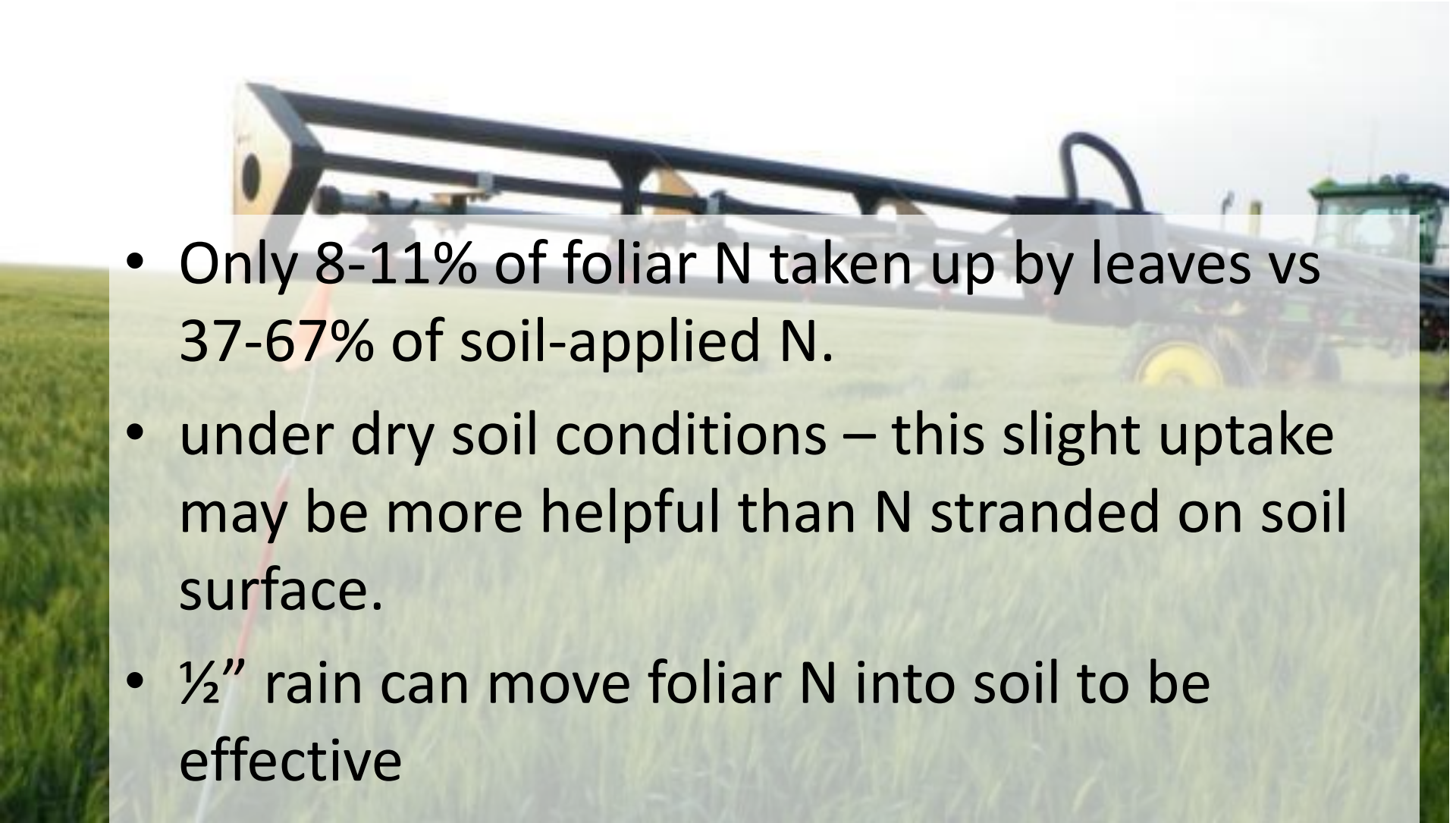
Yield increase of 3.4 bu/ac. No increase at 10/12 sites.

Sources, Placement, Timing

- Are there more efficient placements of N to make protein



Foliar N Application?



- Only 8-11% of foliar N taken up by leaves vs 37-67% of soil-applied N.
- under dry soil conditions – this slight uptake may be more helpful than N stranded on soil surface.
- ½” rain can move foliar N into soil to be effective

PAN Recipe (post anthesis N)

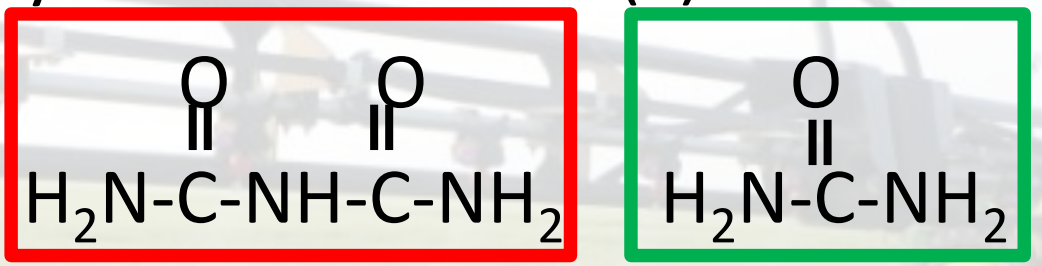
- Tested by NDSU and a track record

1. 30 lb N/ac as UAN (28-0-0) or 10 US gpa
2. Dilute 50:50 with 10 US GPA water
3. Apply 7-10 days post anthesis
4. Avoid heat of day – early morning or evening

Foliar N Options

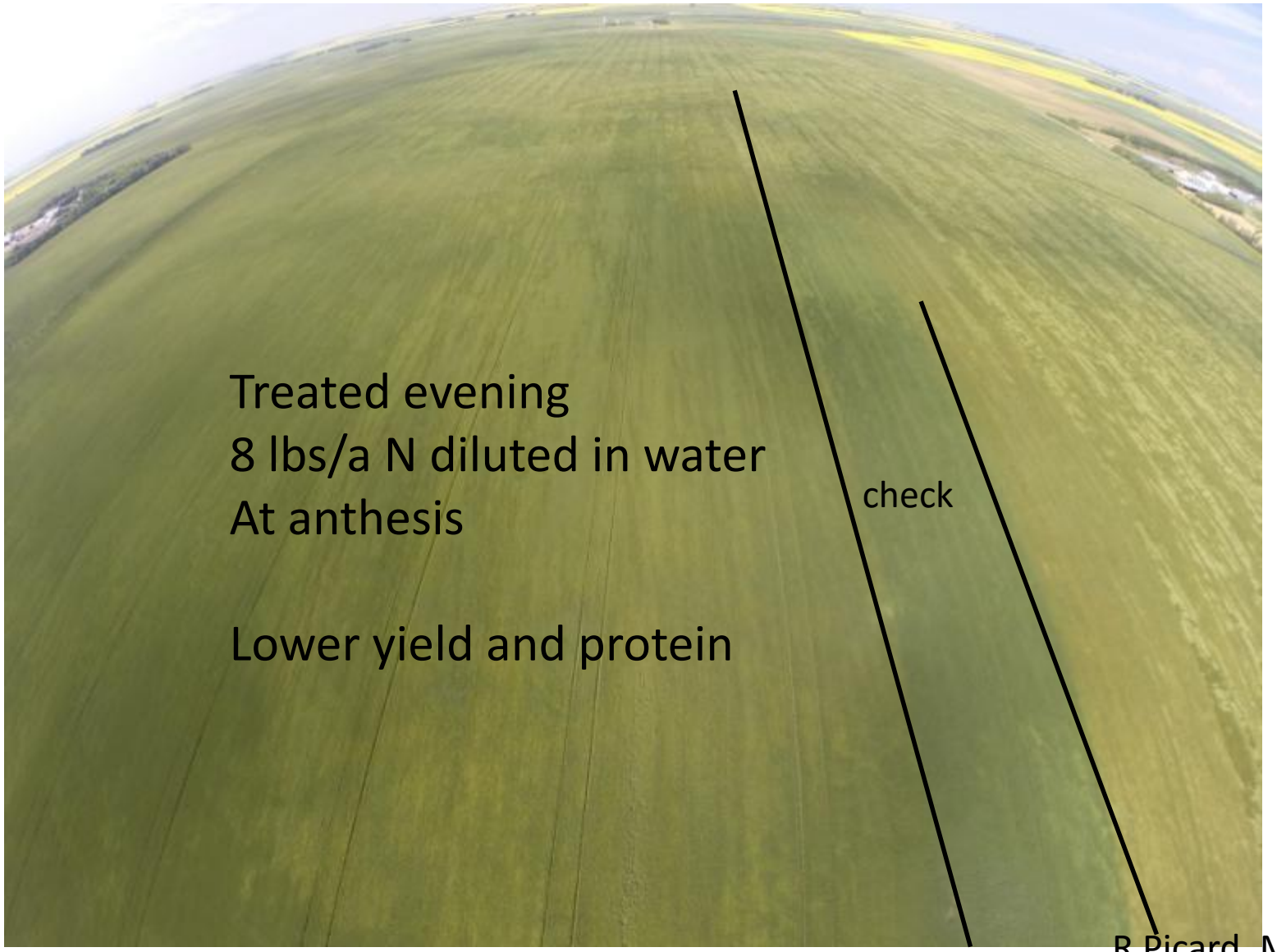
- NDSU studies:
- A number of controlled release N fertilizers
- Usually urea hooked to a C chain
- Less foliar burn, more expensive
- Protein increase requires same N rate as UAN, which makes them quite expensive
- https://www.ndsu.edu/fileadmin/soils/pdfs/foliarNreport.pdf

Foliar Urea

- Can also be used as a foliar spray but “brewed up” on own
- less salt injury to leaf than UAN(?)
- But BIURET 
- May result from heating urea above its melting point (132°C) during manufacture
- Toxic nature – more related to foliar than soil application
- <1% Biuret for foliar (<0.3% for some fruit crops)

Mikkelson, IPNI. Better Crops, 2007

Other protein enhancement treatment



R Picard, MAFRD

Product Specification

46-0-0 Granular Urea

Chemical Formula $(NH_2)_2CO$

Chemical Analysis	Minimum % by Weight	Maximum % by Weight	Typical
Total Nitrogen	46.0%	46.3%	46.1%
Biuret	0.7%	1.2%	0.9%
Moisture	0.1%	0.3%	0.2%
Conditioning Agent	N/A	0.5%	0.41%

Physical Analysis	Low/Minimum Range	High/Maximum Range	Typical
Bulk Density (Compacted)	49	52	51 lbs/ft³ (817 kg/m³)
Bulk Density (Non-compacted)	45	47	46 lbs/ft³ (753 kg/m³)
Angle of Repose	28°	35°	33°
Size Guide Number (SGN)	265	285	274
Uniformity index (UI)	55	65	60
Hardness			7.6 lbs (3.4 kg)

Effective November 2015

For example:

46.1% N

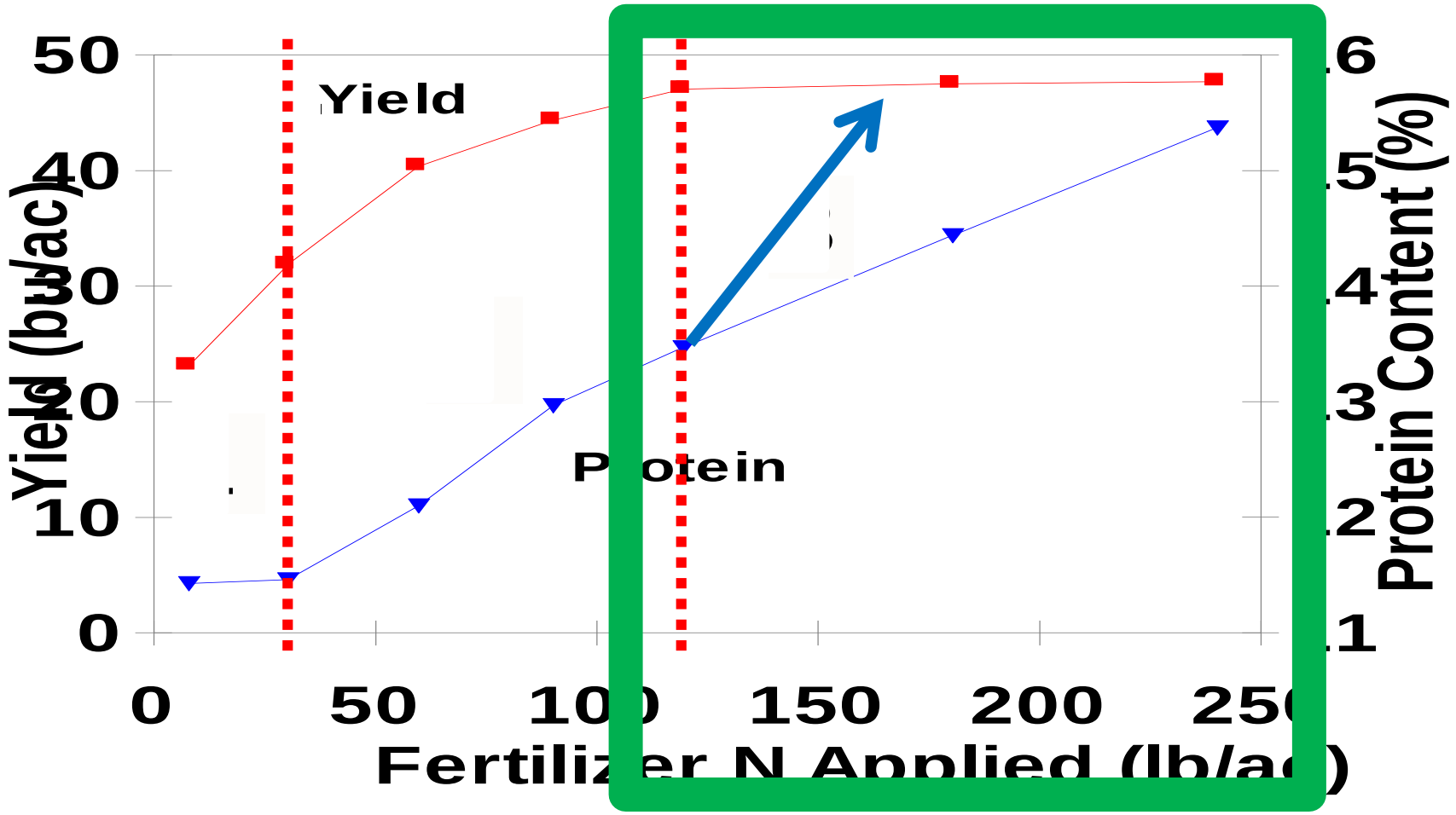
0.9% biuret

2015 MB studies

High yielding varieties: Brandon and Prosper

- Targeting N rates to achieve high yield in protein impact range
- Investigate N rate, timing ,source & placement
- Decision tools?

Effect of N on Yield and Pro
CWRS Wheat (Moist: <127 m

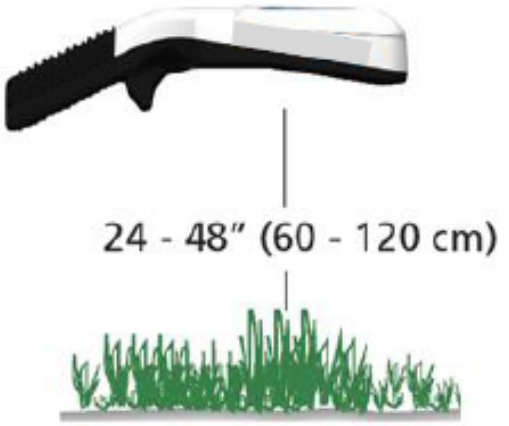


Agronomic data from G. Racz

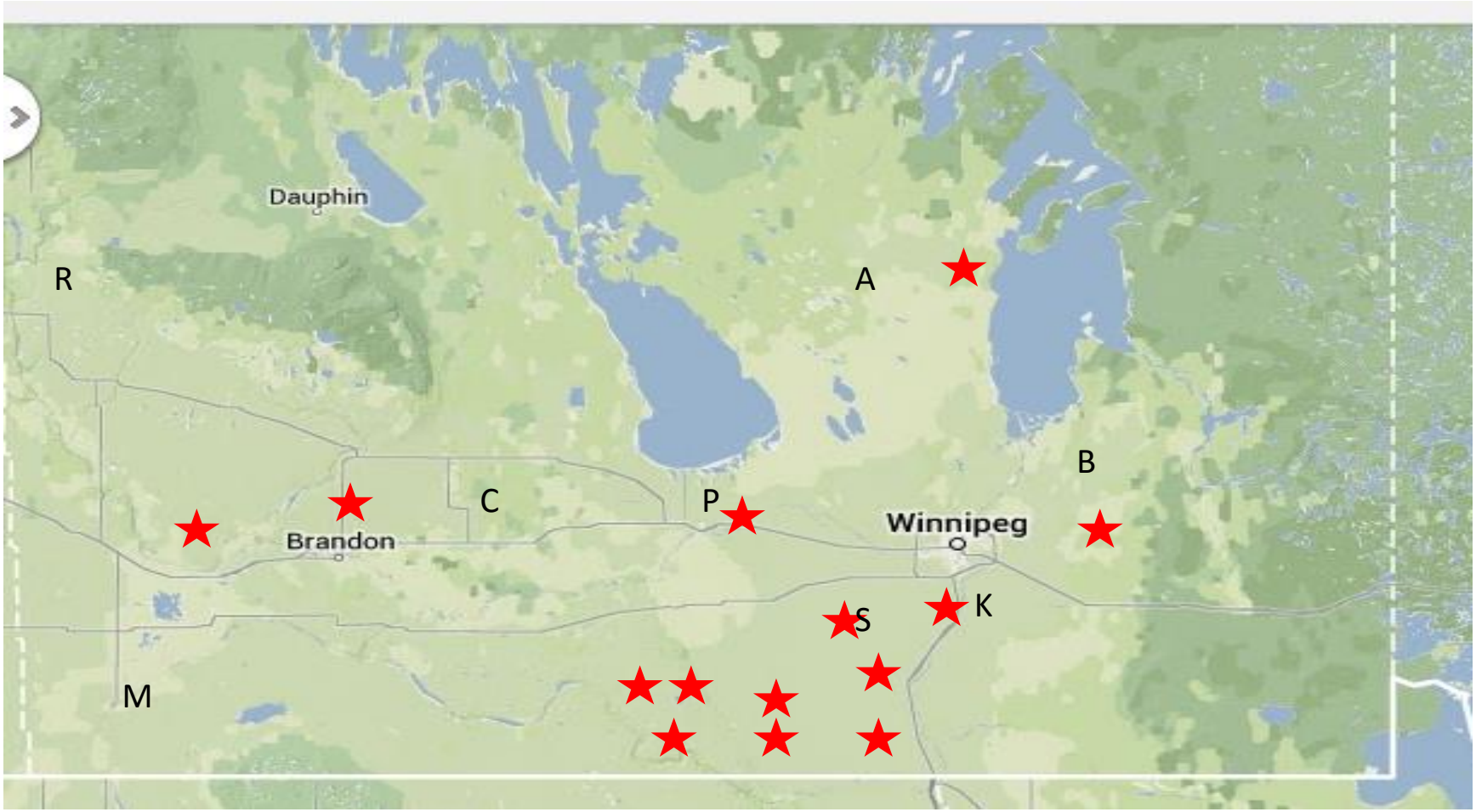
To apply late season or not?

- Flag leaf N concentration (sampled at heading) < 4.2%
- Chlorophyll readings
  - Irrigated spring wheat at heading < 93 to 95% of well-fertilized reference plot

Optical sensors of biomass (NDVI)
Hand-held GreenSeeker



2015 small plot and OFT studies

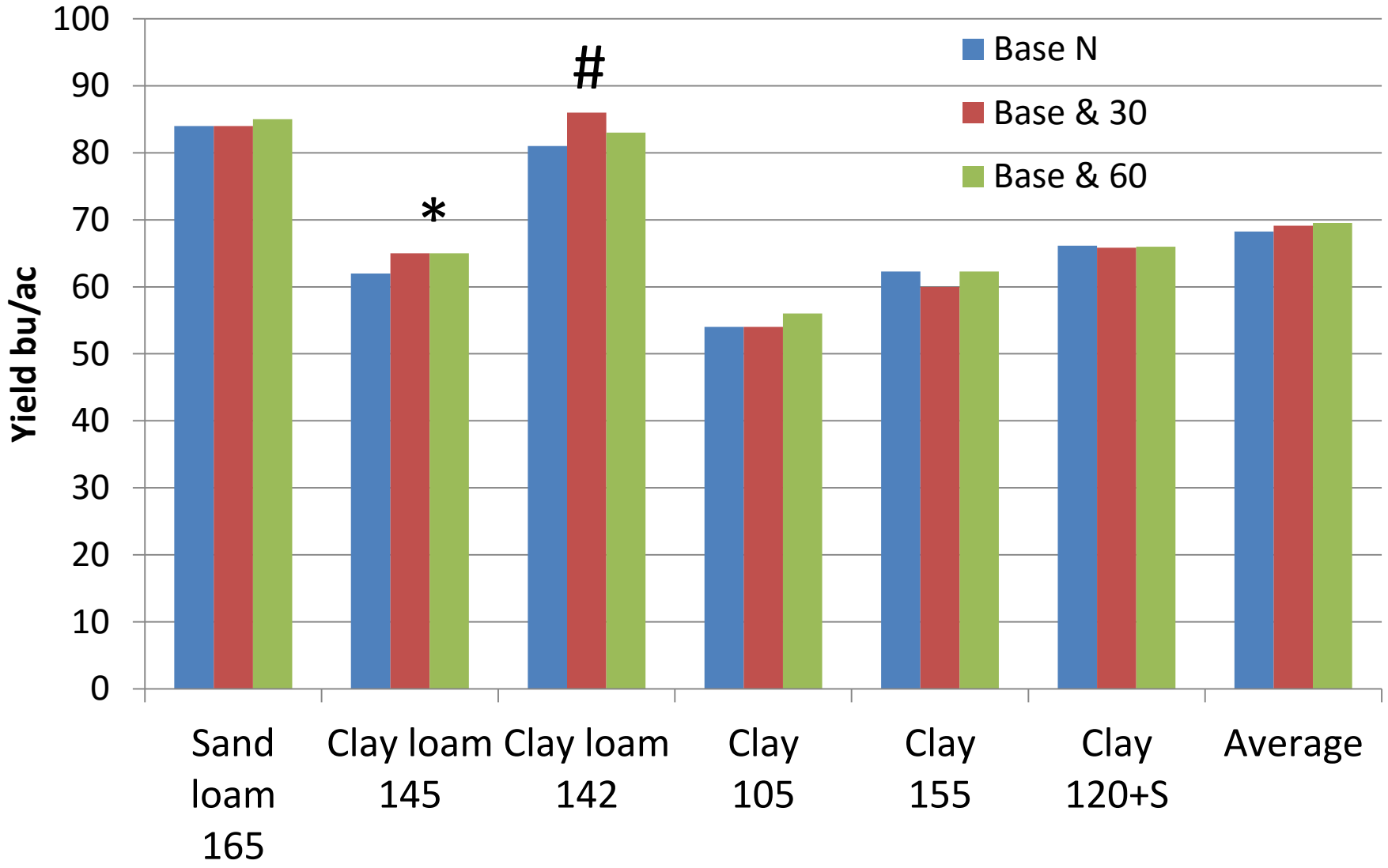


Suggested protocols
1) Increasing base rates of N

Base N	**&30**	**&60**	**Base N**	**&60**	**&30**	**&60**	**Base N**	**&30**	**Base N**
Rest of field 1	2	3	4	5	6	7	8	9	Rest of field

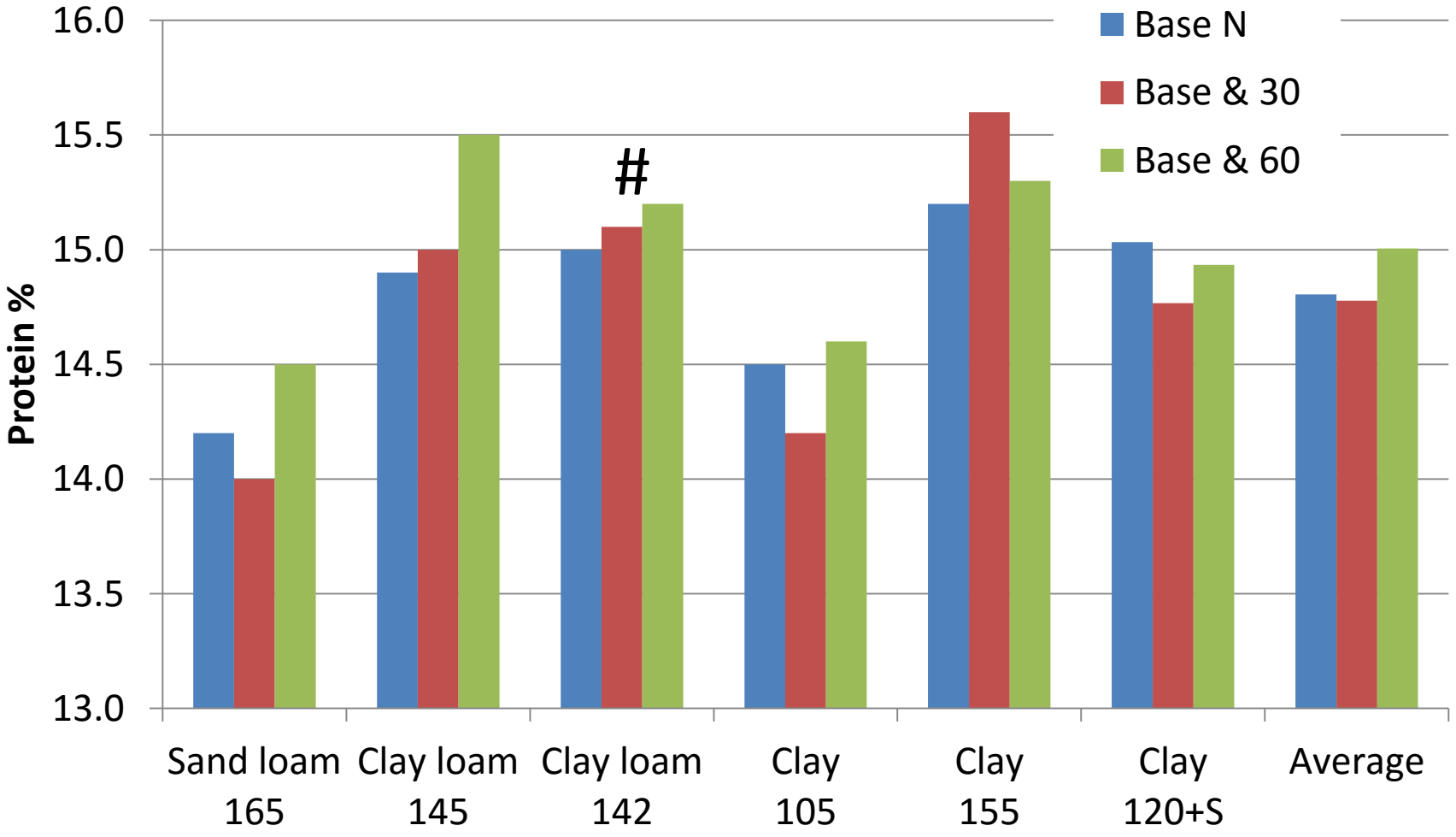
- Base rate – grower rate for yield
- 3-4 reps
- randomized

Base rate N additions on yield - OFT



Soil texture and Base N (fertilizer & Soil nitrate-N to 2')

Base rate N additions on protein - OFT

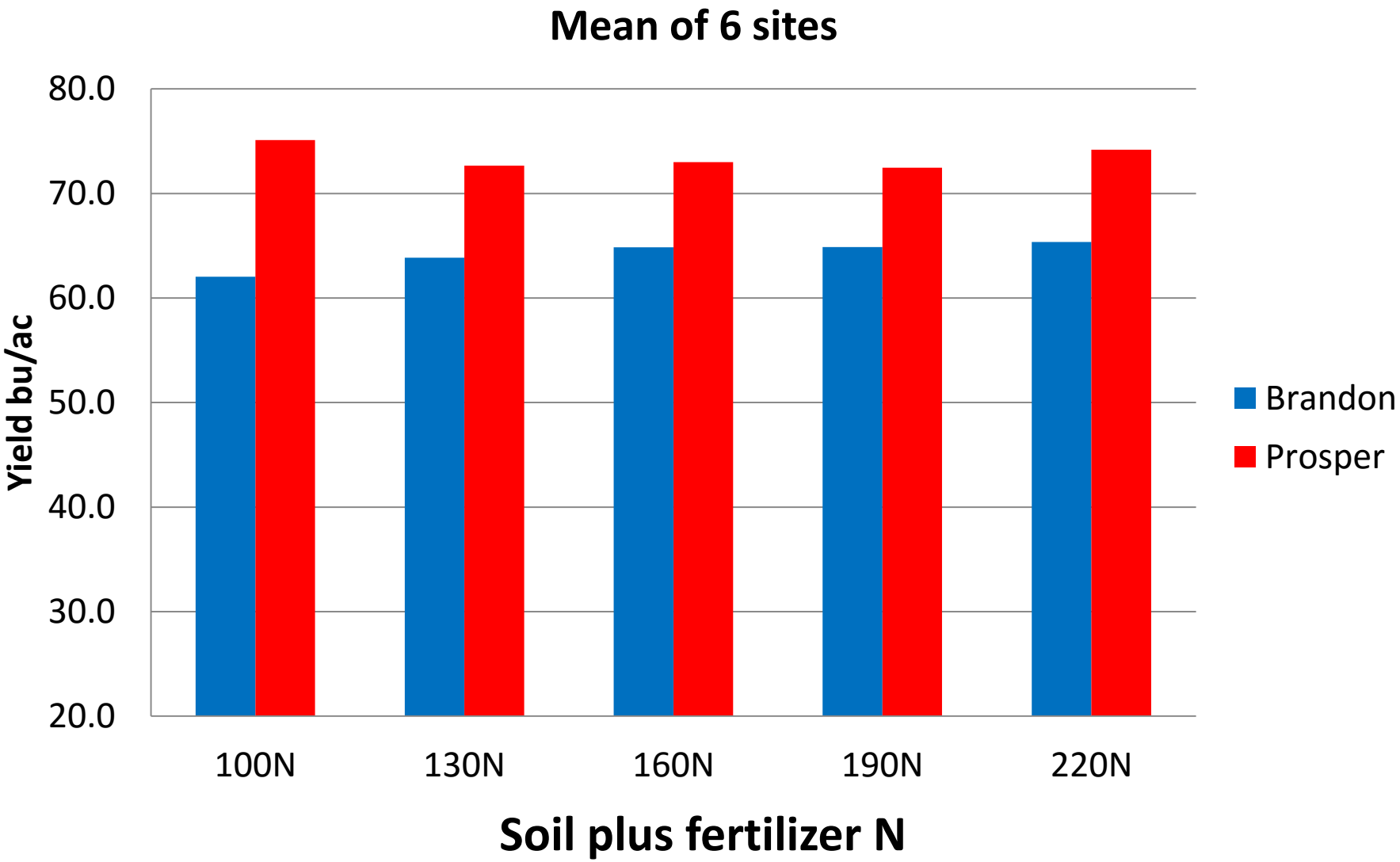


Soil texture and Base N (fertilizer & Soil nitrate-N to 2')

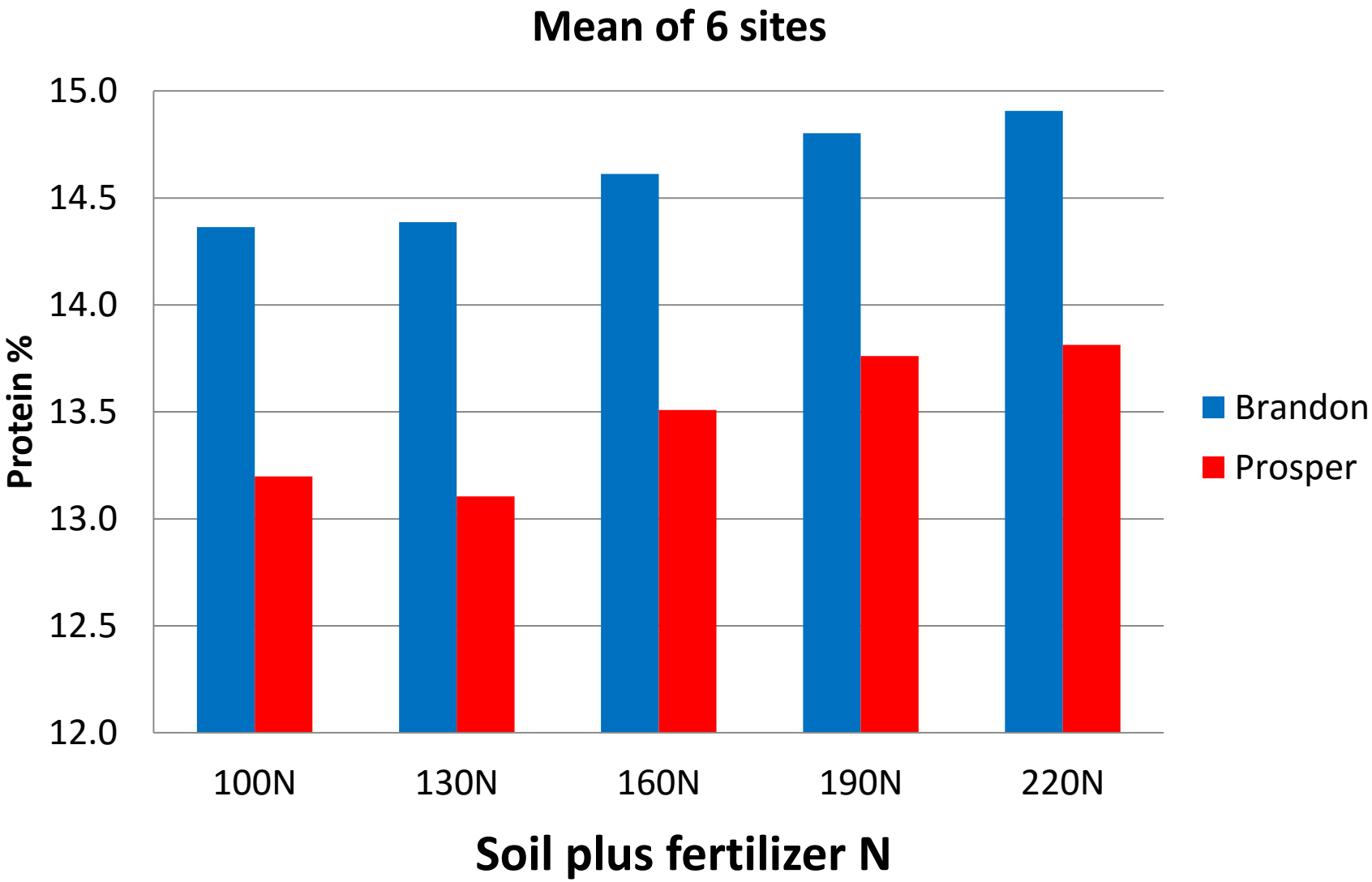
2015 OFT findings

- Yield potential was modest compared to recent farmer experience
- Due to: lodging, late May frost, heat at heading
- Little yield advantage to increasing N
- Adequate (>14%) protein levels attained with base rates and minor benefit to added N

Wheat yield with applied N



Wheat protein with applied N

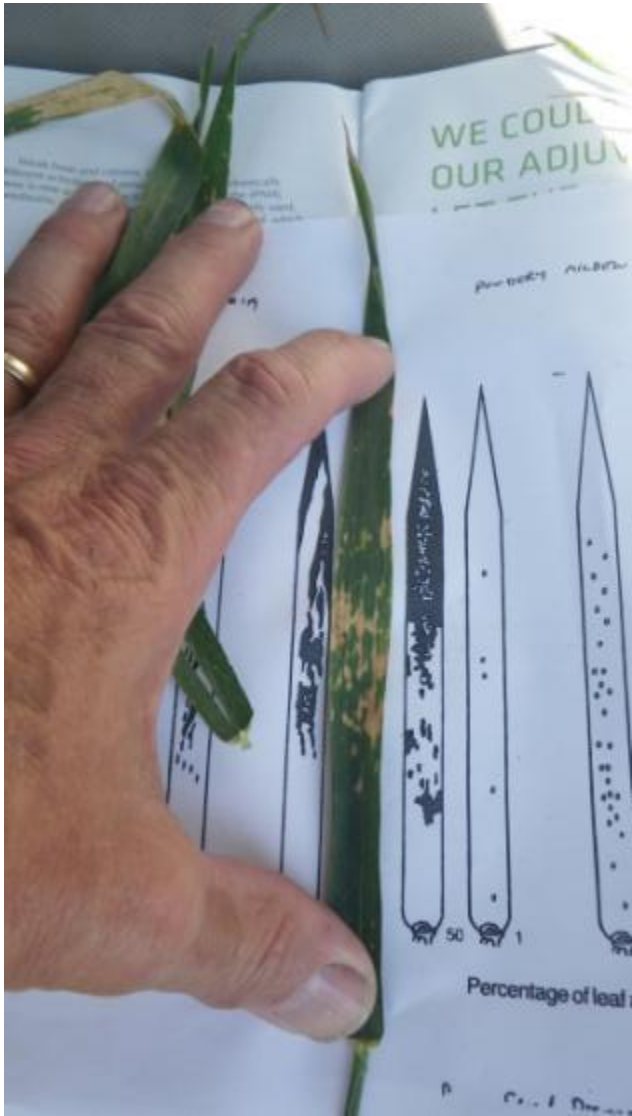


2) Post anthesis N (PAN)

Base N	&30 PAN	Base N	&30 PAN	Base N	&30 PAN	Base N	&30 PAN	Base N	&30 PAN
Rest of field 1	2	3	4	5	6	7	8	9	10

PAN application

Leaf burn	Rep 1	Rep 2	Rep 3	Average	
Base N	1	2	1	1	Sign @
& PAN 30	14	16	15	15	5%



Leaf burn	Rep 1	Rep 2	Rep 3	Average	
Base N	1	1	1	1.0	
& PAN 30	9	17	9	11.7	5%

Leaf burn	Rep 1	Rep 2	Rep 3	Average	
Base N	0	0	0	0.0	sign at 5%
& PAN 30	5.4	4.8	3.7	4.6	

Portage - CMCDC

	Leaf burn %	Yield (bu/ac)	Protein %
Base N	0.0 c	65.5 a	13.7
& PAN 30 FF	30.7 a	58.9 b	14.0
& PAN 30 DRB	16.8 b	62.6 a	14.2

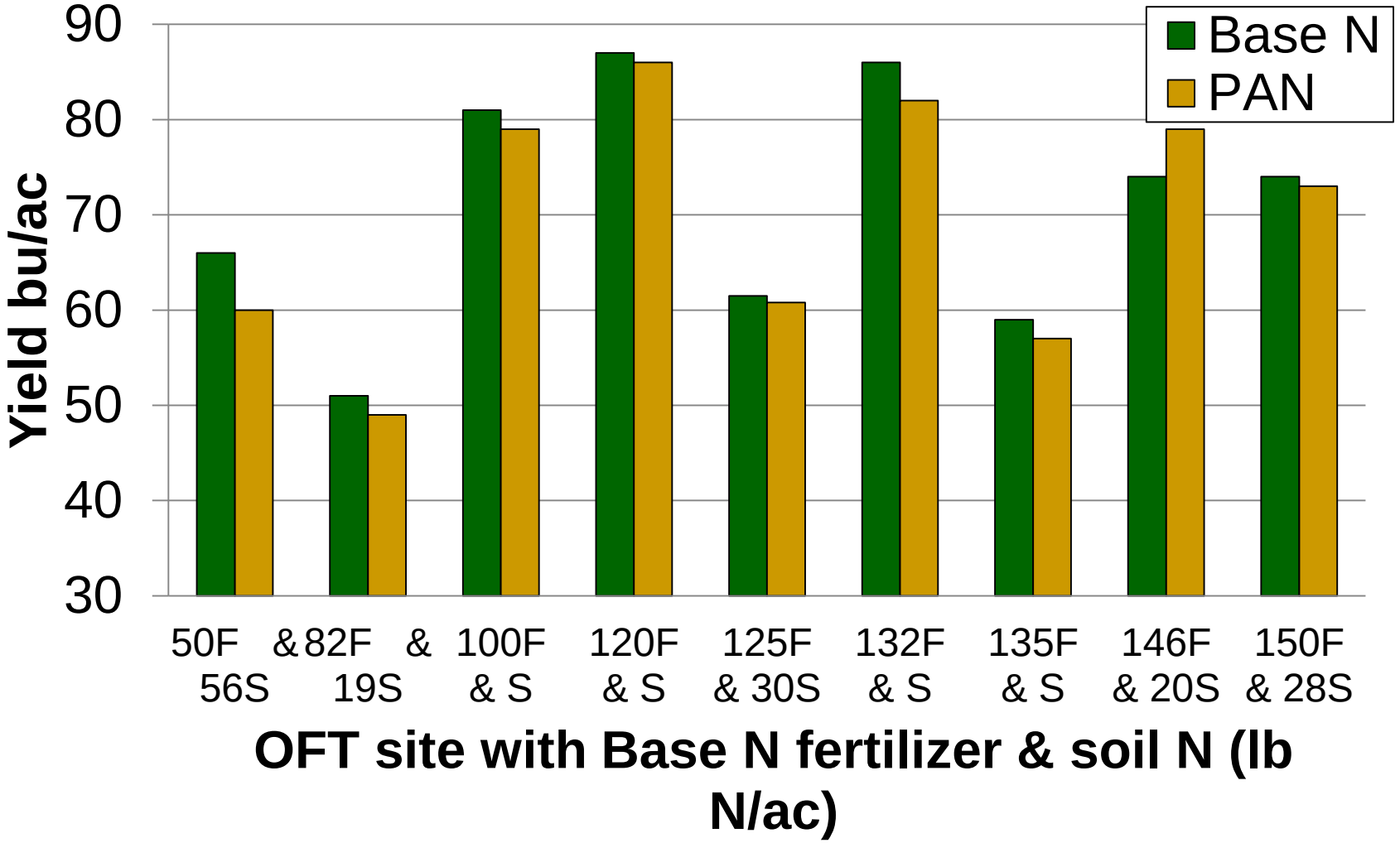
Harvest


1.9 mph
Nudge
<4.0 in
12.3 %
Yield, Dry
88 bu/ac
Fan speed
950 rpm
1130 rpm
Back
Run1

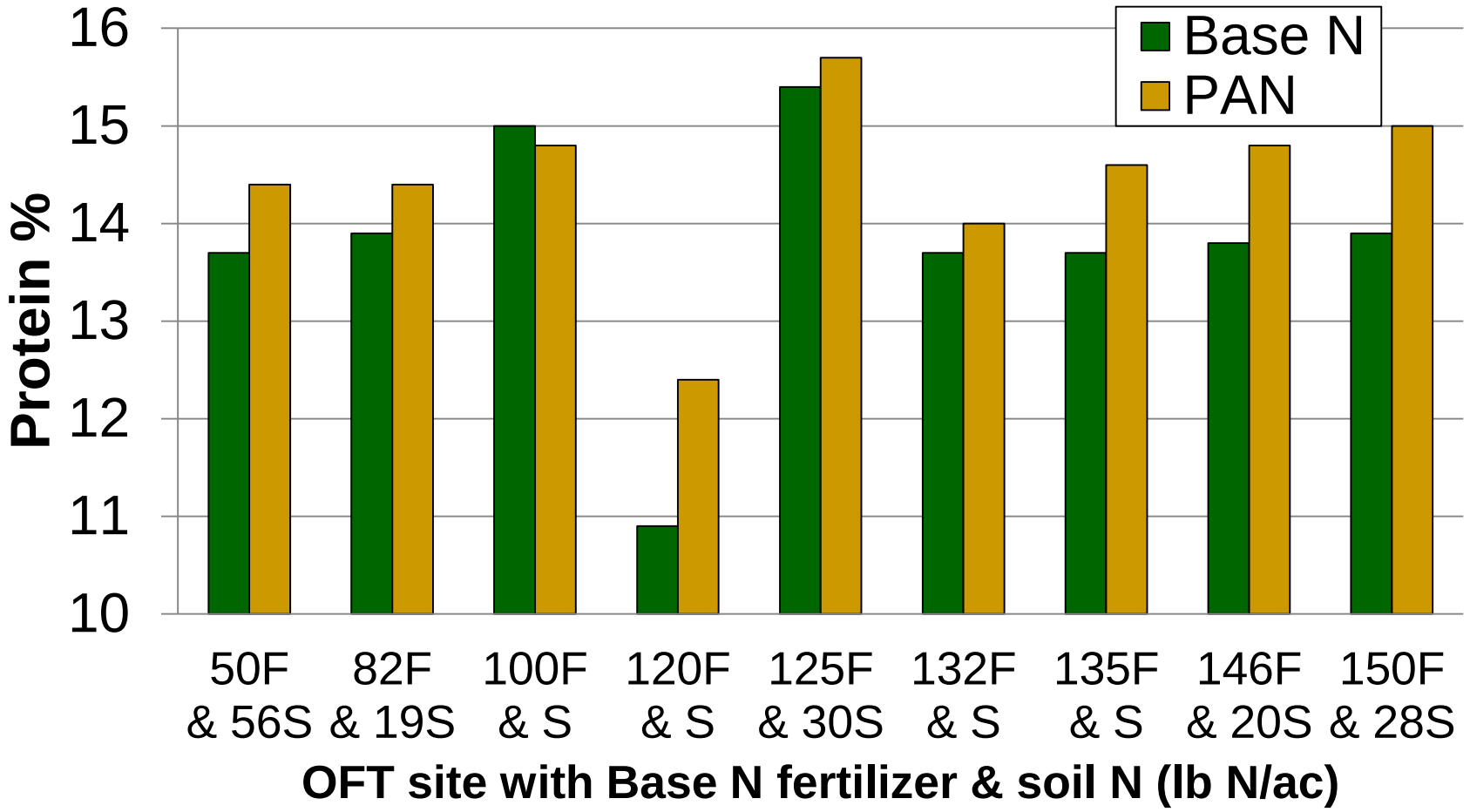

J&M Manufacturing
750

Harvest

Wheat Yield


Base N
PAN
Yield bu/ac
90
80
70
60
50
40
30
50F 56S
& 82F 19S
&
100F & S
120F & S
125F & 30S
132F & S
135F & S
146F & 20S
150F & 28S
OFT site with Base N fertilizer & soil N (lb N/ac)

Wheat Protein



Clay loam site with largest protein increase

Yield (bu/ac)	Rep 1	Rep 2	Rep 3	Average	
Base N	86.6	84.8	89.5	87.0	NS
& PAN 30	85.4	84.6	88.4	86.2	

Protein	Rep 1	Rep 2	Rep 3	Average	
Base N	10.9	10.7	11.1	10.9	sign @
& PAN30	12.5	12.2	12.6	12.4	5%

HVK%	Rep 1	Rep 2	Rep 3	Average	
Base N	58	60	62	60	sign @
& PAN 30	88	90	83	87	5%

Summary – no yield impact, large protein increase and increased HDK.

R Picard, MAFRD

2015 OFT PAN Findings

- Severe leaf burn at some sites, related to heat and humidity at application
- Minimal effect of yield at most sites
- protein increase averaged about 1%

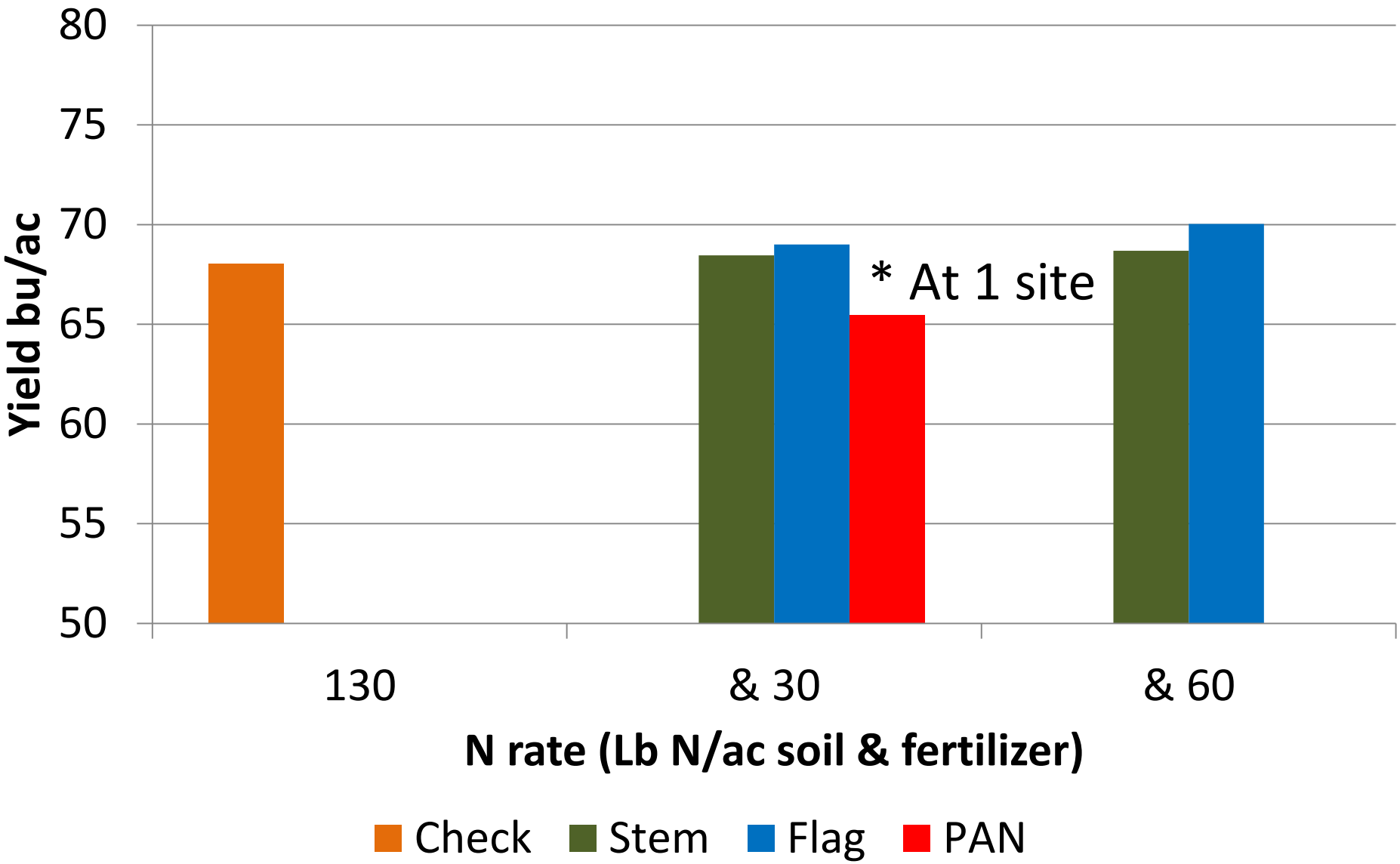
(varied 0-1.5%)

Stage 1: Start of stem elongation.

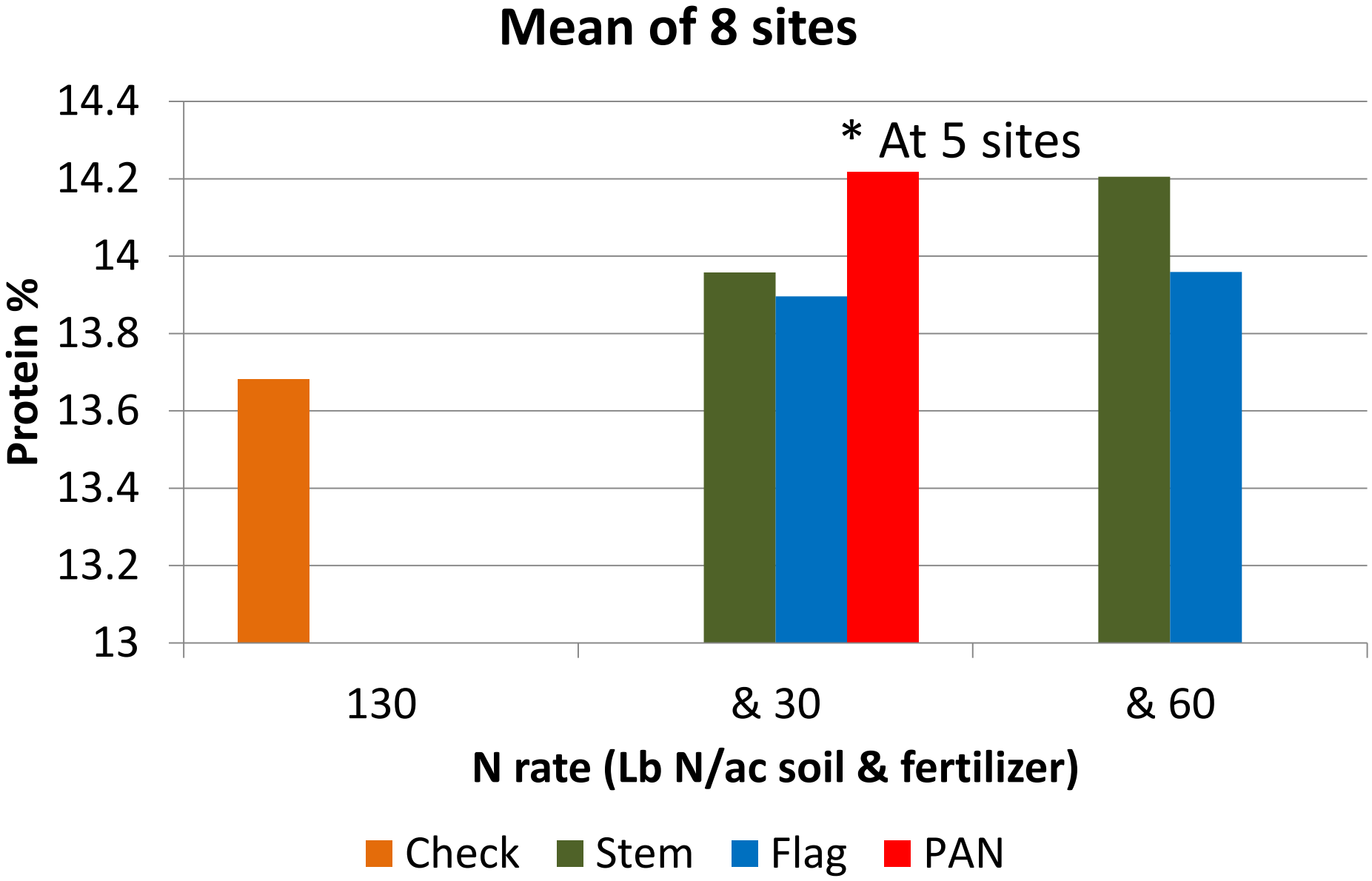
Stage 2:full flag leaf emergence

Prosper wheat – N timing

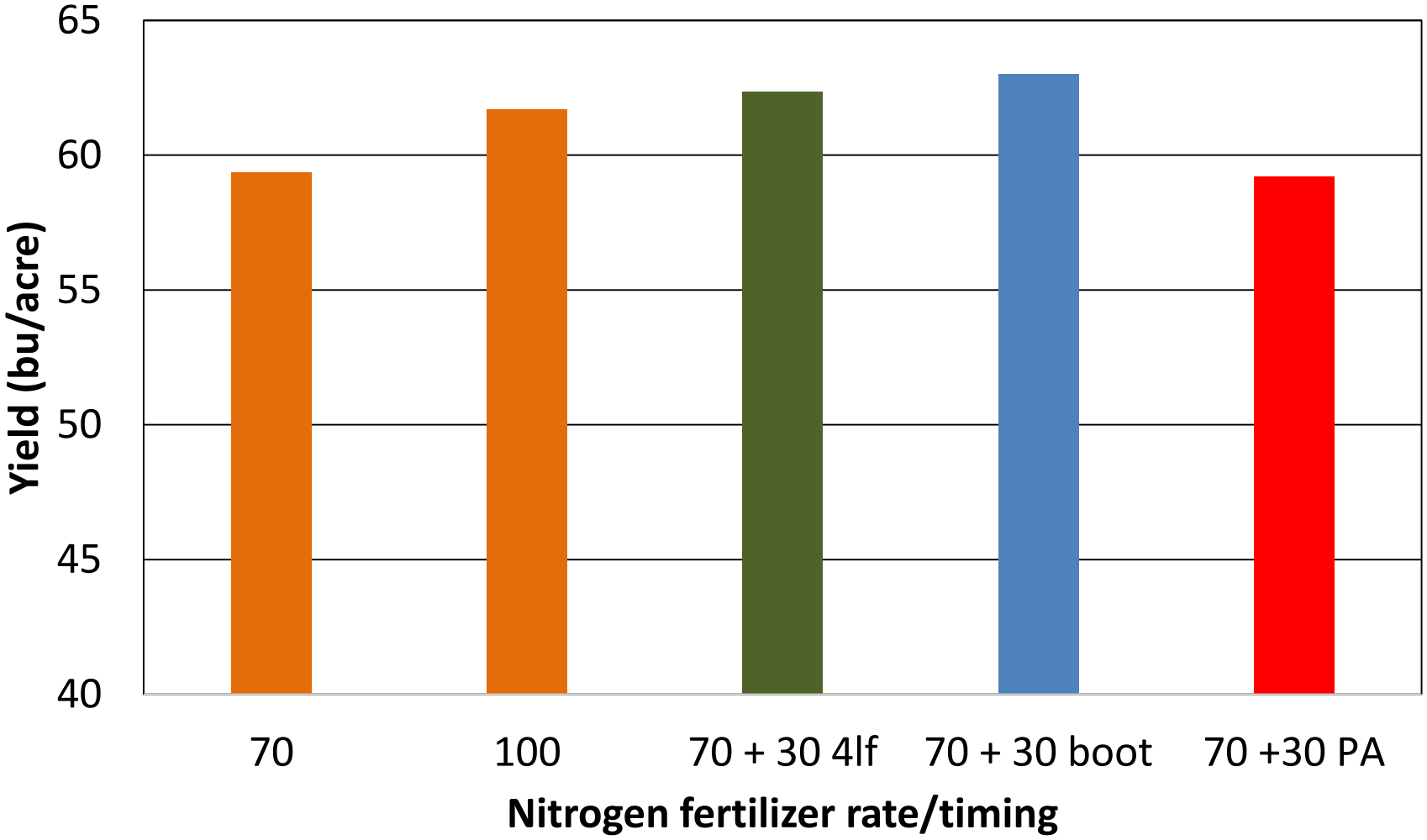
Mean of 8 sites



Prosper wheat – N Timing

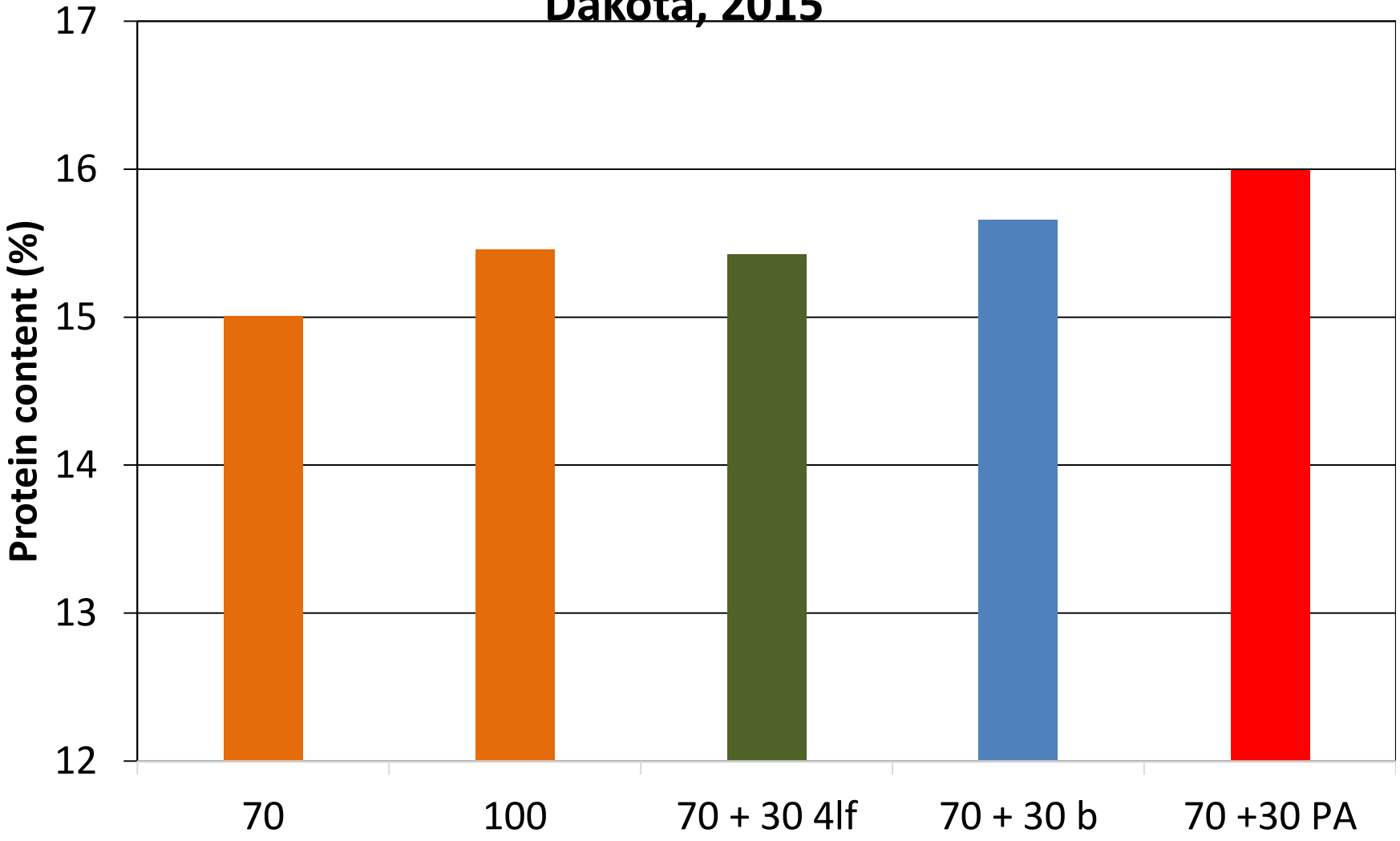


Effect of nitrogen fertilizer rate/timing on yield of spring wheat, combined over two locations in North Dakota, 2015.



(Ransom, 2015)

Impact to fertilizer nitrogen rate and timing on protein content, average of two locations in North Dakota, 2015



(Ransom, 2015)

Does it pay?

- Comparison of returns
  - Protein from 13.6% to 14.5%
  - Cost per acre $33.35 (application and material $24.71 plus lost of wheat to wheel tracks)
  - Premium/discount $.05 per fifth ($.25 per %)
  - Price/bu @13.5 protein (71.1 bu/a x $4.55=$323.51)
  - Price/bu @14.5 protein (71.1 bu/a x $4.80=$341.28)
  - Benefit of $17.77 per acre
  - Net loss: $17.77 minus $33.35 = -$15.58

(Ransom, 2015)

When does it pay (assuming a 1% protein bump)? (NDSU)

Protein Premium ($/point)	Yield (bu/acre)		
	50	70	90
0.25	-$20.85	-$15.85	-$10.85
0.50	-$8.35	$1.65	$11.65
0.75	$4.15	$19.15	$34.15
1.00	$16.65	$36.65	$56.65

(Ransom, 2015)

What for 2016?

- Seeding medium yield, high protein varieties
- Consider N rates with N calculator

- Seeding high yield, lower protein varieties
- Consider 2.5 lb soil & fert N/bu thumb rule
- Use PAN

Partners in 2015 studies

MB Wheat and Barley Growers Association

Farmers Edge Laboratories

KOCH Fertilizers

Richardson Pioneer staff and Kelburn Farm

RJP Seed

MAFRD – ag extension and research staff

ANTARA Research

Agri-Truth

University of Manitoba

More in 2016!!!! Small plot research and looking for more OFT cooperators