University of California

Nitrogen Management Training

for Certified Crop Advisers

Nitrogen Management for Annual Crops

UC Cooperative Extension | University of California Agriculture and Natural Resources

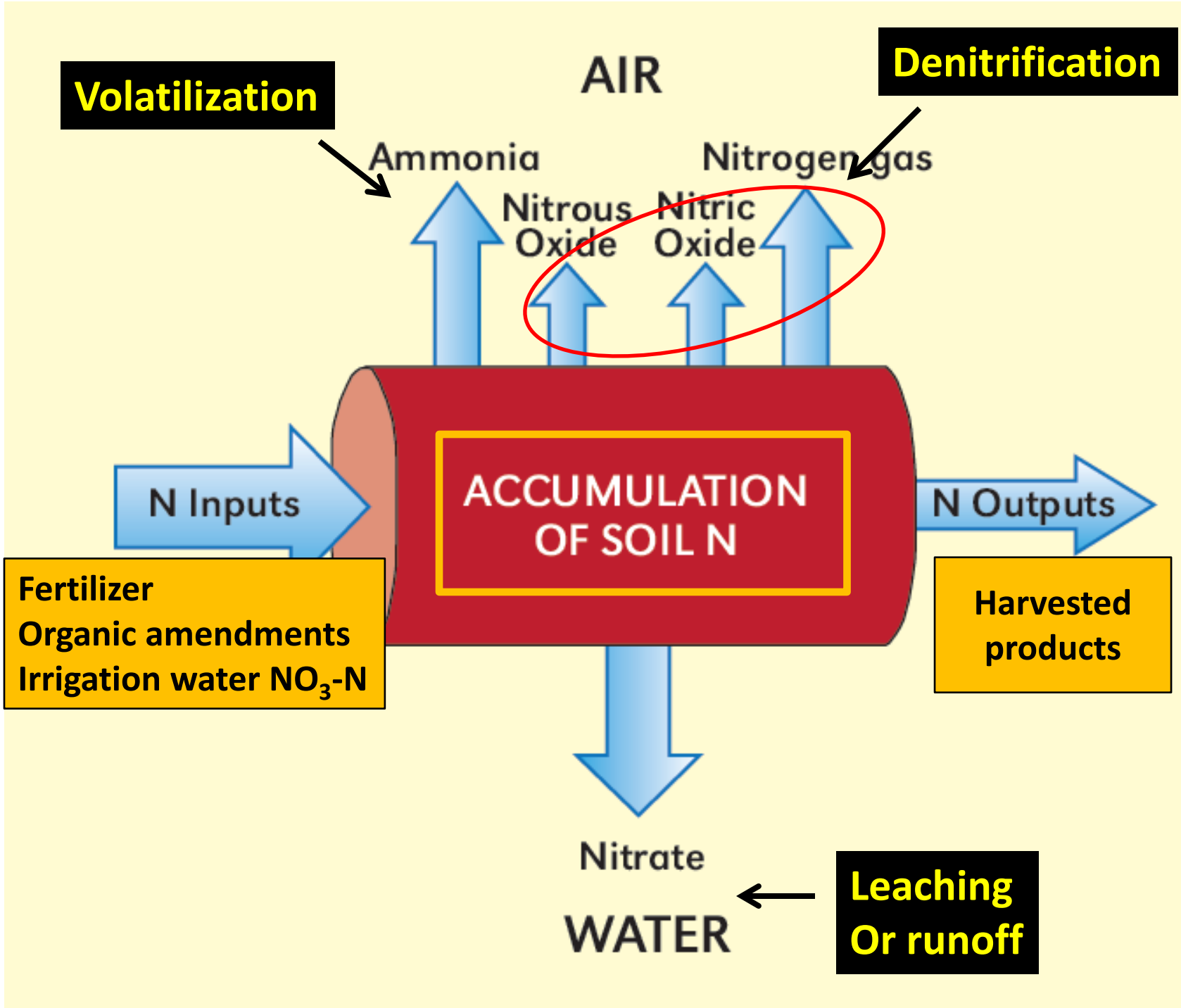
Regulatory Background:

The Water Quality Control Boards will:

- Institute nitrogen use reporting for agriculture
- Use that information to estimate potential environmental N loading through the use of 'mass balance' calculations

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 Or runoff

N Losses: Volatilization

Volatilization losses can be significant for:

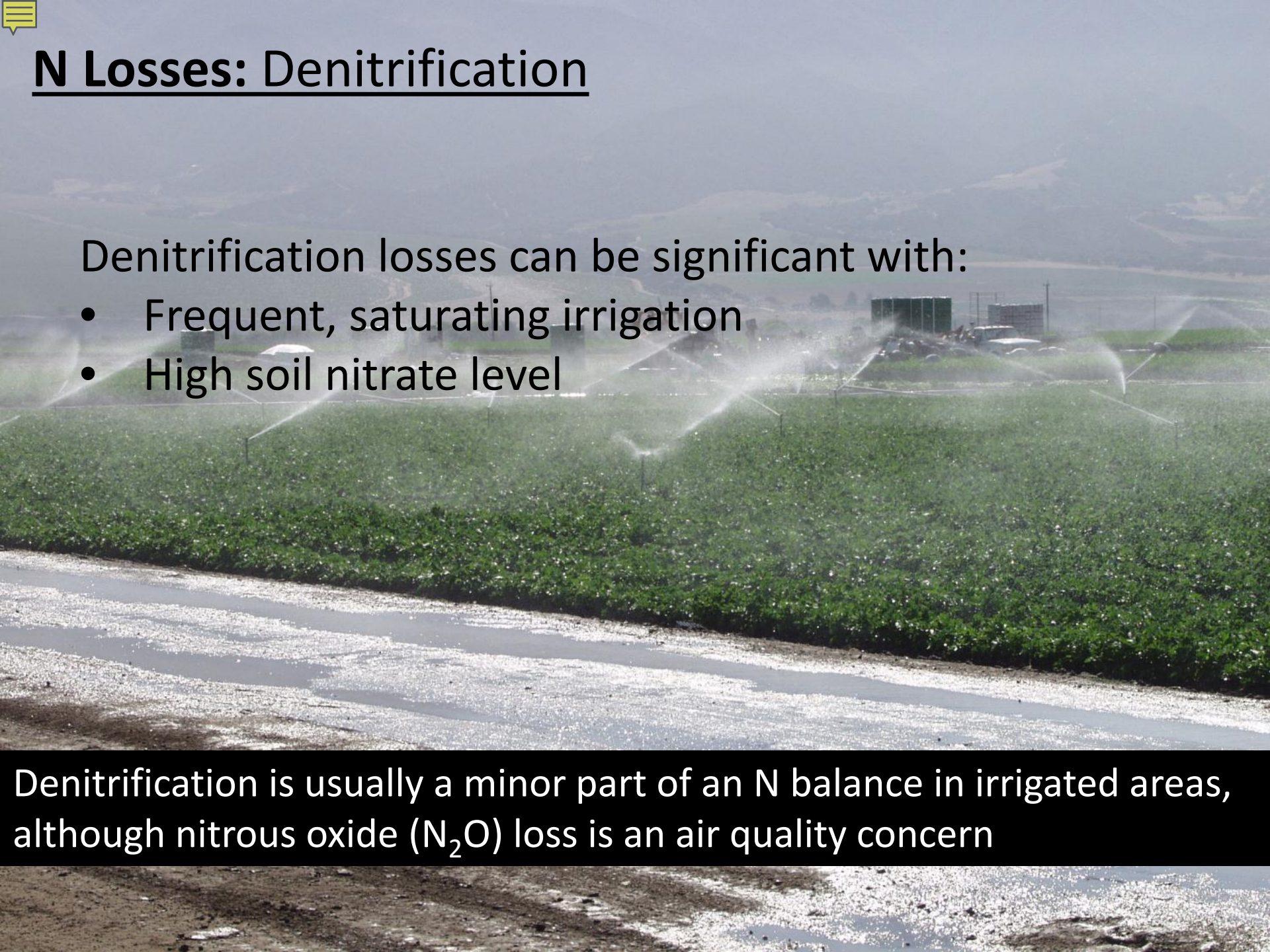
- Anhydrous ammonia, especially water-run
- Top-dressed urea
- Animal manure

- Losses up to 30% of applied N are possible
- Volatilization losses to the atmosphere are environmentally damaging when N is deposited in wild lands

N Losses: Denitrification

Denitrification losses can be significant with:

- Frequent, saturating irrigation
- High soil nitrate level



Denitrification is usually a minor part of an N balance in irrigated areas, although nitrous oxide (N_2O) loss is an air quality concern

N Losses: Long-term Soil storage

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

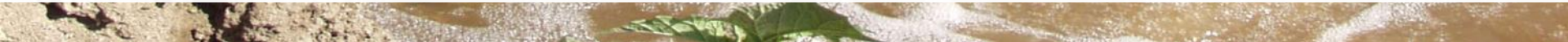
- Significant long-term soil N sequestration is uncommon, and probably limited to conservation tillage management

N Losses: Leaching

Nitrate leaching losses are likely to be significant where N loading (from all sources) substantially exceeds crop N removal

N Losses:

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

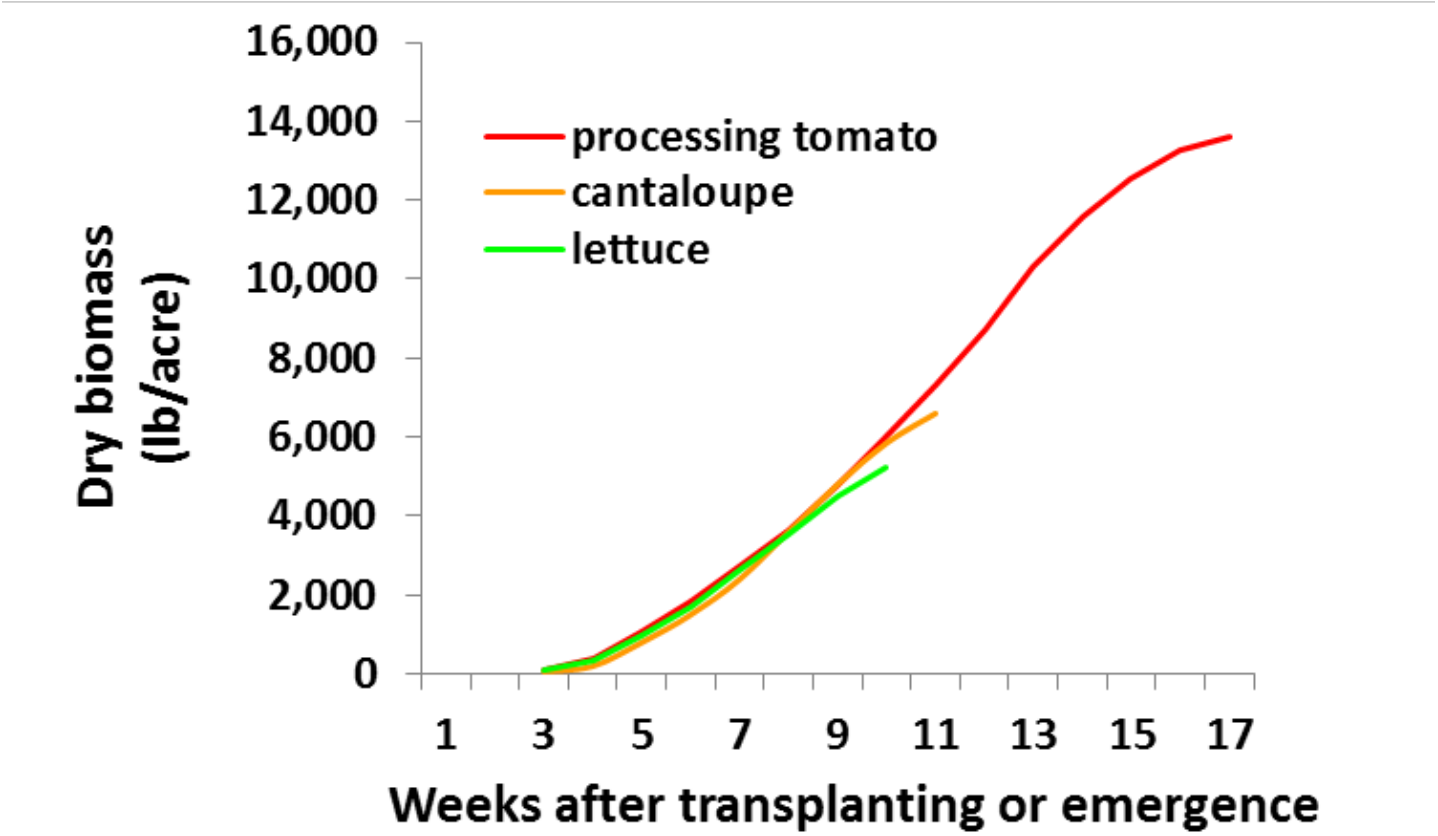


N Management And Regulations

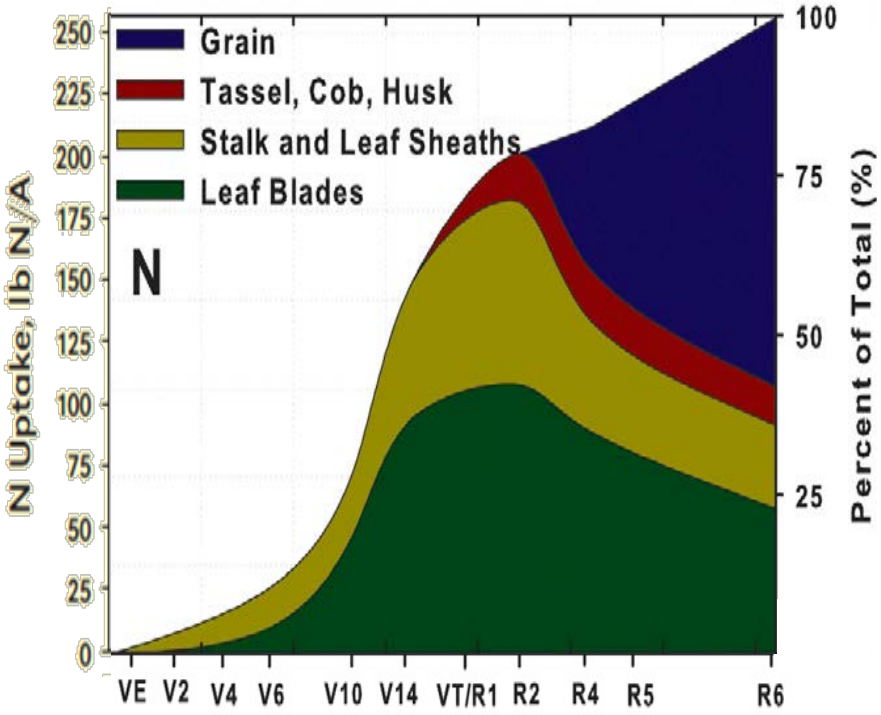
- Some crops, and some production systems, will get more scrutiny than others
- To keep under the regulatory radar, ‘strategic’ N management will be needed: evaluate N requirement on a field-specific basis, making use of non- fertilizer N sources

Annual Crop Growth and N Uptake Timing

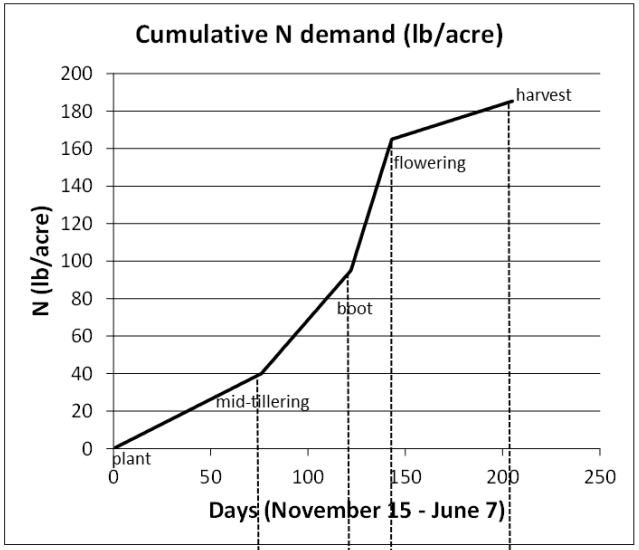
Characteristic Growth Pattern

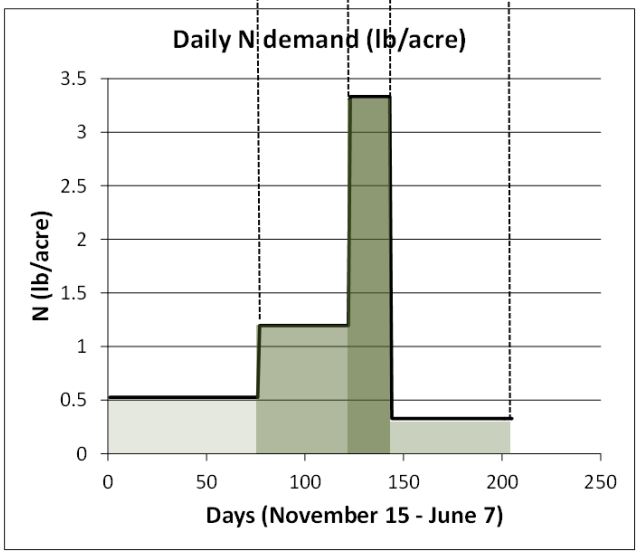


Characteristic Growth Pattern



Corn





Wheat

Left: Ross R. Bender, Jason W. Haegele, Matias L. Ruffo, and Fred E. Below, Agronomy Journal • Volume 105, Issue 1 • 2013

Strategic Nitrogen Management: Crediting Non-Fertilizer N Sources

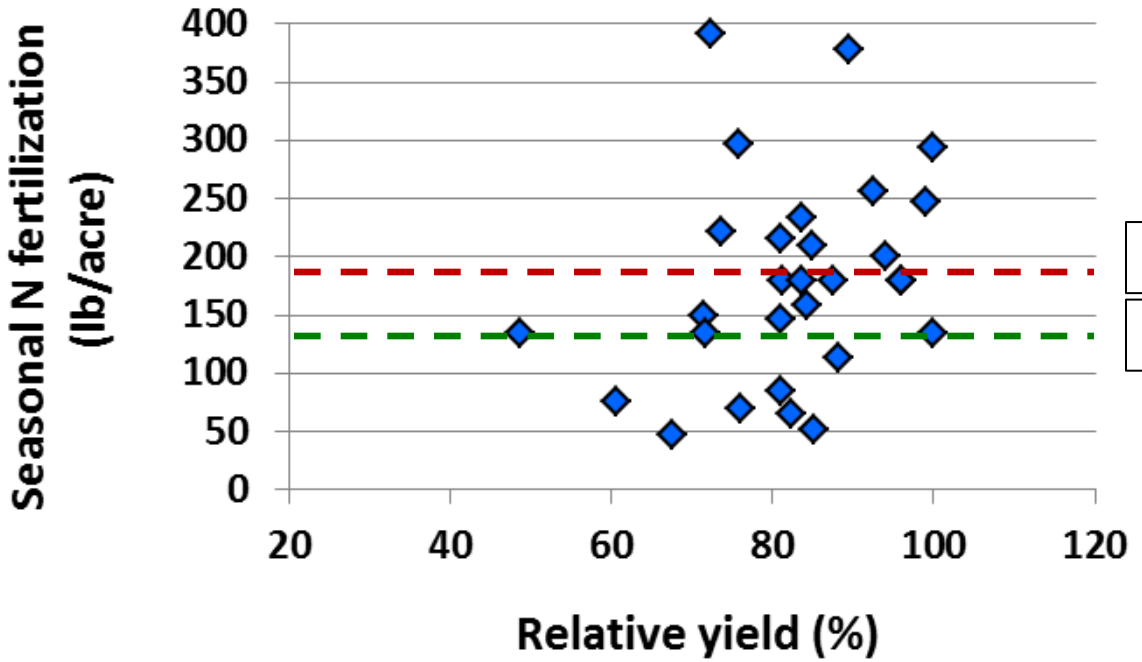
Field-Specific N Management

Develop a *reasonable* N fertilization template then modify for:

- Residual soil NO_3^--N
- Soil N mineralization potential
- Irrigation water NO_3^--N
- In-season plant analysis ?

Developing a Reasonable N Template

Lettuce Example: | **2004-05 coastal lettuce survey**



Since N deficiency in commercial fields is uncommon, seasonal N rates on the lower end of the normal range should be sufficient in most cases

Soil Nitrate Testing

Post-establishment soil NO_3^--N

- Often called Pre-sidedress Soil Nitrate Testing (PSNT)

Why is post-establishment soil NO_3^--N sampling important ?

- It integrates the main factors influencing soil N mineralization (rapid N mineralization from residues and amendments has already taken place)

- The measurement is taken after crop establishment, when additional leaching should be controllable (given good irrigation management)

Crediting Soil Nitrate

How to calculate a ‘fertilizer credit’ for residual soil NO_3-N ?
There is no ‘right’ answer for all situations

- To what depth?
- What about spatial variability?

Possible approaches:

- Credit a fraction of residual N (50-75% ?)
- Credit all residual N above a ‘threshold’ (5 PPM ?)

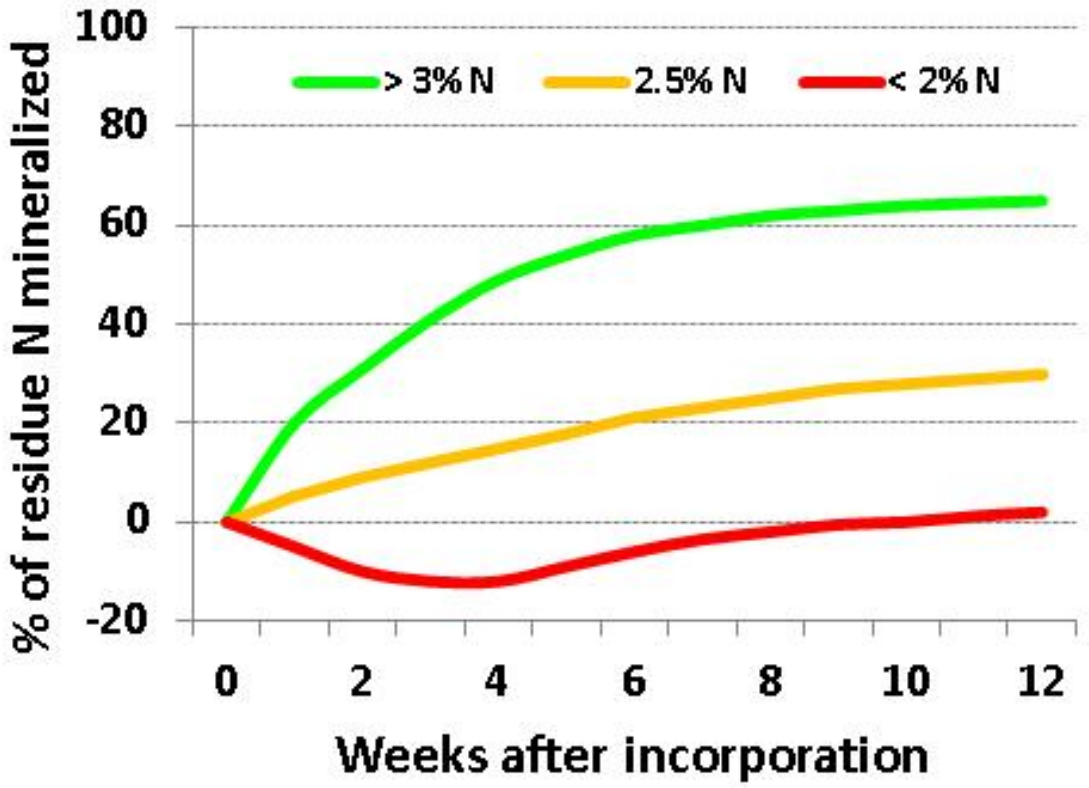
Crediting Organic N

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

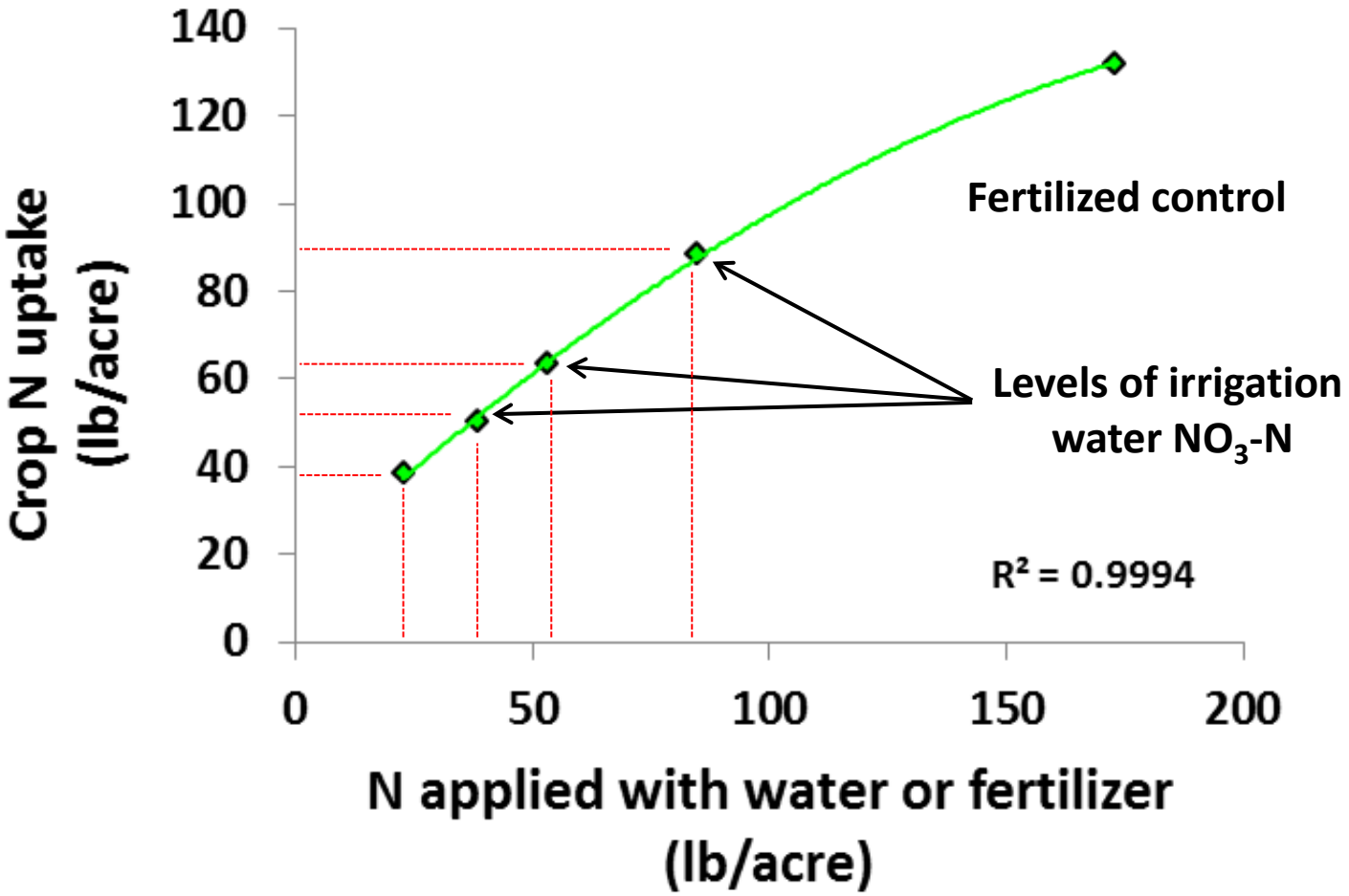
Example:
Top 12 inches of soil weighs ≈ 3,800,000 lb/acre
≈ 2,000 lb organic N per % organic matter
≈ 20-40 lb N/acre per % soil organic matter

Crediting Prior Crop Residue N



In general, more than 90 days after soil incorporation, crop residue N behaves similarly to that of existing soil organic N

Crediting Irrigation Water N: Controlled Moisture Conditions



2013 irrigation water NO_3^--N uptake efficiency trial

- continuously injected varying levels of NO_3^--N from 0-40 PPM
- measured lettuce biomass N at harvest

Plant Tissue Testing

Plant Tissue Testing for Annual Crops:

Leaf total N

- overall crop N status

Petiole NO_3^--N

- NO_3^--N taken up but not yet assimilated into organic compounds

Plant Tissue Testing : Leaf Total N Monitoring

- Provides a reliable indicator of plant N status
- Changes relatively slowly over time
- Is poorly correlated with soil NO_3^--N availability early in the season when N uptake is slow, *so it has limited value in early season fertilization decisions*

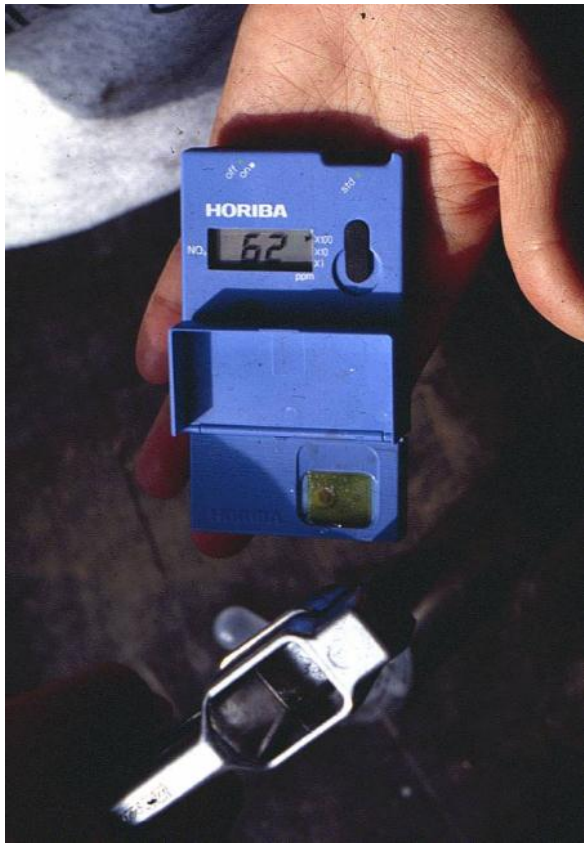
Plant Tissue Testing : Petiole N Monitoring

Advantages of petiole NO_3^--N :

- easily / quickly measured

Disadvantages of petiole NO_3^--N :

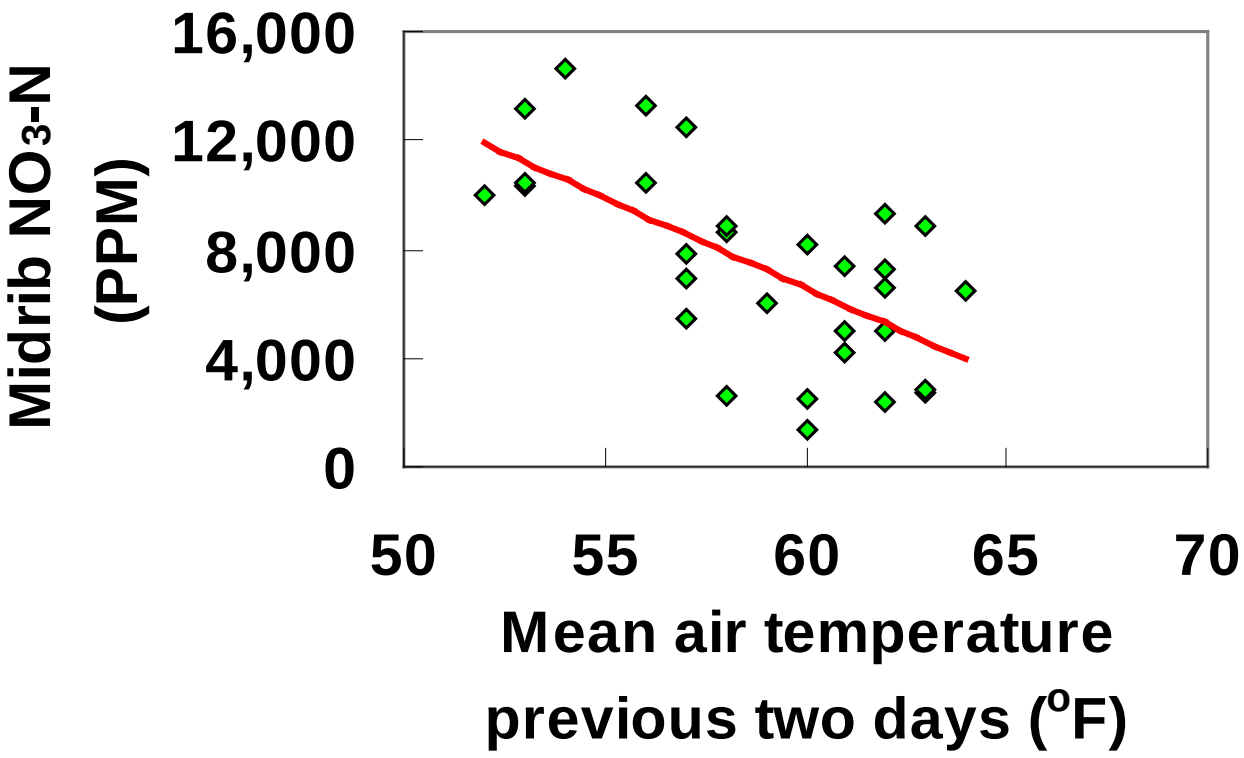
- Environmental factors unrelated to soil N availability can affect results



Plant Tissue Testing : Petiole N Variability

Why is petiole NO_3^--N so variable?

- Environmental factors affect the rate at which the plant incorporates NO_3^--N into organic compounds



Plant Tissue Testing: Summary

- Whole leaf sampling gives a snapshot of current crop N status but, if it is in the 'adequate' range, does not predict additional N needed more than 7-10 days

- Maintaining high petiole NO_3^--N through the season should ensure sufficient N; but because environmental conditions can cause low petiole NO_3^--N even when soil NO_3^--N is adequate, *using petiole analysis to determine fertigation requirement can lead to unnecessary fertilization*

N Management Reporting: Agronomy vs. Regulatory Reporting

- The regulatory interest in N use reporting is to estimate the potential for environmental N loading
- CCAs will need to help clients maintain productivity while minimizing unnecessary N application

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Course materials available at:

ciwr.ucanr.edu/NitrogenManagement

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