Nitrogen use efficiency in field crops

NITROGEN MANAGEMENT PLAN WORKSHEET

1. Crop Year (Harvested): _____

2. Member ID# _____

3. Name: _____

4. APN(s):	5. Field(s) ID	

CROP NITROGEN MANAGEMENT PLANNING		N APPLICATIONS/CREDITS	26. Recommended/ Planned N	27. Actual N
6. Crop		**15. Nitrogen Fertilizers**		
7. Production Units		16. Dry/Liquid (lbs/ac)		
8. Projected Yield (Units/Acre)		17. Foliar N (lbs/ac)		
9. N Recommended (lbs/ac)		**18. Organic Material N**		
10. Acres		19. Available N in Manure/Compost (lbs/ac estimate)		
Post Production Actuals		20. Total Available N Applied (lbs per acre)		
11. Actual Yield (Units/Acre)		**21. Nitrogen Credits (est)**		
12. Total N Applied (lbs/ac)		22. Available N carryover in soil; (annualized lbs/acre)		
13. ** N Removed (lbs N/ac)		23. N in Irrigation water (annualized, lbs/ac)		
14. Notes:		24. Total N Credits (lbs per acre)		
		25. Total N Applied & Available		

PLAN CERTIFICATION		
28. CERTIFIED BY:	29. CERTIFICATION METHOD	X
	30. Low Vulnerability Area, No Certification Needed	
	31. Self-Certified, approved training program attended	
DATE:	32. Self-Certified, UC or NRCS site recommendation	
	33. Nitrogen Management Plan Specialist	

NITROGEN MANAGEMENT PLAN WORKSHEET

1. Crop Year (Harvested):	4. APN(s):	5. Field(s) ID

Objectives:

- **Require growers to give more attention to efficient N use**
- **Allow the Board to estimate the 'Nitrogen balance' for important crops**

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Basic assumption of a 'nitrogen balance' :

- **N applied to a field but not removed in harvested products is at risk of *eventual* loss to the environment, mostly through nitrate leaching**

Therefore:

- ***At similar yield levels*, a grower consistently applying substantially more N than his neighbor is probably releasing more N to the environment *over time***

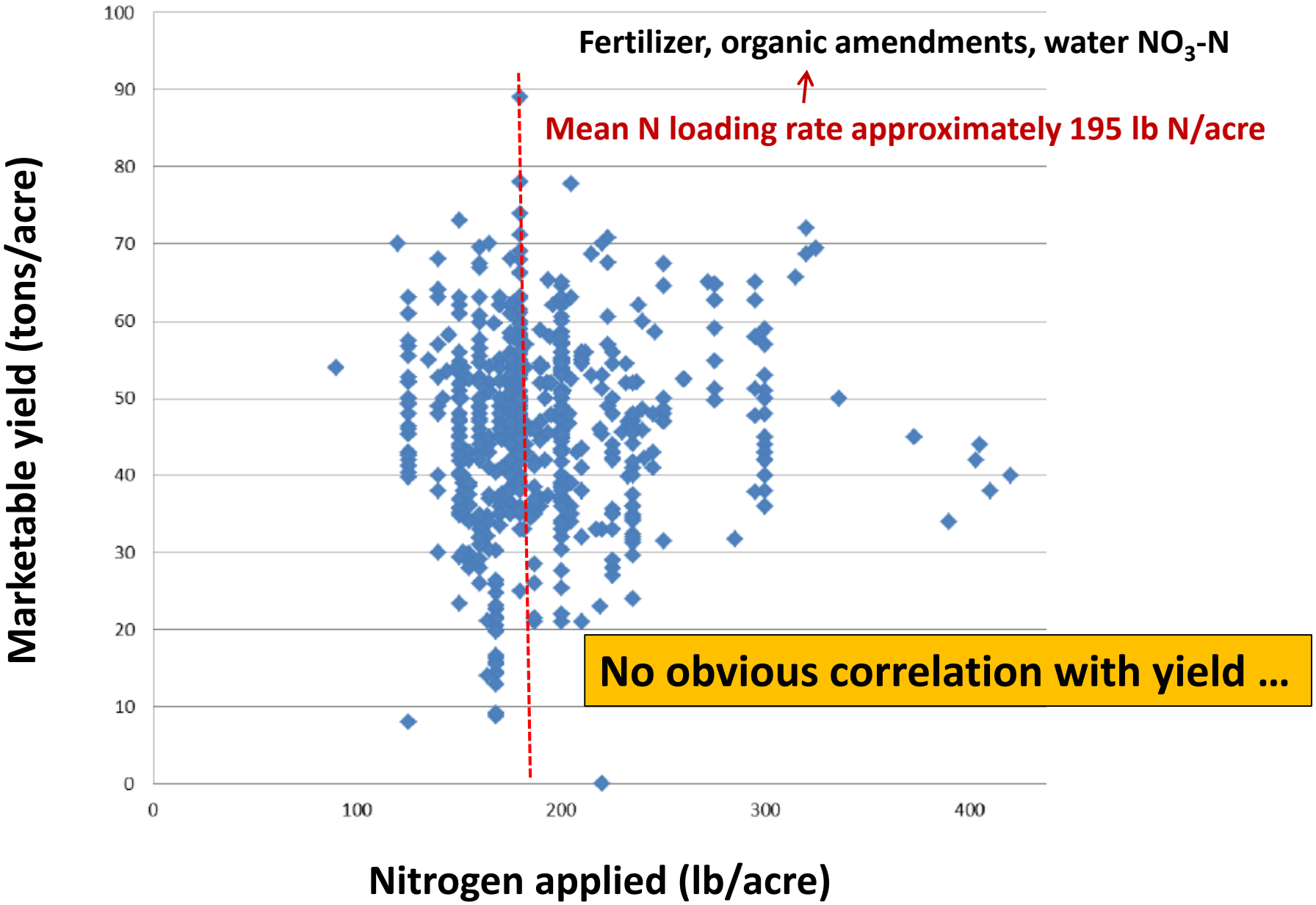
What does the nitrogen balance for processing tomatoes look like?

It depends on:

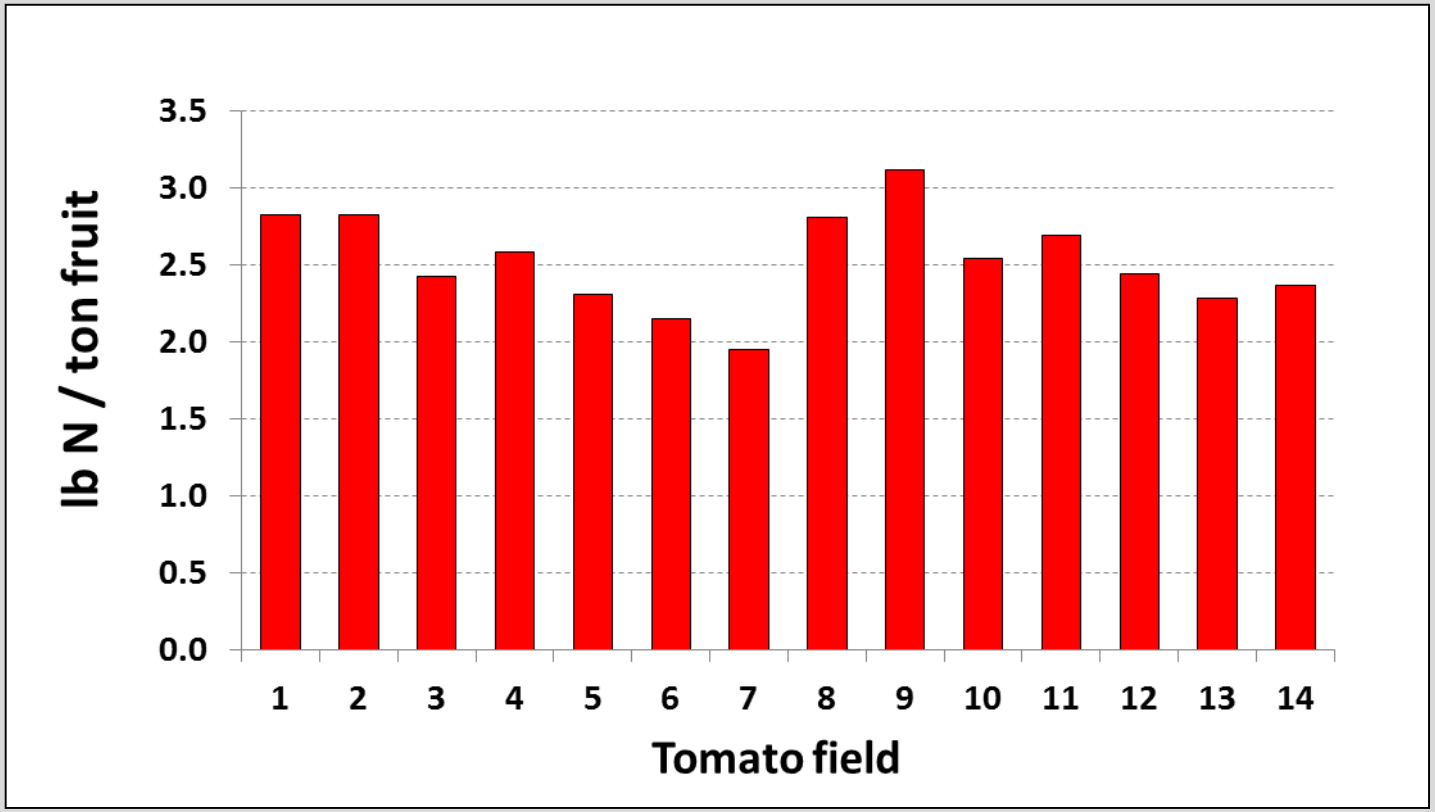
- **Amount of N loading (fertilizer, amendments, irrigation water NO_3-N)**
- **Fruit yield**
- **How you do the calculation**

  - simplest form (seasonal N input - harvest N removal)

2013 Survey of processing tomato growers:



Sampling in many commercial fields provides crop N uptake information:



- Fruit varies in N content, averaged approximately 2.6 lb/ton; other estimates slightly higher (up to 3 lb N/ton?)
- Harvested fruit averaged 55-65% of total crop N uptake

Lazcano et al., 2015, California Agriculture 69:222-229

Yield effects on N dynamics:

	Approximate amount of N/acre		
Yield (tons/acre)	Crop N uptake	N in harvested fruit	N in residue
40	200	110	90
50	230	140	90
60	270	170	100
70	310	200	110

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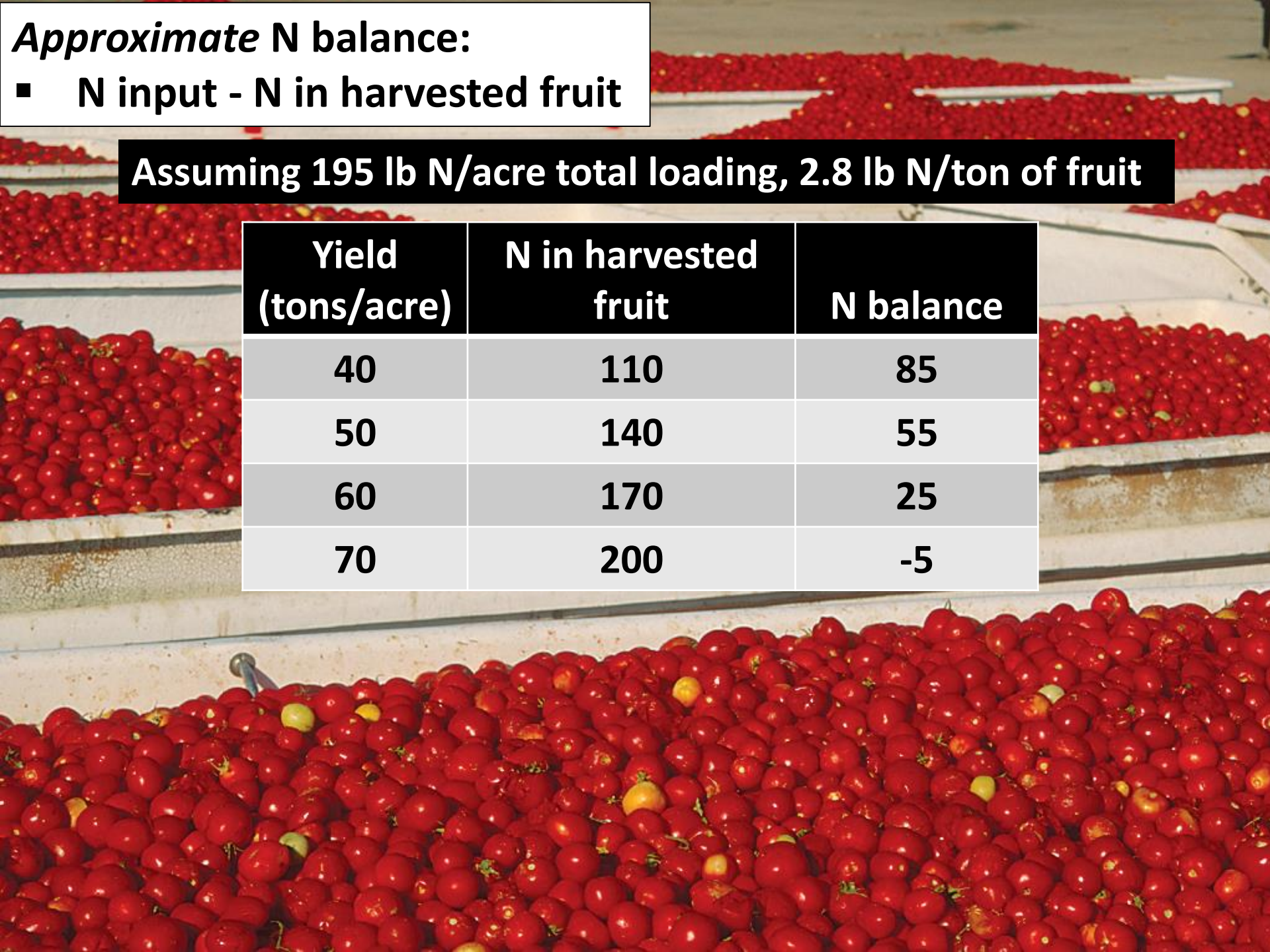
Tomatoes take up a significant amount of non-fertilizer N



Approximate N balance:

- N input - N in harvested fruit

Assuming 195 lb N/acre total loading, 2.8 lb N/ton of fruit

Yield (tons/acre)	N in harvested fruit	N balance
40	110	85
50	140	55
60	170	25
70	200	-5

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This is not all lost to leaching !!!

- There are other N loss mechanisms
- Typically 80-100 lb N/acre is in the vines; much of that N can be captured by a succeeding crop *if the management of that succeeding crop accounts for this carry-over N*

N balance for other crops?

https://www.ipni.net/app/calculator/home

Crops

- ☆ Alfalfa (DM)
- ☆ Almonds, with shell
- ☆ Alsike clover (DM)
- ☆ Apples
- ☆ Bahiagrass
- ☆ Barley grain
- ☆ Barley straw

http://plants.usda.gov/npk/main

Nutrient Content of Crops

Select Crops
About the Crop Nutrient Tool
Nutrient Data Sources
Download Crop Nutrient Database

A tool for calculating the approximate amount of nitrogen, phosphorus, and potassium that is removed

Step 1

Select the crop type(s) in which you are interested.
At least one selection must be made:

- ☐ Cereal and Oil Crops
- ☐ Forage Crops
- ☐ Fiber and Miscellaneous Crops
- ☐ Tree and Fruit Crops
- ☐ Vegetable Crops

OR...

Enter the full or partial name of a crop (i.e. 'corn').
All crops from any crop type will be displayed on the following page.
The search will be performed so that any crop name containing the string entered will be retrieved.

Click the button below to view a list of crops associated with the crop type(s) selected above.

View Crop List | Reset Selections

So, how to determine N fertilizer need?

- Since yield and N rate were poorly correlated, use the lower side of current rates as a starting point
- Consider crop N uptake requirement based on realistic yield potential
- Adjust for field-specific factors

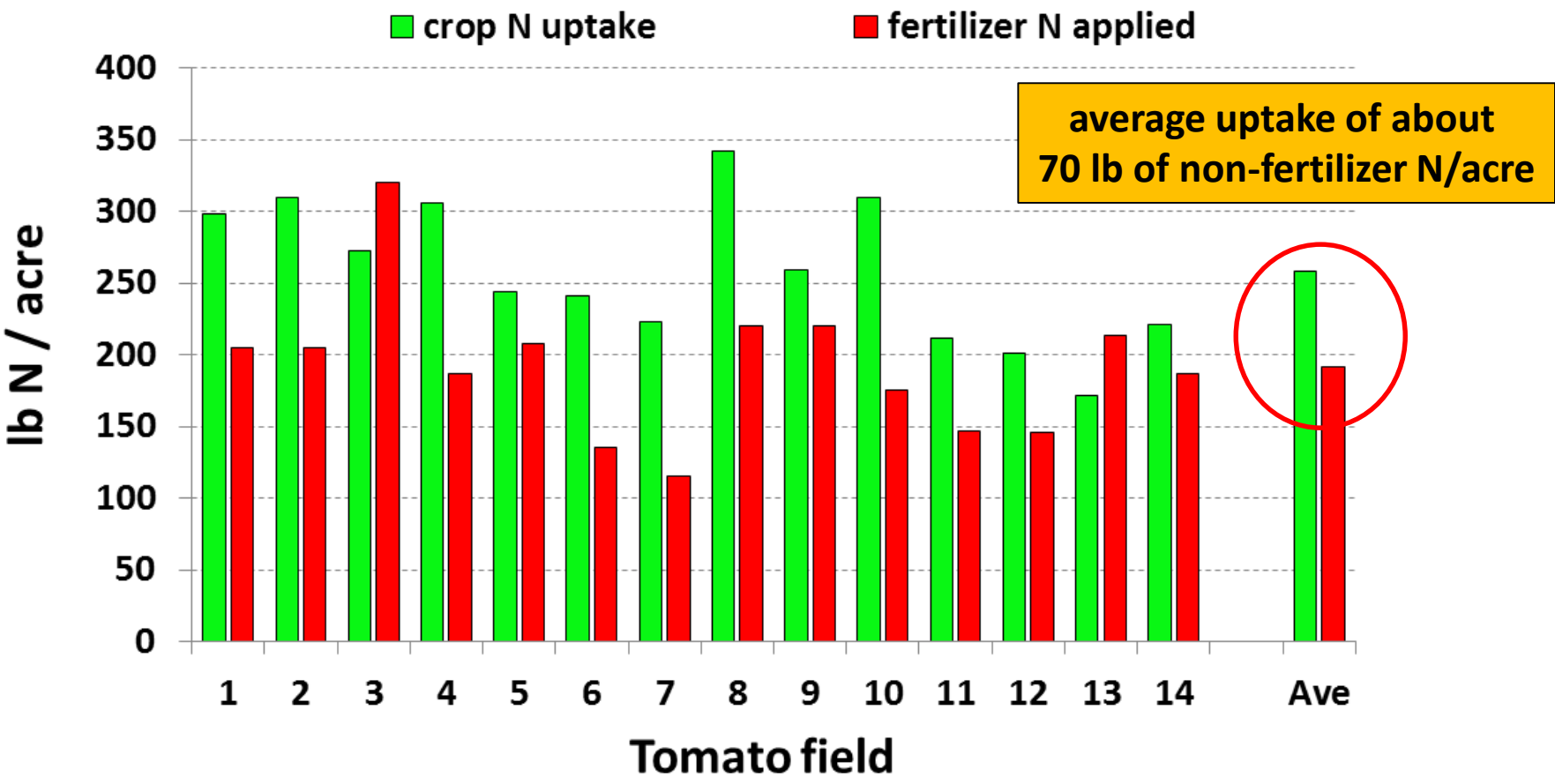
Calculating crop N uptake requirement:

- Tomato fruit N content of 2.6 lb N/ton is adequate
- Fruit typically represents about 55-65% of total crop N uptake

Yield goal (tons/acre)	Approximate N uptake requirement* (lb/acre)
40	195
50	225
60	260
70	300

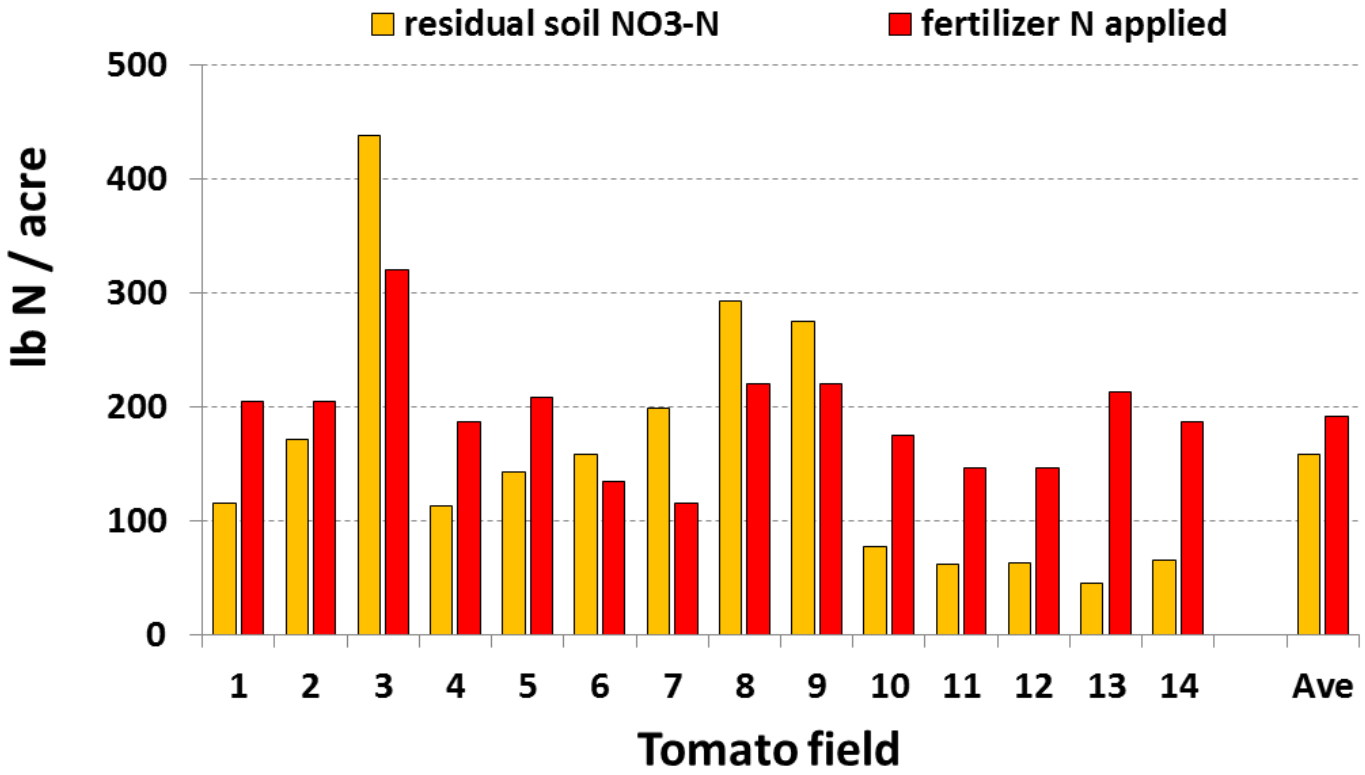
** N uptake requirement does not mean N fertilizer requirement !!*

Non-fertilizer N contributes substantially to crop N uptake:



Lazcano et al., 2015, California Agriculture 69:222-229

Residual soil NO_3-N varies widely, but few growers consider it when formulating N fertilization programs:



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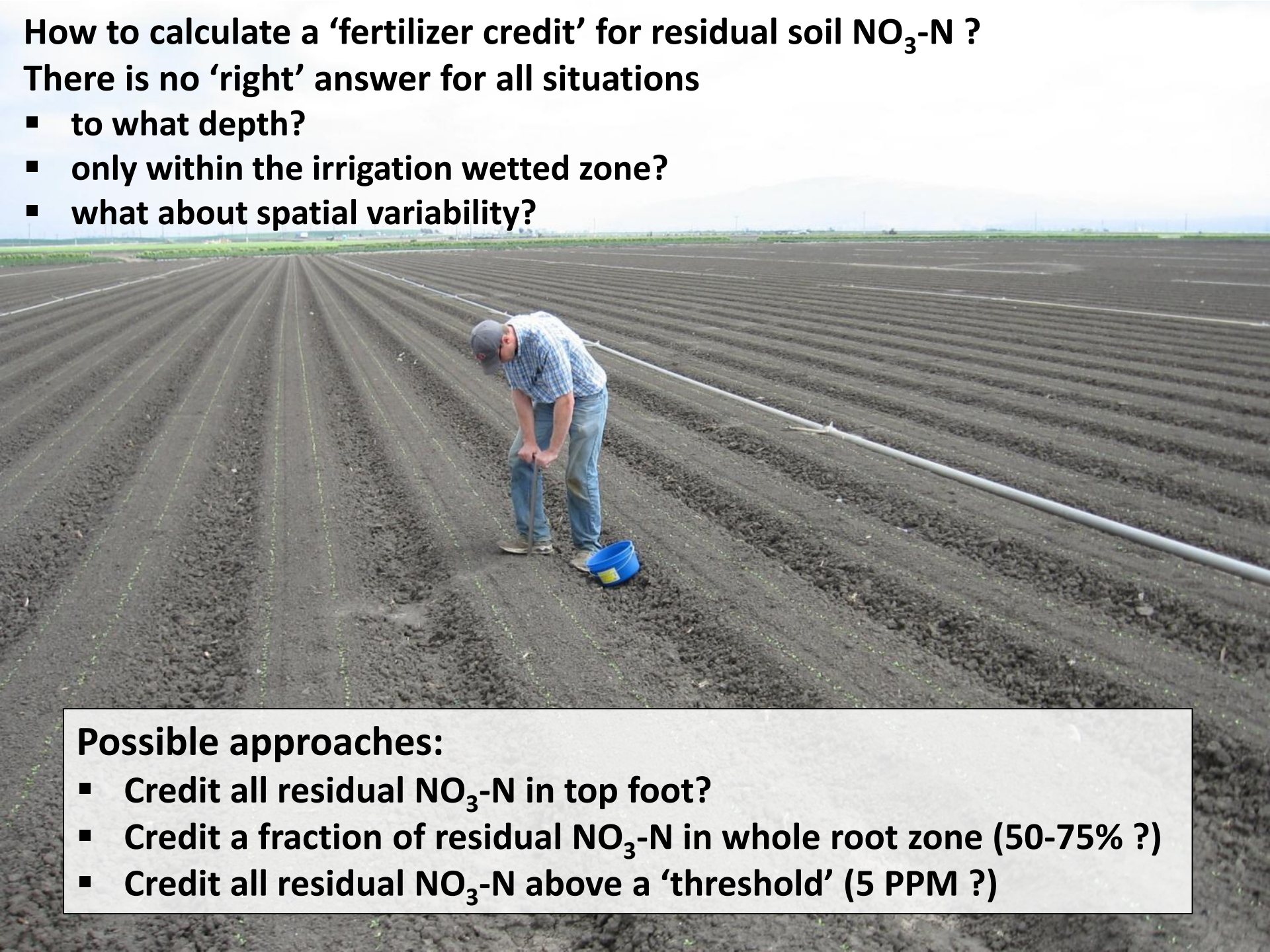
Why is residual soil NO_3-N sampling so important ?

- If measured at or just after transplant establishment, most N mineralization from prior crop residues and amendments has already taken place, and leaching should be controllable (given good irrigation management)

How to calculate a 'fertilizer credit' for residual soil NO_3-N ?

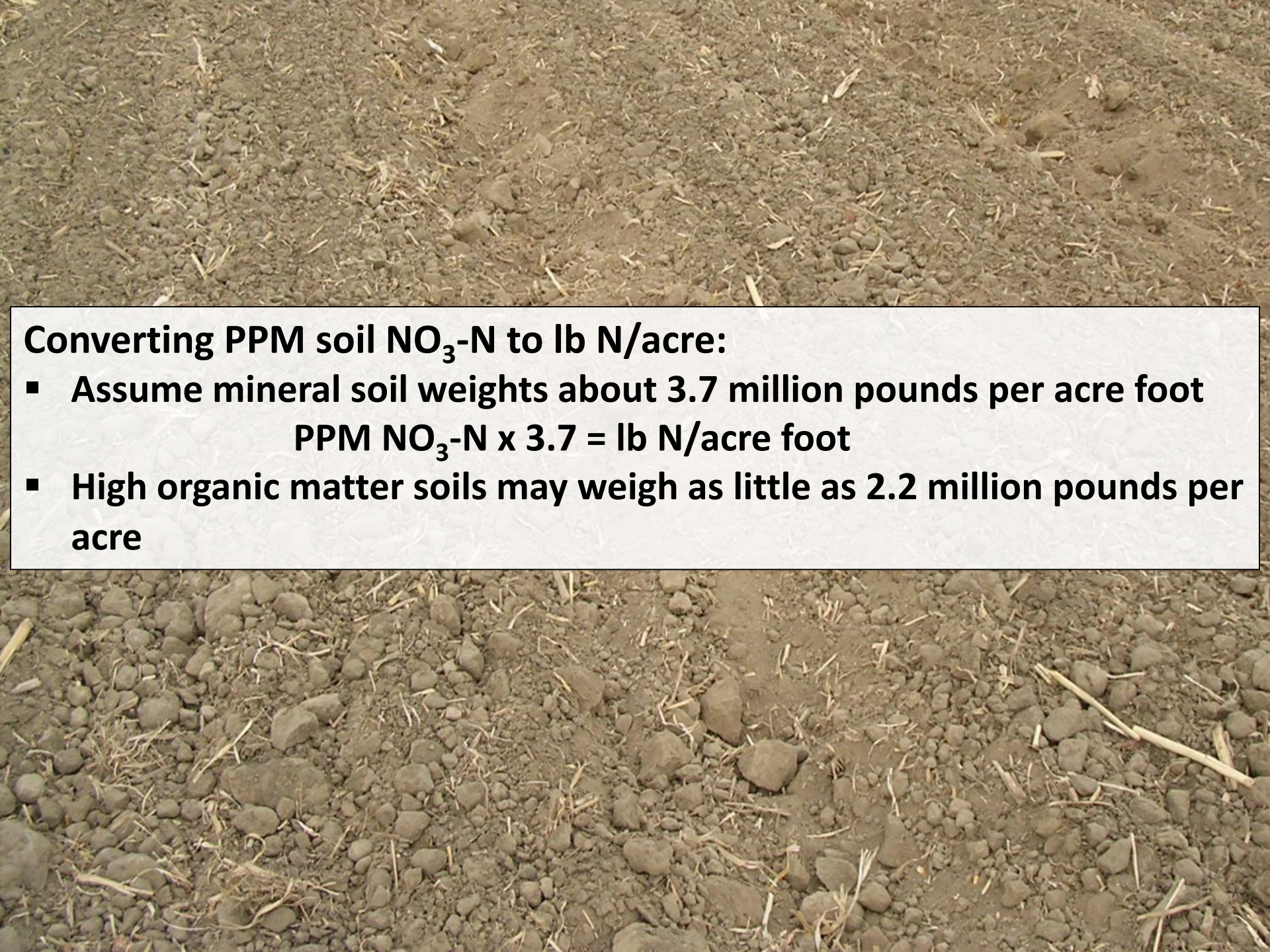
There is no 'right' answer for all situations

- **to what depth?**
- **only within the irrigation wetted zone?**
- **what about spatial variability?**



Possible approaches:

- **Credit all residual NO_3-N in top foot?**
- **Credit a fraction of residual NO_3-N in whole root zone (50-75% ?)**
- **Credit all residual NO_3-N above a 'threshold' (5 PPM ?)**



Converting PPM soil NO_3-N to lb N/acre:

- **Assume mineral soil weights about 3.7 million pounds per acre foot**

  PPM NO_3-N x 3.7 = lb N/acre foot

- **High organic matter soils may weigh as little as 2.2 million pounds per acre**

Irrigation efficiency is important:

- **At normal levels of in-season soil NO_3-N, each inch of leaching could remove >15 lb N/acre from the root zone**

Crediting NO_3-N in irrigation water :

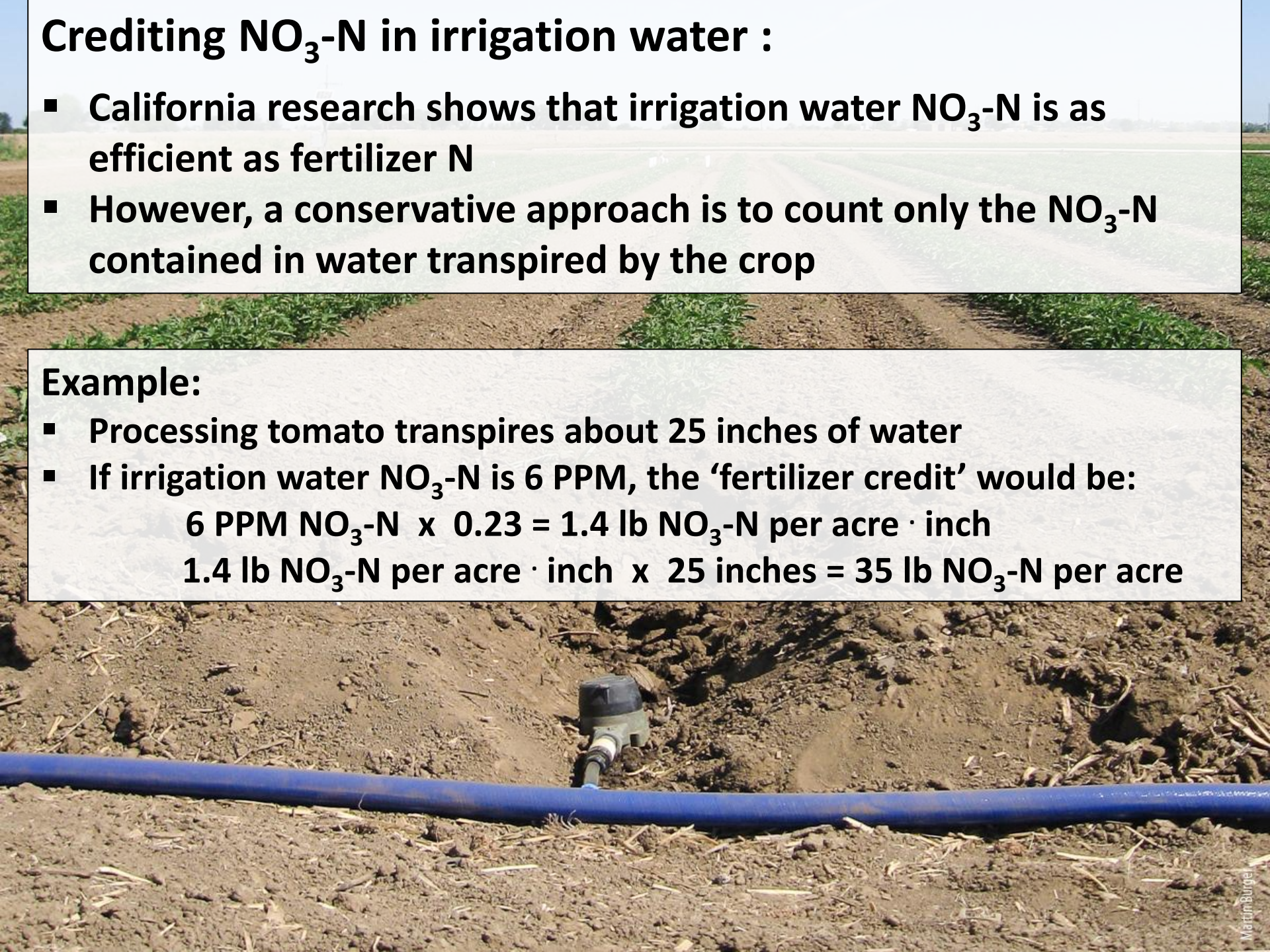
- California research shows that irrigation water NO_3-N is as efficient as fertilizer N
- However, a conservative approach is to count only the NO_3-N contained in water transpired by the crop

Example:

- Processing tomato transpires about 25 inches of water
- If irrigation water NO_3-N is 6 PPM, the 'fertilizer credit' would be:

$$6 \text{ PPM } NO_3\text{-N} \times 0.23 = 1.4 \text{ lb } NO_3\text{-N per acre} \cdot \text{inch}$$

$$1.4 \text{ lb } NO_3\text{-N per acre} \cdot \text{inch} \times 25 \text{ inches} = 35 \text{ lb } NO_3\text{-N per acre}$$



In summary:

- **At current levels of fertilization, most crops show a substantial positive N balance (more N applied than removed in harvested products); minimizing that N balance will reduce regulatory interest in your operation**
- **Efficient use of residual soil NO_3-N can reduce N fertilization rates and improve N balance across crop rotations**
- **In-season N leaching losses are controlled by efficient irrigation**