January 2020

Irrigation and Nitrogen Management Training

for Grower Irrigation and Nitrogen Management Plan Self-Certification

cdfa

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

Cures

Irrigation and Nitrogen Management Training for Grower INMP Self-Certification

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Irrigated Lands Regulatory Program (ILRP)

- Managed by the Regional Water Quality Control Board
- Applies to all growers who irrigate commercial crops
- Board uses Waste Discharge Requirements (WDR) to specify what growers and coalitions must implement to protect groundwater and surface water.

Regulations: Waste Discharge Requirements

- Growers with irrigated lands must either join regional coalitions or meet WDR requirements individually.

- Coalition Tasks in the Central Valley:
  - Groundwater quality assessments and plans
  - Monitoring long term groundwater quality trends
  - Assess which BMPs protect groundwater quality
  - Surface water quality monitoring
  - Compilation of data submitted by growers and reports to Regional Water Board

Regulations: Waste Discharge Requirements

- Growers are responsible for:
  - Attending one outreach event (yearly)
  - Farm Evaluation Survey (5 years)
    - (kept on farm)
  - Sediment and Erosion Management Plans
    - Where needed (kept on farm)
  - **Irrigation and Nitrogen Management Plans**
    - Yearly (kept on farm)
  - **Irrigation and Nitrogen Management Plan Summary Report**
    - Yearly (submitted to Coalition)

Certifying Irrigation and Nitrogen Management Plans

- Options for certification:
  - Certified Crop Adviser with Nitrogen Management Training
  - Certified Professional Soil Scientist
  - Certified Professional Agronomist
  - Technical Service Providers
  - Certified Agricultural Irrigation Management Specialists
  - **Grower Self-Certification (owned or managed fields only)**

Grower Self-Certification Requirements

- Nitrogen Management Plan Certification Training
  - 4 hours
  - Passing grade (70%) on test*
- Certification Period
  - 3 years
- Re-certification
  - Continuing education required
    - 3 hours in 3-year time period beginning January 1

* Test can be taken multiple times

Irrigation and Nitrogen Management Plan Certification Training

- Project administered by the Coalition for Urban Rural Environmental Stewardship (**CURES**)

- Certification presentations are by Certified Crop Advisors (CCA) who have completed the UC/CDFA Nitrogen Management Program as a trainer

- Coalitions facilitate the training meetings

Irrigation and Nitrogen Management Plan Certification Training

- Regulatory Oversight of Grower Trainings
  - Water Board has approved this INMP training approach
  - **CDFA** and the **Coalitions** will audit presentations at grower trainings to ensure professionalism by CCAs

Irrigation and Nitrogen Management Plan Certification Training

- Provide information for
  - Efficient use of nitrogen fertilizers
  - Minimize environmental impacts
  - Meet Regulatory compliance requirements
    - Irrigation and Nitrogen Management Plan
    - Irrigation and Nitrogen Management Summary Report

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

Member ID: _______ INMP Field or MU: ____________________ Crop: _________________ Total Acres: ______

IRRIGATION MANAGEMENT		
1. Irrigation Method*	**Pre-Season Planning**	
(check one for Primary; if applicable, check one for Secondary) Primary Secondary[1] ☐ ☐ Drip ☐ ☐ Micro Sprinkler ☐ ☐ Furrow ☐ ☐ Sprinkler ☐ ☐ Border Strip ☐ ☐ Flood	2. Crop Evapotranspiration (ET, inches)	
	3. Anticipated Crop Irrigation (inches)	
	4. Irrigation Water N Concentration (ppm or mg/L, as NO_3-N)	

5. Irrigation Efficiency Practices* (Check all that apply)

- ☐ Laser Leveling
- ☐ Use of ET in scheduling irrigations
- ☐ Water application schedule to need
- ☐ Use of moisture probe (e.g. tensiometer)
- ☐ Soil Moisture Neutron Probe
- ☐ Pressure Bomb
- ☐ Other ______________________________
- ☐ Other ______________________________

HARVEST / YIELD INFORMATION				
Harvest / Yield Information			**Expected (A)**	**Actual (B)**
6. Production Unit (lbs, tons, etc.)		**7. Harvested Yield***		

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
☐ Split Fertilizer Applications ☐ Irrigation Water N Testing ☐ Soil Testing ☐ Tissue/Petiole Testing ☐ Fertigation ☐ Foliar N Application ☐ Cover Crops ☐ Variable Rate Applications using GPS ☐ Other: ________________ ☐ Other: ________________	9. Soil – Available N in Root Zone (Annualized, lbs/ac)		
	10. N in Irrigation Water* (Annualized, lbs/ac)		
	11. Organic Amendments* (Manure/Compost/Other, lbs/ac estimate)		
	12. Dry/Liquid Fertilizer N* (lbs/ac)		
	13. Foliar Fertilizer N* (lbs/ac)		
	14. TOTAL NITROGEN (lbs/ac)		

[1] A secondary irrigation system could be used for crop germination, frost protection, crop cooling, etc.
***(Bold Text)** Data to be reported to the Coalition on the INMP Summary Report, based on Actual Yield and Actual N.

Plan Certifier Initials ☐

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) SUMMARY REPORT

Refer to your Irrigation and Nitrogen Management Plan (INMP) Worksheet and Parcel Inventory for information to complete an INMP Summary. Report for each field or Management Unit.

STEP 1: GENERAL INFORMATION

Member ID: ____________________

Forms Completed By: ____________________

Crop Year (Harvested): ____________________

Submittal Date: ____________________

STEP 2: OUTLIER NOTIFICATION RECEIPT

The Coalition provided information about this membership's nitrogen efficiency for the previous crop year and identified management units that were considered outliers compared to other Coalition members growing the same crop.

Please check the box below if you were identified as an outlier by the Coalition.

☐

STEP 3: INMP CERTIFICATION METHOD

☐ Certified INMP Specialist (e.g. certified crop adviser who has completed the CDFA training program)

☐ Self-Certified (CDFA training program)

☐ Self-Certified (follows NRCS or UC Cooperative Extension site-specific recommendations)

☐ Self-Certified (No fertilizers applied)

STEP 4: INMP SUMMARY REPORT

Complete the table below for each field or management unit for this membership. ***All values should be on a per acre basis.***

Field or Management Unit	Crop	Crop Age	Total Irrigated Acres	Total N Applied Lbs/acre				Yield	Prod. Unit	Yield Info*
Refer to Parcel Inventory		Perennial only (years)	(acres)	N in Irrigation Water (lbs/acre)	Organic Amendments (lbs/acre)	Dry/Liquid Fertilizers (lbs/acre)	Foliar Fertilizers (lbs/acre)	Harvested Yield (lbs/acre or tons/acre)	(lbs or tons)	

*Use this column to provide information about yield i.e. nonbearing; crop not harvested; type of harvest (e.g. silage, grain). If you harvest straw, please contact your Coalition.

Overview of Nitrogen and Groundwater Quality Issues

Section 1

Section 1 Learning Objectives

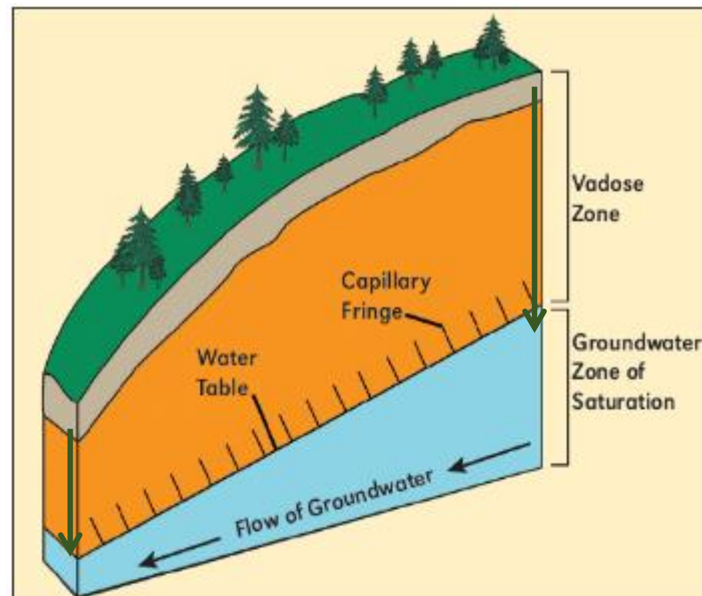
- Recognize how nitrate became a problem
- Recall areas that are more vulnerable to nitrate contamination.
- List the sources of nitrogen.
- Distinguish between the different ways to measure nitrate in the groundwater.

How Did Nitrate Become a Problem?

- In nature, nitrogen (N) cycles through soil, water, and plants at low concentrations (approx. 2ppm).
- Agriculture requires high N input to produce profitable crops which increases soil N concentrations.
- **Inefficiency** of irrigation and N applications leads to nitrate leaching losses.

Why is Shallow Groundwater Most Affected?

- Nitrate ($N0_3^-$) is an anion (negatively charged) and is not retained by the soil. It moves with water.
- Water moving below the root zone can carry nitrate with it.
- After years of downward flow with water, nitrate eventually reaches the aquifer.
- The ***closer*** the groundwater is to the source, the **sooner** nitrate will reach the groundwater.

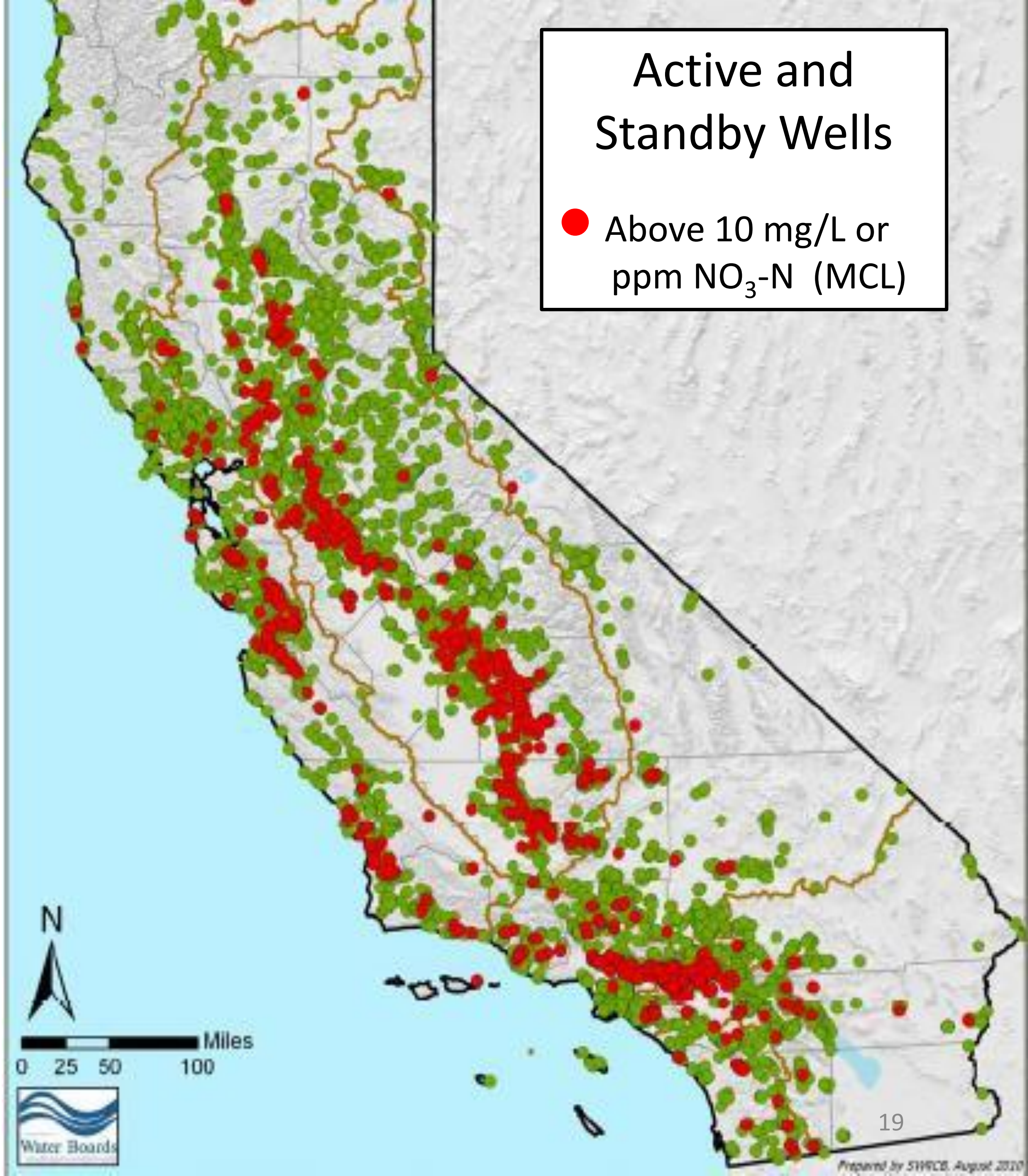


Nitrate. What is the Problem?

- Nitrate in Drinking Water
  - Federal/CA Maximum Contaminant Level (MCL) is 10 ppm Nitrate expressed as NO_3–N
    - MCL was determined by US EPA, “to prevent methemoglobinemia in infants”
  - Concentrations in drinking water of some CA aquifers exceed this level.
    - CA State Water Resources Control Board noted that 8% of drinking water wells exceed the nitrate threshold.

Nitrate Problem Areas in California

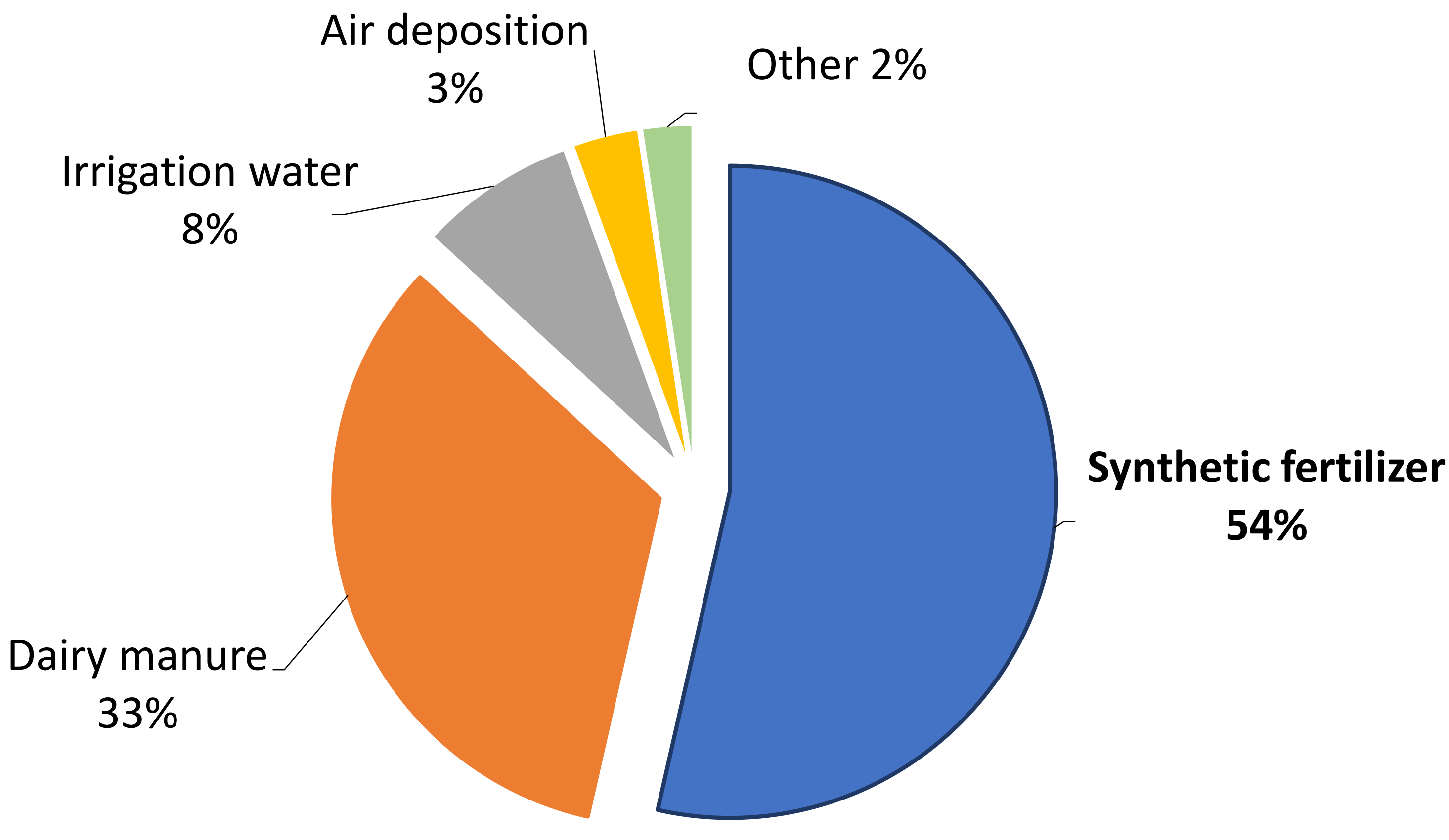
Areas with shallow groundwater and intensive agriculture are vulnerable to nitrate contamination



- **Above** MCL
- **Below** MCL

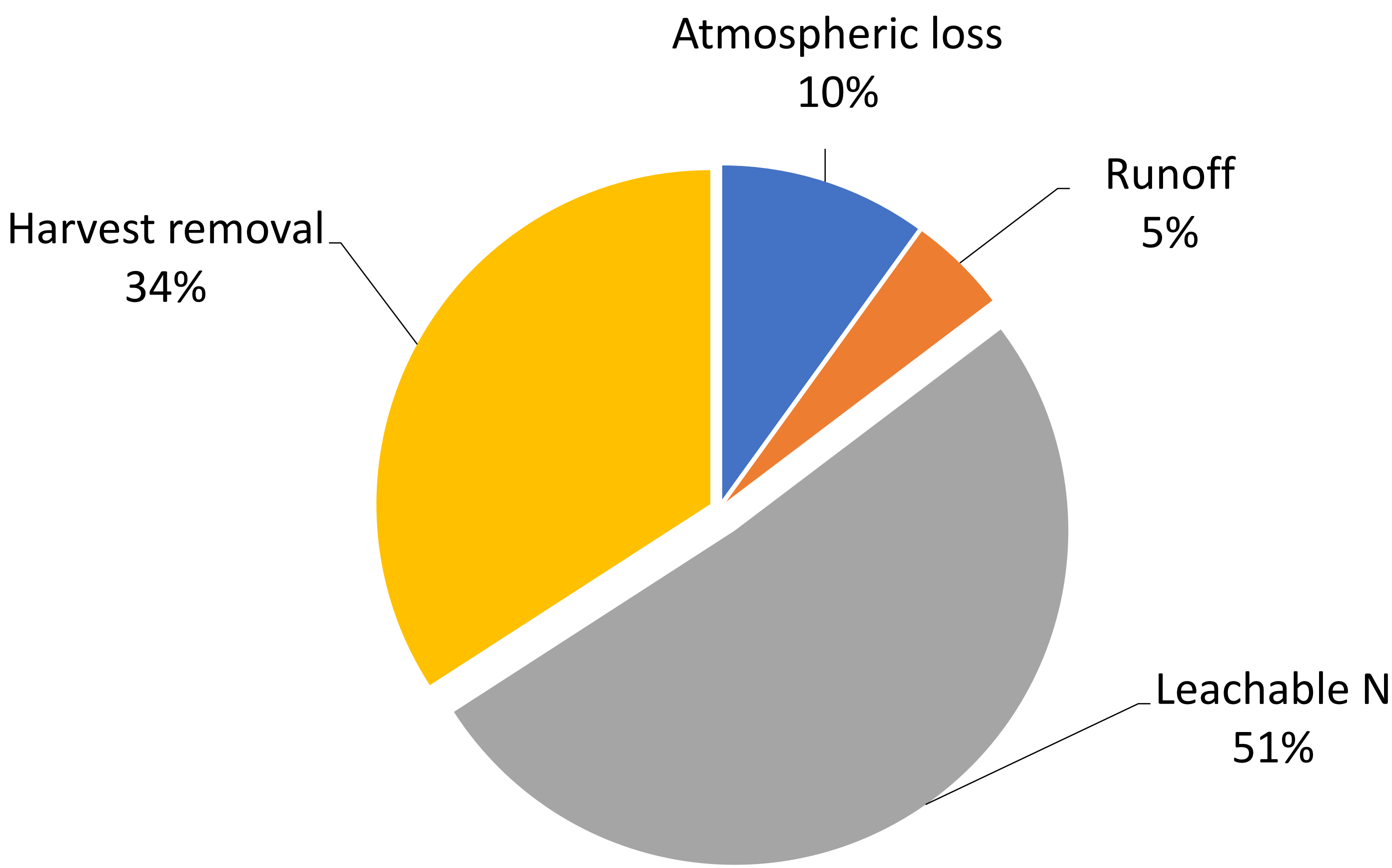
(Maximum Contaminant Level)

Where is nitrogen coming from in California?



Data from Salinas Valley and Tulare Lake Basin

Of the total N inputs where is nitrogen going in California?



Data from Salinas Valley and Tulare Lake Basin

Dealing with Nitrate Pollution

- No inexpensive method exists to remove nitrate once it is in water

- Source control: Accounting for all the sources of nitrogen in the system leads to more efficient use of nitrogen and fertilizer products.
    - Sources of nitrogen:
        - Mineralization of organic nitrogen
        - Residual soil nitrogen
        - Nitrogen in irrigation water
        - Nitrogen fertilizers

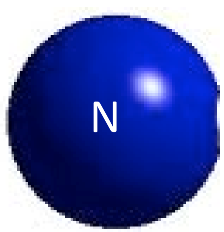
Measuring Nitrate Concentrations

Preferred Unit

Maximum contaminant levels

Measuring **Nitrate-N**:

10 ppm NO_3^--N
(measures only the N in the Nitrate)



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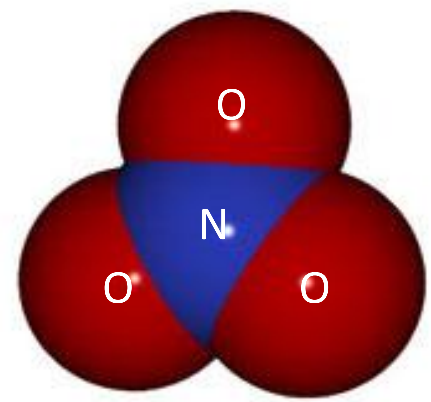
Measuring **Nitrate**:

45 ppm NO_3
(measures **N + O_3**)



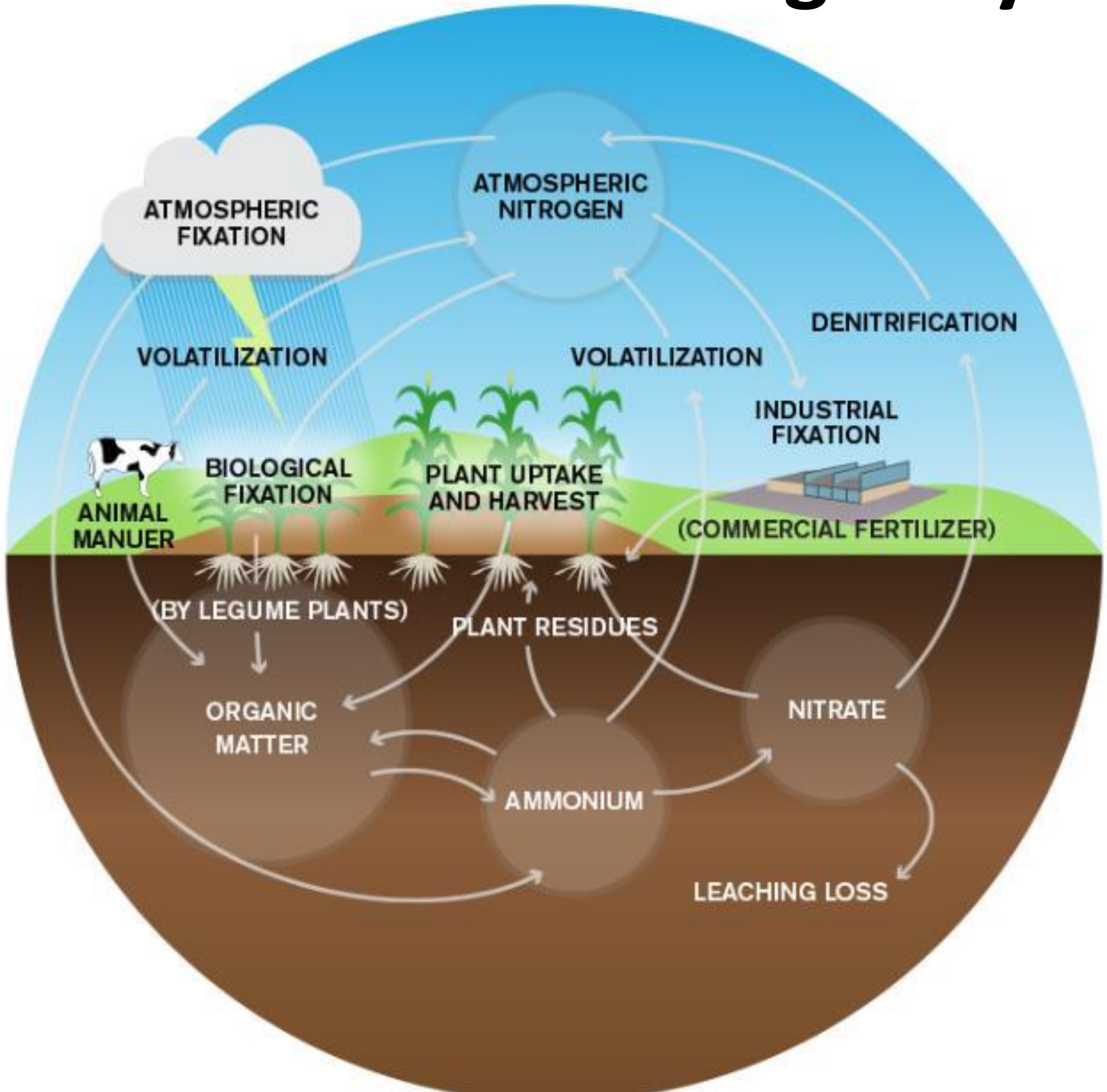
Nitrogen in Crop Production Systems

Section 2

Section 2 Learning Objectives

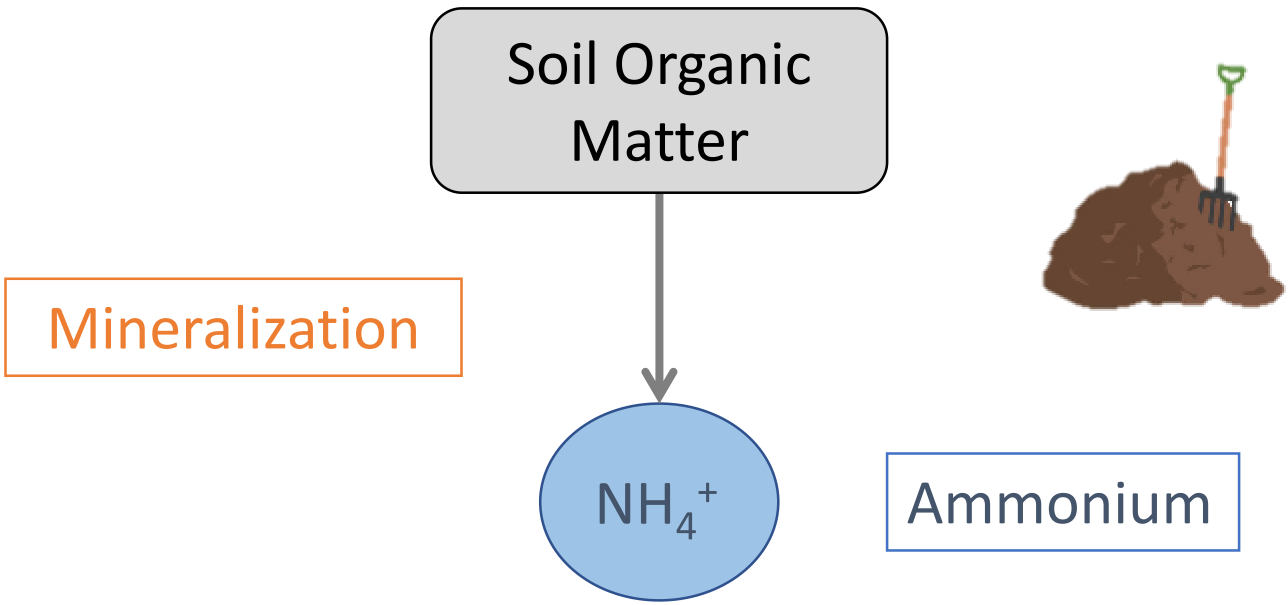
- Identify the parts of the nitrogen cycle and recognize conditions that favor each process
  - Mineralization
  - Nitrification
  - Plant uptake
  - Microbe uptake (Immobilization)
  - Volatilization
  - Denitrification
  - Leaching

Overview of the nitrogen cycle



Mineralization

A microbial process that converts **organic** N to plant available **inorganic** N in the form of ammonium (NH_4^+)



Soil Organic Matter

- Soil organic matter consists of fresh residues, partially decomposed organic materials, and humus
- Soil organic matter stores soil carbon and nutrients in the soil
- The process of N release from soil organic matter is driven by microbes
  - Carbon and nutrients are taken up as microbes grow then they are released as mineral N upon death (mineralization).

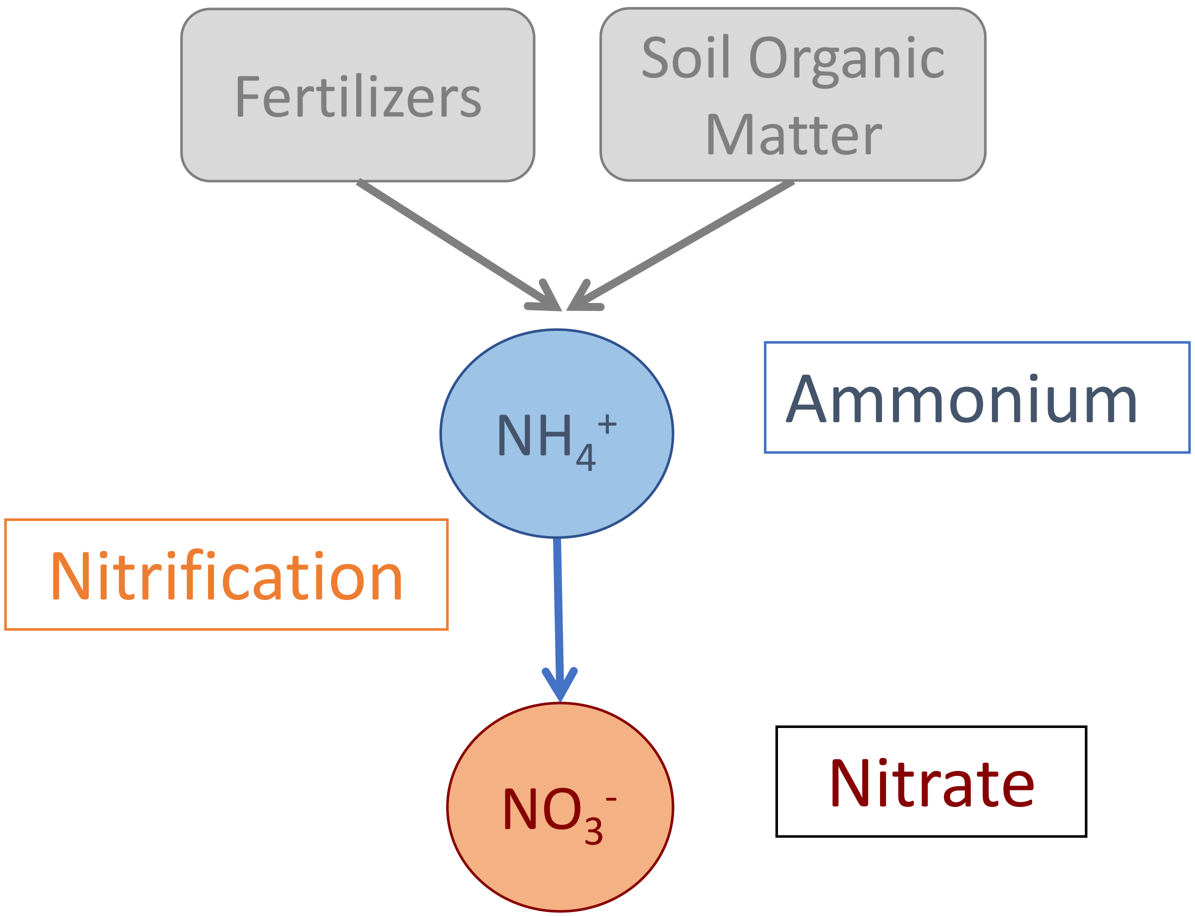
Mineralization

Organic N to Mineral N

- Carbon-to-Nitrogen ratio (C:N) of organic materials is one of the main factors controlling mineralization rates.
- Environmental conditions such as , tillage (aeration), temperature, and moisture enhance mineralization rates.

Nitrification

A microbial process that converts **ammonium (NH_4^+)** to **nitrate (NO_3^-)**



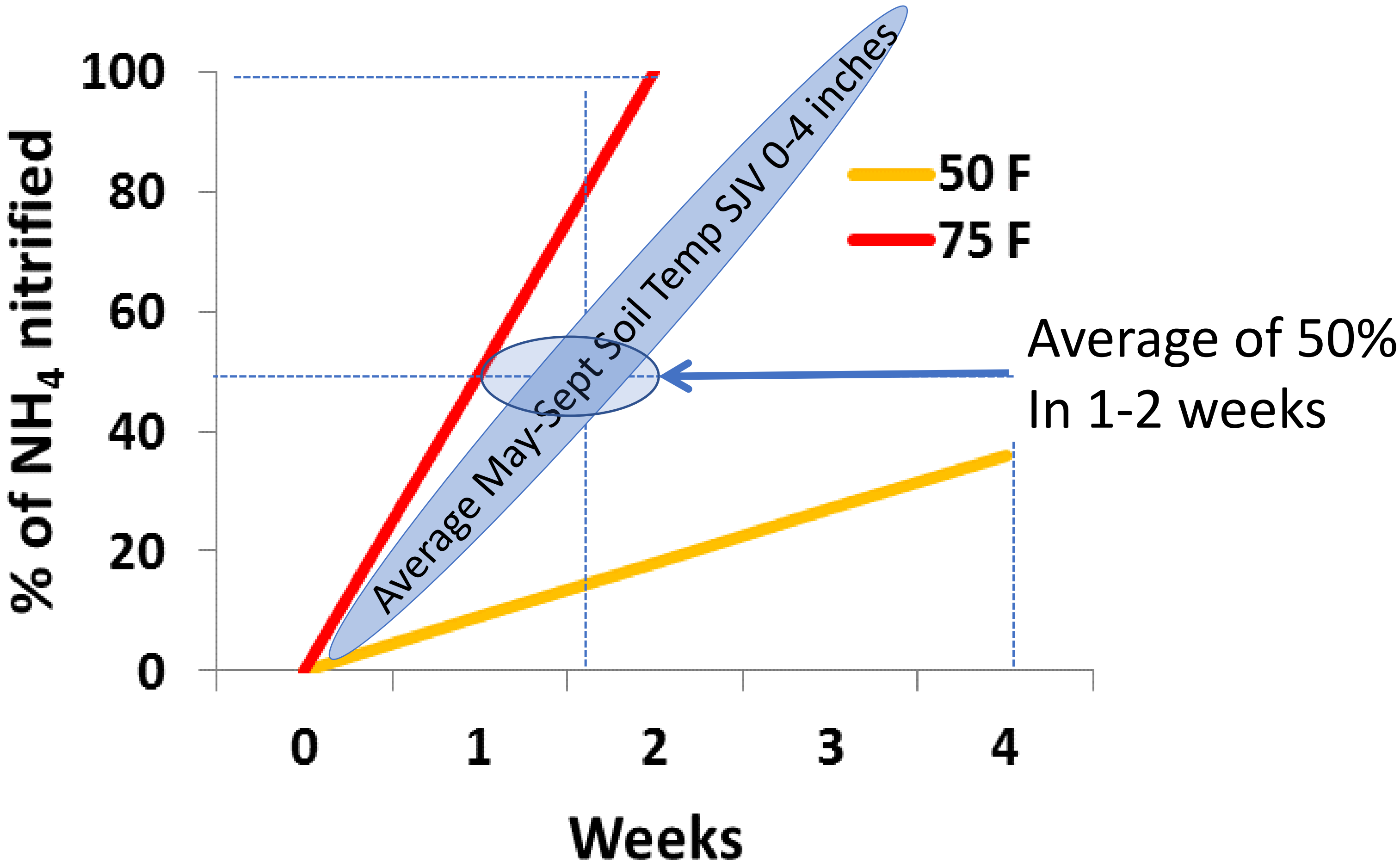
Nitrification

Ammonium → Nitrate

- Ammonium is used as an energy source by bacteria resulting in the production of nitrate
  - Nitrate is readily available for plant uptake

- Process enhanced by warm, moist, and well aerated soils

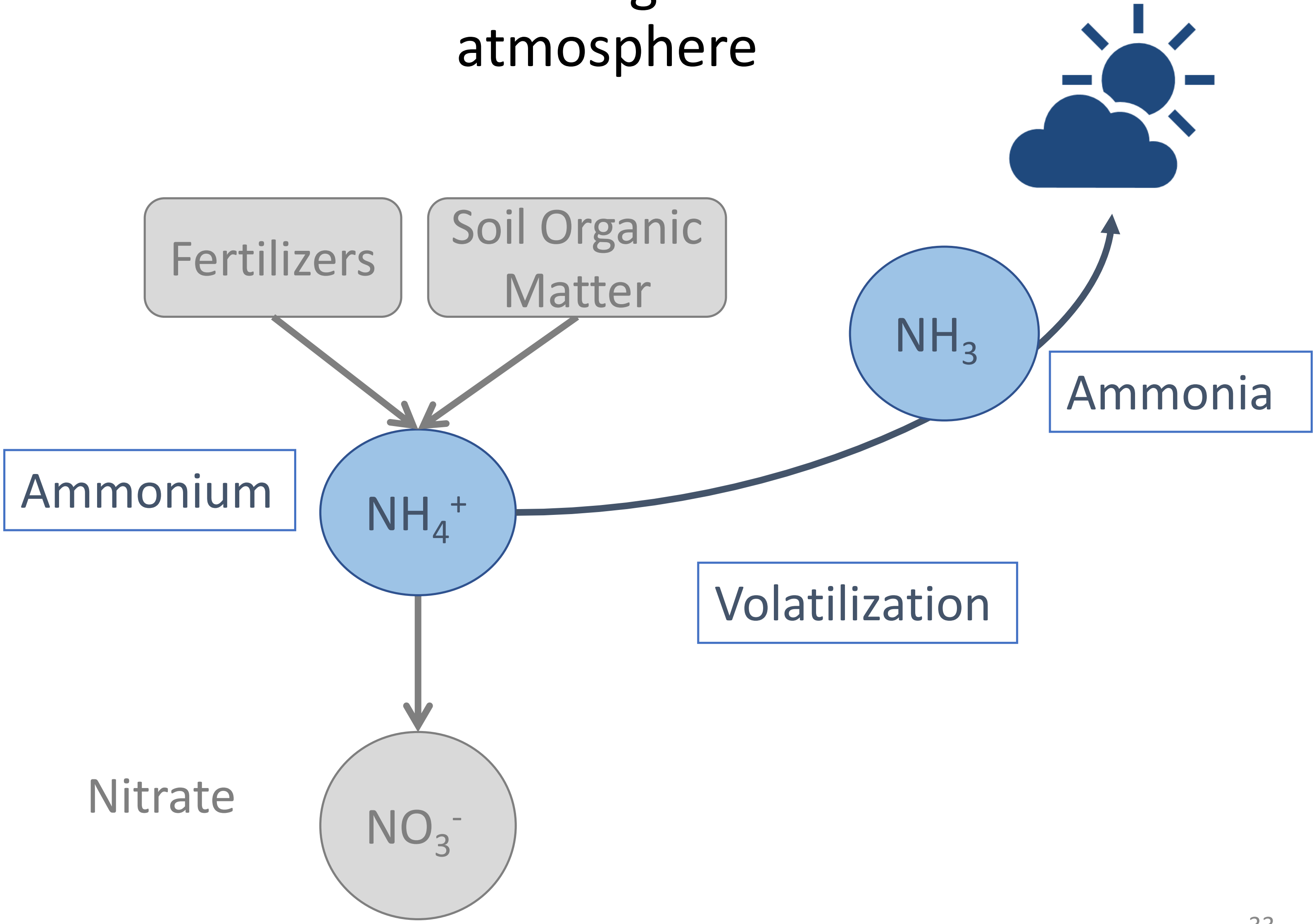
Nitrification: How Quickly Does it Occur?



(Figure: Adapted from Western Fertilizer Handbook)

Ammonia Volatilization

Volatilization is the loss of gaseous ammonia to the atmosphere

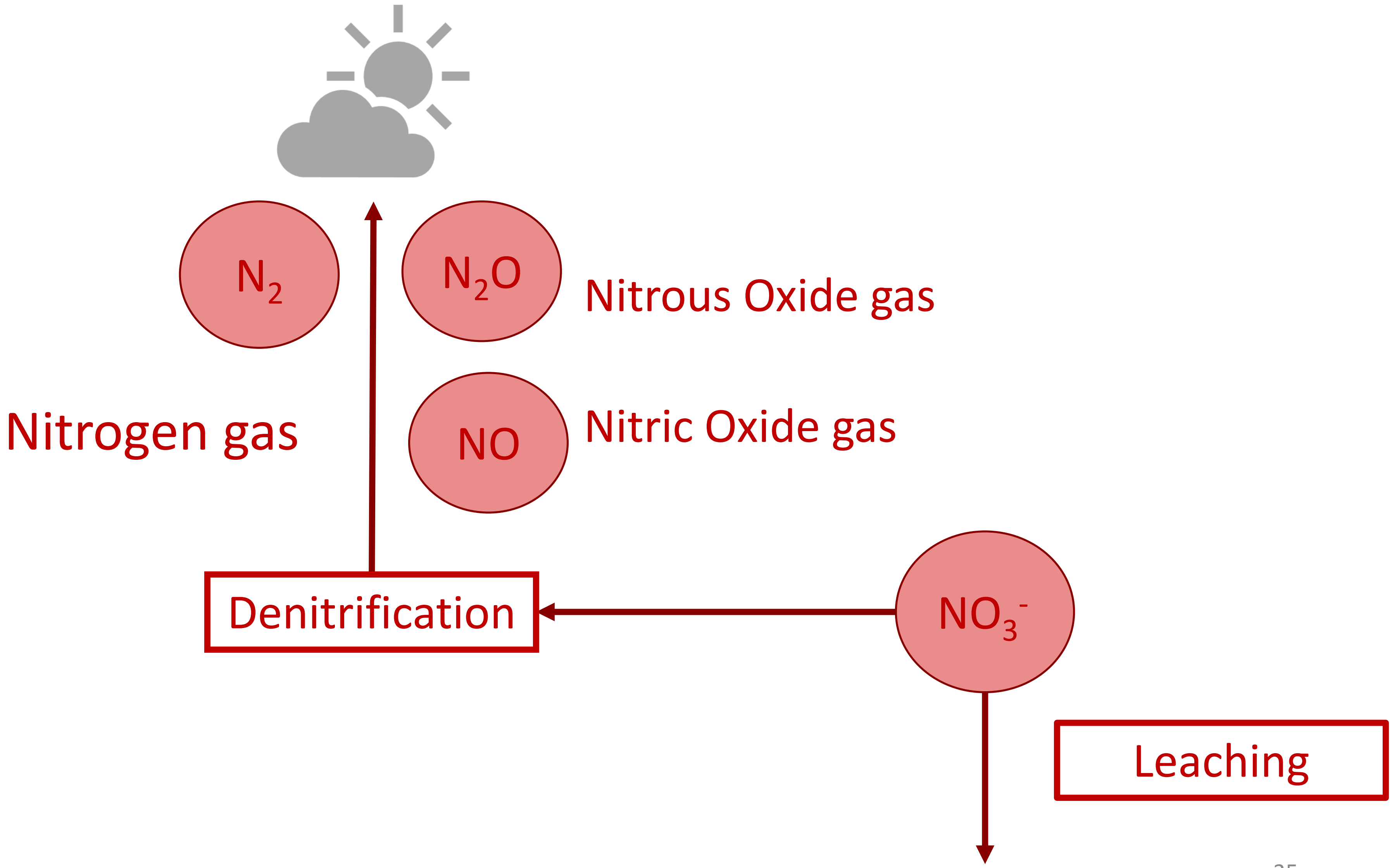


Ammonia Volatilization

The loss of gaseous ammonia (NH_3) to the atmosphere

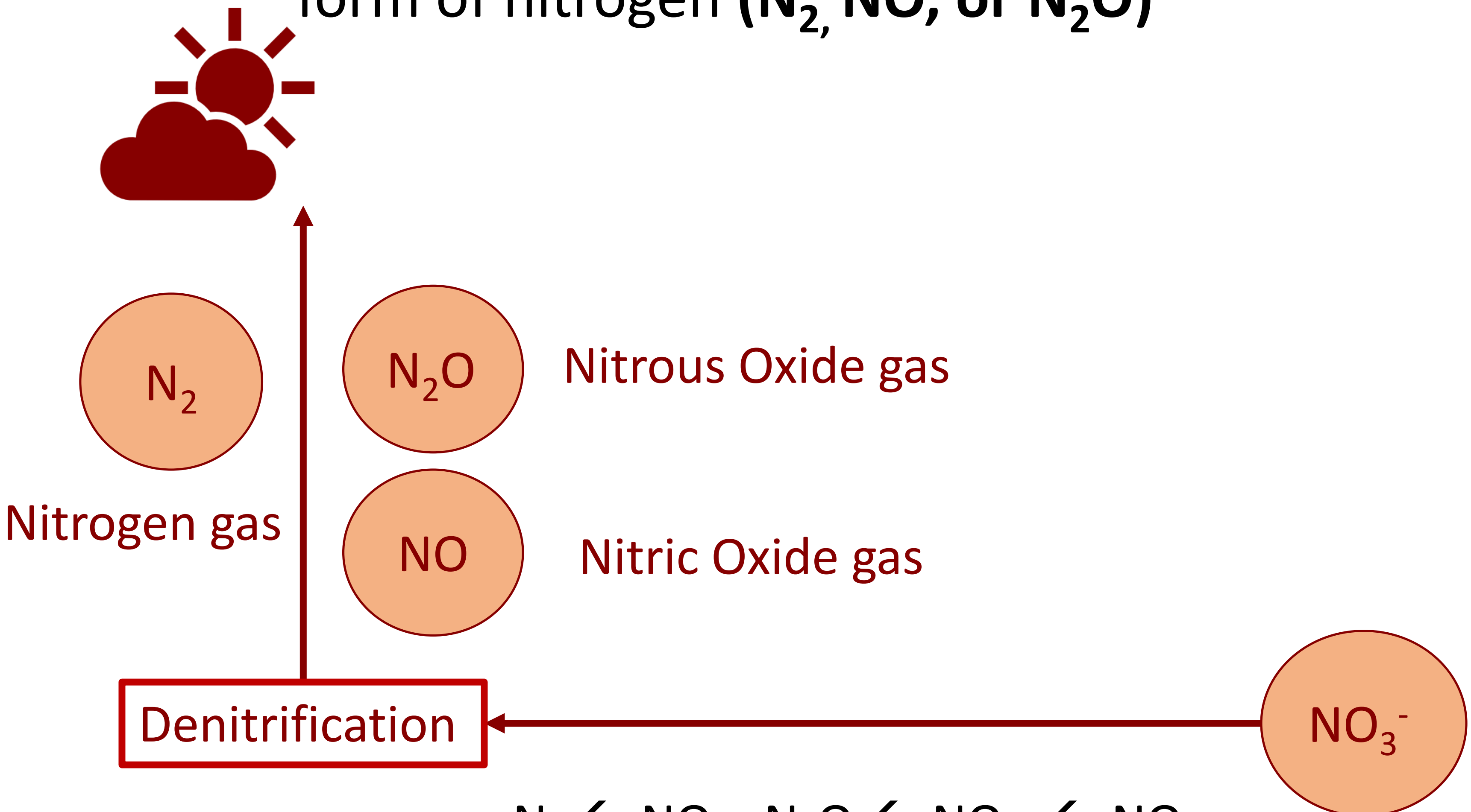
- Materials where ammonia gas is present or is a result of their breakdown include fresh manure, ammonia injections, urea, and UAN
- Conditions that favor volatilization
  - Lack of soil incorporation
  - Dry soil (low moisture content)
  - Coarse-textured soils (sandy)
  - High pH soils/water

Nitrogen Cycle –Nitrate Losses



Denitrification

A microbial reduction of **nitrate (NO_3^-)** to a **gaseous** form of nitrogen **(N_2, NO, or N_2O)**



$N_2 \leftarrow NO + N_2O \leftarrow NO_2^- \leftarrow NO_3^-$

Denitrification

Anaerobic reduction of $NO_3 \rightarrow N_2O$, NO, and N_2 gas

- Occurs under warm, anaerobic conditions
  - Most significant in wetlands and rice paddies

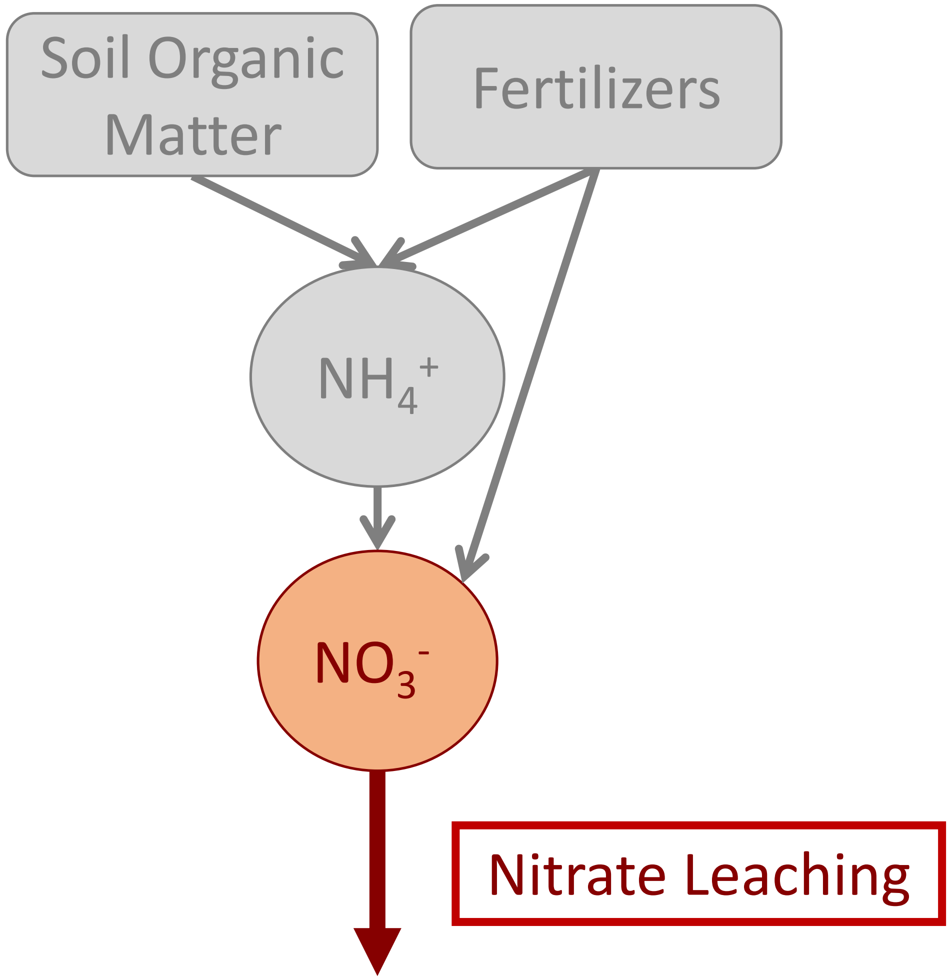
- In irrigated agriculture most N loss occurs during a brief period when the soil is warm, wet, and high in nitrate (i.e. fertigation)

- Of the N losses denitrification is potentially the smallest

  (1- 4 lbs N/acre per irrigation or rain event)

Nitrate Leaching

Loss of nitrate (NO_3^-) from the soil due to irrigation or rain. Greatest loss potential of nitrogen from the soil

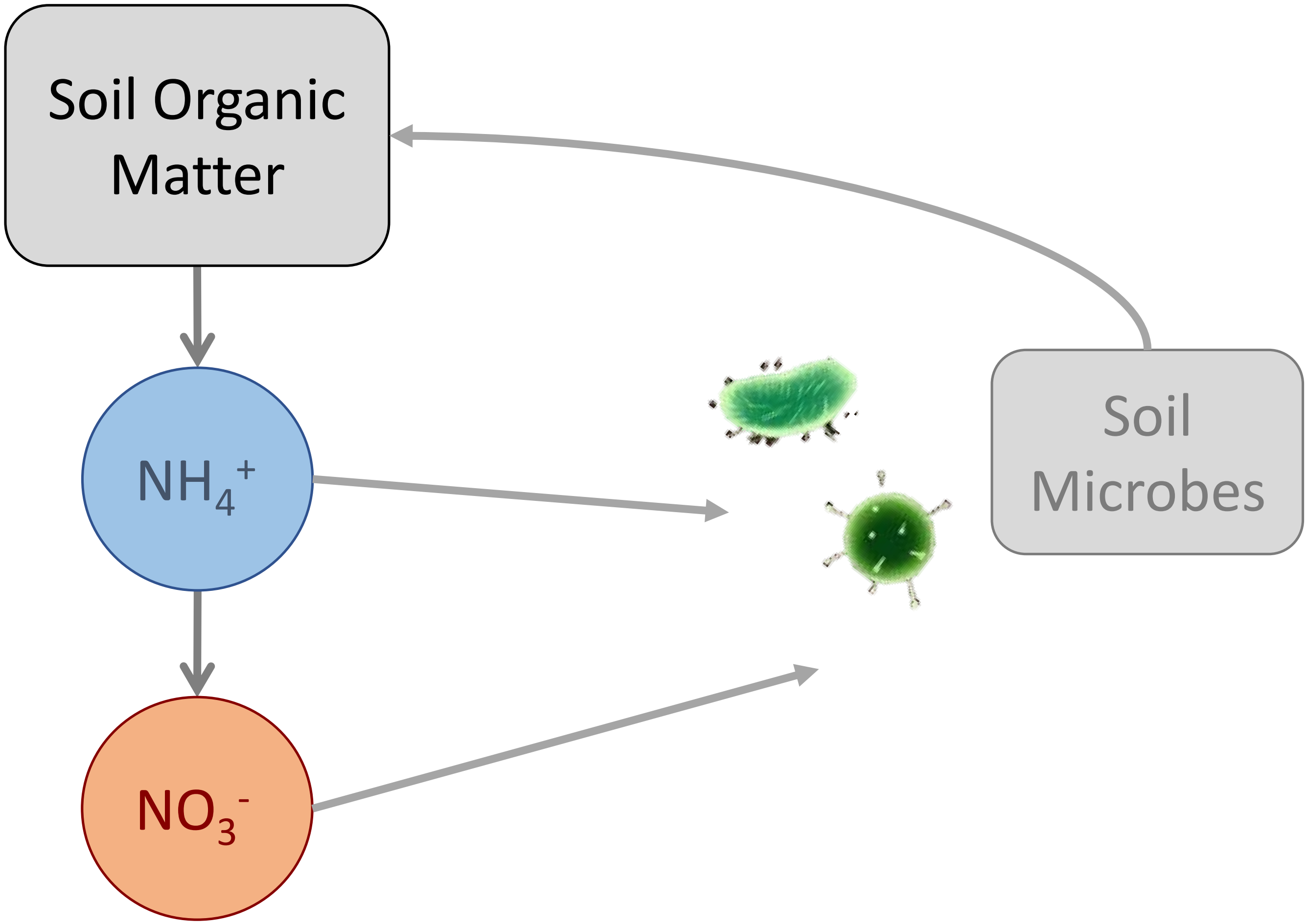


Nitrate Leaching

Movement of nitrate below the root zone

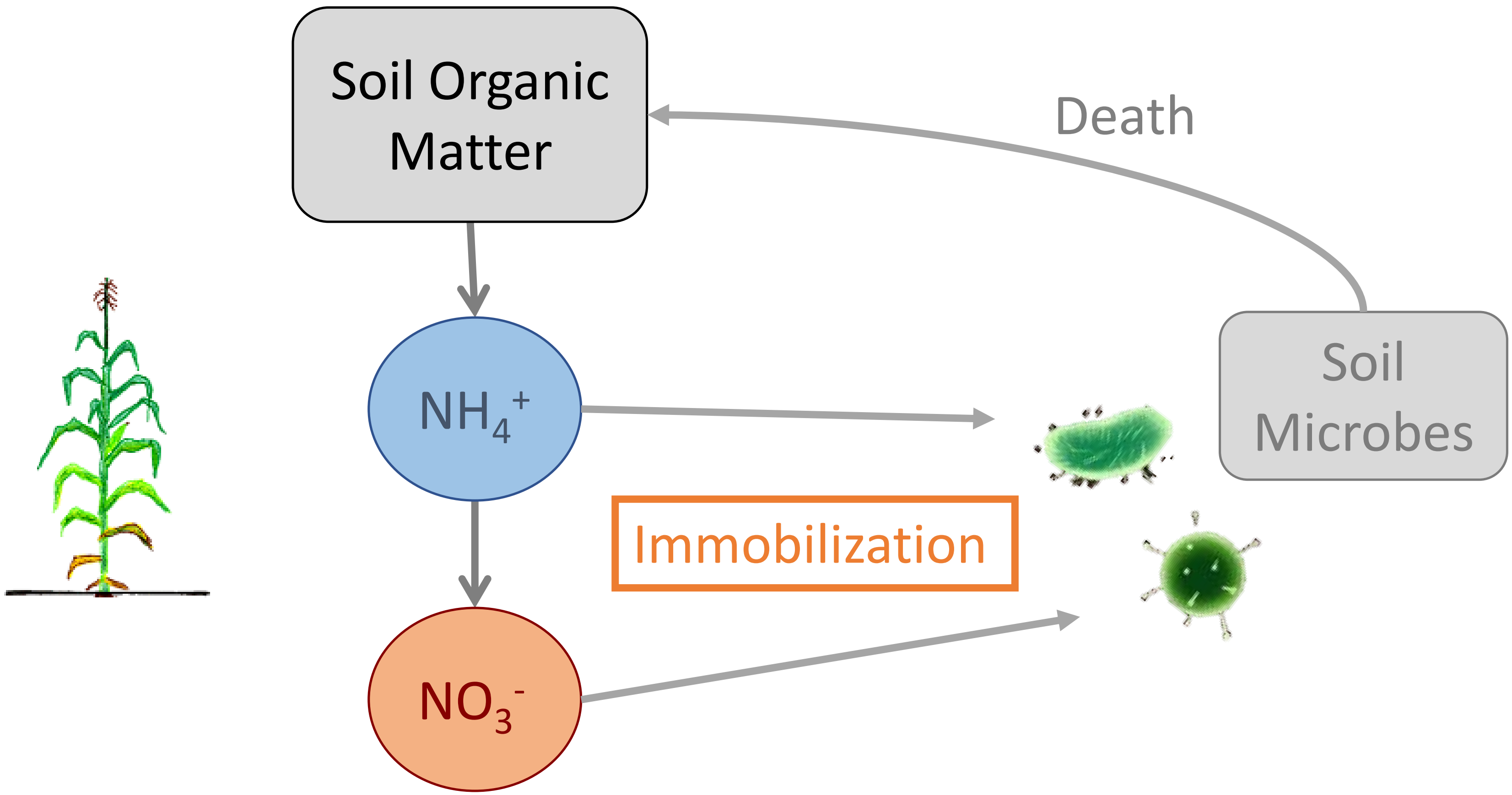
- Reasons why nitrate can leach:
  - Nitrate (NO_3^-) is negatively charged, so it is not held by the soil particles because they are also negatively charged
  - Poor management practices such as applying excess N and irrigation water and not matching application timing with crop demand

Nitrogen Cycle- Microbes



Immobilization

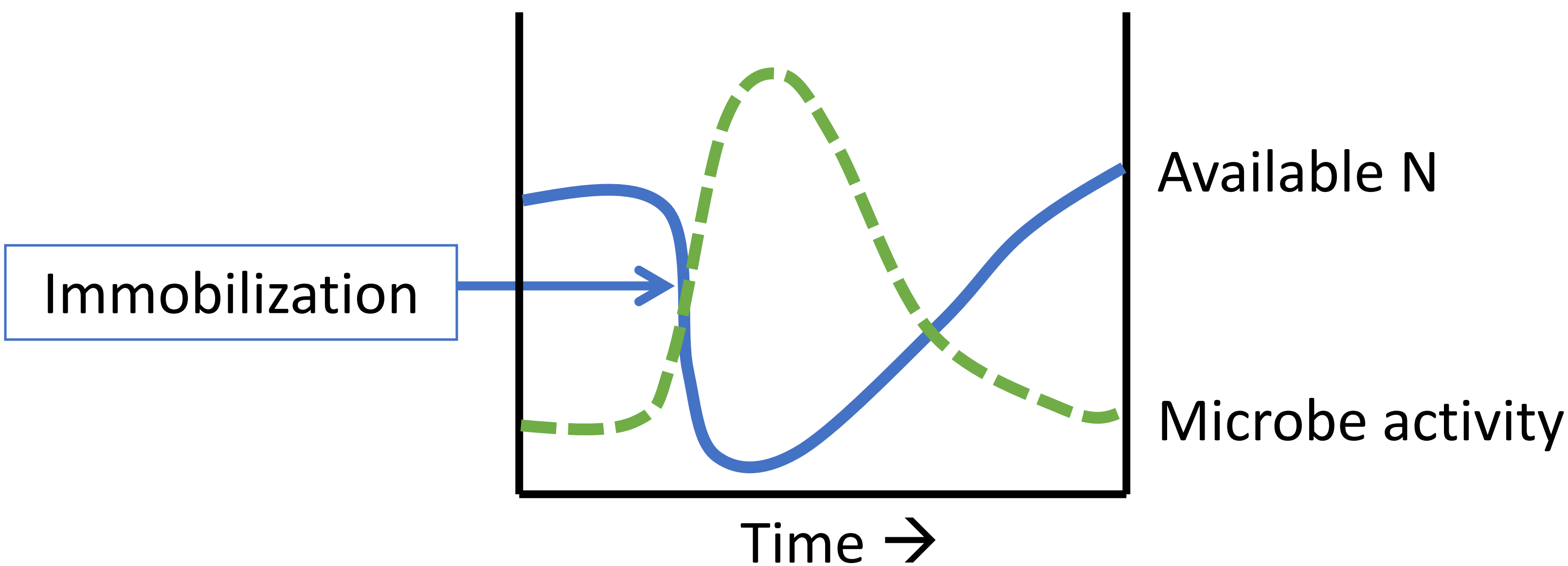
Microbes incorporate mineral N from soil solution into organic compounds in their cells



Immobilization

Mineral N to Organic N

- Microbe uptake of nitrate is very efficient.
- If a high carbon energy source is available, and temperature/moisture conditions are favorable Microbe N uptake can cause crops to be N deficient



Organic Matter Decomposition in Soils

- Decomposition rates depend on the source:
  - Main Sources: Plant residues (crops, cover crop, compost) and animal manure
  - Sources contain different organic carbon compounds depending on crop residue type and age

1. Sugars, Starches 2. Proteins 3. Hemicellulose and cellulose 4. Woody tissues (lignin)	Rapid decomposition ↓ Slow decomposition

Organic Matter C:N Ratios

Material	% C	% N	C:N
Sawdust	50	0.05	600
Wheat Straw	38	0.5	80
Corn residue	40	0.7	57
Rotted Manure	41	2.1	**20**
Broccoli Residues	35	1.9	18
Vetch Cover Crop	40	3.5	11
Soil Bacteria	50	10	5

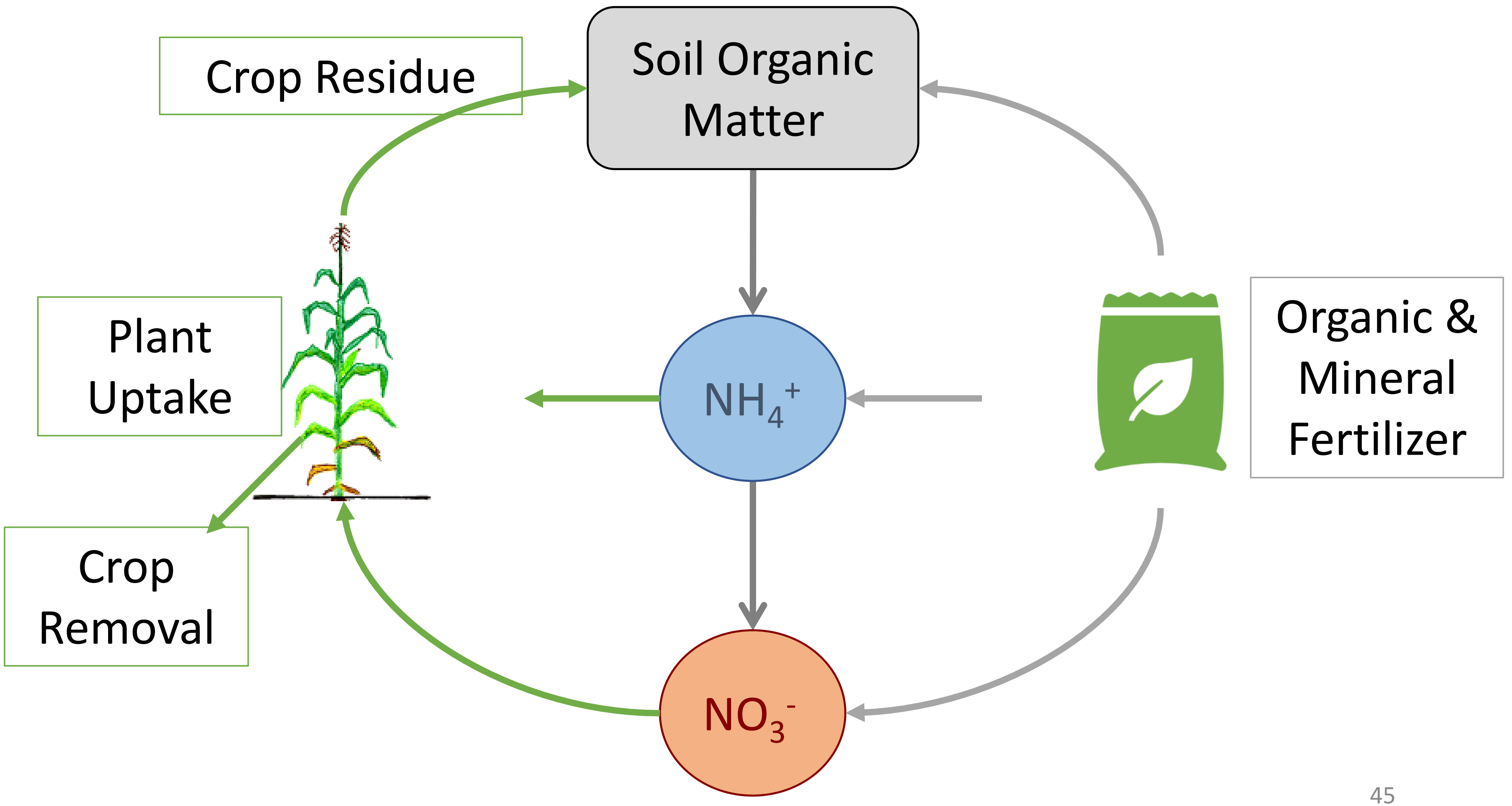
Slow Decomposition /Favors Immobilization

20:1 (2% N)

Rapid Decomposition /Favors Mineralization

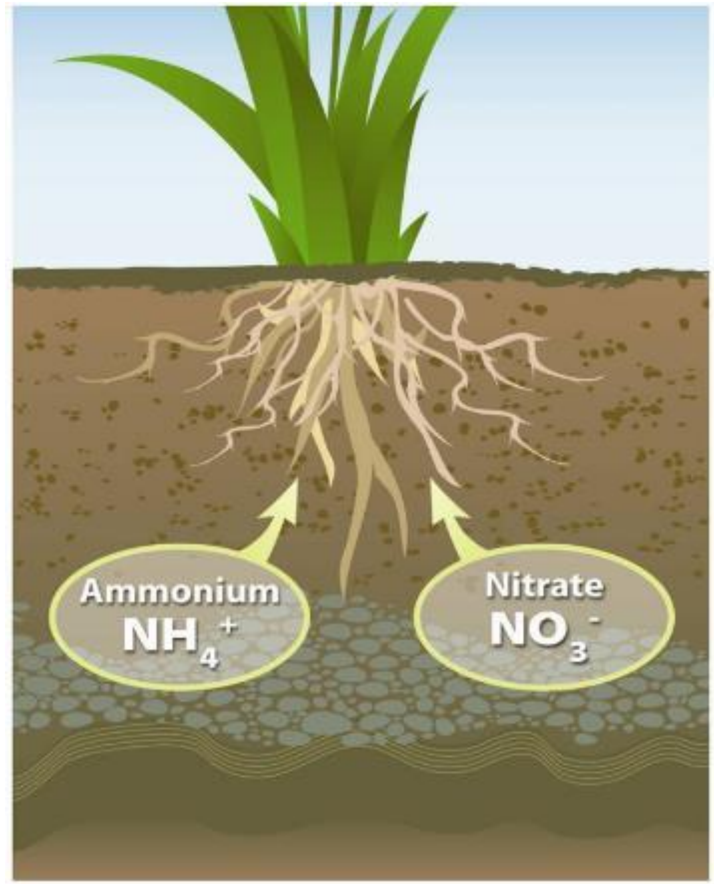
Generally: A C:N ratio of **20:1** (2% N) is the dividing line between **mineralization** (immediate release) and **immobilization** (N binding and subsequent release).

Nitrogen Cycle- Fertilizer Inputs and Crop Removal



Nitrogen Cycle –Plant Uptake

- Ammonium is only available in soils for short periods of time until converted to nitrate.
- Therefore, on a whole the most N form taken up is nitrate.



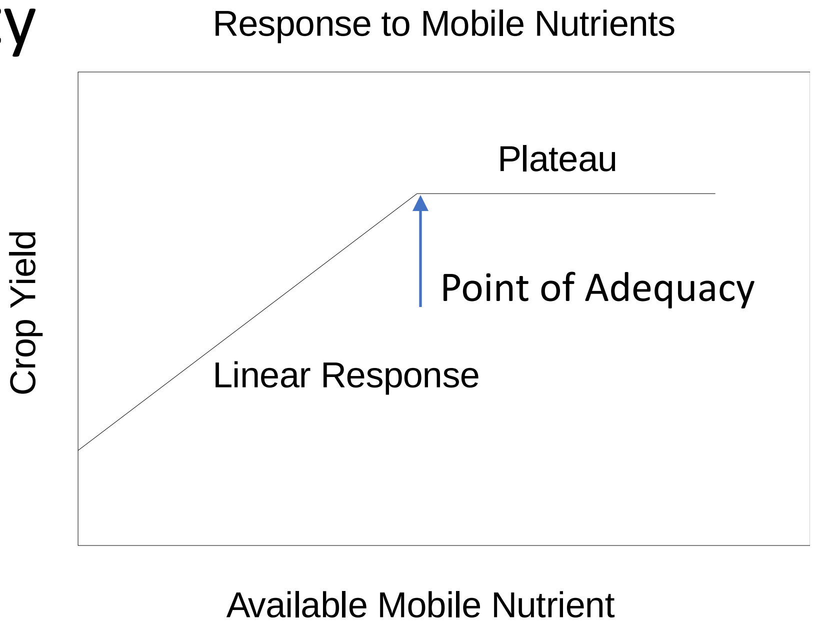
Nitrogen Assimilation

- Nitrogen assimilation is the formation of **organic** nitrogen compounds like amino acids from **inorganic** nitrogen compounds

  - Assimilation drives plant N uptake
  - Plants only assimilate the needed amount plus a small amount of "luxury consumption" ~10-15% of total N
  - Thus N available in the soil, that is in excess of plant needs, may be leached to groundwater

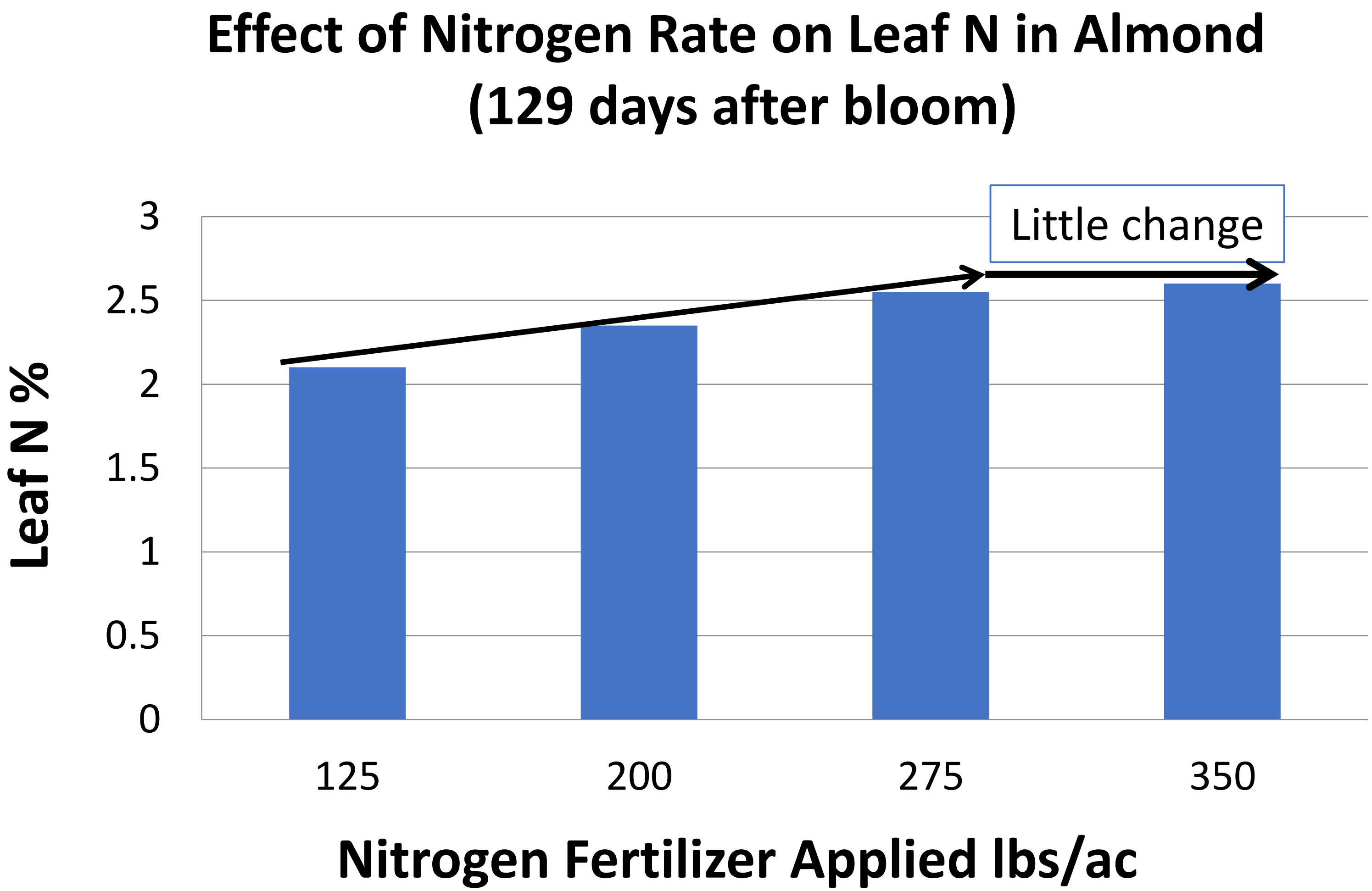
Nitrogen and Crop Productivity

- Nitrogen availability generally limits crop productivity until adequacy is reached, then response to N plateaus
  - Fertilization past a level of adequacy does **not** increase productivity



Nitrogen in Plants

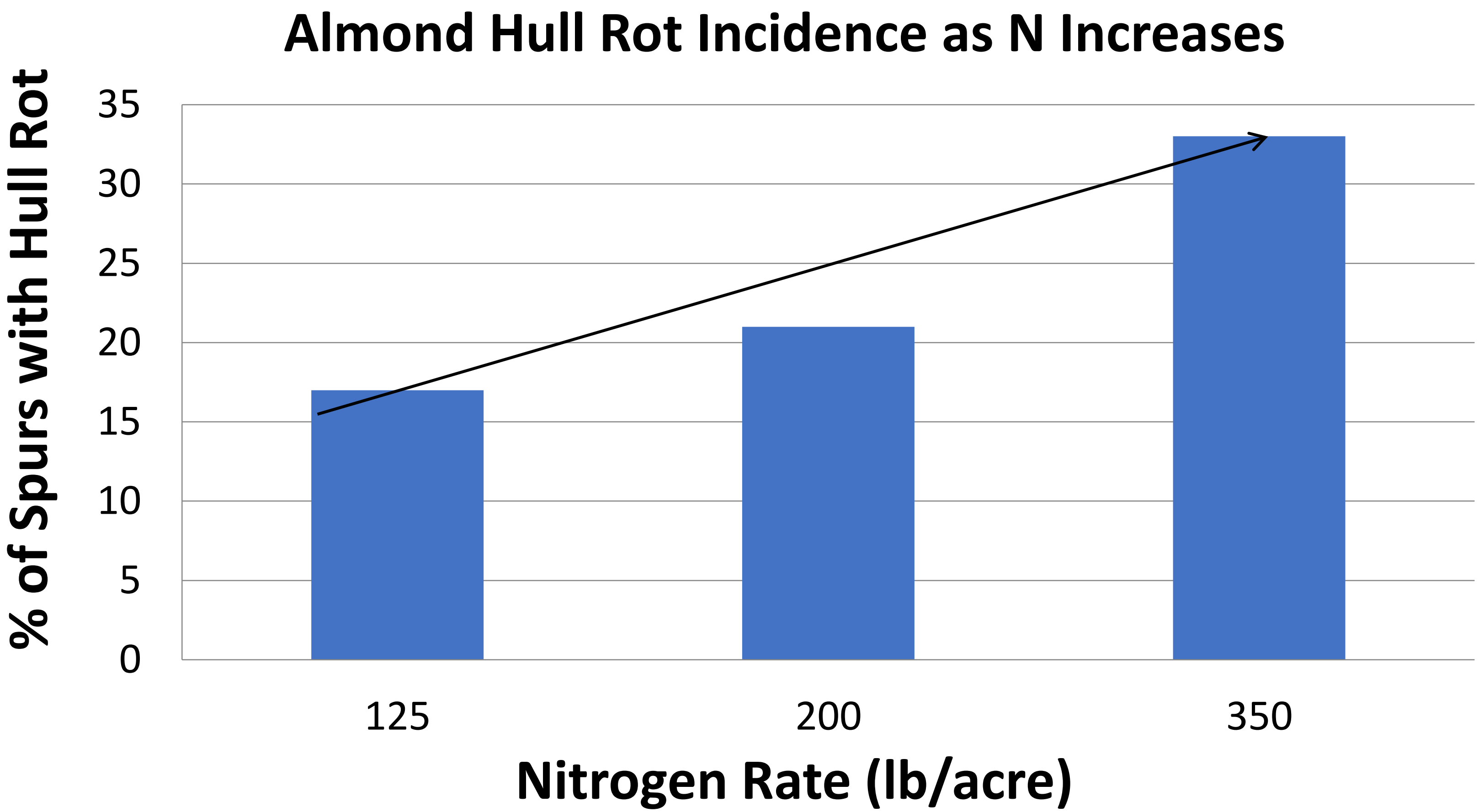
N in Excess of Demand is Inefficiently Used



Muhammad, 2013

Nitrogen in Plants

Excess N Example



(Elana Peach-Fine, MSc. 2013)

Nitrogen Cycle Review – Mineralization and Nitrification

Fertilizers

Soil Organic Matter

Mineralization

NH_4^+

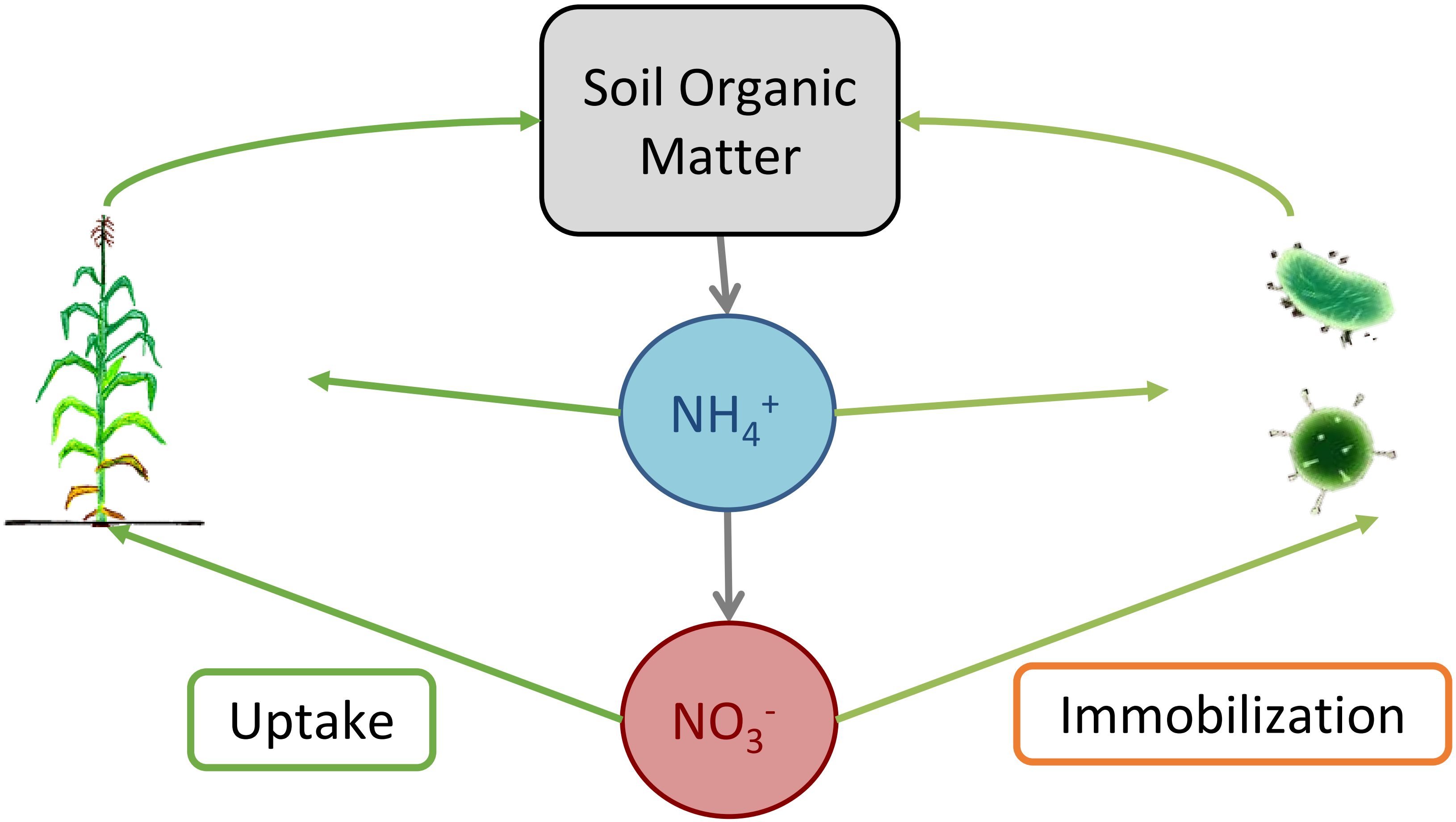
Ammonium

Nitrification

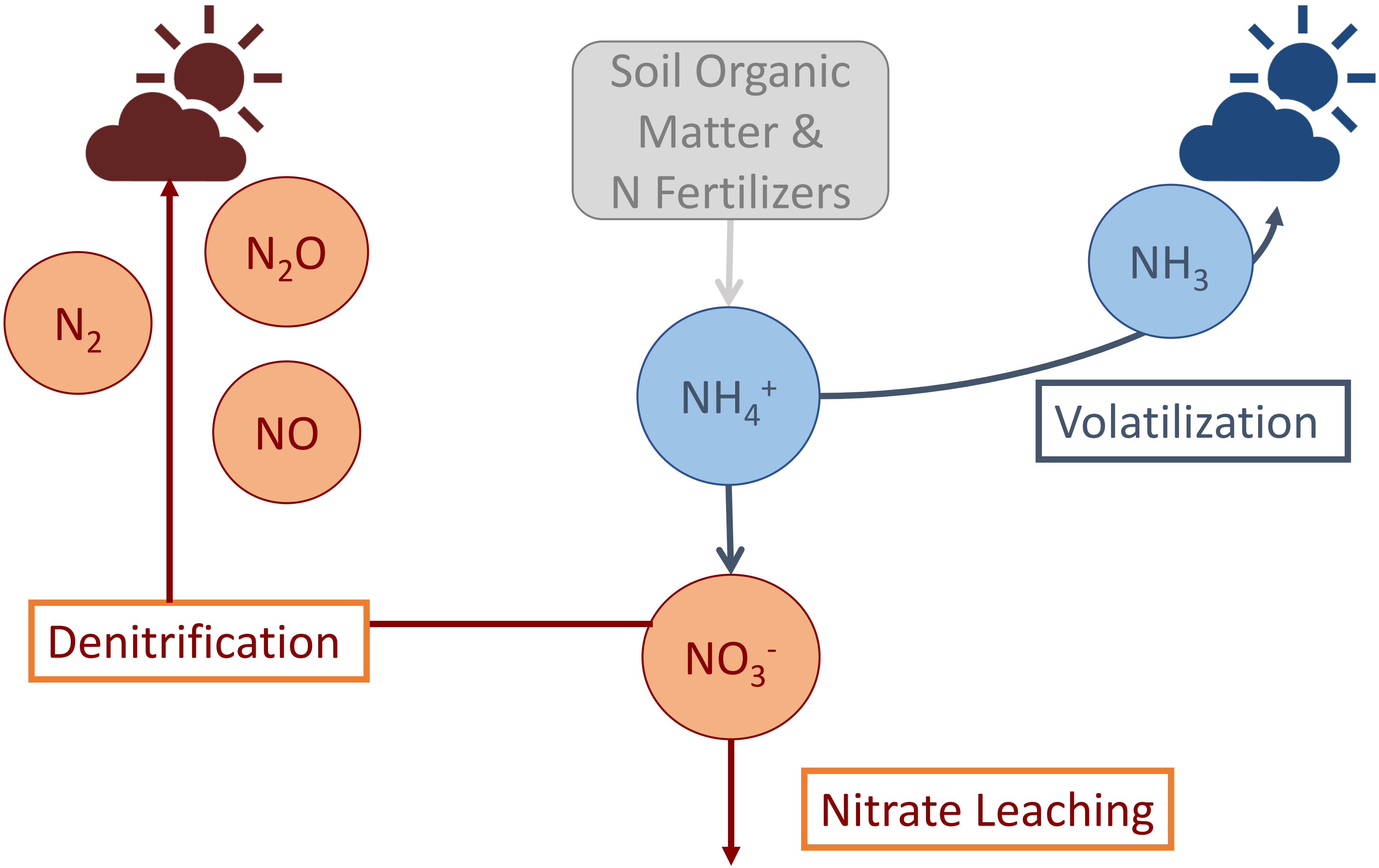
NO_3^-

Nitrate

Nitrogen Cycle Review –Plants and Microbes



Nitrogen Cycle Review -losses



Nitrogen Fertilizers and Management

Section 3

Section 3 Learning Objectives

- Recognize the different categories of nitrogen fertilizers and their composition
- Identify their potential for N loss

Nitrogen Source Groups

- Ammonium-forming fertilizers
  - Form ammonium on reaction with soil moisture or by urease conversion
- Ammonium fertilizers
- Nitrate fertilizers
- Combination fertilizers
- Organic materials
  - Release mineral N over time through microbial activity

Ammonium-forming Fertilizers
Anhydrous ammonia

- When AA contacts water or moist soil, it forms ammonium and hydroxyl ions raising the pH around the application site

$$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$$

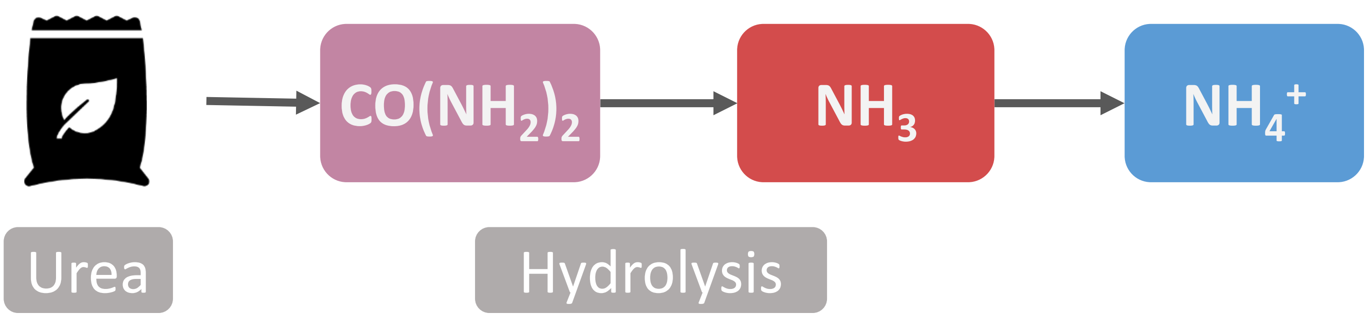
Volatilization of Anhydrous Ammonia
How large can losses be?

- In a field trial conducted by UC Davis to quantify ammonia volatilization loss from water run AA, they found that:
  - Ammonia volatilization averaged 30% of applied N over the whole field
  - Ammonium concentration declined down the length of the furrow by more than 50%
    - Poor N application uniformity

Ammonium-forming Fertilizers

Urea

- Highly soluble and uncharged
  - Moves freely through soil with water
- Enzymatic breakdown of urea in the soil produces NH_4^+ and bicarbonate
  - Bicarbonate increases soil pH
- Rate of hydrolysis increases with temperature and decreases under high application rates



Volatilization of Urea
How large can losses be?

- When urea is surface applied and not incorporated volatilization losses can be high
  - Up to 30% loss in 14 days without rainfall or irrigation
- Factors that increase volatilization
  - Surface application without incorporation or irrigation
  - High temperature and wind speed
  - Low soil buffering capacity (sandy soils)
  - High pH soils

Ammonium Fertilizers

- Ammonium sulfate [$(NH_4)_2SO_4$] (21-0-0)
- Ammonium/phosphorus combinations
  - Monoammonium phosphate (MAP)
  - Diammonium phosphate (DAP)
  - Ammonium polyphosphate (10-34-0)
- Ammonium fertilizers are temporarily resistant to leaching until converted to nitrate
  - Short timeframe especially in warmer weather

Nitrate Fertilizers

- Potassium nitrate
- Calcium nitrate (CN-9)

- Nitrate is negatively charged and moves with the water front
  - Most susceptible to N loss via leaching

Combination Fertilizers

- Combination fertilizers can provide a rapid availability of nitrate and a continued supply as the ammonium is converted to nitrate.

- Ammonium nitrate (NH_4NO_3)

- Calcium ammonium nitrate (CAN-17)
  - 17% N (32% of N as ammonium, 68% as nitrate)

- Urea ammonium nitrate (UAN) solutions
  - 32% N (50% as urea, 25% ammonium, 25% nitrate)
  - different concentrations (UAN-28, UAN-32, etc.)

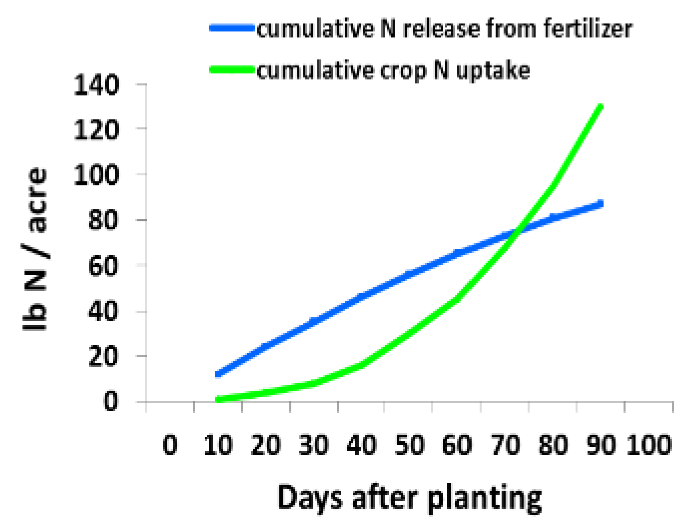
Organic Materials

- Organic materials differ from mineral fertilizers by the rate that N mineralizes and becomes plant available
- Sources
  - Manure and other animal byproducts
  - Cover crops, compost and green waste
- Contains both
  - Mineral N (immediately available) NH_4 and NO_3
  - Organic N (slowly available after microbial conversion)

Controlled Release Fertilizers

The release of nutrients can be controlled using an organic coating on fertilizers

- Benefits
  - Can slow the transformation of $NH4^{+}$ to NO_3^{-}
  - May reduce leaching potential compared to preplant or single sidedress systems
- Drawbacks
  - Higher cost per unit of N
  - Match between N release and crop N uptake is often imperfect
  - Temperature dependent



Section 3 Summary

- Selecting the appropriate N source for the crop / irrigation management situation can lead to the greatest nitrogen use efficiency.

- Reducing nitrogen losses from:
  - Volatilization
  - Denitrification
  - Runoff
  - Leaching

Efficient Irrigation Management

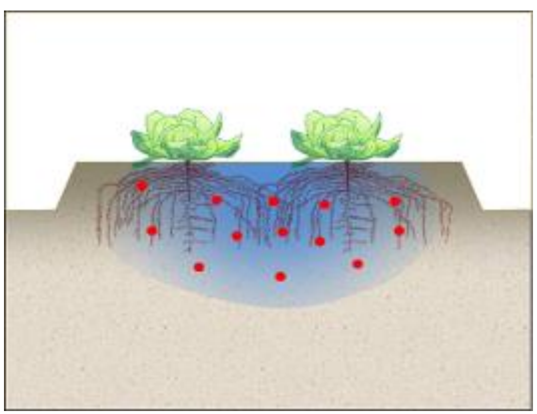
Section 4

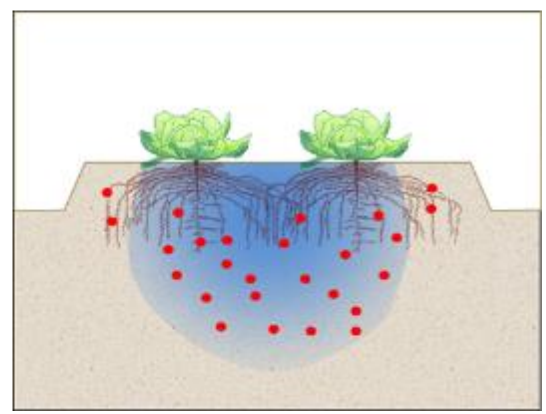
Section 4 Learning Objectives

- Describe the three steps to becoming a more efficient irrigator
  - Proper irrigation scheduling
  - Measure applied water
  - Design and maintain high performing irrigation systems
- Recall what causes non-uniformity in irrigation systems and identify methods to address non-uniformity
- Identify proper methods for fertigation timing and length of injection

Irrigating Efficiently

- Requires supplying the crop water needs while minimizing irrigation losses:
  - Percolation of water below the root zone
  - Runoff of water
- Successful nitrogen management depends on efficient irrigation management
  - Excess applied water can cause nitrogen runoff or leaching to ground waters



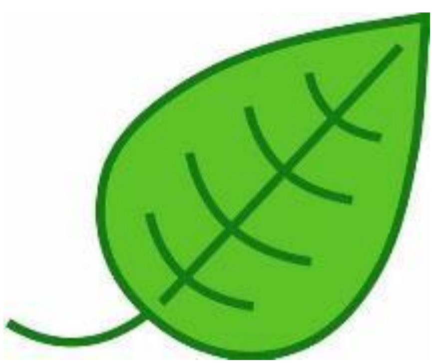


Proper Irrigation Scheduling

Deciding When to Irrigate and How Much to Apply?

- Scheduling aids include measurements of plant water status, soil water status or content and using weather to estimate crop water use.

Plant



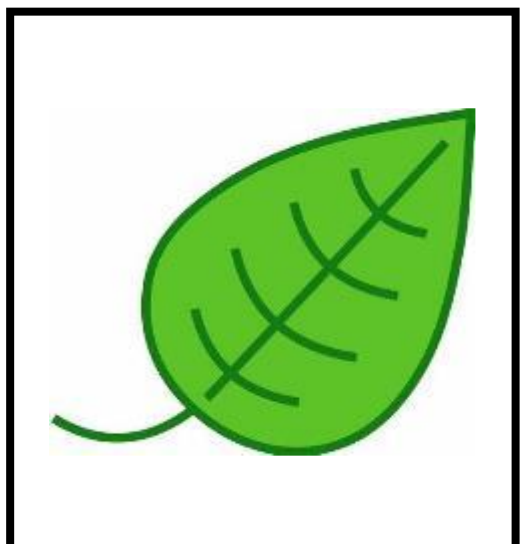
Soil

Weather

Irrigation Scheduling

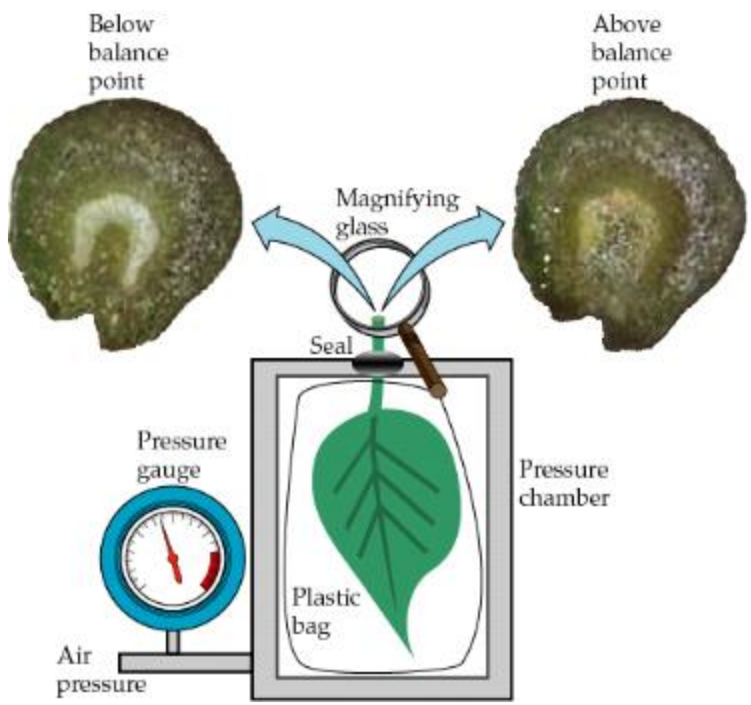
Plant Monitoring Approach

- Measure signs of plant water stress to Indicate **when** to irrigate



Pressure Chamber

- Measures stem water potential, a level of plant water stress, which if used with critical level information can tell you **when** to irrigate.



Pressure Chamber

Example

Reading (-bars)	Walnut	Almond
-6.0 to -8.0	Mild to moderate stress, can affect shoot growth	Low stress, ideal conditions for shoot growth
-10.0 to -12.0	High stress, wilting of leaves, reduced nut size, defoliation	Mild to moderate stress
-14.0 to -18.0	Severe stress, defoliation and dying trees	Moderate stress, suggested during hull split

Irrigation Scheduling
Soil Monitoring Approach

- Estimates **available water** in the root zone by measuring how tightly water is held in the soil (water tension) or by estimating water content

Soil Moisture Monitoring Devices

Electrical Resistance Blocks

Tensiometer

Neutron Meter

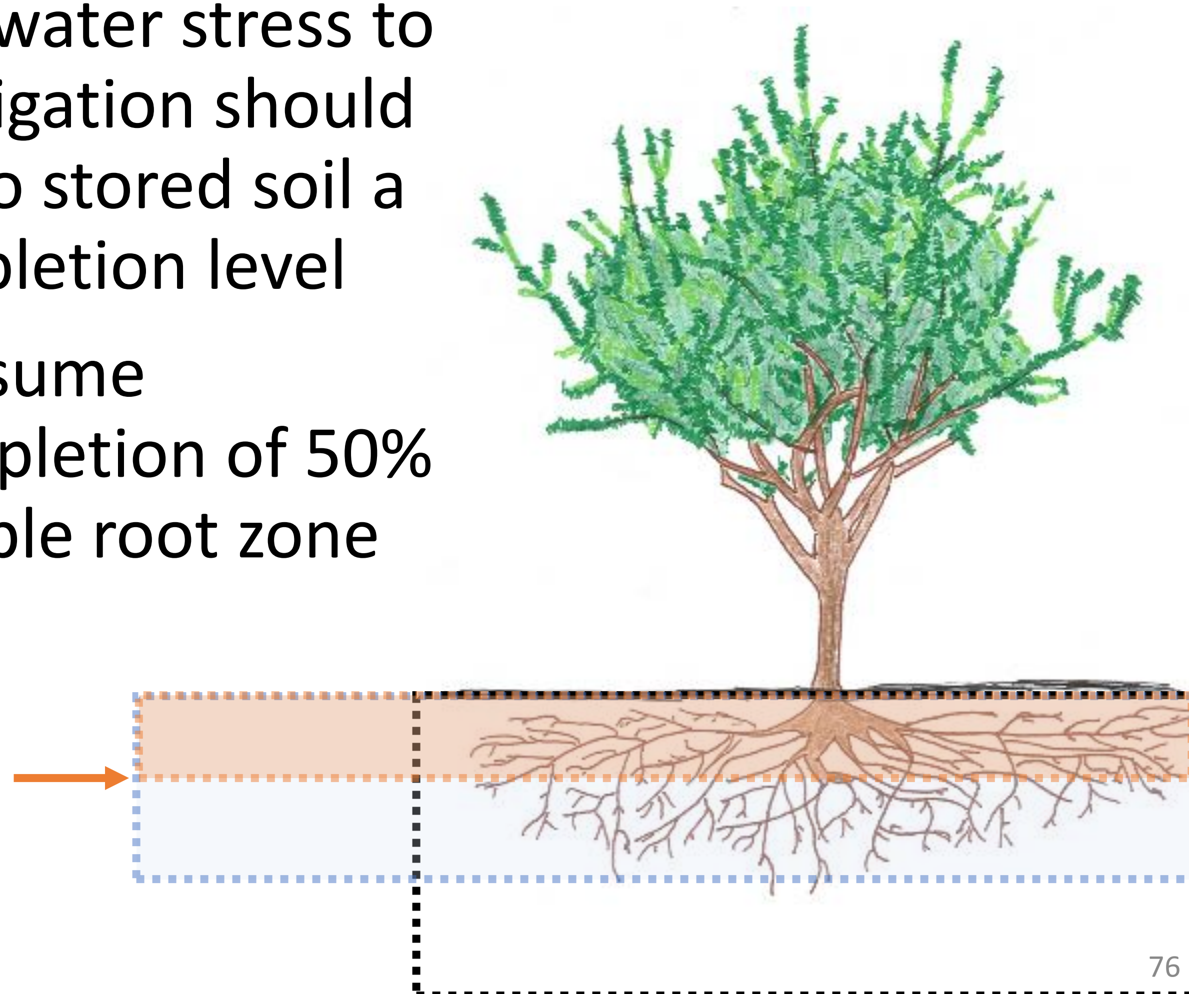
Dielectric Sensors

Measure Water Tension

Estimate Water Content

Deciding When to Irrigate

- To minimize water stress to the plant, irrigation should occur prior to stored soil a moisture depletion level
- Generally assume allowable depletion of 50% of the available root zone moisture

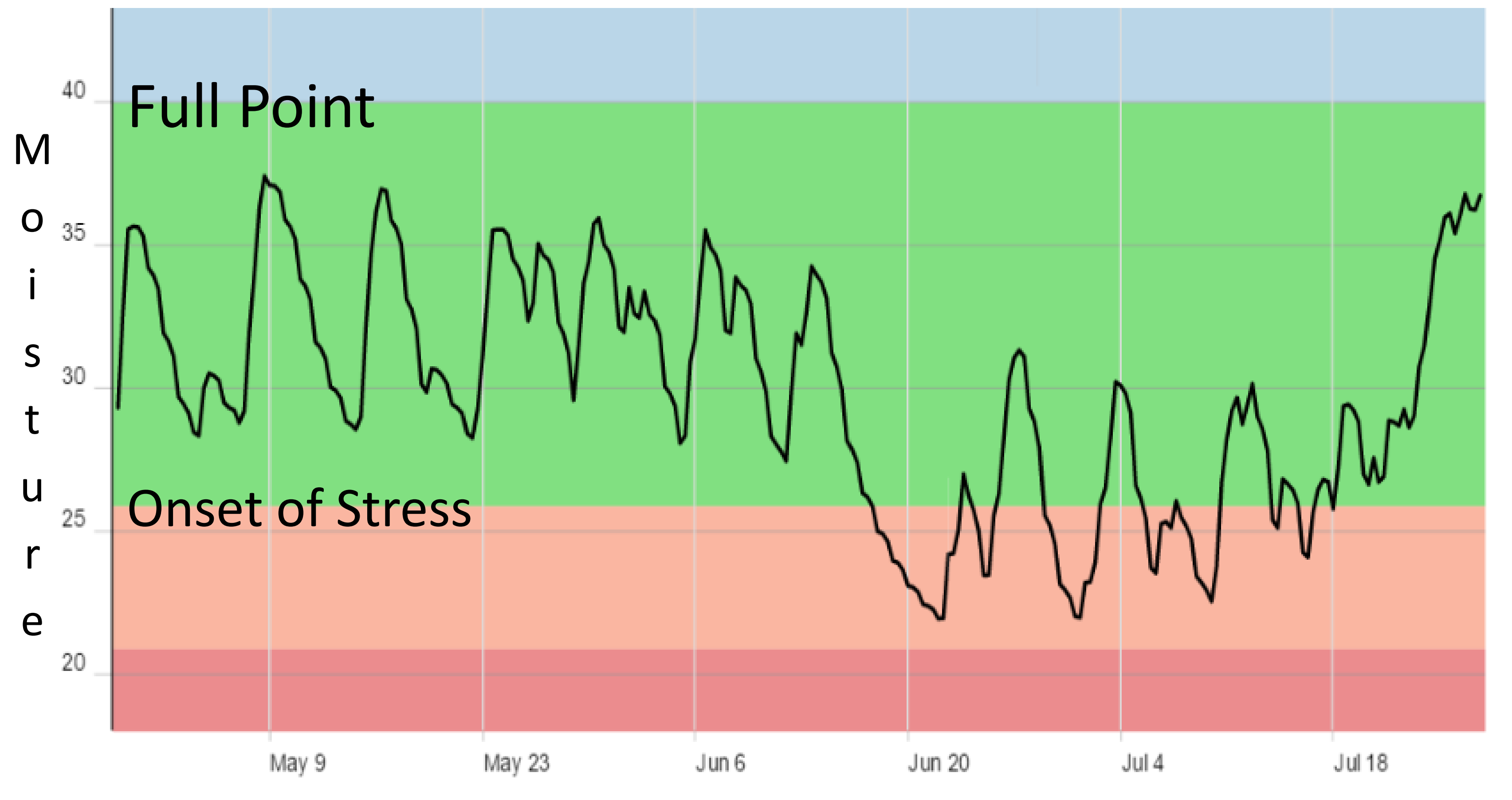


Tensiometer Reading Example

Tension	Sand/ Loamy Soil	Sandy Loam	Loam/ Silt Loam	Clay Loam /Clay
(centibars)	Depletion of the Plant-Available Water (%)			
10	0	0	---	---
30	40	25	0	0
50	65	55	10	10
70	75	60	25	20
90	80	65	35	25
110	85	68	40	32
130	87	70	47	38
150	90	73	52	43
170	95	76	55	46
190	98	79	58	49

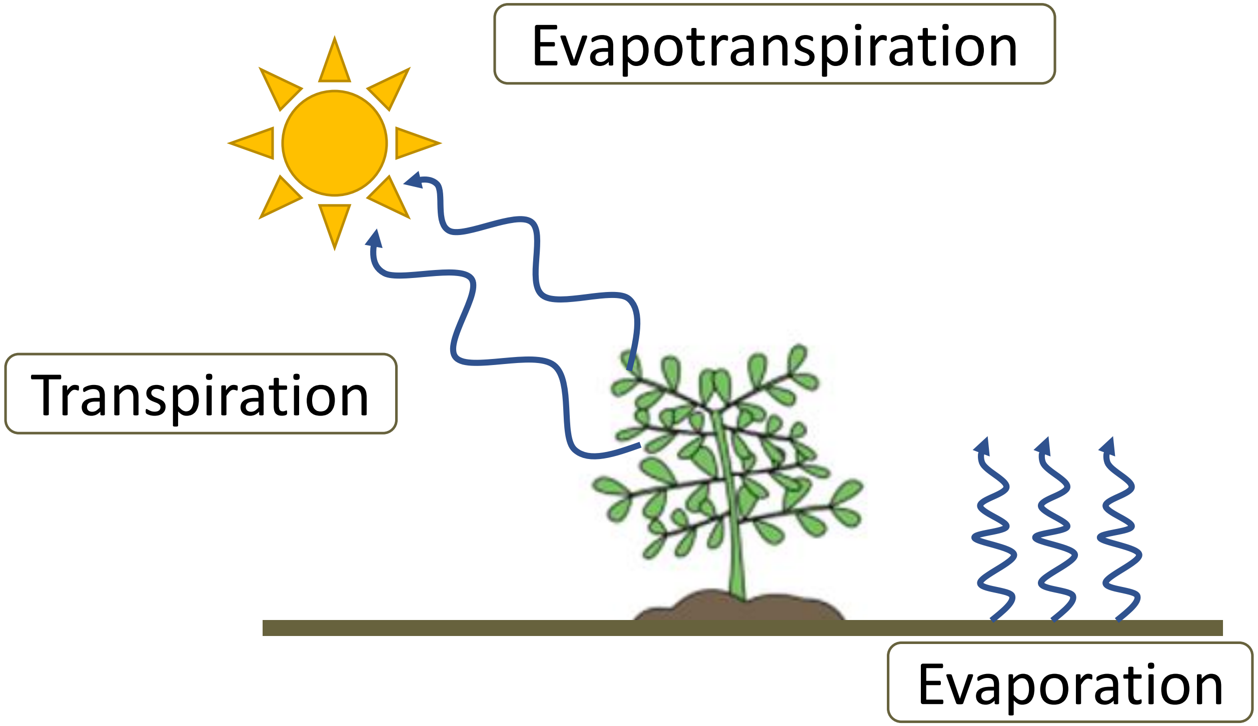
Dielectric Sensor Reading Example

Root zone moisture summation reading as a result of: crop water use and irrigation



Irrigation Scheduling
Weather Monitoring Approach

- Climatic conditions including solar radiation, temperature, humidity, wind speed, drive plant water use (ETc)



Estimating Crop Water Use (ETc)

- ETc = Crop Water Use
- ETo = Reference Evapotranspiration
  - Provided by CIMIS network of nearly 100 weather stations throughout California
- Kc Crop Coefficient
  - Ratio at which the crop uses water compared to the reference crop (pasture grass)
  - Dependent on crop size and age

$$\boxed{ET_c = ET_o \times K_c}$$

www.cimis.water.ca.gov

CIMIS and ETo

- CIMIS provides real-time and historic ETo estimates
- California has 18 reference zones that vary due to climatic factors

www.cimis.water.ca.gov

ET Information

- Monthly normal or historical averages can be used for planning irrigations.

- However, each season has some variability in water use and can be accounted for by using current year information available though the CIMIS program then adjusting irrigations appropriately.

www.cimis.water.ca.gov

Crop Coefficients (Kc)

- For annual crops Kc’s are closely related to the plant coverage which increases from planting over the season until fresh harvest or declines with late harvested crops.

- For trees and vines Kc’s increase beginning at leaf out and decline towards leaf drop. Kc’s can be over 1.0 due to their tall stature and being planted in rows.

Crop Water Use (ETc)

Example: Historical Monthly ETo, Almond ET Zone 12

	Kc	**ETo**	**ETc**
Mar	0.62	3.41	2.11
Apr	0.80	5.10	4.09
May	0.94	6.82	6.44
Jun	1.05	7.80	8.20
Jul	1.11	8.06	8.93
Aug	1.11	7.13	7.90
Sept	1.06	5.40	5.73
Oct	0.92	3.72	3.41
Nov	0.69	1.80	1.23
			47.43

Meeting Crop Water Use (ETc)

- Stored Soil Moisture
  - Plant-available at the beginning of the season as a result of rainfall or off-season irrigation (measured or estimated)
  - In-season effective rainfall
    - Rainfall that is stored in the root zone
- Applied Irrigation Water

$$= \text{Crop Water Use (ETc)} - \frac{\text{Stored Soil Moisture}}{2} - \text{Effective Rainfall}$$

Estimating Stored Soil Moisture

- Root Zone Water-Holding Capacity
  - Controlling factors:
    - Soil texture and structure
    - Depth of root zone
- Effective Winter Rainfall
  - Controlling factors:
    - Rainfall Amount
    - Environmental (climate) evaporative demand

Water stored in the rootzone cannot exceed the total root zone water holding capacity

Capacity of the Soil to Store Water

Stored Soil Moisture Capacity (in)	=	Plant Available Water-holding Capacity (in/ft)	x	Rooting Depth (ft)

Soil Texture	AWC (in water/ft soil)
Very coarse sands	0.4 - 0.75
Coarse sands, fine sands, loamy sands	0.75 - 1.25
Sandy loams, fine sandy loams	1.25 - 1.75
Very fine sandy loams, loams, silt loams	1.50 - 2.30
Clay loams, silty clay loams, sandy clay loams	1.75 - 2.50
Sandy clays, silty clays, clays	1.60 - 2.50

Estimating Effective Winter Rainfall

- In the beginning of the growing season, perennial crops as well as early planted annuals water requirements can often be met by:
  - Stored soil moisture from non-growing season rainfall
  - In-season rainfall
- Effective Winter Rainfall relies on the use of total monthly rainfall and monthly ETc during the non-growing season

$$\boxed{\text{Effective Winter Rainfall} = \text{Monthly Rainfall} - \text{Monthly ETc}}$$

Estimating Effective Winter Rainfall
Example

$$\text{Monthly Rainfall} - \text{Monthly ETc} = \text{Effective Winter Rainfall}$$

ET Zone 12 Merced 2016

	Monthly Rainfall (in)	Monthly ETc (in)	Effective Rainfall (in)
Nov 16-30	0.92	0.61	0.31
Dec	2.23	0.40	1.83
Jan	2.75	0.50	2.25
Feb	2.36	0.81	1.55
Total			**6.0**

Estimating Stored Soil Moisture
From Winter Rainfall Example

- Almond orchard in Merced
  - clay loam soil available water holding capacity = 2.0 in/ft
  - 4ft crop rooting depth
  - total effective winter rainfall = 6.0 in

$$\boxed{2.0 \text{ in/ft}} \times \boxed{4 \text{ ft}} = \boxed{8.0 \text{ in}} > \boxed{6.0 \text{ in}}$$

- 6.0 in of rainfall will be stored in the soil
  - Only about ½ of the available 6.0 in can be used before inducing crop stress therefore **3.0 in** (6.0 / 2) can be used for scheduling
  - If post harvest irrigation or frost protection water was applied, it should be added up the 8.0 inch maximum

In-Season Effective Rainfall

- In-season rainfall, that enters and is stored in the root zone, called effective rainfall, should be accounted for when scheduling irrigation

$$\boxed{\begin{gathered}\text{Effective Rainfall (in)} = \\ [\text{Rainfall from event(in)} - 3\text{ days ETo after event(in)}] \times 0.75\end{gathered}}$$

In-Season Effective Rainfall

Example

- Merced CIMIS Station 148, April 8–10, 2016:
  - Rainfall from event: 2.65 in.
  - ETo April 11-13: 0.5 inches

$$\boxed{\text{Effective Rainfall (in)} = (2.65\text{ in} - 0.5\text{ in})\text{x } 0.75 = \mathbf{1.6\ in}}$$

Irrigation Scheduling

Using stored winter rainfall and in-season effective rainfall

	ETc	=	In-Season rainfall (in)	Stored Moisture (in)	Irrigation Application (in)
Mar	2.1		2.1	0	0
Apr	4.1		1.6	1	1.5
May	6.4		0	1	5.4
Jun	8.2		0	1	7.2
Jul	8.9		0		8.9
Aug	7.9		0		7.9
Sep	5.7		0		5.7
Oct	3.4		0		3.4
Nov 1-15	0.6		0		0.6
Season	**47.3**	=	**3.7**	**3.0**	**40.6**

Applying the Irrigation

- Monthly irrigation amounts should be scheduled based on:
  - A frequency to minimize plant water stress
  - A duration based on water infiltration characteristics and irrigation system application rate

Irrigation System	Typical Frequency During Peak Water Demand
Drip	Daily
Microsprinklers	3-4 days
Sprinklers	10-14 days
Furrow	14+ days

Meeting Crop Water Use (ETc)

Micro-irrigation System Example

Almonds on micro sprinklers for July near Modesto

1. Determine Irrigation Frequency : every 4 days

2. Determine Crop Water Use ETc

historical ET July 1-31 = 8.9 in

8.9 in.	÷	31 days	=	0.29 in/day

3. Determine Application Amount

0.29 in/day	x	4 days	=	1.15 in

Meeting Crop Water Use (ETc)

How long to run the system?

- Need to know the system application rate (in/hr) in order to know how long to run the system

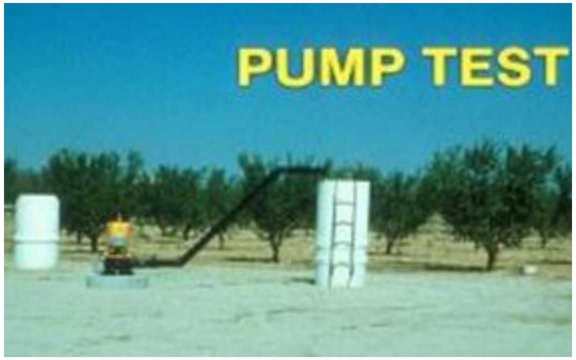
- Hours of operation = $\dfrac{inches\ of\ water\ use\ (ETc)}{application\ rate\ (\frac{in}{hr})}$

$$\frac{1.15\ inches\ of\ water\ use\ (ETc)}{0.05\ application\ rate\ (\frac{in}{hr})} = 23 \text{ hours}$$

Determining Applied Water

Gallons per Acre (gal/acre)

- Flow meter
  - Meter flow rate x time of operation / acres
- Pump Test
  - Pump flow rate x time of operation / acres



*Flow rate and time of operation must be in the same time unit

Determining Applied Water

Gallons per Acre (gal/acre)

- Emitter flow rate
  - Emitter flow rate x emitters per acre x time of operation
- Use Manufacturers flow rates
  - Flow rate at operational pressure x time of operation x nozzles/acre

*Flow rate and time of operation must be in the same time unit

Determining Applied Water

Convert From Gallons per Acre to:

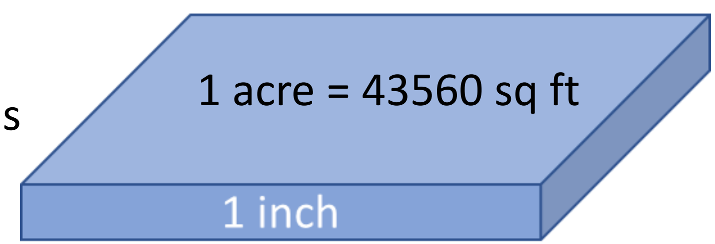
- *Inches Applied*

$$\frac{Gallons\ applied\ per\ acre}{27154^{*}} = \text{Inches applied per acre}$$

- Application Rate

$$\frac{Inches\ applied\ per\ acre}{time\ of\ operation} = \text{Inches per hour (application rate)}$$

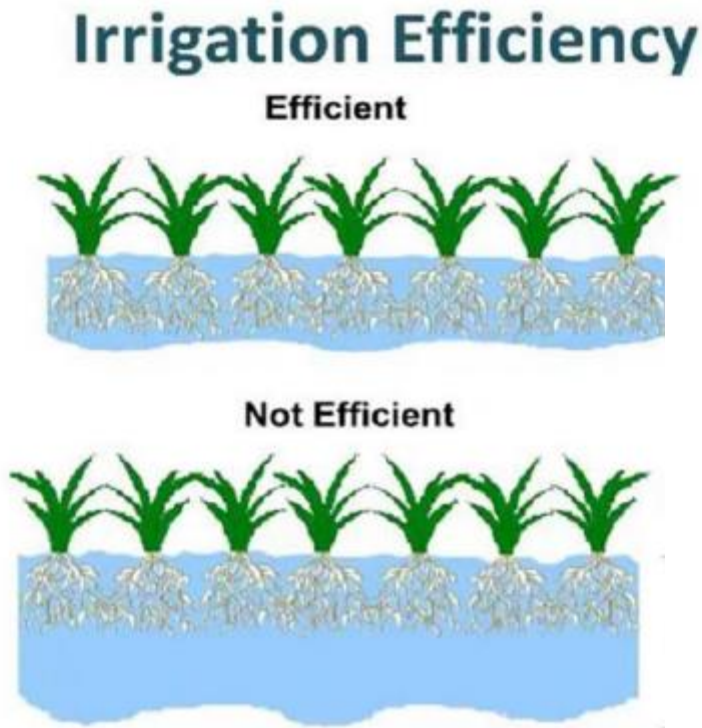
* 1 inch of water on 1 acre = 27154 gallons



Irrigation Efficiency (IE)

How well you—the irrigator—apply the correct amount of water to satisfy crop water use

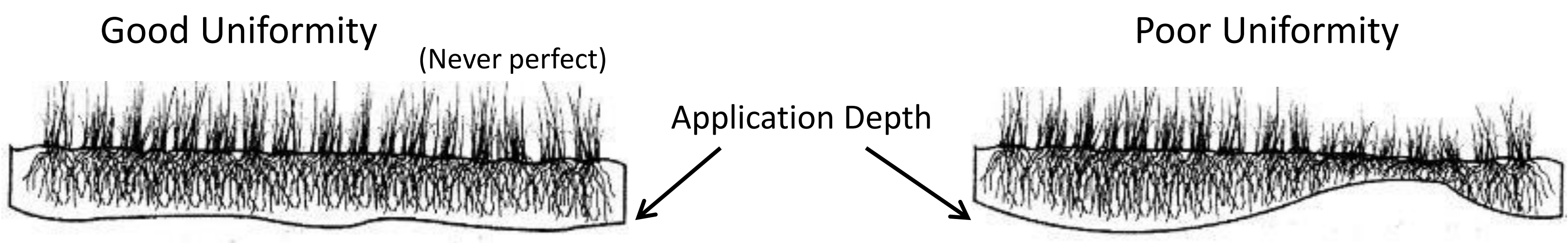
If all the applied water is used by the crop IE = 100%



Water Losses reduce IE:
Deep percolation below root zone in excess of that required for salt leaching or Surface runoff that is not reused

Irrigation Uniformity

A measure of how evenly water is applied to the field



- Poor uniformity means that portions of the field are getting less water than others.
    - Causes poor plant performance due to water logging and nitrate leaching or plant water stress

Irrigation Efficiency and Distribution Uniformity

Irrigation Efficiency

Presuming we estimate crop water use and apply that amount of irrigation without deep percolation or runoff losses. We have good efficiency

Distribution Uniformity

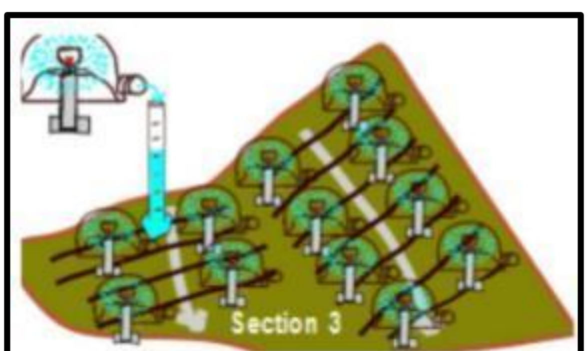
The **distribution uniformity** is often calculated when performing an **irrigation** audit.

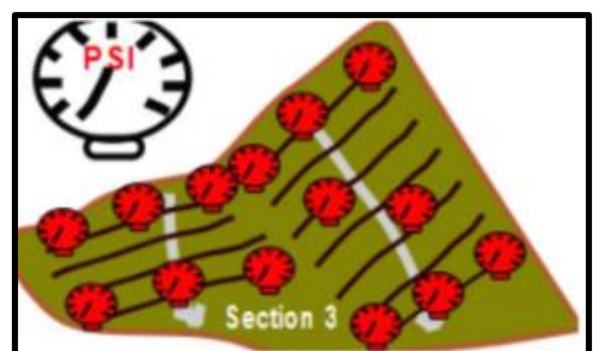
Measure flows or pressures at the emitters or sprinklers

DU = Ratio of lowest quartile to population average

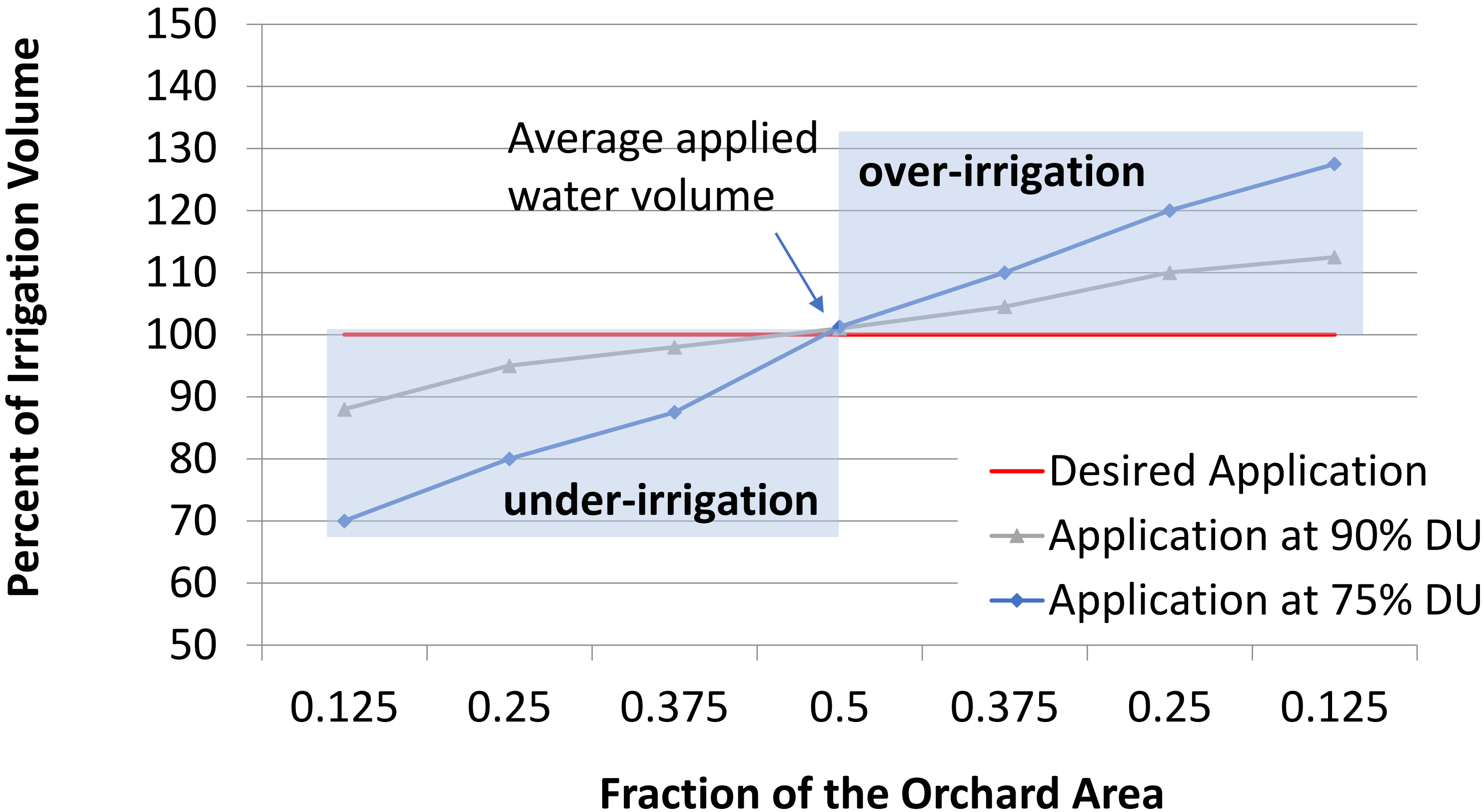
Measuring DU

- Mobile irrigation lab
  - Several RCDs offer DU testing
- DIY
  - Use a graduated cylinder and stopwatch to measure emitter/sprinkler flow at various points in the system
  - Use a pressure gauge to measure uniformity of pressure across the field





Distribution Uniformity



The 75 % DU over and under applies 30 % of the average.
The 90 % DU over and under applies 11% of the average.

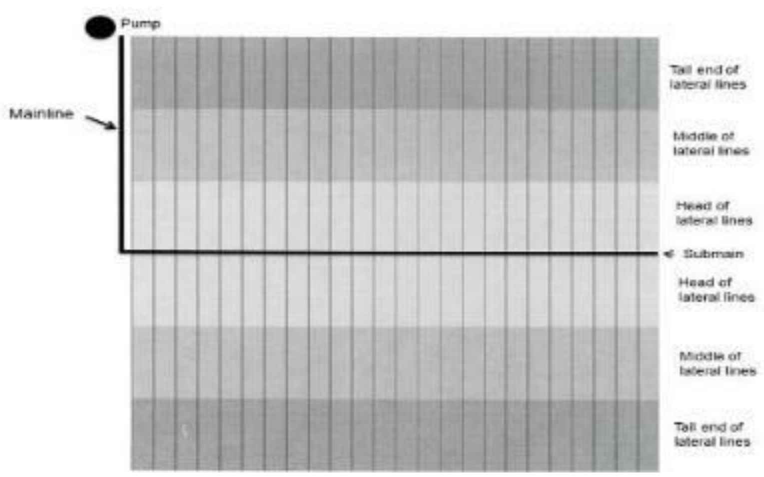
Using a Distribution Uniformity (DU) Test Results

- The solution lies in improving DU to a point where there is minimal difference in the over and under-irrigation levels of the field and not to simply increase the applied water to ensure all areas get the desired amount.
- A DU of about 90% is ideal, as research has shown that trees for example are able to produce optimally with about 90% of full irrigation *.
- Fields with lower DU should be analyzed to determine the problem and solutions implemented to improve DU.

* Shackel, K. et.al.2017 ABC Water Production Function Report

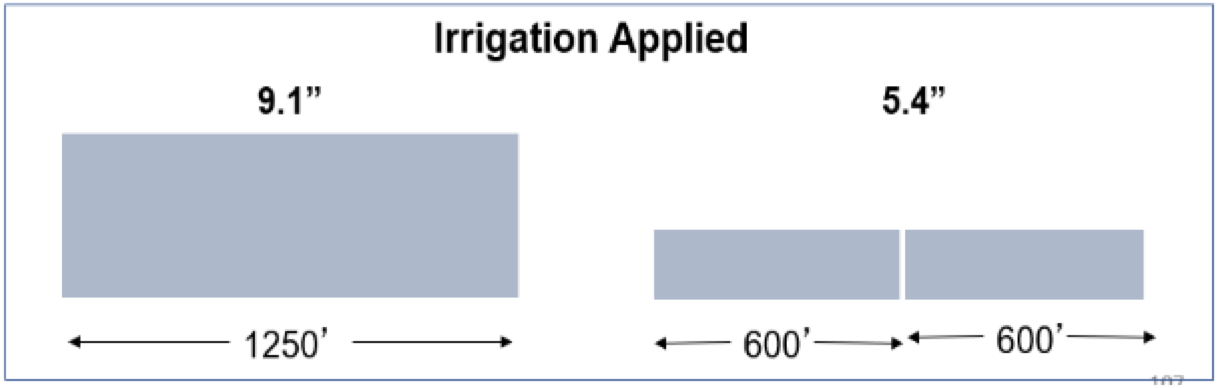
Improving Irrigation Efficiency and Distribution Uniformity

- Improved Irrigation Design
- Irrigation System Maintenance

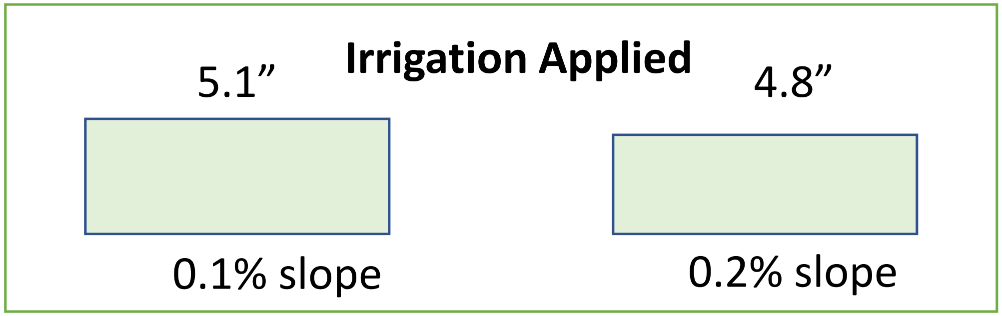


Surface Irrigation Design
Improvements

- Shortening field length

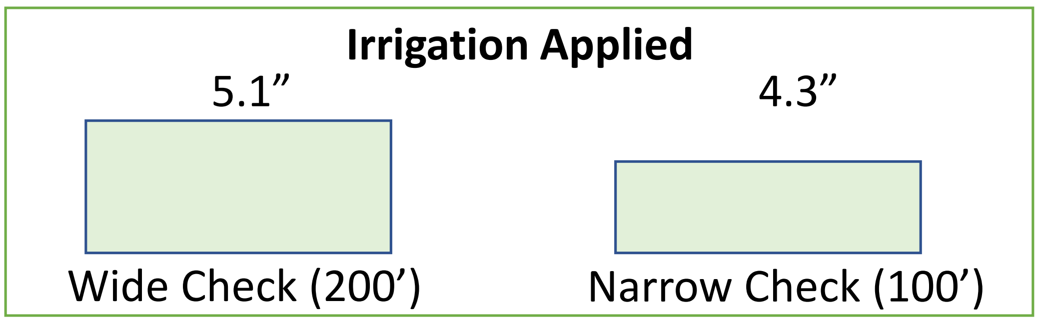


- Increased field slope



Surface Irrigation Design
Improvements

- Increase border check flow per foot of check
  - Same flow on two check widths



- Collect and reuse tailwater runoff

Pressurized Irrigation Design

Improvements

- Use appropriate pressure regulators, filters, and emitters for system
- Use pressure-compensating (PC) drippers, microsprinklers, and sprinklers when pressure variations occur
  - Provide nearly constant discharge rate across a range of operating pressures
- Consider pipe sizing and how that affects pressures at emitter due to friction losses

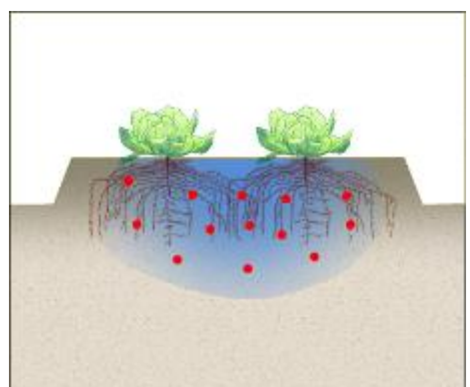
Irrigation System Maintenance

Pressurized systems

- Clean and flush filters, mainlines, submains and lateral lines regularly
- Walk the field and monitor for leaks and breaks frequently
- Check emitters for physical particles, biological and chemical clogging at least twice per season

Fertigation

- Inject N during the middle to near end of an irrigation event
  - Early injection can result in nitrogen moved out of the root zone
  - Late injection can result in fertilizer left in the system which can foster biological growth and cause plugging



Fertigation

Injection Timing

- Injections should last at least 1 hour* for uniform application
  - When products are injected too quickly, there is insufficient time to distribute the fertilizer uniformly
- At least 1 hour* of clean water should follow to ensure uniform application.
  - All fertilizer should leave the lines

*depending on length of lines, shorter lateral lines may require less time for application and flush and longer lateral lines may require additional time.

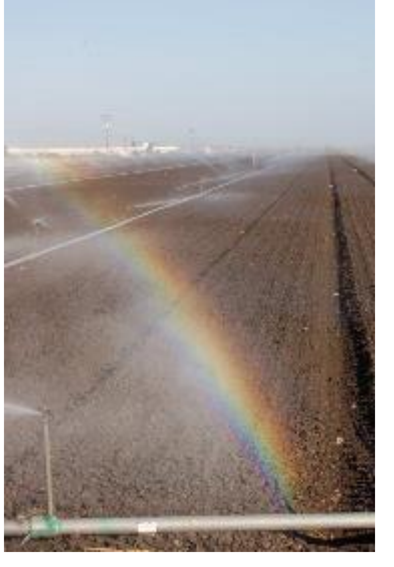
Managing Salinity
Leaching salts and not nitrate

- Periodic soil and irrigation water testing will help determine when leaching is needed
  - Leaching is not necessary every irrigation or perhaps even every season but only when soil salinity crop tolerances are approached.

- Leaching is most efficient in the winter and should not coincide with critical periods of nitrogen uptake and fertilization

Section 4 Summary

- Efficient irrigation practices are critical to good nitrogen management
- How do you become a more efficient irrigator?
  - Use weather, soil moisture, or crop water status information to understand irrigation needs
  - Measure applied water
  - Design and maintain high performing irrigation systems



Efficient Nitrogen Management

Section 5

Section 5 Learning Objectives

- Identify the 4R nitrogen management practices
- Apply the right rate equation to determine crop N demand
- Recognize the benefits of increasing Nitrogen Use Efficiency (NUE)
- Recall the components needed to calculate N contribution of organic materials
- Interpret lab reports to determine N contribution of irrigation water

Applying the 4R Principle

Right Rate	• Match supply with crop demand
Right Time	• Apply coincident with crop demand and uptake
Right Place	• Ensure delivery to active root zone
Right Source	• Supply nitrogen in plant available form

Apply the Right N Rate

The right rate equation

Demand

Crop N Demand

=

Supply

N in soil

N in irrigation water

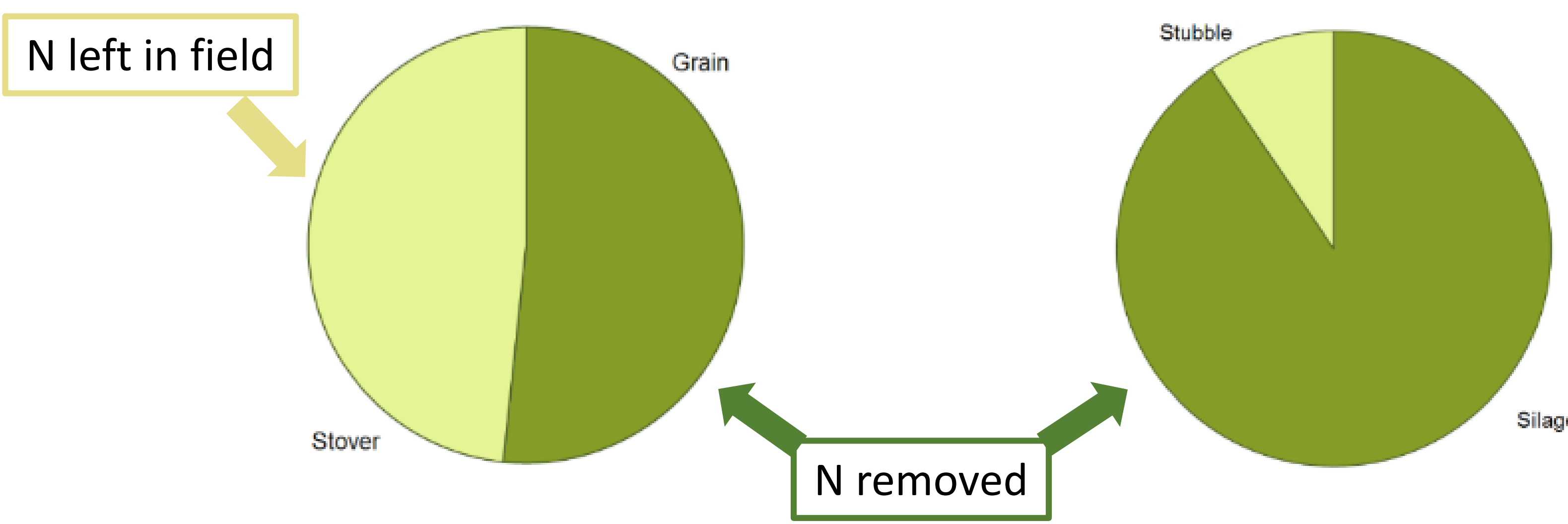
N in fertilizer

Use the right rate equation to avoid excess N, increase nitrogen use efficiency, and increase profitability by accounting for all N inputs.

Right Rate: N Demand

How to determine crop nitrogen demand

- Approach depends on proportion of N removed from the field during harvest and N left in the field as crop residues or perennial tissue
- Example: grain corn vs silage corn



Right Rate: N Demand

Crop	Yield	Removal Rate	Total N Removed
Corn silage	30 ton/acre	7.56 lbs. N/ton	227 lbs. N/acre
Corn grain	6 ton/acre	24 lbs. N/ton	144 lbs. N/acre

The difference is the amount of N in the Stover **83** lbs. N/acre

If grain corn is provided with only 144 lbs. N/acre (N removed) reduced yield will occur

- Therefore, N should be provided to make up for N removed + N in crop residue

Right Rate: N Demand Examples

ALMOND

Nonpareil
- N removal 68 lb per 1000 kernels

Monterey
- N removal 65 lb per 1000 kernels

Growth Requirement
- Yield 2,000-4,000 = 0 lb N
- Yield 1,000-2,000 = 20 lb N
- Yield <1,000 = 30 lb N

PISTACHIO

Kerman:
- N removal 28 lb per 1000*

Growth Requirement:
- On-year: 25 lb N
- Off-year=25-40 lb N

*Dry CPC assessed yield

Walnut

- N removal 19 lb per 1000 lb in shell
  8% moisture

Growth Requirement:
- Mature orchard = included in above
- Immature orchard: not yet available

Right Rate: N Demand

Nitrogen Use Efficiency (NUE) when most N is removed by crop

$$NUE = \frac{Lbs\ N\ \boldsymbol{removed}\ by\ crop}{Lbs\ N\ applied\ all\ sources}$$

Examples: silage corn & mature orchards

Right Rate: N Demand

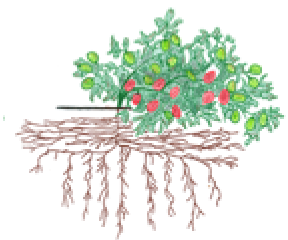
Nitrogen Use Efficiency (NUE) when only part of N is removed with crop

$$NUE = \frac{Lbs\ N\ \boldsymbol{removed}\ by\ crop + N\ \boldsymbol{for\ growth}}{Lbs\ N\ applied\ all\ sources}$$

Examples: immature orchards

Right Rate: N Demand

Nitrogen Use Efficiency (NUE) when only part of N is removed with crop



$$NUE = \frac{Lbs\ N\ \boldsymbol{removed}\ by\ crop + N\ \boldsymbol{in\ crop\ residue}}{Lbs\ N\ applied\ all\ sources}$$

Examples: grain corn, tomatoes, vegetables

Right Rate: N Demand

Nitrogen Use Efficiency (NUE)

- What is a reasonable NUE ?
  - Achievable NUE= 70% (More of a target)
  - Average worldwide < 50%
- The highest efficiency is achieved by a combination of right rate, right time, right place and right source.
- Management of croplands to minimize Losses via volatilization, denitrification, runoff and leaching

Right Rate: N Demand

Methods for Setting Realistic Yield Goals

- Use experience of the potential of a particular field and then consider environmental conditions.
  - For annuals, weather at planting can have a major effect.
  - For perennials, the past year's yield plus winter and spring weather can be critical.

- Set target of 10% above the field's 3-5 year average, excluding years with unusual negative conditions
  - Caution: Estimating too high of a yield can result in over application

Right Rate: N Demand
N removal rates

Nitrogen concentrations in harvested plant parts - A literature overview

Daniel Geisseler

2016

Provides an overview of N removed in harvested plant parts for field crops, vegetables, and tree and vine crops.

https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Geisseler_Report_2016_12_02.pdf

Right Rate: N Demand

Estimating total demand example: tomato

Crop N Demand

=

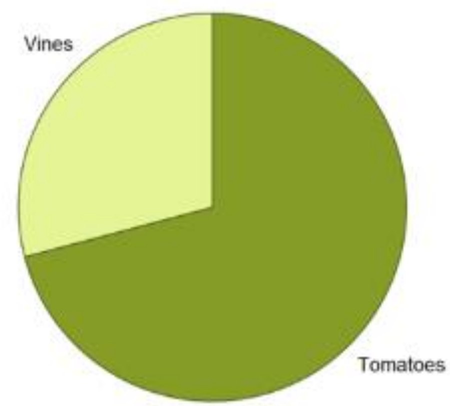
N removed per unit of crop yield + N in crop residue × Estimated Yield

Nitrogen Use Efficiency

Right Rate: N Demand

Estimating total demand example: Processing Tomato

- N removal with crop = 2.73 lbs. N/ton fresh weight
- N left in field with crop residue 1.17 lbs. N/ton
- Yield expected is 50 tons per acre
- Estimated crop demand?



Approximately 70% of the total aboveground N was in tomatoes, with the rest being in the vines [3].

Demand Function

Estimating total demand Example: Processing Tomatoes

$$\frac{278\text{ lbs. N}}{\text{acre}} = \frac{\left(\frac{2.73\text{ lbs. N}}{\text{ton yield}} + \frac{1.17\text{ lbs. N}}{\text{ton}}\right) \times \frac{50\text{ tons yield}}{\text{acre}}}{0.7}$$

Apply the Right N Rate

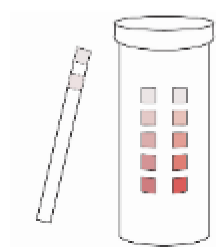
The right rate equation

Demand

$$\frac{278 \text{ lbs. N}}{\text{acre}}$$

=

Supply



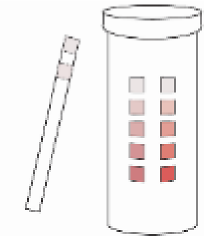
Residual N in Soil

N mineralized in soil

Irrigation water

Fertilizer

Right Rate: N Supply
N in the Soil



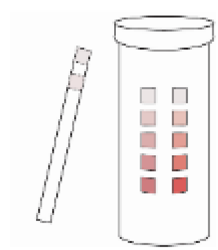
- Soil Nitrate Testing should be performed at planting or before side-dress
  - Testing through lab
  - Nitrate Quick Test
- Example
  - results = 20ppm NO_3-N in dry soil
  - 20 x 4 = 80 lbs. N/ac available in top foot of soil

Apply the Right N Rate
The right rate equation

Demand = **Supply**

$$\frac{278 \text{ lbs. N}}{\text{acre}}$$

=



80 lbs. N /acre

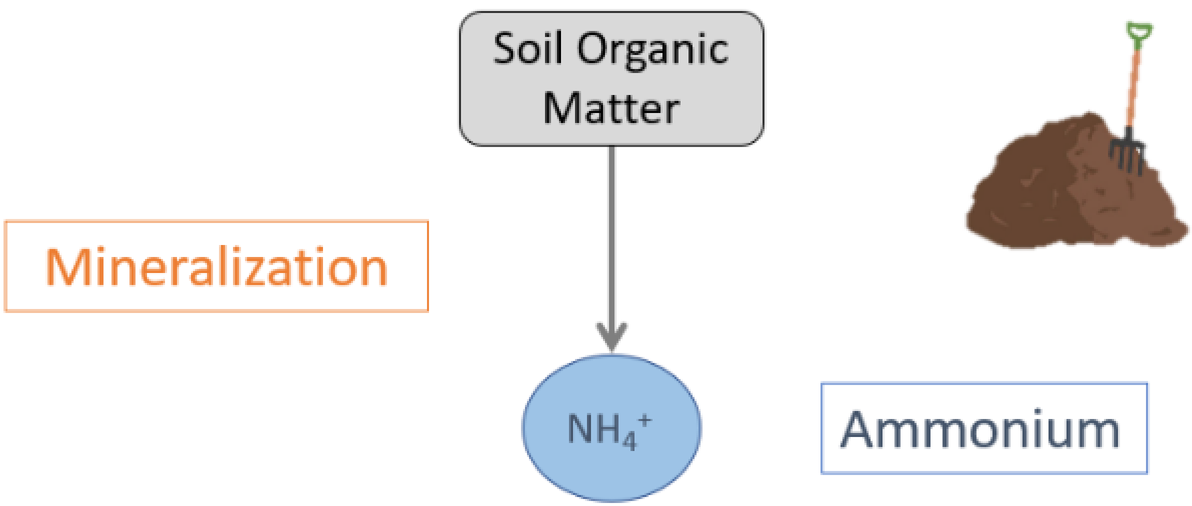
N mineralized in soil

Irrigation water

Fertilizer

Right Rate: N Supply
N Mineralized in the Soil

- Organic matter applied to the soil, in-season, such as manure, compost, or cover crop residue will release N over time (mineralization)
  - N released will become available to plant for uptake



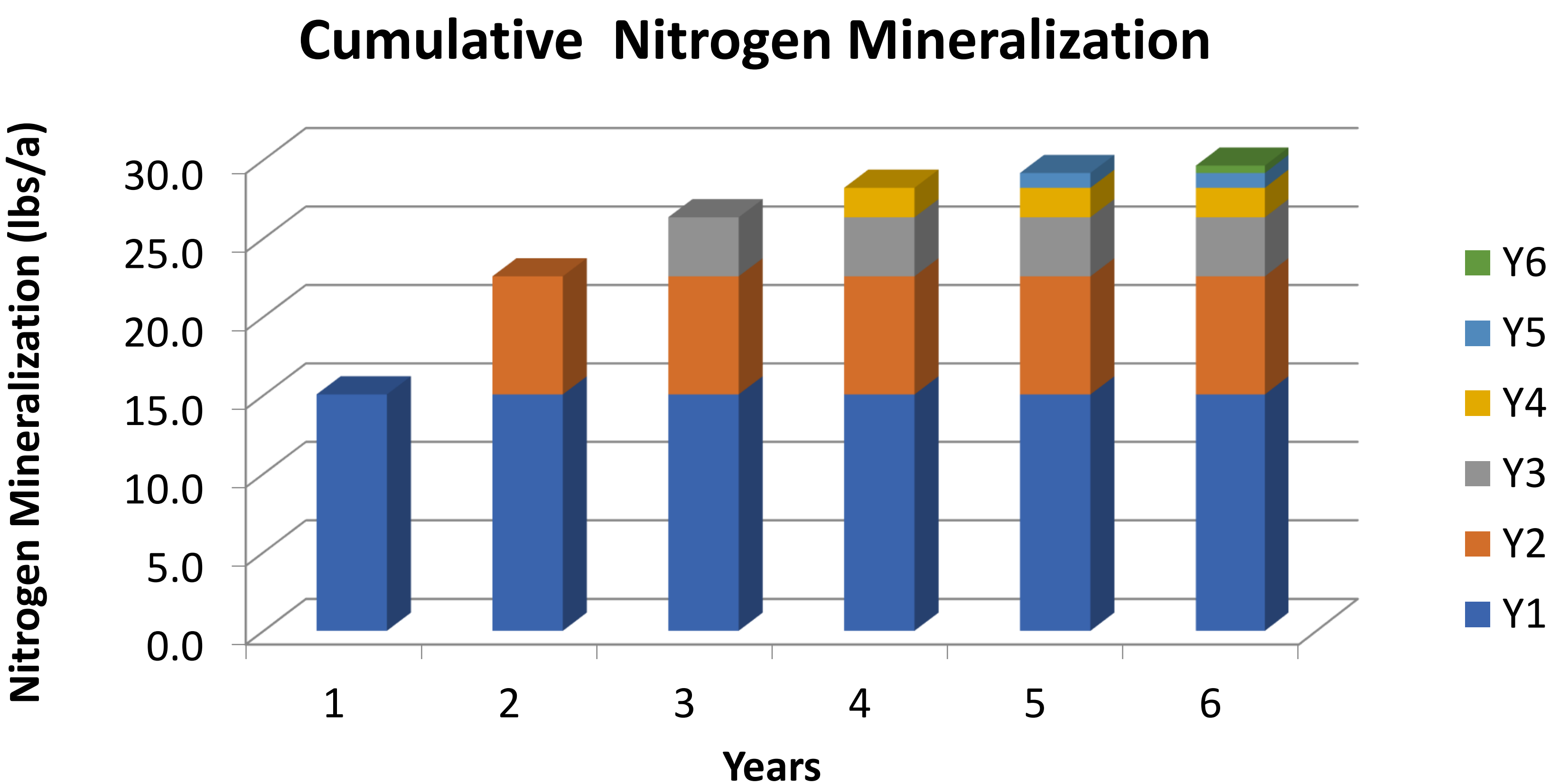
Right Rate: N Supply
N Mineralized in the Soil

- Single application of organic matter
  - N credits = dry lbs. OM x % N x % decomposition 1st year

- Consistent application OM or growing of cover crop
  - N Contribution = Dry lbs. OM x % N x 70%

First Year Decomposition Rates	
Cured Compost	5-10%
Dried Manure	20-30%
Cover Crop	10-35%
Lagoon Water	40-50%

Continual application of the same amount of organic N each year 43 lbs N / acre



In each subsequent year of application the available mineral N increases and a steady state is approached after about 4 years.

Right Rate: N Supply
N Mineralized in the Soil

- Example
  - 1st year applying cured compost @ 5 tons/ac
    - Expected 1st year decomposition rate 7.5%
    - % N estimated from lab report 2%

N credit = 10,000 lbs compost /ac x 0.02 x 0.075

N credit = $\boxed{\text{15 lbs N /ac}}$

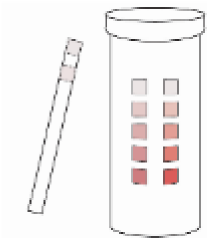
Apply the Right N Rate

The right rate equation

Demand

$$\frac{278\ \text{lbs. N}}{\text{acre}} =$$

Supply



80 lbs. N /acre

$\boxed{\text{15 lbs. N /acre}}$

Irrigation water

Fertilizer

Right Rate: N Supply
N in irrigation water

Formula for Nitrate-N

Nitrate-N concentration (ppm) x inches irrigation applied x 0.23

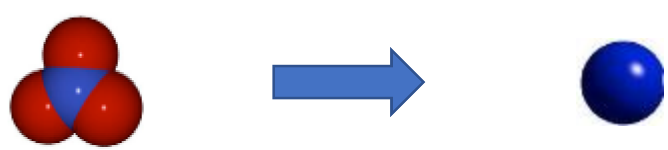
- Example
  - 2.3 ppm Nitrate-N and you apply 36 in. of water
    - 2.3 x 36 x 0.23 =
    - 19 lb N per 36 inches of water applied

Right Rate: N Supply
N in irrigation water

- What if your lab report lists your water as Nitrate (ppm)?

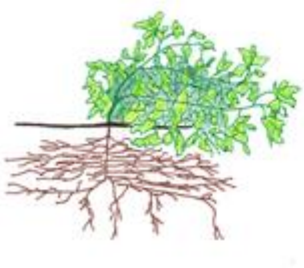
- Formula for converting Nitrate to Nitrate-N

Nitrate (ppm) ÷ 4.43 = Nitrate-N (ppm)



Apply the Right N Rate
The right rate equation

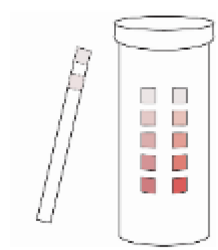
Demand



$$\frac{278\ \text{lbs. N}}{\text{acre}}$$

=

Supply



80 lbs. N
/acre

15 lbs. N
/acre

19 lbs. N
/acre

Fertilizer

Apply the Right N Rate

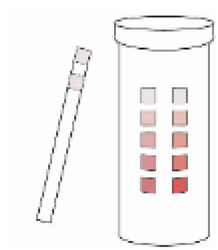
The right rate equation

Demand

$$\frac{278 \text{ lbs. N}}{\text{acre}}$$

=

Supply



80 lbs. N
/acre

15 lbs. N
/acre

19 lbs. N
/acre

$\boxed{\text{164 lbs. N /acre}}$

Demand – Residual N in soil - N mineralized – N in water =

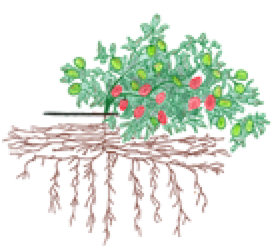
Right Rate

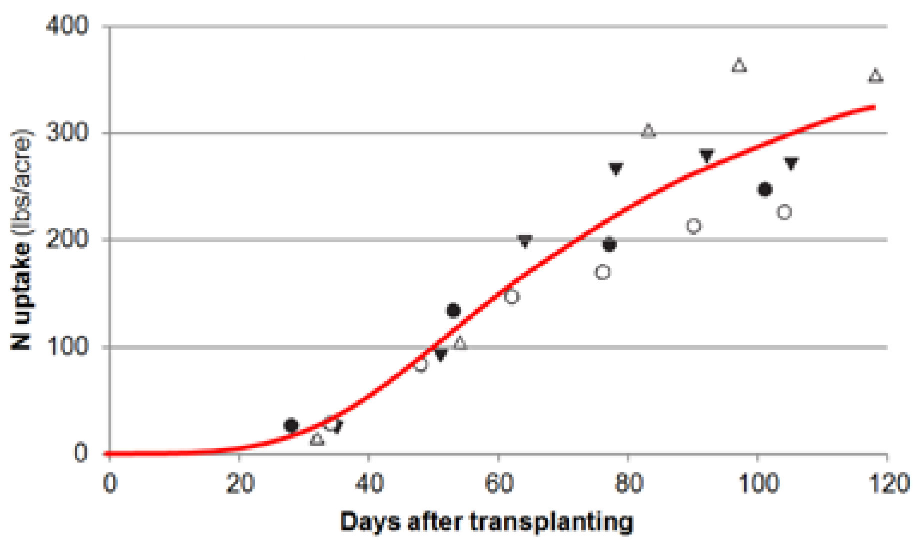
Nutrient Balance: Law of the Minimum

- The efficiency of nitrogen depends on the adequacy of all essential elements and growth conditions
  - If a nutrient is inadequate yield can be lost and response to other elements will be limited
  - If a nutrient is oversupplied money, time, and energy is wasted

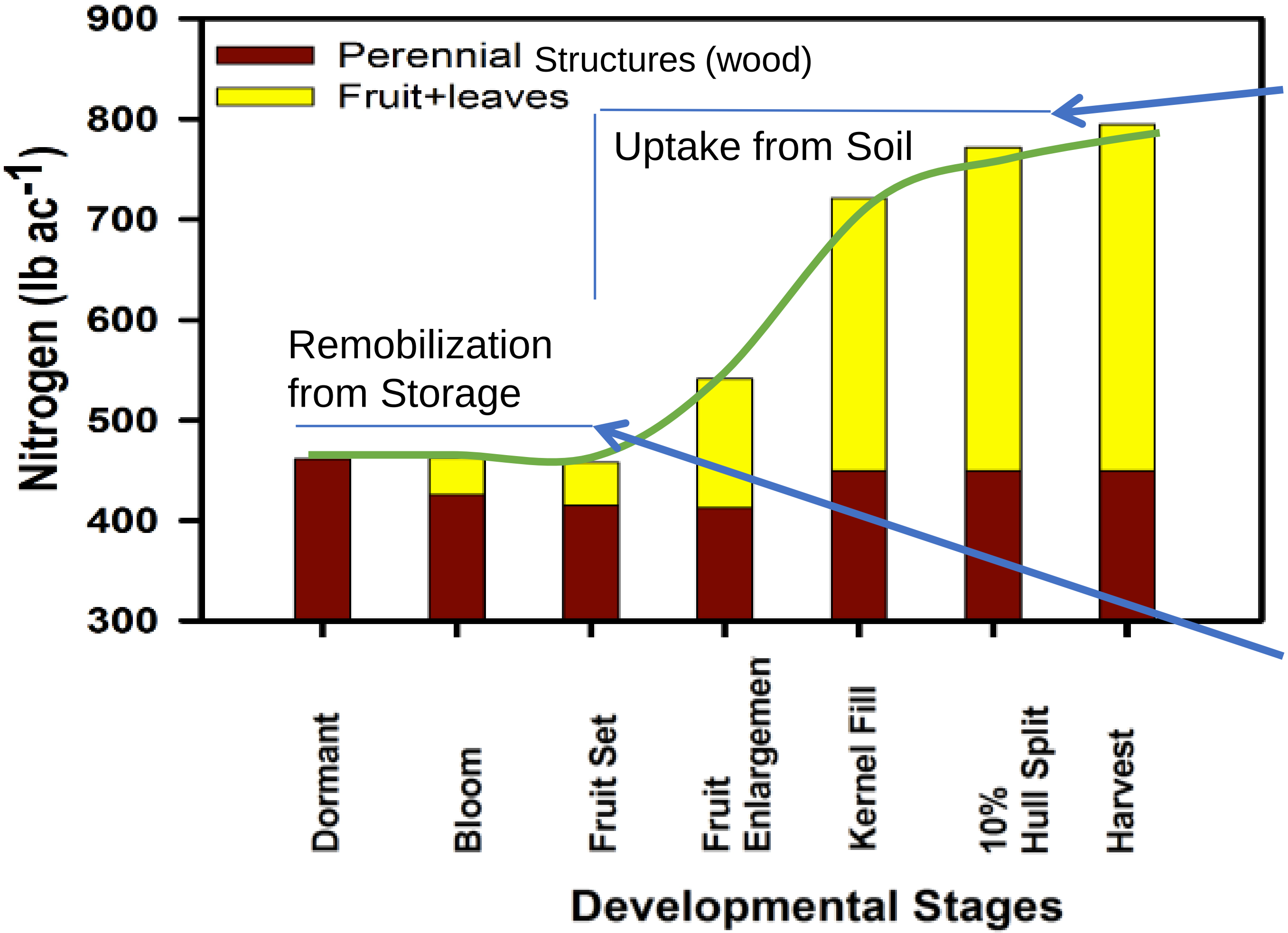
Right Time

- Match application timing with timing of crop nitrogen uptake





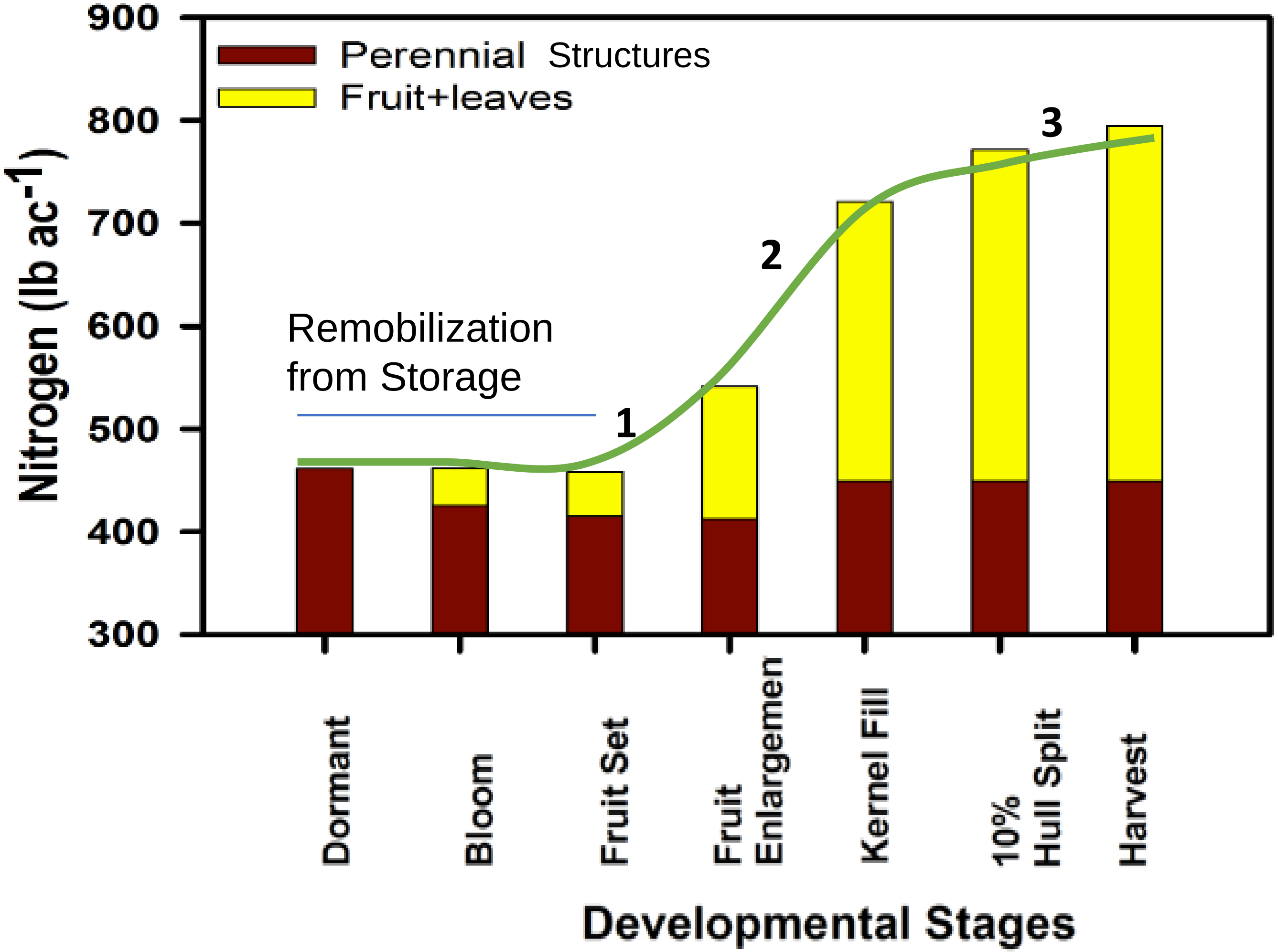
Right Time
Almond Example



Uptake commences at mid-leaf out and is essentially complete by hull split.

From dormancy to fruit set there is very little N uptake. Only N redistribution.

Right Time
Almond Example



Recommended N Split:

1. 20% Leaf Out-Fruit Enlargement
2. 30% Fruit Enlargement/30% Kernel Fill
3. 20% Hull-split through early Post-Harvest*

* Less if July leaf samples show adequate N

Right Place

Where are the roots? Where does N uptake occur?

- How to manage
  - for a crop with a 1-foot rooting depth?
  - for a crop with a 4-foot rooting depth?

(Photo's Courtesy Tim Hartz and IPNI)

Right Place

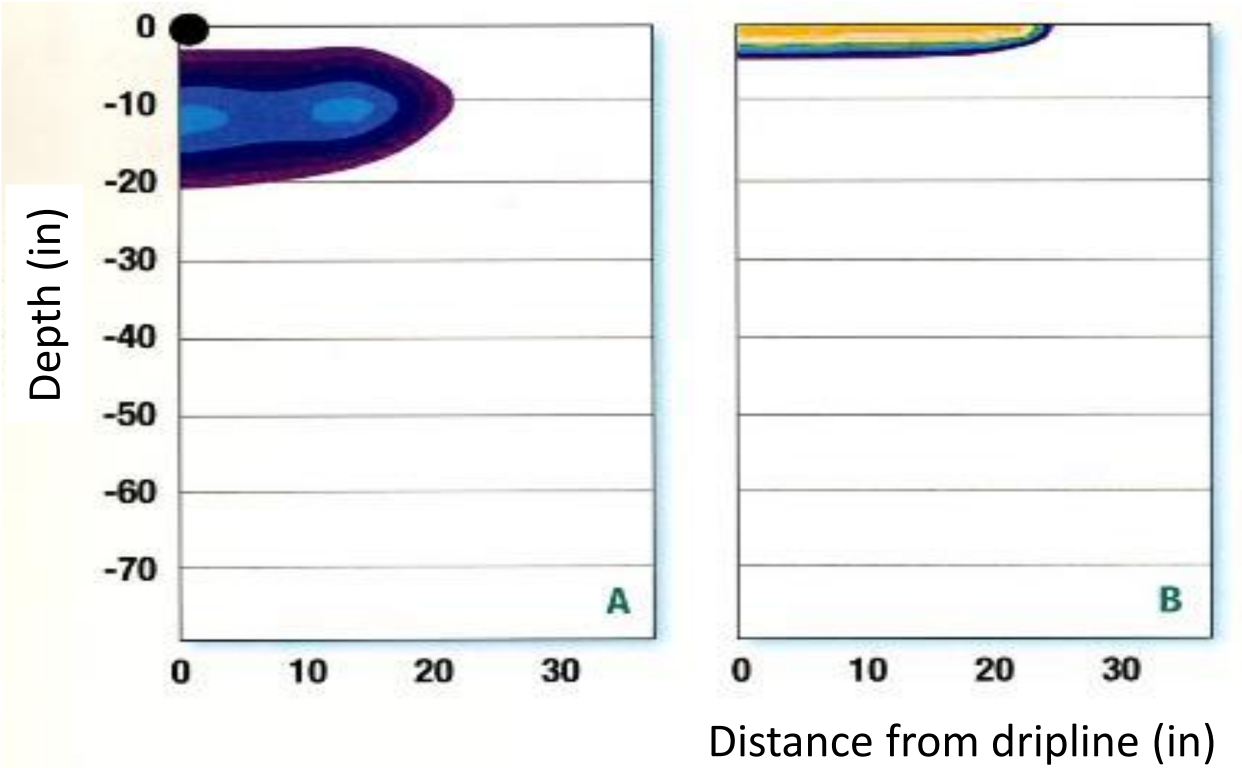
Where are the roots? Where does N uptake occur?

	Main Root Activity and Effectiveness Main (inches)
Almond	8-23
Apricot	8-16
Cherry	4-16
Peach	0-32
Plum	10-24
Walnut	0-36

The Right Place

- Manage irrigation systems to ensure N is delivered in the root zone
  - Apply irrigation uniformly across the orchard
  - Apply the correct amount of irrigation water to prevent leaching and saturated soil conditions
  - Irrigate after dry fertilization to minimize NH_3 volatilization
  - Inject liquid fertilizers at a time to position the fertilizer where the roots are located

Right Place
Surface Drip Example



2 hour injection near **start** of 27 to 36 hour Irrigation	2 hour injection near **end** of 27 to 36 hour Irrigation

(Blaine Hanson, “Fertigation with Microirrigation”)

Section 5 Summary

- The highest nitrogen use efficiency is achieved by the best combination of right rate, right time, right place and right source.

  - This requires understanding the dynamics of nitrogen in the soil and the plant and irrigation system performance to reduce nitrogen losses

Irrigation and Nitrogen Management Plan & Summary Report

Section 6

Irrigation and Nitrogen Plan & Summary

- Growers are responsible for:
  - **Irrigation and Nitrogen Management Plans**
    - (yearly, kept on farm)
  - **Irrigation and Nitrogen Management Plan Summary Report**
    - (yearly, submitted to Coalition)

Case Studies

- 2 practice case studies (walnut & silage corn)

- ***<u>Tear out the INMP worksheet in the back of your binder to follow along</u>***

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

Member ID: ______ INMP Field or MU: ________________ Crop: ______________ Total Acres: _____

IRRIGATION MANAGEMENT

1. Irrigation Method[1]	Pre-Season Planning	
(check one for Primary; if applicable, check one for Secondary) Primary Secondary[1] ☐ ☐ Drip ☐ ☐ Micro Sprinkler ☐ ☐ Furrow ☐ ☐ Sprinkler ☐ ☐ Border Strip ☐ ☐ Flood	2. Crop Evapotranspiration (ET, inches)	
	3. Anticipated Crop Irrigation (inches)	
	4. Irrigation Water N Concentration (ppm or mg/L, as NO_3-N)	

5. Irrigation Efficiency Practices[a] (Check all that apply)

- ☐ Laser Leveling
- ☐ Use of ET in scheduling irrigations
- ☐ Water application schedule to need
- ☐ Use of moisture probe (e.g. tensiometer)
- ☐ Soil Moisture Neutron Probe
- ☐ Pressure Bomb
- ☐ Other ____________________
- ☐ Other ____________________

HARVEST / YIELD INFORMATION

Harvest / Yield Information			Expected (A)	Actual (B)
6. Production Unit (lbs, tons, etc.)		7. Harvested Yield[a]		

NITROGEN MANAGEMENT

8. Nitrogen Efficiency Practices[a] (Check all that apply)	Nitrogen Sources	Recommended/ Planned N (A)	Actual N (B)
☐ Split Fertilizer Applications ☐ Irrigation Water N Testing ☐ Soil Testing ☐ Tissue/Petiole Testing ☐ Fertigation ☐ Foliar N Application ☐ Cover Crops ☐ Variable Rate Applications using GPS ☐ Other: ____________ ☐ Other: ____________	9. Soil – Available N in Root Zone (Annualized, lbs/ac)		
	10. N in Irrigation Water[a] (Annualized, lbs/ac)		
	11. Organic Amendments[a] (Manure/Compost/Other, lbs/ac estimate)		
	12. Dry/Liquid Fertilizer N[a] (lbs/ac)		
	13. Foliar Fertilizer N[a] (lbs/ac)		
	14. TOTAL NITROGEN (lbs/ac)		

[1] A secondary irrigation system could be used for crop germination, frost protection, crop cooling, etc.
[a](Bold Text) Data to be reported to the Coalition on the INMP Summary Report, based on Actual Yield and Actual N.

Plan Certifier Initials

Walnut Case Study

Walnut: Conditions

- 100 acres Mature Walnuts
- Soil – Clay Loam, 5ft deep over consolidated layer
- Estimated yield 3.0 tons per acre
- Seasonal Water Sources
  - Stored soil moisture = 4.5 in
  - In-season effective rainfall = 1.5 in
  - Irrigation = 36 in applied via solid set sprinkler
- Irrigation Scheduling
  - ET Estimation: 42 inches
  - Pressure chamber/ bomb
- Nitrogen sources
  - Irrigation 36 inches. Nitrate water test = 1.1 ppm Nitrate-N
  - UAN, Fertigation, Monthly
  - No organic material applied (manure or composts)
  - Winter cover crop (peas, beans, vetch, and barley) each year
  - Tissue testing

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

Member ID #: 1234 **Member Name:** John Doe

Was this management unit identified as a statistical outlier by the Coalition last year?

☐ Yes ☒ No

Crop Year (Harvested): 2019

- Enter the membership ID #
- Enter the name of the person completing this form. This should be the owner or manager of the farm or the individual certifying the plan
- Enter the Crop Year for which your report is based on. Crop year for this plan is the 12 months prior to harvest

PARCEL MANAGEMENT					
Management Unit (MU) or Field	APN	County	Crop	Crop Age (Years)	Irrigated Acres
1-1 Walnut	002-025-016	Stanislaus	Walnut	12	100
				Total Acres:	

- Enter the Field Identification (ID) for each unique management unit.
- Enter the Assessor's Parcel Number (APN). If field has more than one APN enter both.
- Also include county, crop, crop age, and irrigated acreage.

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

Member ID: 1234 INMP Field or MU: 1-1 Walnut Crop: Walnut Total Acres: 100

IRRIGATION MANAGEMENT		
1. Irrigation Method*	**Pre-Season Planning**	
(check one for Primary; if applicable, check one for Secondary) Primary Secondary[1] ☐ ☐ Drip ☐ ☐ Micro Sprinkler ☐ ☐ Furrow ☐ ☐ Sprinkler ☐ ☐ Border Strip ☐ ☐ Flood	2. Crop Evapotranspiration (ET, inches)	
	3. Anticipated Crop Irrigation (inches)	
	4. Irrigation Water N Concentration (ppm or mg/L, as NO_3-N)	

5. Irrigation Efficiency Practices* (Check all that apply)

- ☐ Laser Leveling
- ☐ Use of ET in scheduling irrigations
- ☐ Water application schedule to need
- ☐ Use of moisture probe (e.g. tensiometer)
- ☐ Soil Moisture Neutron Probe
- ☐ Pressure Bomb
- ☐ Other ______________________
- ☐ Other ______________________

Walnut: Conditions

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- Irrigation Scheduling
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  - No organic material applied (manure or composts)
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  - Tissue testing

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

Member ID: 1234 INMP Field or MU: 1-1 Walnut Crop: Walnut Total Acres: 100

IRRIGATION MANAGEMENT		
1. Irrigation Method*	**Pre-Season Planning**	
(check one for Primary; if applicable, check one for Secondary) Primary Secondary[1] ☐ ☐ Drip ☐ ☐ Micro Sprinkler ☐ ☐ Furrow X ☐ Sprinkler ☐ ☐ Border Strip ☐ ☐ Flood	2. Crop Evapotranspiration (ET, inches)	42
	3. Anticipated Crop Irrigation (inches)	36
	4. Irrigation Water N Concentration (ppm or mg/L, as NO_3-N)	1.1

5. Irrigation Efficiency Practices* (Check all that apply)	
☐ Laser Leveling	☐ Soil Moisture Neutron Probe
☒ Use of ET in scheduling irrigations	☒ Pressure Bomb
☒ Water application schedule to need	☐ Other ______________________
☐ Use of moisture probe (e.g. tensiometer)	☐ Other ______________________

HARVEST / YIELD INFORMATION				
Harvest / Yield Information			**Expected (A)**	**Actual (B)**
6. Production Unit (lbs, tons, etc.)		**7. Harvested Yield***		
NITROGEN MANAGEMENT				
8. Nitrogen Efficiency Practices* (Check all that apply)		**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
☐ Split Fertilizer Applications		9. Soil – Available N in Root Zone (Annualized, lbs/ac)		
☐ Irrigation Water N Testing		**10. N in Irrigation Water*** (Annualized, lbs/ac)		
☐ Soil Testing		**11. Organic Amendments*** (Manure/Compost/Other, lbs/ac estimate)		
☐ Tissue/Petiole Testing		**12. Dry/Liquid Fertilizer N*** (lbs/ac)		
☐ Fertigation		**13. Foliar Fertilizer N*** (lbs/ac)		
☐ Foliar N Application		14. TOTAL NITROGEN (lbs/ac)		
☐ Cover Crops				
☐ Variable Rate Applications using GPS				
☐ Other: ____________________				
☐ Other: ____________________				

Walnut: Conditions

- 100 acres Mature Walnuts
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  - UAN, Fertigation, Monthly
  - No organic material applied (manure or composts)
  - Winter cover crop (peas, beans, vetch, and barley) each year
  - Tissue testing

<table>
<tr><th colspan="5">HARVEST / YIELD INFORMATION</th></tr>
<tr><th colspan="3">Harvest / Yield Information</th><th>Expected (A)</th><th>Actual (B)</th></tr>
<tr><td>6. Production Unit
(lbs, tons, etc.)</td><td>tons</td><td>7. Harvested Yield*</td><td>3</td><td></td></tr>
</table>

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<tr><th colspan="4">NITROGEN MANAGEMENT</th></tr>
<tr><th>8. Nitrogen Efficiency Practices*
(Check all that apply)</th><th>Nitrogen Sources</th><th>Recommended/ Planned N (A)</th><th>Actual N (B)</th></tr>
<tr><td rowspan="6">☒ Split Fertilizer Applications
☒ Irrigation Water N Testing
☐ Soil Testing
☒ Tissue/Petiole Testing
☒ Fertigation
☐ Foliar N Application
☒ Cover Crops
☐ Variable Rate Applications using GPS
☐ Other: ____________
☐ Other: ____________</td><td>9. Soil – Available N in Root Zone
(Annualized, lbs/ac)</td><td></td><td></td></tr>
<tr><td>10. N in Irrigation Water*
(Annualized, lbs/ac)</td><td></td><td></td></tr>
<tr><td>11. Organic Amendments*
(Manure/Compost/Other, lbs/ac estimate)</td><td></td><td></td></tr>
<tr><td>12. Dry/Liquid Fertilizer N* (lbs/ac)</td><td></td><td></td></tr>
<tr><td>13. Foliar Fertilizer N* (lbs/ac)</td><td></td><td></td></tr>
<tr><td>14. TOTAL NITROGEN (lbs/ac)</td><td></td><td></td></tr>
</table>

HARVEST / YIELD INFORMATION				
Harvest / Yield Information			**Expected (A)**	**Actual (B)**
6. Production Unit (lbs, tons, etc.)	**tons**	**7. Harvested Yield***	**3**	

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
■ Split Fertilizer Applications ■ Irrigation Water N Testing ☐ Soil Testing ■ Tissue/Petiole Testing ■ Fertigation ☐ Foliar N Application ■ Cover Crops ☐ Variable Rate Applications using GPS ☐ Other: ________________ ☐ Other: ________________	9. Soil – Available N in Root Zone (Annualized, lbs/ac)		
	10. N in Irrigation Water* (Annualized, lbs/ac)		
	11. Organic Amendments* (Manure/Compost/Other, lbs/ac estimate)		
	12. Dry/Liquid Fertilizer N* (lbs/ac)		
	13. Foliar Fertilizer N* (lbs/ac)		
	14. TOTAL NITROGEN (lbs/ac)	**?**	

Right Rate: N Recommended Box 14

Crop N Demand

=

$$\frac{\left(\text{N removed per unit of crop yield} \times \text{Estimated Yield}\right) + \text{N needed for tree maintenance}}{\text{Nitrogen Use Efficiency}}$$

Right Rate: N Recommended Box 14

$$\frac{159 \text{ lbs. N}}{\text{acre}} = \frac{\frac{37 \text{ lbs. N}}{\text{ton yield}} \times \frac{3 \text{ ton yield}}{\text{acre}}}{0.7 \quad \text{NUE}}$$

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

HARVEST / YIELD INFORMATION				
Harvest / Yield Information			Expected (A)	Actual (B)
6. Production Unit (lbs, tons, etc.)	tons	**7. Harvested Yield***	3	

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
■ Split Fertilizer Applications ■ Irrigation Water N Testing ☐ Soil Testing ■ Tissue/Petiole Testing ■ Fertigation ☐ Foliar N Application ■ Cover Crops ☐ Variable Rate Applications using GPS ☐ Other: ______________ ☐ Other: ______________	9. Soil – Available N in Root Zone (Annualized, lbs/ac)		
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	11. Organic Amendments* (Manure/Compost/Other, lbs/ac estimate)		
	12. Dry/Liquid Fertilizer N* (lbs/ac)		
	13. Foliar Fertilizer N* (lbs/ac)		
	14. TOTAL NITROGEN (lbs/ac)	159	

Estimating Supply

Demand

159 lbs. N /acre

=

Supply

N in Organic Materials

N in irrigation water

N in fertilizer

Walnut: Conditions

- 100 acres Mature Walnuts
- Soil – Clay Loam, 5ft deep over consolidated layer
- Estimated yield 3.0 tons per acre for 2019
- Seasonal Water Sources
  - Stored soil moisture = 4.5 in
  - In-season effective rainfall = 1.5 in
  - Irrigation = 36 in applied via solid set sprinkler
- Irrigation Scheduling
  - ET Estimation: 42 inches
  - Pressure chamber/ bomb
- Nitrogen sources
  - Irrigation 36 inches. Nitrate water test = 1.1 ppm Nitrate-N
  - UAN, Fertigation, Monthly
  - No organic material applied (manure or composts)
  - Winter cover crop (peas, beans, vetch, and barley) each year
  - Tissue testing

Organic Material N Box 11

- Cover Crop: Peas, beans, vetch, and barley
  - 3000 lbs Dry Matter/ cover crop planted acre
  - 60 % of total tree acreage planted
  - 3000 x 0.60 = 1800 lbs. dry matter / ac
- Legumes = 2.8% N   Grasses 1.5% N
  - average of mix = 2.4% N
  - 1800 lbs. x .024 = 43 lbs. N /ac
  - At 70% efficiency: 43 x .70 = 30 lbs. N /acre

Estimating Supply

Demand

159 lbs. N /acre

=

Supply

30 lbs. N /ac

N in irrigation water

N in fertilizer

N in Irrigation Water Box 10

- Irrigation Water
  - 36 inches / season applied via solid set sprinkler
  - Nitrate from water test = 1.1 ppm Nitrate-N

- Formula for Nitrate-N
  - Nitrate-N concentration (ppm) x inches irrigation applied x 0.23 lbs/ac inch conversion

- 1.1 ppm Nitrate-N x 36 in. x 0.23 = 9 lbs. N /ac

Estimating Supply

Demand

159 lbs. N /acre

=

Supply

30 lbs. N /ac

9 lbs. N /ac

N in fertilizer

Estimating Supply

Demand

159 lbs. N /acre

=

Supply

30 lbs. N /ac

9 lbs. N /ac

120 lbs. N /ac

Demand – N mineralized – N in water =

HARVEST / YIELD INFORMATION				
Harvest / Yield Information			Expected (A)	Actual (B)
6. Production Unit (lbs, tons, etc.)	tons	**7. Harvested Yield***	3	

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
■ Split Fertilizer Applications	9. Soil – Available N in Root Zone (Annualized, lbs/ac)	0	
■ Irrigation Water N Testing	**10. N in Irrigation Water*** (Annualized, lbs/ac)	9	
☐ Soil Testing	**11. Organic Amendments*** (Manure/Compost/Other, lbs/ac estimate)	30	
■ Tissue/Petiole Testing	**12. Dry/Liquid Fertilizer N*** (lbs/ac)	120	
■ Fertigation	**13. Foliar Fertilizer N*** (lbs/ac)	0	
☐ Foliar N Application	14. TOTAL NITROGEN (lbs/ac)	159	
■ Cover Crops			
☐ Variable Rate Applications using GPS			
☐ Other: ________________			
☐ Other: ________________			

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

HARVEST / YIELD INFORMATION				
Harvest / Yield Information			Expected (A)	Actual (B)
6. Production Unit (lbs, tons, etc.)	**tons**	**7. Harvested Yield***	**3**	

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
■ Split Fertilizer Applications	9. Soil – Available N in Root Zone (Annualized, lbs/ac)	**0**	
■ Irrigation Water N Testing ☐ Soil Testing	**10. N in Irrigation Water*** (Annualized, lbs/ac)	**9**	
■ Tissue/Petiole Testing ■ Fertigation	**11. Organic Amendments*** (Manure/Compost/Other, lbs/ac estimate)	**30**	
☐ Foliar N Application ■ Cover Crops	**12. Dry/Liquid Fertilizer N*** (lbs/ac)	**120**	
☐ Variable Rate Applications using GPS ☐ Other: ______________	**13. Foliar Fertilizer N*** (lbs/ac)	**0**	
☐ Other: ______________	14. TOTAL NITROGEN (lbs/ac)	**159**	

Plan Certifier Initials **JD**

Recording Actual Values

- At the end of the season you have:
  - Produced a yield of 3.2 tons
  - Applied a total of 170 lbs. of N
    - Including contributions:
      - cover crop 30 lb N
      - irrigation water 9 lb N
      - Fertilizer 131 lb N

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

HARVEST / YIELD INFORMATION				
Harvest / Yield Information			Expected (A)	Actual (B)
6. Production Unit (lbs, tons, etc.)	tons	**7. Harvested Yield***	3	3.2

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
■ Split Fertilizer Applications ■ Irrigation Water N Testing ☐ Soil Testing ■ Tissue/Petiole Testing ■ Fertigation ☐ Foliar N Application ■ Cover Crops ☐ Variable Rate Applications using GPS ☐ Other: ______________ ☐ Other: ______________	9. Soil – Available N in Root Zone (Annualized, lbs/ac)	0	
	10. N in Irrigation Water* (Annualized, lbs/ac)	9	9
	11. Organic Amendments* (Manure/Compost/Other, lbs/ac estimate)	30	30
	12. Dry/Liquid Fertilizer N* (lbs/ac)	120	131
	13. Foliar Fertilizer N* (lbs/ac)	0	
	14. TOTAL NITROGEN (lbs/ac)	159	170

Plan Certifier Initials: JD

Certification:

- ☐ Certified INMP Specialist (e.g. Certified Crop Adviser who has completed the CDFA training program)
- ☒ Self-Certified by Member who has completed the CDFA training program
- ☐ Self-Certified by Member who follows NRCS or UC site-specific recommendations (documentation required)
- ☐ I do not apply nitrogen

I, ______________________, certify this INMP in accordance with the statement above.

____ (Signature) _____________ (Date)

If the certifier is not the Member, the Member additionally agrees as follows:

I, ______________________, Member, have provided information and data to the certifier above that is, to the best of my knowledge and belief, true, accurate, and complete, that I understand that the certifier may rely on the information and data provided by me and is not required to independently verify the information and data, and that I further understand that the certifier is not responsible for any damages, loss, or liability arising from subsequent implementation of the INMP by me in a manner that is inconsistent with the INMP's recommendations for nitrogen application. I further understand that the certification does not create any liability for claims for environmental violations.

____ (Signature) _____________ (Date)

ILRP PARCEL AND FIELD INVENTORY

STEP 1: GENERAL INFORMATION

Member ID: 1234 Crop Year (harvested): 2019

Name: John Doe

STEP 2: FIELD AND PARCEL INVENTORY

Populate the following table with parcels for which the INMP Summary Report is being submitted. You can define a field or a "Management Unit" as a parcel or parcels with the same crop, fertilizer inputs, irrigation management practices, and nitrogen management practices.

<u>If you do not apply nitrogen fertilizer to your fields these forms are still required to be returned. Please enter a 0 (zero) for nitrogen applied on the INMP Summary Report.</u>

Field ID or Management Unit (MU)	Not Farmed*	APN	County	Crop	Crop Age *(Perennial only)*	Irrigated Acres
1-1 Walnut	☐	002-025-016	Stanislaus	Walnut	12	100
	☐					
	☐					
	☐					
	☐					
	☐					
	☐					

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) SUMMARY REPORT

Refer to your Irrigation and Nitrogen Management Plan (INMP) Worksheet and Parcel Inventory for information to complete an INMP Summary. Report for each field or Management Unit.

STEP 1: GENERAL INFORMATION	STEP 2: OUTLIER NOTIFICATION RECEIPT	STEP 3: INMP CERTIFICATION METHOD
Member ID: __________ Forms Completed By: __________ Crop Year (Harvested): __________ Submittal Date: __________	The Coalition provided information about this membership's nitrogen efficiency for the previous crop year and identified management units that were considered outliers compared to other Coalition members growing the same crop. Please check the box below if you were identified as an outlier by the Coalition. ☐	☐ Certified INMP Specialist (e.g. certified crop adviser who has completed the CDFA training program) ☐ Self-Certified (CDFA training program) ☐ Self-Certified (follows NRCS or UC Cooperative Extension site-specific recommendations) ☐ Self-Certified (No fertilizers applied)

1. Enter the membership ID #
2. Enter the name of the person completing this form. This needs to be the owner or manager of the farm or the individual certifying the plan
3. Enter the Crop Year for which your report is based on
4. Enter Date form is filled out

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) SUMMARY REPORT

Refer to your Irrigation and Nitrogen Management Plan (INMP) Worksheet and Parcel Inventory for information to complete an INMP Summary. Report for each field or Management Unit.

STEP 1: GENERAL INFORMATION	STEP 2: OUTLIER NOTIFICATION RECEIPT	STEP 3: INMP CERTIFICATION METHOD
Member ID: ____________ Forms Completed By: ____________ Crop Year (Harvested): ____________ Submittal Date: ____________	The Coalition provided information about this membership's nitrogen efficiency for the previous crop year and identified management units that were considered outliers compared to other Coalition members growing the same crop. Please check the box below if you were identified as an outlier by the Coalition. ☐	☐ Certified INMP Specialist (e.g. certified crop adviser who has completed the CDFA training program) ☐ Self-Certified (CDFA training program) ☐ Self-Certified (follows NRCS or UC Cooperative Extension site-specific recommendations) ☐ Self-Certified (No fertilizers applied)

- The Coalition provided information about this membership's nitrogen efficiency for the previous crop year and identified management units that were considered outliers compared to other Coalition members growing the same crop.
  - Check the box if you were identified

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) SUMMARY REPORT

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) SUMMARY REPORT

Refer to your Irrigation and Nitrogen Management Plan (INMP) Worksheet and Parcel Inventory for information to complete an INMP Summary. Report for each field or Management Unit.

STEP 1: GENERAL INFORMATION	STEP 2: OUTLIER NOTIFICATION RECEIPT	STEP 3: INMP CERTIFICATION METHOD
Member ID: ______ Forms Completed By: ______ Crop Year (Harvested): ______ Submittal Date: ______	The Coalition provided information about this membership's nitrogen efficiency for the previous crop year and identified management units that were considered outliers compared to other Coalition members growing the same crop. Please check the box below if you were identified as an outlier by the Coalition. ☐	☐ Certified INMP Specialist (e.g. certified crop adviser who has completed the CDFA training program) ■ Self-Certified (CDFA training program) ☐ Self-Certified (follows NRCS or UC Cooperative Extension site-specific recommendations) ☐ Self-Certified (No fertilizers applied)

- Certified Crop Adviser with Nitrogen Management Training (Any crop and any field)
- Grower Self-Certification (Owned or managed fields only)

STEP 4: INMP SUMMARY REPORT

Complete the table below for each field or management unit for this membership. ***All values should be on a per acre basis.***

Field or Management Unit	Crop	Crop Age	Total Irrigated Acres	Total N Applied Lbs/acre				Yield	Prod. Unit	Yield Info*
Refer to Parcel Inventory		Perennial only (years)	(acres)	N in Irrigation Water (lbs/acre)	Organic Amendments (lbs/acre)	Dry/Liquid Fertilizers (lbs/acre)	Foliar Fertilizers (lbs/acre)	Harvested Yield (lbs/acre or tons/acre)	(lbs or tons)	
1-1 walnut	Walnut	12	100	9	30	131	0	3.2	tons	

- Information sourced from Irrigation and Nitrogen Management Plan
  - Post Production Actual Values

IRRIGATION & NITROGEN MANAGEMENT PRACTICES

Complete the following tables for each field or Management Unit (refer to ILRP Parcel and Field Inventory Sheet).

Field or MU	Primary Irrigation Method (Select one)						Secondary Irrigation Method (Select one)					
	Drip	Micro Sprinkler	Furrow	Sprinkler	Border Strip	Flood	Drip	Micro Sprinkler	Furrow	Sprinkler	Border Strip	Flood
1-1 Walnut	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Field or MU	Irrigation Efficiency Practices (Check all that apply)						
	Laser Leveling	Use of ET in scheduling irrigations	Water application scheduled to need	Use of moisture probe (e.g. tensiometer)	Soil Moisture Neutron Probe	Pressure Bomb	Other
1-1 Walnut	☐	☒	☒	☐	☐	☒	
	☐	☐	☐	☐	☐	☐	

IRRIGATION & NITROGEN MANAGEMENT PRACTICES

Complete the following tables for each field or Management Unit (refer to ILRP Parcel and Field Inventory Sheet).

Field or MU	Nitrogen Efficiency Practices (Check all that apply)								
	Split Fertilizer Applications	Irrigation Water N Testing	Soil Testing	Tissue/ Petiole Testing	Fertigation	Foliar N Application	Cover Crops	Variable Rate Applications using GPS	Other
1-1 Walnut	■	■	☐	■	■	☐	■	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

Silage Corn Irrigation and Nitrogen Management Plan / Summary

Corn Silage: Conditions

- 40 acres silage corn
- Soil– sandy loam
- Seasonal Water Sources
    - Stored soil moisture = 1.0 in
    - In-season effective rainfall = 0 in
    - Irrigation = 36 in applied Irrigation water as furrow irrigation
- Irrigation Scheduling
    - ET Estimation: 24 inches
- Nitrogen Sources
    - Soil analysis pre-plant
    - Water test = 9.0 ppm Nitrate-N with ET = 24 in
    - Applied fertilizer, starter plus side dress
    - Corral manure applied
- Estimated yield 30 tons per acre

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

Member ID #: 1234 **Member Name:** John Doe

Was this management unit identified as a statistical outlier by the Coalition last year?

☐ Yes ☒ No

Crop Year (Harvested): 2019

PARCEL MANAGEMENT					
Management Unit (MU) or Field	**APN**	**County**	**Crop**	**Crop Age** (Years)	**Irrigated Acres**
1-2 corn	005-234-5678	San Joaquin	Silage Corn		40

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

Member ID: 1234 INMP Field or MU: 1-2 corn Crop: corn Total Acres: 40

IRRIGATION MANAGEMENT		
1. Irrigation Method*	**Pre-Season Planning**	
(check one for Primary; if applicable, check one for Secondary) Primary / Secondary[1] ☐ ☐ Drip ☐ ☐ Micro Sprinkler X ☐ Furrow ☐ ☐ Sprinkler ☐ ☐ Border Strip ☐ ☐ Flood	2. Crop Evapotranspiration (ET, inches)	24
	3. Anticipated Crop Irrigation (inches)	36
	4. Irrigation Water N Concentration (ppm or mg/L, as NO_3-N)	9.0

5. Irrigation Efficiency Practices* (Check all that apply)

- ☒ Laser Leveling
- ☒ Use of ET in scheduling irrigations
- ☒ Water application schedule to need
- ☐ Use of moisture probe (e.g. tensiometer)
- ☐ Soil Moisture Neutron Probe
- ☐ Pressure Bomb
- ☐ Other ____________________
- ☐ Other ____________________

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

HARVEST / YIELD INFORMATION					
Harvest / Yield Information				Expected (A)	Actual (B)
6. Production Unit (lbs, tons, etc.)	tons		**7. Harvested Yield***	30	

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
☒ Split Fertilizer Applications ☒ Irrigation Water N Testing ☒ Soil Testing ☐ Tissue/Petiole Testing ☐ Fertigation ☐ Foliar N Application ☐ Cover Crops ☐ Variable Rate Applications using GPS ☐ Other: ____________ ☐ Other: ____________	9. Soil – Available N in Root Zone (Annualized, lbs/ac)		
	10. N in Irrigation Water* (Annualized, lbs/ac)		
	11. Organic Amendments* (Manure/Compost/Other, lbs/ac estimate)		
	12. Dry/Liquid Fertilizer N* (lbs/ac)		
	13. Foliar Fertilizer N* (lbs/ac)		
	14. TOTAL NITROGEN (lbs/ac)	?	

Right Rate: N Recommended Box 14

415 lbs. N /acre

$$= \frac{\frac{9.7 \text{ lbs. N}}{\text{ton yield}} \times \frac{30 \text{ tons}}{\text{acre}}}{0.7}$$

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

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

HARVEST / YIELD INFORMATION					
Harvest / Yield Information				Expected (A)	Actual (B)
6. Production Unit (lbs, tons, etc.)	**tons**	**7. Harvested Yield***		**30**	

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
■ Split Fertilizer Applications	9. Soil – Available N in Root Zone (Annualized, lbs/ac)		
■ Irrigation Water N Testing	**10. N in Irrigation Water*** (Annualized, lbs/ac)		
■ Soil Testing			
☐ Tissue/Petiole Testing	**11. Organic Amendments*** (Manure/Compost/Other, lbs/ac estimate)		
☐ Fertigation			
☐ Foliar N Application	**12. Dry/Liquid Fertilizer N*** (lbs/ac)		
☐ Cover Crops			
☐ Variable Rate Applications using GPS	**13. Foliar Fertilizer N*** (lbs/ac)		
☐ Other: ________________			
☐ Other: ________________	14. TOTAL NITROGEN (lbs/ac)	**415**	

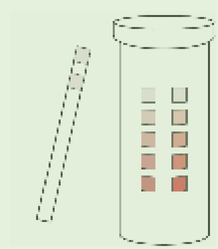
Apply the Right N Rate

The right rate equation

Demand

$\frac{\text{415 lbs. N}}{\text{acre}}$ =

Supply



Residual N in Soil

N mineralized in soil

Irrigation water

Fertilizer

Soil Available Nitrogen Box 9

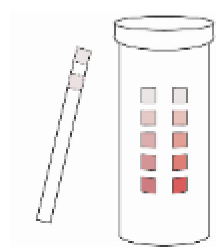
- Soil test pre plant
- Mineral N available in the top 2 feet of soil
  - 2 ft x 33 lbs. N/ft =

66 lbs. N/acre

Primary Nutrients	
Nitrate-Nitrogen	33.0 Lbs/AF
Phosphorus-P_2O_5	174 Lbs/AF
Potassium-K_2O (Exch)	1020 Lbs/AF
Potassium-K_2O (Sol)	125 Lbs/AF

Apply the Right N Rate

The right rate equation

Demand		Supply			
					
$\frac{\text{415 lbs. N}}{\text{acre}}$	=	66 lbs. N/ac	N mineralized in soil	Irrigation water	Fertilizer

Organic Amendments Box 11

- 5^{th} year applying corral manure @ 5 tons/ac
- % N estimated from lab report 0.83%

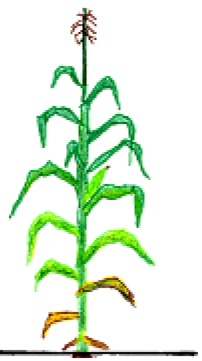
- N credit = 10,000 lbs. compost /ac x 0.0083 x 0.70
- N credit = 58 lbs N /ac

Apply the Right N Rate

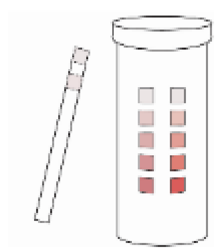
The right rate equation

Demand

Supply



$$\frac{415 \text{ lbs. N}}{\text{acre}} =$$



66 lbs. N/ac

58 lbs. N /ac

Irrigation water

Fertilizer

N in Irrigation Water Box 10

- Crop Water Use: 24 inches ETc
  - Depending on location, time of planting, corn variety, and weather the ET of corn can range from 21-27 in.
- If more water is being applied than crop ET some water is leaching and the crop is not using all N applied.
  - In this case, only the amount of N in the ET water volume should be credited.

N in Irrigation Water Box 10

- Irrigation Water
  - 24 inches
  - Water test = 9.0 ppm Nitrate-N

- Formula for Nitrate-N
  - Nitrate-N concentration (ppm) x inches irrigation applied x 0.23 lbs/ac inch conversion

- 9.0 ppm Nitrate-N x 24 in. x 0.23 = 50 lbs. N /ac

Apply the Right N Rate

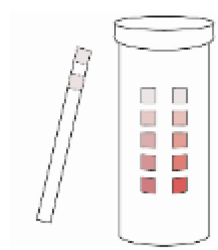
The right rate equation

Demand

$$\frac{415 \text{ lbs. N}}{\text{acre}}$$

=

Supply



66 lbs. N/ac

58 lbs. N /ac

50 lbs. N /ac

241 lbs. N /ac

Demand – N in soil - N mineralized – N in water

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

HARVEST / YIELD INFORMATION				
Harvest / Yield Information			Expected (A)	Actual (B)
6. Production Unit (lbs, tons, etc.)	**tons**	**7. Harvested Yield***	**30**	

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
■ Split Fertilizer Applications ■ Irrigation Water N Testing ■ Soil Testing ☐ Tissue/Petiole Testing ☐ Fertigation ☐ Foliar N Application ☐ Cover Crops ☐ Variable Rate Applications using GPS ☐ Other: ________________ ☐ Other: ________________	9. Soil – Available N in Root Zone (Annualized, lbs/ac)	**66**	
	10. N in Irrigation Water* (Annualized, lbs/ac)	**50**	
	11. Organic Amendments* (Manure/Compost/Other, lbs/ac estimate)	**58**	
	12. Dry/Liquid Fertilizer N* (lbs/ac)	**241**	
	13. Foliar Fertilizer N* (lbs/ac)	**0**	
	14. TOTAL NITROGEN (lbs/ac)	**415**	

Recording Actual Values in NMP

- At the end of the season you have:
  - Produced a yield of 30.5 tons /ac
  - Applied a total of 424 lbs. of N
    - Including contributions:
      - Soil N Test 66 lbs. N
      - Organic amendments 58 lbs. N
      - irrigation water 50 lbs. N
      - Fertilizer 250 lbs. N

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) WORKSHEET

HARVEST / YIELD INFORMATION				
Harvest / Yield Information			Expected (A)	Actual (B)
6. Production Unit (lbs, tons, etc.)	**tons**	**7. Harvested Yield***	**30**	**30.5**

NITROGEN MANAGEMENT			
8. Nitrogen Efficiency Practices* (Check all that apply)	**Nitrogen Sources**	**Recommended/ Planned N (A)**	**Actual N (B)**
■ Split Fertilizer Applications	9. Soil – Available N in Root Zone (Annualized, lbs/ac)	**66**	**66**
■ Irrigation Water N Testing	**10. N in Irrigation Water*** (Annualized, lbs/ac)	**50**	**50**
■ Soil Testing	**11. Organic Amendments*** (Manure/Compost/Other, lbs/ac estimate)	**58**	**58**
☐ Tissue/Petiole Testing	**12. Dry/Liquid Fertilizer N*** (lbs/ac)	**241**	**250**
☐ Fertigation	**13. Foliar Fertilizer N*** (lbs/ac)	**0**	**0**
☐ Foliar N Application	14. TOTAL NITROGEN (lbs/ac)	**415**	**424**
☐ Cover Crops			
☐ Variable Rate Applications using GPS			
☐ Other: ______________			
☐ Other: ______________			

Certification:

- ☐ Certified INMP Specialist (e.g. Certified Crop Adviser who has completed the CDFA training program)
- ■ Self-Certified by Member who has completed the CDFA training program
- ☐ Self-Certified by Member who follows NRCS or UC site-specific recommendations (documentation required)
- ☐ I do not apply nitrogen

I, ______________________, certify this INMP in accordance with the statement above.

____ (Signature) _____________ (Date)

If the certifier is not the Member, the Member additionally agrees as follows:

I, ______________________, Member, have provided information and data to the certifier above that is, to the best of my knowledge and belief, true, accurate, and complete, that I understand that the certifier may rely on the information and data provided by me and is not required to independently verify the information and data, and that I further understand that the certifier is not responsible for any damages, loss, or liability arising from subsequent implementation of the INMP by me in a manner that is inconsistent with the INMP's recommendations for nitrogen application. I further understand that the certification does not create any liability for claims for environmental violations.

____ (Signature) _____________ (Date)

ILRP PARCEL AND FIELD INVENTORY

STEP 1: GENERAL INFORMATION

Member ID: 1234 Crop Year (harvested): 2019

Name: John Doe

STEP 2: FIELD AND PARCEL INVENTORY

Populate the following table with parcels for which the INMP Summary Report is being submitted. You can define a field or a "Management Unit" as a parcel or parcels with the same crop, fertilizer inputs, irrigation management practices, and nitrogen management practices.

If you do not apply nitrogen fertilizer to your fields these forms are still required to be returned. Please enter a 0 (zero) for nitrogen applied on the INMP Summary Report.

Field ID or Management Unit (MU)	Not Farmed*	APN	County	Crop	Crop Age *(Perennial only)*	Irrigated Acres
1-1 Corn	☐	005-234-5678	San Joaquin	Corn		40
	☐					
	☐					
	☐					
	☐					
	☐					
	☐					

IRRIGATION AND NITROGEN MANAGEMENT PLAN (INMP) SUMMARY REPORT

Refer to your Irrigation and Nitrogen Management Plan (INMP) Worksheet and Parcel Inventory for information to complete an INMP Summary. Report for each field or Management Unit.

STEP 1: GENERAL INFORMATION	STEP 2: OUTLIER NOTIFICATION RECEIPT	STEP 3: INMP CERTIFICATION METHOD
Member ID: ____________ Forms Completed By: ____________ Crop Year (Harvested): ____________ Submittal Date: ____________	The Coalition provided information about this membership's nitrogen efficiency for the previous crop year and identified management units that were considered outliers compared to other Coalition members growing the same crop. Please check the box below if you were identified as an outlier by the Coalition. ☐	☐ Certified INMP Specialist (e.g. certified crop adviser who has completed the CDFA training program) ☐ Self-Certified (CDFA training program) ☐ Self-Certified (follows NRCS or UC Cooperative Extension site-specific recommendations) ☐ Self-Certified (No fertilizers applied)

1. Enter the membership ID #

   Enter the name of the person completing this form. This needs to be the owner or manager of the farm or the individual certifying the plan

   Enter the Crop Year for which your report is based on

   Enter Date form is filled out

2. The Coalition provided information about this membership's nitrogen efficiency for the previous crop year and identified management units that were considered outliers compared to other Coalition members growing the same crop.

   Check the box if you were identified

3. Certified Crop Adviser with Nitrogen Management Training (Any crop and any field)

   Grower Self-Certification (Owned or managed fields only)

STEP 4: INMP SUMMARY REPORT

Complete the table below for each field or management unit for this membership. ***All values should be on a per acre basis.***

Field or Management Unit	Crop	Crop Age	Total Irrigated Acres	Total N Applied Lbs/acre				Yield	Prod. Unit	Yield Info*
Refer to Parcel Inventory		Perennial only (years)	(acres)	N in Irrigation Water (lbs/acre)	Organic Amendments (lbs/acre)	Dry/Liquid Fertilizers (lbs/acre)	Foliar Fertilizers (lbs/acre)	Harvested Yield (lbs/acre or tons/acre)	(lbs or tons)	
1-1 Corn	Corn		40	50	58	250	0	30.5	tons	silage

- Information sourced from Irrigation and Nitrogen Management Plan
  - Post Production Actual Values

IRRIGATION & NITROGEN MANAGEMENT PRACTICES

Complete the following tables for each field or Management Unit (refer to ILRP Parcel and Field Inventory Sheet).

Field or MU	Primary Irrigation Method (Select one)						Secondary Irrigation Method (Select one)					
	Drip	Micro Sprinkler	Furrow	Sprinkler	Border Strip	Flood	Drip	Micro Sprinkler	Furrow	Sprinkler	Border Strip	Flood
1-2 Corn	☐	☐	■	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Field or MU	Irrigation Efficiency Practices (Check all that apply)						
	Laser Leveling	Use of ET in scheduling irrigations	Water application scheduled to need	Use of moisture probe (e.g. tensiometer)	Soil Moisture Neutron Probe	Pressure Bomb	Other
1-2 Corn	☐	■	■	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	

IRRIGATION & NITROGEN MANAGEMENT PRACTICES

Complete the following tables for each field or Management Unit (refer to ILRP Parcel and Field Inventory Sheet).

	Nitrogen Efficiency Practices (Check all that apply)								
Field or MU	Split Fertilizer Applications	Irrigation Water N Testing	Soil Testing	Tissue/ Petiole Testing	Fertigation	Foliar N Application	Cover Crops	Variable Rate Applications using GPS	Other
1-2 Corn	■	■	■	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	☐	☐	☐	

Resources for Nitrogen Application and Management Practices

Section 7

The last chapter in the Curriculum Binder is for your reference to irrigation and nitrogen management “go to“ websites.

Irrigation and Nitrogen Management Grower Certification Program Exam

- 30 Questions
  - Multiple Choice, True/False, and Irrigation and Nitrogen Management Plan Fill-in
- Test Score
  - 70% to pass (21/30 correct)
- Test Rules
  - Individual
  - Closed book
- Results
  - Sent via email or mail (if no email provided) in 2-3 weeks

Alternative Options for Exam

- You may skip the test today, study the materials and return to take the test at an upcoming meeting or call the coalition office for details on taking it at their office
- If you do not pass (70%), you may take a re-test at another grower training session (you will not need to sit through the whole course, just take the test) or at the coalition office.
  - Average pass rate is 80%
- You can elect not to take the test and work with a Certified Crop Advisor for INMP certification.