Cost:Return of Specific Management Decisions

Nitrogen Fertilization of SJV Grain Wheat

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February 24, 2017 – SJV Nitrogen Management: How agriculture is meeting the challenge
Hanford, CA

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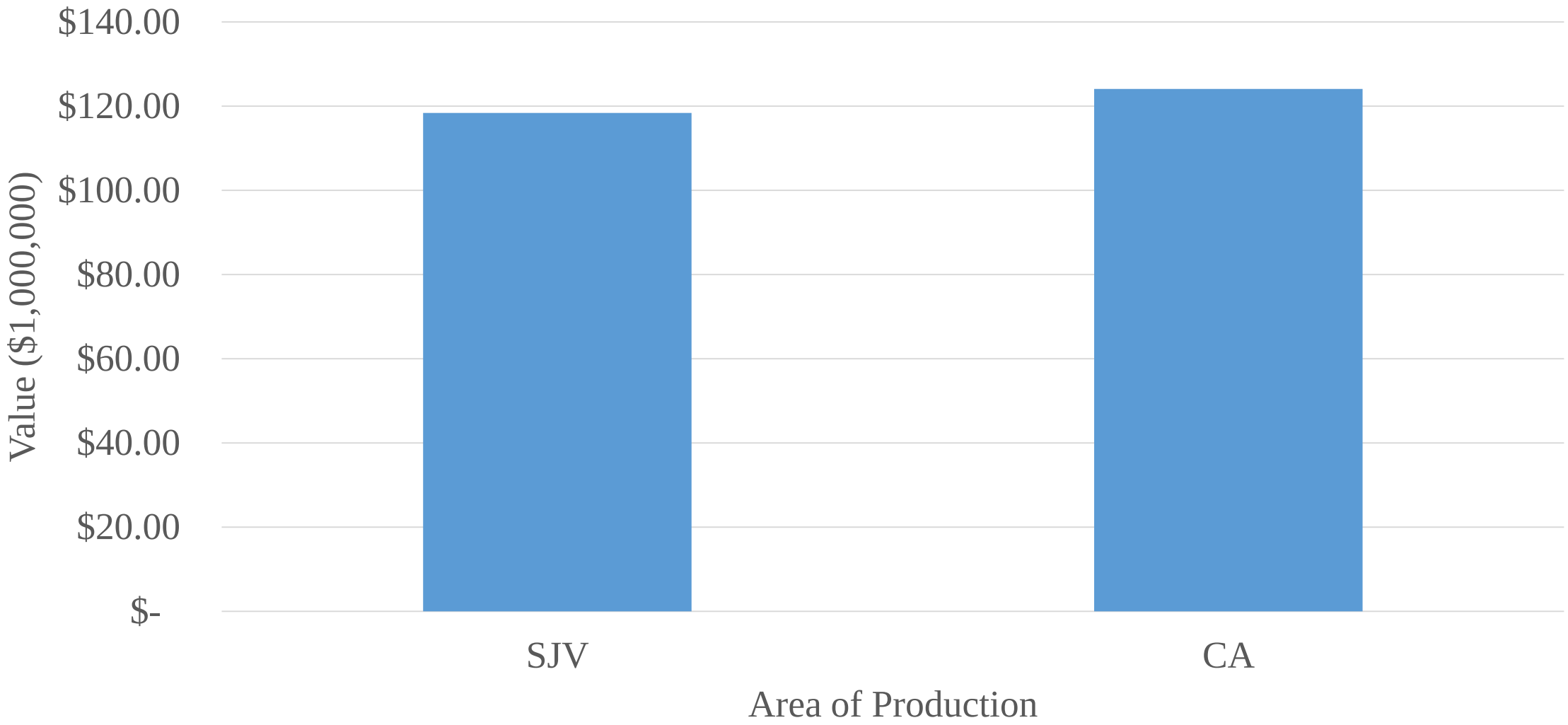
What does a farmer do?

- Manage natural resources
- Manage biodiversity
- Produce consumable goods
- Maintain land tenure
- Industrialize and innovate
- Take financial risks
- Negotiate in markets
- Navigate regulation

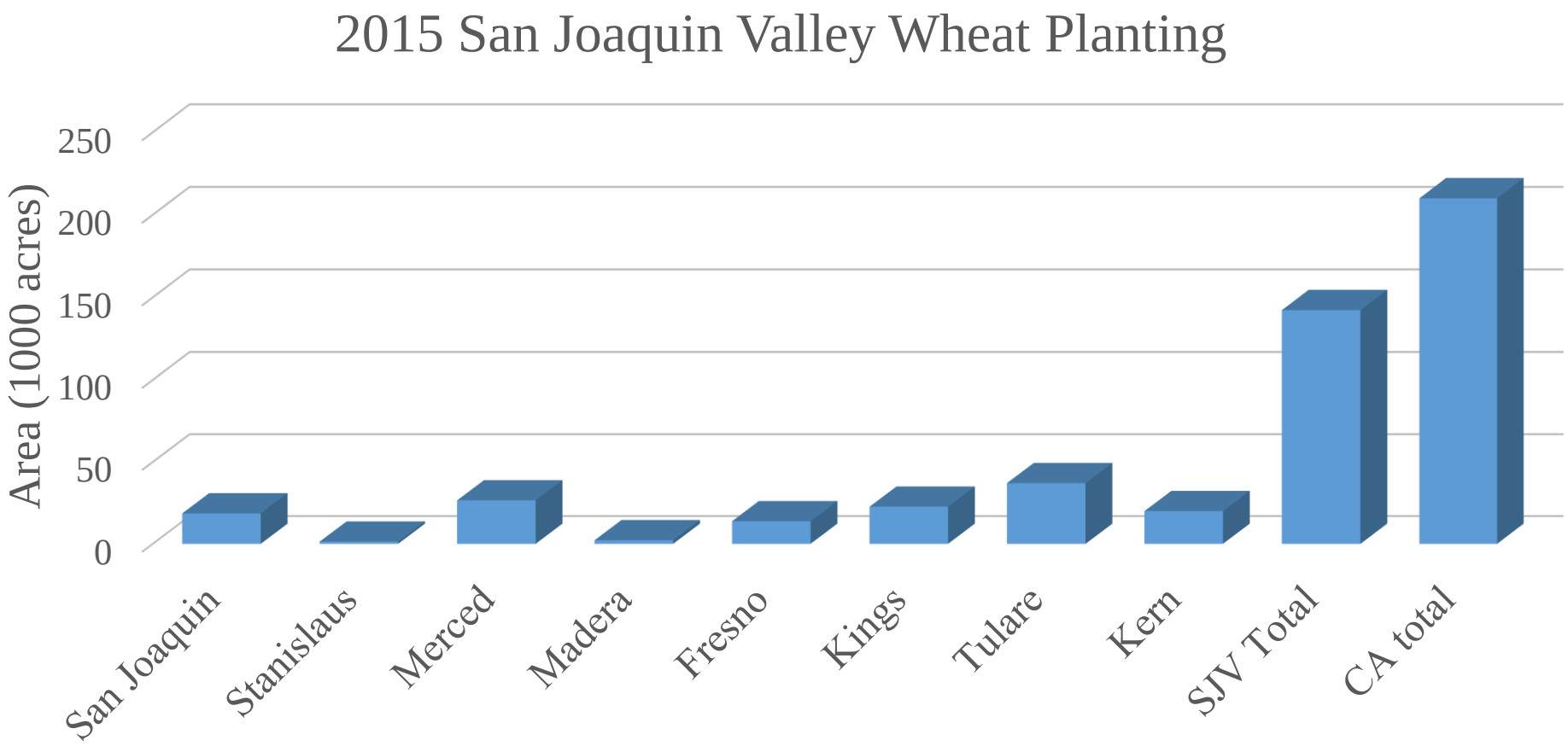
What doesn’t a farmer do?

“I don’t farm for practice.” Tulare County wheat farmer

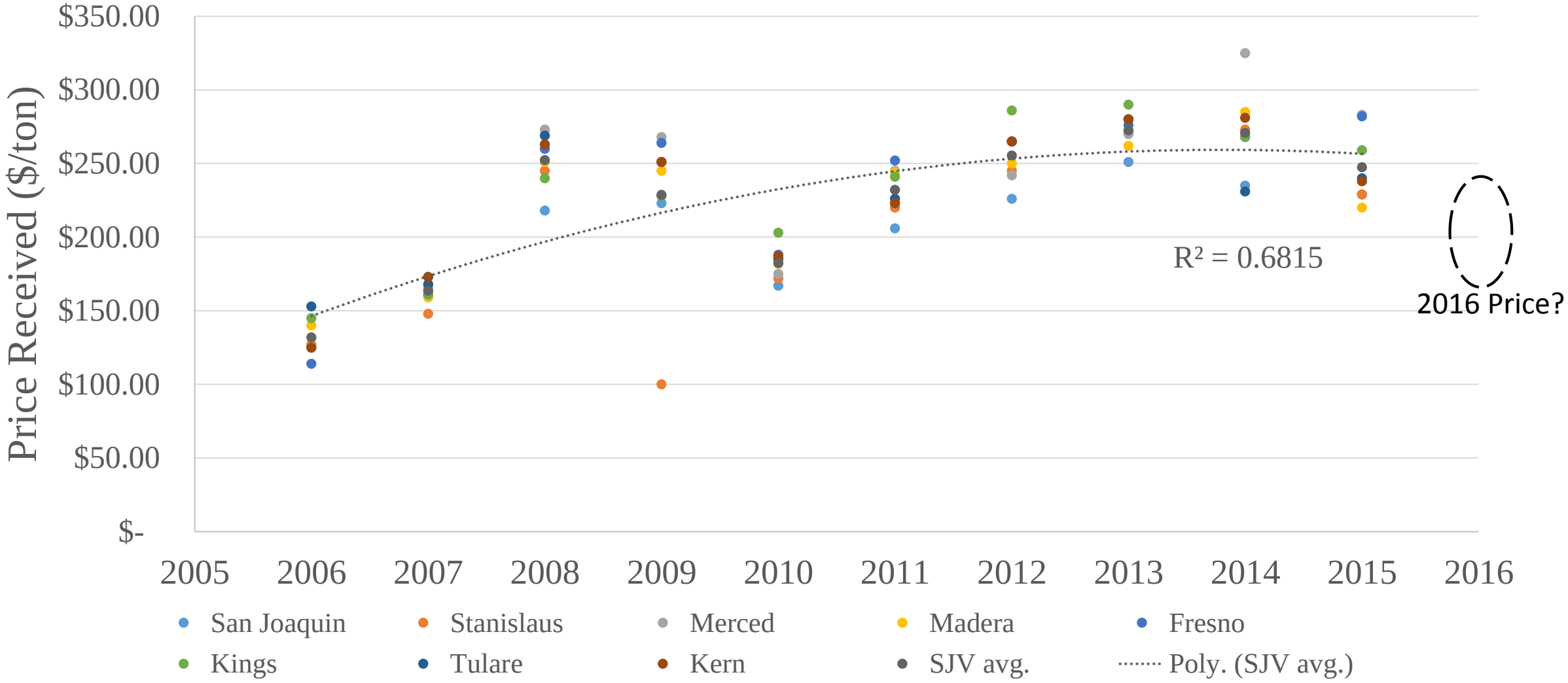
Value of 2015 SJV Wheat



Wheat in the SJV of CA



10 Year SJV Wheat Value Trend



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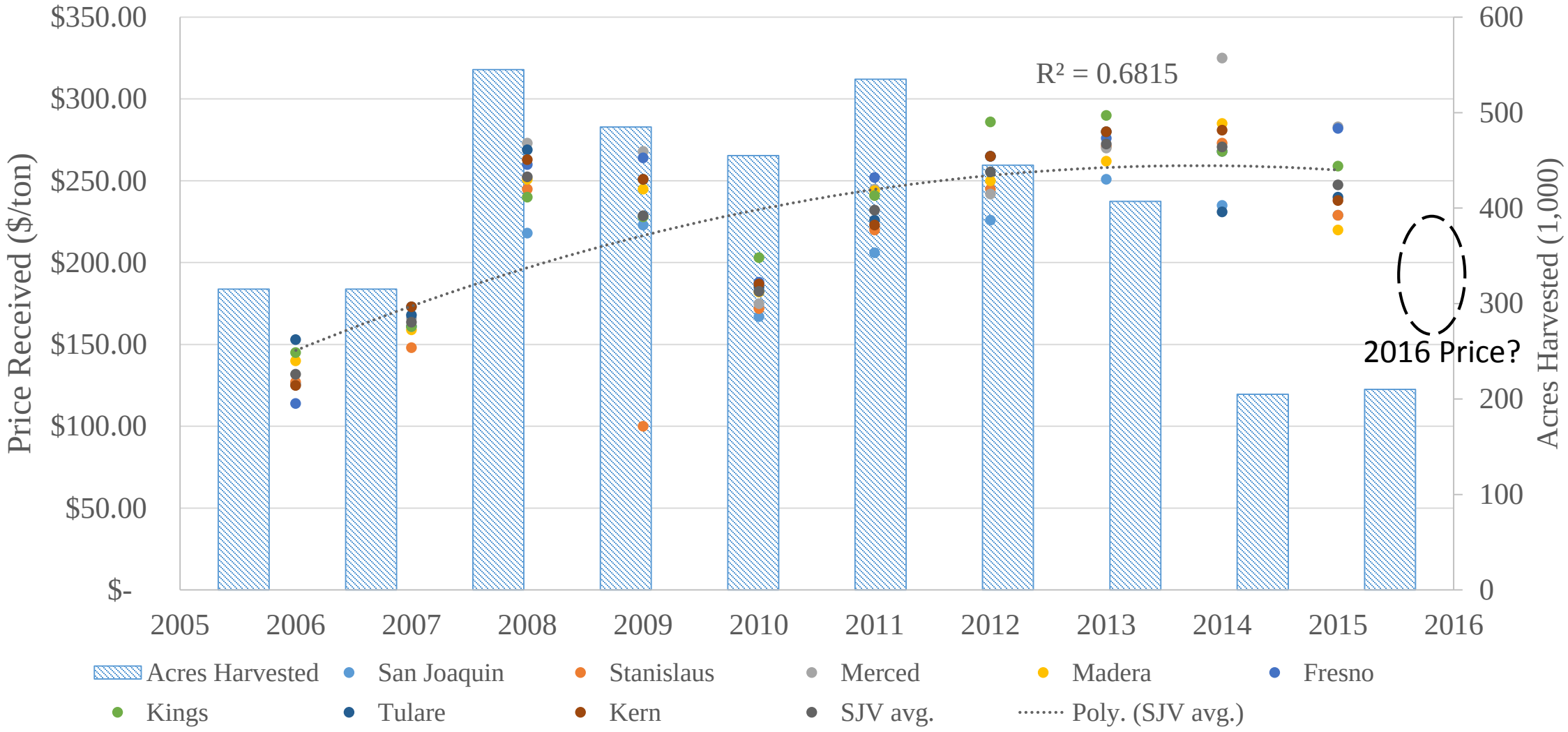
10 Year SJV Wheat Value and CA Acreage Harvested Trends



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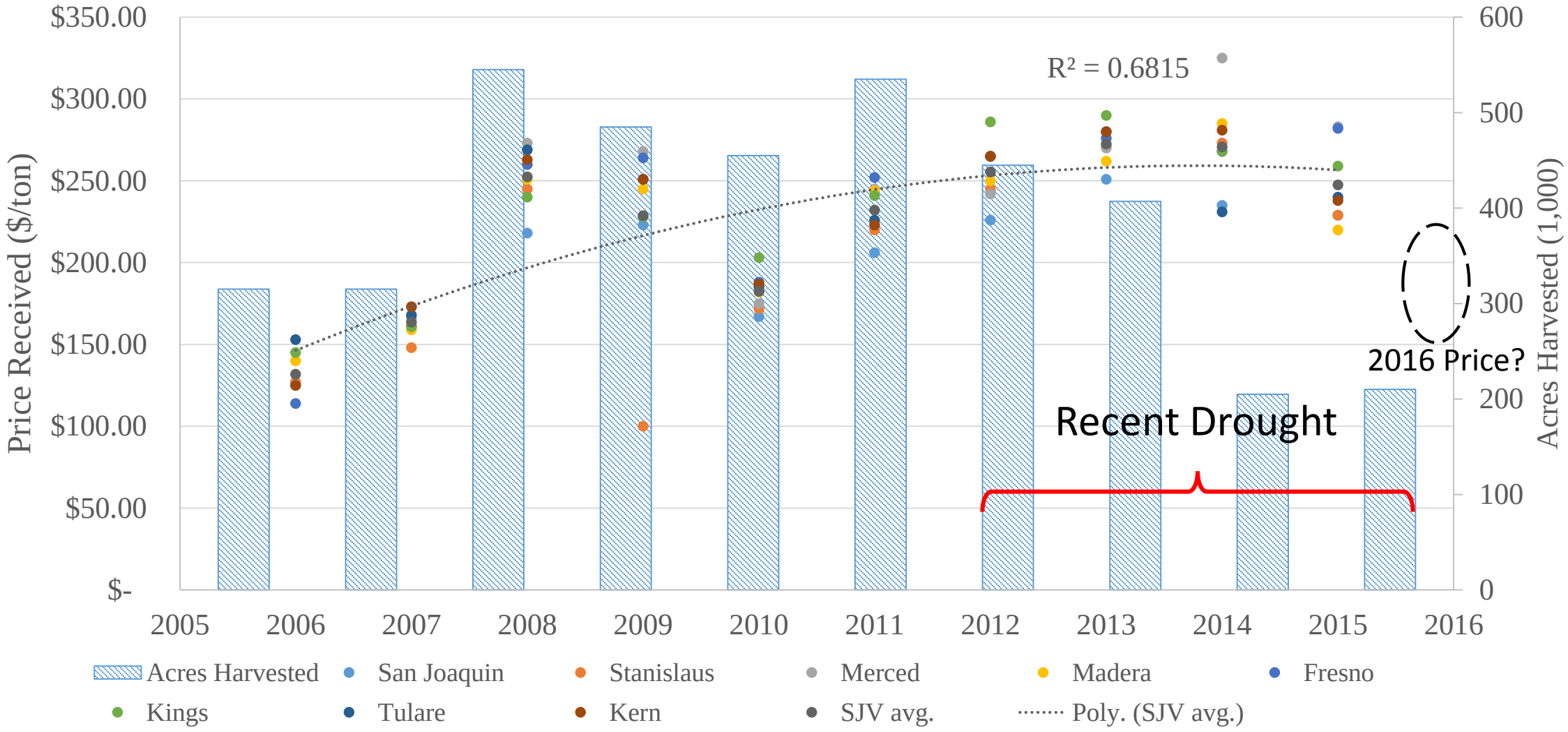
10 Year SJV Wheat Value and CA Acreage Harvested Trends



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UC COOPERATIVE EXTENSION
SAN JOAQUIN VALLEY - 2013

Table 2. COSTS AND RETURNS PER ACRE TO PRODUCE WHEAT FOR GRAIN

Wright, S., Hutmacher, R., Klonsky, K., & De Moura, R., 2013

	Quantity/ Acre	Unit	Price or Cost/Unit	Value or Cost/Acre
GROSS RETURNS				
Grain	4.00	ton	220.00	880
Straw	2.00	ton	35.00	70
TOTAL GROSS RETURNS	6.00	ton		950
OPERATING COSTS				
Fertilizer:				**185**
80-0-0 (Anhydrous Ammonia)	120.00	lb N	0.69	83
46-0-0 (Urea)	50.00	lb N	0.75	38
32-0-0 (UN32)	80.00	lb N	0.81	65
Seed:				**56**
Wheat	130.00	lb	0.43	56
Herbicide:				**54**
Express (soluble granules)	1.00	oz	26.49	26
MCPA Amine	1.00	pint	3.68	4
Axial XL	16.00	floz	1.47	24
Custom:				**58**
Air application (Helicopter)	2.00	acre	8.00	16
Combine Wheat	1.00	acre	32.00	32
Pest Control Advisor	1.00	acre	10.00	10
Irrigation:				**167**
Water	20.00	acin	8.33	167
Assessment:				**4**
California Wheat Commission (CWC)	4.00	ton	1.00	4
Labor:				**20**
Equipment Operator Labor	0.82	hrs	13.80	11
Non-Machine Labor	0.75	hrs	11.04	8
Machinery:				**29**
Fuel-Gas	0.00	gal	4.07	0
Fuel-Diesel	5.42	gal	3.84	21
Lube				3
Machinery Repair				5
Interest on Operating Capital (5.75%)				14
TOTAL OPERATING COSTS/ACRE				586
NET RETURNS ABOVE OPERATING COSTS				364

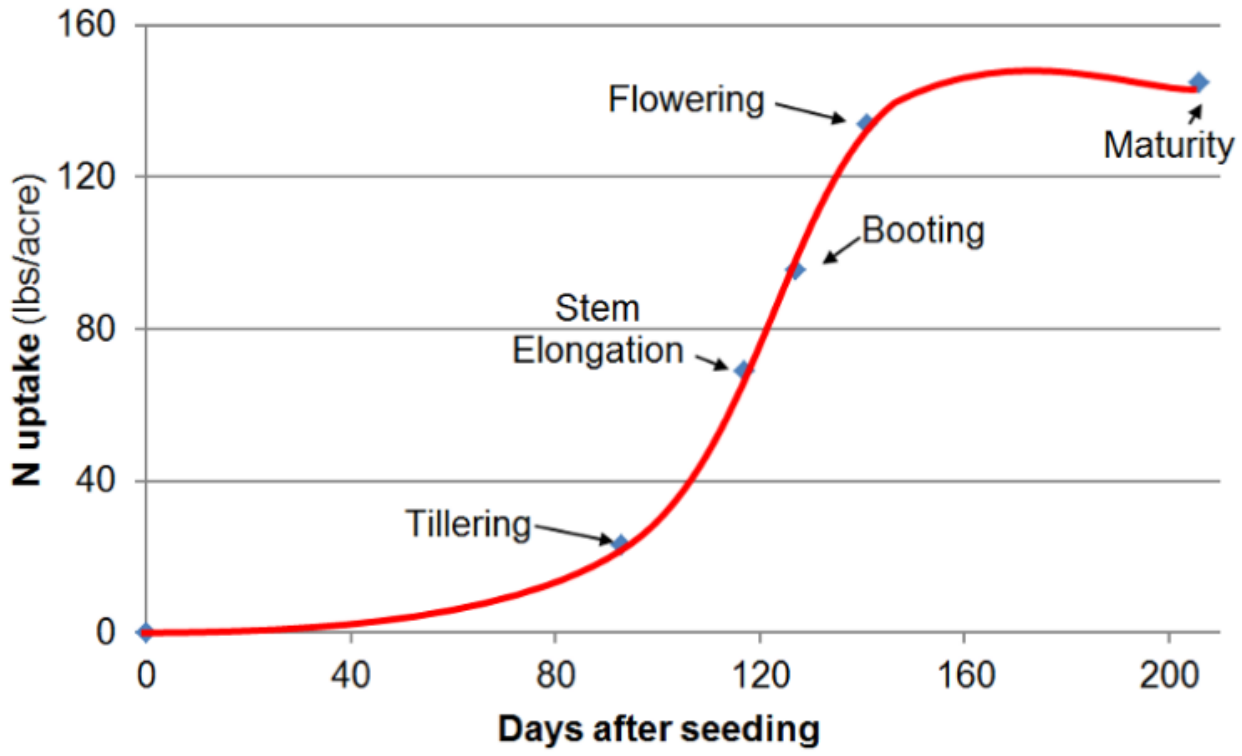
$185

32%

$586

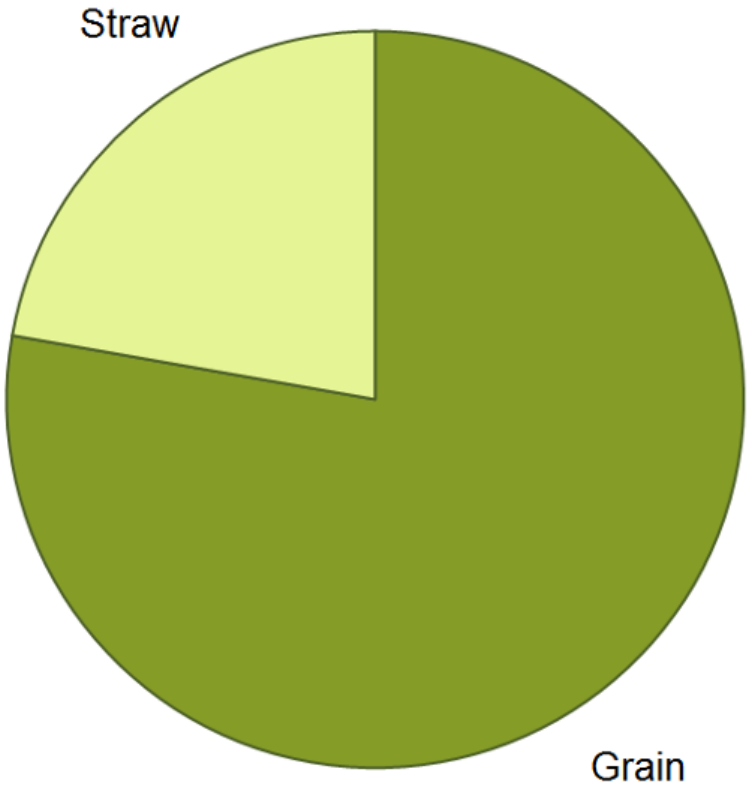
N Uptake and Partitioning in Wheat

Seasonal N Uptake



(McGuire et al., 1998, from CDFA-FREP and UC Davis Fertilization Guidelines)

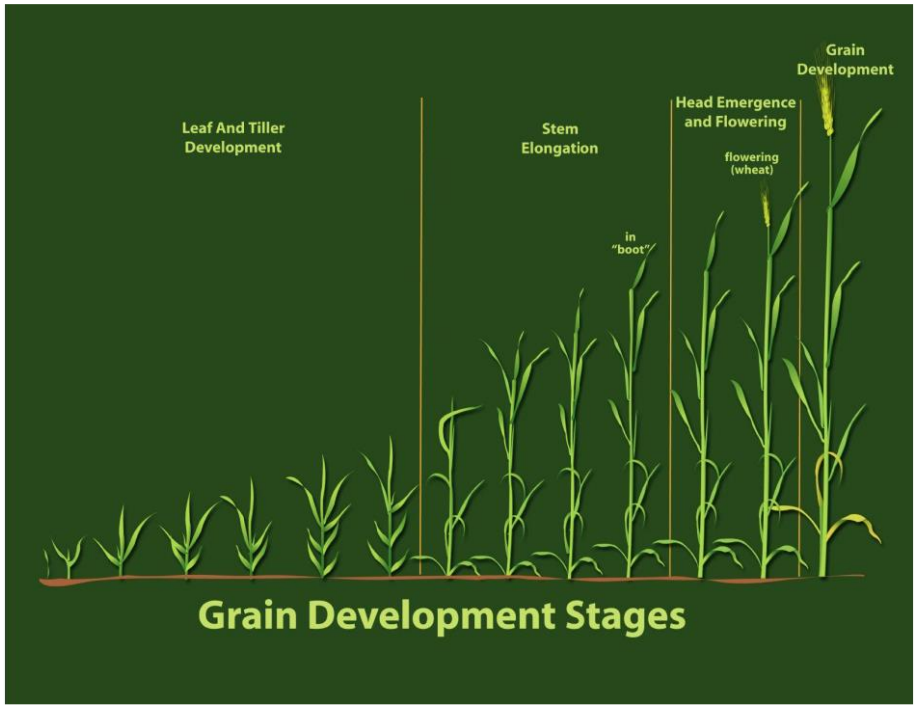
Nitrogen Partitioning



(Linquist et al., 1992; McGuire et al., 1998, from CDFA-FREP and UC Davis Fertilization Guidelines)

Yield – Protein Goals in SJV Wheat

- In SJV, 3-3.5 tons grain/A at 13% protein is normal
- N fertilizer at **early vegetative stages** is most effective at producing **biomass and setting yield potential**; **late N applications** (flowering) can **increase protein by ~1-3%** of grain mass. ***Flowering N uptake is about 50% more efficient than preplant***.
  - (Aksland, 2012; Brittan, 2012 in Sacramento; Jackson, et al., 2001; Wuest & Cassman, 1992)



Wheat Fertilizer N Needs?

Average of 3 lbs N uptake/100 lbs grain

Grain Yield (lbs/acre)	Crop N uptake (lbs/acre)	70% NUE application req. (lbs N/100 lbs grain)[1]	Source
5,705	145	3.6	McGuire et al., 1998
7,040	230	4.7	Linquist et al., 1992
7,000[2]	228	4.7	Aksland, 2012
7,000[3]	214	4.4	Western Fert. Handbook

[1] Assuming 13% protein

[2] Reported in CA Alfalfa and Forage Symposium Proceedings, cited as CA Wheat Comm. value

[3] Estimated using Linquist et al., 1992 and McGuire et al., 1998 findings of 75% N to grain

Regulatory N Management Compliance

- Irrigated Lands Regulatory Program and Dairy General Order require **NUE of 1.4 A:R or 70%** to be achieved
- **Certified NMP's and annual reporting** to water quality coalitions or to the regional water board

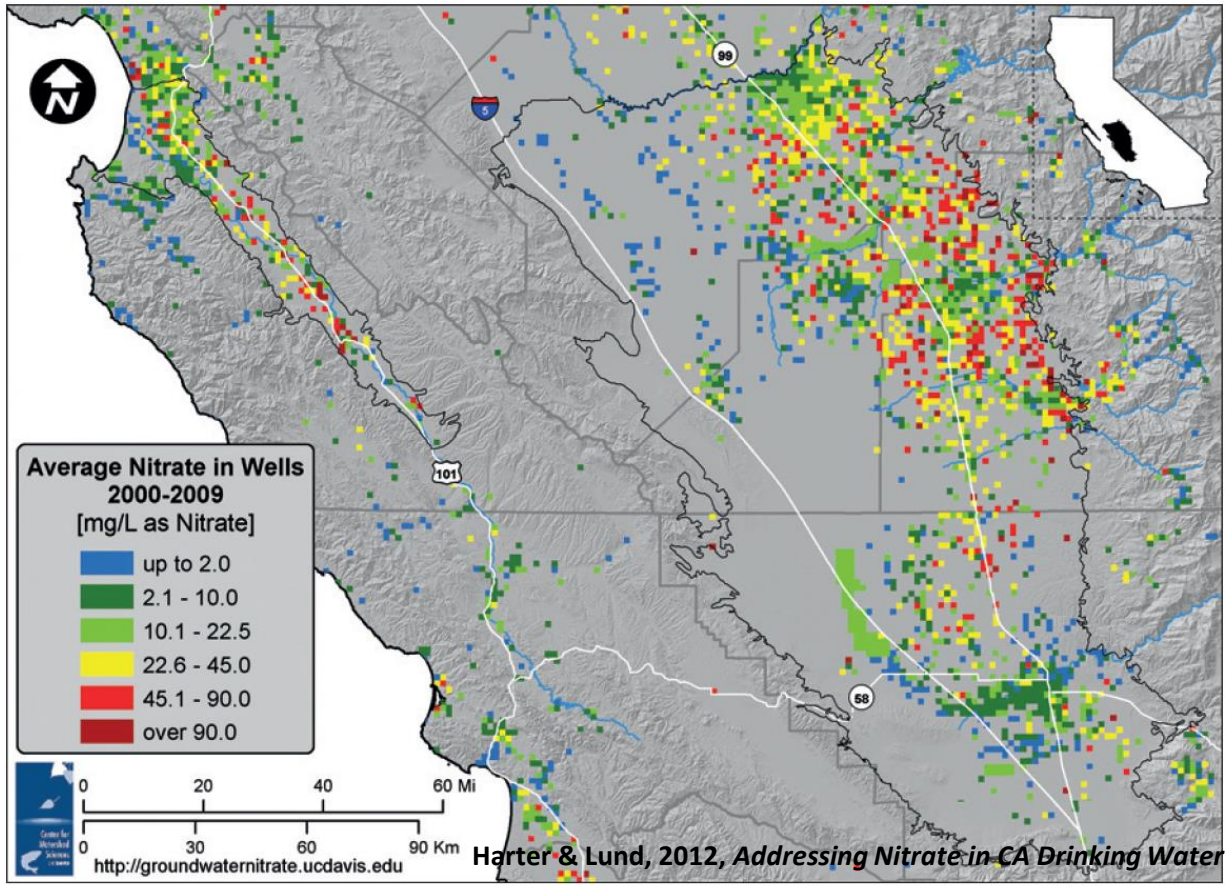


Figure 11. Mean of the time-average nitrate concentration (mg/L) in each well belonging within a square mile land section, 2000–2009. Some areas in the TLB are larger than 1 square mile. Source: Boyle et al. 2012.

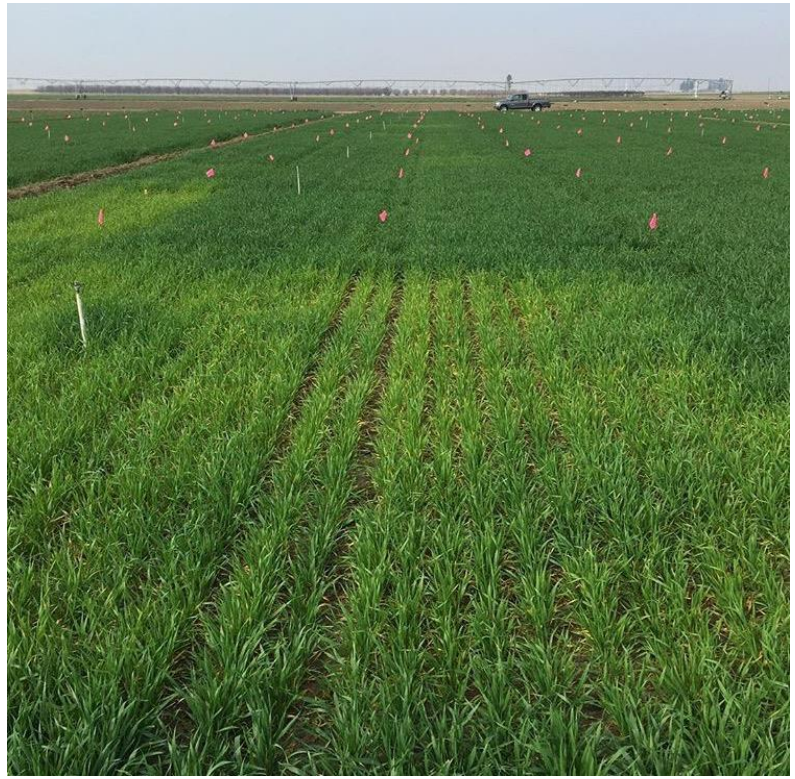
West Side Research & Extension Center

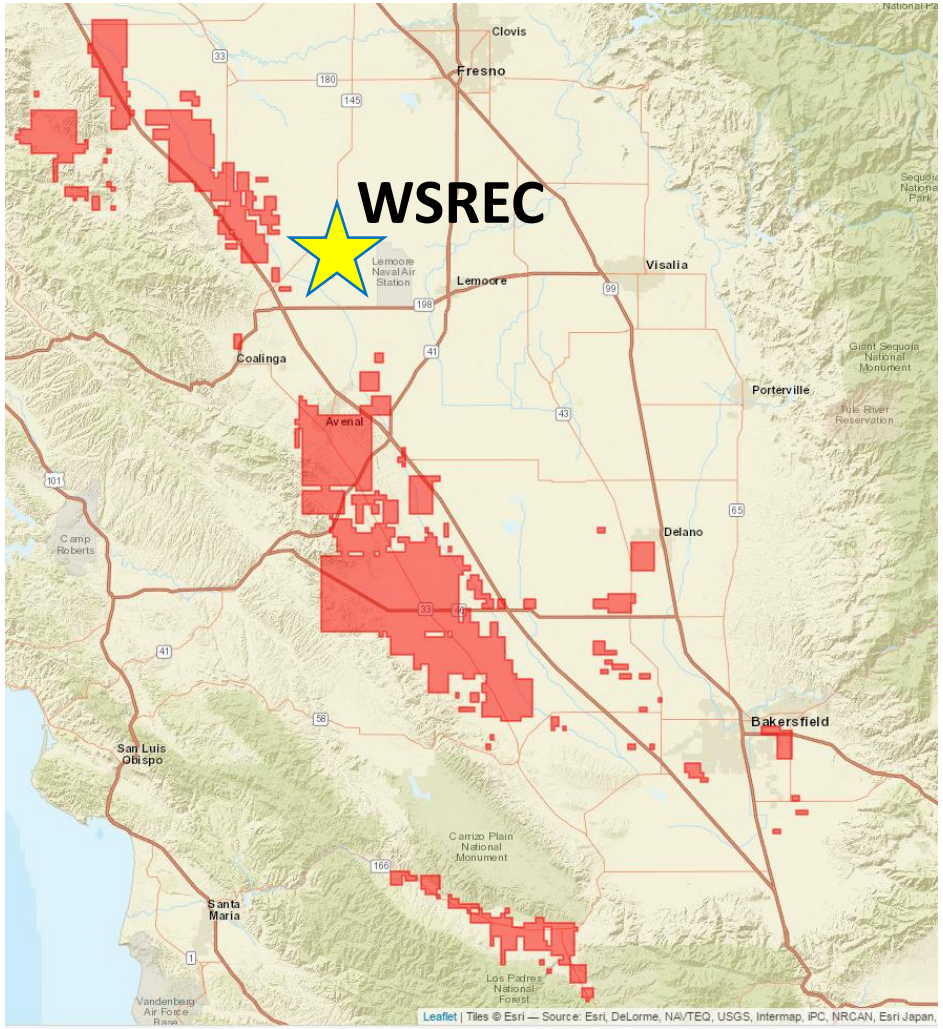
2014 & 2015 Wheat N Fertilizer Study

Panoche clay loam

3 N rates

7 application timings





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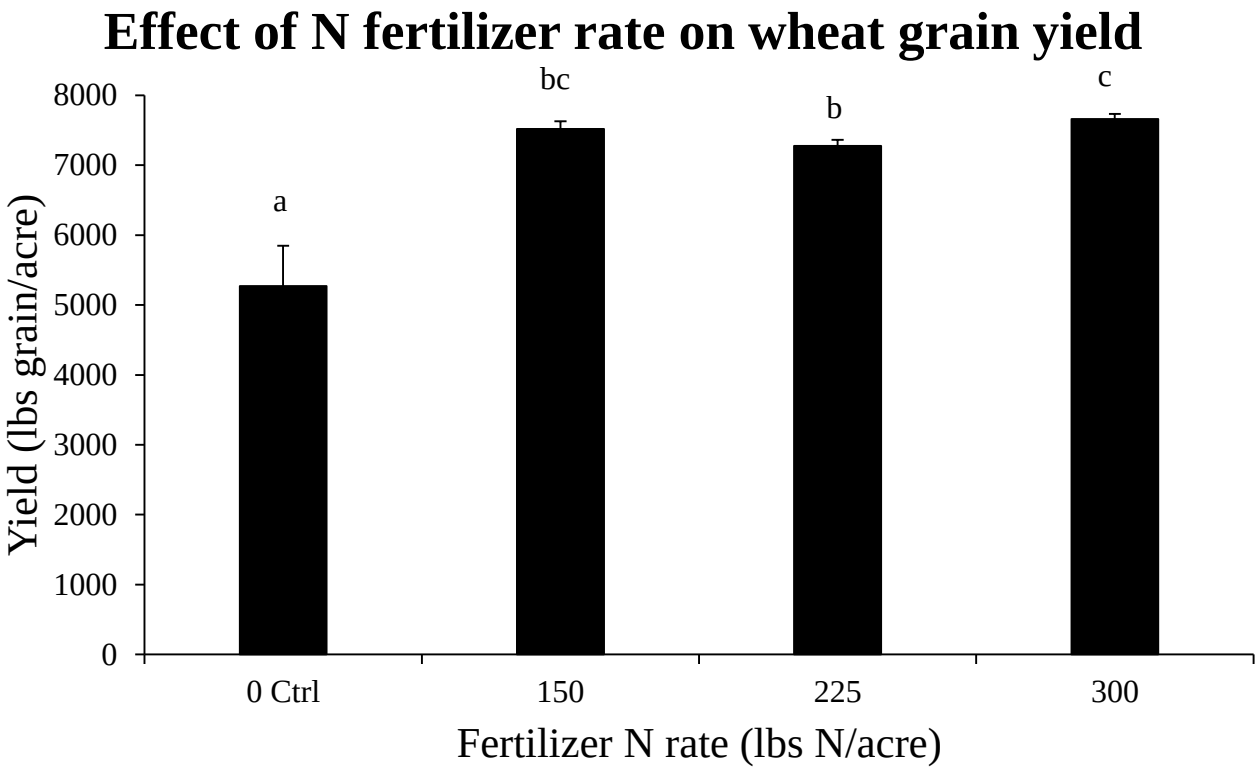
Grain Yield

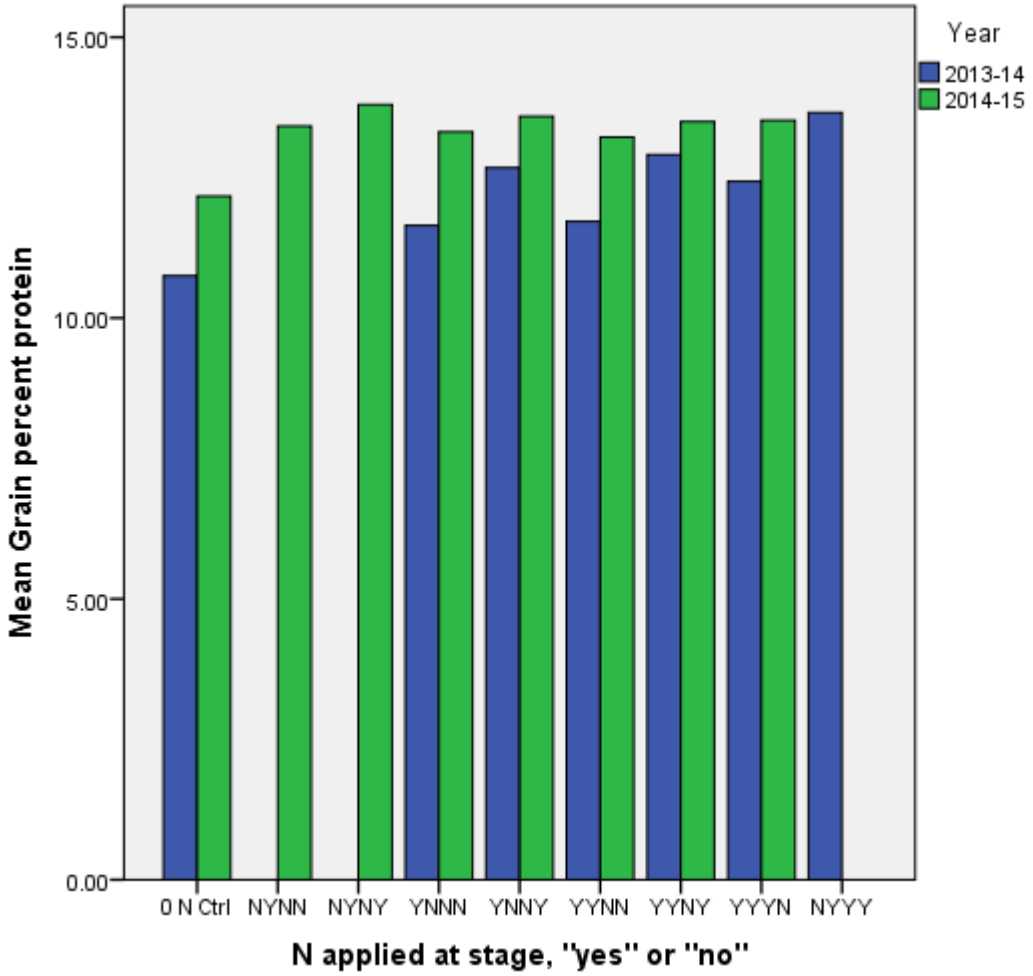
- No year effect
- No surprises

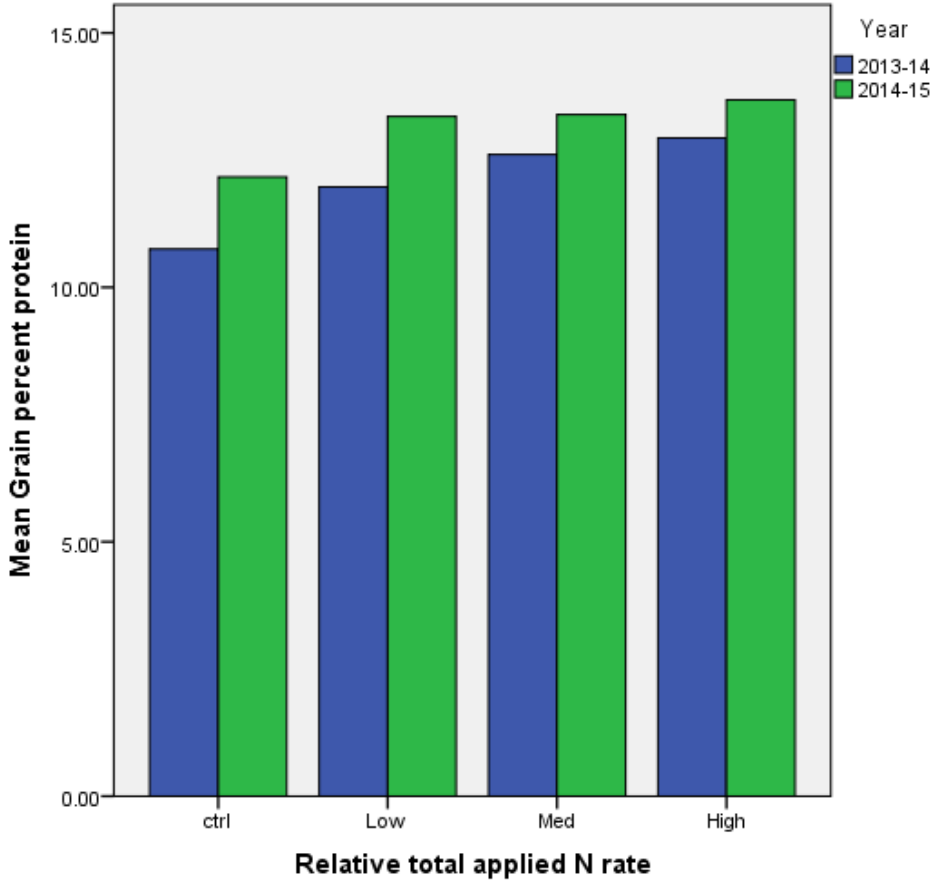


Treatment (lbs N/acre)	Yield (lbs grain/acre)	SEM
0 Ctrl	5270 a	578.11
150	7521 bc	107.32
225	7279 b	86.46
300	7662 c	70.35

Values followed by the same lowercase letter are not significantly different at α = 0.05 according to Tukey's HSD

Significant Effect of Year and Interactions of Year*Timing & *Rate on Grain Protein %





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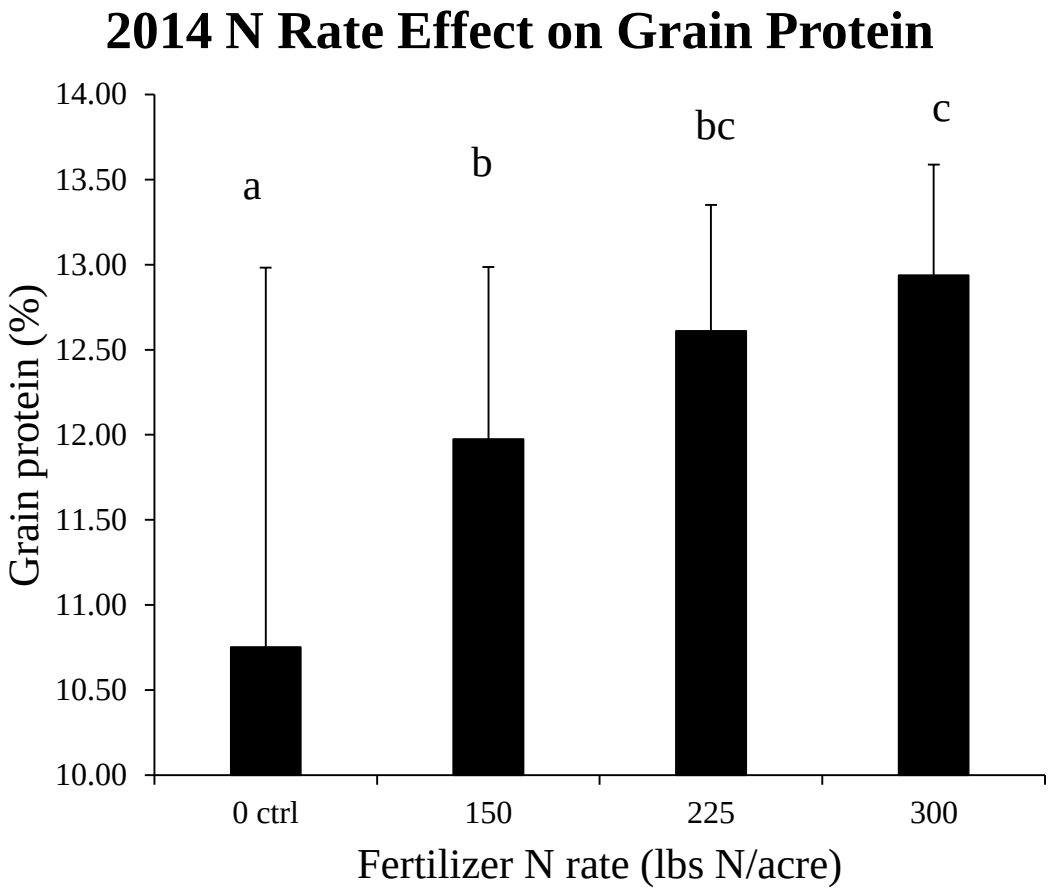
2014 N Rate on Grain Protein

Treatment	Protein %	
0 N Ctrl	10.75	a
150	11.98	b
225	12.61	bc
300	12.94	c

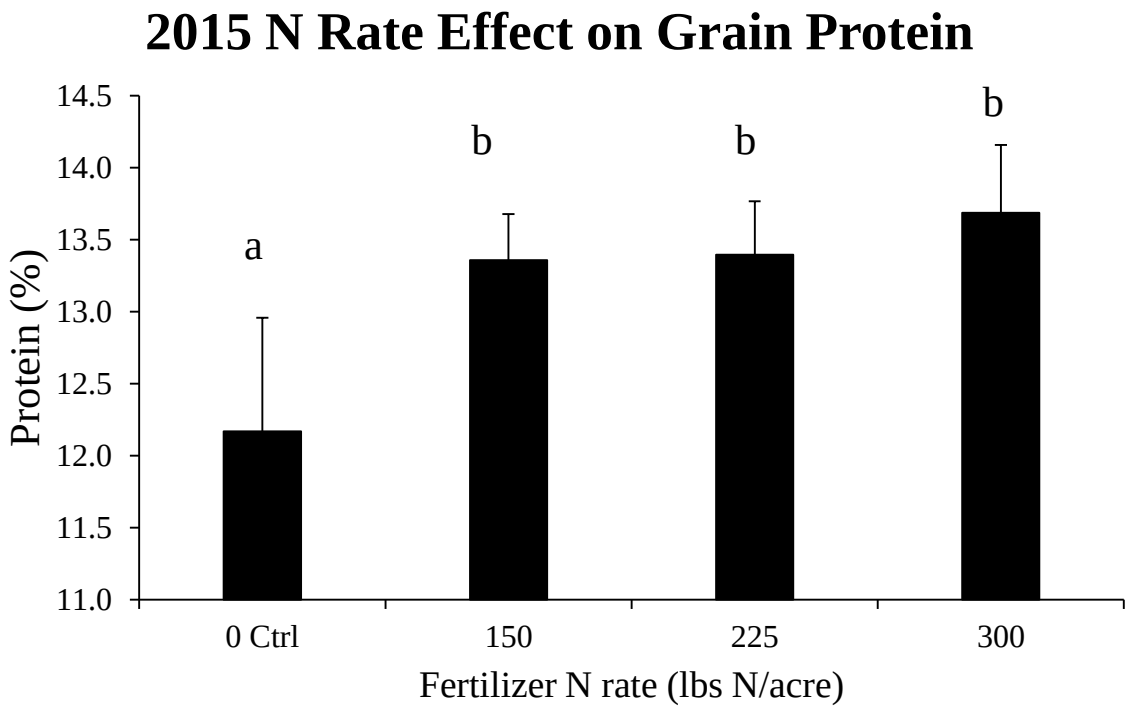
Values followed by the same letter are not significantly different at α = 0.05 according to Tukey's HSD



2015 N Rate on Grain Protein

Treatment	Protein	
0 N Ctrl	12.17	a
150	13.36	b
225	13.40	b
300	13.69	b

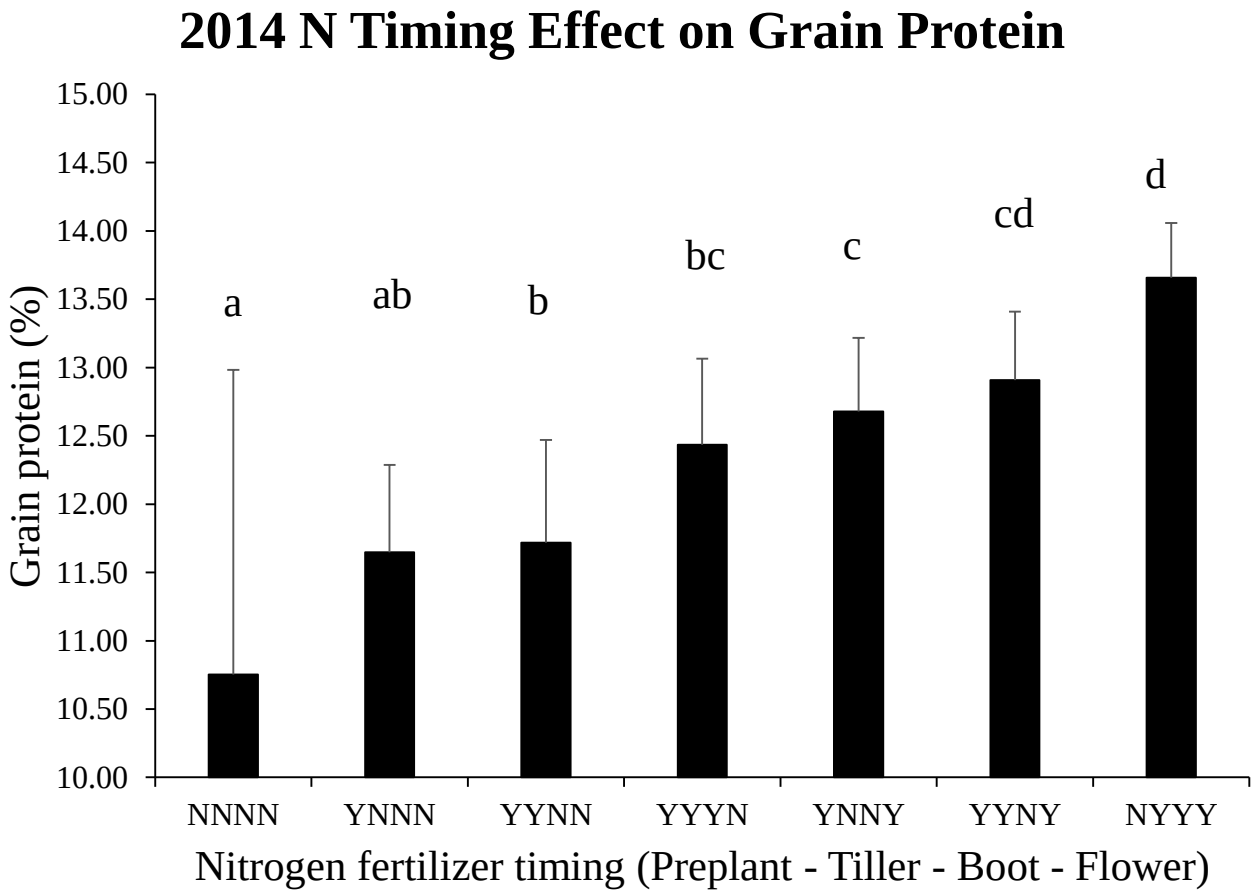
Values followed by the same letter are not significantly different at α = 0.05 according to Tukey's HSD



2014 N Timing on Grain Protein

Treatment	Grain protein (%)	
NNNN	10.75	a
YNNN	11.65	ab
YYNN	11.72	b
YYYN	12.43	bc
YNNY	12.68	c
YYNY	12.91	cd
NYYY	13.66	d

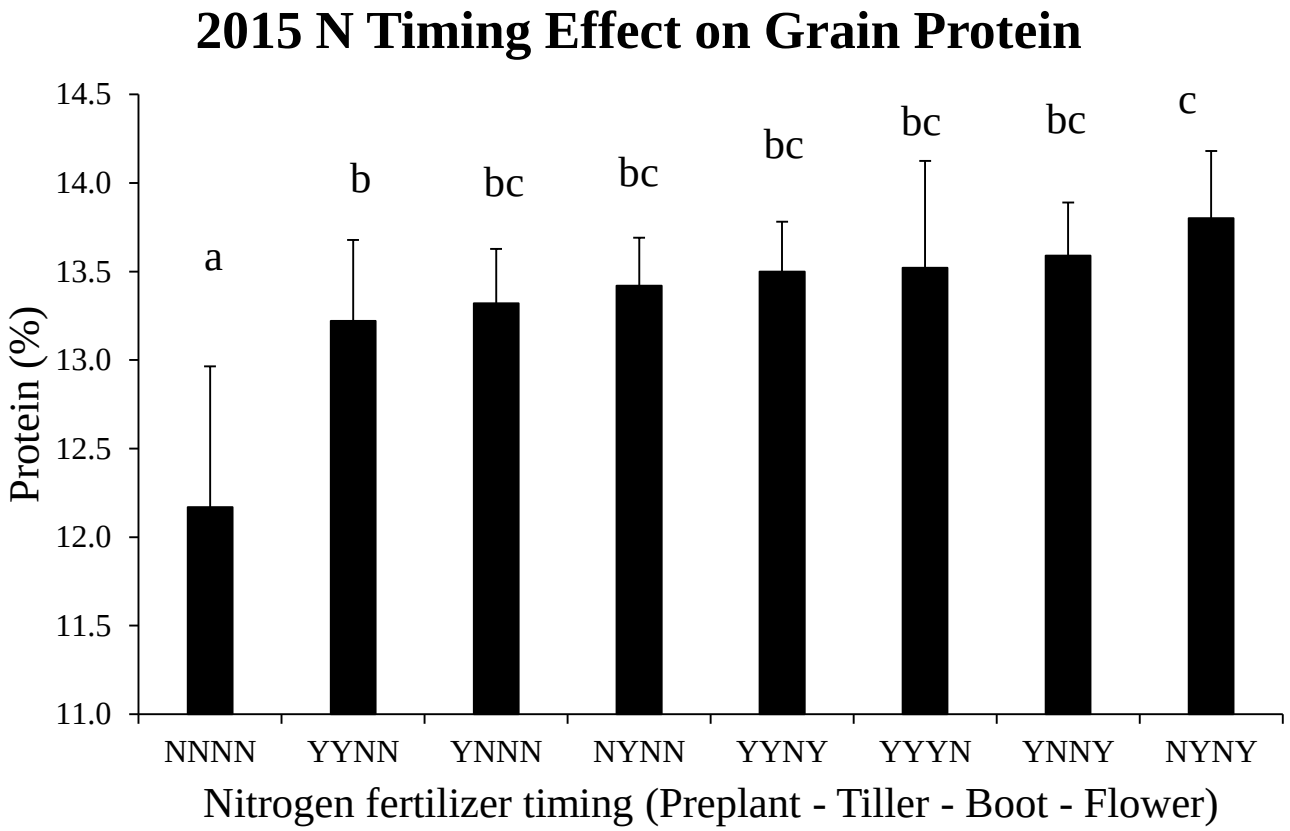
Values followed by the same letter are not significantly different at α = 0.05 according to Tukey's HSD



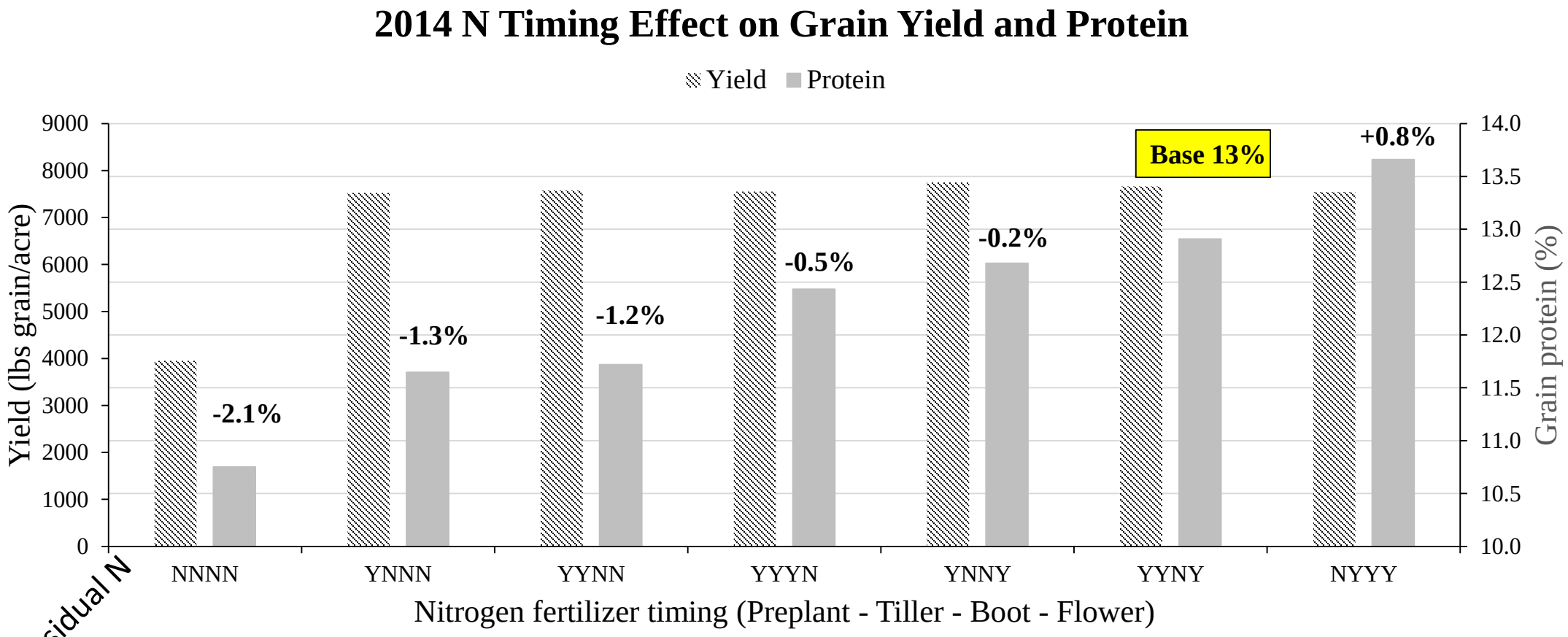
2015 N Timing on Grain Protein

Treatment	Protein (%)	
NNNN	12.17	a
YYNN	13.22	b
YNNN	13.32	bc
NYNN	13.42	bc
YYNY	13.50	bc
YYYN	13.52	bc
YNNY	13.59	bc
NYNY	13.80	c

Values followed by the same letter are not significantly different at α = 0.05 according to Tukey's HSD



Interaction between Yield and Protein



40 lbs/acre residual N

7,600 lbs/acre avg. yield

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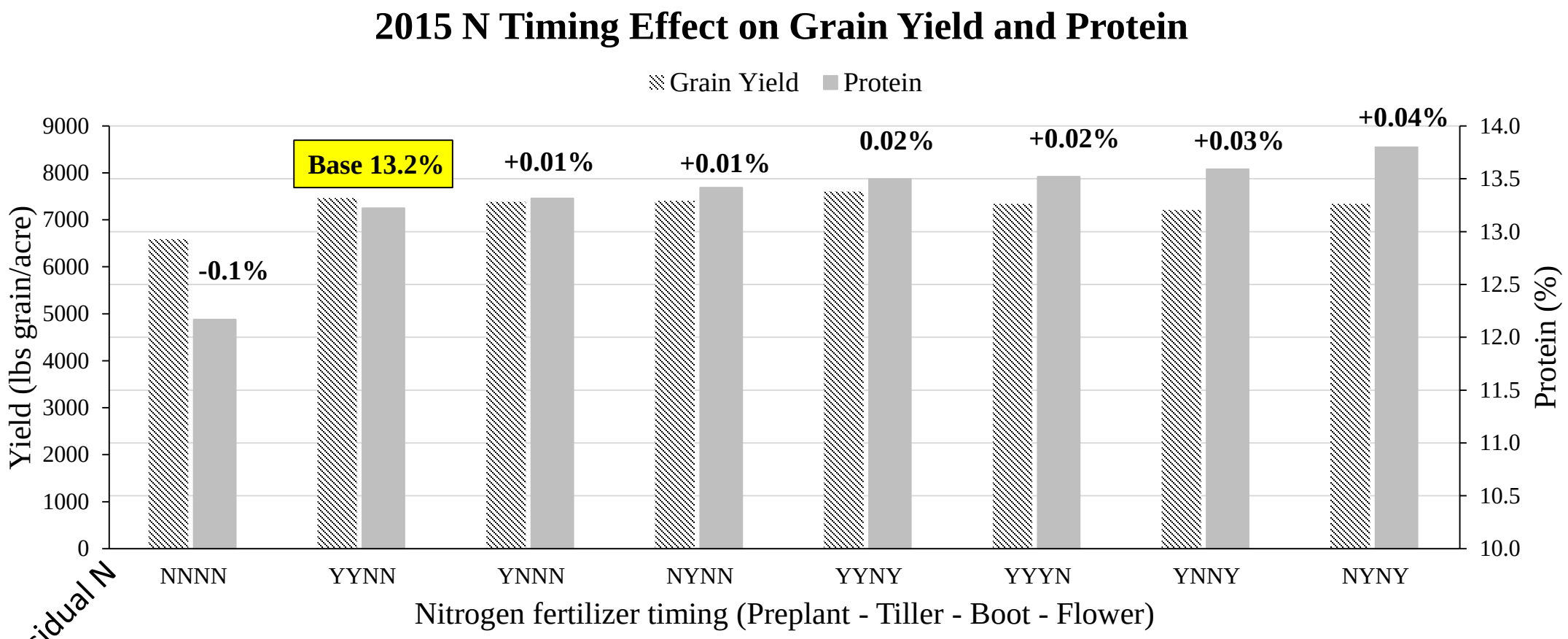
2nd Year Interaction between Yield &Protein



80 lbs/acre residual N

7,400 lbs/acre avg. yield

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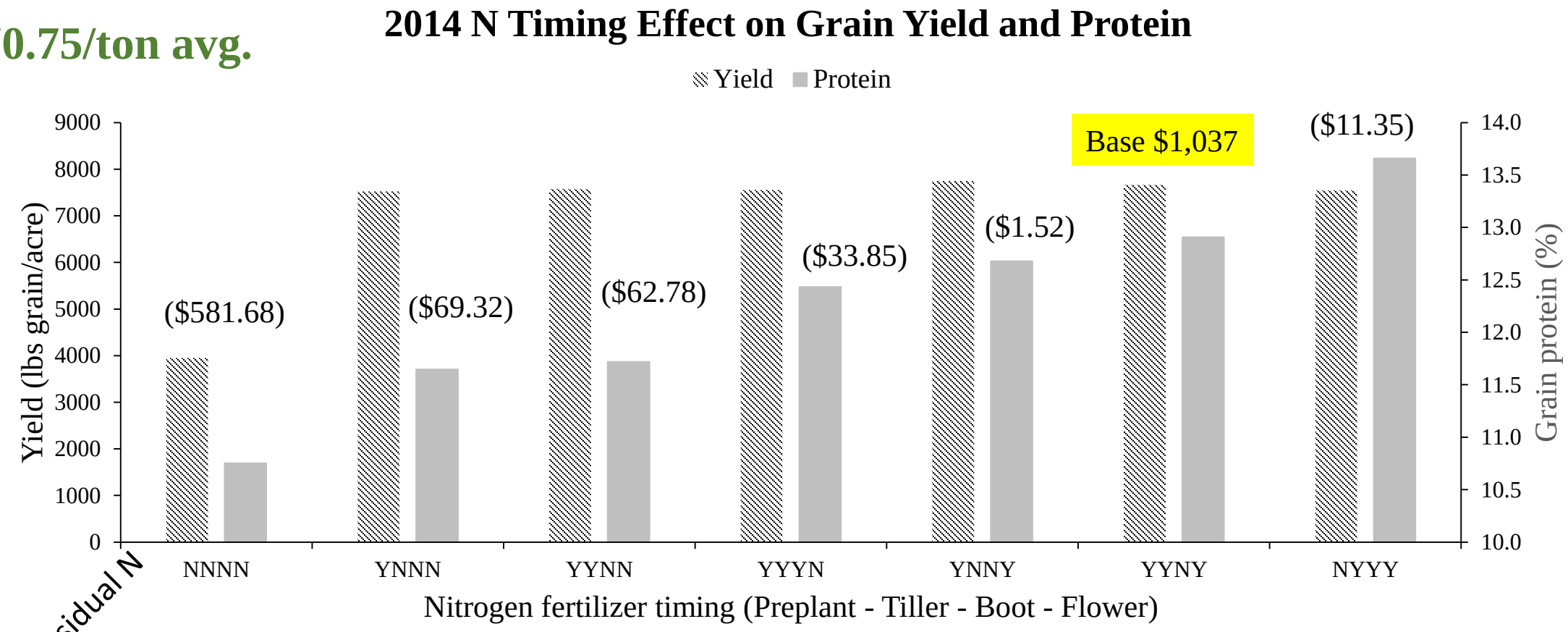
Price Adjustment *Example* for Grain Protein Variation in 2015 SJV

Price received for 4 ton (133 bu)/acre common red wheat @ market of $247/ton			
Protein %	**Price aug./bu**	**Price/acre**	**Price difference/acre**
13.50	$ 0.04	$ 995.98	$ 7.98
13.25	$ 0.02	$ 990.66	$ 2.66
13.00	**$ -**	**$ 988.00**	$ -
12.75	$ 0.05	$ 981.35	$ (6.65)
12.50	$ 0.10	$ 974.70	$ (13.30)
12.25	$ 0.15	$ 968.05	$ (19.95)
12.00	$ 0.20	$ 961.40	$ (26.60)
11.75	$ 0.30	$ 948.10	$ (39.90)
11.50	$ 0.40	$ 934.80	$ (53.20)

~$6.00 spread

Interaction between Yield and Protein

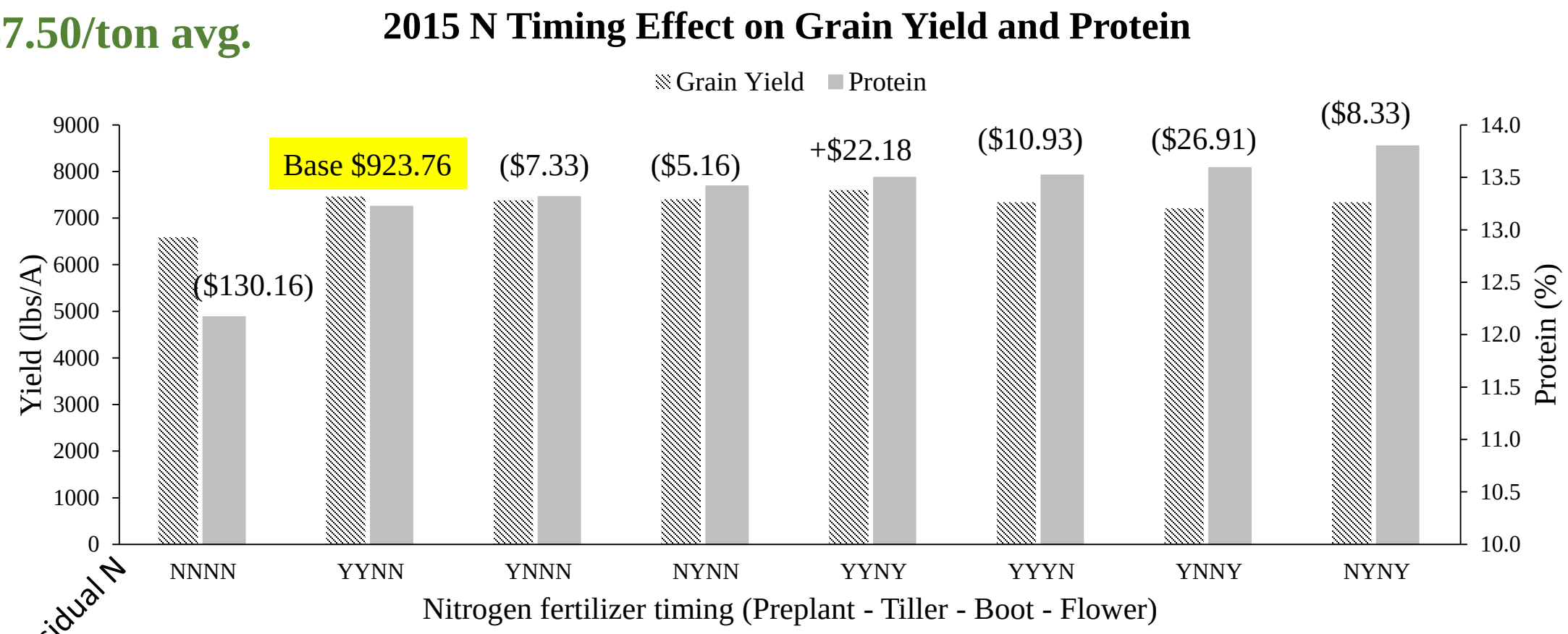
$270.75/ton avg.



40 lbs/acre residual N

2nd Year Interaction between Yield &Protein

$247.50/ton avg.



80 lbs/acre residual N

Example Price Received for Various Yields in 2015 SJV

Price received for common red wheat w/13% protein @ market of $247/ton		
Yield (lbs/acre)	Price/acre	Price difference/acre
5000	$ 617.50	$ (370.50)
6000	$ 741.00	$ (247.00)
7000	$ 864.50	$ (123.50)
8000	$ 988.00	$ -
9000	$ 1,111.50	$ 123.50
10000	$ 1,235.00	$ 247.00

$123.50 spread

Each 0.25% protein shift is worth about 4% of the value of each 1,000 lbs yield shift

Example Wheat Fertilizer N Costs

Assuming 3 lbs N uptake/100 lbs grain				
Grain yield (lbs/acre)	Plant N requirement (lbs N/acre)	Applied with 70% uptake efficiency	Cost/acre of UN32 @ $330/ton delivered	Fertilizer cost/acre of 30% N inneficiency
5,000	150	214	$ 35.36	$ 10.61
6,000	180	257	$ 42.43	$ 12.73
7,000	210	300	$ 49.50	$ 14.85
8,000	240	343	$ 56.57	$ 16.97
9,000	270	386	$ 63.64	$ 19.09
10,000	300	429	$ 70.71	$ 21.21

300 lbs N/acre applied @ 80% NUE = savings of **$8.91**/acre + possible yield or protein gain

A 10% improvement in NUE attributed 100% to grain yield = 1,000 lbs/acre increase

Take Away?

- Effects of rate and timing on yield and protein can be separated
- Economic incentives: Yield goal > fertilizer savings ≈ protein goal
- Increasing N rate had diminishing $ returns on yield – improving NUE at a stage with the most impact on yield will be most beneficial.
- Improved methods for predicting crop response to N fertilization may be the next best investment in NUE/yield improvement.
- If economic sustainability is truly a priority, this is a can of worms that should be investigated more.

No Systems are Created Equally

N Fertilization costs as a proportion of total operating costs

- Organic spinach ---------- 11.7%
- Pistachios, SJV ---------- 9.8%
- Romaine hearts ---------- 6.5%
- Almonds, SJV ---------- 9.0%
- Wine grapes, Sac Valley ---- 2.9%
- Fresh market plums --------- 1.0%
- Grain wheat, Sac Valley ---- 27.2%
- Corn silage, SJV ---------- 23.1%
- SDI processing tomatoes ----7.8%
- Walnuts, SJV ---------- 7.7%

These examples demonstrate a range of 26 % points

Good Starting Point for Farm Operation Costs Evaluation

coststudies.ucdavis.edu/current

Filter current studies using the map of California

From Alfalfa to Wheat

Current Studies

Commodity	Region	County	Year	Production Conditions
Alfalfa [pdf]	San Joaquin Valley South	Tulare	2016	50 acre study; Small #125 bales, custom harvested
Alfalfa [pdf]	San Joaquin Valley South	Tulare	2016	300 acre study; #1300 bales, custom & grower harvested
Alfalfa [pdf]	Sacramento Valley, San Joaquin Valley North	see map	2015	Establish and produce; flood irrigation
Alfalfa [pdf]	Sacramento Valley - Northern Delta	see map	2014	Sub-surface drip irrigation
Alfalfa [pdf]	Intermountain, Sacramento Valley, San Joaquin Valley North, San Joaquin Valley South	see map	2013	ORGANIC, Establishment and Production, Hay
Alfalfa [pdf]	Intermountain	Siskiyou	2012	Establishment and production, Scott Valley - Mixed Irrigation
Alfalfa [pdf]	Intermountain	Siskiyou	2012	Establishment and production, Butte Valley - Center Pivot Irri
Almonds [pdf]	San Joaquin Valley North	see map	2016	Organic, solid set sprinkler irrigation
Almonds [pdf]	Sacramento Valley	see map	2016	Establish and produce an orchard, micro-sprinkler irrigation
Almonds [pdf]	San Joaquin Valley North	see map	2016	Establish and produce an orchard, micro-sprinkler irrigation
Walnuts [pdf]	San Joaquin Valley North	see map	2013	Establishment & Production
Walnuts [pdf]	North Coast	Lake	2013	Organic
Walnuts [pdf]	Sacramento Valley	see map	2012	Establishment and Production. Micro-sprinkler irrigation.
Walnuts [pdf]	North Coast	Lake	2012	Chandler variety, Homesite
Walnuts [pdf]	Sacramento Valley, San Joaquin Valley North	Lake	2009	Hulling and Drying Facility Cost Study
Wheat [pdf]	Sacramento Valley	see map	2016	Irrigated
Wheat [pdf]	San Joaquin Valley South	see map	2013	Small Grain, Irrigated

Questions?