

Fertility requirements for peas and alternative crops

Rich Koenig, Extension
Soil Fertility Specialist

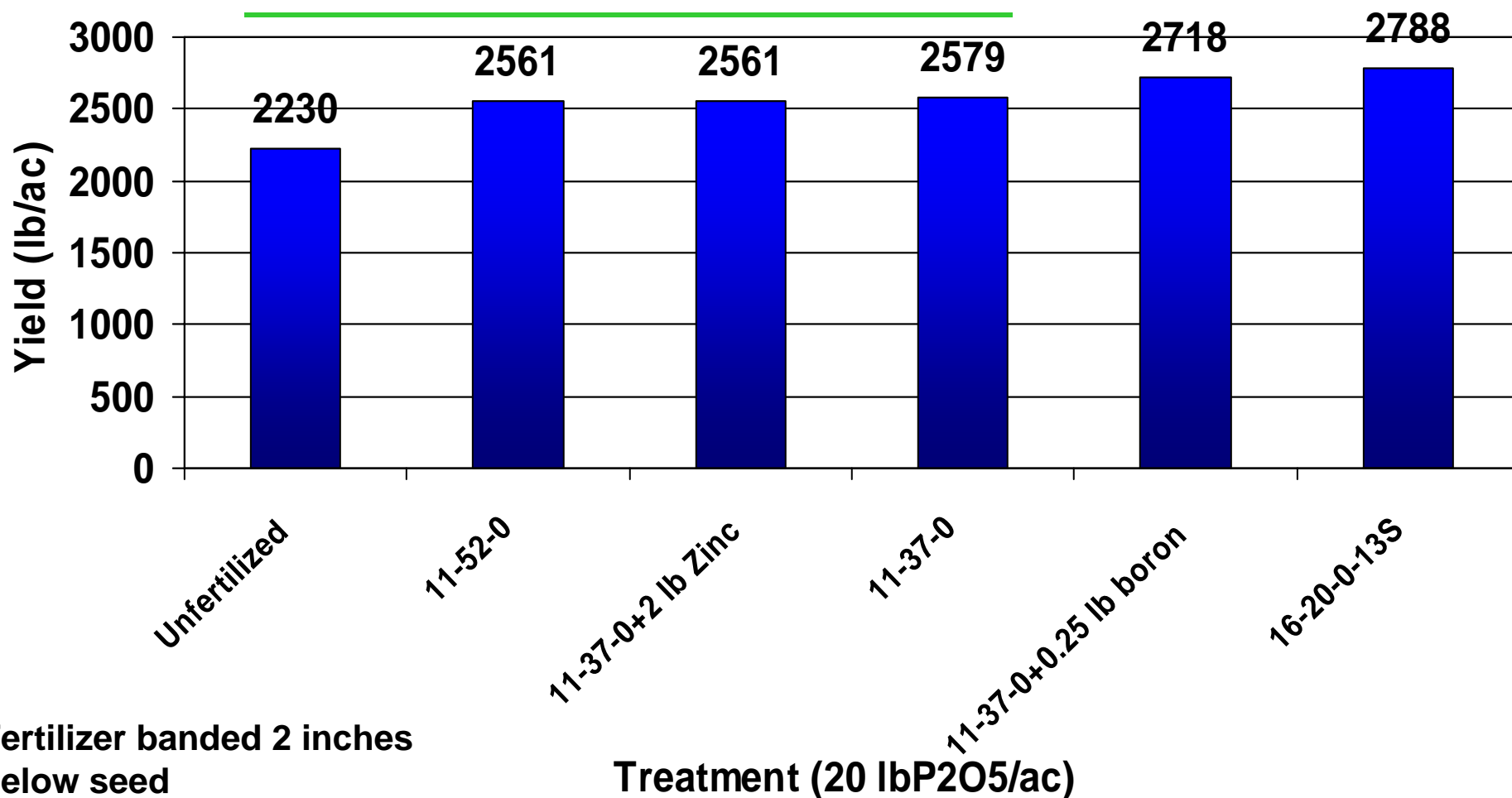
Topics

- **2005 pea fertility study results**
- **General information on fertilizing legumes**
 - **Generally, minimal fertility requirements**
- **Liming studies - winter wheat**
- **Hard wheat N fertility**

2005 green pea fertility trial soil test results (1 foot depth)

Parameter	Average of 4 samples	Interpretation
Soil pH	5.5	Borderline for peas (>5.5)
Phosphorus	22 ppm	Adequate for peas (>12)
Potassium	360 ppm	Adequate for peas (>75)
Sulfur	3 ppm	Very low for peas (>10)
Zinc	1.7 ppm	Adequate for peas (>0.8)
Boron	0.18 ppm	Very low for peas (>0.5)
Iron	49 ppm	Adequate for peas (>5)
Manganese	27 ppm	Adequate for peas (>1)
Copper	1.5 ppm	Adequate for peas (>0.2)

2005 green pea yields



Dry pea, lentil and chickpea fertility

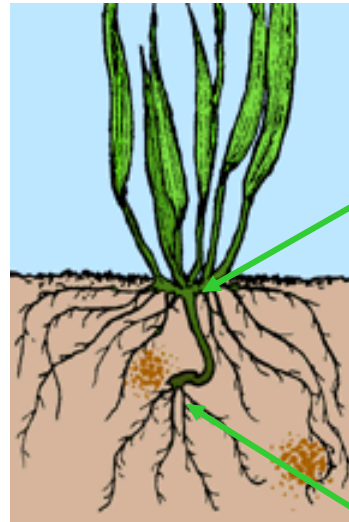
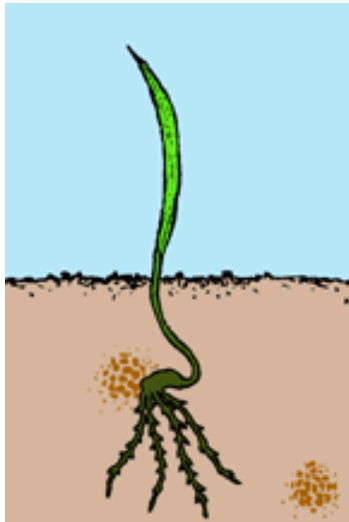
- **University of Idaho guides**
 - <http://www.uidaho.edu/wq/wqfert/wqfertls.html>
- **Authored by R. Mahler**
- **Emphasize**
 - **Inoculation for fields without a history of legume for last 5 years, or pH below 5.7**
 - **Inoculum for peas/lentils is different than for chickpeas**
 - **Soil test for phosphorus, sulfur, zinc and boron**
 - **Molybdenum when pH < 5.7 (seed treatment)**

Fertilizer placement for legumes

- No nitrogen, potassium or sulfur with the seed (too soluble)
- Small amounts of phosphorus (<10 lb P₂O₅/ac) with the seed are okay
- Ideal placement is below or below and beside the seed

Rooting patterns and starter and deep band fertilizer placements

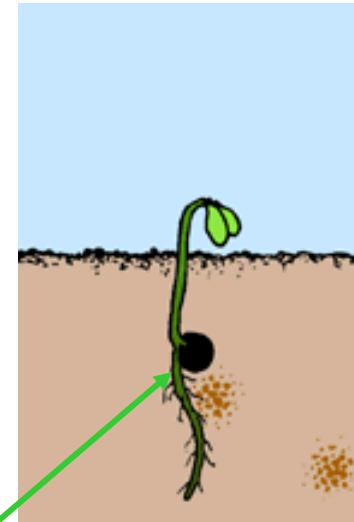
Wheat



Secondary root system

Primary root systems

Legumes



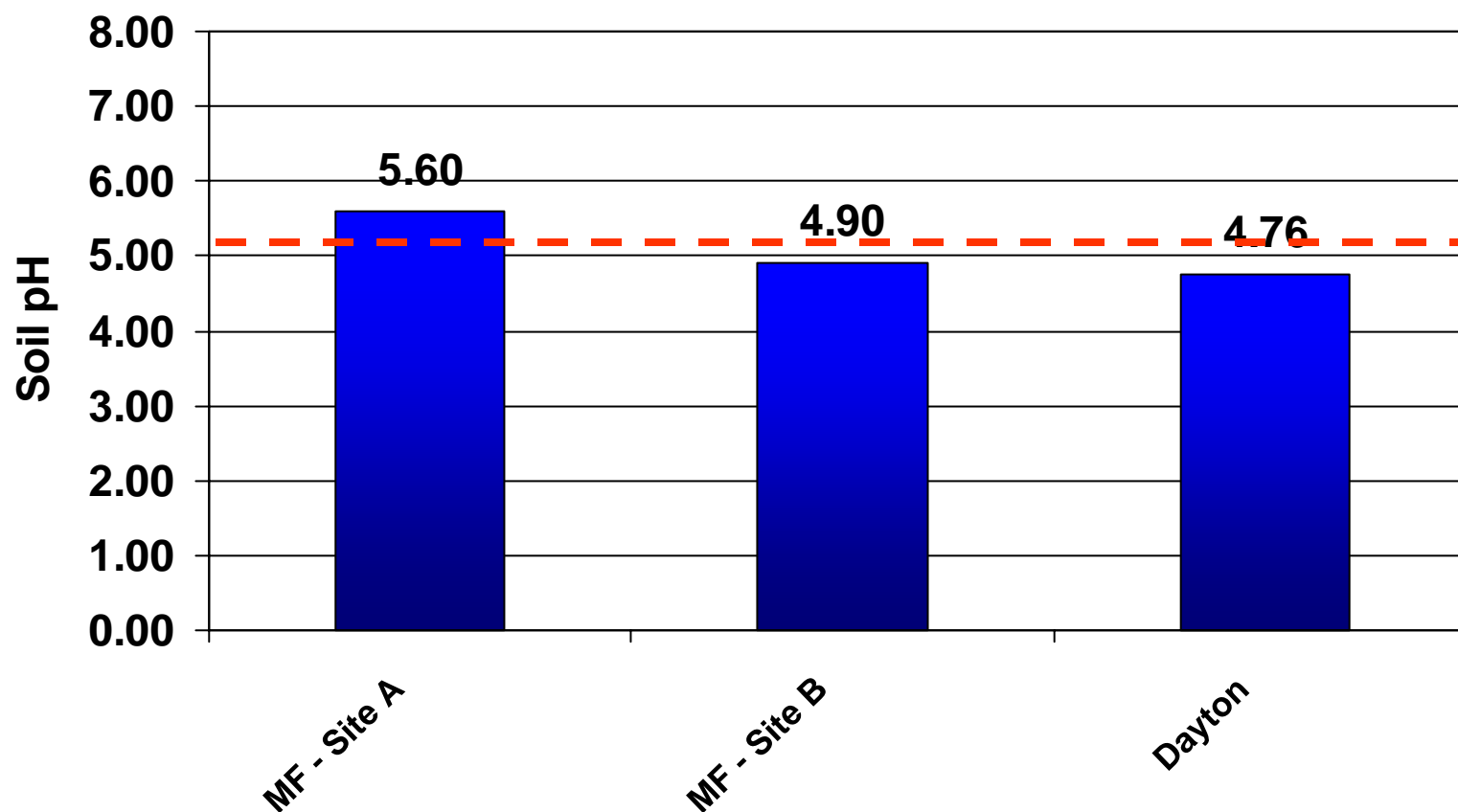
Soil pH issues

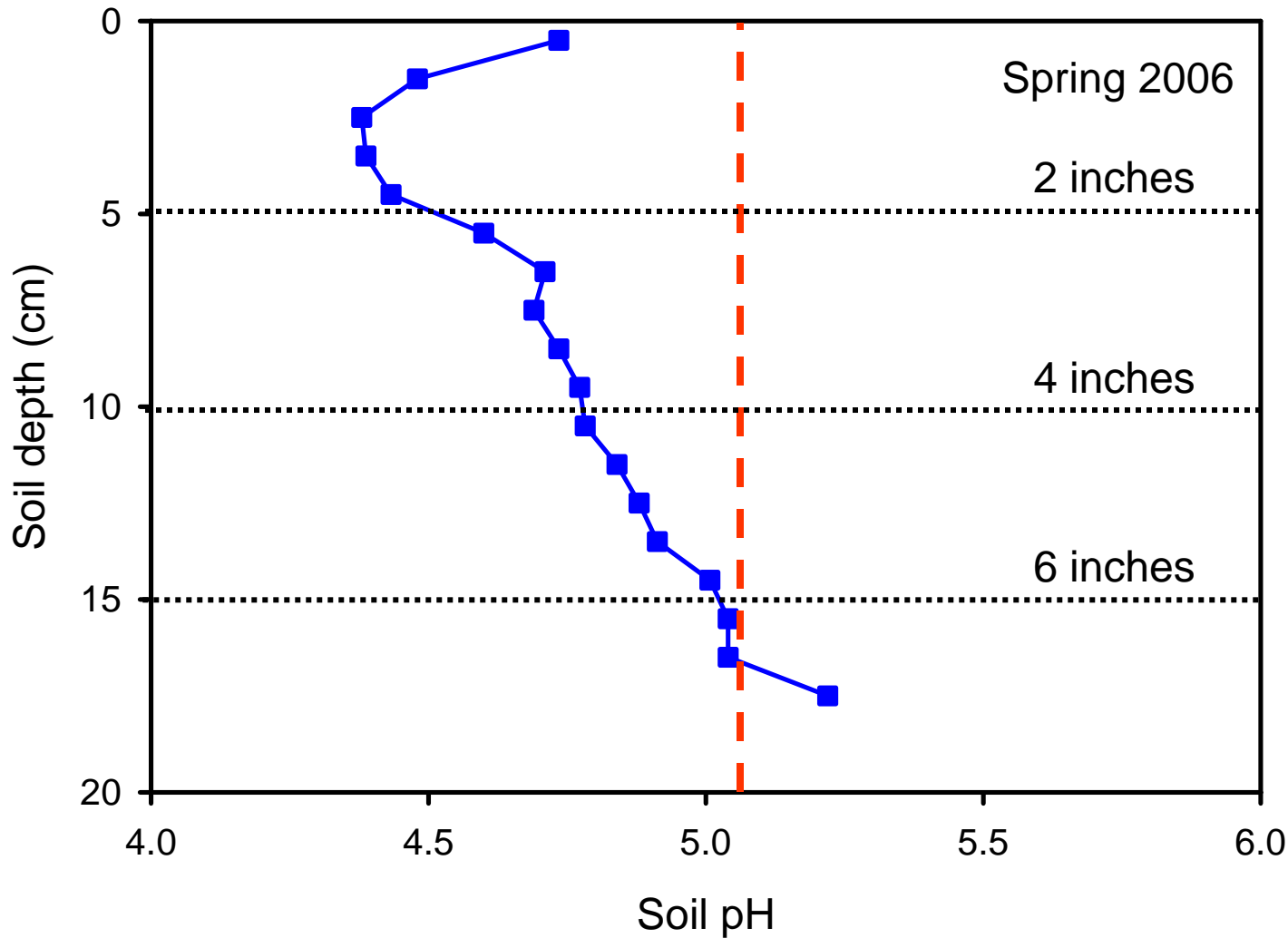
- Native prairie soil pH was 6.5 to 7.2
- 1984 survey conducted by R. Mahler at University of Idaho found >45% of soils in N. Idaho have pH below 5.6
- Critical pHs
 - Pea: 5.5
 - Lentil: 5.6
 - Chickpea: ?? (likely in the same range as peas/lentils)
 - Wheat: 5.1
- Issues: nutrient availability, toxicity, disease interactions, herbicide persistence

Long term liming studies

- **Milton-Freewater**
 - **Initiated in 2005**
 - **Lime rates of 0, 2000, 4000, 10000 lb/acre**
 - **Sulfur rate of 2000 lb/ac**
 - **Wheat-pea rotation**
 - **Established on pea side in spring 2005 (site A); wheat side in fall 2005 (Site B)**
 - **2005 pea crop yield; 2006 pea and wheat crop yields**
- **Dayton**
 - **Initiated in spring 2006 on established winter wheat**

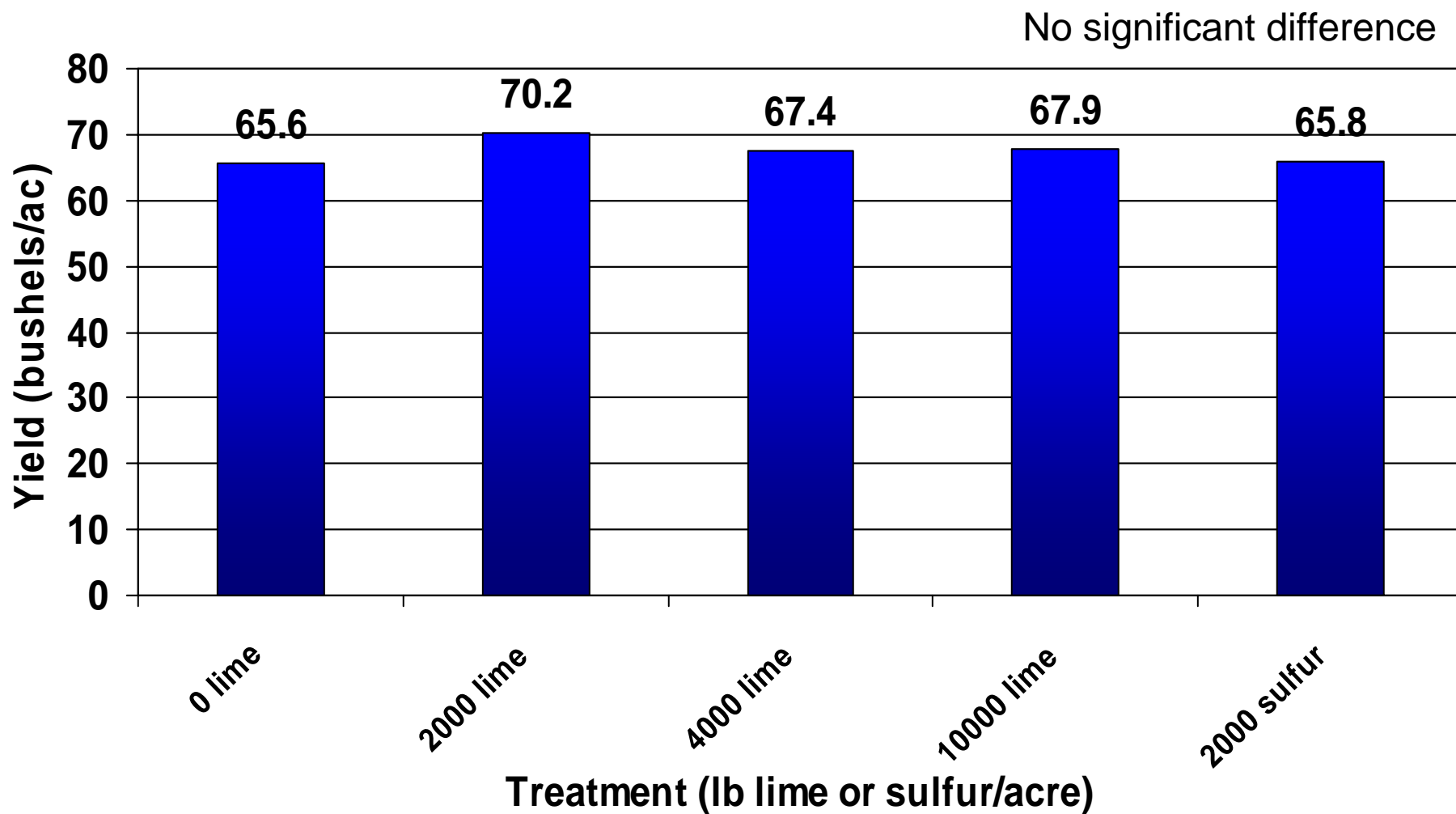
Initial soil pH, 0 to 6-inch depth



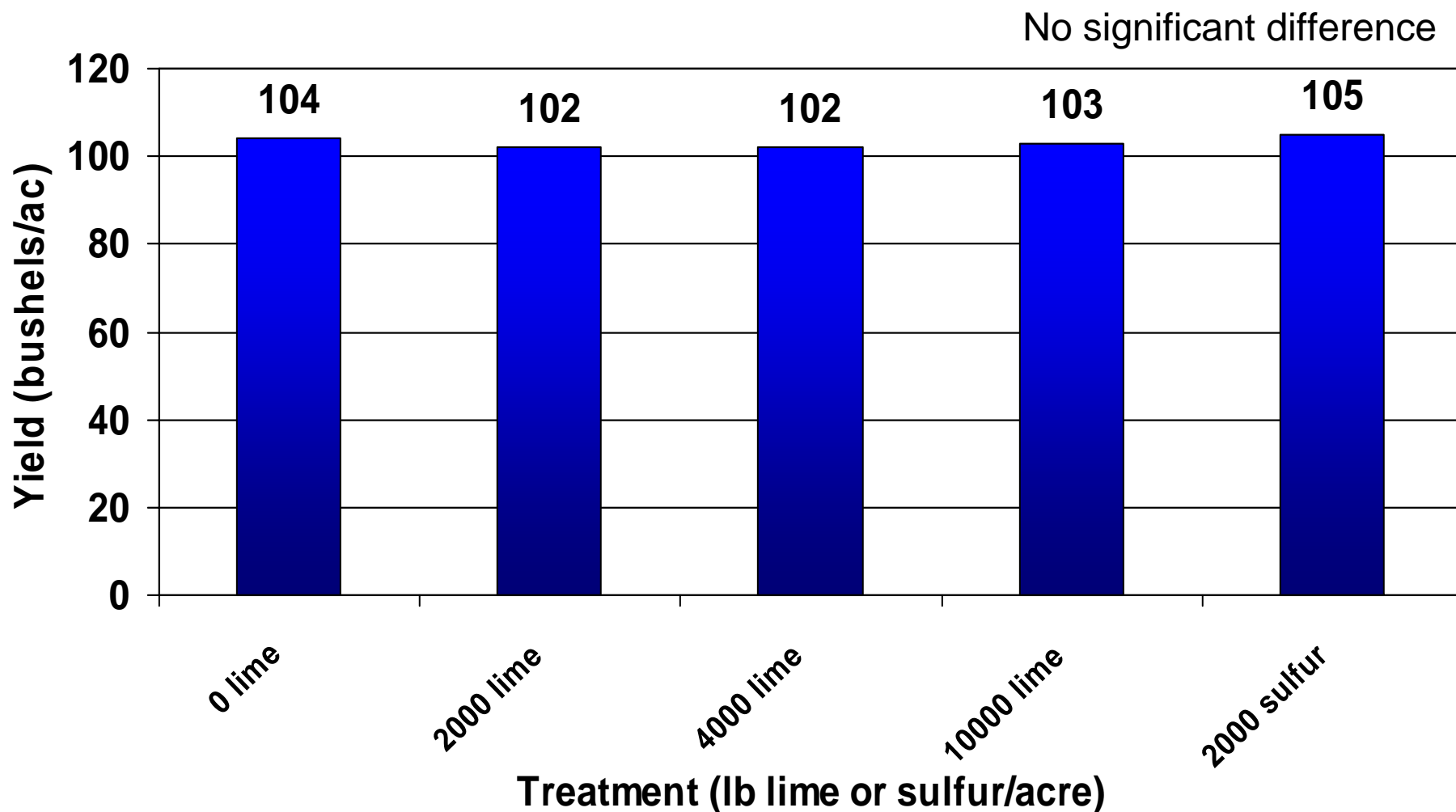


Soil pH distribution with depth in a long term (20+ year) direct seeded field near Dayton, WA

2006 winter wheat yields - MF



2006 winter wheat yields - Dayton



Hard Wheat Nitrogen Fertility

Research funded by the Washington Wheat Commission

Information

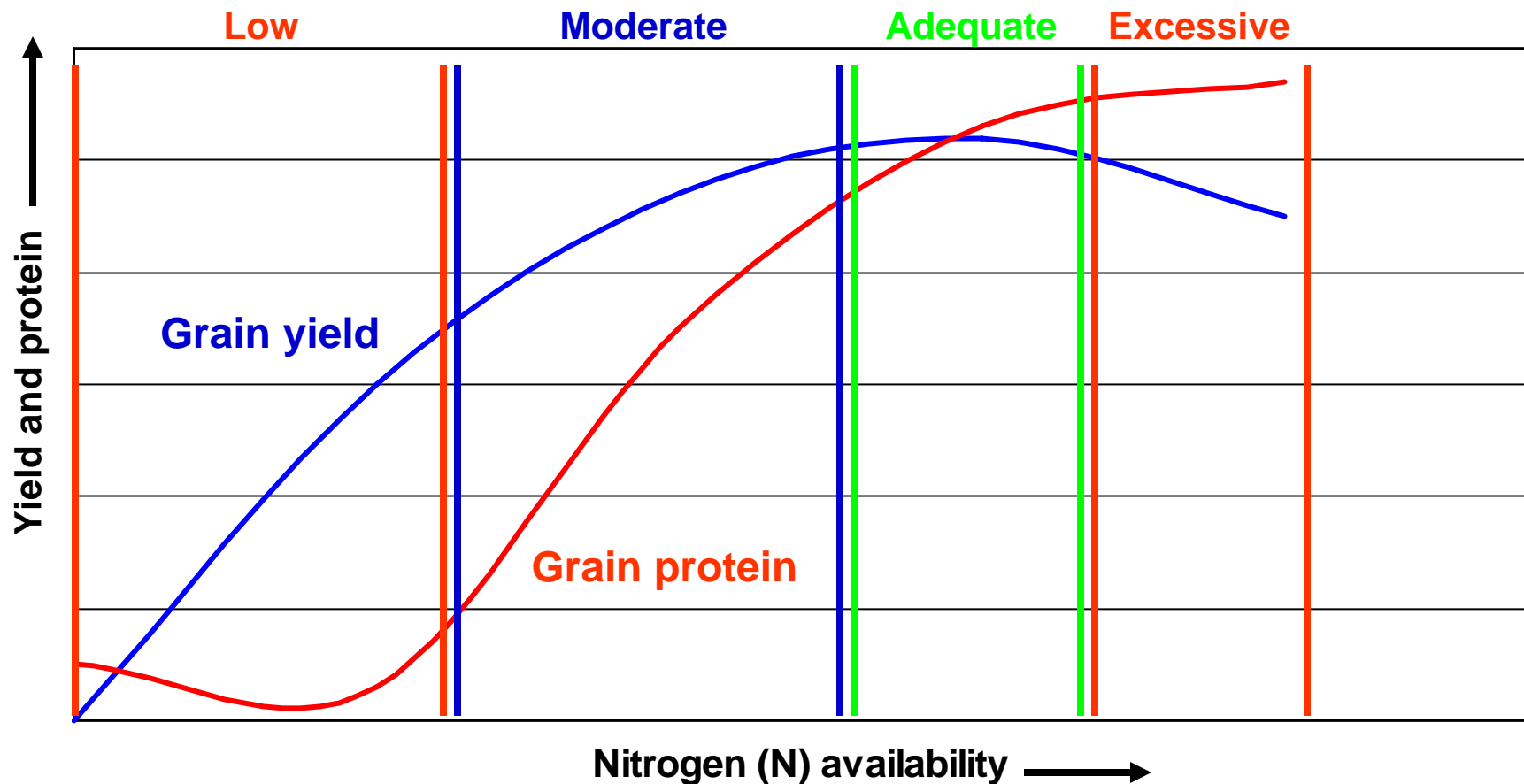
- Protein management (on the web)
 - *Nitrogen management for hard wheat protein enhancement – PNW 578*
- Fertilizer guides (on the web)
 - *Dryland winter wheat – EB 1987 from WA State University*
 - Other guides from Oregon and Idaho
- WSU Variety testing program (variety.wsu.edu)
- Fertilizer “briefs” from the Washington Wheat Commission

Data from WSU Variety Testing Program

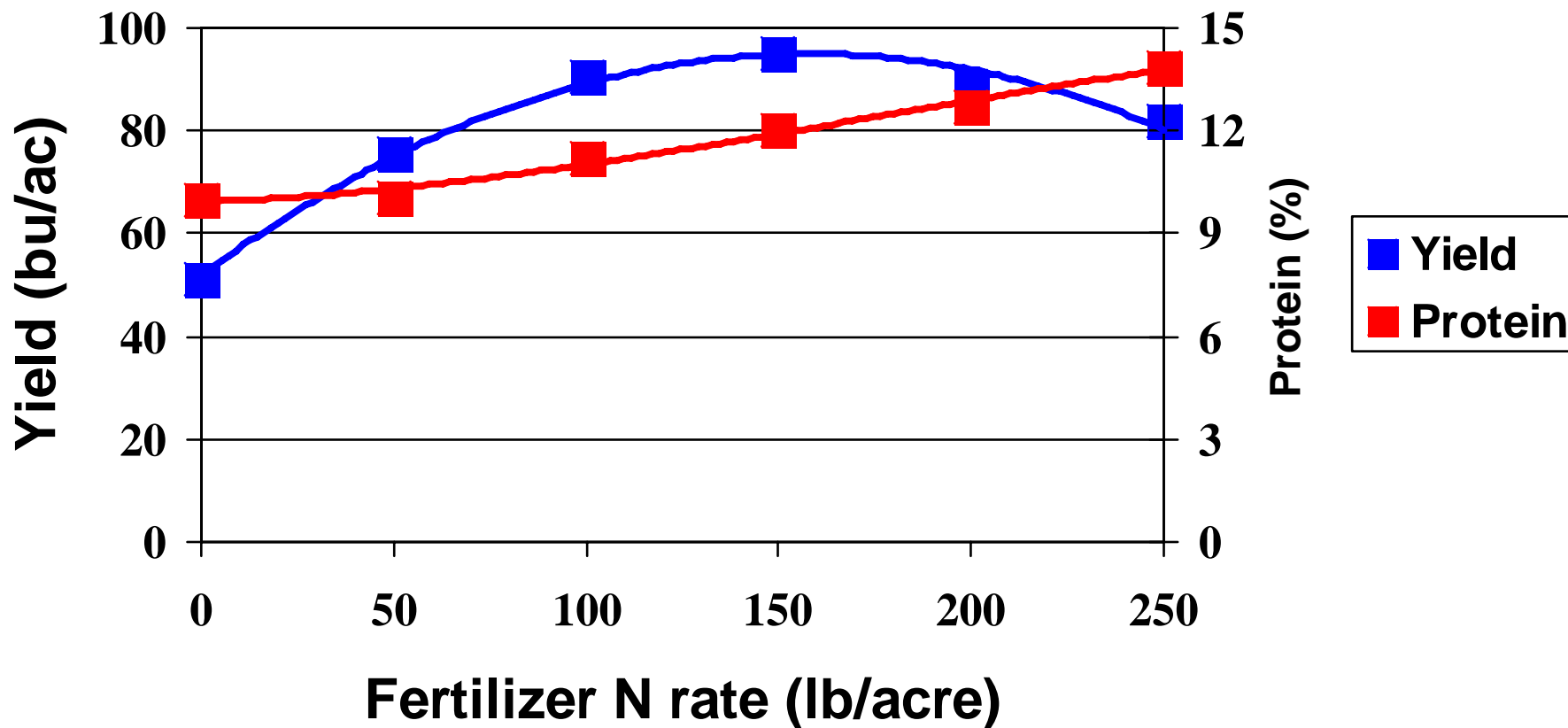
Average performance of HRSW (2002-05)

Rainfall zone	Yield	Protein	Applied N	Soil+fert N
	bu/ac	%	lb/acre	lb/acre
Below 16"	37	15.4	92	218
16 to 20"	55	14.5	121	218
Above 20"	76	13.5	146	281

Wheat 101: Yield and protein responses to nitrogen



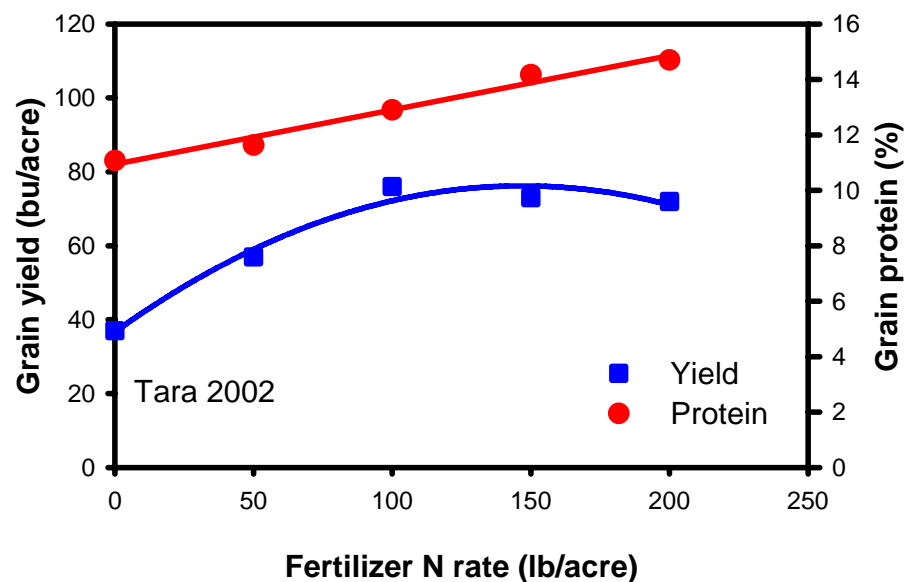
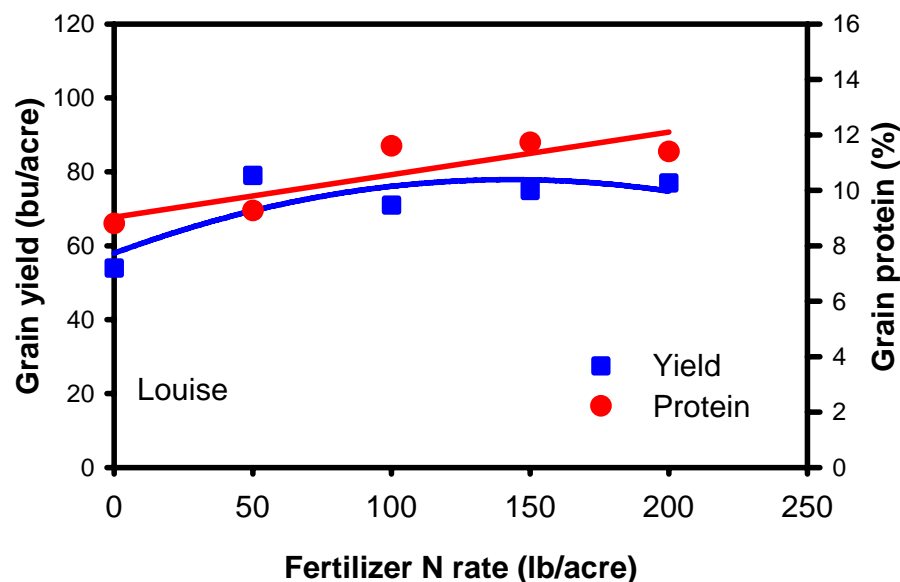
Hard red winter wheat – Pullman



Variety: Falcon

+132 lb N/ac soil contribution

2006 Spring Wheat Data



Site near Colfax, WA; 50 lb/acre 16-20-0 starter placed with the seed; 105 lb N/ac soil contributions

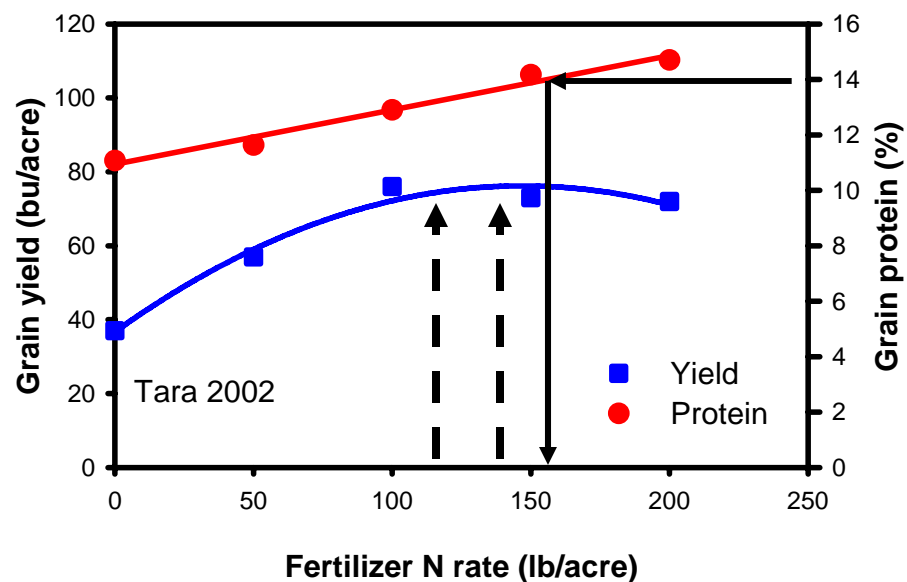
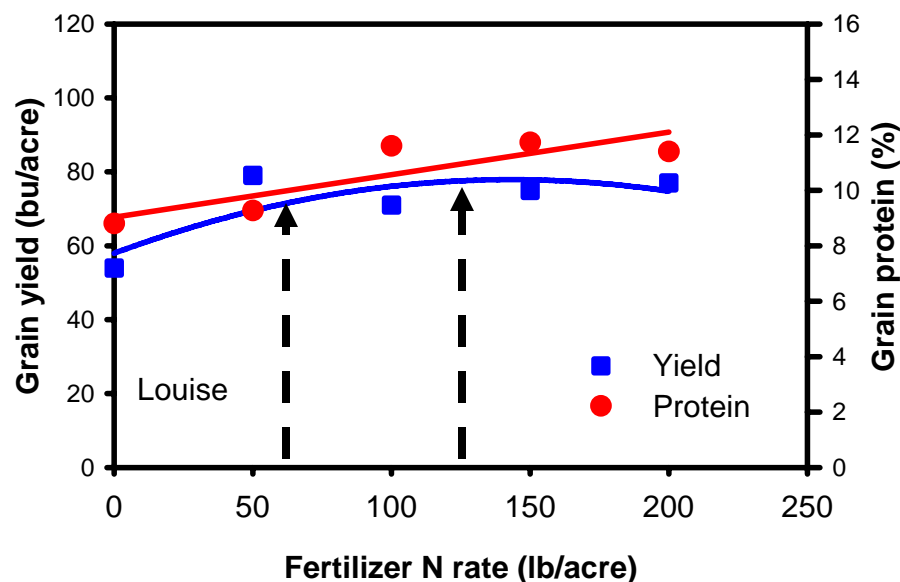
Louise Soft White Near Colfax

	Wheat price (\$/bushel)							
	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75
\$/lb N	Optimum N rate (lb/acre)							
0.20	109	110	114	117	117	120	120	122
0.25	101	102	106	110	111	114	114	117
0.30	92	94	99	103	104	108	108	111
0.35	84	87	92	96	98	102	103	106
0.40	75	79	84	89	91	95	97	100
0.45	66	71	77	82	85	89	91	95
0.50	58	63	70	76	79	83	85	89

Tara 2002 Hard Red Near Colfax

	Wheat price (\$/bushel)							
	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00
\$/lb N	Optimum N rate (lb/acre)							
0.20	134	135	135	137	137	137	138	138
0.25	130	132	132	134	134	134	135	135
0.30	127	129	130	131	131	132	133	133
0.35	124	126	127	128	129	129	131	131
0.40	121	123	124	126	126	127	128	128
0.45	118	120	121	123	124	124	126	126
0.50	114	117	118	120	121	122	123	124

2006 Spring Wheat Data



Site near Colfax, WA; 50 lb/acre 16-20-0 starter placed with the seed; 105 lb N/ac soil contributions

Unit N Supply Analysis

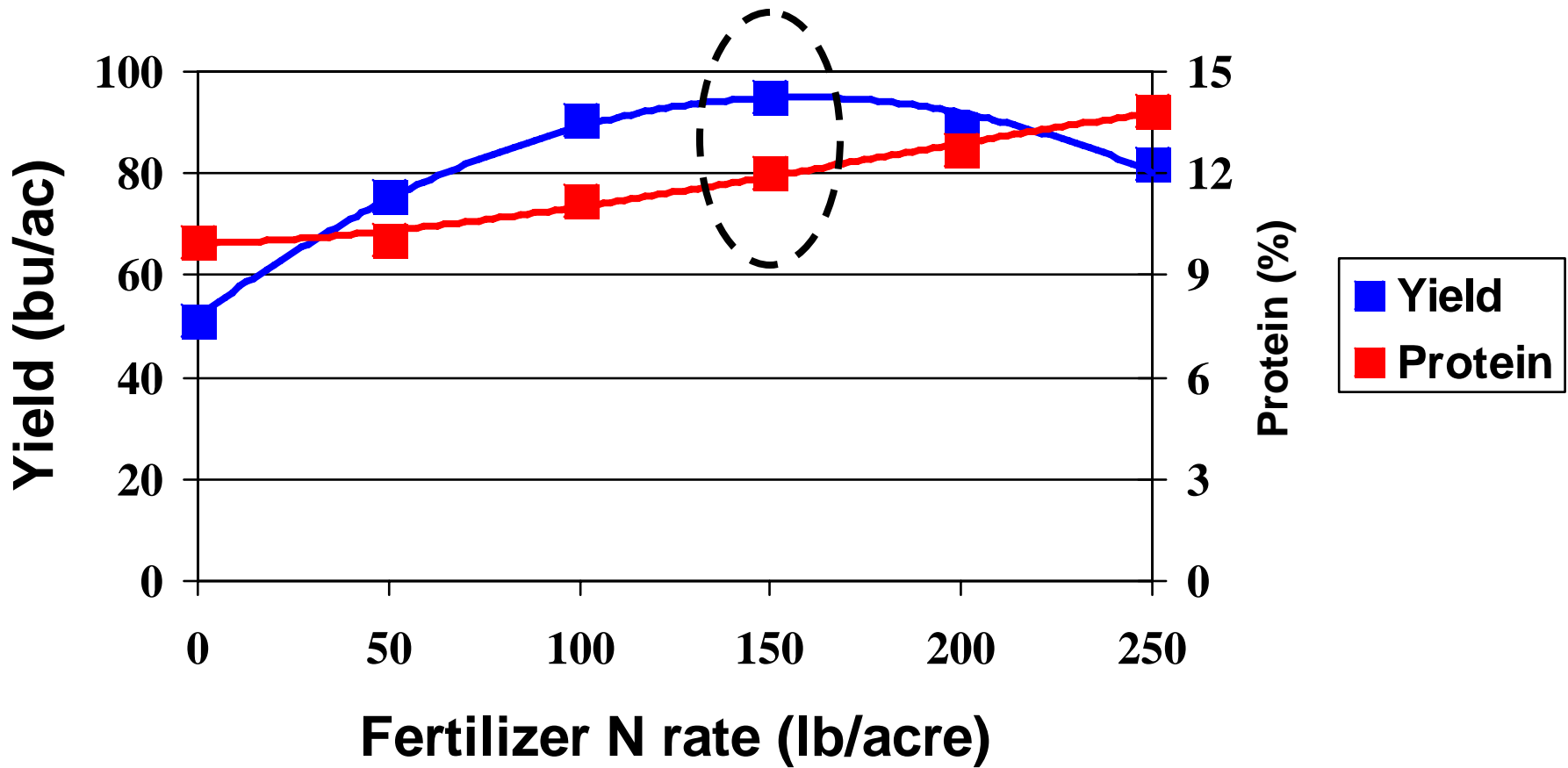
	lb fertilizer N/bushel	lb soil+fertilizer N/bushel	Standard lb N supply/bushel
Tara 2002			
114 lb fert N/ac	1.53	2.94	3.6
138 lb fert N/ac	1.80	3.17	
155 lb fert N/ac*	2.01	3.68	
Louise			
58 lb fert N/ac	0.82	2.30	2.7
122 lb fert N/ac	1.58	2.95	

*required to obtain 14% protein

The amount of available N is critical

- With soft white wheat the penalty for under-fertilization is lower yield
- With hard wheat the penalty is lower yield and, in some years, significant discounts for low grain protein
- ***Protein targets for hard wheats occur at or slightly above the point of maximum yield***
- ***For this reason, the ability to accurately predict yield at the time of fertilizer application seriously limits your ability to achieve protein goals***

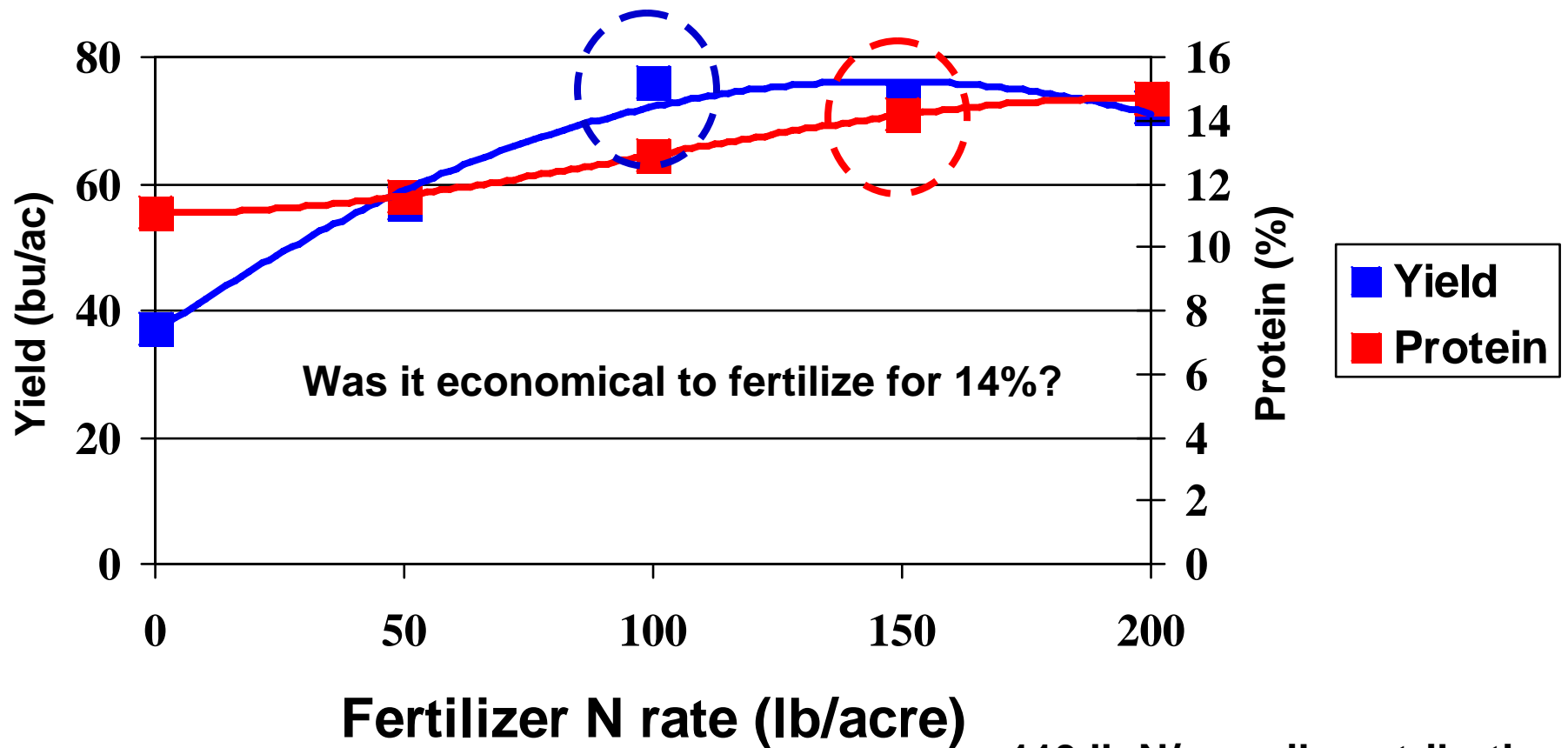
Hard red winter wheat – Pullman



Variety: Falcon

+132 lb N/ac soil contribution

Hard red spring wheat – Colfax



Variety: Tara 2002

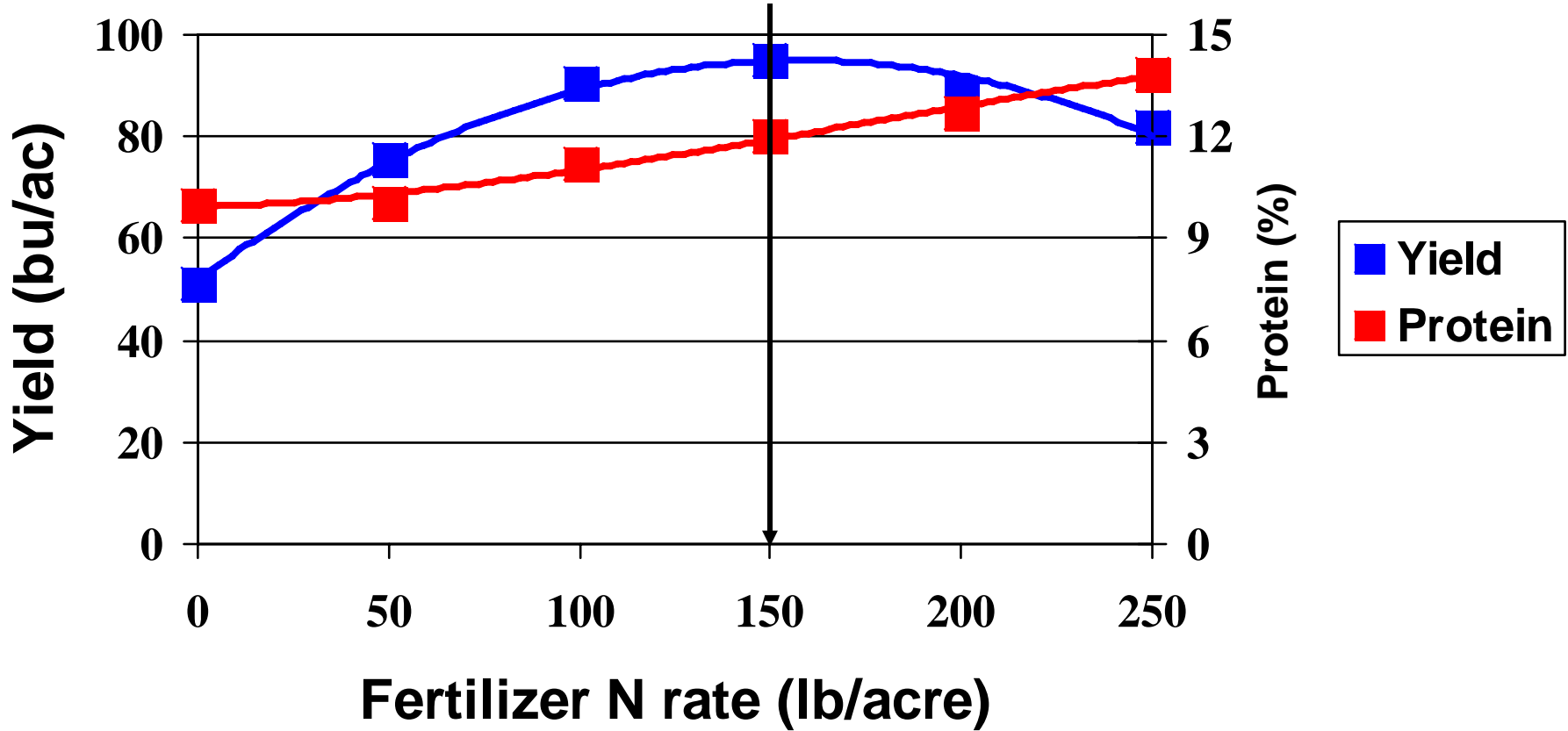
+113 lb N/ac soil contribution

It's not the N applied but the total N supply

- The total amount of N available to wheat is the most important factor in achieving yield and protein goals, not the N fertilizer rate
- Soil N contributions must be accounted for before determining how much fertilizer N is needed

Fertilizer nitrogen response Hard red winter wheat – Pullman

1.6 lb fertilizer N/bu

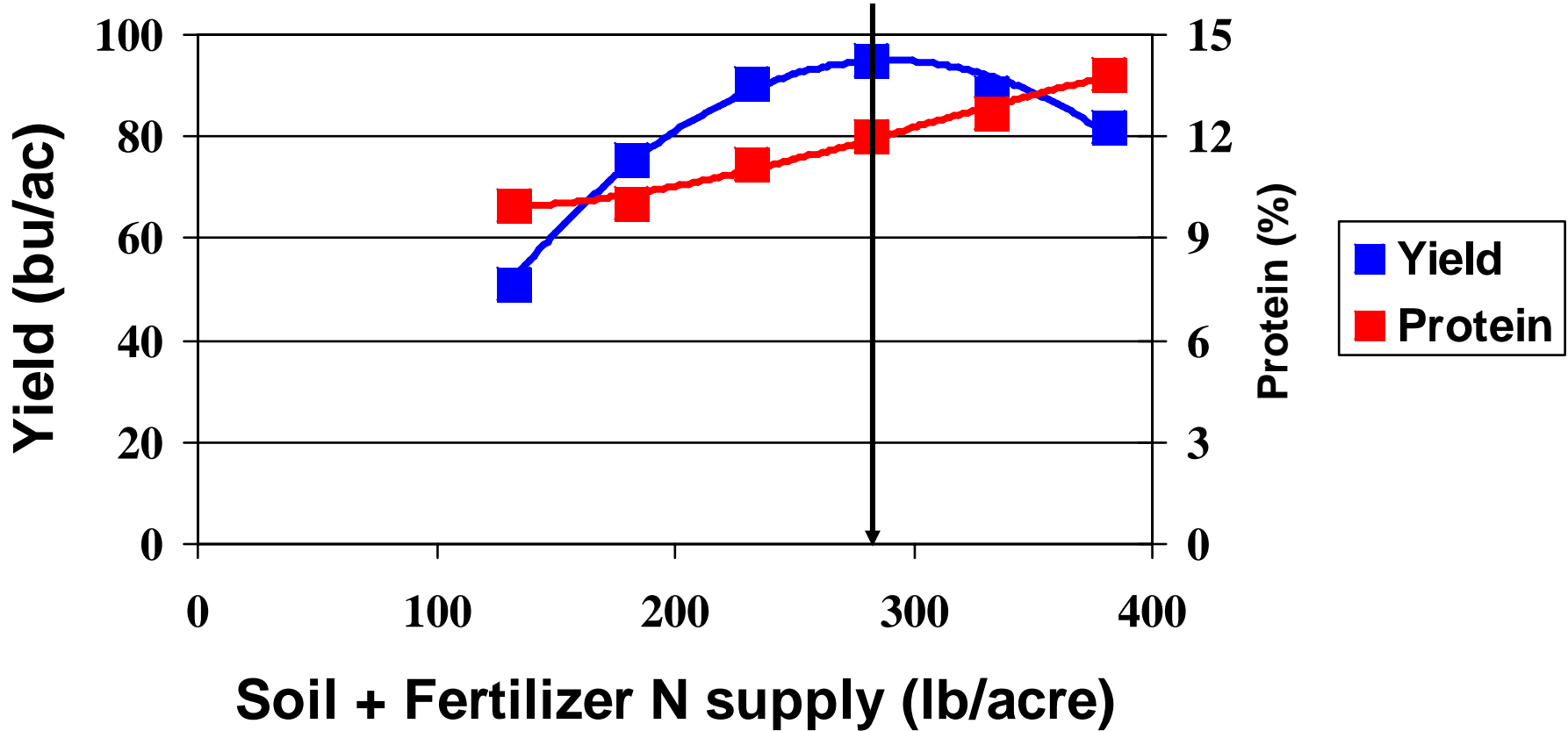


Variety: Falcon

+132 lb N/ac soil contribution

Total nitrogen supply response Hard red winter wheat – Pullman

3 lb soil+fertilizer N/bu



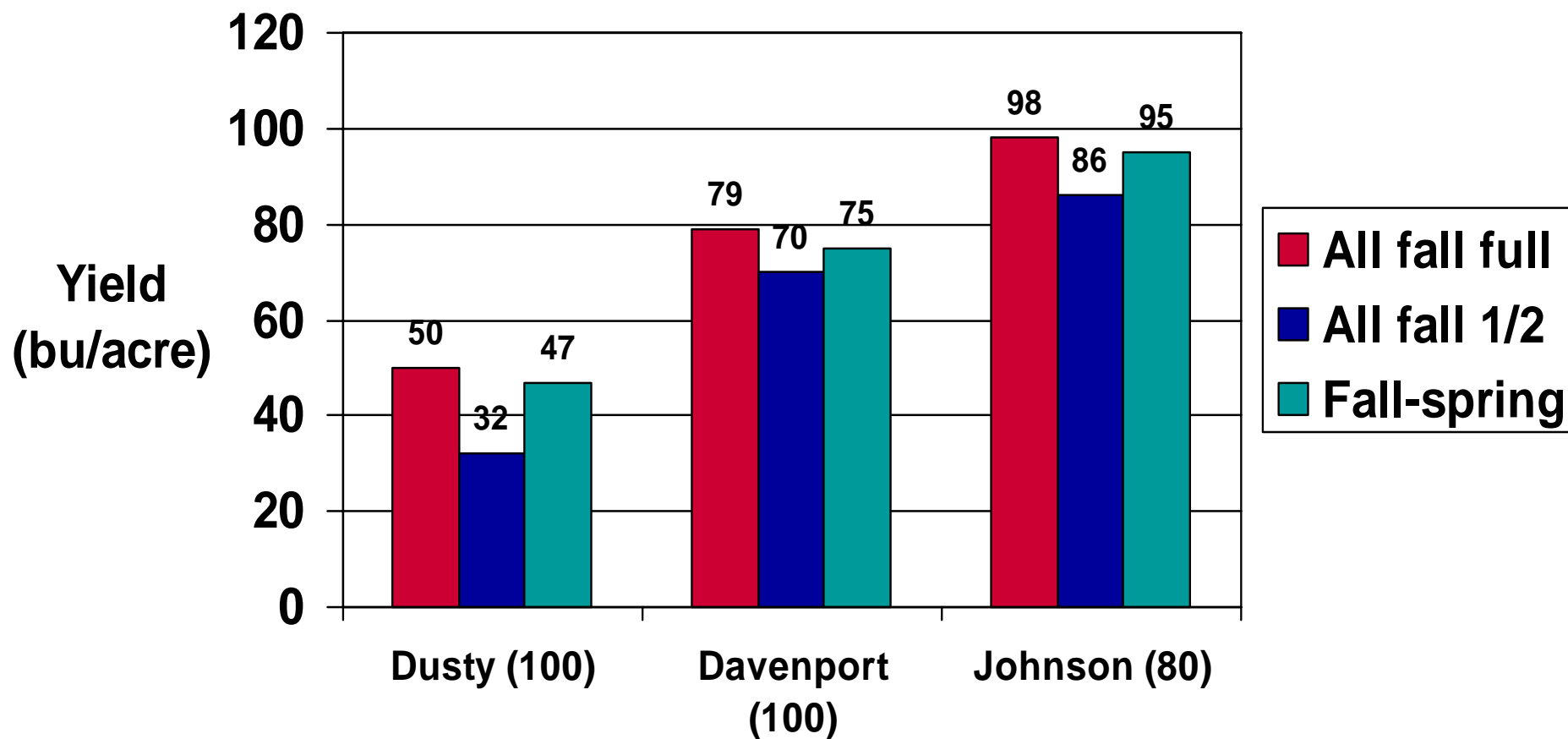
Variety: Falcon

132 lb N/ac soil contribution

Average nitrogen supply requirements

- Unit N supply requirement for different market classes
 - Soft white winter and spring: 2.7 lb N/bushel (range: 1.8 to 3.9)
 - Hard red winter: 3.0 lb N/bushel (range?)
 - Hard red spring: 3.6 lb N/bushel (~2 to >5)
 - Hard white winter/spring: 3.2 lb N/bushel (range?)

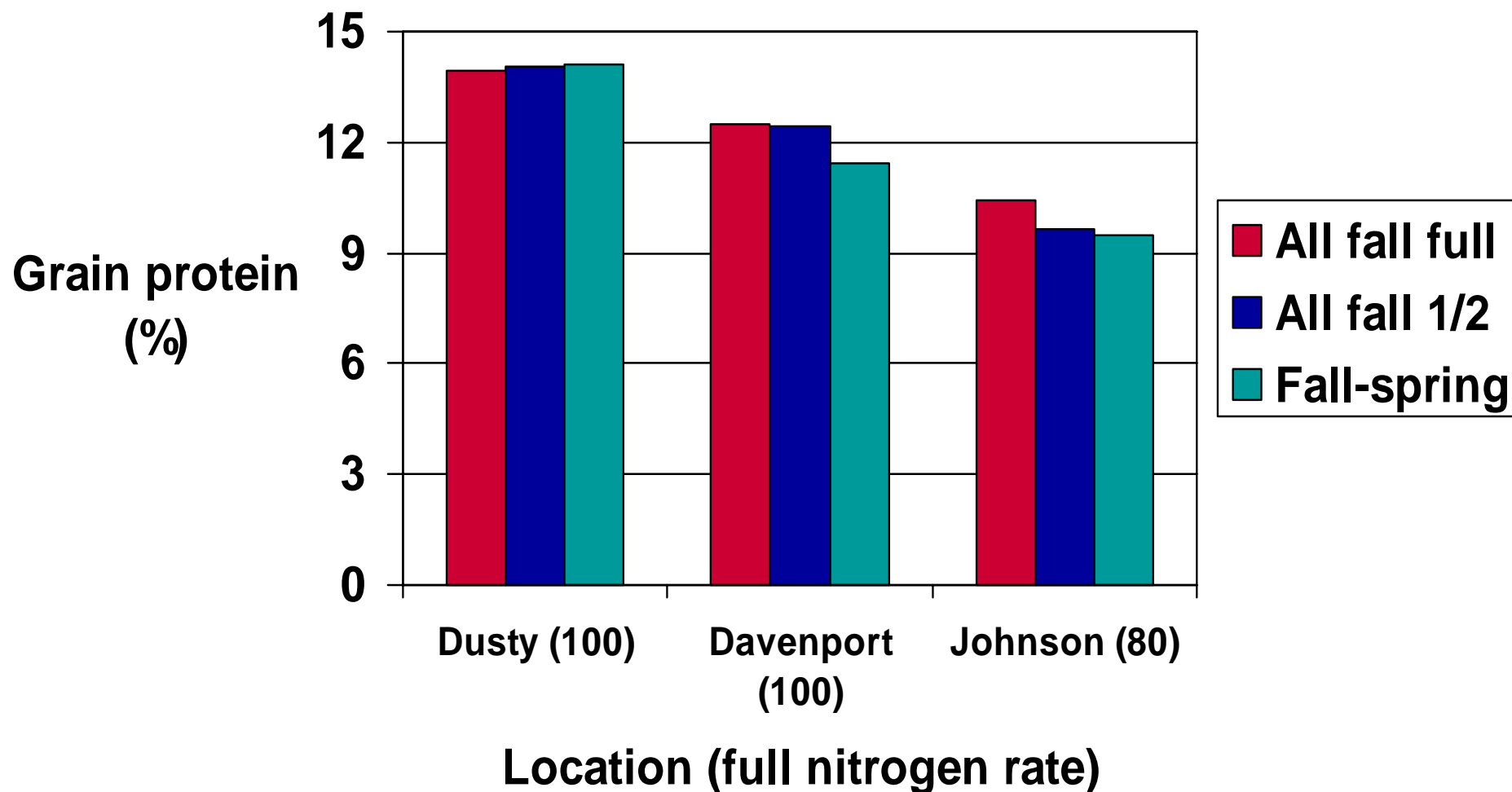
2005-06 hard red winter N timing studies



Location (full nitrogen rate)

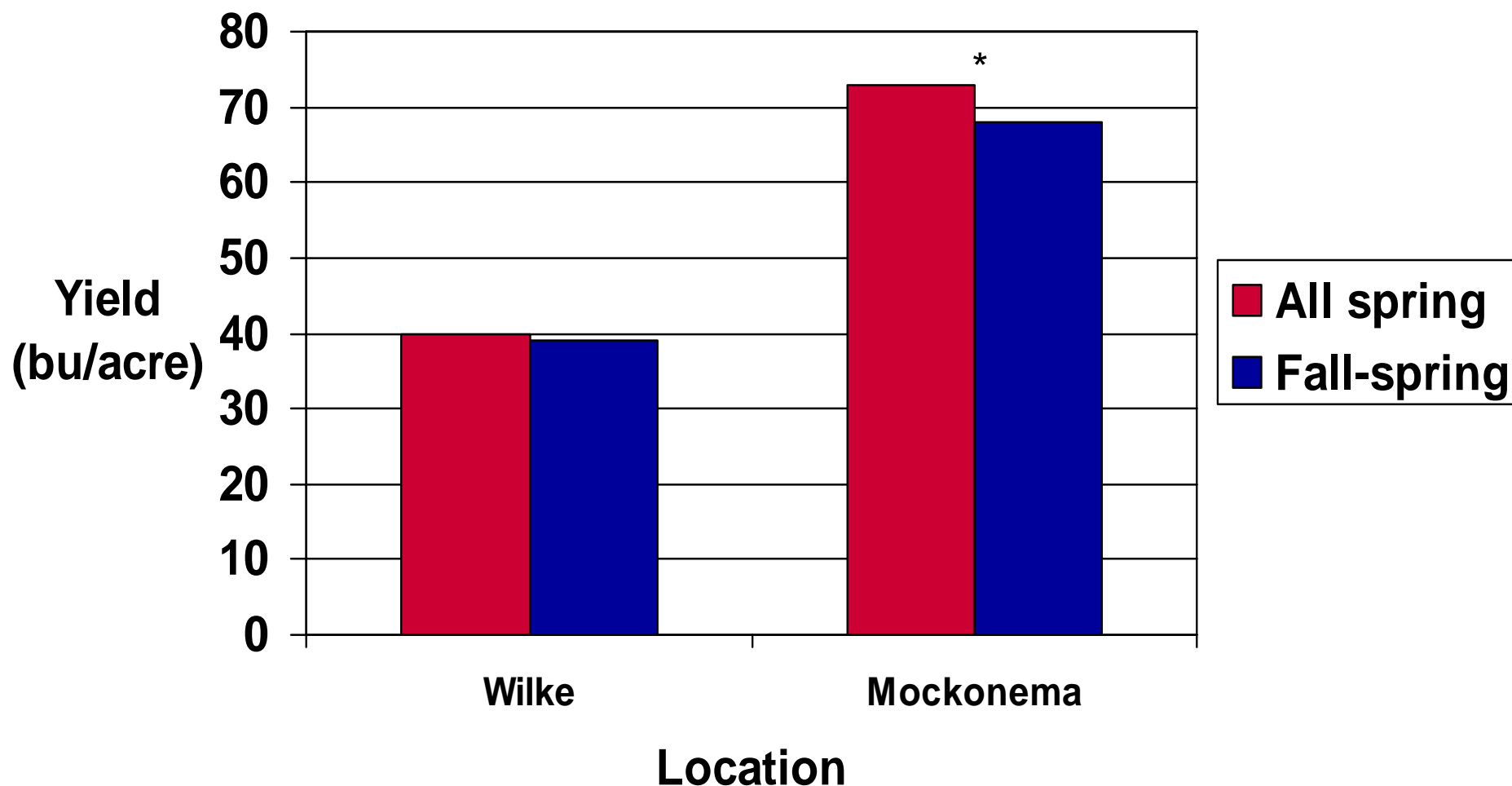
Spring-applied nitrogen in 3rd week in March, 2006

2005-06 hard red winter N timing studies



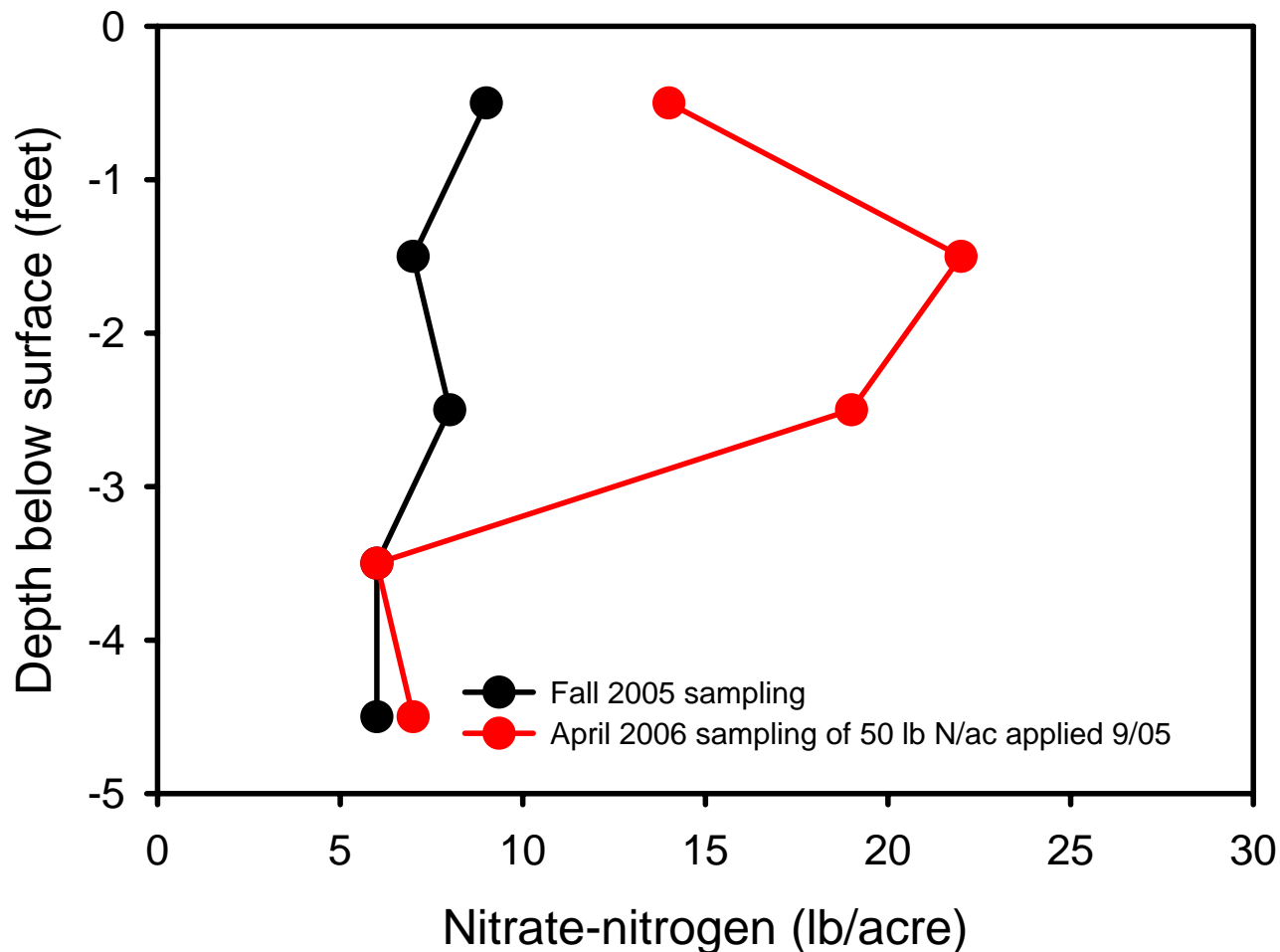
Spring-applied nitrogen in 3rd week in March, 2006

Hard red spring split vs. all spring

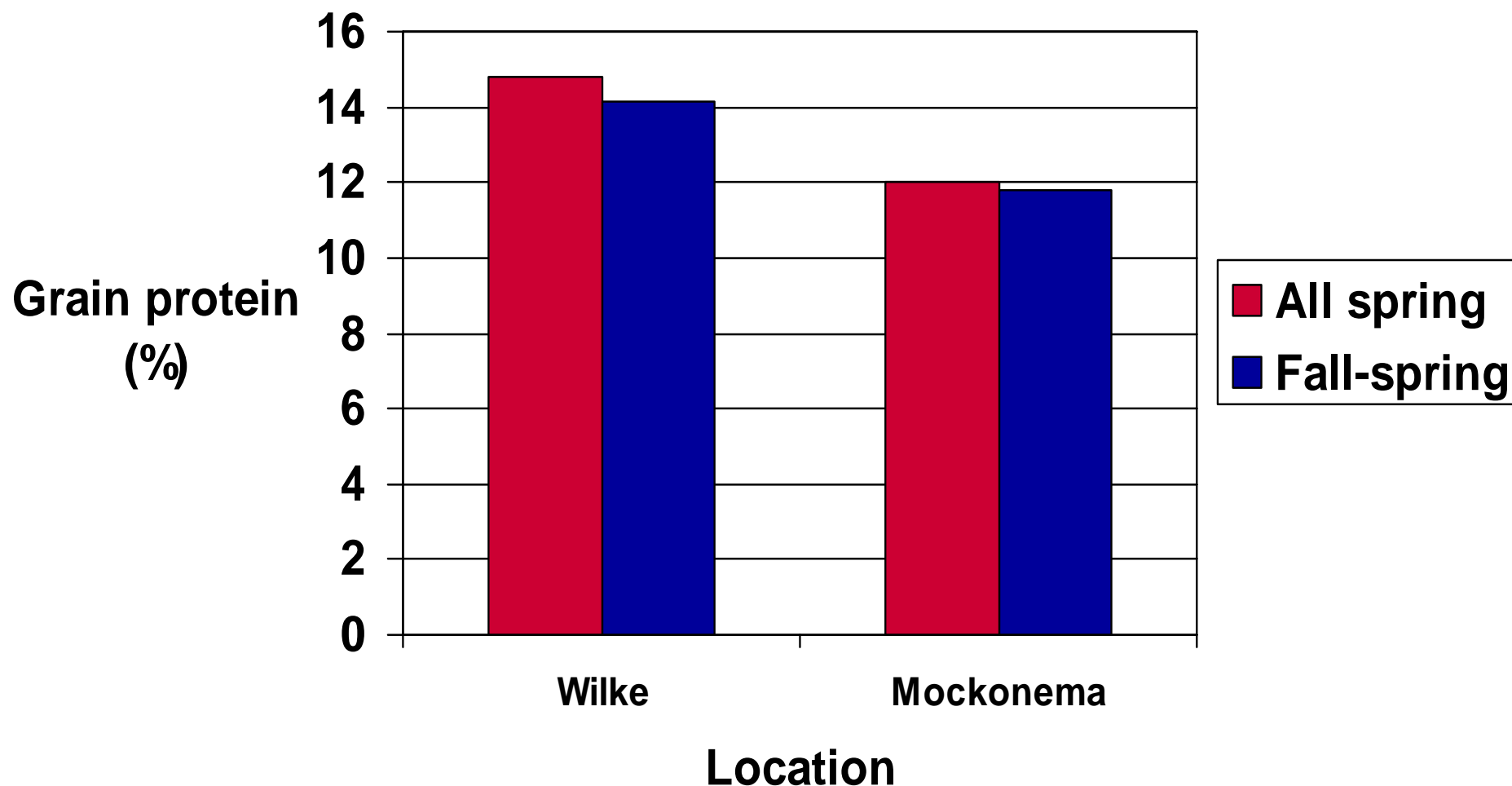


100 lb N/acre with 50-50 split (Wilke); 140 lb N/ac with 80-60 split (Mockonema)

2006 spring wheat (Davenport) - fall applied 50 lb N/ac



Hard red spring split vs. all spring

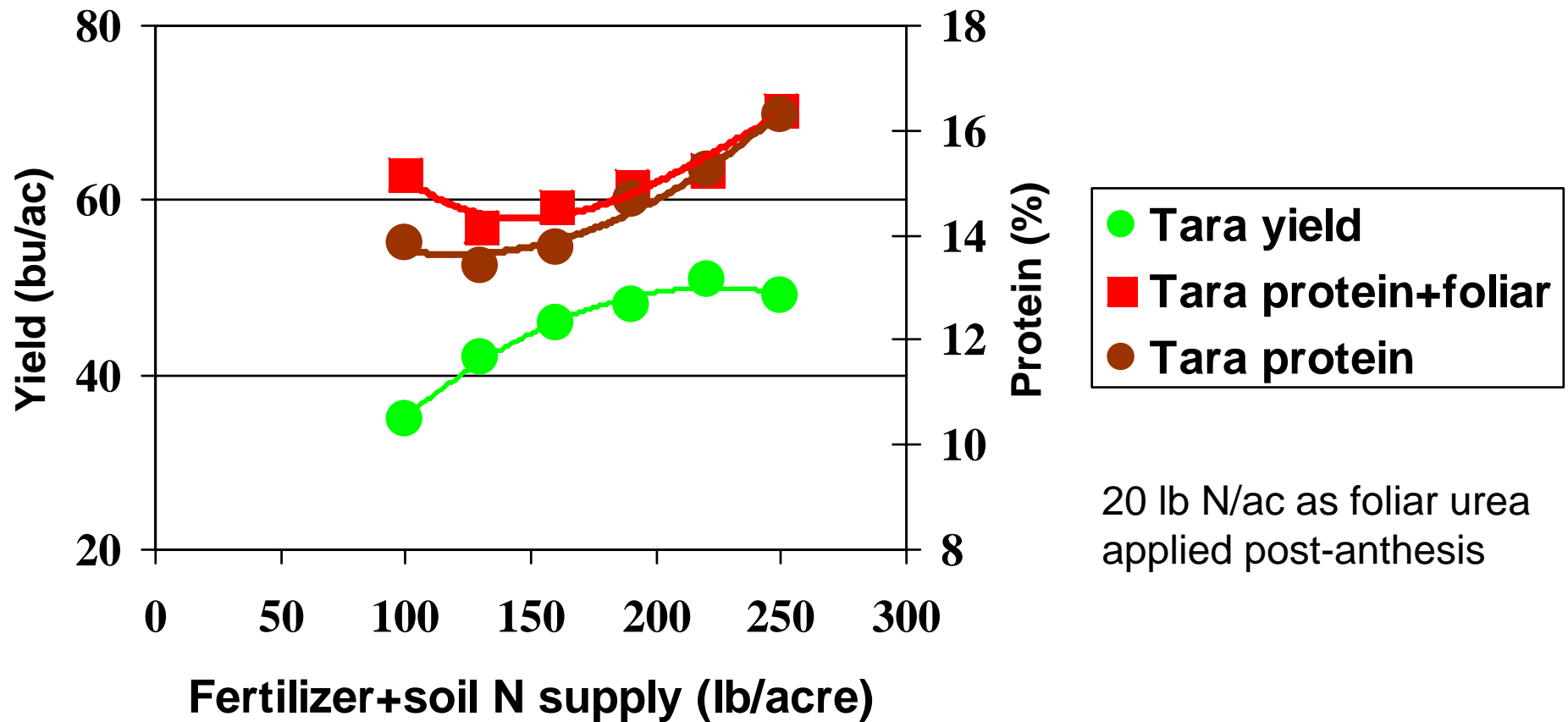


100 lb N/acre with 50-50 split (Wilke); 140 lb N/ac with 80-60 split (Mockonema)

Fall fertilizing for spring wheat

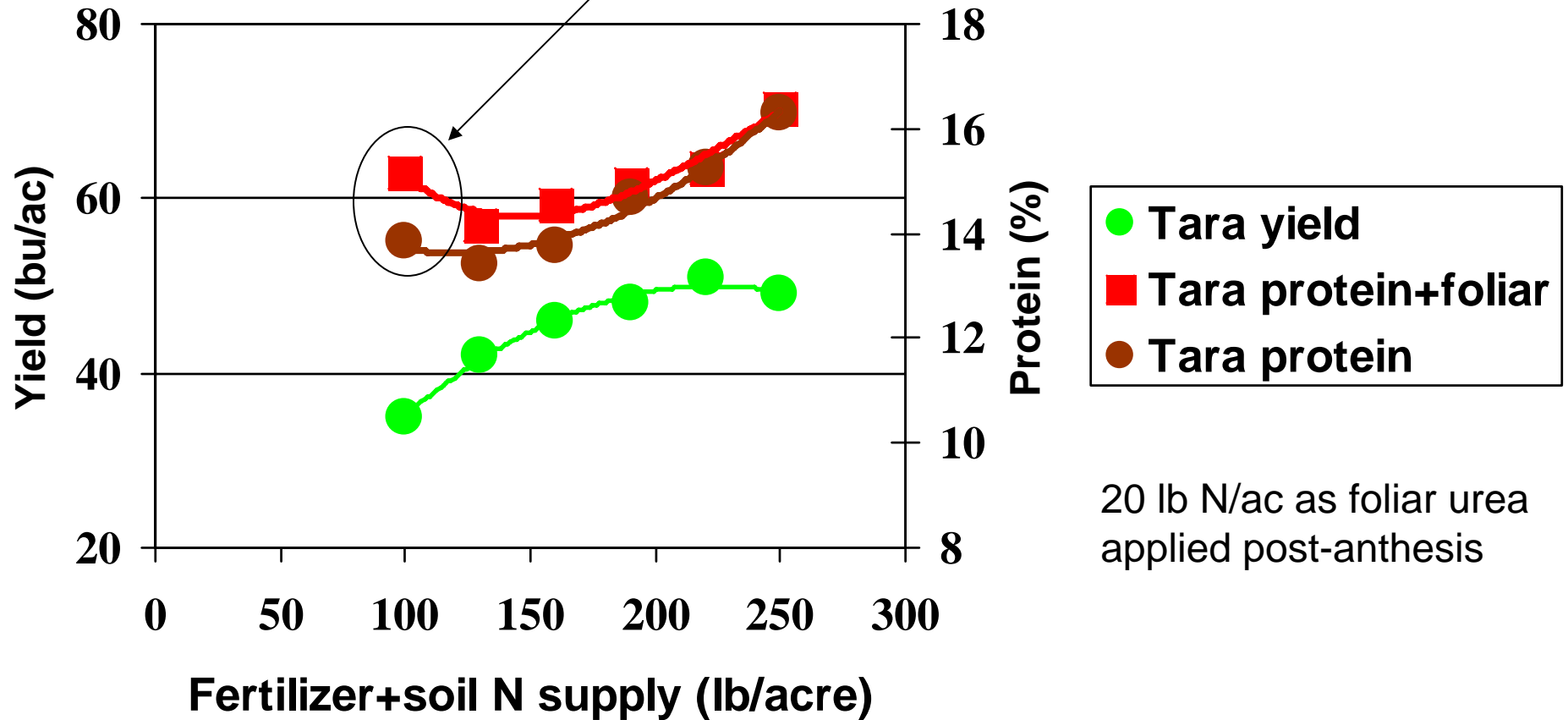
- *Highly dependent on residual soil N, its distribution in the profile, the rainfall zone and weather*
 - If there is already substantial residual N in the profile then there is no need to fall apply N for hard spring wheat
 - Fall applied N may not be necessary in years when late spring moisture leads to active rooting and good utilization of spring-applied N by spring wheat
 - Fall timing important
 - Early fall (low rainfall) → late fall (high rainfall)

Foliar N for increasing grain protein? 2005 data for Tara 2002 at St. John



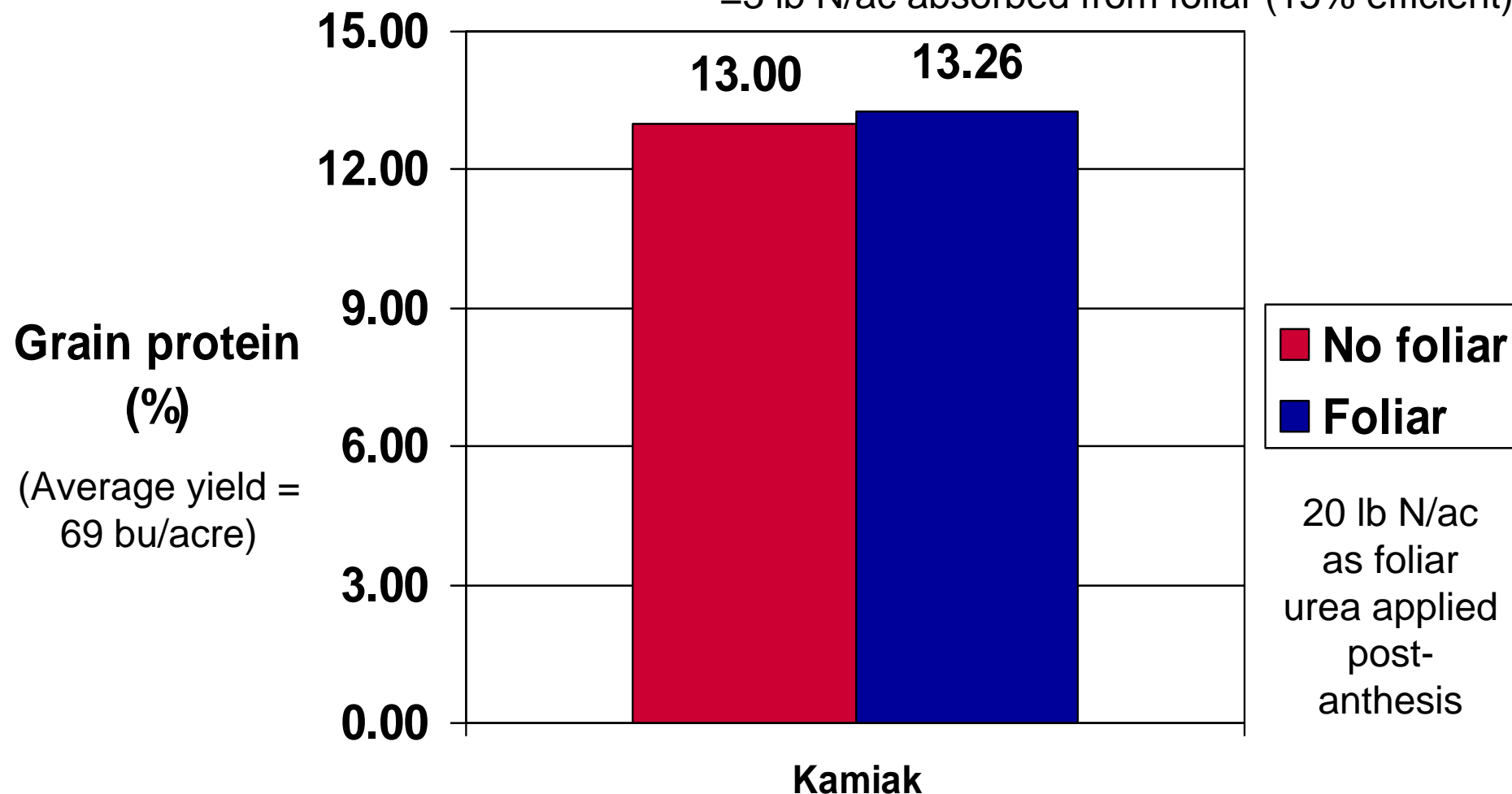
+1.31% protein = 4.4 lb N/ac from foliar

Foliar N for increasing grain protein? 2005 data for Tara 2002 at St. John



2006 hard red spring (Hank) response to foliar N

=3 lb N/ac absorbed from foliar (15% efficient)



Considerations with hard wheat

- **Higher risk crop in high rainfall zones**
 - **Greater \$ investment in nitrogen**
 - **Possibly lower yields than soft white wheat**
 - **Protein more difficult to achieve**
 - **Premiums and discounts are an issue**
 - **Fertilize at planting or in crop year but you don't know what premiums and discounts are until harvest**
- **Greater potential return in high rainfall zones due to higher yield**
- **Should you grow it?**

Economic considerations

- **January 22, 2007 prices**
 - **Common soft white ~\$4.50/bu**
 - **Hard red winter ~\$5.15/bu (\$0.03 per ½ down protein discount; no premium)**
- **Hard red winter wheat requires ~10% (0.3 lb/bushel) more nitrogen than soft white winter**
 - **~\$0.15/bu higher cost**
 - **But, many hard red varieties yield 5+ bushels lower than soft whites (see variety.wsu.edu)**

Economic considerations

- **January 22, 2007 prices**
 - **Common soft white ~\$4.50/bu**
 - **Hard red spring ~\$5.30/bu (\$0.01 per ¼ down protein discount; no premium)**
- **Hard red spring requires ~30% more nitrogen than soft white spring**
 - **~\$0.45/bu higher cost**
 - **But, many soft white springs yield the same as hard red springs (see variety.wsu.edu)**

Soft white winter wheat unit N supply

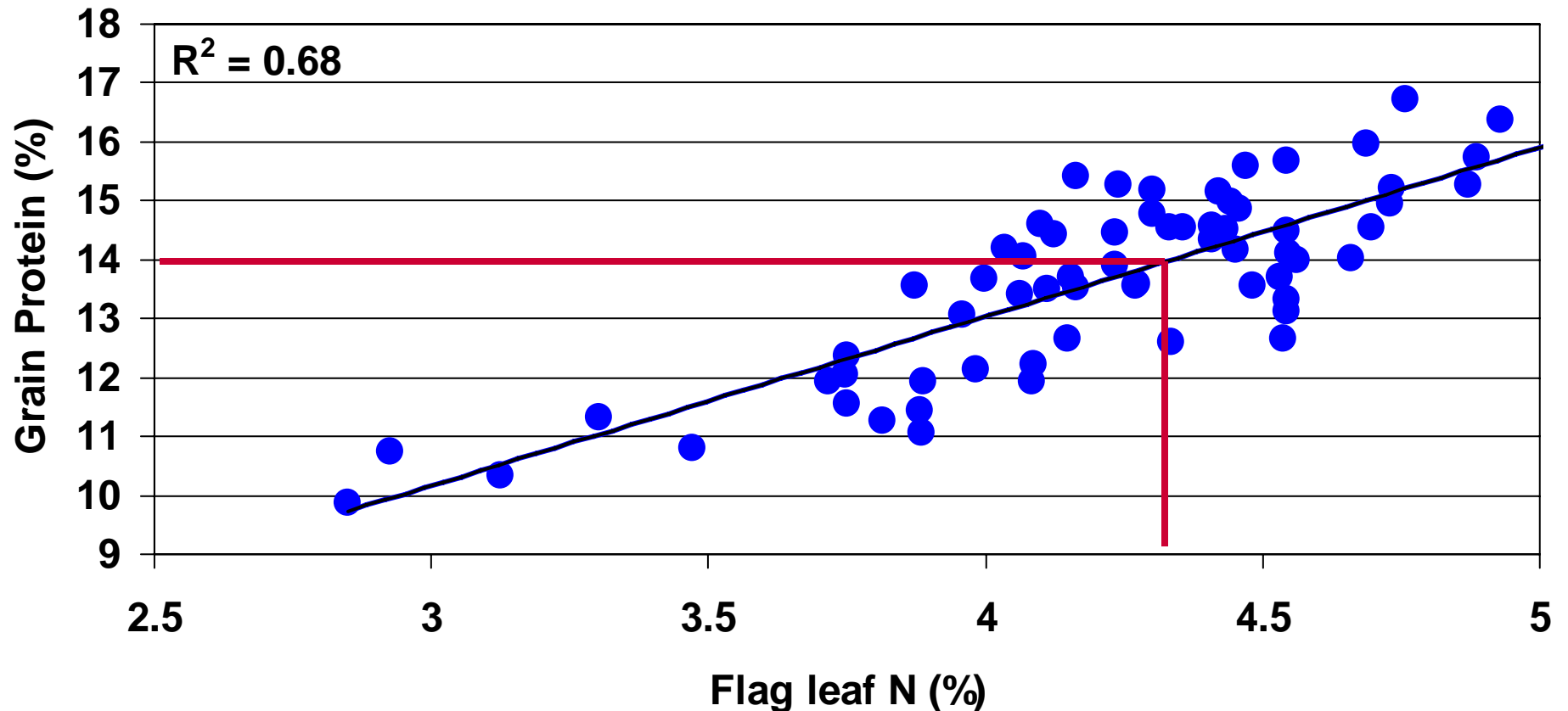
Data from T. Fiez (1994)

Site-year	Footslope	S. Backslope	Shoulder	N. Backslope	Mean
Farmington-1990	2.5 lb N/bu	1.8 lb N/bu	2.2 lb N/bu	2.1 lb N/bu	2.1 lb N/bu
Pullman-1990	3.3 lb N/bu	2.3 lb N/bu	2.7 lb N/bu	2.3 lb N/bu	2.6 lb N/bu
Farmington-1991	3.6 lb N/bu	3.3 lb N/bu	3.0 lb N/bu	2.9 lb N/bu	3.2 lb N/bu
Pullman-1991	3.1 lb N/bu	2.3 lb N/bu	3.9 lb N/bu	3.4 lb N/bu	3.2 lb N/bu
Mean	3.1 lb N/bu	2.4 lb N/bu	3.0 lb N/bu	2.7 lb N/bu	2.8 lb N/bu

Tools: sampling

- **Soil**
 - **Fall**
 - Moisture
 - Preplant for winter wheat
 - Pre-fall fertilization for spring wheat
 - **Spring**
 - Moisture
 - Over-winter N movement in winter wheat
 - Preplant for spring wheat
- **Tissue or leaf sampling**

Flag leaf N and grain protein relationship spring wheat at head emergence



Flag leaf N and grain protein relationship spring wheat at flowering

