Sustainability Through Sound Irrigation and Fertilization Practices

Andre Biscaro,
Irrigation and Water Resources Advisor
University of California Cooperative Extension, Ventura County

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Presentation Outline

- Sustainability and water quality
- Factors affecting offsite movement of chemicals
- Nitrate in ground and surface water
- Resources to improve nitrogen and water management
- THF study results
- N in organic systems

Sustainability

Merriam-Webster:

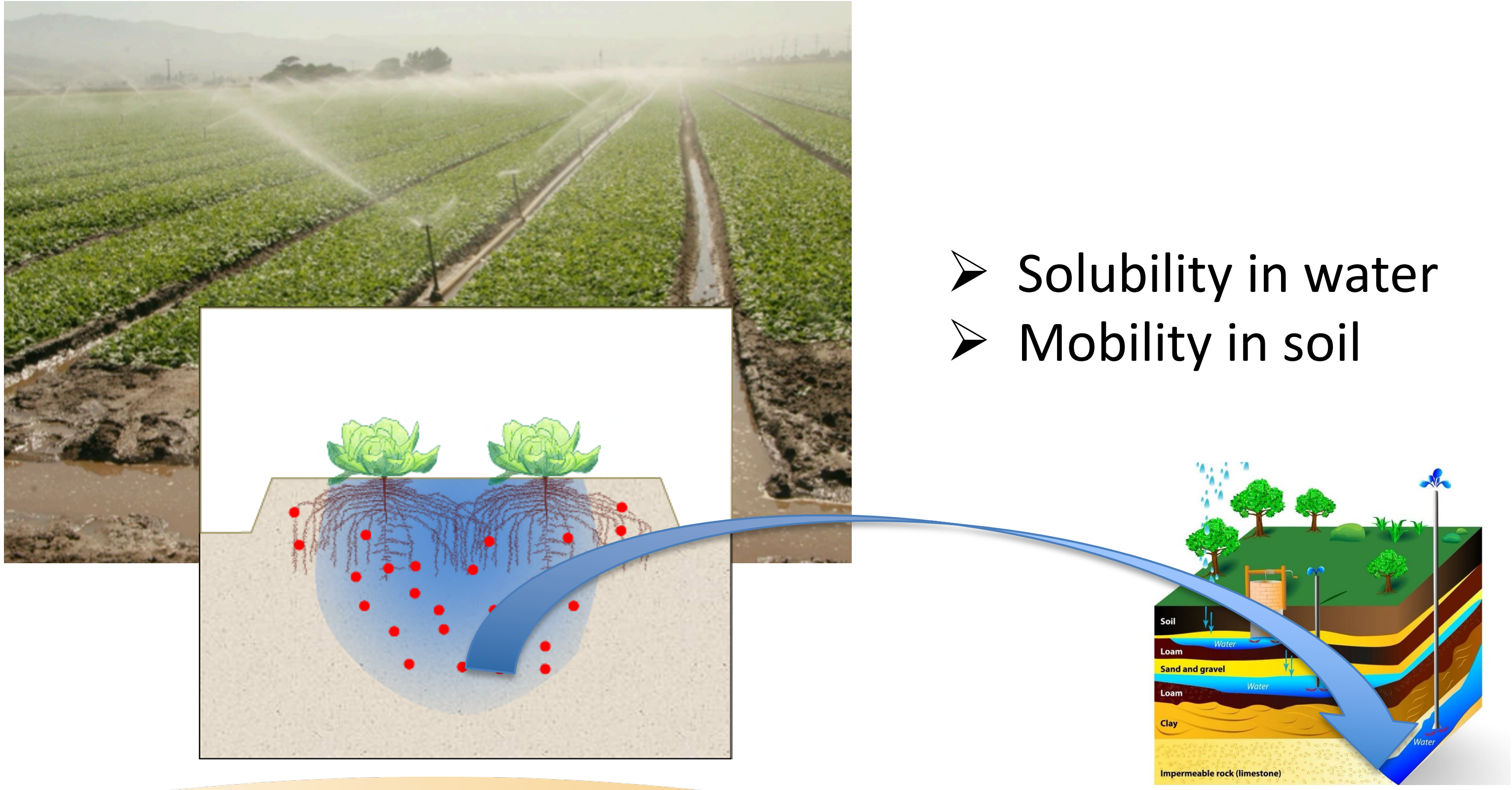
Of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged.

Oxford:

Avoidance of the depletion of natural resources in order to maintain an ecological balance.

Factors Affecting Offsite Movement of Chemicals

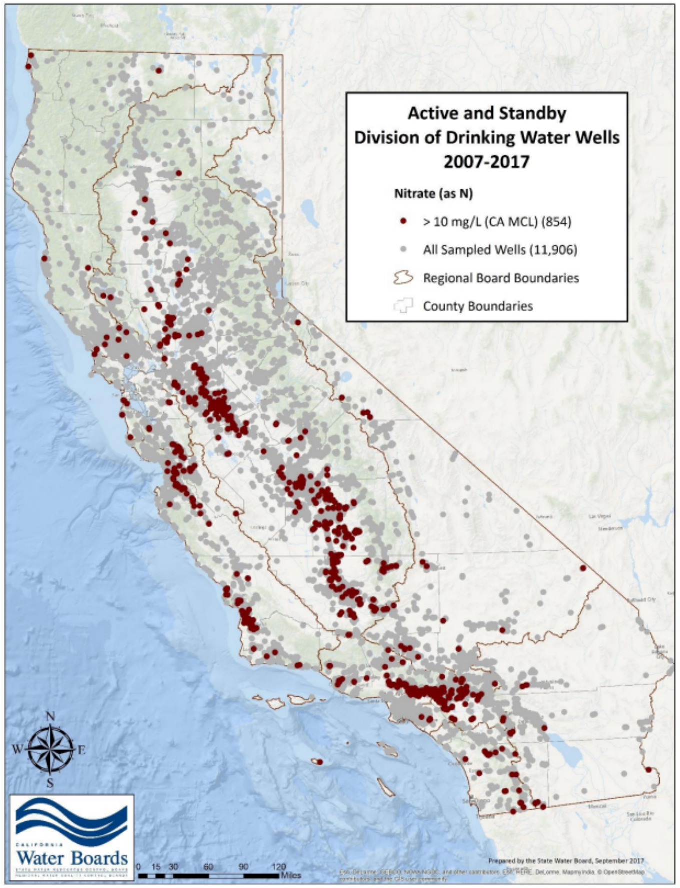
- Runoff and deep percolation (leaching): irrigation and rainfall exceeds soil infiltration and soil water holding capacity



- Solubility in water
- Mobility in soil

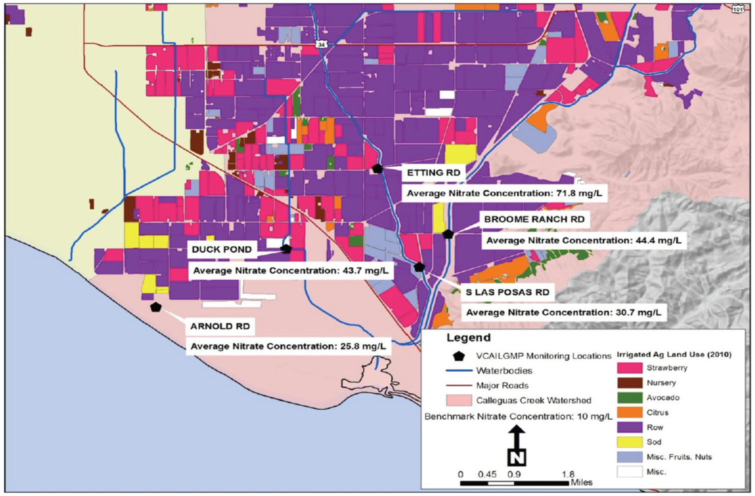
Exceeding nitrate levels in ground and surface water

State Water Resources Control Board
Division of Water Quality
GAMA Program



Active and standby public drinking water wells that had at least one detection of nitrate (as N) above the MCL, 2007-2017, 854 wells. *(Source: Public Well Data using GeoTracker GAMA).*

Lower Calleguas Creek Aver. Nitrate



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Nitrogen Use Reporting

NITROGEN MANAGEMENT PLAN WORKSHEET

1. Crop Year (Harvested): ________

2. Member ID# ________

3. Name:

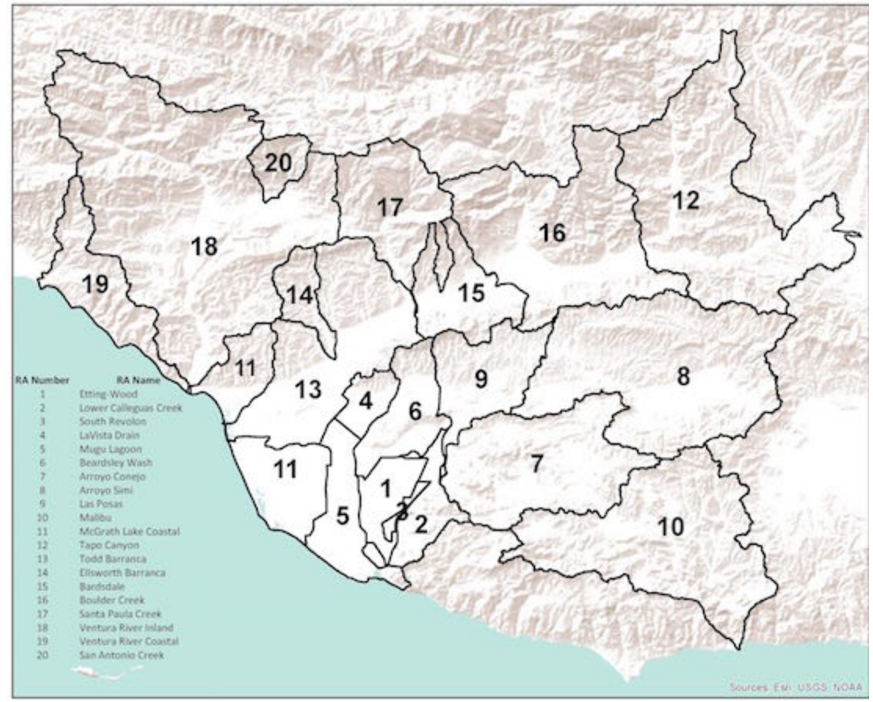
4. APN(s):	5. Field(s) ID	

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

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

** Your Coalition will provide the method to be used to estimate N Removed.

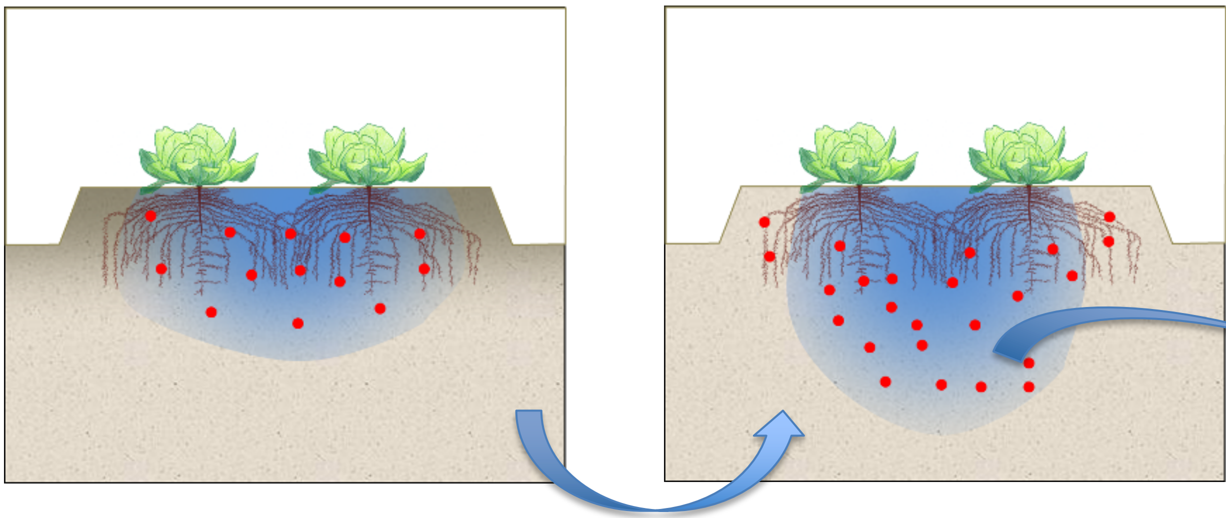
Responsibility Areas



[Farm Bureau of Ventura County:](http://www.farmbureauvc.com/issues/water-issues/water-quality/management)
http://www.farmbureauvc.com/issues/water-issues/water-quality/management

Circumstances conducive to nitrate leaching:

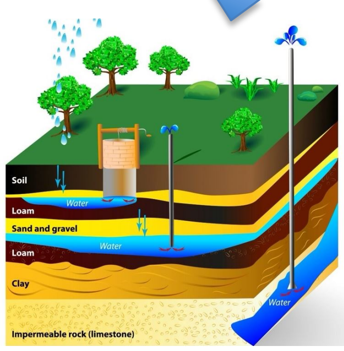
- ✓ Crops sensitive to mild water stress (increased irrigation frequency)
- ✓ Crops with shallow, or relatively shallow root system
- ✓ Crops grown on well-drained soils
- ✓ High-value crops (small yield losses can cause significant impact on returns)



<u>Typical number of irrigation events</u>:
Strawberries: 50-60
Celery: 15-20

https://apps1.cdfa.ca.gov/fertilizerresearch/docs/Nitrate_Tool.html

- ✓ Most soil N is in the form of nitrate
- ✓ Nitrate is very soluble in water
- ✓ Nitrate is weekly held in the soil CEC



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Key to Successful Irrigation and N Management: Right Rate, at the Right time

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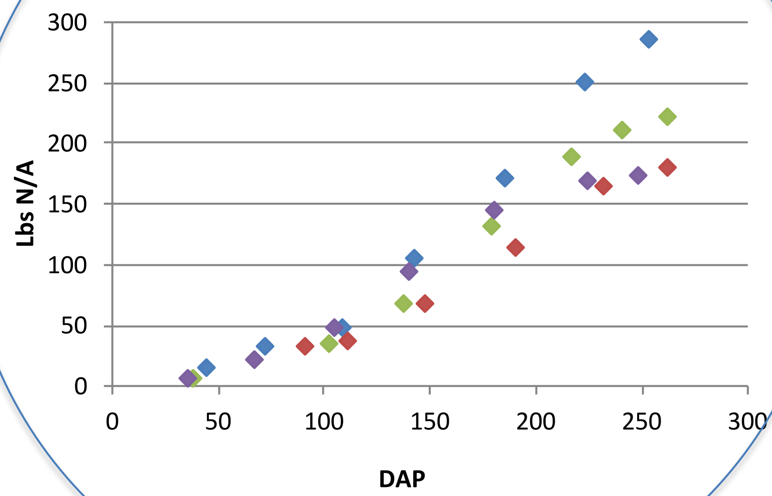
Key N Management Info

Crop N uptake

UC Studies



Soil N

Nitrate Quick Test

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N in irrigation water

- mg/L (ppm) NO_3-N × 0.227 = lb of N/ac-in of water

Irrigation water of 10mg/L NO_3-N

- ✓ 1.5 AF: 41 lbs N/acre
- ✓ 2.5AF: 68 lbs N/acre

http://calag.ucanr.edu, APRIL–JUNE 2017, page 63

An injection system generated irrigation water with NO_3-N concentrations of 12, 25 and 45 mg/L.

which irrigation water NO_3-N can substitute for fertilizer N. Two questions commonly asked by growers are whether plants can effectively use N at the low concentrations common in irrigation water, and to what degree irrigation inefficiency reduces water NO_3-N availability. We undertook this study to document the agronomic value of irrigation water NO_3-N in the production of vegetable crops under field conditions representative of the Salinas Valley.

Irrigation water NO_3-N trials

Four field trials were conducted at the U.S. Department of Agriculture Agricultural Research Service (USDA-ARS) facility near Salinas between 2013 and 2015. The soil was a Chualar sandy loam. Before planting, fields were sprinkler-irrigated to leach residual soil NO_3-N so that all trials were conducted with low background soil N availability. The well water used for pre-plant leaching as well as for all in-season irrigation ranged between 2 and 4 mg/L NO_3-N over the course of this study. The experimental design for each trial was a randomized complete block, with four replications. Individual plots consisted of four beds, each 40 inches (1 meter) wide and 40 feet (12.2 meters) long, with all data collected from the middle two beds.

Crisphead lettuce 'Telluride' was seeded on May 16, 2013, in two rows per bed and germinated using sprinklers. A soil anticrustant solution containing 17 lb/ac (19 kg/ha) of N was applied to all treatments at planting to improve germination. After plants were thinned to a final in-row spacing of approximately 12 inches (30 centimeters), drip tape was installed on top of the beds and the field was drip-irrigated for the rest of the season.

Crop growth and N uptake were compared across a range of treatments simulating different irrigation water NO_3-N concentrations during the drip-irrigated phase of the crop. The different NO_3-N concentrations were achieved by using water-powered proportional injectors to enrich all drip-applied water to 12, 25 or 45 mg/L NO_3-N. Injected NO_3-N was a blend of $Ca(NO_3)_2$ and $NaNO_3$ to maintain a cation balance similar to groundwater (Ca:Na milliequivalent ratio of 1.0). A water sample was collected from each treatment during each irrigation to confirm that the target NO_3-N concentrations were achieved. Additionally, an unfertilized control and a fertilized control treatment were included; both were irrigated using water containing only 2 mg/L NO_3-N. The fertilized control received five fertigations of ammonium nitrate solution (AN-20) totaling 150 lb/ac (168 kg/ha) of N. Also, all treatments were fertilized with potassium thiosulfate (KTS) in two fertigations of 30 lb/ac (34 kg/ha) of K each.

Each N treatment was evaluated at two levels of irrigation to observe the interaction between irrigation efficiency and crop uptake of irrigation water NO_3-N. The lower level of irrigation, 110% of crop evapotranspiration (ET_c), was chosen to represent efficient management with minimal leaching. The higher level of irrigation, 160% of ET_c, was chosen to represent less efficient irrigation management; we have observed a number of Salinas Valley vegetable fields in which irrigation reached as high as 200% of ET_c (Smith et

Calculating the N in irrigation water

Calculation of the amount of nitrogen in irrigation water requires knowledge of both the N concentration and the volume of water applied. Laboratory analysis for nitrate in water is commonly reported as milligrams per liter (mg/L) or parts per million (ppm); these units are numerically the same: 1 mg/L equals 1 ppm. Labs may report concentration either as nitrate (NO_3^-) or nitrate-N (NO_3-N); the conversion between the two is

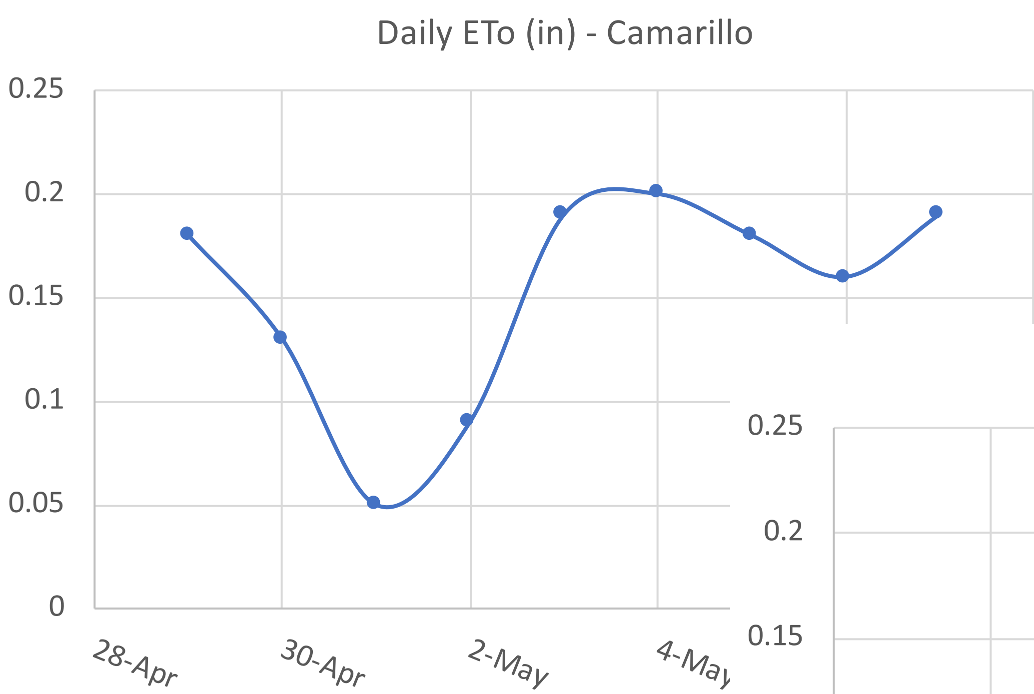
$$NO_3^- \div 4.43 = NO_3\text{-}N$$

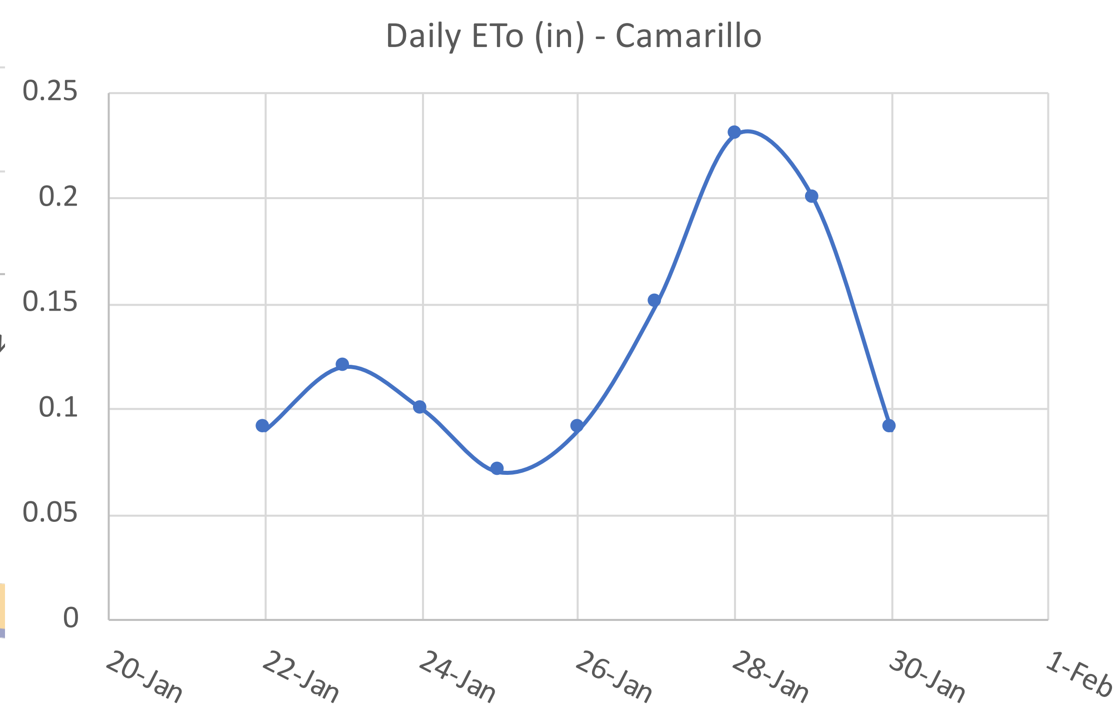
To convert NO_3-N concentration to mass of N applied, this equation can be used:

$$\text{mg/L } NO_3\text{-}N \times 0.227 = \text{lb of N/ac-in of water}$$

Nitrate is usually the only form of N present in irrigation water in an agronomically significant amount, so it is the only N form reported on the typical water test. However, recycled municipal wastewater, which is increasingly being used for irrigation in California, can contain more ammonium N (NH_4-N) than NO_3-N, as well as some organic forms of N that become relatively quickly available in soil. Wastewater treatment plants routinely test for these other N sources in addition to NO_3-N, and this information is publicly available. One should consider all forms of N when estimating the amount of plant-available N in recycled water.

Why is irrigation scheduling challenging?





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ET-Based Irrigation

ETo

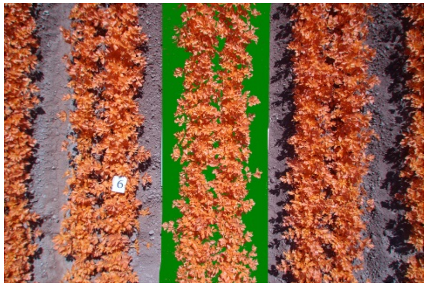
https://cimis.water.ca.gov/

x

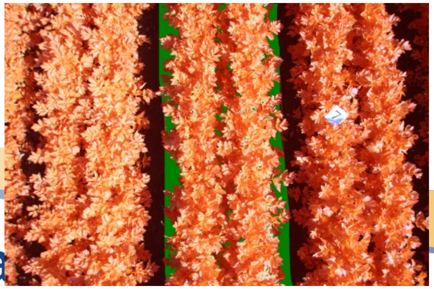
Kc

20%

60%



90%



Water recommendation

Soil Moisture Sensors

Advantages (Pros)

- Direct measure of tension
- Can interface with data logger
- No salinity interference
- Responsive at high moisture
- Contents independent of soil texture

Disadvantages (Cons)

- May require frequent maintenance

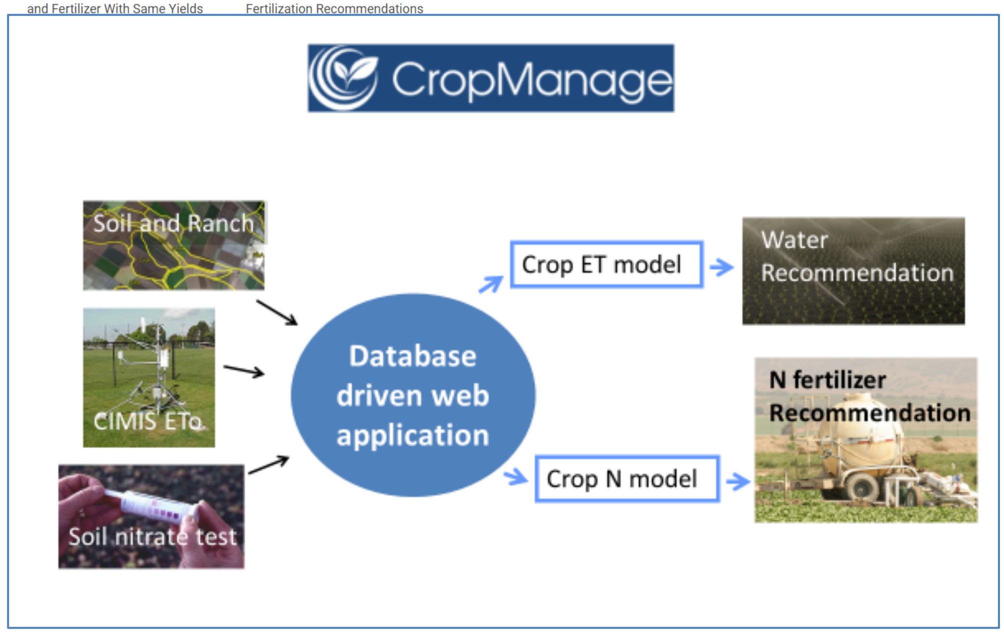
cropmanage.ucanr.edu

Benefits to Growers

Based on a few simple inputs, CropManage can provide any level of irrigation and fertilization decision support in order to validate or improve your existing operation' production—and increase your overall confidence.

20% to 40% Reduction in Water and Fertilizer With Same Yields

Supports Irrigation AND Fertilization Recommendations



Ventura County:
- Strawberry
- Celery

<u>Six replicated studies:</u>
- Equal or higher yields
- Water and N fert. use varied

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Assessing the Impact of Nitrogen Fertilizer Amounts and Sources on Strawberry Yield and Shelf Life

THF 2018/2019

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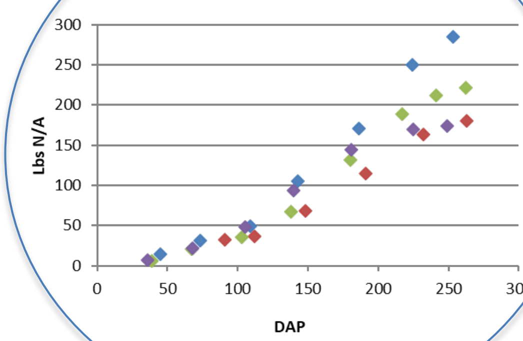
Treatments

	Low	Medium	High
	----- lbs N/ac/week -----		
Early season (Oct-Feb)	2	4	6
Late season (Mar-May)	6	10	14
	------- lbs N/ac -------		
Total applied (Oct 8-May 31)	118	208	298

Applied as CN9 and as AN20

Previous Studies



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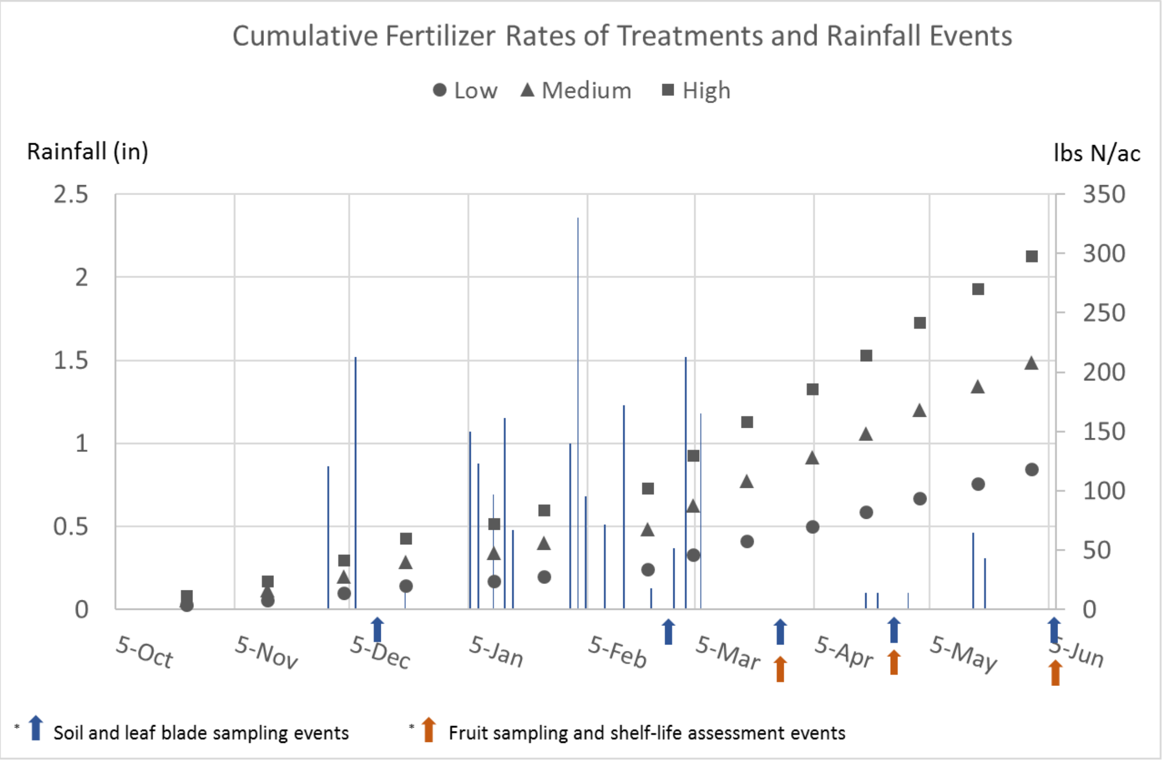
Treatments



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Treatments Application

Early season, lower rates

Mid-late season, higher rates

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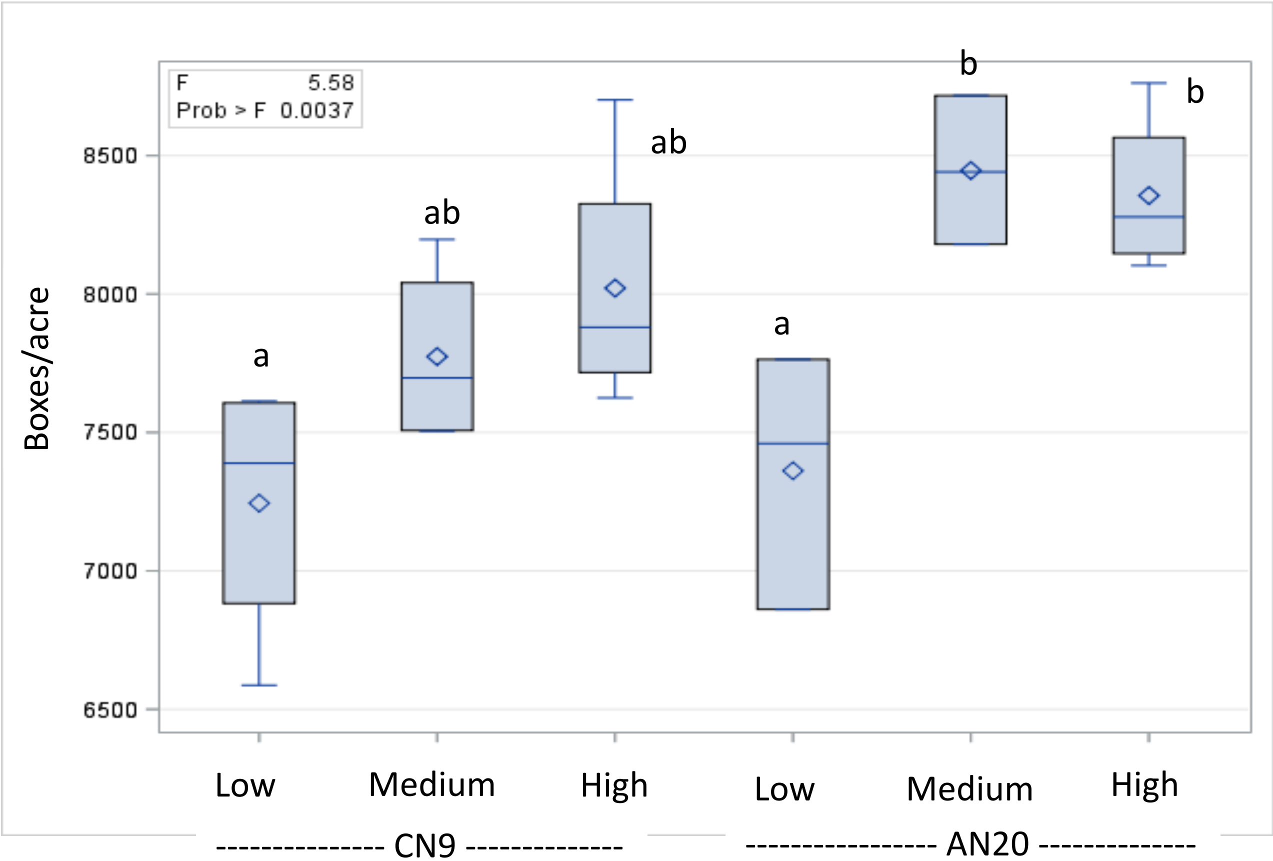
Results

Total Marketable Yield, Fronteras



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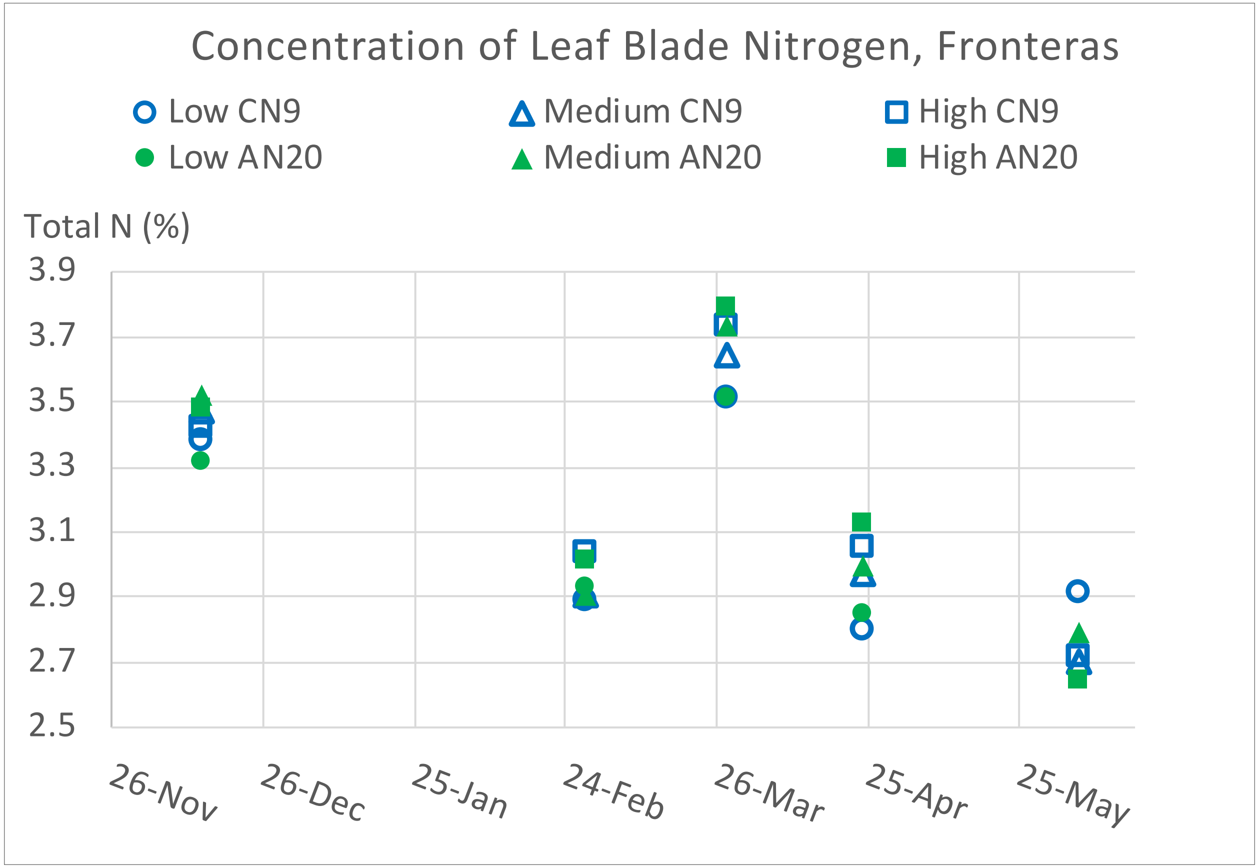
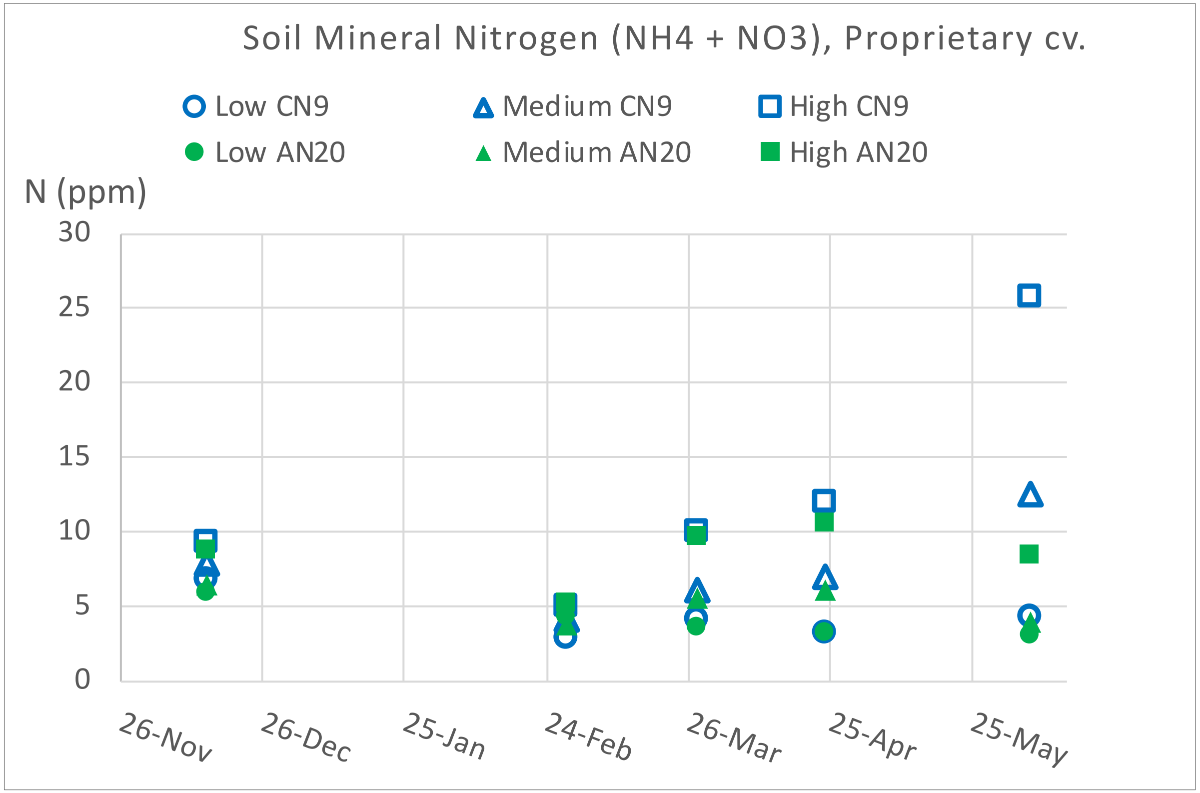
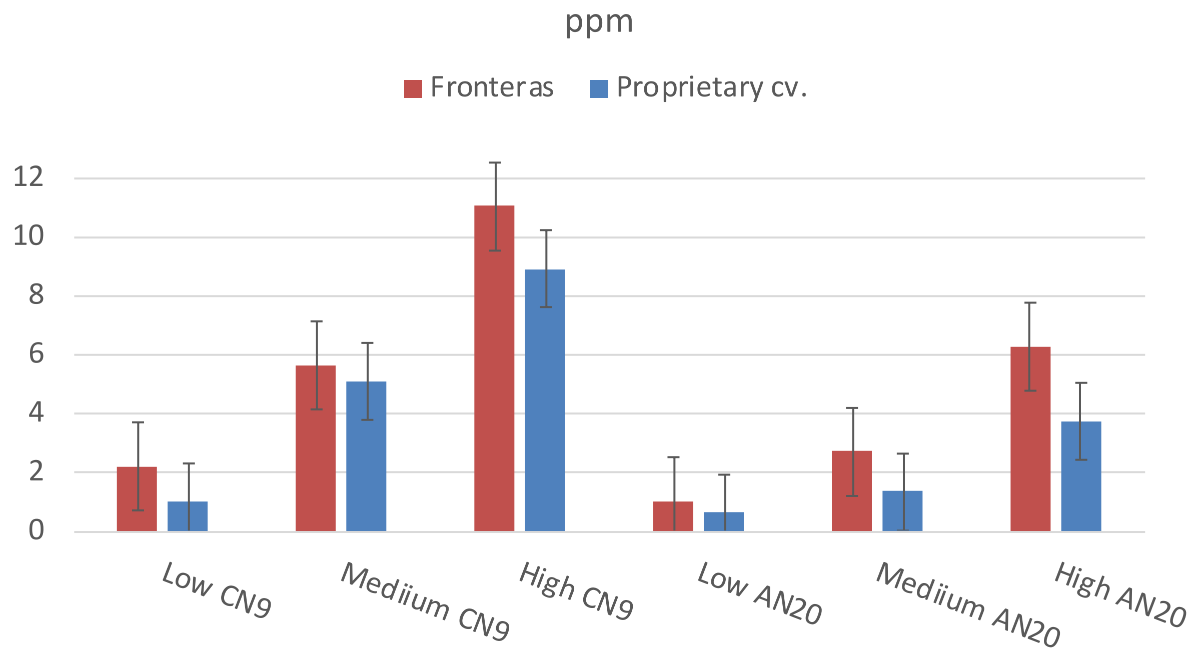


Concentration of Leaf Blade Nitrogen, Fronteras
Low CN9
Medium CN9
High CN9
Low AN20
Medium AN20
High AN20
Total N (%)
3.9
3.7
3.5
3.3
3.1
2.9
2.7
2.5
26-Nov
26-Dec
25-Jan
24-Feb
26-Mar
25-Apr
25-May



Soil Mineral Nitrogen (NH4 + NO3), Proprietary cv.
Low CN9
Medium CN9
High CN9
Low AN20
Medium AN20
High AN20
N (ppm)
30
25
20
15
10
5
0
26-Nov
26-Dec
25-Jan
24-Feb
26-Mar
25-Apr
25-May

NO_3-N at 12-24 in depth (at crop termination)



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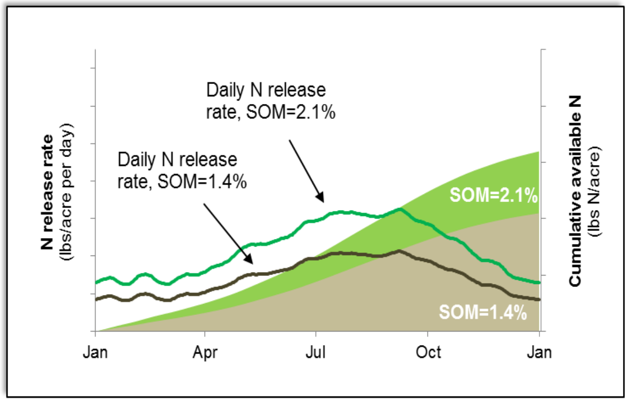
Organic Production and its Challenges to Sustainability

Organic Systems

Soil Organic Matter



In-Season Fertilizers

Major N contributions

Organic Amendments

Material	Typical C:N ratio	N available after 12 weeks	Releases in
Municipal yard trimmings composts	13 - 20	-3% - 4%	Years
Poultry manure composts	6 - 8	30 - 35%	Weeks-months
Granular fertilizers	5 - 7	38 - 86%	Days-weeks
Blood & feather meal	3 - 4	65 - 70%	Days
Liquid fertilizers	4 - 6	65 - 70%	Days

Cover Crops

Common name	Estimated N fixed lbs N/acre/year
Berseem clover	240 - 360
Purple vetch	130 - 300
Field pea	210 - 300
Lana woolypod vetch	230
Subterranean clover	140 - 180
Austrian winter pea	150
Bell bean	80 - 150
Medic	80 - 130
Cowpea	50 - 70

Crop Residues

Crop	Example yield (tons/acre)	Expected crop residues (lb N/ton yield)	Expected crop residues (lb N/acre)	Source
Lettuce	16-21	4.9	78-102	[1,12]
Tomato (fresh-market)	20	4.5	88	[17, w/ supplemental data]
Tomato (processing)	54	2.2	119	[9]
Sweet potato	17	0.2	4	[20]
Broccoli	7 - 10	25.4	178 - 255	[12]
Carrot	20	7.1	142	[15]
Melon	23	3.0	69	[6,19]
Potato	24	4.7	114	[21]
Strawberry	36	2.7	95	[2]
Spinach	9-16	3.2	29-51	[13]

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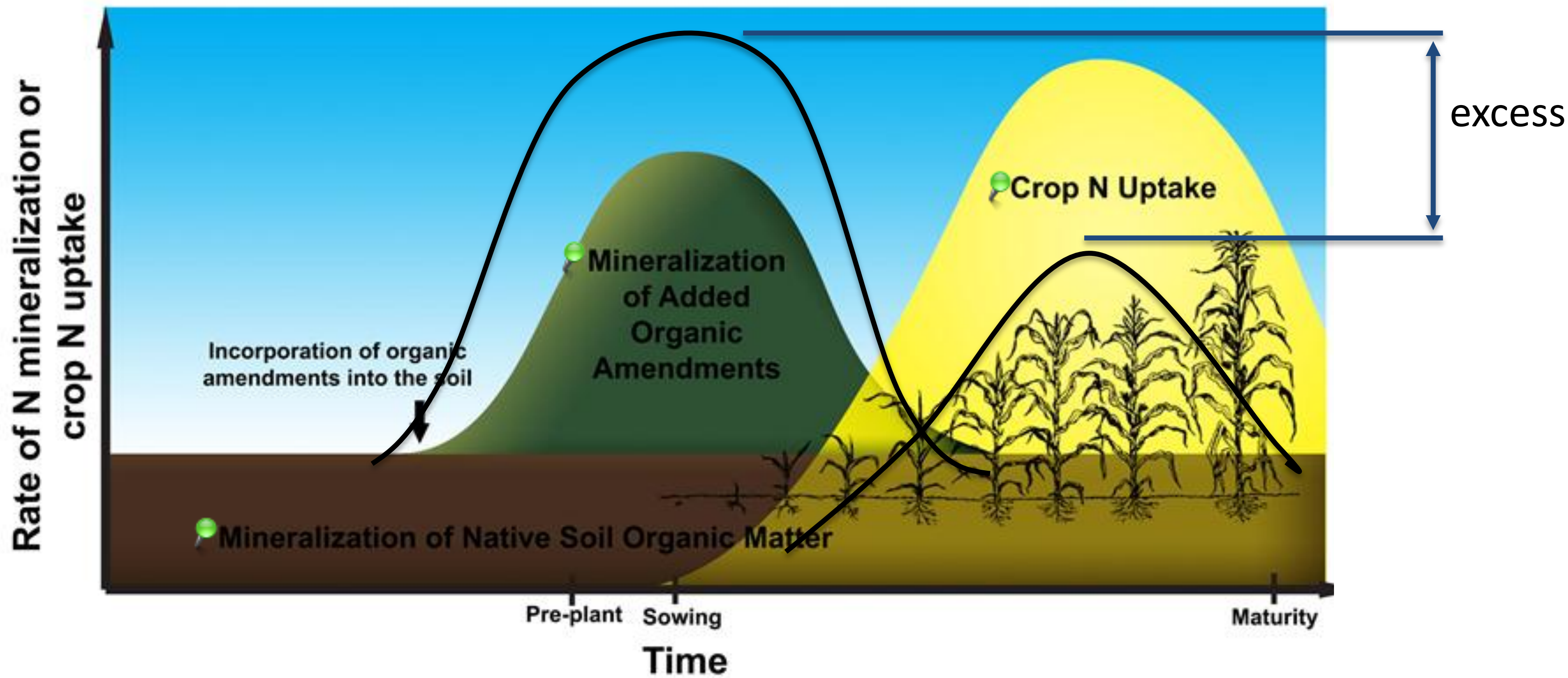
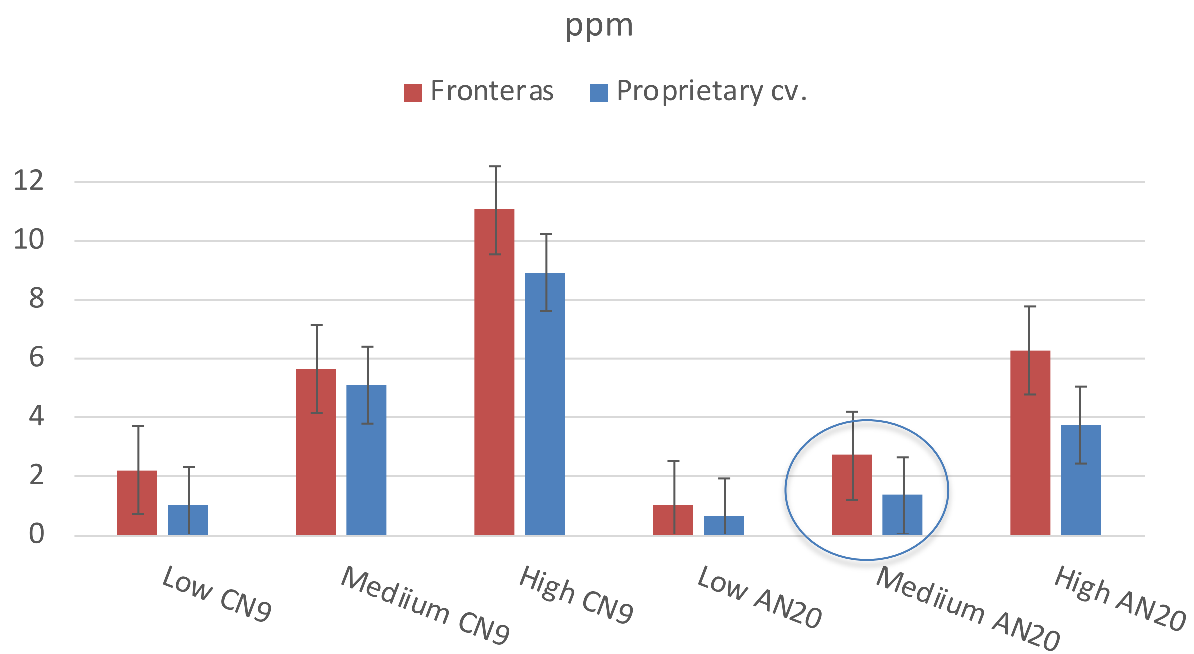
Organic Nitrogen Availability and Uptake



NO_3-N at 12-24 in depth



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Best practices for irrigation and fertilization can leverage production efficiency, yields and environmental sustainability.

Summary

- ✓ Sustainable irrigation and fertilization depend on the use of information and technology; creating local information is key.
- ✓ Irrigation: ET-based irrigation, soil moisture sensors and accurate crop coefficients.
- ✓ N fertilization: robust uptake curves, frequent soil analysis and adequate choice of fertilizer type.
- ✓ Sustainability depends on using the Right Rate and Right Time of water and fertilizers.

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- Hortau®

Questions/comments?

Thank you!

asbicaro@ucanr.edu
(805)645-1465