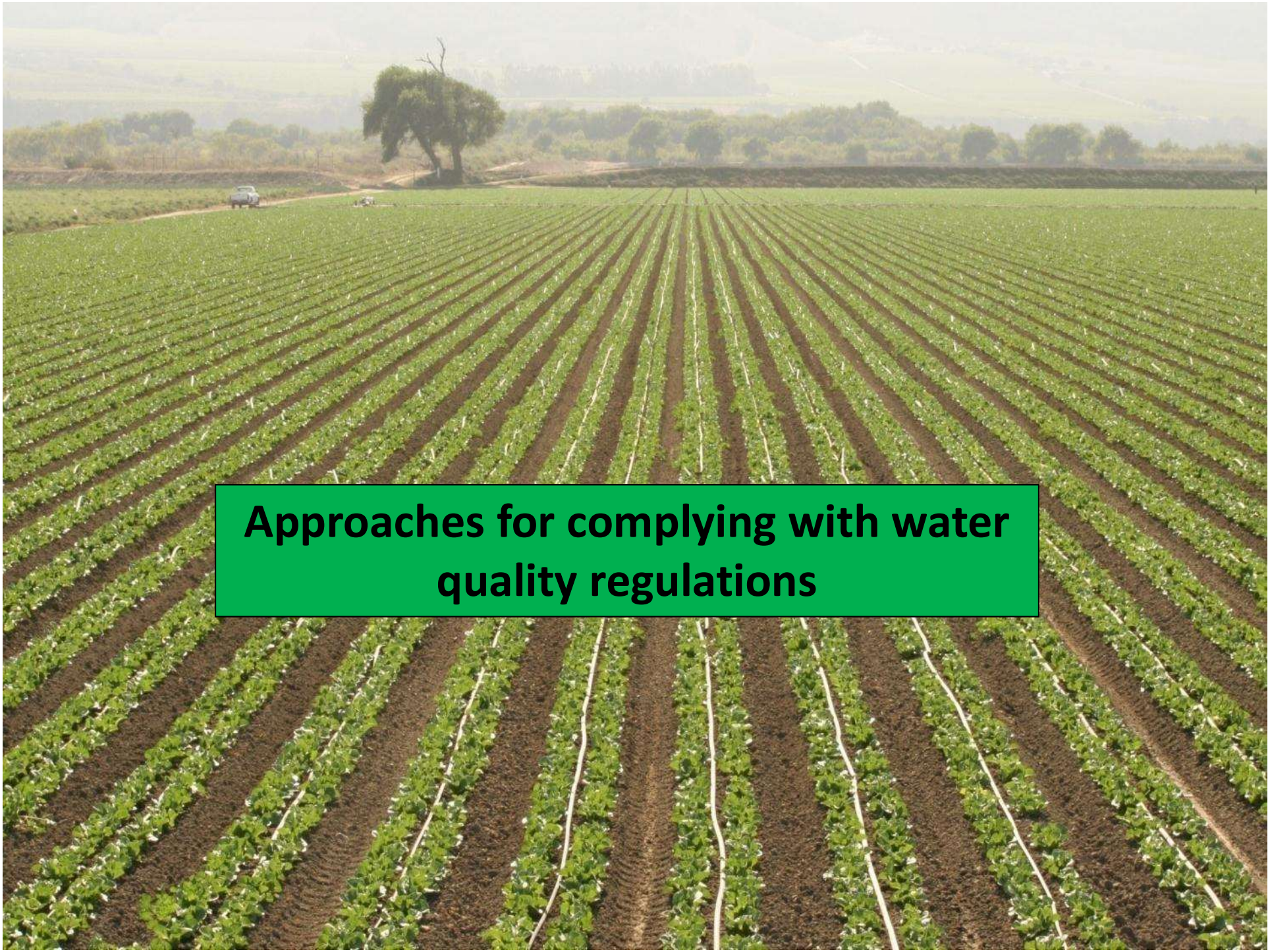
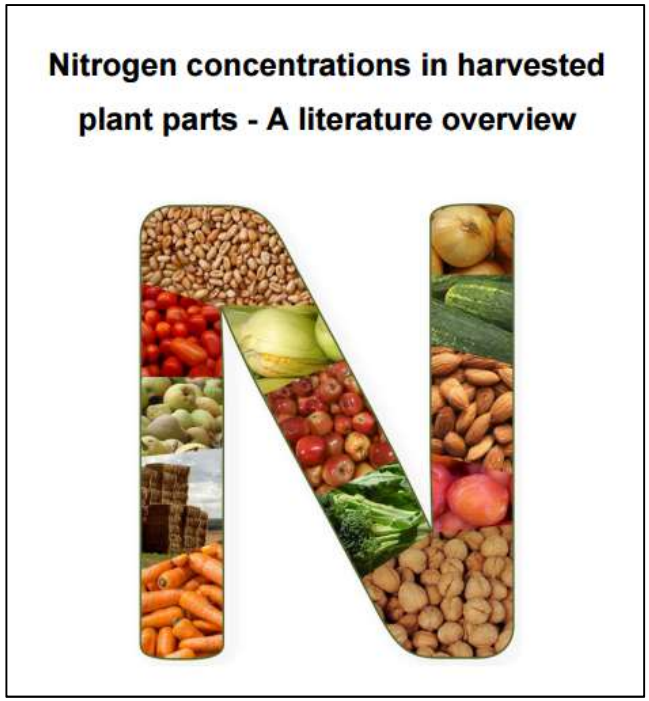

Approaches for complying with water quality regulations


Compliance will be a moving target …

2016 report to the Region 5 (Central Valley) Water Board:



The intent is to establish defensible calculations for 'N balance':

- **N application vs. *harvest removal***
  - **A/R**
  - **A-R**

For long-term compliance …

- **What practices will get you *closest* to a zero N balance?**

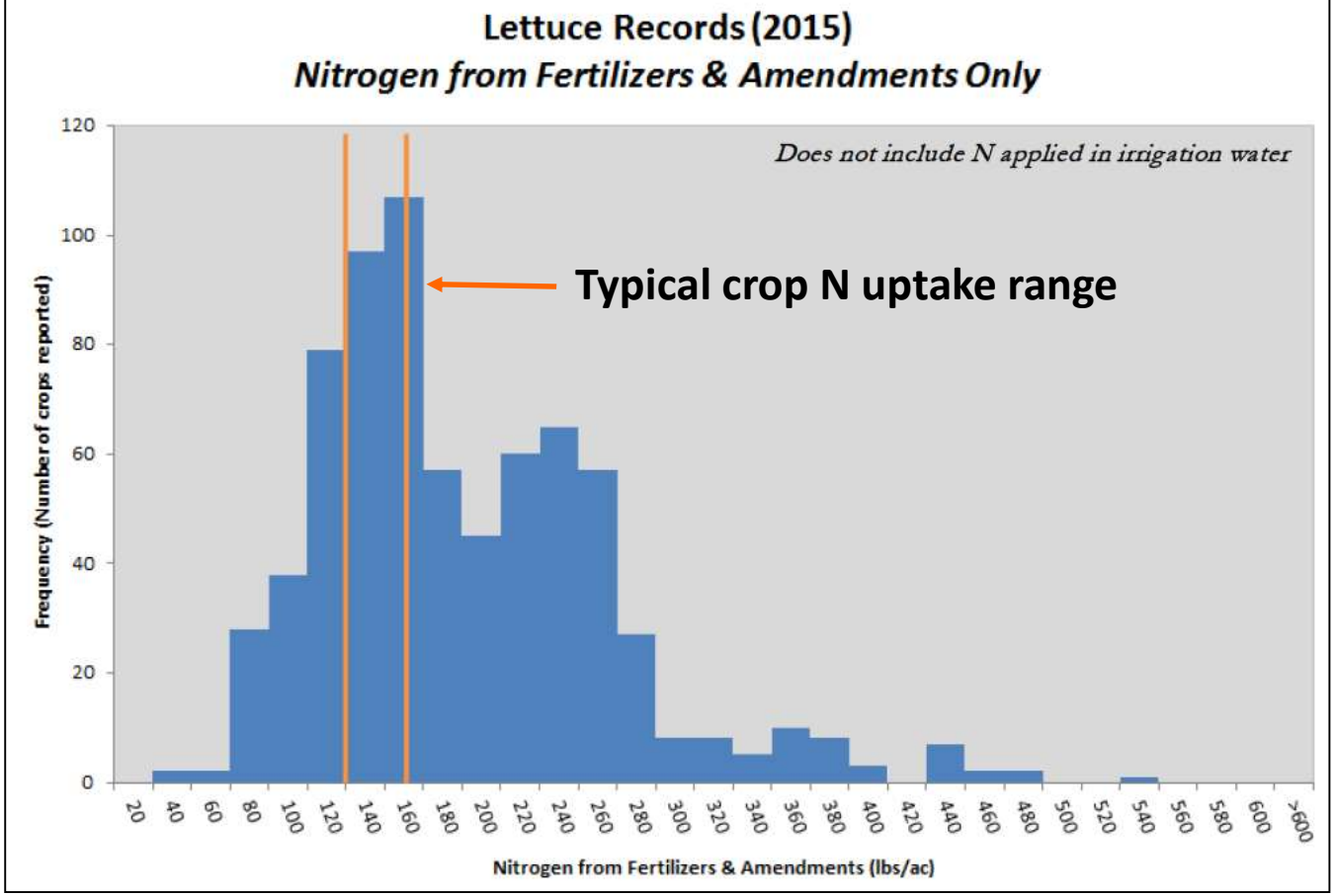
SUMMARY OF TOTAL NITROGEN APPLIED REPORTING REQUIREMENT DATA

CENTRAL COAST REGION

Chris Rose
February 2016

Grower Reported N from Fertilizers

(718 Crop Records) Compared to Specific Crop Nitrogen Uptake



Fertilizer alone:

55% reported more N application than *crop uptake*

(*nearly 100% reported more N application than harvest N removal*)

Regional Boards are also tracking N application in irrigation water:

Grower Reported Nitrate Concentration and Nitrogen Applied in Irrigation Water by county 2015

Irrigation Water Concentration (NO3-N) (as reported) (By Ranch)

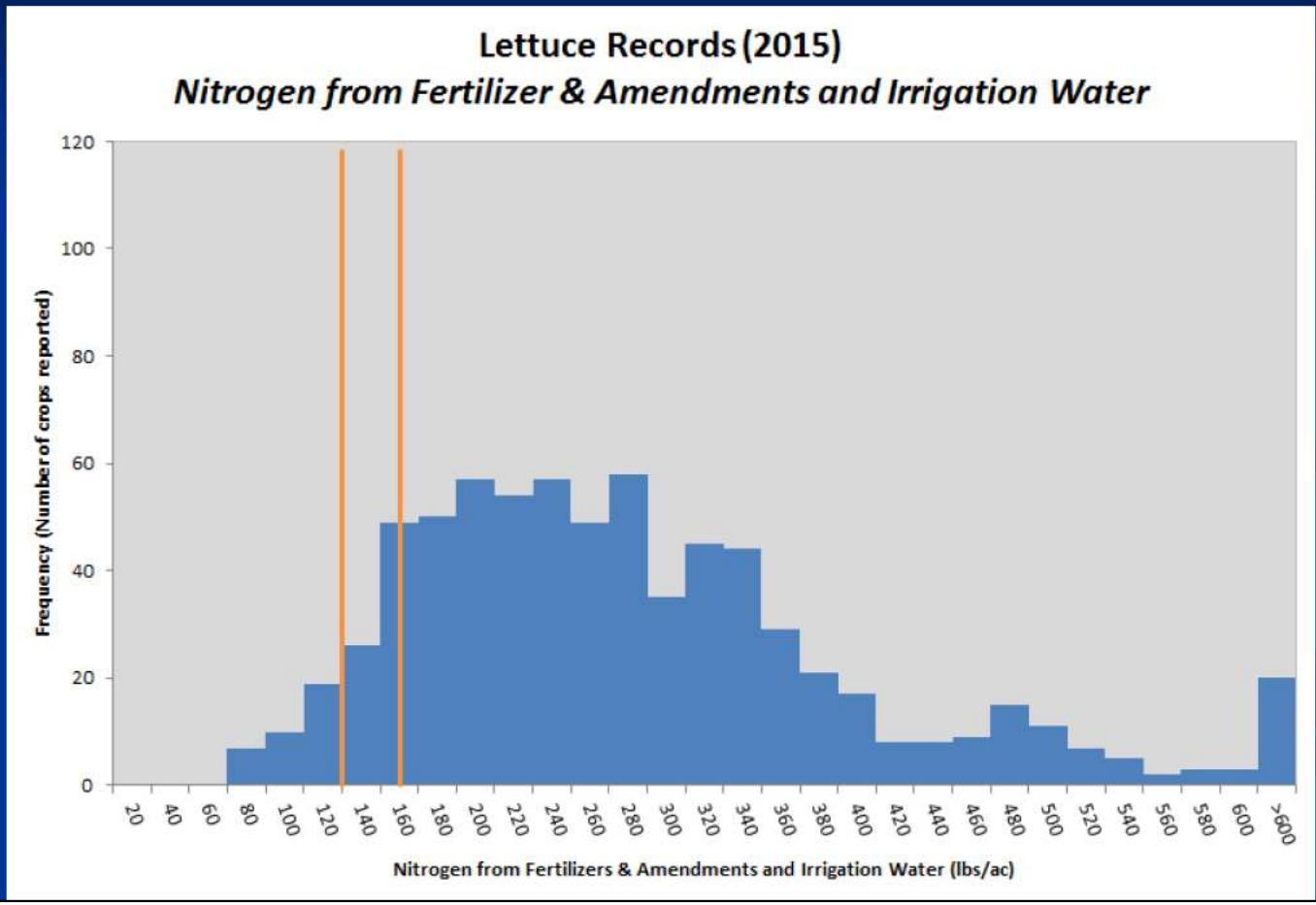
	All	Conventional	Organic	SLO	Monterey	S. Barbara	S. Benito	S. Clara	S. Cruz
Max (mg/l)	435			95	122	435	43	56	38
Min (mg/l)	0			6	0	0	0	1	0
Average (mg/l))	21			35	21	22	7	14	16

Mass of Nitrogen Applied in Irrigation Water (By Ranch)

Max (lbs/ac)	5440			980	1571	5440	191	476	300
On a ranch → Min (lbs/ac)	0			3	0	0	0	0	0
On a ranch → Average (Mean) (lbs/ac)	181			222	190	211	32	91	98

Grower Reported N from Fertilizers + Irrigation

(718 Crop Records) Compared to Specific Crop Nitrogen Uptake



Fertilizer + NO_3-N in irrigation water:

87% reported more N application than *crop N uptake*

N applied below, within, or above uptake range for the crop 2015

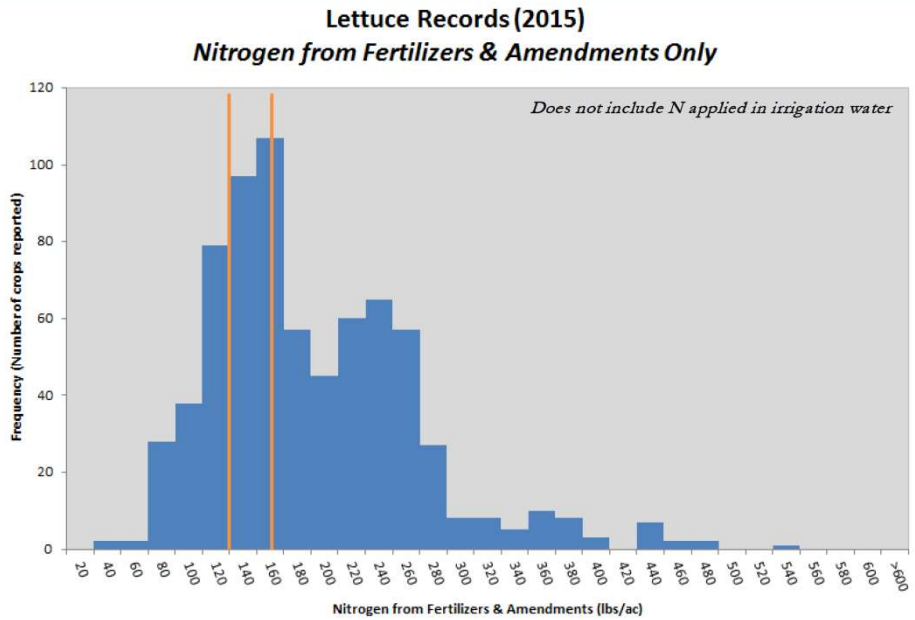
Crop	Needs Range		Fertilizer Only				Fertilizer + Water			
	Min	Max	Below	Within	Above	Records	Below	Within	Above	Records
Broccoli	180	337	124 38.2%	178 54.8%	23 7.1%	325	36 11.1%	192 59.1%	97 29.8%	325
Cauliflower	180	355	62.0 35.4%	105.0 60.0%	8.0 4.6%	175	16 9.1%	120 68.6%	39 22.3%	175
Celery	200	250	48.0 33.6%	51.0 35.7%	44.0 30.8%	143	19 13.3%	28 19.6%	96 67.1%	143
Lettuce	120	150	149 20.8%	178 24.8%	391 54.5%	718	36 5.0%	55 7.7%	627 87.3%	718
Spinach	120	130	35 29.9%	5 4.3%	77 65.8%	117	11 9.4%	2 1.7%	104 88.9%	117
Strawberry	200	240	40 44.4%	19 21.1%	31 34.4%	90	11 12.2%	12 13.3%	67 74.4%	90
ALL			458 29%	536 34%	574 37%	1568	129 8%	409 26%	1030 66%	1568

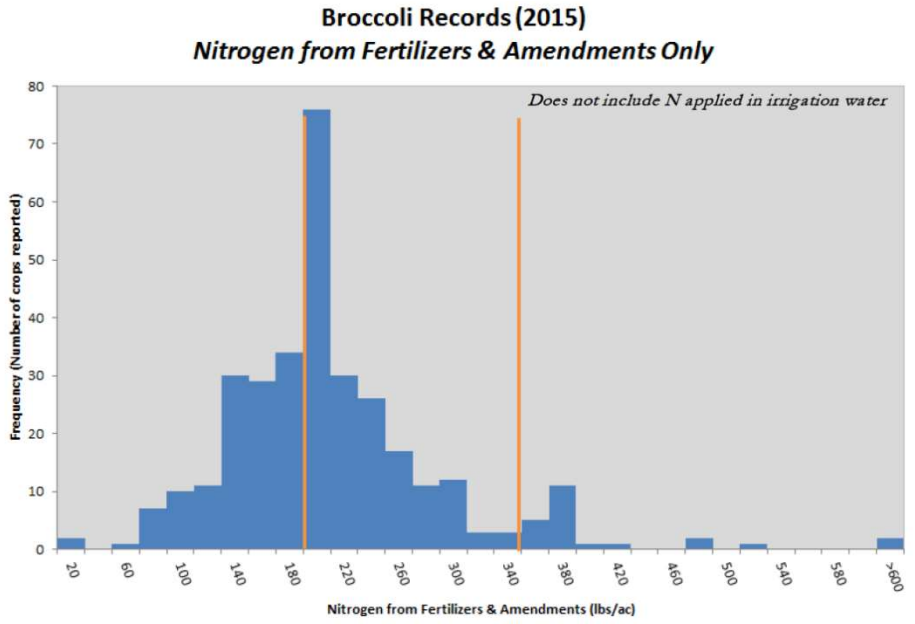
Priority 1:
Rethink N fertilization template

- Why are some growers' N rates so much higher than others?

- Why is N application on broccoli and cauliflower substantially less than crop N uptake, when N application on lettuce and other leafy greens is much higher than crop N uptake?

Grower Reported N from Fertilizers
(718 Crop Records) Compared to Specific Crop Nitrogen Uptake





Priority 2:
Account for N in irrigation water

Irrigation Water Concentration (NO3-N) (as reported) (By Ranch)									
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On a ranch

On a ranch

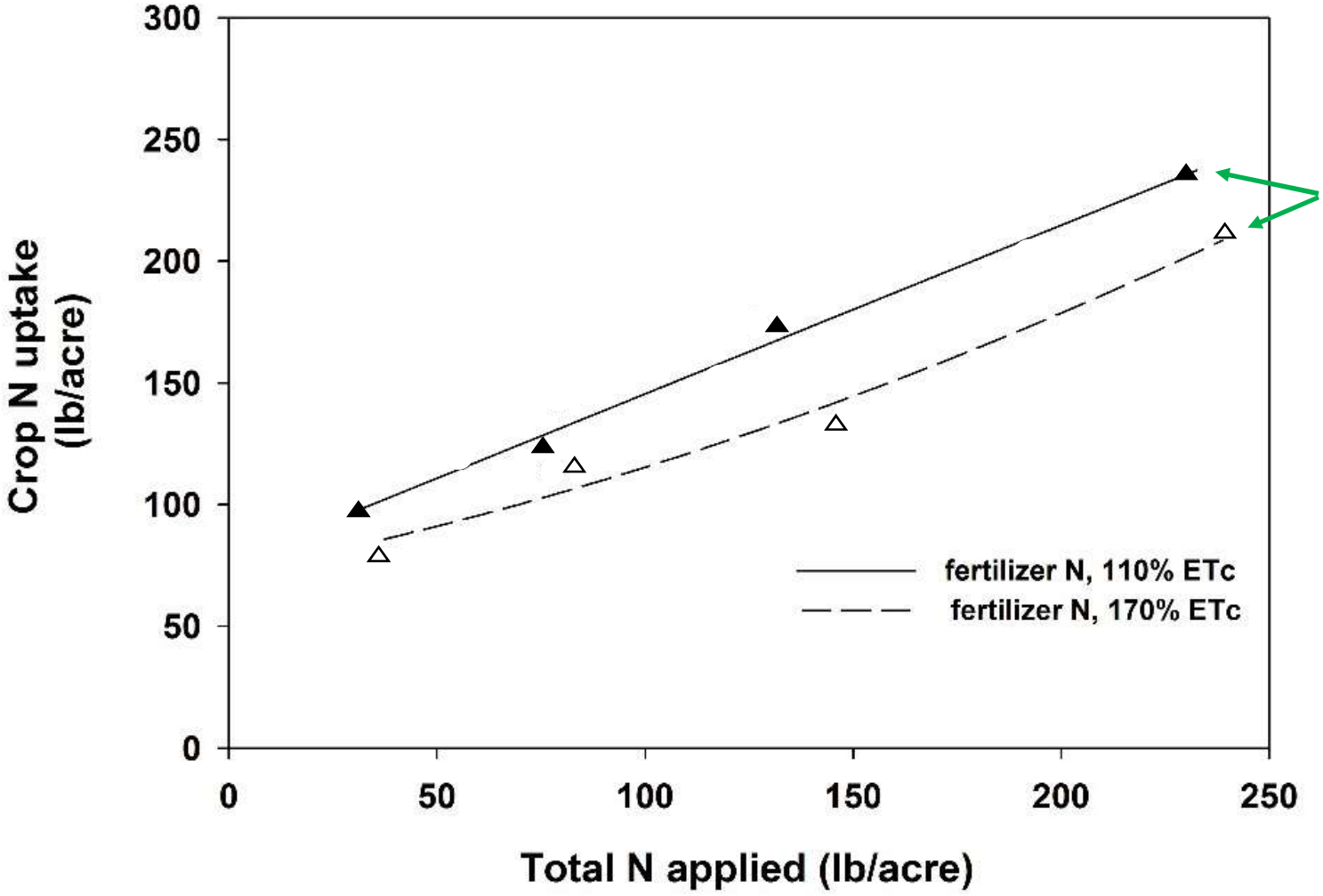
How, exactly ???

2013-15 Irrigation water NO_3-N uptake efficiency trials:

- continuously injected varying levels of NO_3-N from 2-45 PPM to simulate irrigation water NO_3-N
- Compared with crop response to normal N fertigation

2015 Broccoli trial:

- **Efficiency of N recovery from water NO_3-N *at least as good* as from N fertilizer**



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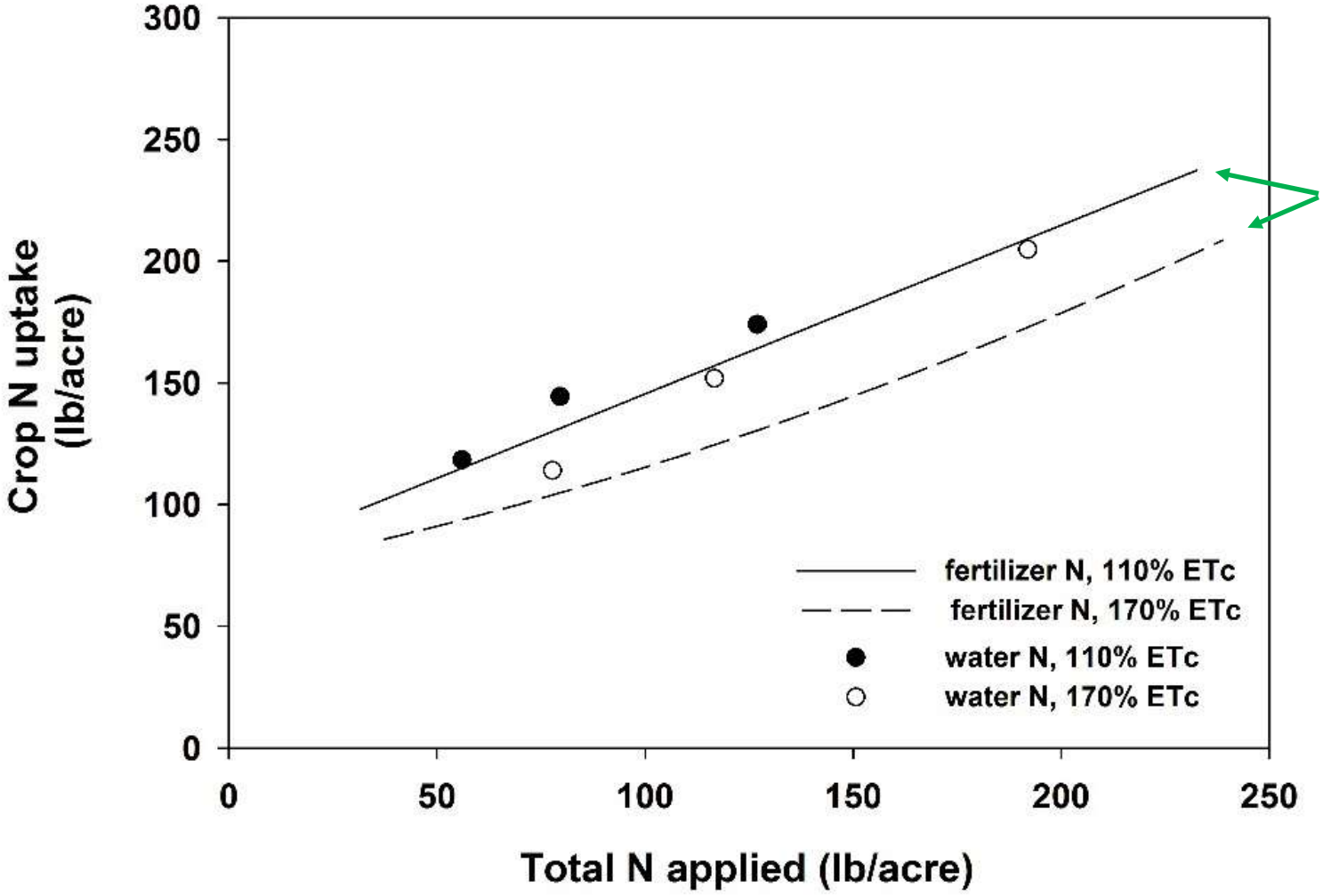
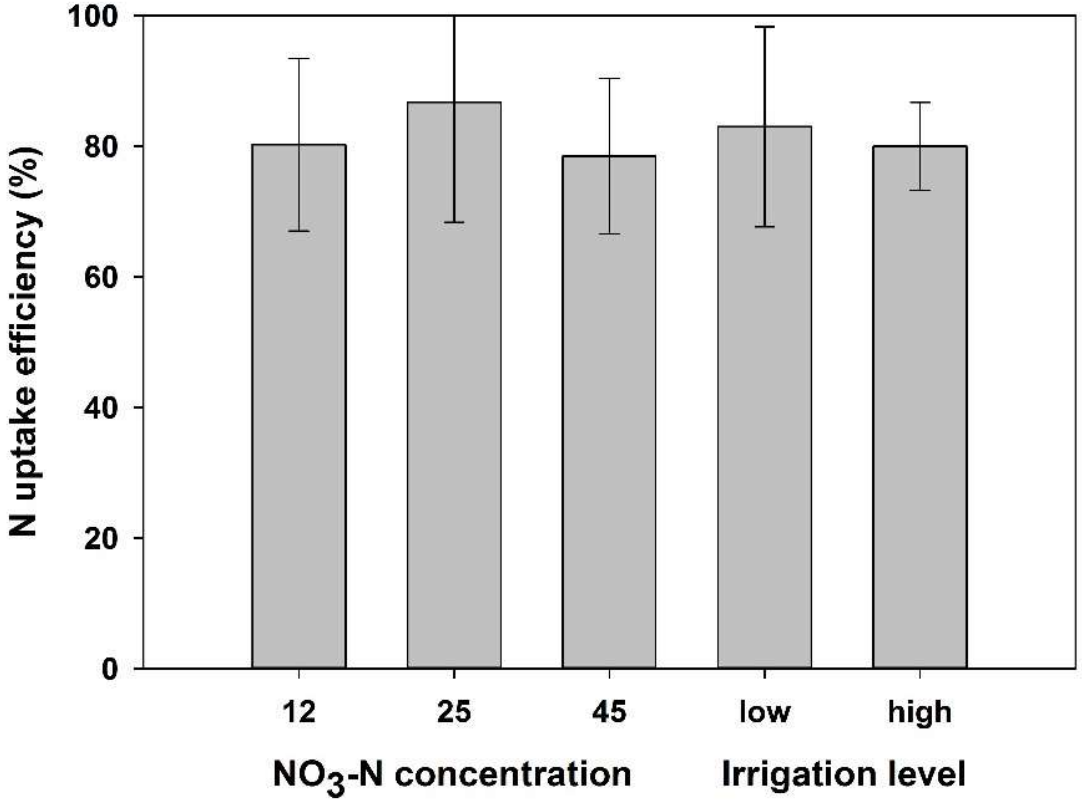


Response to N fertigation at two irrigation levels

Mean N uptake efficiency (NUE) of irrigation water NO_3-N:

- Across 4 trials ≈ 80% of irrigation water NO_3-N was taken up by the crop
- Neither NO_3-N concentration nor irrigation efficiency affected NUE



How can that be?

- Very low background residual soil NO_3-N in these fields
- All NO_3-N enriched water was drip applied, in relatively small individual applications
  - small leaching events, so plants have an opportunity to access part of the NO_3-N in the water that eventually leached

Calculating a 'fertilizer credit' for irrigation water NO_3-N:

- A 'fertilizer credit' is different than 'uptake efficiency'
  (both fertilizer N and water N are subject to inefficiency due to leaching)

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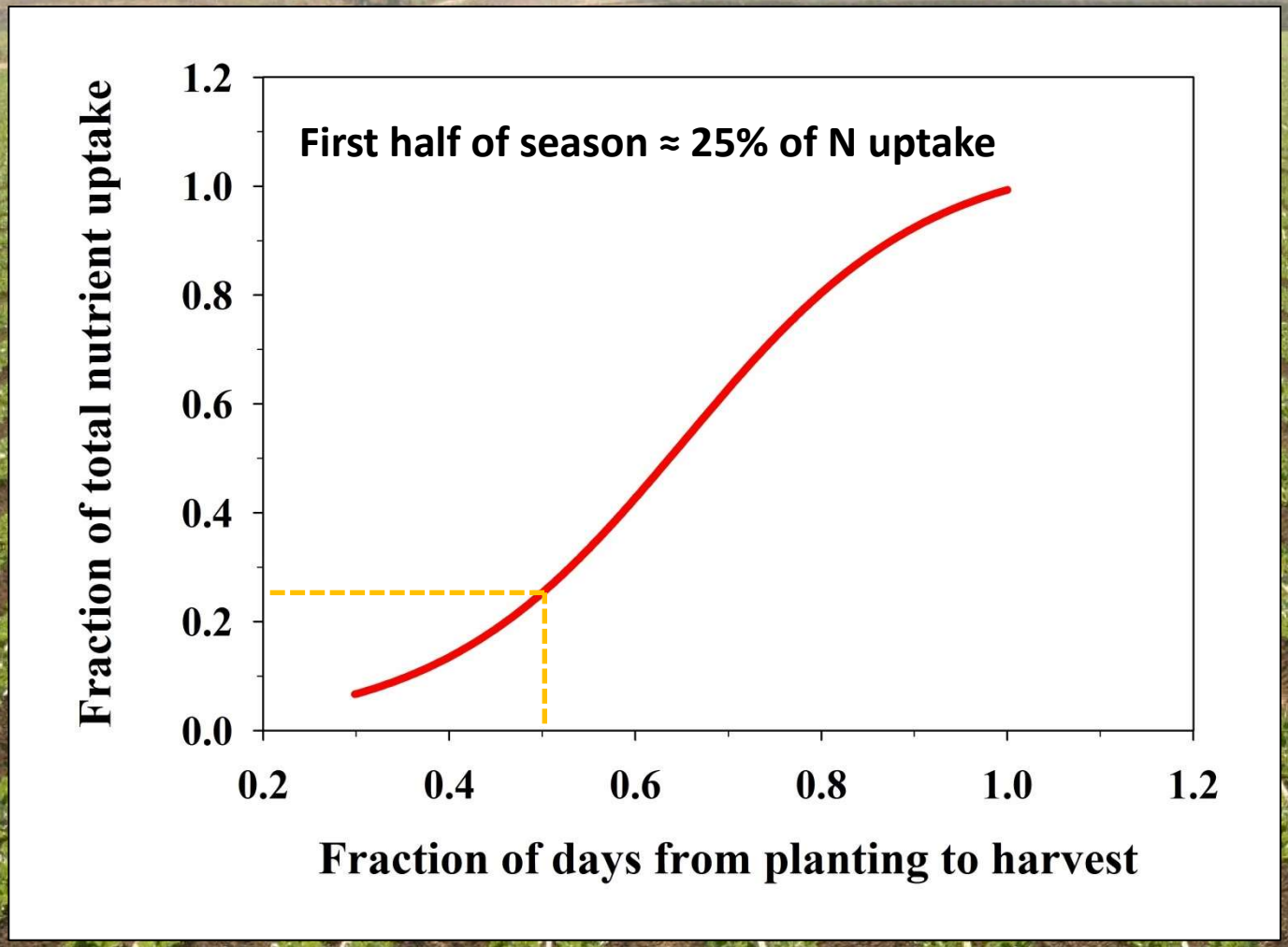
- Apply an in-season 'discount' for inefficiency with sprinklers ?

Priority 3:
Maximize efficiency of applied N

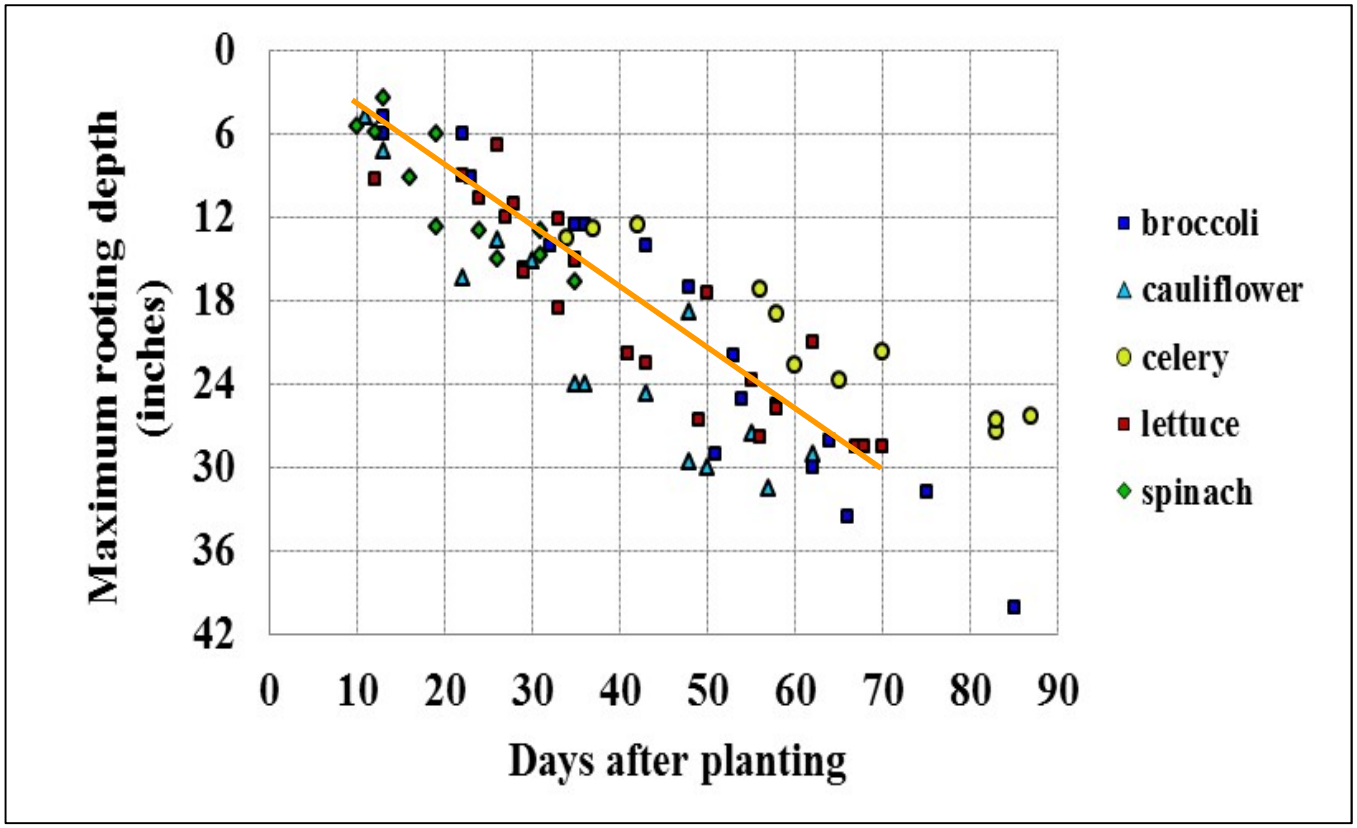


- Minimize preplant and early-season application

The earlier N is applied, the more likely it leaches below the root zone:

- **Roots take weeks to develop**

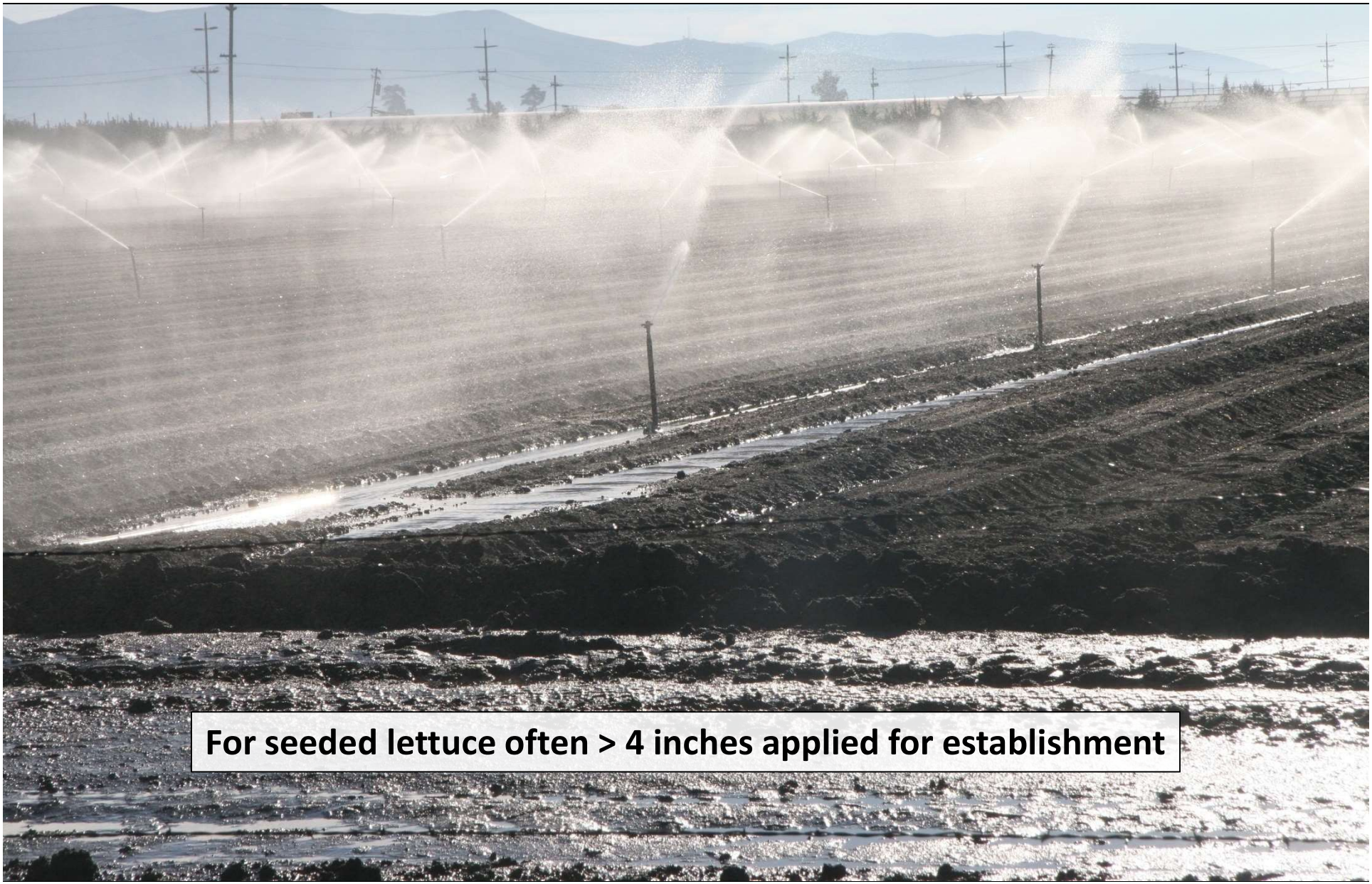
Salinas Valley fields:



Rooting depth increases ≈ ½" per day, across crops

The earlier N is applied, the more likely it leaches below the root zone:

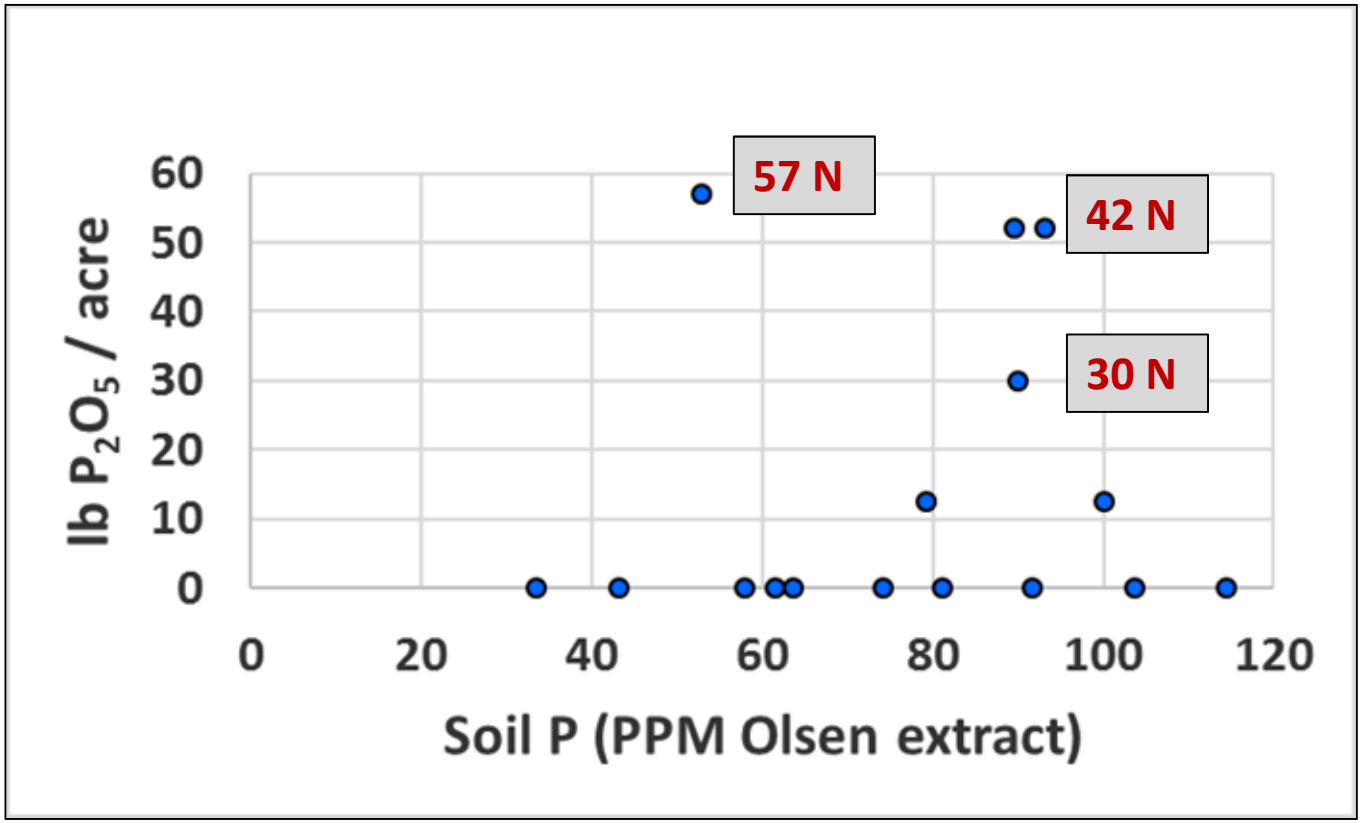
- **Irrigation tends to be least efficient during crop establishment**



Preplant N rate strongly influenced by P management:

- **Is preplant P necessary?**
- **If so, why use a high-N fertilizer?**

Preplant P management in 16 successful summer lettuce fields:



First sidedress can also be highly inefficient:

- **Is it needed?**
- **How much is needed?**

Can fertilizer technology improve early season N efficiency ?

GREENFEED™

Nitrogen Technology Evaluations
Richard Smith 2012-2016

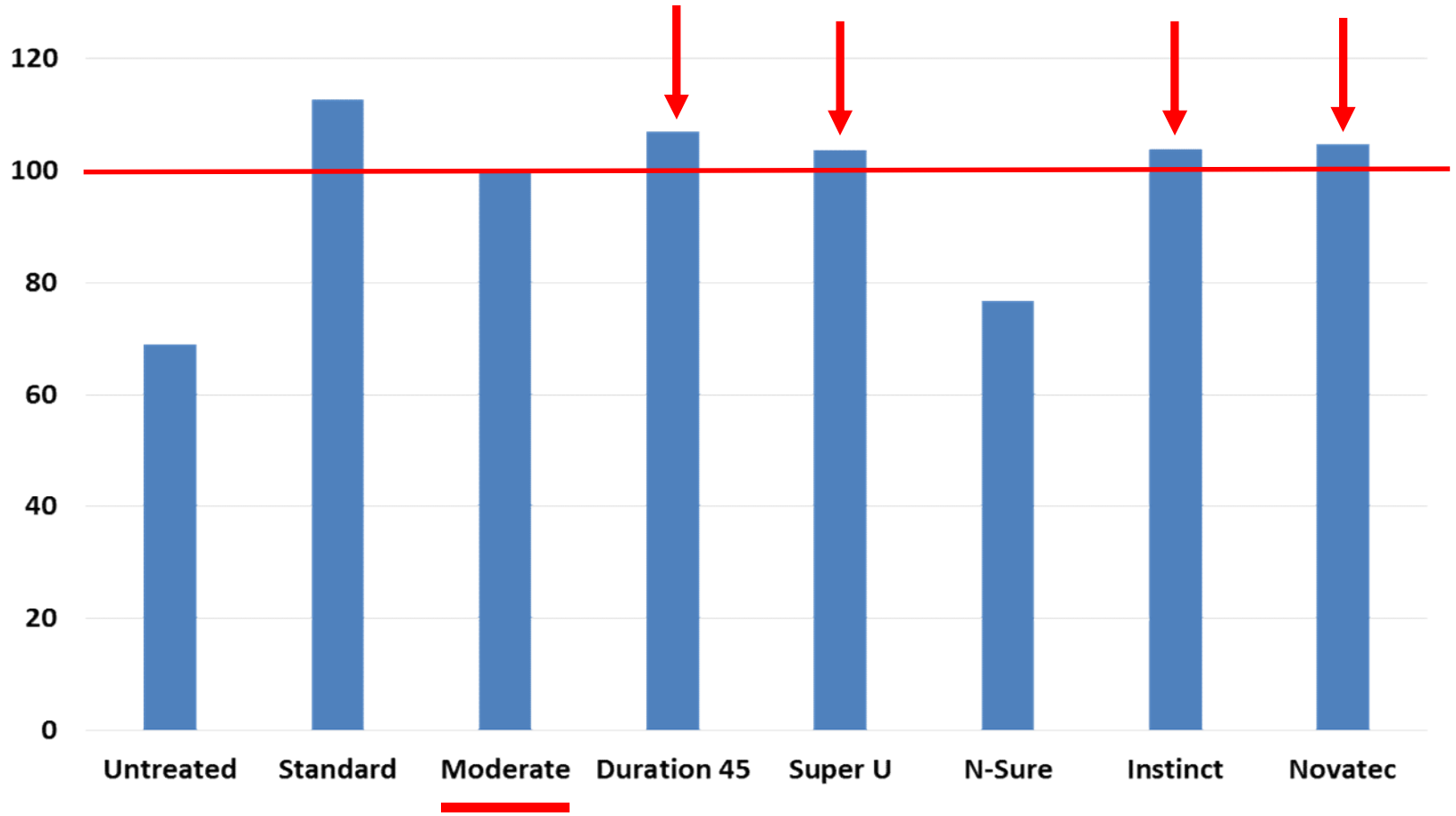
Material	Trade name	Comment
Nitrification inhibitors		
Nitrapyrin	Instinct	Inhibitor or Nitrosomonas and Nitrobacter, commonly used in the cornbelt
DMPP	Novatec	Inhibitor or Nitrosomonas and Nitrobacter. The active ingredient is commonly used in Europe
DCD + urease inhibitor fertilizer additive	Agrotain Plus	DCD is the nitrification inhibitor and is mixed with a urease inhibitor; used as a fertilizer additive
DCD + urease inhibitor impregnated urea prill	Super U	DCD is the nitrification inhibitor and is mixed with a urease inhibitor; formulated as a dry prill
Controlled release		
Polymer coated urea prill	Duration 45	Polyurethane coated urea prill
Urea triazone	N-Sure	Ring of urea molecules; liquid formulation

Nitrogen Technology Evaluations:

- All trials included an untreated control, a standard fertilizer at a ‘standard’ N rate (enough to produce max yield), and at a ‘moderate’ rate (25-35% less than the standard)
- All ‘enhanced’ fertilizer products were applied at the ‘moderate’ rate to observe any efficiency improvement

Average Yield of Spinach

- **Mean of 7 trials**

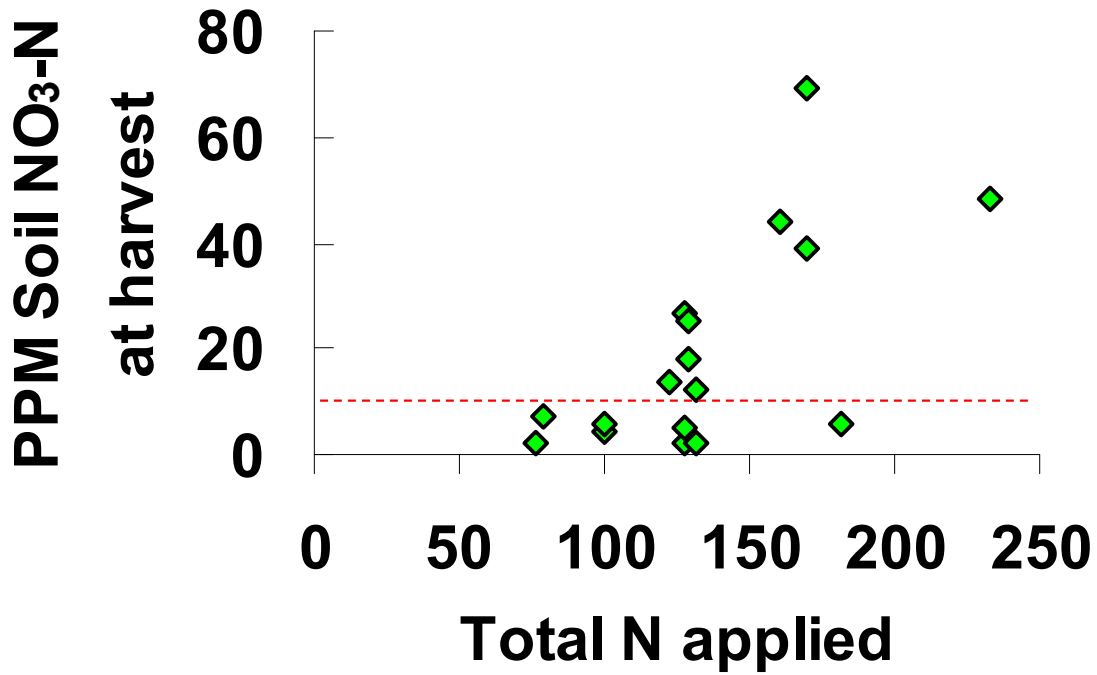


Conclusion: Fertilizer technology can improve N efficiency *modestly*, but on a field-specific basis

Priority 3: Maximize efficiency of applied N

- **Manage in-season inputs to draw down soil NO_3-N at harvest**

N management in 18 successful summer lettuce fields:



How to manage the draw down of soil NO_3-N?