

Irrigation and Nitrogen Management Web-Based Software for Lettuce Production



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Acknowledgements

- California Department of Food and Agriculture, Fertilizer Research and Education Program
- UC ANR Communication Services
- Grower participants
- Chiquita FreshExpress

Nitrate is part of CA Central Coast Agricultural Water Quality Regulations

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD CENTRAL COAST REGION

ORDER NO. R3-2012-0011

CONDITIONAL WAIVER OF WASTE DISCHARGE FOR DISCHARGES FROM IRRIGATED LANDS

The California Regional Water Quality Control Board finds that:

1. The Central Coast Region has approximately 435,000 acres of agricultural land, with approximately 3000 agricultural operations, which may discharge waste that falls into the category of discharges of waste from irrigated lands.
2. The Central Coast Region has more than 17,000 miles of streams/rivers) and approximately 4000 square miles of agricultural land, or may be, affected by discharges of waste from irrigated lands.
3. The State Water Resources Control Board (State Water Resources Control Board) and Regional Water Quality Control Boards (Regional Water Boards) are the primary entities with primary responsibility for the coordination and control of discharges to the Porter-Cologne Water Quality Control Act (Porter-Cologne Act, Water Code Division 7). The legislature, in the Porter-Cologne Act, has authorized the State Water Board to exercise its full power and jurisdiction to protect the waters in the State from degradation, considering

TIER 3

DISCHARGERS ENROLLED UNDER THE CONDITIONAL WAIVER OF WASTE DISCHARGE REQUIREMENTS FOR DISCHARGES FROM IRRIGATED LANDS

This Monitoring and Reporting Program Order No. R3-2012-0011-03 (MRP) is issued pursuant to California Water Code (Water Code) section 13267 and 13269, which authorize the California Regional Water Quality Control Board, Central Coast Region (hereafter Central Coast Water Board) to require preparation and submittal of technical and monitoring reports. Water Code section 13269 requires a waiver of waste discharge requirements to include as a condition, the performance of monitoring and the public availability of monitoring results. The Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands Order No. R3-2012-0011 (Order) includes criteria and requirements for three tiers. This MRP sets forth monitoring and reporting requirements for **Tier 3 Dischargers** enrolled under the Order. A summary of the requirements is shown below.

SUMMARY OF MONITORING AND REPORTING REQUIREMENTS FOR TIER 3:

- Part 1: Surface Receiving Water Monitoring and Reporting (*cooperative or individual*);
- Part 2: Groundwater Monitoring and Reporting;
Nitrate Loading Risk Factor Determination and Total Nitrogen Reporting (*required for subset of Tier 3 Dischargers if farm/ranch has high nitrate loading risk to groundwater*);
- Part 3: Annual Compliance Form;
- Part 4: Photo Monitoring (*required for subset of Tier 3 Dischargers if farm/ranch contains or is adjacent to a waterbody impaired for temperature, turbidity or sediment*);
- Part 5: Individual Surface Water Discharge Monitoring and Reporting;
- Part 6: Irrigation and Nutrient Management Plan (*required for subset of Tier 3 Dischargers if farm/ranch has High Nitrate Loading Risk*);
- Part 7: Water Quality Buffer Plan (*required for subset of Tier 3 Dischargers if farm/ranch contains or is adjacent to a waterbody impaired for temperature, turbidity or sediment*);

Change in Nitrate Concentration 1993 to 2007 (Nitrate as NO₃)

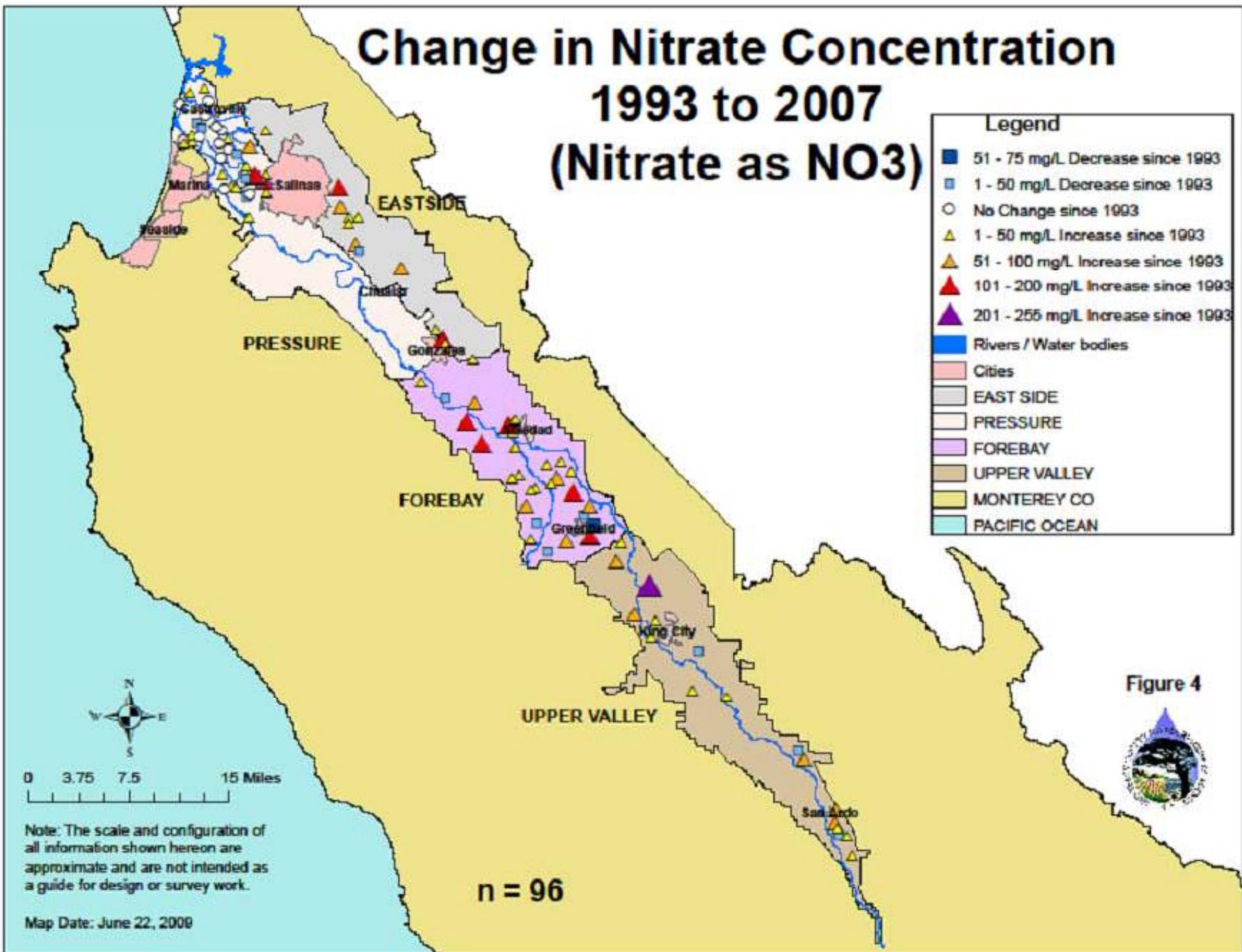
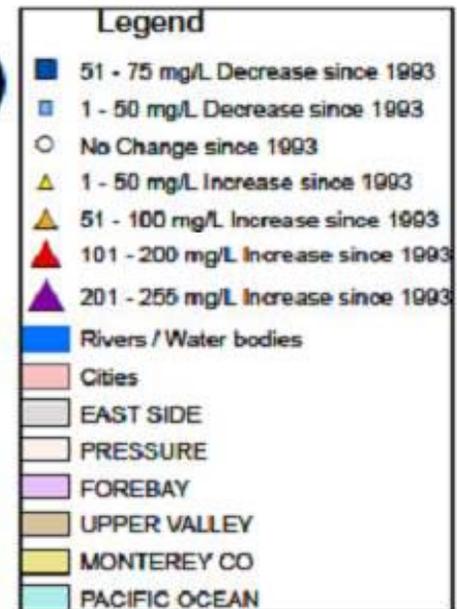


Figure 4



Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for design or survey work.

Map Date: June 22, 2009



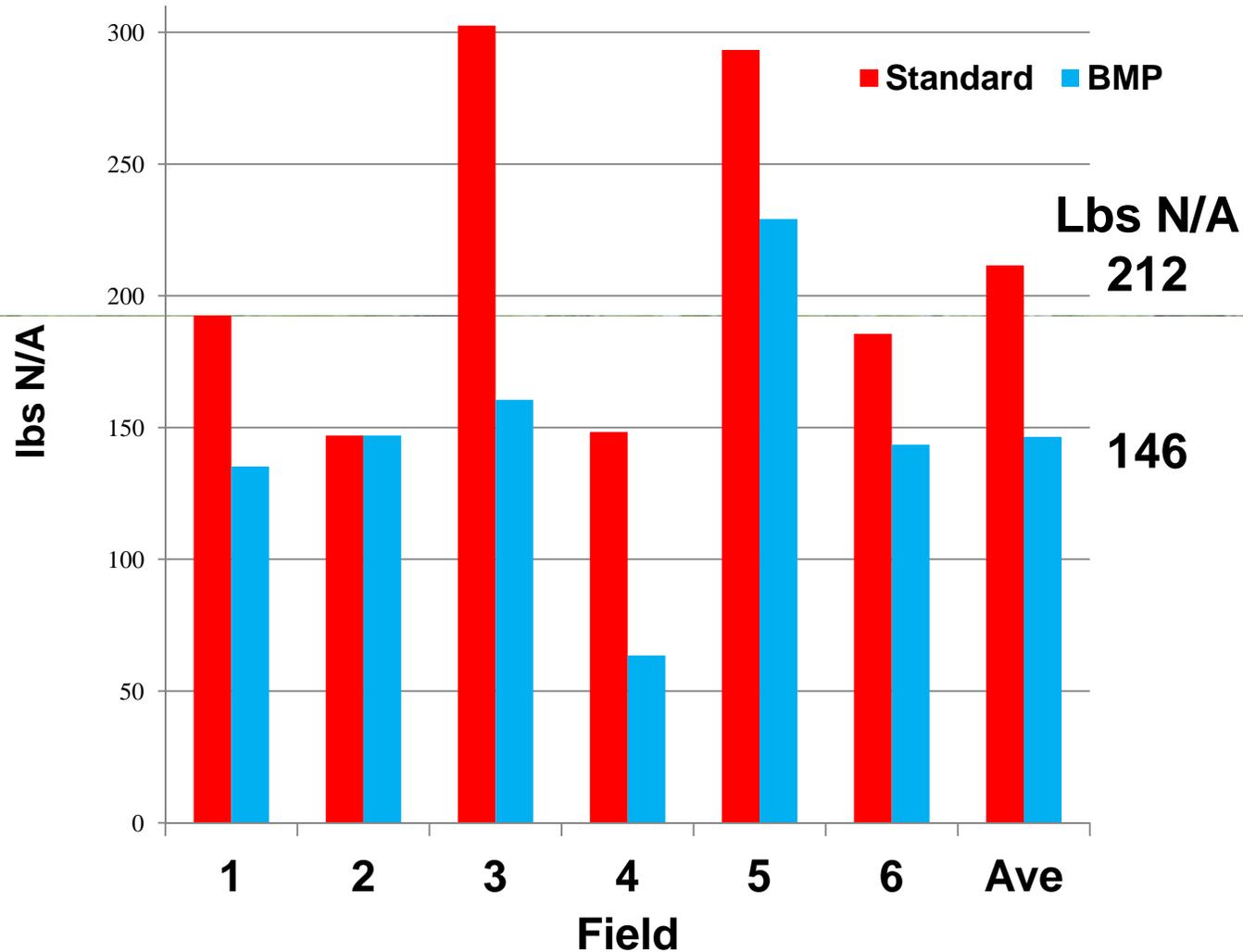
- **regulatory compliance will require management changes**
 - ✓ use nitrogen fertilizer more efficiently
 - ✓ account for all sources contributing to crop uptake of N
 - ✓ improve irrigation management
 - ✓ record keeping and reporting
 - ✓ document improvements in water quality

Tools for Managing Water and Nitrogen Fertilizer in Lettuce

- Quick nitrate soil test
(20 ppm $\text{NO}_3\text{-N}$ = 70 to 80 lbs of N/acre/ft)
- Weather-based irrigation scheduling



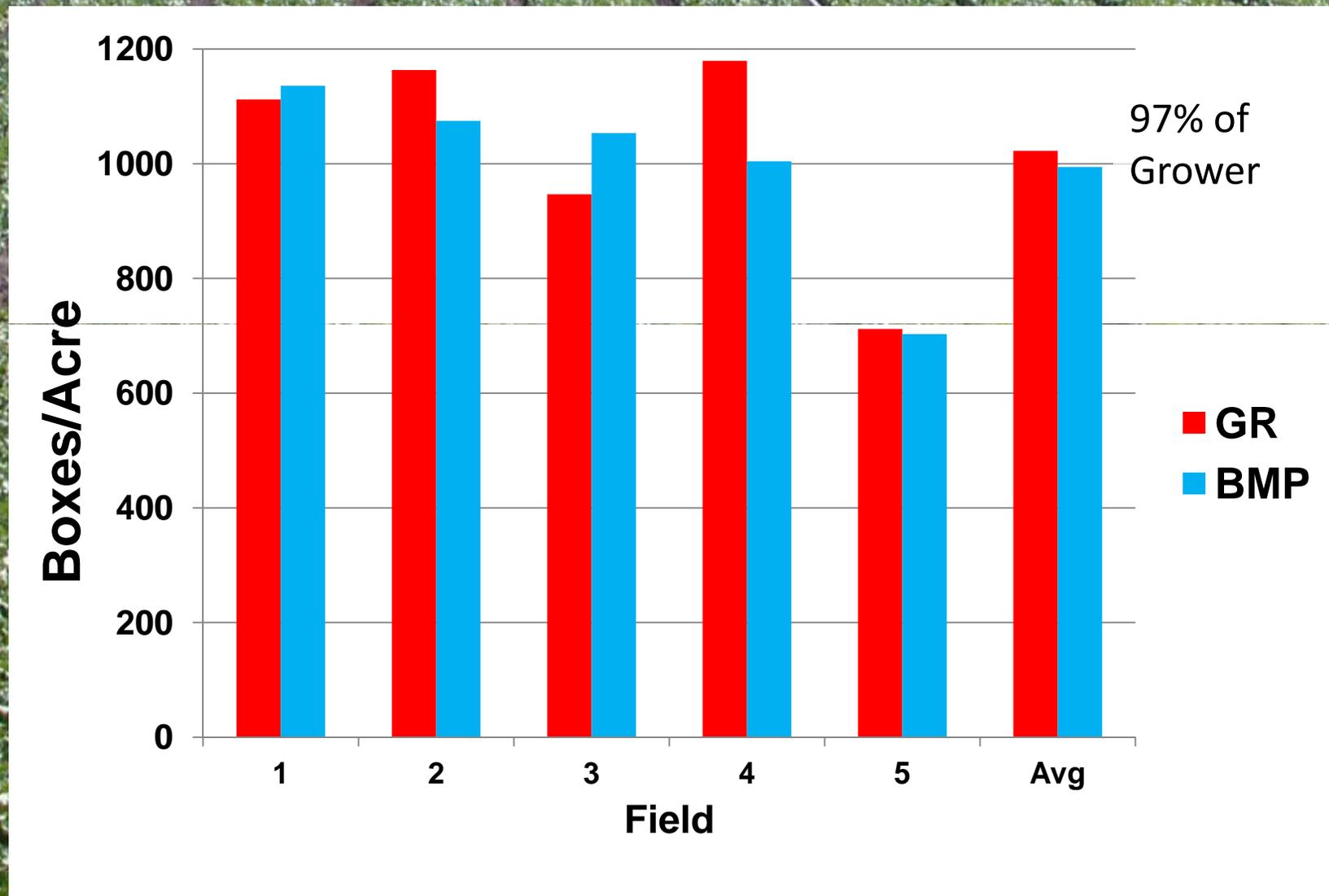
Commercial Lettuce Nitrogen Fertilizer Trials



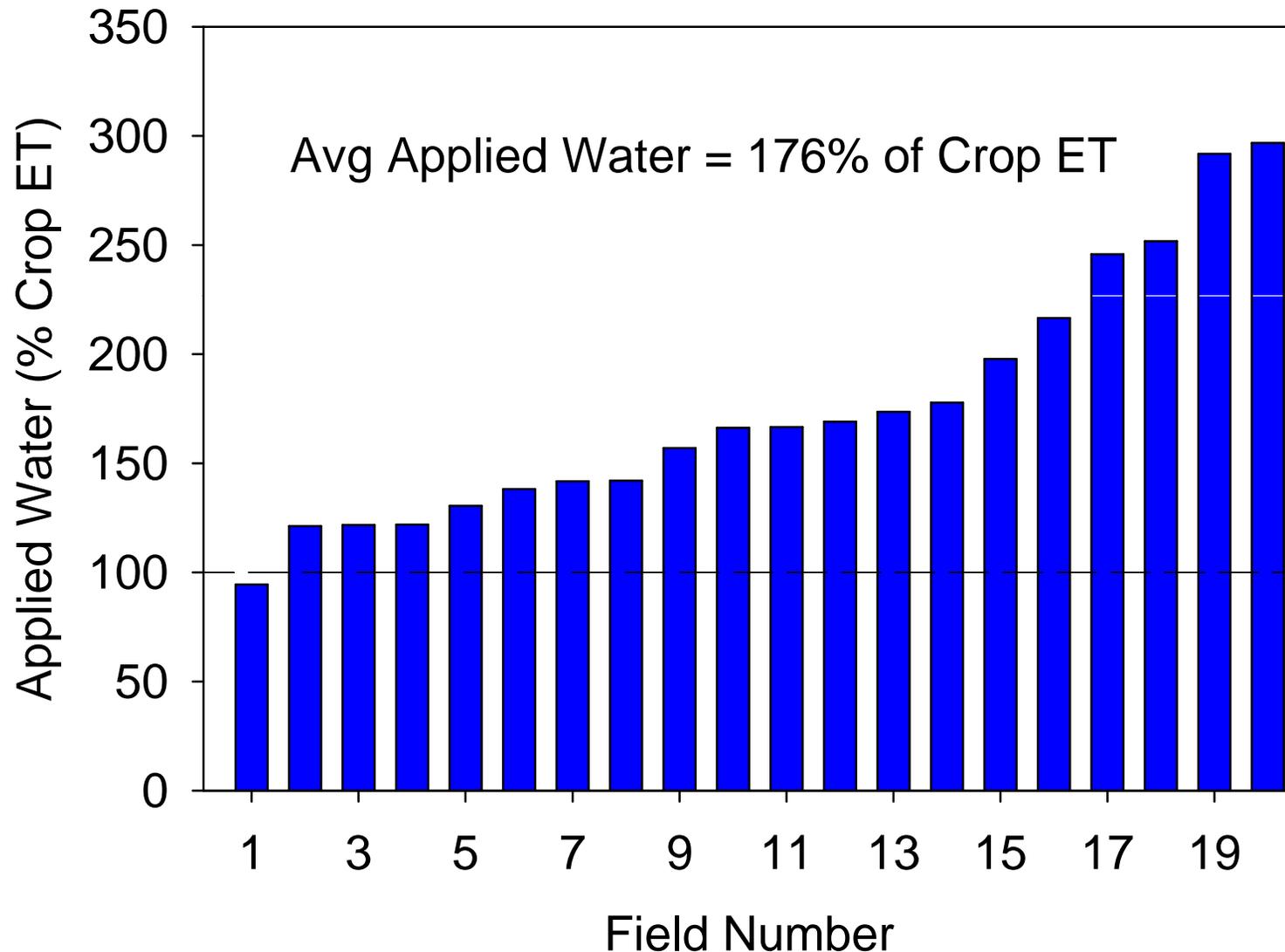
Difference
66 lbs/A

@ 0.60/lb N
=\$40/A

Commercial Yield



Applied Water as Percentage of Crop ET (Lettuce)

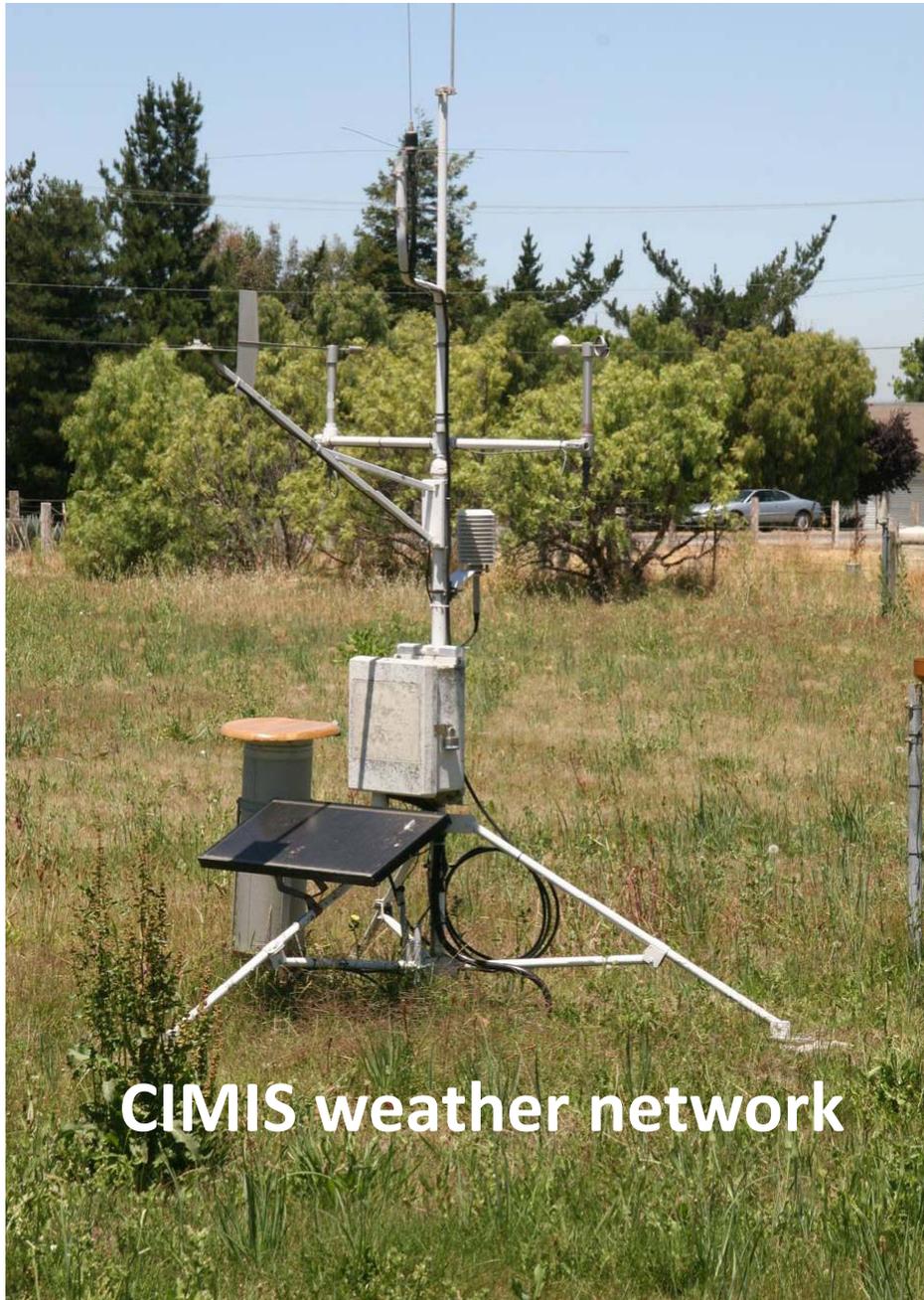


Irrigation Trials in Lettuce

Trial Site	Standard	Weather - based	Estimated Crop ETc (inches)	Irrigation requirement ¹ (inches)	Water use reduction (%)
	Total Applied Water (inches)				
King City	17.7	14.7	10.1	13.4	17
S. Salinas	9.9	8.7	7.6	8.9	12
San Ardo	19.4	11.9	6.7	8.7	39
N. Salinas	10.7	10.4	7.0	8.4	3
S. Salinas 2	10.9	10.1	6.1	7.6	7
Average	13.7	11.2	7.5	9.4	16

1. Irrigation requirement = ETc/distribution uniformity

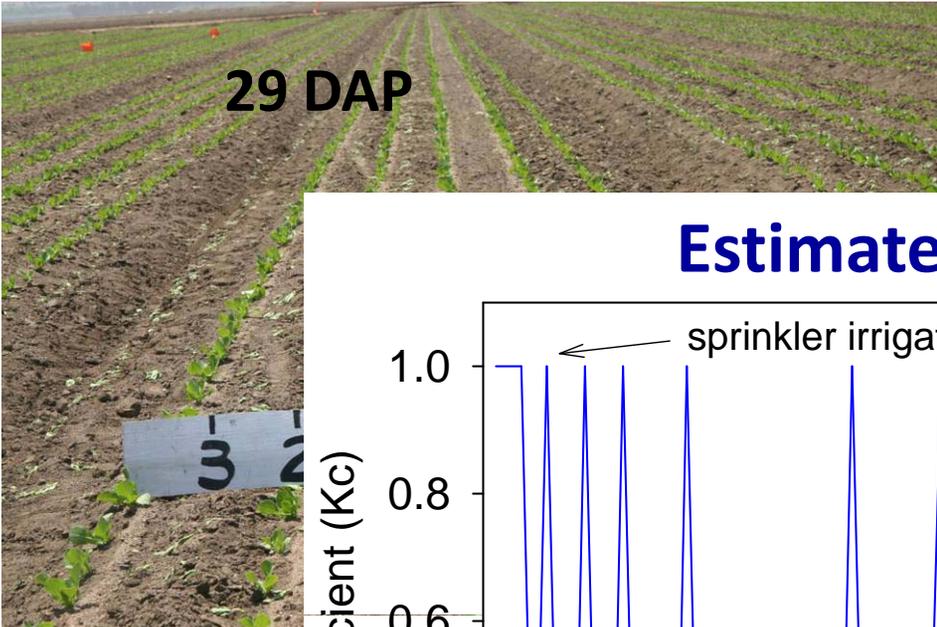
Weather-based Irrigation Scheduling



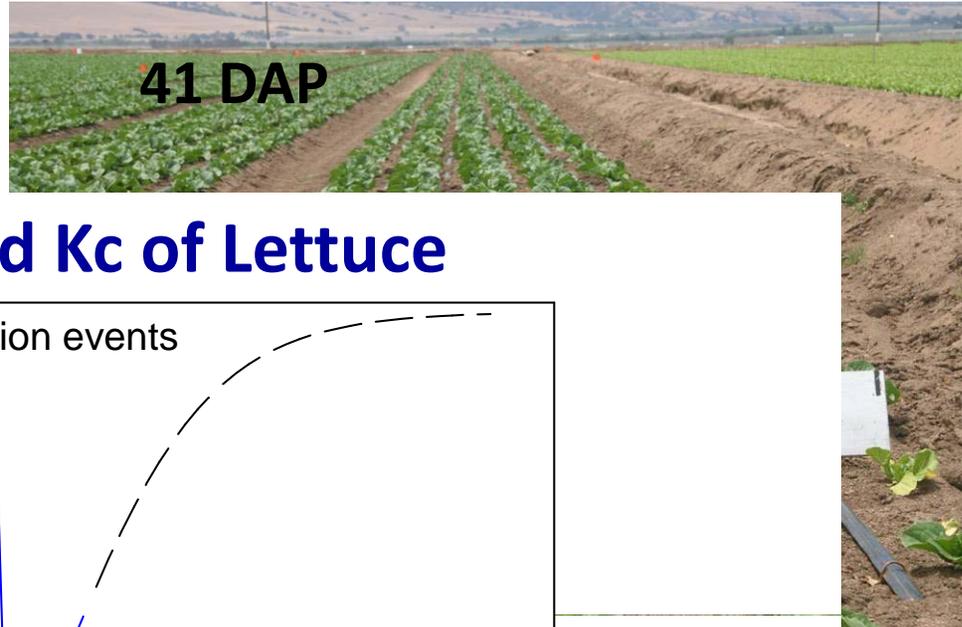
Converting Reference ET to
Crop ET:

$$ET_{\text{crop}} = ET_{\text{ref}} \times K_{\text{crop}}$$

K_c can vary from 0.1 to 1.2



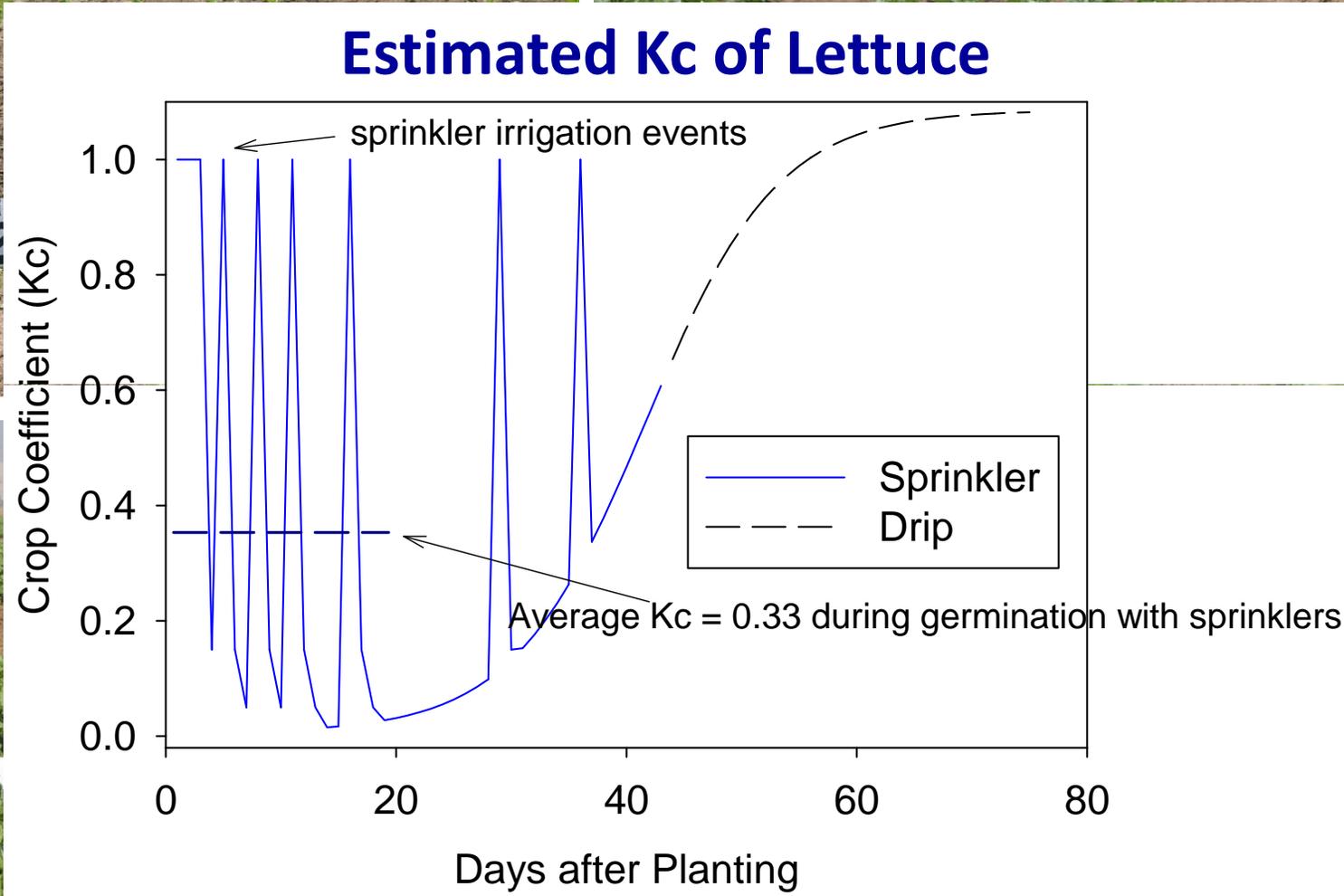
29 DAP



41 DAP



47 DAP



Other factors for determining an irrigation schedule:

- **Soil water holding capacity**
- **Crop rooting depth**
- **Irrigation system application rate**
- **Irrigation system application uniformity**
- **Leaching fraction (water salinity)**
- **Crop development stage**

How can water and N management tools be useful for large vegetable growing operations?

- 
- A photograph of a large-scale vegetable growing operation. The image shows long, straight rows of young green plants in a field. White plastic mulch is visible between the rows. In the background, there are trees and a white car parked on a dirt road. The sky is overcast.
- Large growing operations have multiple decision makers
 - One farm manager may be responsible for >200 fields during a season
 - Other responsibilities besides water and fertilizer N management

Web-based Irrigation and N management software for lettuce

<https://ucanr.org/cropmanage>

CropManage



Login

To login enter your e-mail and password below.

E-mail Address

Password

Login

[Forgot Password](#)

[Create New Account](#)

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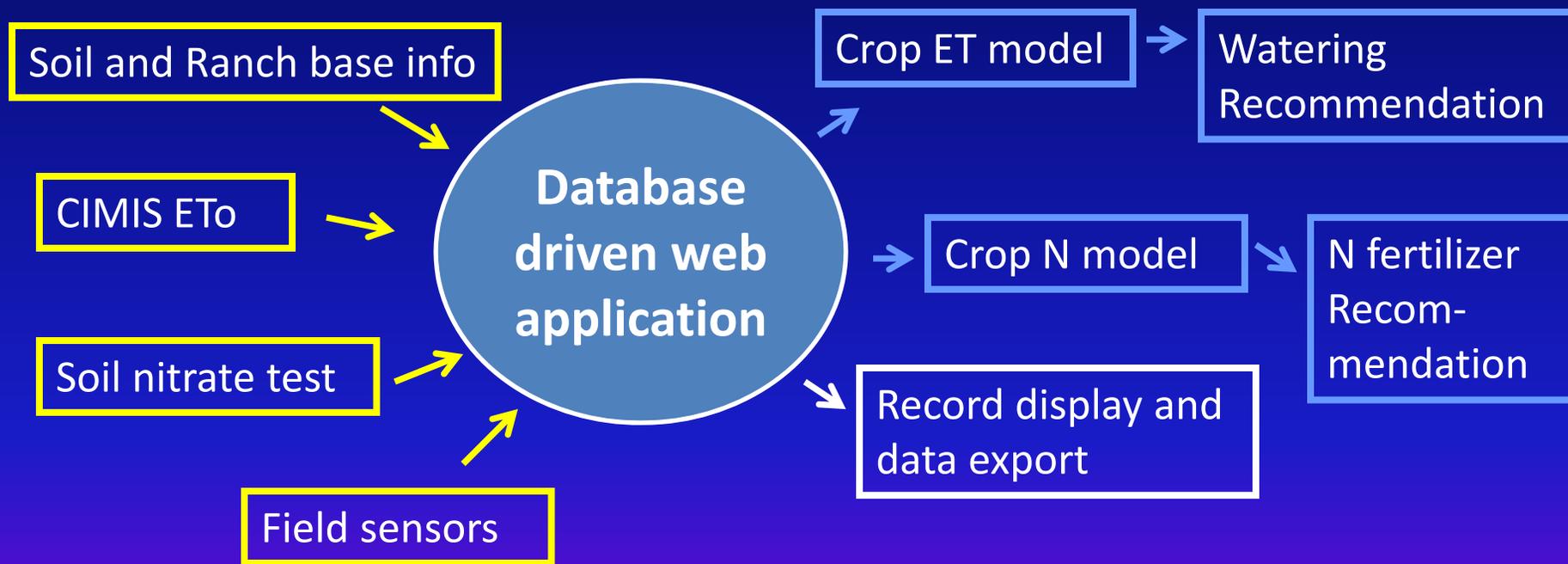
CropManage Web-based Tool:

Assist growers in making decisions on irrigation and nitrogen fertilizer management

- ✓ Intuitive, simple, quick to use.
- ✓ Accessible from smart phone, tablet computer, desktop computer
- ✓ Guide irrigation schedules using CIMIS weather data.
- ✓ Guide nitrogen fertilization decisions using quick nitrate test data.
- ✓ Maintain and share irrigation, fertilizer, and soil test records for multiple fields and farms.

CropManage

Integrate information from multiple sources

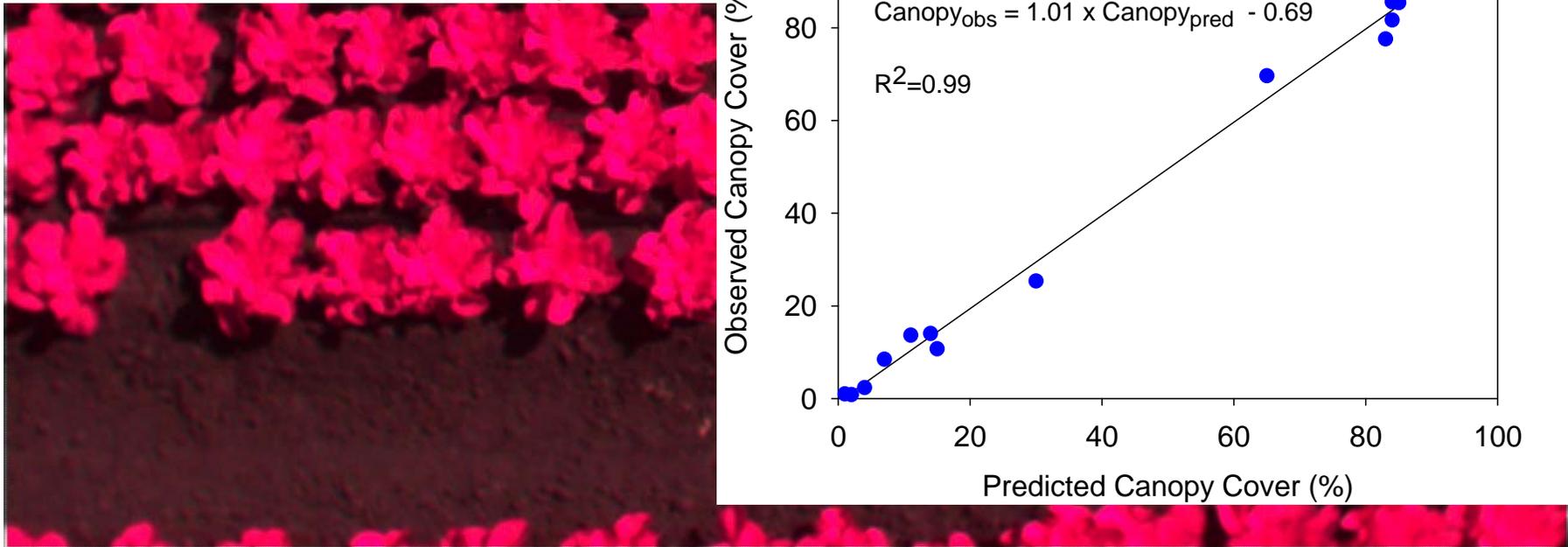
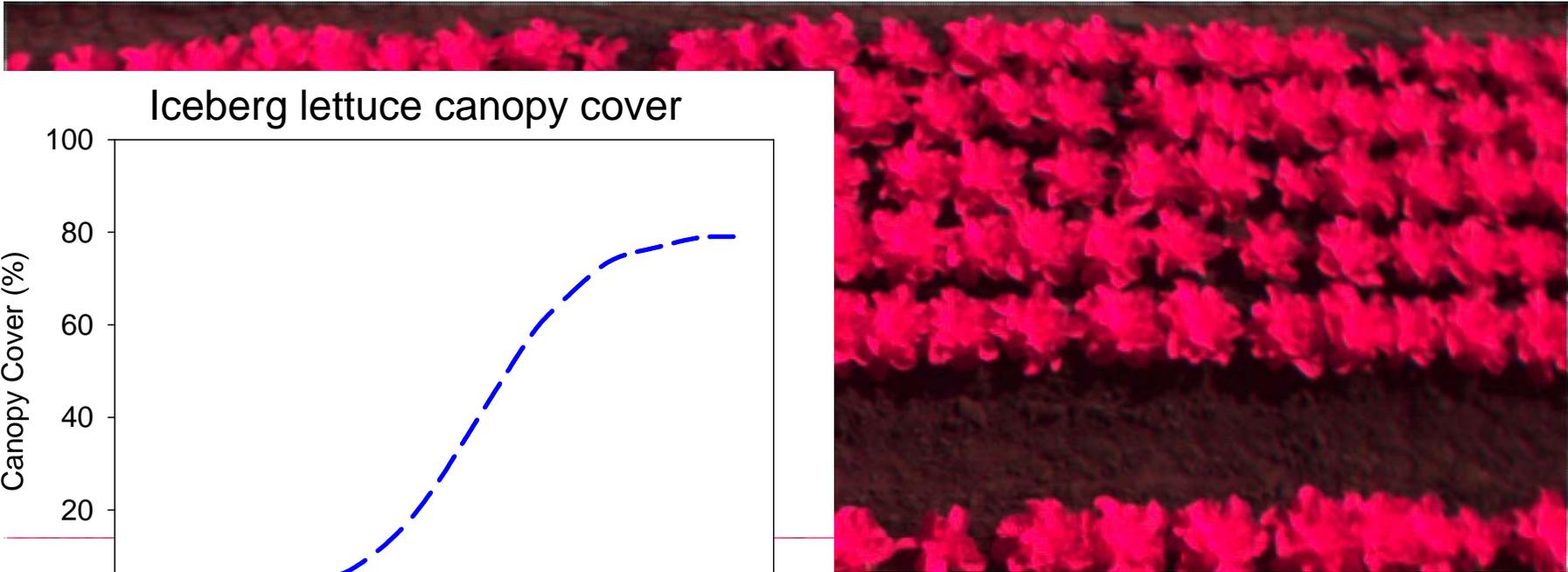


Decision support using crop models

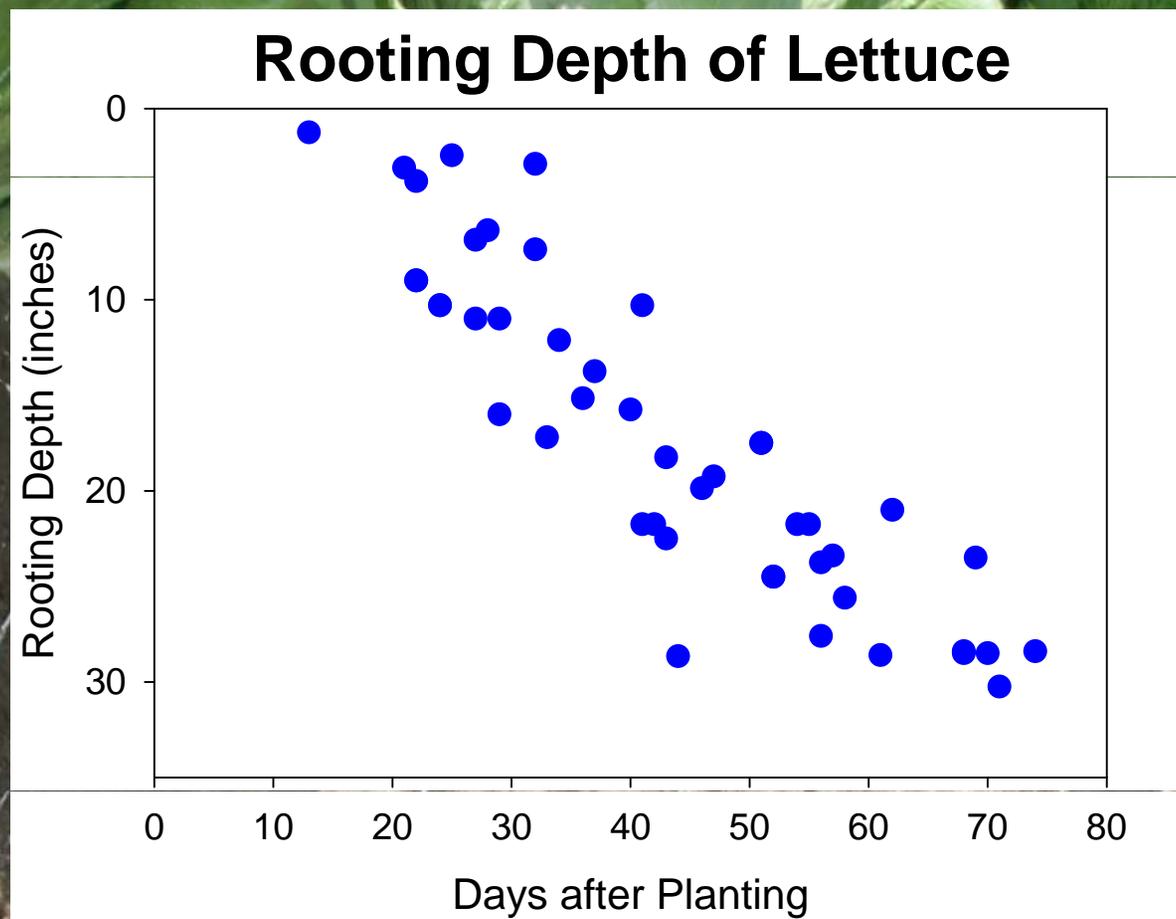
How is N fertilizer rate determined from the quick nitrate test?

Fertilizer N Rate = Future Crop N uptake

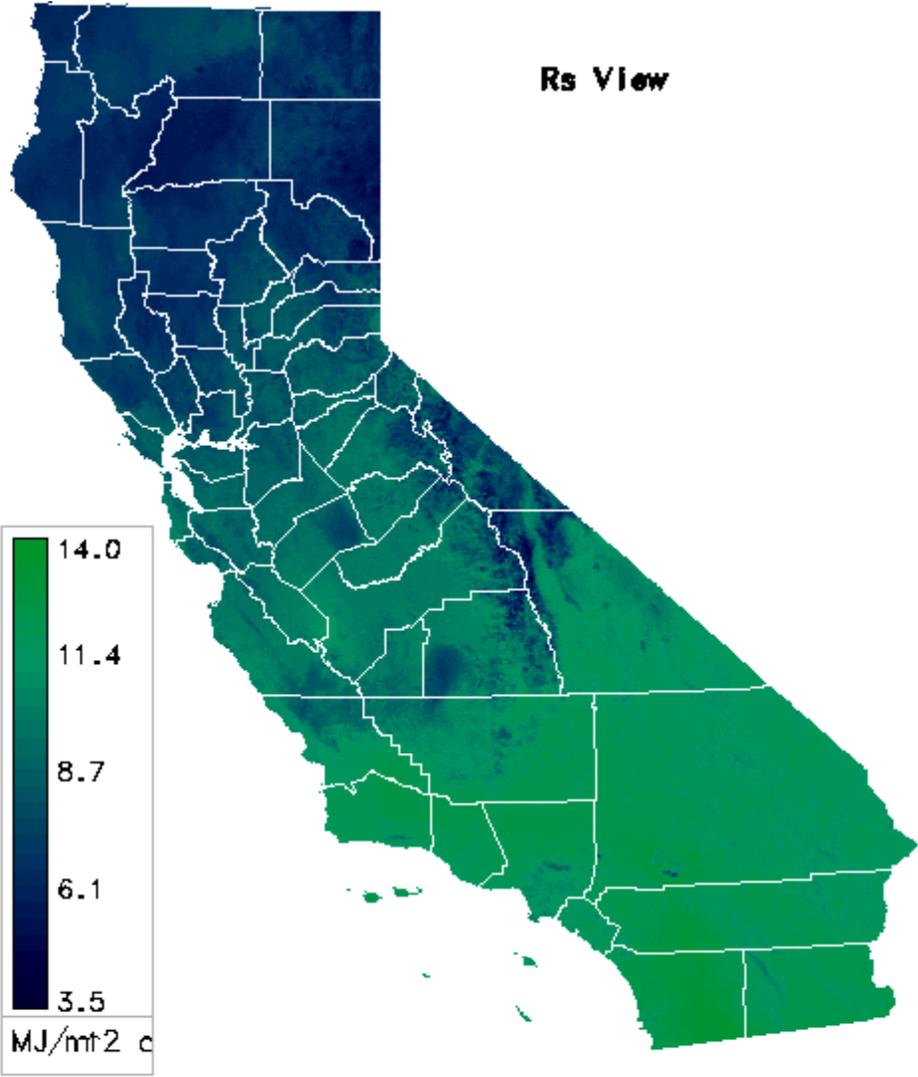
- (Quick Test N - threshold $\text{NO}_3\text{-N}$)
- predicted soil mineralization N
- predicted plant residue N



Available moisture depends on soil type and rooting depth



Spatial CIMIS ETo Reporting

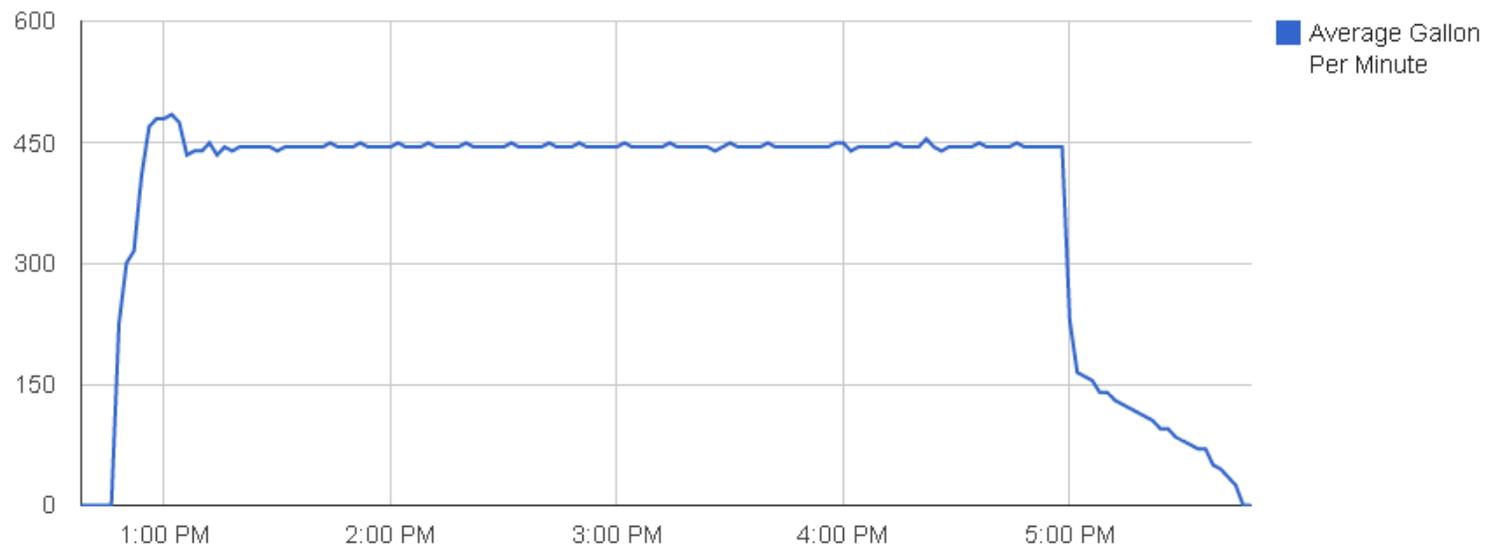


How much water was applied?

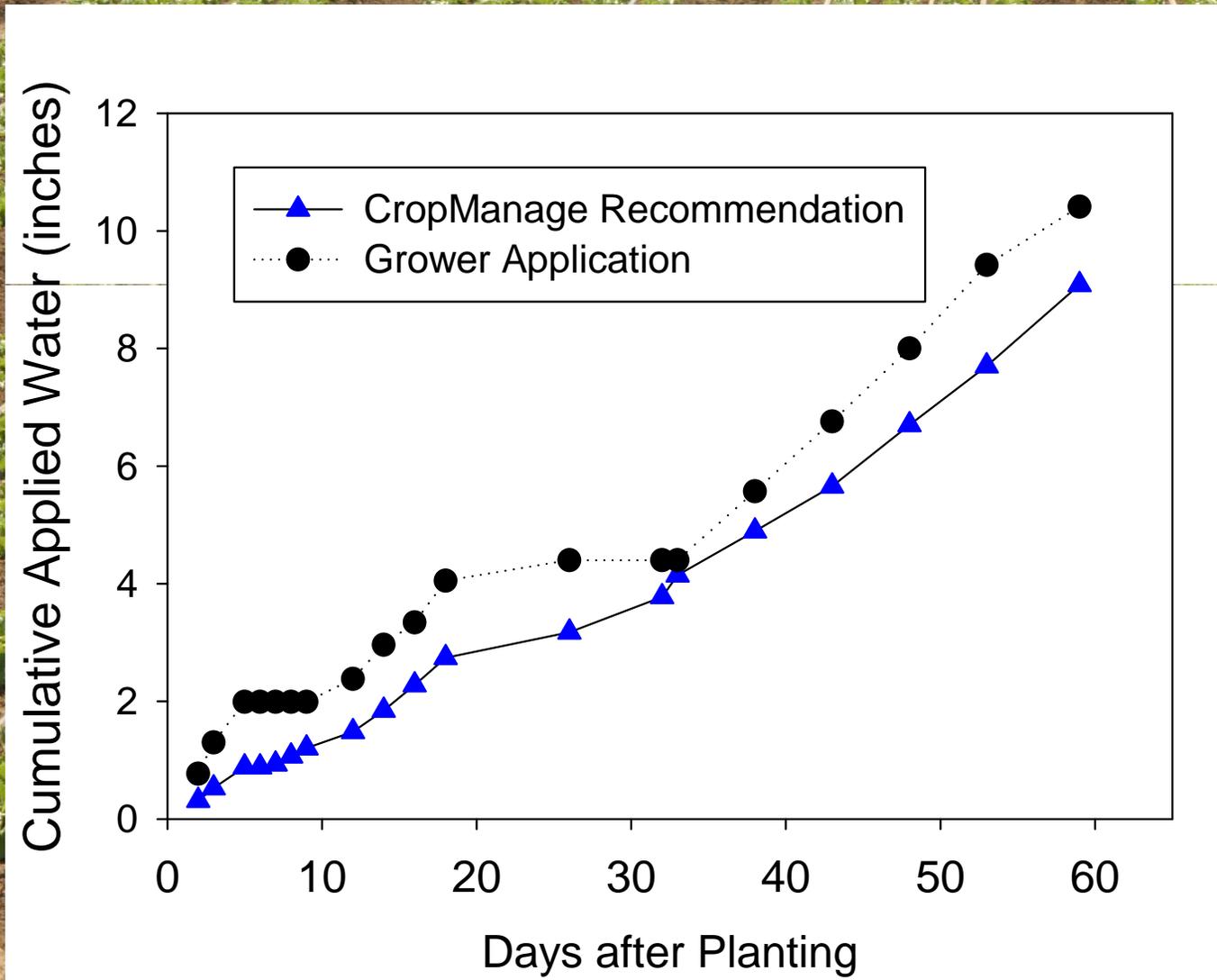


Flow Meter Data

Flow Meter Data on Oct 17, 2012



Evaluate and document water management





Ranch List

Select a Ranch to work in from the list below.

- [Bondesen](#)
- [Bryon's Test](#)
- [Calla Roberts Ranch](#)
- [Chualar](#)
- [Corey](#)
- [East Garlinger Ranch](#)
- [Fanoe](#)
- [Gabilan Ranch](#)
- [Hess](#)
- [Hilltown](#)
- [Home](#)
- [Hunter Lane](#)
- [Ikeda Bros Ranch 37](#)
- [J Pettit](#)
- [Los Coches](#)
- [Martella UC trial](#)
- [Molera](#)

CropManage

[Ranch Home](#) | [Ranch List](#) | [Site Administration](#) | [Help](#)

Ranch/Field: South Mortensen Ranch

Plantings

Showing ALL Plantings

Planting	Wet Date	Lot	Action
Taylor Lettuce M 20	3/31/2012	20	edit planting
Romaine 24 standard	8/11/2012	24	edit planting
Romaine 24 UC	8/11/2012	24	edit planting

- [New Planting](#)
- [View Current Plantings](#)
- [Import Export Options](#)

CropManage

[Ranch Home](#)[Planting Home](#)[Ranch List](#)[Site Administration](#)[Help](#)

Ranch/Field: South Mortensen Ranch, Lot 24, loam

Planting: [Romaine 24 standard](#), 9.1 acres

Crop: Romaine 5 row, 80 inch bed, 8/11-10/17/12

Planting

Soil Summary

[Show / Hide Columns](#)

Sample Date	Sample Reading (ppm)	Crop Stage	Sample Depth (ft)	Sample Analysis	Soil
9/18/12	200	2nd drip fertigation	1	Quick Strip	95.2
9/18/12	100	2nd drip fertigation	2	Quick Strip	47.6
10/4/12	200	3rd drip fertigation	1	Quick Strip	95.2

Soil Summary

Show / Hide Columns

Sample Date	Sample Reading (ppm)	Crop Stage	Sample Depth (ft)	Sample Analysis	Soil Nitrate-N (ppm)	Soil Mineral N (lb/acre)
9/18/12	200	2nd drip fertigation	1	Quick Strip	95.24	387.67
9/18/12	100	2nd drip fertigation	2	Quick Strip	47.62	193.83
10/4/12	200	3rd drip fertigation	1	Quick Strip	95.24	387.67
10/4/12	150	3rd drip fertigation	2	Quick Strip	71.43	290.75
10/8/12	90	4th drip fertigation	1	Quick Strip	42.86	174.45
10/8/12	200	4th drip fertigation	2	Quick Strip	95.24	387.67

New Soil Sample

View all Nutrients

Fertilizer Summary

Show / Hide Columns

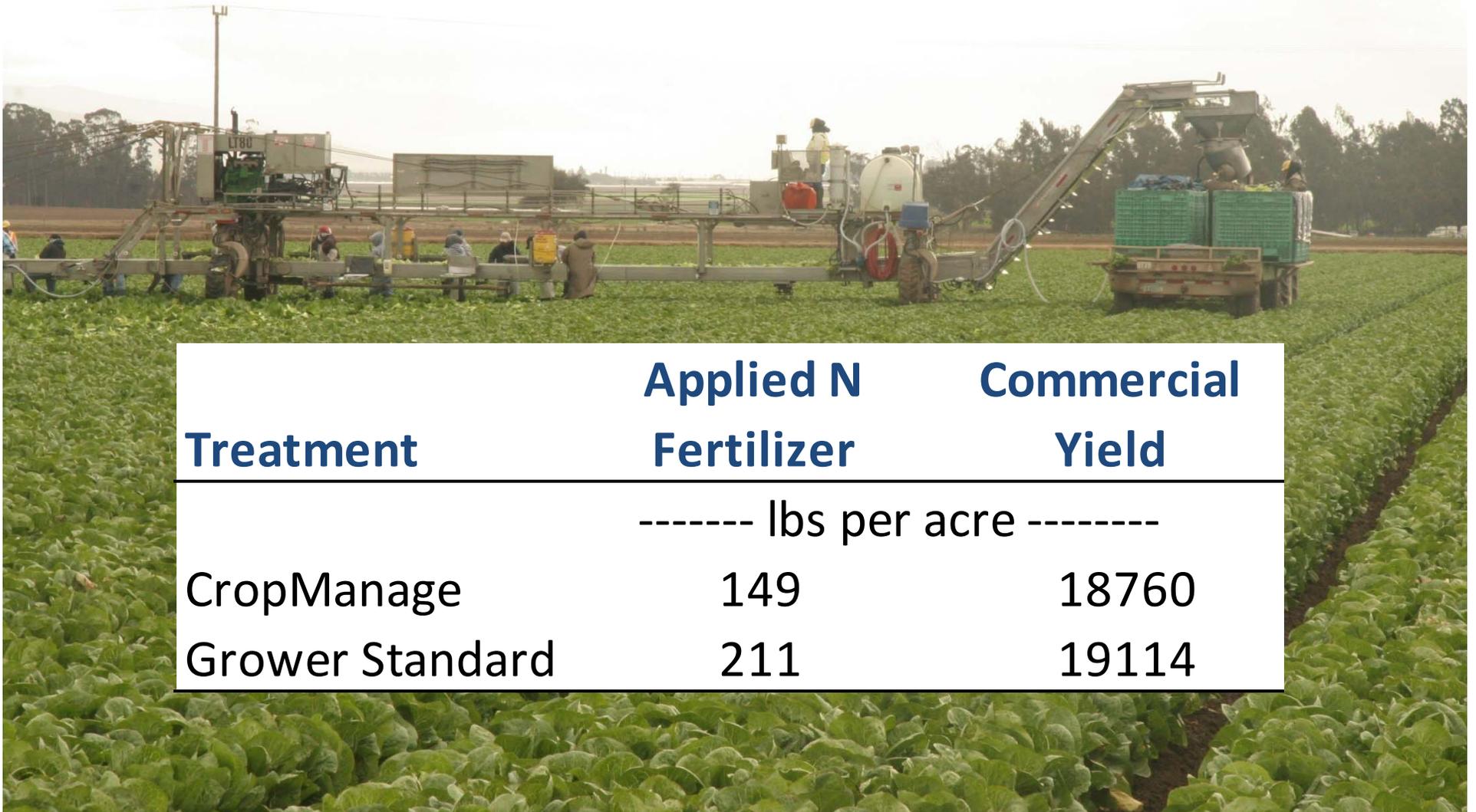
Fertilizer Date	Soil NO ₃ -N (ppm)	Crop Stage	Fertilizer N Recommended (lb N/acre)	Cumulative N Uptake	Fertilizer	Applied N (lb N/acre)	Applied Fertilizer
8/28/12	N/A	Post-thinning	N/A	4.74	28-0-0-5	92.8	30.0 gallons/acre
9/13/12	N/A	1st drip fertigation	N/A	16.50	28-0-0-5	30.9	10.0 gallons/acre
9/18/12	47.62	2nd drip fertigation	0.0	23.09	28-0-0-5	30.9	10.0 gallons/acre
9/24/12	N/A	3rd drip fertigation	N/A	34.05	Nphuric 15-0-0-49	9.5	5.0 gallons/acre

Watering Summary Table

Show / Hide Columns							Show Previous Columns		Show Next Columns	
Water Date	Irrigation Method	Recommended Irrigation Interval (days)	Recommended Irrigation Amount (inches)	Recommended Irrigation Time (hours)	Irrigation Water Applied (inches)	Kc	Canopy Cover (%)	Average Reference ET (inches/day)	Total Crop ET (inches)	
8/11/12	sprinkler	N/A	N/A	N/A	0.49 in	0.00	0	0.00	0.00	
8/14/12	Sprinkler	2.2	0.38 in	1.28 hrs	0.63 in	0.48	0	0.20	0.29	
8/16/12	Sprinkler	1.6	0.35 in	1.17 hrs	0.48 in	0.70	0	0.19	0.26	
8/20/12	Sprinkler	3.1	0.36 in	1.19 hrs	0.48 in	0.37	1	0.18	0.27	
8/28/12	Sprinkler	7.4	0.30 in	1.02 hrs	0.94 in	0.20	2	0.14	0.23	
9/13/12	Drip	9.4	0.60 in	4.03 hrs	0.72 in	0.21	21	0.16	0.54	
9/18/12	Drip	9.0	0.34 in	2.24 hrs	0.78 in	0.40	36	0.15	0.30	
9/24/12	Drip	7.0	0.57 in	3.82 hrs	0.66 in	0.60	56	0.14	0.52	
9/28/12	Drip	7.2	0.42 in	2.78 hrs	0.63 in	0.77	67	0.12	0.38	
10/3/12	Drip	5.1	0.79 in	5.27 hrs	0.69 in	0.87	76	0.16	0.71	
10/9/12	Drip	6.8	0.74 in	4.91 hrs	0.90 in	0.94	81	0.12	0.66	
10/17/12	Drip	8.3	0.81 in	5.41 hrs	0.57 in	0.98	84	0.09	0.73	
Totals			5.66 in	33.10 hrs	7.97 in				4.89 in	

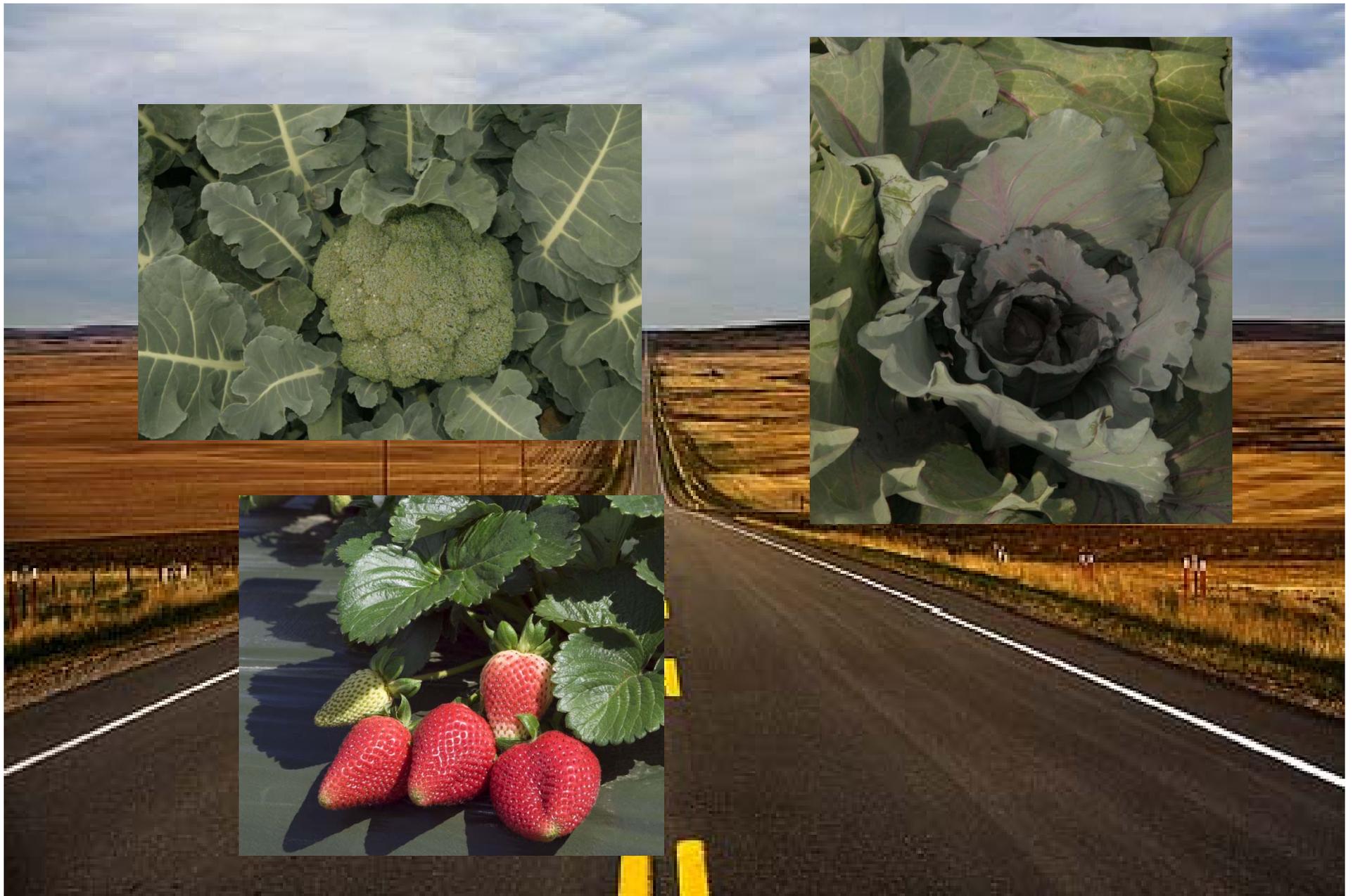
[New Watering](#)
[View Flow Meter Data](#)
[View Rainfall Data](#)

Field Validation of CropManage



Treatment	Applied N Fertilizer	Commercial Yield
	----- lbs per acre -----	
CropManage	149	18760
Grower Standard	211	19114

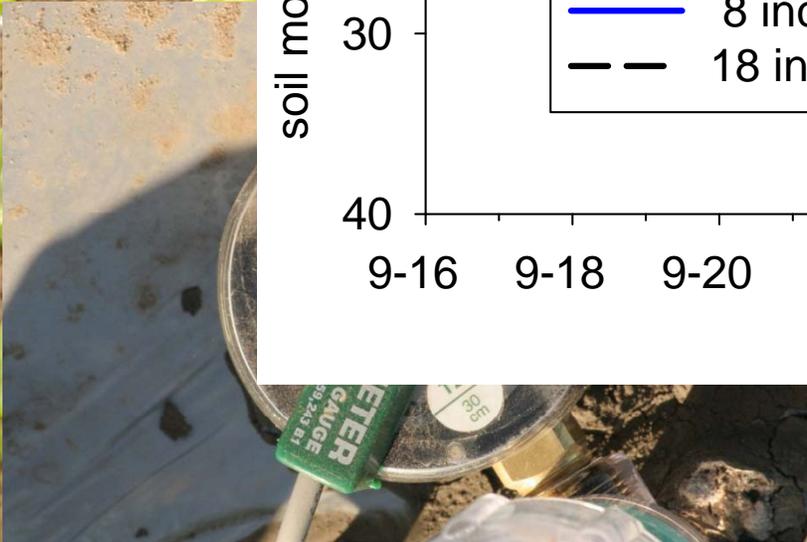
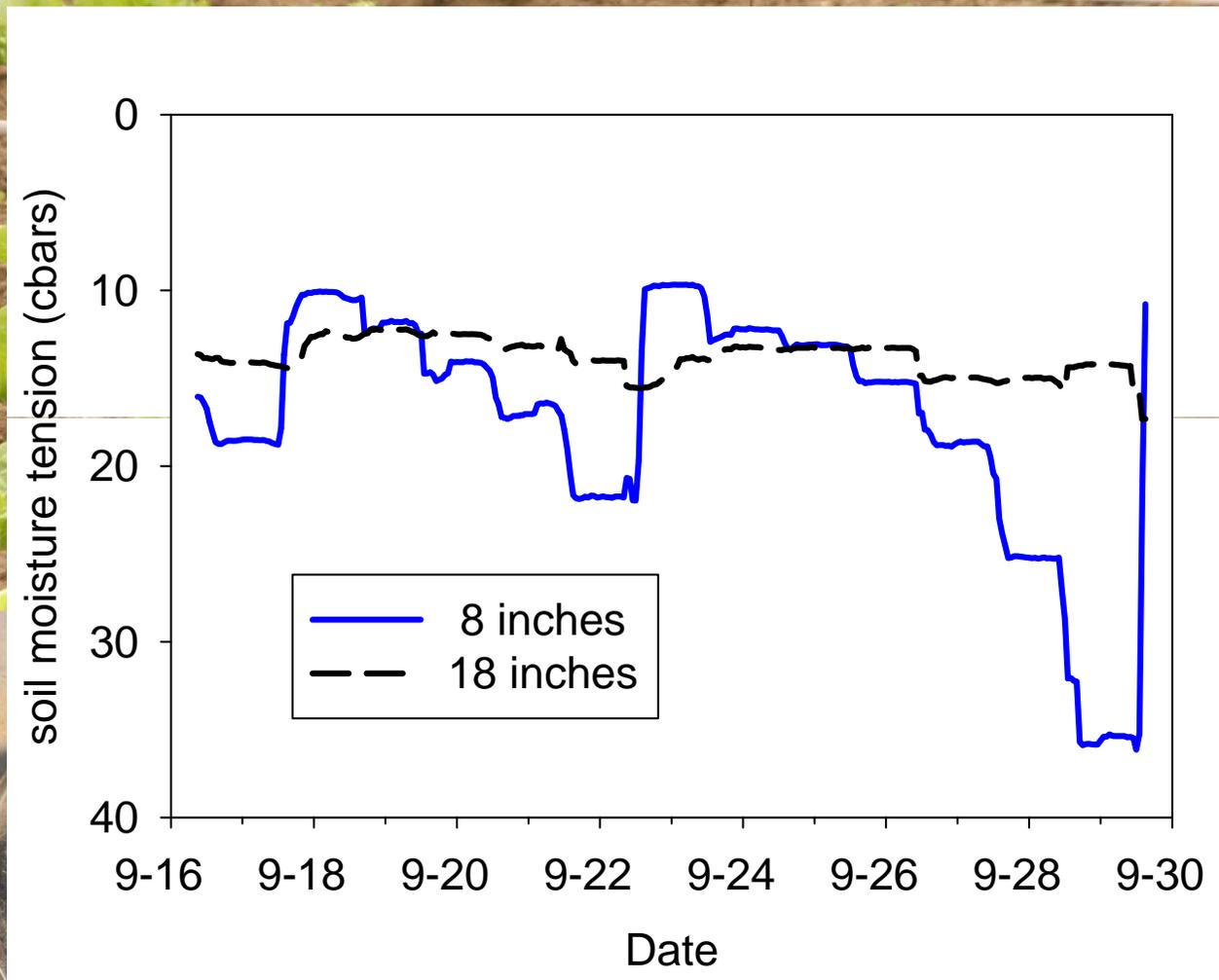
The road ahead...



Interface with UCD online Soil Survey Tool



Soil moisture monitoring



Final Thoughts

- Web-based applications can integrate complex data and models into simple to use decision support tools
- *CropManage* is not just for growers. It is a potential tool for crop consultants to use in assisting growers with water and N management decisions.
- We will offer training workshops on CropManage beginning March 2013.