



Addressing Nitrogen Removal and Irrigation Requirements of Ventura County Vegetable Crops



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

Outline

- INM Plan and Report
- Applied vs Removed N
- N removal project
- A-R examples
- ET-based irrigation
- Irrigation app





IRRIGATION AND NUTRIENT MANAGEMENT PLAN (INMP)

Grower ID: _____ Management Unit ID: _____ Crop: _____ Total Acres: _____

SECTION 1: PRE-SEASON PLANNING		
Irrigation Management		Harvest Projection
1. Crop Evapotranspiration (ETc, inches)		4. Production Unit* (lbs, tons, etc.)
2. Anticipated Crop Irrigation (inches)		5. Projected Harvest Yield
3. Irrigation Water N Concentration (ppm or mg/L, as NO ³ -N)		
SECTION 2: NITROGEN MANAGEMENT		
	Recommended/Planned N (A)	Actual N (B)*
Applied Nitrogen Fertilizers		
7. Dry/Liquid Fertilizer N* (lbs/ac)		
8. Foliar Fertilizer N* (lbs/ac)		
Applied Organic Material N		
9. Organic Amendments* (Manure/Compost/Other, lbs/ac estimate)		
Applied Irrigation N		
10. N in Irrigation Water* (lbs/ac)		
Nitrogen Credits		
11. Soil – Available N in Root Zone (lbs/ac)		
Total Nitrogen Recommended/Applied		
12. TOTAL NITROGEN* (7+8+9+10) (lbs/ac)	Sum of boxes 7+8+9+10+11	Sum of boxes 7+8+9+10
SECTION 3: HARVEST YIELD		
13. Harvest Yield* (lbs./ton/etc.)/ac)	Same as box 5	

* (Bold Text) Actuals to be reported to VCAILG on the INMR.

Plan Certifier Initials

Irrigation and Nitrogen Management Plan

- Due March 1st 2025
- Kept on-farm

Irrigation and Nitrogen Management Report

- Due March 1st 2026
- Submit to VCAILG



IRRIGATION AND NUTRIENT MANAGEMENT REPORT (INMR)

Refer to your INMP Worksheet(s) for information to complete the INMR for each Management Unit (MU) ID. Duplicate pages if additional lines are needed.

GENERAL INFORMATION		
VCAILG ID #: _____ Form Completed By: _____ Crop Year: _____ Submittal Date: _____		
OUTLIER NOTIFICATION RECEIPT	ALTERNATIVE REPORTING	INMP CERTIFICATION METHOD
<p>Was the Member notified by the coalition last year that a Management Unit that they manage was identified as an outlier?</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	<p>Does the Member meet the alternative reporting qualifications for "A" only reporting?</p> <p><i>Refer to "A" Only Reporting Qualifications listed in INMP Worksheet Instructions.</i></p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	<p><input type="checkbox"/> Certified by Certified Crop Adviser or NRCS Technical Service Provider</p> <p><input type="checkbox"/> Self-Certified by Member who has completed the CDFA training program</p> <p><input type="checkbox"/> Self-Certified by Member who follows NRCS site-specific recommendations (documentation required)</p> <p><input type="checkbox"/> Certification not required (Member's total farming operation consist of ≤10 acres and has never been identified as an outlier)</p>

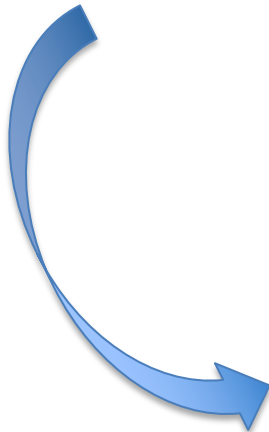
IRRIGATION AND NUTRIENT MANAGEMENT REPORT										
Complete the table below for each Management Unit (MU) for this membership. All values should be on a per-acre basis.										
MU ID	Crop	Crop Age	Total Irrigated Acres	Total N Applied Lbs/acre				Yield	Prod. Unit	Yield Info*
				N in Irrigation Water (lbs/acre) INMP Box 10b	Organic Amendments (lbs/acre) INMP Box 9b	Dry/Liquid Fertilizers (lbs/acre) INMP Box 7b	Foliar Fertilizers (lbs/acre) INMP Box 8b			
Refer to MU and Parcel Inventory		Perennial only (years)	(acres)							

* Use this column to provide information about yield i.e. nonbearing; crop not harvested, etc.

Applied vs Removed N

Applied:

- Fertilizers
- Organic amendments
- Irrigation water N



Other N sources:

- Residual soil N
- SOM mineralization



Goal: calculate the load of N that is left in the field following crop production

Removed:

all N that leaves the field with the produce (boxes)

Calculating Removed N, A/R Ratio and A-R Difference



Fresh Market Celery Removal Coefficient:

- 0.00106 (yield in lb/acre)

Yield (lb/acre) x 0.00106 = lb N removed/acre

78,000 lb/acre x 0.00106 = 82.7 lb N/acre

Example:

Applied 300 lb N/acre

Removed 82.7 lb N/acre

A-R = 217.3 lb N/acre

A/R = 3.6

Development of Nitrogen Removal Coefficients for Vegetable and Berry Crops

Richard Smith, Michael Cahn, Aparna Gazula, Andre Biscaro



Goal: establish crop coefficients for crops lacking this information

- ✓ 55 crops and crop products were sampled in commercial production fields between 2020 and 2023

Procedures (cont.)



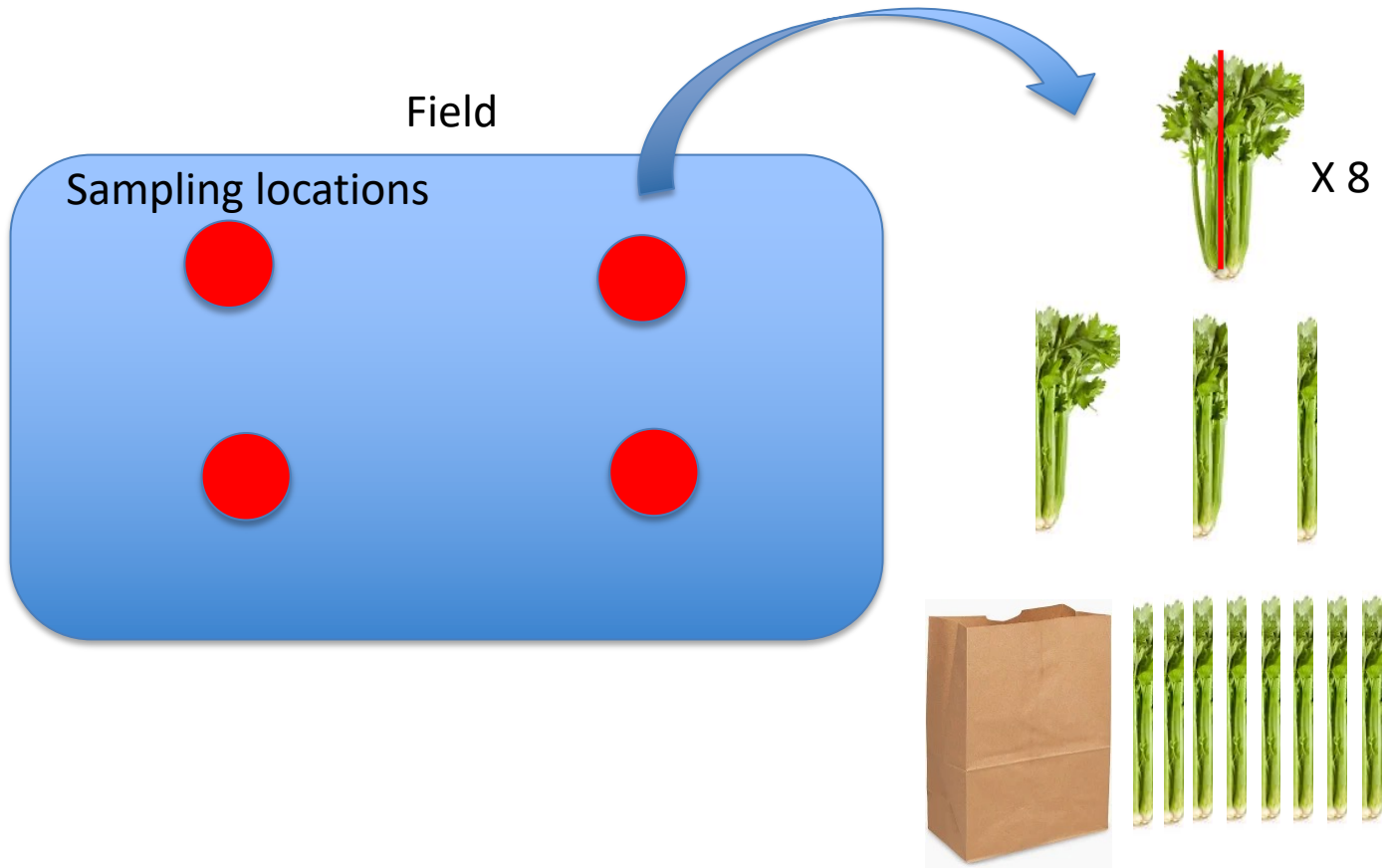
- ✓ An average of 15 fields were sampled per commodity and commodity type, with four samples collected per field at different locations throughout the field to account for site variability
- ✓ Each sample consisted of six to eight subsamples collected from the harvested produce.

Procedures (cont.)



- ✓ The fresh weight of each sample was taken in the field, and each sample oven dried and sent to the UC Davis Analytical Lab for total nitrogen analysis.
- ✓ Dry matter content and total nitrogen for each sample were used to calculate the removal coefficient.

Illustration of celery sampling:



Results

Commodity	Product	Pack type	mean coeff	min coeff	max coeff	mean %DM	min %DM	max %DM	mean %N	min %N	max %N	# fields sampled
A choy	Fresh Market	Carton	0.00269	0.00200	0.00422	5.72	4.23	9.85	4.76	3.43	5.52	15
Amaranth	Fresh Market	Carton	0.00613	0.00435	0.01483	10.97	7.69	26.97	5.62	4.4	6.1	15
Annual Artichoke	Fresh Market	Carton	0.00382	0.00344	0.00448	16.26	12.71	20.25	2.40	1.86	3.17	19
Arugula	Bulk	Bulk	0.00580	0.00507	0.00685	9.43	7.30	11.86	6.22	4.83	6.96	15
Beans, Green (Snap)	Fresh Market	Carton	0.00328	0.00285	0.00394	10.33	7.56	13.68	3.24	2.55	3.77	10
Beet (with tops)	Fresh Market	Carton	0.00305	0.00269	0.00344	11.06	8.51	12.48	2.79	2.28	3.91	15
Berries, black	Fresh Market	Carton	0.00223	0.00140	0.00294	15.16	12.57	17.55	1.48	0.98	2.05	30
Berries, blue	Fresh Market	Carton	0.00078	0.00020	0.00119	15.32	13.08	17.09	0.51	0.14	0.81	15
Berries, raspberry	Fresh Market	Carton	0.00180	0.00160	0.00208	13.64	11.60	16.21	1.33	1.02	1.55	29
Bok Choy, baby	Fresh Market	Carton	0.00209	0.00085	0.00344	3.57	1.88	5.33	5.73	4.24	6.58	15
Bok Choy, Full size	Fresh Market	Carton	0.00178	0.00148	0.00188	4.75	3.90	5.39	3.78	2.76	4.36	12
Broccoli	Fresh Market	Carton	0.00463	0.00390	0.00579	9.11	8.05	11.04	5.09	4.22	6.01	19
Broccolini	Fresh Market	Carton	0.00520	0.00433	0.00690	11.16	9.44	13.49	4.67	3.44	5.51	15
Brussels Sprout	Fresh Market	Carton	0.00628	0.00540	0.00790	14.08	13.11	15.75	4.47	3.71	5.44	21
Cabbage, Green	Bulk Cored	Bulk	0.00183	0.00125	0.00229	7.26	6.38	8.04	2.51	1.80	3.02	15
Cabbage, Green	Bulk Whole	Bulk	0.00173	0.00107	0.00225	7.34	6.48	8.36	2.37	1.38	3.01	16
Cabbage, Green	Fresh Market	Carton	0.00221	0.00161	0.00357	7.86	5.74	10.95	2.82	2.06	3.26	25
Cabbage, Red	Bulk Cored	Bulk	0.00205	0.00138	0.00257	8.92	8.25	9.62	2.30	1.47	2.70	15
Cabbage, Red	Fresh Market	Carton	0.00201	0.00155	0.00239	8.10	7.16	9.46	2.50	1.73	3.05	18
Cauliflower	Fresh Market	Carton	0.00283	0.00234	0.00339	7.06	6.07	8.01	4.02	3.49	4.93	28
Celery	Fresh Market	Carton	0.00106	0.00052	0.00144	4.99	3.57	6.64	2.19	0.99	3.03	16
Celery	Processing	Bulk	0.00100	0.00064	0.00128	4.51	3.49	6.74	2.34	0.95	3.13	7
Chinese Celery	Fresh Market	Carton	0.00301	0.00161	0.00418	7.12	6.16	8.59	4.24	2.48	5.65	15
Chayote tips	Fresh Market	Carton	0.00542	0.00311	0.00714	7.37	5.36	9.11	7.40	3.87	8.58	15
Cilantro	Clip	Bulk	0.00595	0.00449	0.00810	11.13	8.22	14.06	5.35	4.83	6.24	19
Cilantro	Bunch	Carton	0.00413	0.00250	0.00488	8.44	7.37	9.91	4.94	2.81	6.05	17
Cucumber	Fresh Market	Carton	0.00114	0.00088	0.00144	4.86	4.40	5.66	2.33	1.88	2.57	18
Endive	Fresh Market	Carton	0.00274	0.00216	0.00346	7.63	6.34	9.20	3.60	2.85	4.59	15
Escarole	Fresh Market	Carton	0.00242	0.00191	0.00292	6.67	5.65	7.61	3.64	3.15	4.41	15
Fennel	Fresh Market	Carton	0.00202	0.00132	0.00238	7.43	6.75	8.25	2.72	1.96	3.16	15
Flower, Gerbera	Fresh Market	Bunches	0.00325	0.00276	0.00478	13.24	11.05	14.80	2.46	2.05	3.62	22
Flower, Snapdragon	Fresh Market	Bunches	0.00239	0.00183	0.00314	10.76	8.61	15.45	2.27	1.52	2.97	15
Flower, Status	Fresh Market	Bunches	0.00327	0.00315	0.00341	27.64	25.48	29.75	1.20	1.10	1.26	3
Gai Choy	Fresh Market	Carton	0.00360	0.00294	0.00523	6.34	5.15	8.37	5.66	4.81	6.25	15
Gailan	Fresh Market	Carton	0.00425	0.00281	0.00575	8.52	5.43	12.96	5.14	4.34	6.04	15
Kale, Baby Lacinato	Bulk	Bulk	0.00705	0.00588	0.00878	11.30	9.40	14.06	6.24	5.57	6.68	15
Kale, Baby Curled Leaf	Bulk	Bulk	0.00631	0.00631	0.00631	10.82	10.82	10.82	5.84	5.84	5.84	1
Kale, Multi Pick	Fresh Market	Carton	0.00548	0.00405	0.00700	13.27	11.87	15.36	4.16	2.64	4.98	42
Leek	Bulk	Bulk	0.00235	0.00157	0.00357	10.82	9.53	11.94	2.17	1.47	3.21	12
Leek	Fresh Market	Carton	0.00213	0.00164	0.00245	12.91	11.63	15.20	1.71	1.08	2.10	3
Leek	Mean	Mean	0.00231	0.00157	0.00357	11.24	9.53	15.20	2.08	1.08	3.21	15

Results (cont.)

Commodity	Product	Pack type	mean coeff	min coeff	max coeff	mean %DM	min %DM	max %DM	mean %N	min %N	max %N	# fields sampled
Lettuce, Baby Green	Bulk	Bulk	0.00338	0.00236	0.00469	6.80	4.98	9.17	4.98	3.60	5.87	21
Lettuce, Baby Red	Bulk	Bulk	0.00356	0.00260	0.00546	6.97	5.20	9.13	5.11	4.36	6.12	23
Lettuce, Butter	Fresh Market	Carton	0.00199	0.00155	0.00266	5.70	4.53	6.72	3.50	2.87	4.05	20
Lettuce, Green Leaf	Fresh Market	Carton	0.00207	0.00148	0.00283	6.80	5.73	7.96	3.06	2.25	3.71	20
Lettuce, Iceberg	Bulk Cored	Bulk	0.00120	0.00099	0.00160	4.02	3.58	4.89	2.99	2.62	3.55	20
Lettuce, Iceberg	Fresh Market	Film Wrap	0.00127	0.00108	0.00168	4.31	3.73	5.13	2.95	2.52	3.80	19
Lettuce, Iceberg	Fresh Market	Naked	0.00129	0.00102	0.00161	4.32	3.77	5.02	2.98	2.46	3.38	21
Lettuce, Iceberg	Mean		0.00125	0.00103	0.00163	4.22	3.69	5.01	2.97	2.53	3.58	60
Lettuce, Red Leaf	Fresh Market	Carton	0.00224	0.00191	0.00307	5.81	5.03	6.99	3.85	3.32	4.41	20
Lettuce, Romaine	Bulk Tops & Tails	Bulk	0.00152	0.00135	0.00189	4.97	4.53	5.52	3.06	2.78	3.43	5
Lettuce, Romaine	Bulk Whole	Bulk	0.00149	0.00136	0.00166	4.91	4.21	5.84	3.06	2.70	3.50	15
Lettuce, Romaine	Mean bulk	Bulk	0.00150	0.00135	0.00189	4.93	4.21	5.84	3.06	2.70	3.50	20
Lettuce, Romaine	Fresh Market	Carton	0.00184	0.00137	0.00247	5.92	5.02	7.59	3.11	2.39	3.71	20
Lettuce, Romaine	Hearts	Carton	0.00188	0.00114	0.00239	5.71	4.29	7.50	3.33	1.64	3.87	21
Lettuce, Romaine	Mean F. Market	Carton	0.00186	0.00125	0.00243	5.81	4.66	7.54	3.22	2.02	3.79	41
Malabar spinach	Fresh Market	Carton	0.00240	0.00147	0.00309	6.71	5.13	9.04	3.69	1.72	5.19	15
Mizuna	Bulk	Bulk	0.00548	0.00454	0.00646	8.97	6.83	10.25	6.19	4.57	7.24	5
Napa Cabbage	Fresh Market	Carton	0.00181	0.00148	0.00212	5.00	4.49	5.90	3.67	2.51	4.73	12
Onion, Dry Red	Bulk	Bulk	0.00126	0.00090	0.00222	11.61	10.62	12.67	1.07	0.80	1.75	16
Onion, Dry Yellow	Bulk	Bulk	0.00164	0.00125	0.00207	11.10	9.81	13.26	1.47	1.21	1.65	15
Parsley, Curly	Fresh Market	Carton	0.00440	0.00325	0.00529	13.88	10.35	16.97	3.28	1.92	4.22	8
Parsley, Italian	Fresh Market	Carton	0.00436	0.00382	0.00499	13.23	9.24	16.26	3.39	2.63	4.38	8
Parsley, All	Mean F. Market	Mean	0.00438	0.00325	0.00529	13.56	9.24	16.97	3.33	1.92	4.38	16
Pea, Edible Pod	Fresh Market	Carton	0.00472	0.00415	0.00526	12.74	11.57	13.76	3.70	3.52	3.88	15
Pea tips	Fresh Market	Carton	0.00727	0.00332	0.00902	11.75	5.43	16.60	6.28	5.27	8.02	15
Pepper, Red Bell	Fresh Market	Carton	0.00194	0.00181	0.00203	8.99	8.87	9.14	2.15	2.04	2.21	3
Radicchio	Bulk	Bulk	0.00216	0.00214	0.00219	6.55	6.52	6.58	3.31	3.28	3.33	2
Radicchio	Fresh Market	Carton	0.00235	0.00211	0.00295	6.96	6.41	7.68	3.40	2.81	4.47	13
Radicchio	Mean	Mean	0.00233	0.00211	0.00295	6.91	6.41	7.68	3.39	2.81	4.47	15
Radish, Red (no tops)	Bulk	Bulk	0.00167	0.00126	0.00213	5.83	5.01	7.17	2.86	2.29	3.23	15
Radish, Red (with tops)	Fresh Market	Carton	0.00248	0.00215	0.00262	6.34	5.73	7.46	3.93	3.30	4.41	15
Rapini	Fresh Market	Carton	0.00605	0.00544	0.00695	9.97	8.86	10.85	6.08	5.45	6.81	15
Shallot	Bulk	Bulk	0.00241	0.00159	0.00339	19.99	19.17	21.20	1.20	0.76	1.66	16
Spinach, Clip	Bulk	Bulk	0.00484	0.00388	0.00702	8.12	6.63	11.18	5.97	5.30	6.40	21
Squash Crookneck	Fresh Market	Carton	0.00182	0.00182	0.00182	7.01	7.01	7.01	2.59	2.59	2.59	1
Squash Zucchini	Fresh Market	Carton	0.00191	0.00163	0.00251	5.80	5.09	6.57	3.31	2.70	4.02	18
Tong Ho	Fresh Market	Carton	0.00344	0.00194	0.00553	6.94	5.50	9.26	4.97	3.53	6.46	15
Water Spinach (Ong Choy)	Fresh Market	Carton	0.00350	0.00241	0.00502	7.25	5.29	9.58	4.91	2.97	6.38	15
Yam Leaves	Fresh Market	Carton	0.00510	0.00353	0.00607	10.35	8.75	13.37	4.98	3.15	5.79	15
Yu choy	Fresh Market	Carton	0.00352	0.00192	0.00535	6.71	4.08	9.47	5.21	4.47	5.82	15

Example:

Commodity	Product	Pack type	mean coeff	min coeff	max coeff	mean %DM	min %DM	max %DM	mean %N	min %N	max %N	# fields sampled
Lettuce, Baby Green	Bulk	Bulk	0.00338	0.00236	0.00469	6.80	4.98	9.17	4.98	3.60	5.87	21

Calculating Removed N, A/R and A-R



Fresh Market Celery Removal Coefficient:

- 0.00106 (yield in lb/acre)

Yield (lb/acre) x 0.00106 = lb N removed/acre

78,000 lb/acre x 0.00106 = 82.7 lb N/acre

Example 1:

Applied 300 lb N/acre

Removed 82.7 lb N/acre

A-R = 217.3 lb N/acre

A/R = 3.6

Example 2:

Applied 200 lb N/acre

Removed 82.7 lb N/acre

A-R = 117.3 lb N/acre

A/R = 2.4

Example 3:

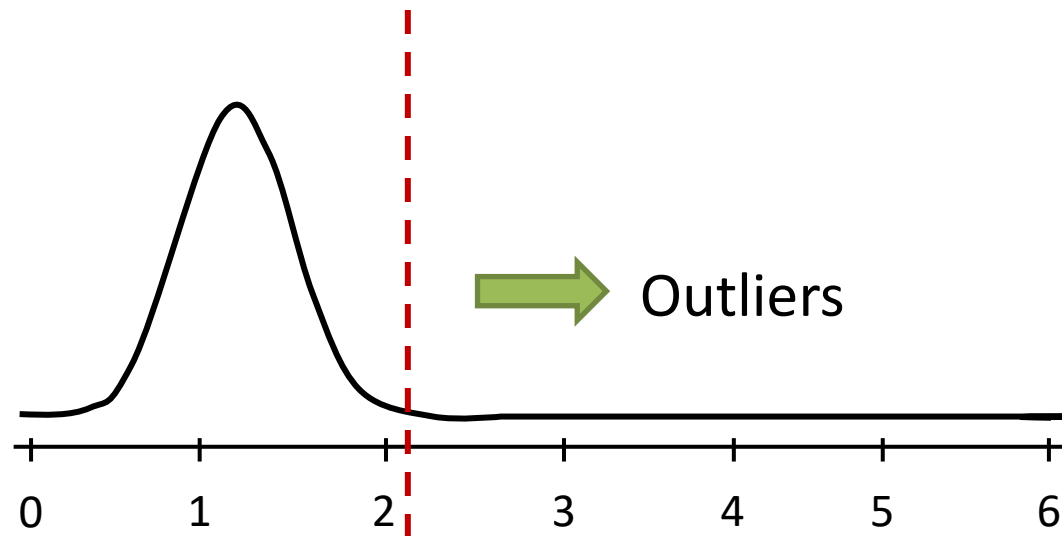
Applied 400 lb N/acre

Removed 82.7 lb N/acre

A-R = 317.3 lb N/acre

A/R = 4.8

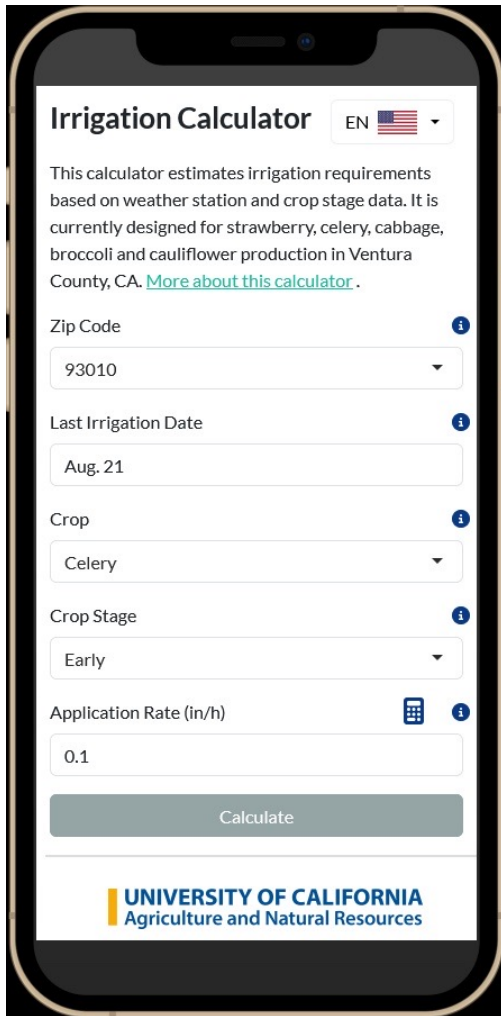
Outlier Threshold



A/R or A-R Values above the Threshold are Outliers

Summary

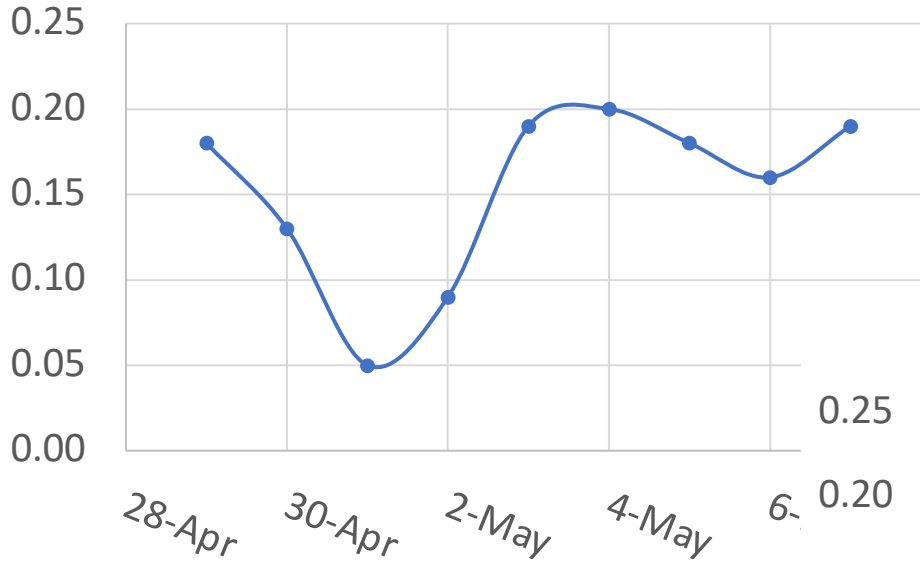
- ✓ N removal coefficients were developed for over 55 vegetable and berry crops and crop products
- ✓ Coefficients are under review by the Regional Water Board
- ✓ The parameters for determining A-R outliers haven't been defined yet
- ✓ Start reviewing and optimizing your N fertilization asap
- ✓ Please reach out with any questions about these coefficients and related calculations



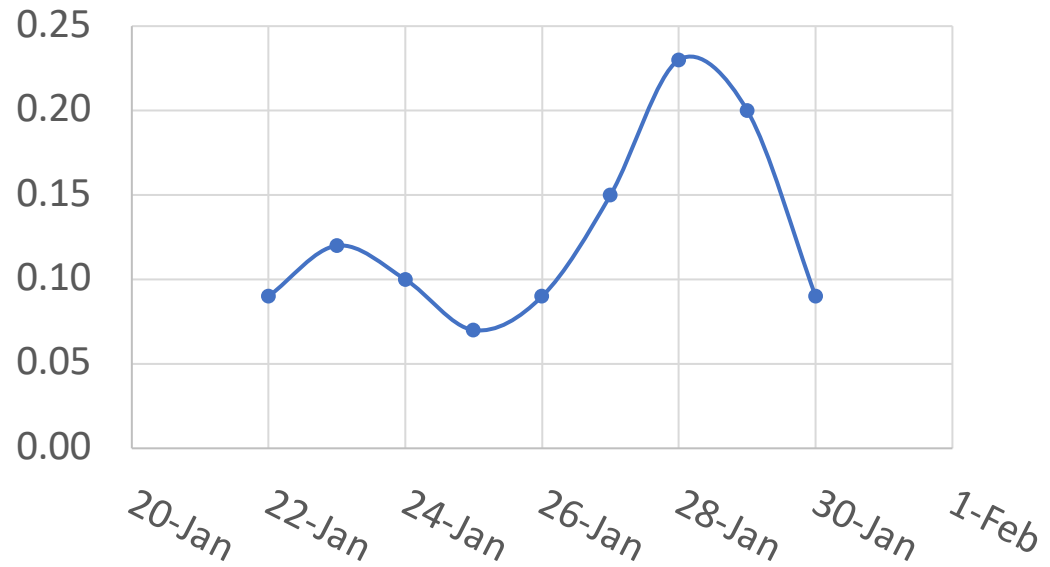
Developing of an Irrigation App to Improve Decisions for Optimal Water Use

Why is irrigation scheduling challenging?

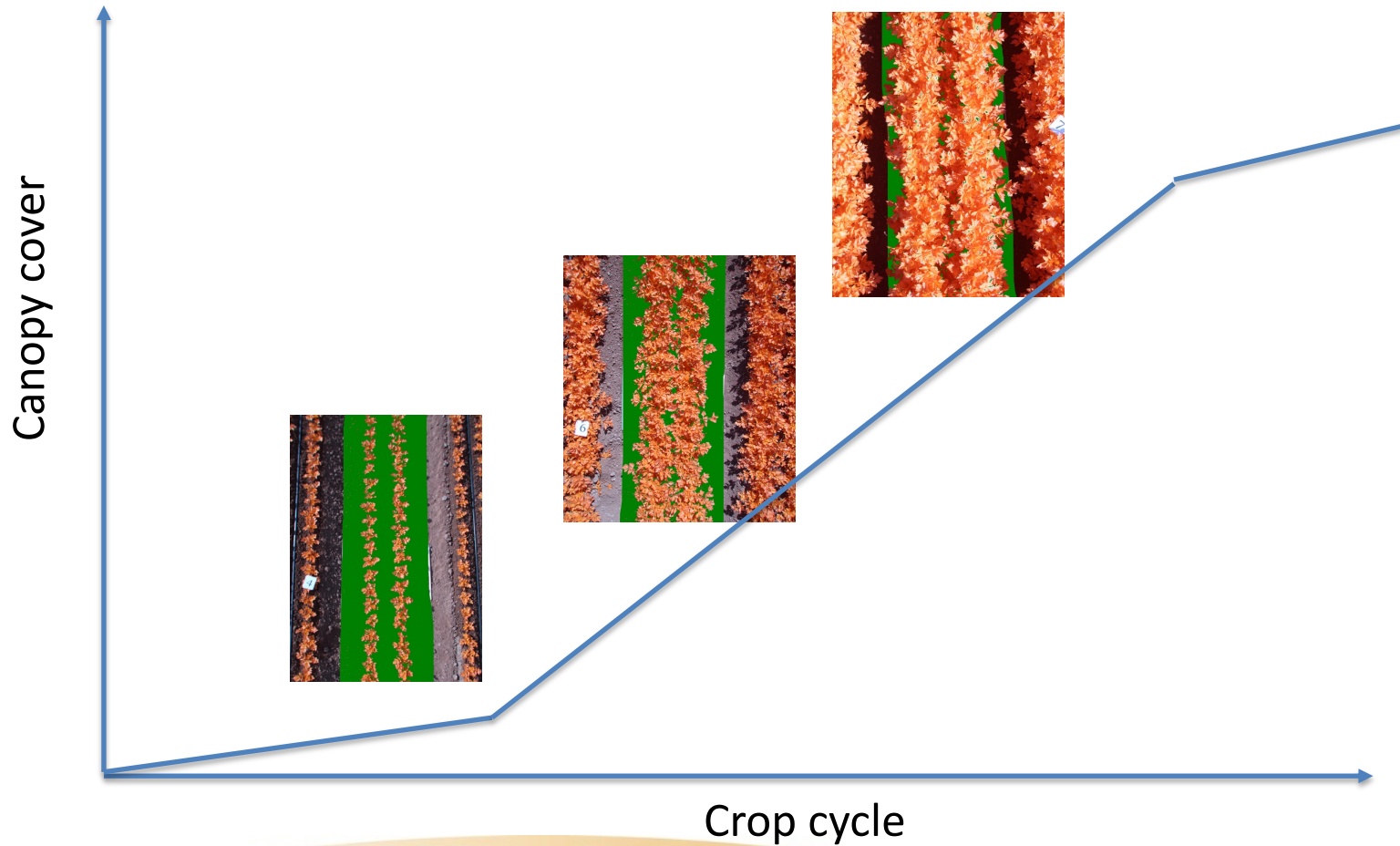
Daily ETo (in) - Camarillo



Daily ETo (in) - Camarillo

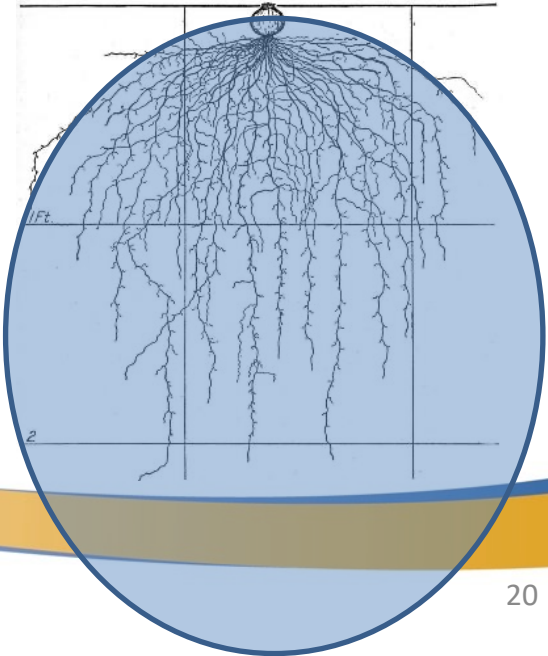
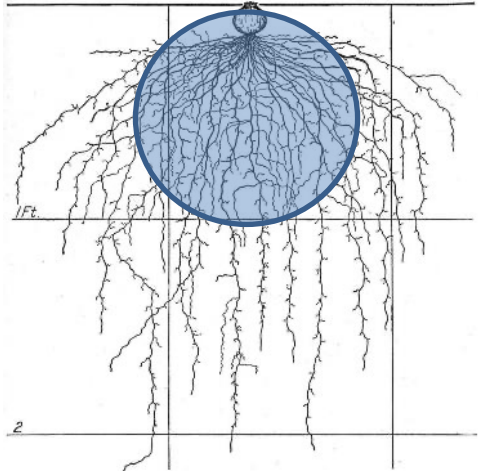
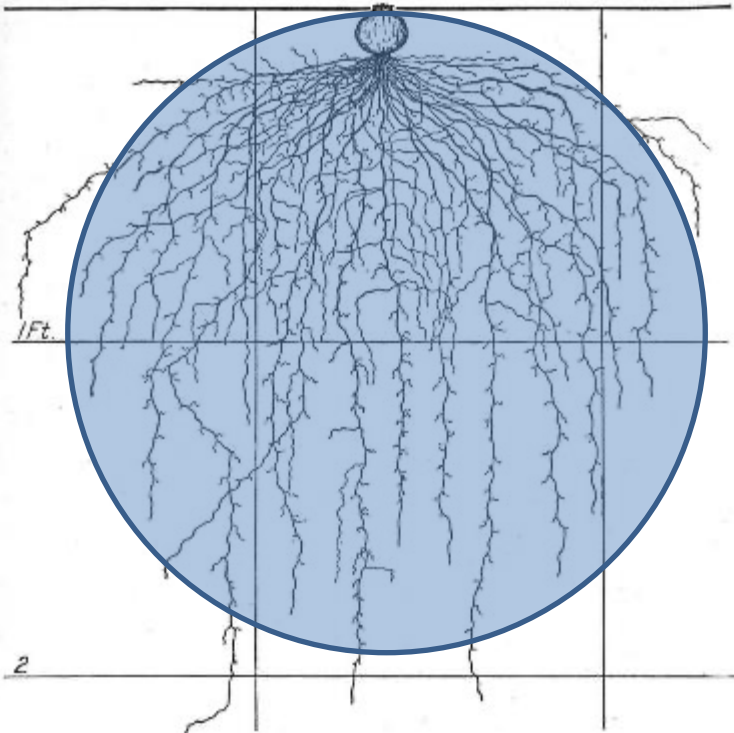


Crop water demand changes according to canopy and weather



Inefficient irrigation

Ideal irrigation



ET-Based Irrigation

Kc (varies with different canopy cover)

ET_o



x

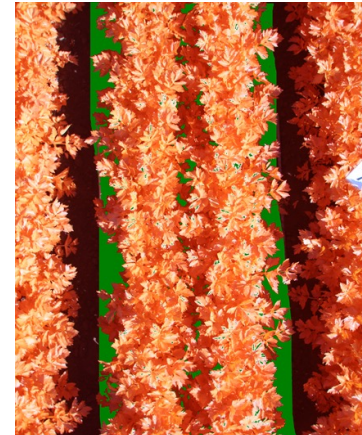
20%



60%



90%



Irrigation
Recommendation

Basic equation: $ET_c = ET_o * K_c$

ET_c = Crop evapotranspiration

ET_o = Reference evapotranspiration

K_c = Crop coefficient

Accounting for distribution uniformity
and leaching fraction:

$$ET_c = ((ET_o * K_c) / (DU/100)) / (1 - LF/100)$$

DU = Distribution uniformity

LF = Leaching fraction

Smarter Decisions. Better Yields.

Based on years of in-depth research and field studies conducted by the University of California, CropManage provides real-time recommendations for the most efficient, effective, and sustainable irrigation and fertilization applications possible.

Sign Up

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's production—and increase your overall confidence.



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

CropManage is ground-truthed in more than 30 field trials and has produced consistent, or in many cases, improved crop yields.



Supports Irrigation AND Fertilization Recommendations

CropManage combines irrigation and fertilization recommendations that, when used together, significantly improve yields while reducing costs.



<https://cropmanage.ucanr.edu/>

Irrigation Calculator EN

This calculator estimates irrigation requirements based on weather station and crop stage data. It is currently designed for strawberry, celery, cabbage, broccoli and cauliflower production in Ventura County, CA. [More about this calculator](#) .

Zip Code 93010

Last Irrigation Date Aug. 21

Crop Celery

Crop Stage Early

Application Rate (in/h) 0.1

Calculate

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

English or Spanish

Chooses the weather station

Collects reference evapotranspiration data since last irrigation

Adjusts the crop coefficient

Converts volume to time

- ✓ Distribution Uniformity: 85%
- ✓ Leaching Fraction: 10%

Example:

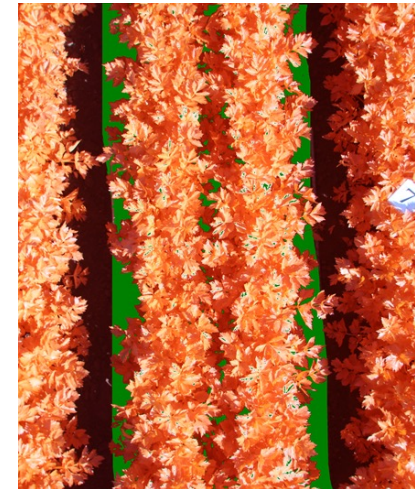
Last irrigation on March 4

Date	ET _o (in)
3/4/25	0.12
3/5/25	0.01
3/6/25	0.07
3/7/25	0.12
total	0.32

K_c = 0.3



K_c = 0.95



$$ET_c = 0.32 * 0.3 = 0.1 \text{ in}$$

$$ET_c = 0.32 * 0.95 = 0.3 \text{ in}$$

DU = 90%
LF = 10%

$$ET_c = (0.1 * 1.1) * 1.1 \\ = 0.12 \text{ in}$$

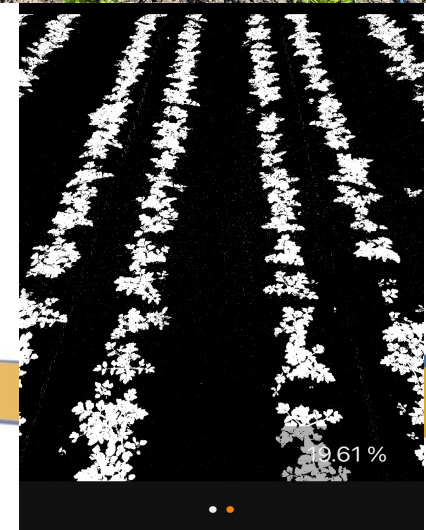
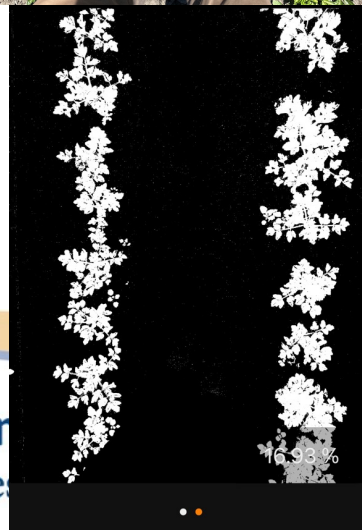
$$ET_c = (0.3 * 1.1) * 1.1 \\ = 0.36 \text{ in}$$

Canopy estimations using the Canopeo app

17.8%

16.9%

19.6%





<https://canopeoapp.com>

Summary

- ✓ Currently beta-testing at celery commercial fields (Duda and Deardorff Family Farms)
- ✓ Avocado Commission grant; beta-testing coming soon.
- ✓ Anticipated outcomes:
 - Increased adoption of data-driven management
 - Improved water use efficiency

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- Thelma Hansen Funds
- Cooperating growers

Questions/comments?

asbicaro@ucanr.edu

(805)645-1465