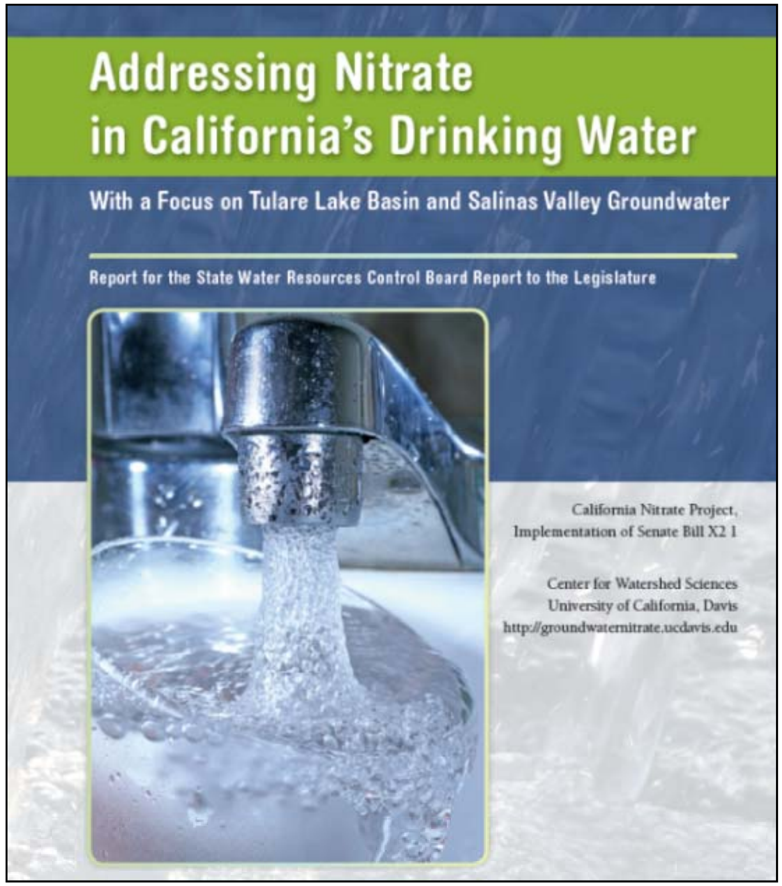
Nitrogen budgeting for vegetable crops

SBX21:

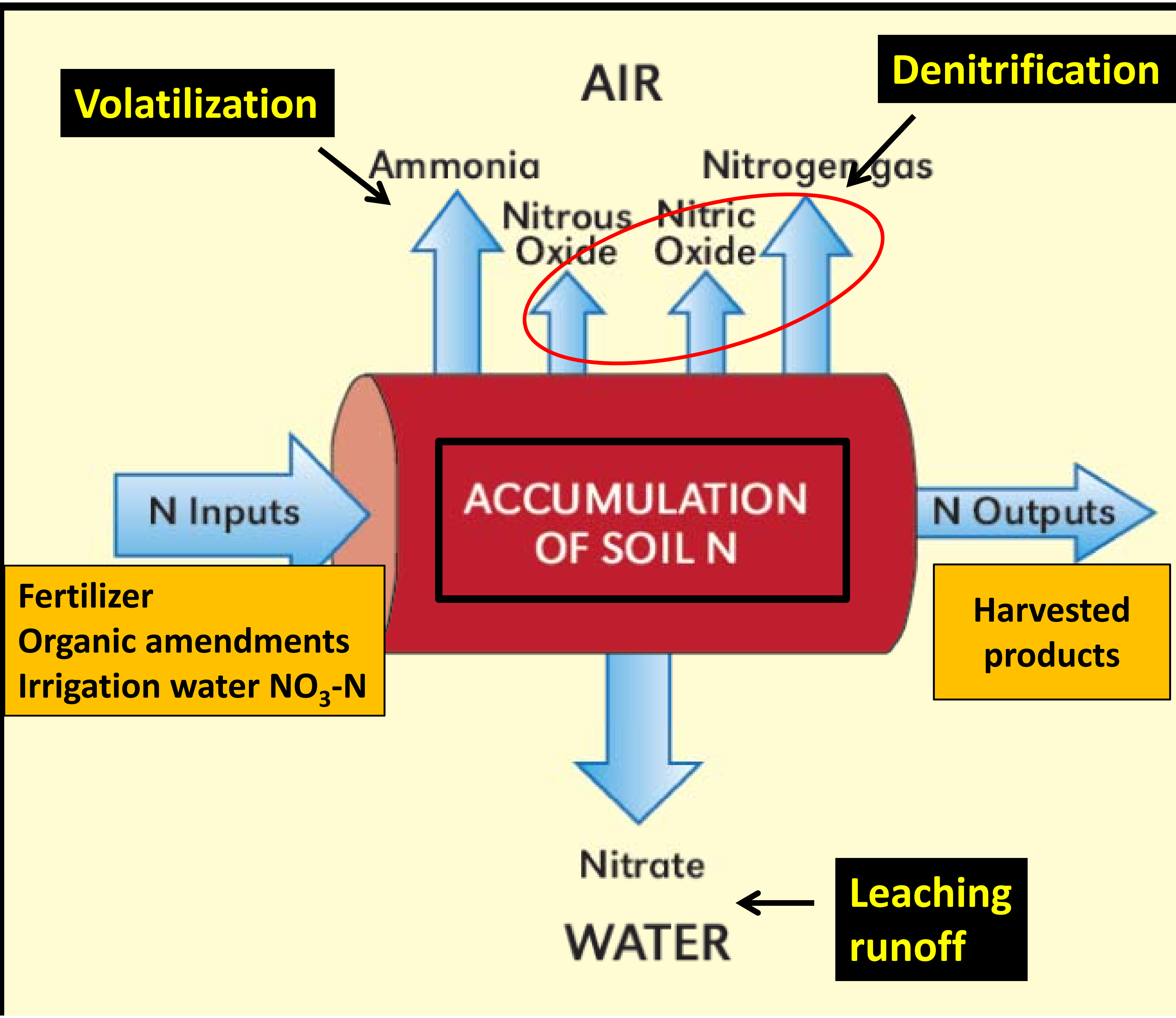
- **2012 special report to the legislature on nitrate in groundwater**



- **Recommendation 11 suggested that a system of agricultural N use reporting would enable the estimation of a nitrogen 'mass balance' for impacted watersheds**
- **Both the Region 5 (Central Valley) and Region 3 (Central Coast) Water Boards are adopting some form of nitrogen use reporting**

Basic assumption of a nitrogen 'mass balance' approach: :

- **N applied to a field but not removed in harvested products is at risk of *eventually* leaving the field in gaseous or liquid form**



AIR
Volatilization
Denitrification
Ammonia
Nitrogen gas
Nitrous Oxide
Nitric Oxide
N Inputs
ACCUMULATION OF SOIL N
N Outputs
Fertilizer
Organic amendments
Irrigation water NO_3-N
Harvested products
Nitrate
WATER
Leaching runoff

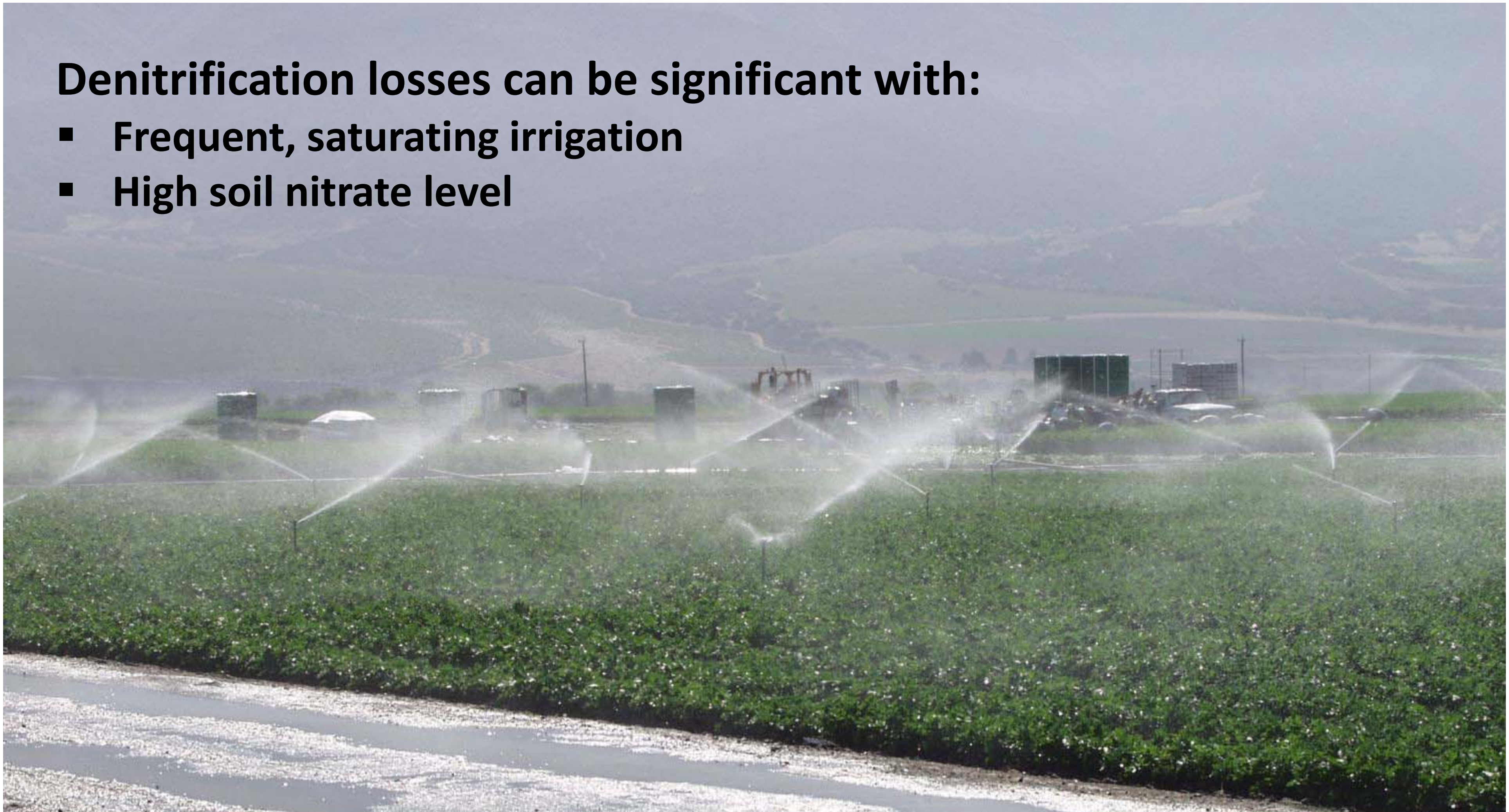
Volatilization losses can be significant for:

- Anhydrous ammonia, especially water-run
- Topdressed urea
- Animal manure

- **Volatilization losses are minimal in central coast production systems**

Denitrification losses can be significant with:

- **Frequent, saturating irrigation**
- **High soil nitrate level**



- **Denitrification as high as 3-4 lb N/acre per irrigation or rainfall event has been measured in coastal vegetable fields (>100 lb N/acre/year), but with the move to drip irrigation much lower losses are likely**
- **Nitrous oxide (N_2O), always a portion of denitrification N loss, is an air quality concern**

What about soil N storage?

- Short-term root zone NO_3-N carryover is common

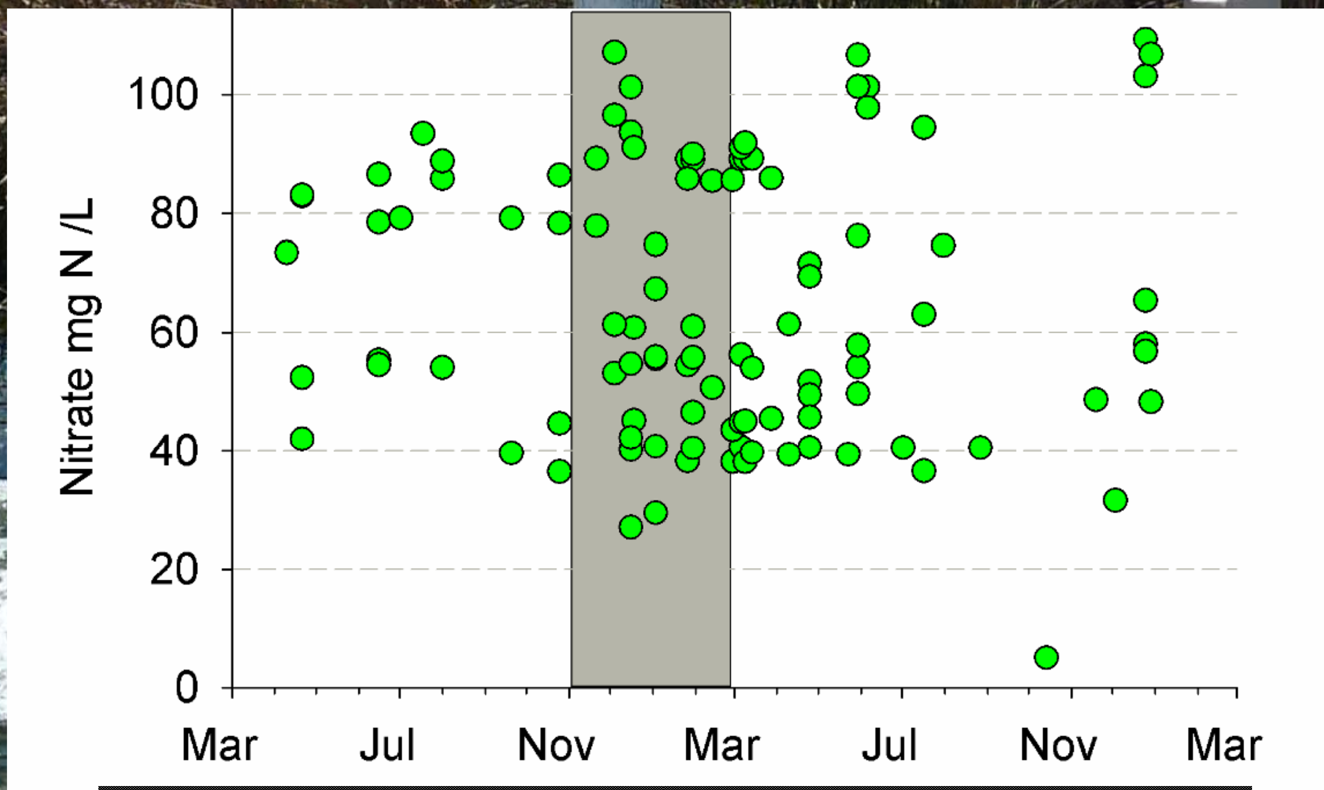
What about soil N storage?

- Significant long-term soil N sequestration in organic matter is uncommon in coastal production systems (with the possible exception of heavy compost users)

Nitrate leaching losses are often significant, and highest with:

- Excessive irrigation
- High soil nitrate level

Coastal tile drain effluent:



PPM NO_3-N	lb NO_3-N / acre · inch
40 - 60	9 - 14
80-100	18 - 23

Bottom line:

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- **Within some level of uncertainty, evaluating agricultural N management on a mass balance basis (inputs – outputs) does estimate the potential for overall environmental N loading (all forms of loss)**
- ***At similar yield levels*, a grower applying substantially more N than his neighbor is probably releasing more N to the environment *over time***

The simplest N balance (input – output) :

	lb N/acre		
Inputs	Spring lettuce	Summer lettuce	Summer broccoli
Fertilizer	170	130	180
Organic amendments	0	0	0
Irrigation water NO_3-N	30	30	40
Total input	**200**	**160**	**220**

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Balance (N removal basis)	130	90	120

'Strategic' N management should be able to capture much of this N

‘Strategic’ N management:

- **Make full use of non-fertilizer N**

Non-fertilizer sources of N :

- **Residual soil NO_3-N**
- **Irrigation water NO_3-N**
- **In-season soil N mineralization**
  - **- prior residue effects**
  - **- soil organic matter mineralization**

Contribution of prior crop residue:

	spinach spring mix	lettuce celery	broccoli cauliflower
Typical residue N content (kg/ha)	20-40	60-80	160-240
Typical residue %N	5-6	2.5-3.5	3-4.5

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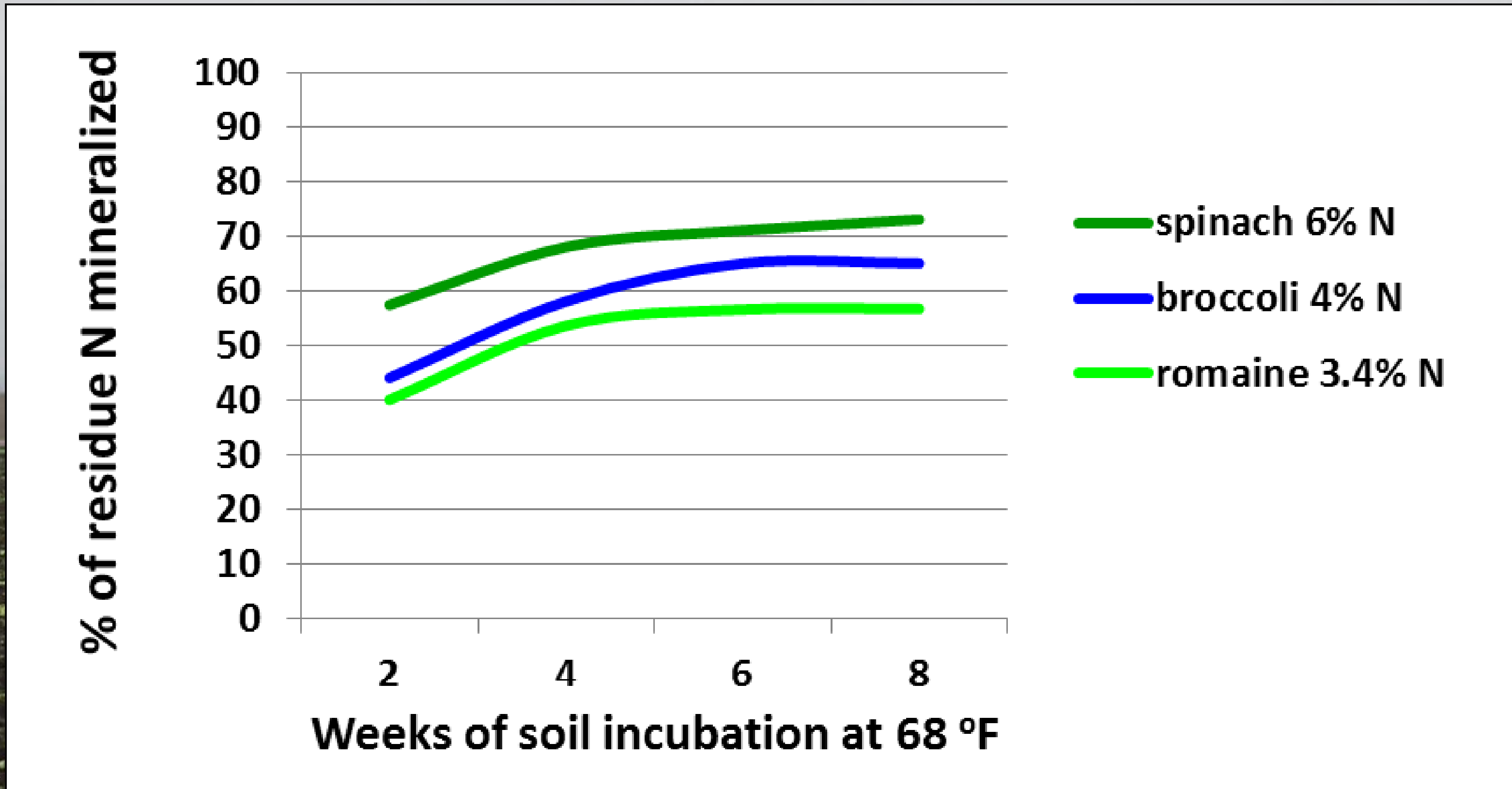


- Within 4-6 weeks after incorporation, crop residue N mineralization slows
- Therefore, the majority of residue effects on soil N availability can be directly measured by soil nitrate testing before fertilizing the subsequent crop

Estimating the contribution of soil N mineralization:

- Between 5 - 6% of soil organic matter is organic N
- You can generally count on net mineralization of at least 1-2% of soil organic N content during a vegetable crop season

Example:

Top 12 inches of soil weighs ≈ 3,800,000 lb/acre

≈ 2,000 lb organic N per % organic matter

≈ at least 20 lb N/acre per % soil organic matter

Strategic N budgeting:

Scenario 1:

- Spring lettuce after winter fallow
- Loam soil, 1.2% organic matter
- Presidedress soil NO_3-N = 5 PPM
- Irrigation water NO_3-N = 10 PPM, 6” of crop ET
- Sprinkler irrigation throughout

Non-fertilizer N		lb N/acre
Residual soil NO_3-N	5 PPM x 3.8 =	19
Irrigation water N	10 PPM x 0.23 x 6 =	14
Soil N mineralization	1.2% O.M. x 20 lb N/acre =	24
Total non-fertilizer input (‘N credits’)		57
Crop N uptake requirement		140
Minimum fertilizer requirement		83
Realistic fertilizer requirement		???

Strategic N budgeting:

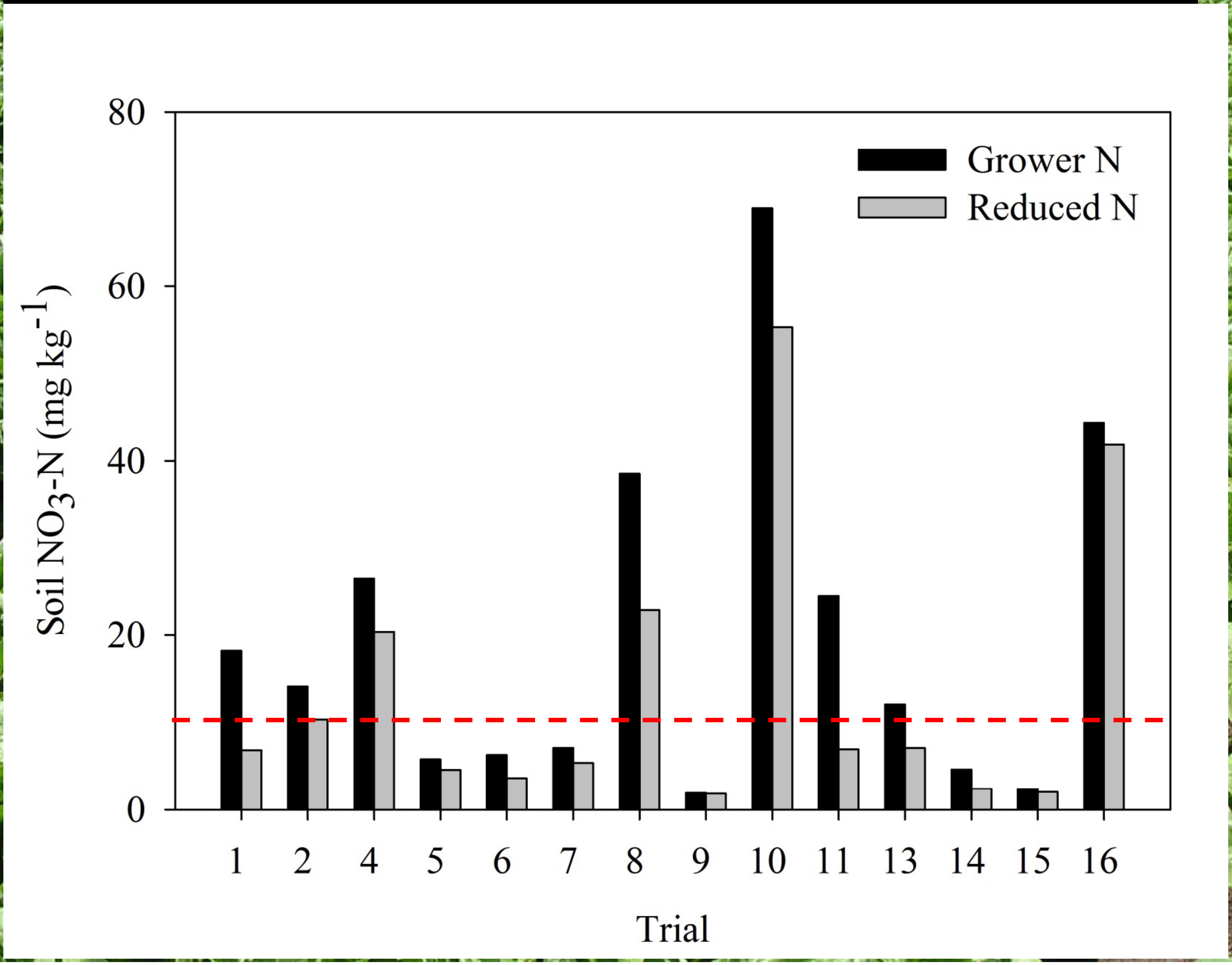
Scenario 2:

- Summer lettuce after spring broccoli
- Clay loam soil, 2.0% organic matter
- Presidedress soil NO_3-N = 25 PPM
- Irrigation water N = 30 PPM, 6” of crop ET
- Sprinkler irrigation for emergence, drip finish

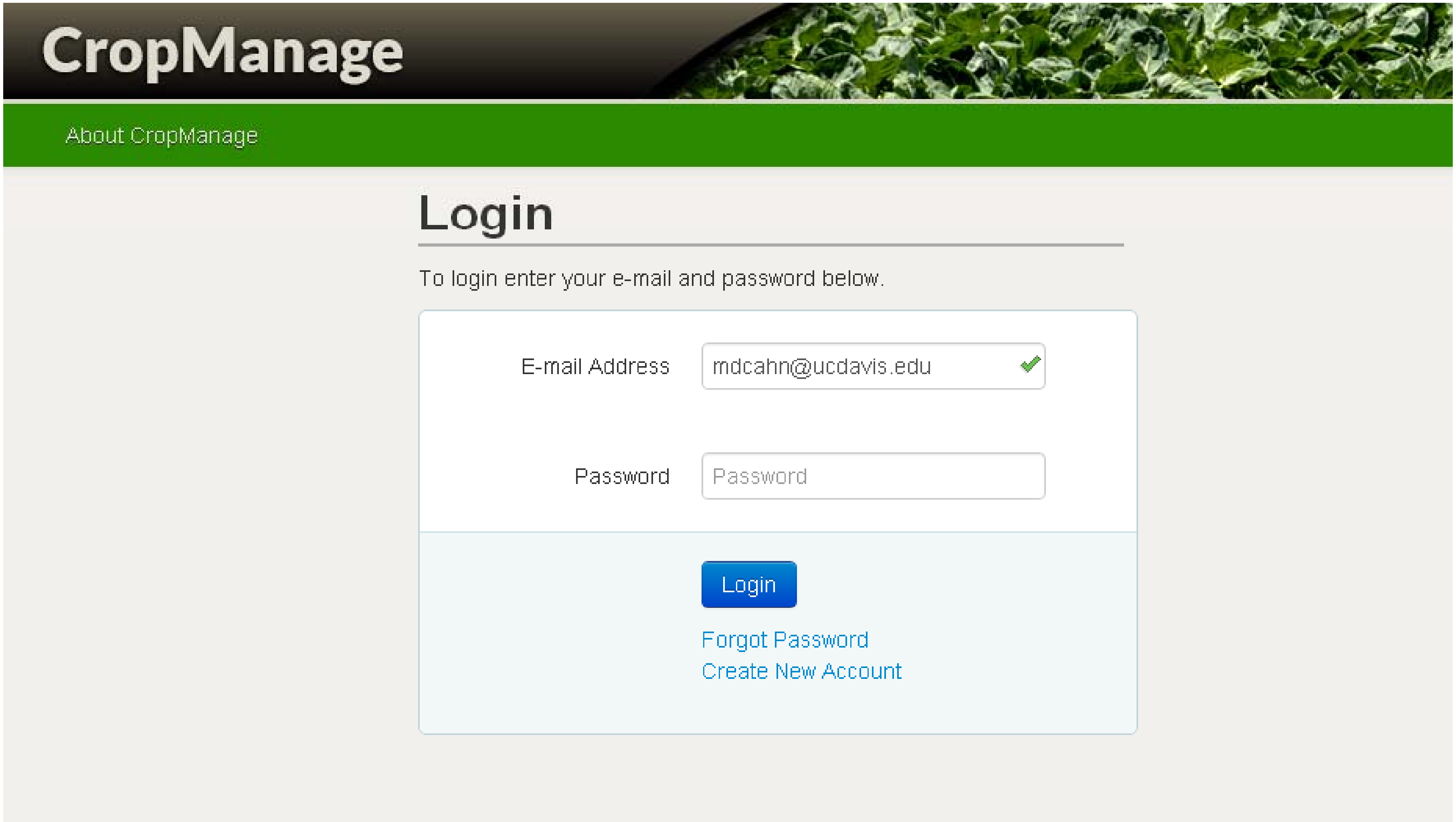
Non-fertilizer N		lb N/acre
Residual soil NO_3-N	25 PPM x 3.8 =	95
Irrigation water N	30 PPM x 0.23 x 6 =	41
Soil N mineralization	2.0% O.M. x 20 lb N/acre =	40
Total non-fertilizer input (‘N credits’)		176
Crop N uptake requirement		140
Minimum fertilizer requirement		0
Realistic fertilizer requirement		???

How much 'cushion' is needed to guarantee maximum production?

Soil NO_3-N at harvest (top foot), 2009 lettuce PSNT trials:



https://ucanr.edu/cropmanage



University of California

Nitrogen Management Training

for Certified Crop Advisers

Salinas, March 5-6

Register at:
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