

# Characterizing the Nitrogen Benefit of Alfalfa-Wheat Rotations

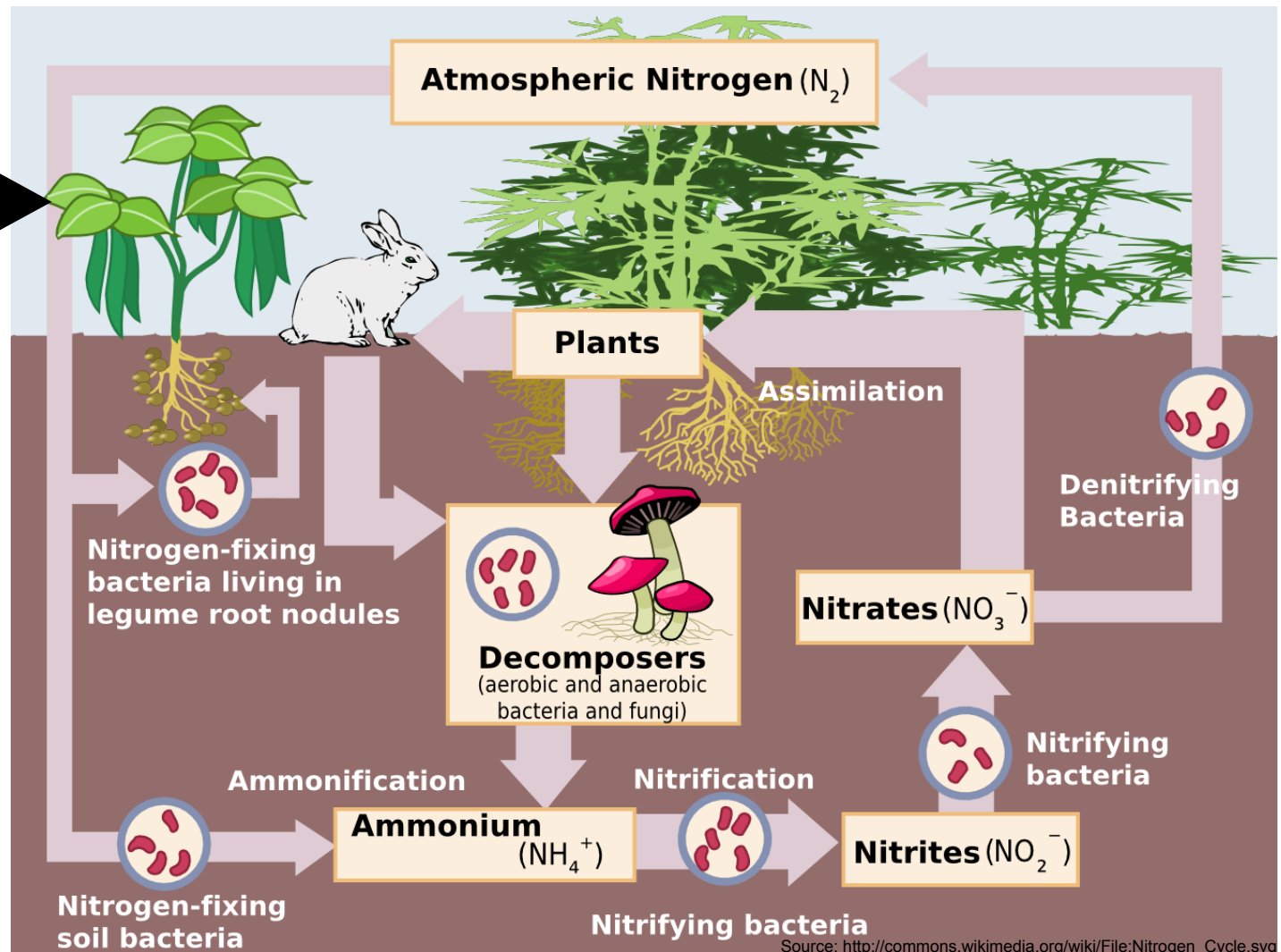
Eric Lin, Dan Putnam, Stu Pettygrove, Mark  
Lundy, Steve Orloff, and Steve Wright

# Benefits of rotations with alfalfa

- Increased soil organic matter
- Increased water use efficiency
- Increased nutrient use efficiency
- Reduced grain yield variability
- Reduced weeds
- Reduced pests and diseases

# But wait! There's more!

Alfalfa can help increase soil N, which subsequent crops can use



# Alfalfa forage in CA can remove 250-1000 lbs N/acre per year, ...

Table 1. Crop removal of Nitrogen at different alfalfa yield and protein levels. Shaded area indicates most likely range for California Central Valley locations.

	Crude Protein of Alfalfa Forage					
	16	18	20	22	24	26
	%Nitrogen in Forage					
Tonnage (t/a)	2.56%	2.88%	3.20%	3.52%	3.84%	4.16%
	Crop Removal of N					
	lbs N/acre					
5	256	288	320	352	384	416
6	307	346	384	422	461	499
7	358	403	448	493	538	582
8	410	461	512	563	614	666
9	461	518	576	634	691	749
10	512	576	640	704	768	832
11	563	634	704	774	845	915
12	614	691	768	845	922	998

Shaded area represents most likely outcome

... and most of the nitrogen comes right out of thin air



Source: [http://commons.wikimedia.org/wiki/File:Medicago\\_sativa\\_root\\_nodules.JPG](http://commons.wikimedia.org/wiki/File:Medicago_sativa_root_nodules.JPG)

# How much N?

- Depends on:
  - Location
  - Soil texture
  - Alfalfa stand age
  - Alfalfa stand density
  - Mineralization rate

# Nitrogen credits

Nitrogen credits are an easy way for growers to determine how much N fertilizer they can save



## Nitrogen Credits for Alfalfa and Soybean in Wisconsin

**First year credit:**

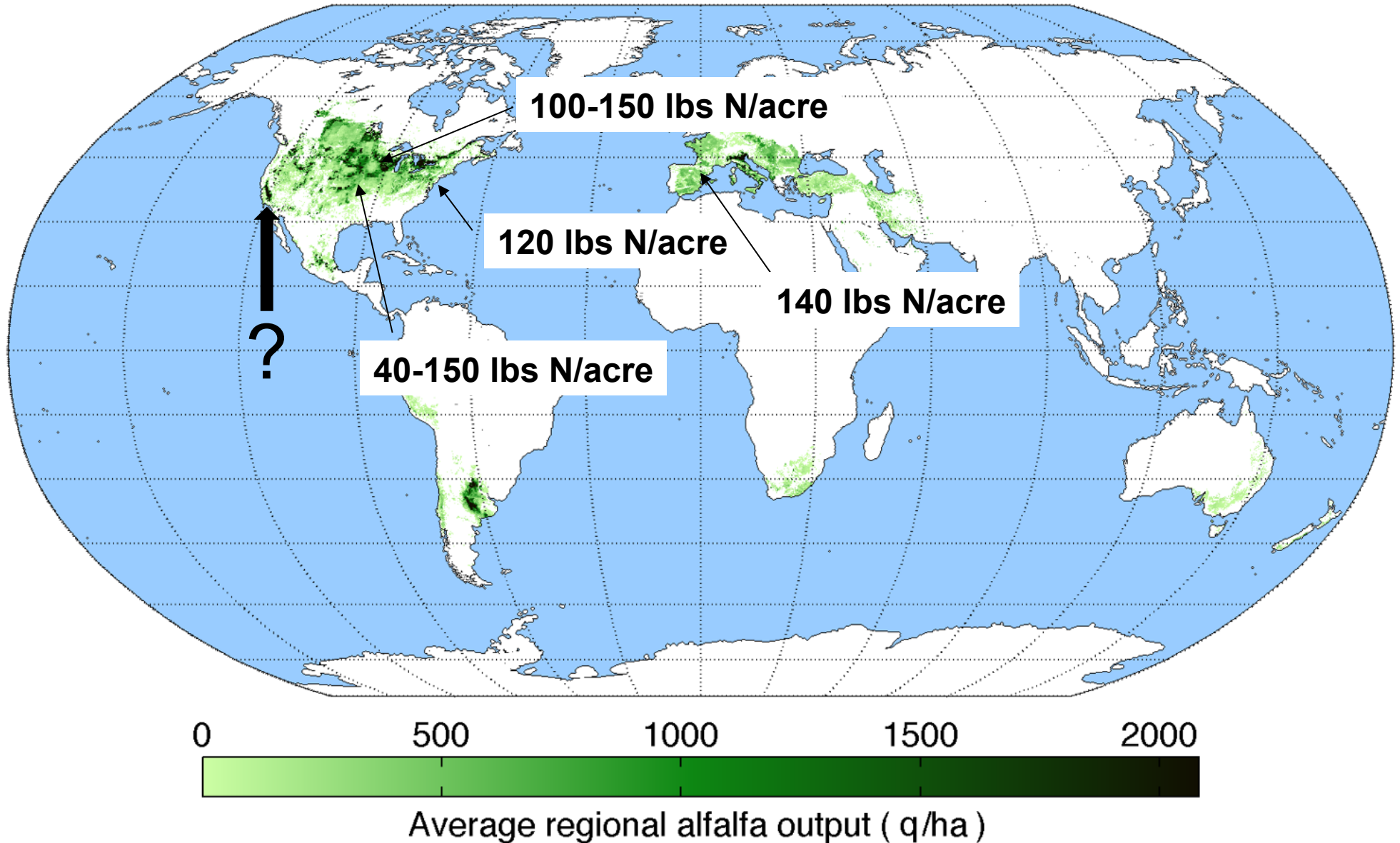
	medium & fine textured soils		sandy soils	
	> 8 inches of regrowth	< 8 inches of regrowth	> 8 inches of regrowth	< 8 inches of regrowth
<b>Alfalfa</b> (stand density)	Nitrogen Credit (lb N/acre)			
Good ....(70-100 % alfalfa, > 4 plants/ft <sup>2</sup> )	<b>190</b>	<b>150</b>	<b>140</b>	<b>100</b>
Fair .....(30-70 % alfalfa, 1.5 - 4 plants/ft <sup>2</sup> )	<b>160</b>	<b>120</b>	<b>110</b>	<b>70</b>
Poor.....(0-30 % alfalfa, < 1.5 plants/ft <sup>2</sup> )	<b>130</b>	<b>90</b>	<b>80</b>	<b>40</b>

**Second year credit:** In the second cropping year following fair and good stands on medium and fine textured soil, you can take a 50 lb N/acre credit.

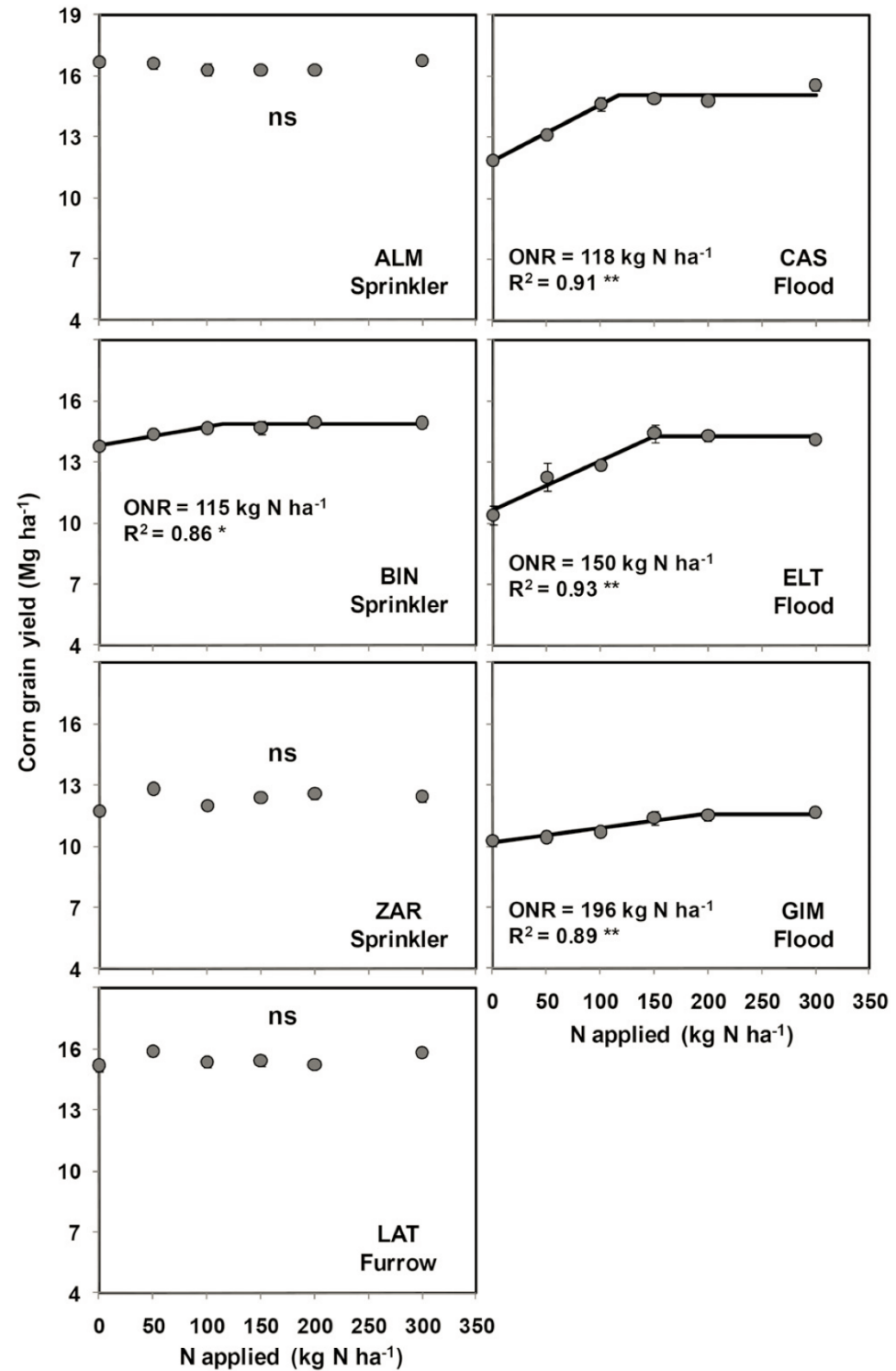
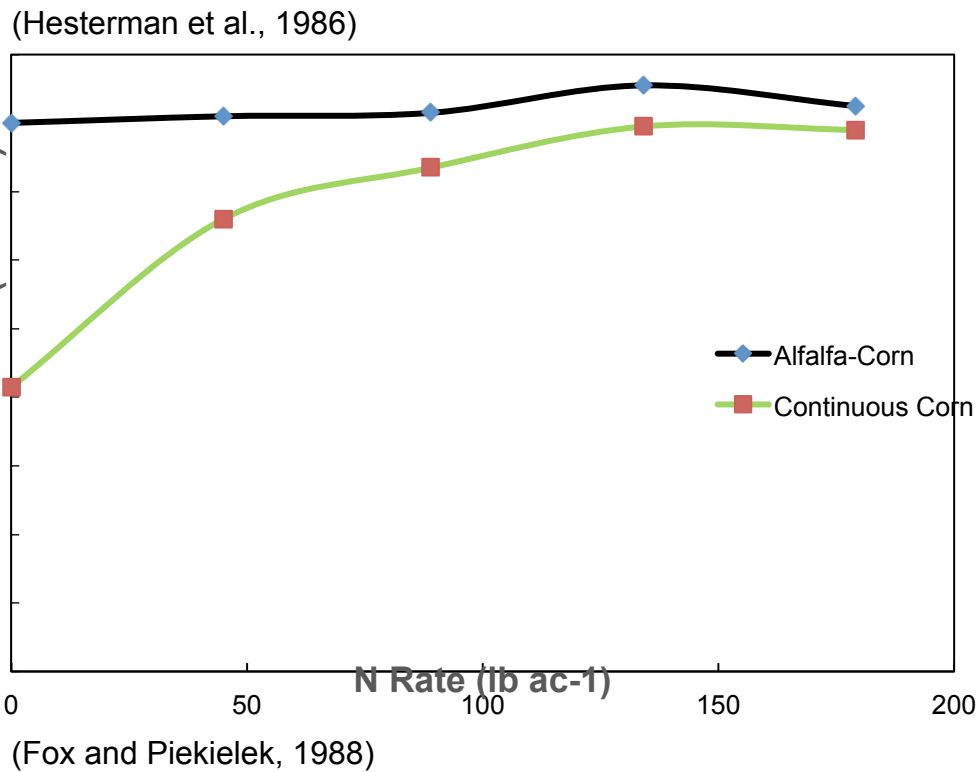
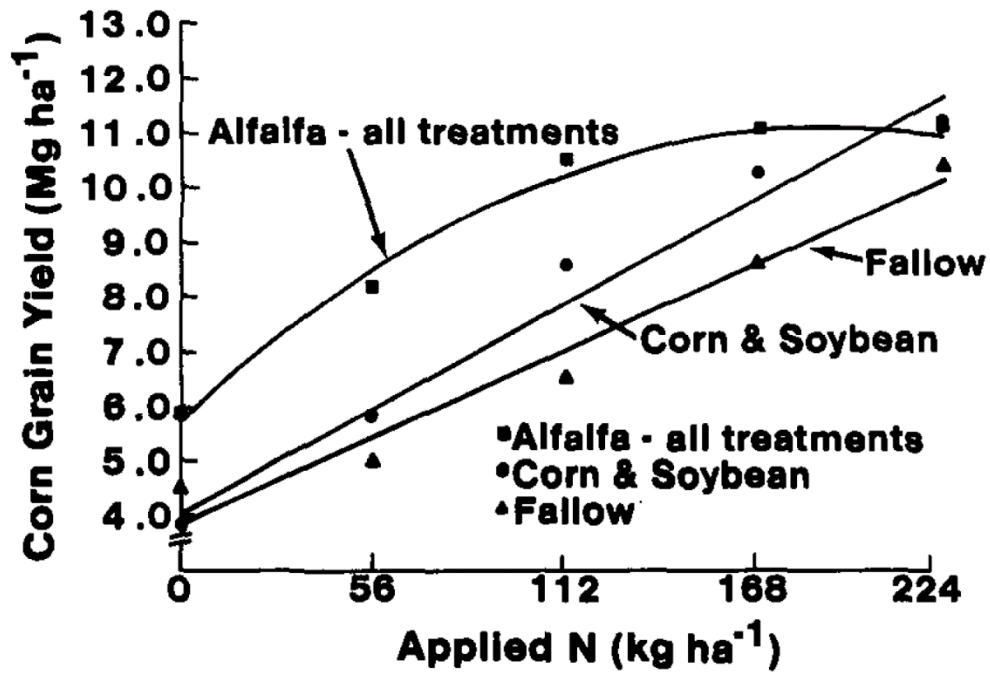
## Soybean

40 lb N /acre is available to crops following soybean in a rotation. No credit on sandy soils.

# Nitrogen Credits around the World

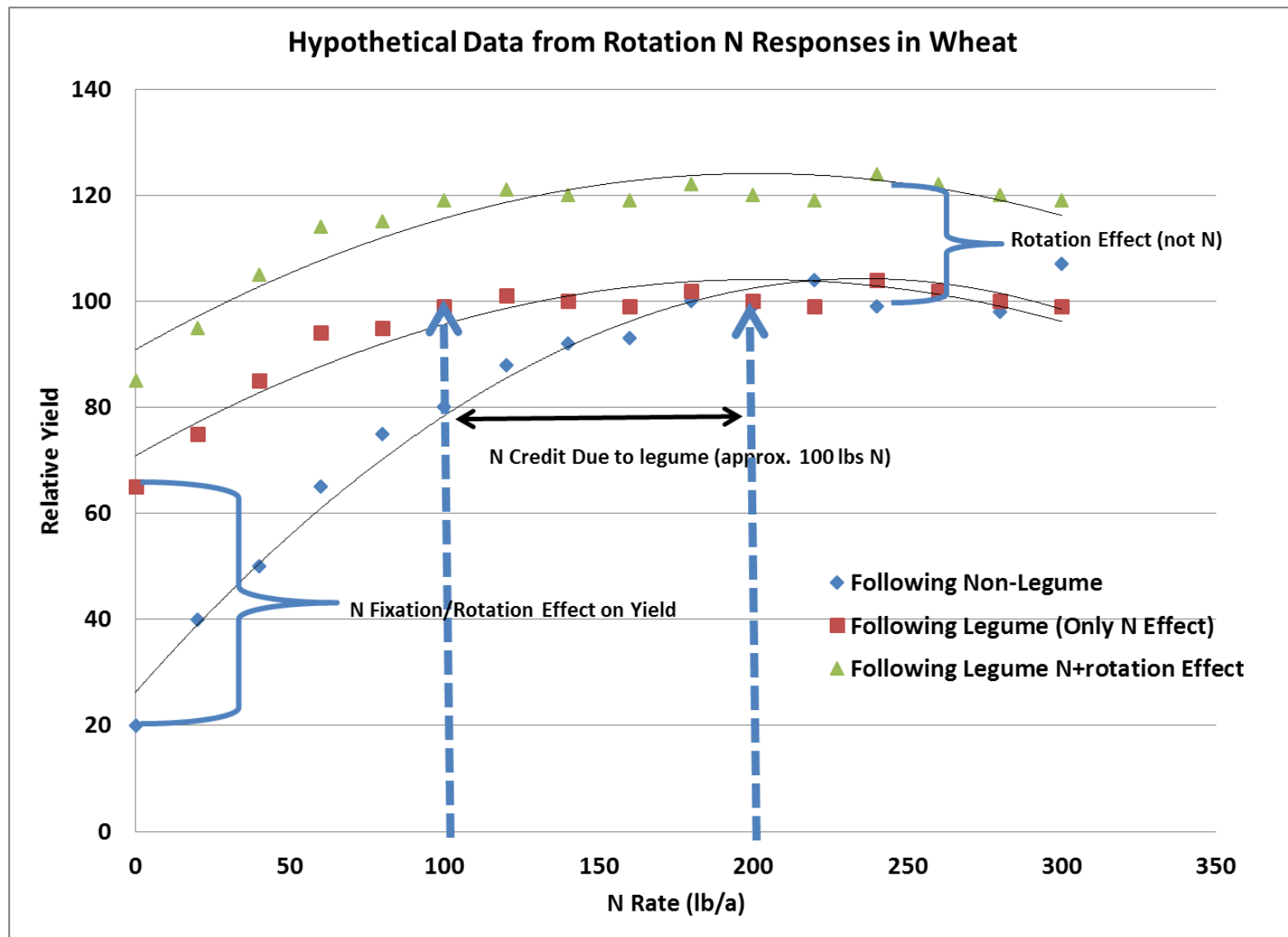






(Cela et al., 2011)

# Developing Nitrogen Credits for California



# Developing Nitrogen Credits for California: Rotation Study

- Two Rotation Treatments:
  - Continuous Alfalfa (3+ years)
  - Grain Rotation (Sudangrass/Wheat)
- Three Locations:
  - Davis (Solano County)
  - Kearney (Fresno County)
  - Tulelake (Siskiyou County)
- Six Nitrogen Rate Treatments in Wheat:
  - 0, 50, 100, 150, 200, 250 lbs N/acre

# Rotation Study Treatments

## Continuous Alfalfa and Grain Rotation



Tulelake



Davis

(Kearney site not pictured)

# Rotation Study Treatments

N Treatments in Wheat following Alfalfa and Grains



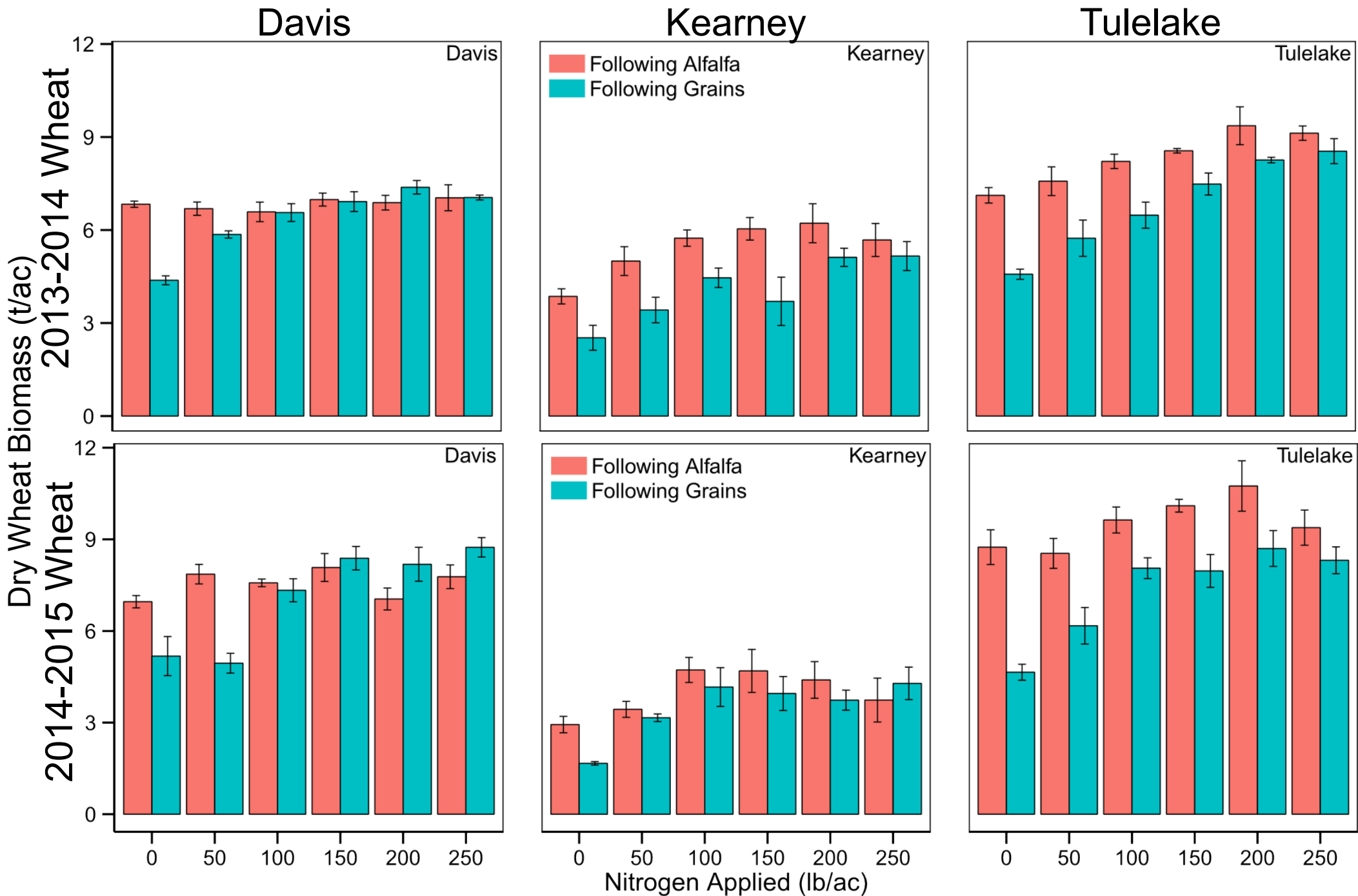
Tulelake



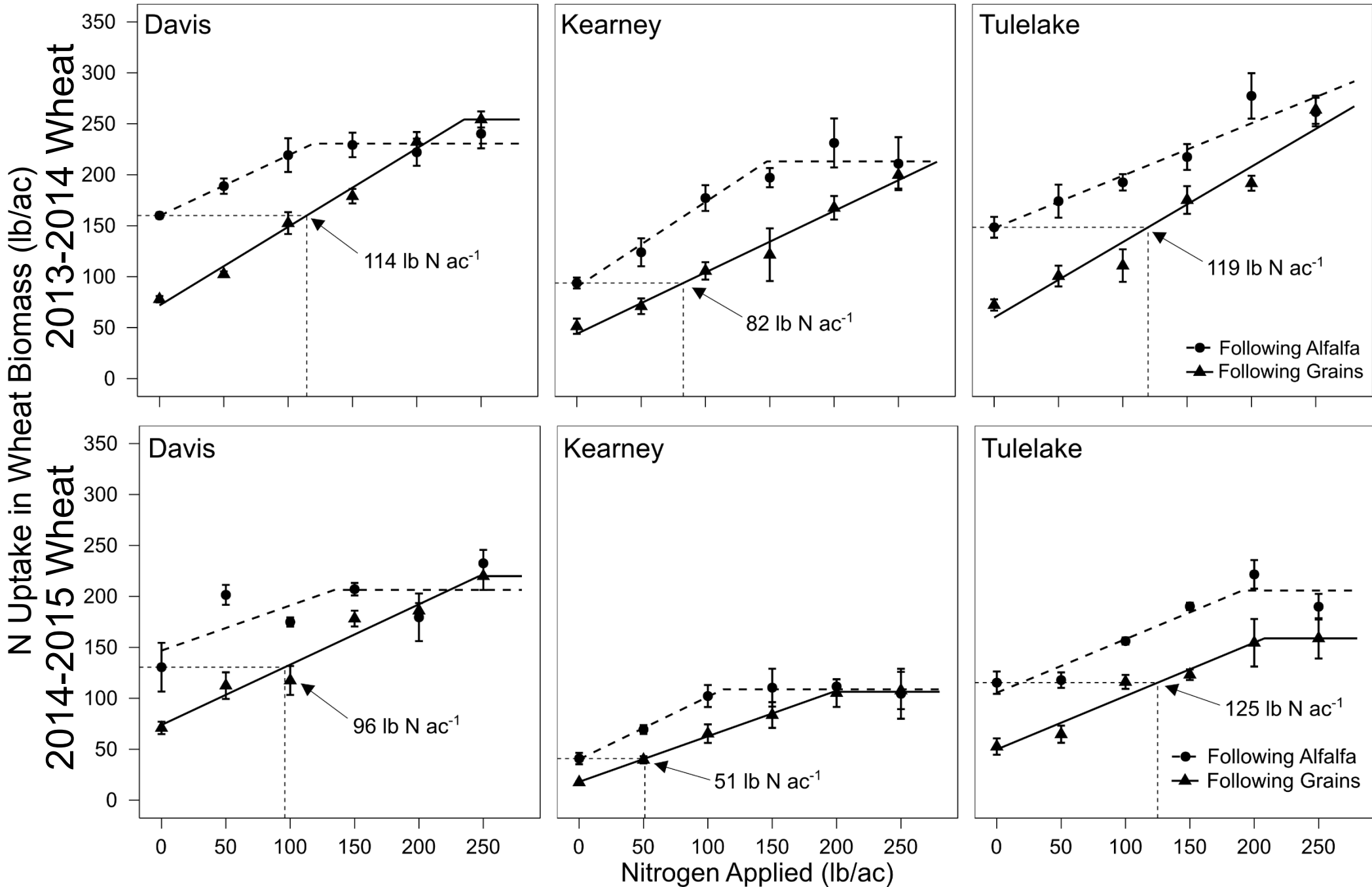
Kearney

(Davis site not pictured)

# What did forage yields tell us?



# Using forage N uptake to help predict N credits



# Conclusions

- Based on forage yields alone, without considering economic N rates, alfalfa's N contribution was:
  - 50-100 lbs N/acre at Kearney (Coarse Soil)
  - 100-150 lbs N/acre at Tulelake (Medium-Textured Soil)
  - 100-120 lbs N/acre at Davis (Medium-Textured Soil)
- Alfalfa provided enough N to satisfy wheat crop at Davis. More N increased grain protein content.
- Non-N rotation effects may have been at play at Tulelake and Kearney



Thanks!



# How much do soil tests say?

- Continuous alfalfa maintained relatively high soil nitrate concentrations compared to grain rotation
- Much less than 25 ppm  $\text{NO}_3^-$  optimum
- Soil total N was not significantly affected

## Nitrate Concentrations in Top 30 cm of Soil

Rotation Treatment	Continuous Alfalfa-Grain	Grain Rotation-Grain
Davis	6.79 ppm	2.86 ppm
Kearney	5.148 ppm	0.4925 ppm
Tulelake	6.95 ppm	3.97 ppm

Soil Total N Content by Depth  
After Continuous Alfalfa and after Grains Rotation  
At Davis, Kearney, and Tulelake

