Best Irrigation and Nitrogen Management Practices in Desert Carrots

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UC CE | University of California
Agriculture and Natural Resources | Cooperative Extension

Project's Background

- Initiated in 2019 (three seasons conducted in IV)
- 3 trials at UC DREC and 13 trials in commercial fields
- Awards: CDFA Fertilizer Research and Education Program (FREP)
  & California Fresh Carrot Advisory Board

Main objective: to develop information and tools on management practices that optimize N and irrigation water use efficiency in desert carrot production systems.

Excess soil moisture and severe drying/wetting:

- Root splitting
- Root rot
- Hairy roots
- Discourages good color formation

Over-applying N fertilizer:

- Roots are vulnerable to forking
- Increases root cracking during harvest and handling
- Higher risk of leaching

Careful management of N in desert carrots is crucial **because** fertilizers are the main source of N, particularly due to low organic matter content of the soils and very low nitrate level of the Colorado River water.

Experimental Sites (2019-2022)

Site	Carrot Variety	Soil classification (0-2 ft.)	Irrigation practice
UC DREC (three trials)	Fresh market	Sandy clay loam	Sprinkler
Commercial fields	Fresh market (4 fields) Processing (9 fields)	Sandy clay loam Sandy loam Loamy sand	Sprinkler (5 fields)
			Furrow (8 fields)

Field Experiment Layout

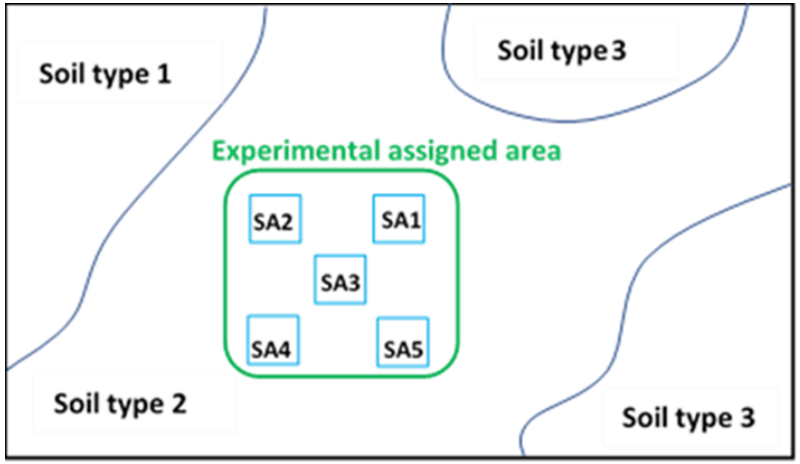
UC DREC Trial (2021-2022)

I1-N1	I1-N2	I1-N3	I1-N4
I2-N1	I2-N2	I2-N3	I2-N4
I2-N4	I2-N3	I2-N2	I2-N1
I1-N2	I1-N4	I1-N1	I1-N1
I1-N3	I1-N1	I1-N2	I1-N4
I1-N4	I1-N2	I1-N3	I1-N3
I2-N2	I2-N1	I2-N4	I2-N2
I2-N3	I2-N4	I2-N1	I2-N3

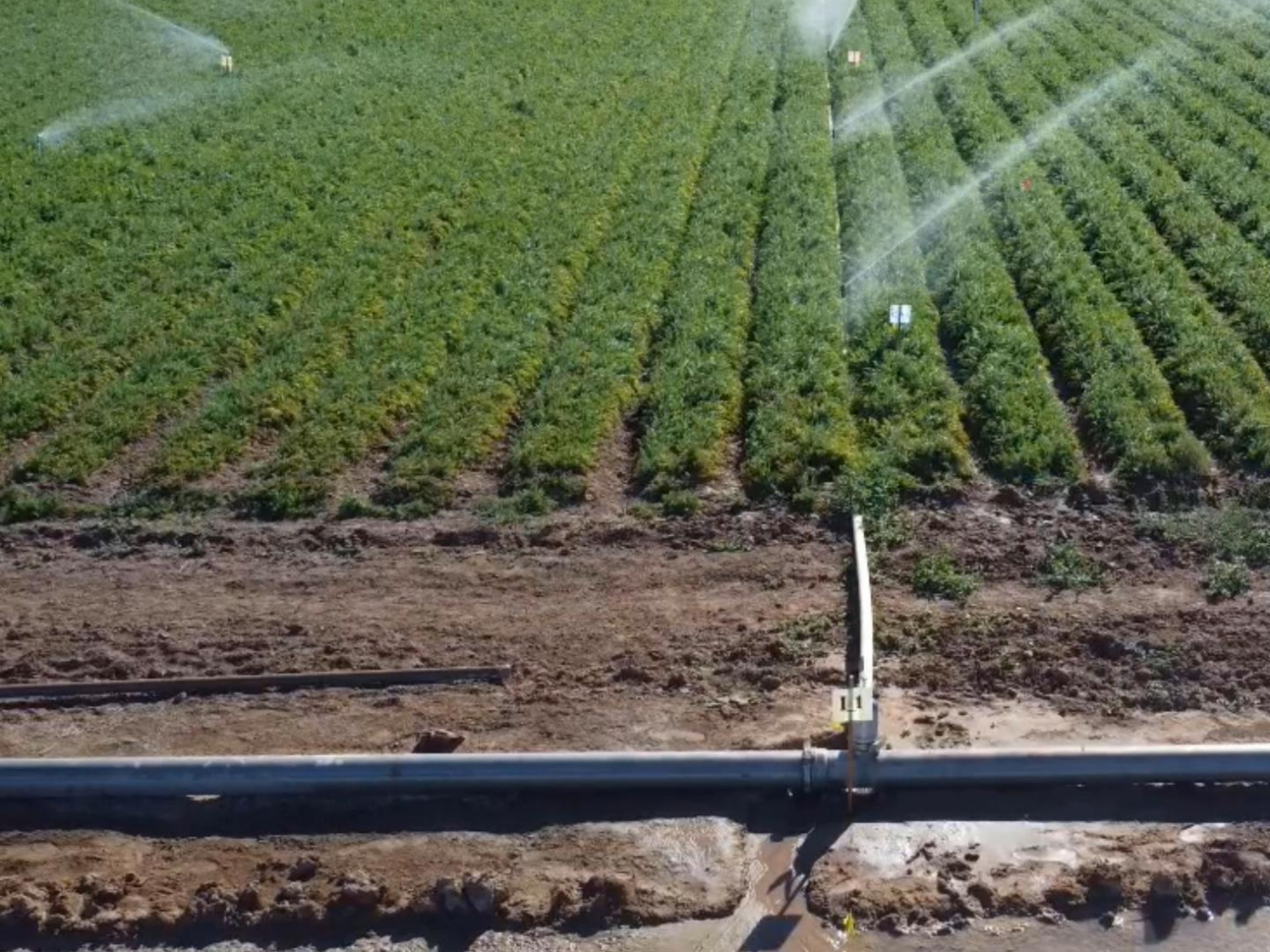
Two irrigation regimes and four nitrogen strategies

(Randomized Complete Block Design with Split Plot Arrangement over four replications)

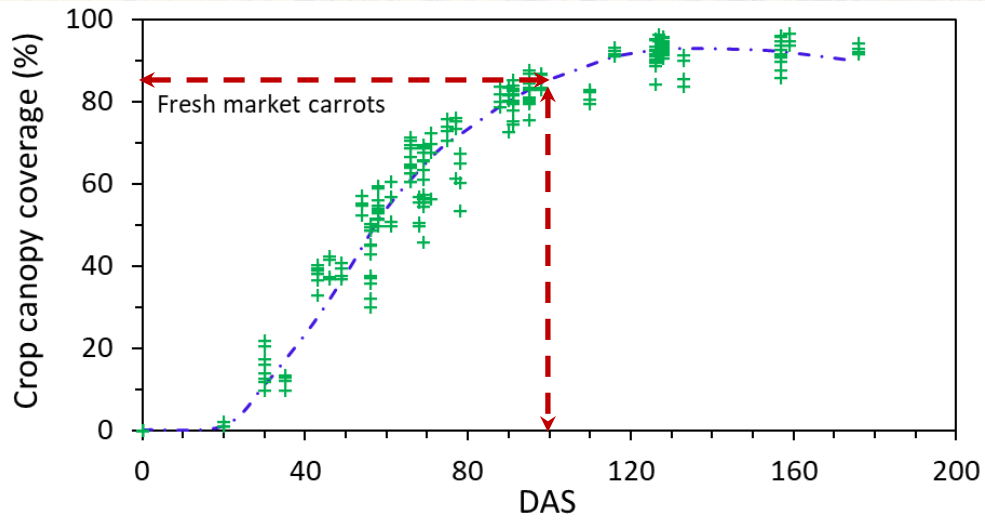
Commercial field/s

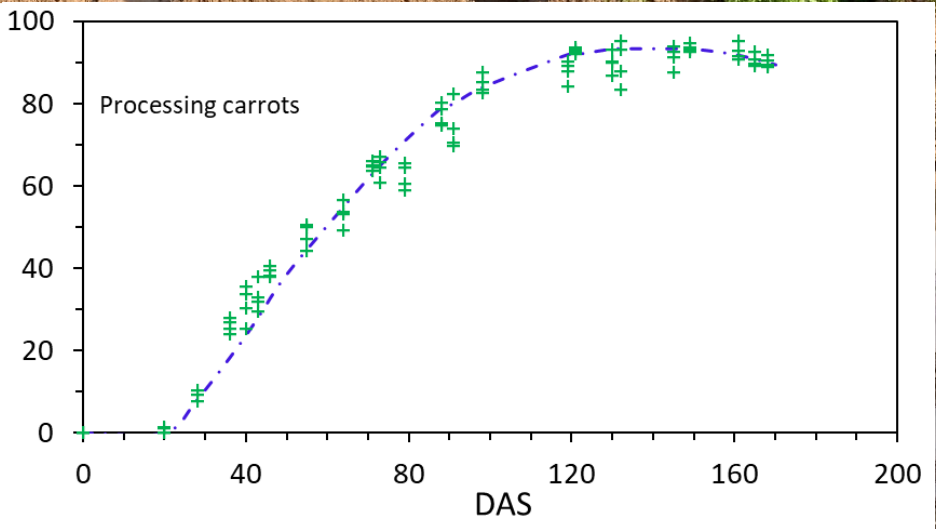


Measurements in five sub-plots (homogeneous soil) at each field under grower practice

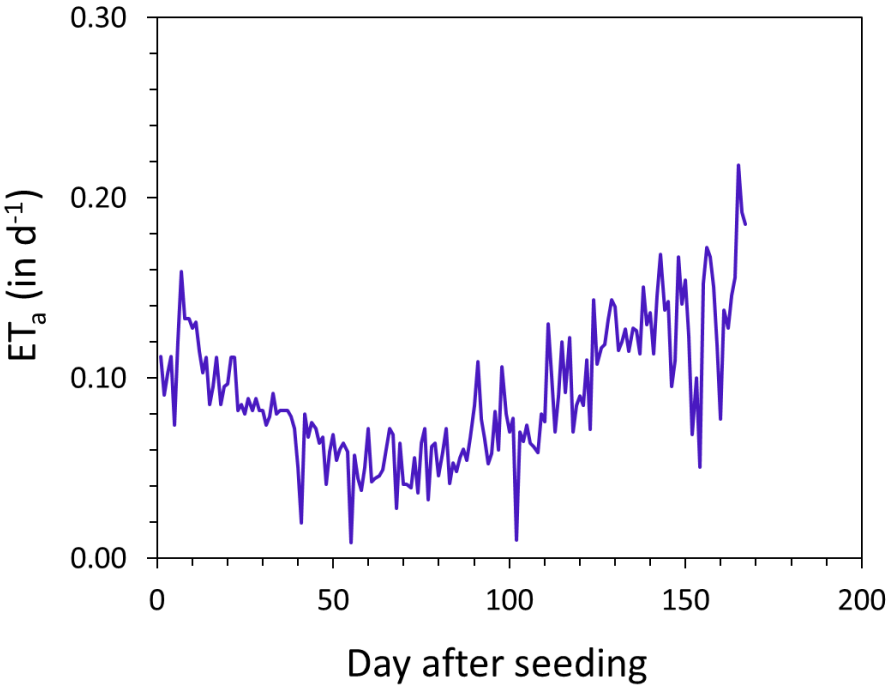


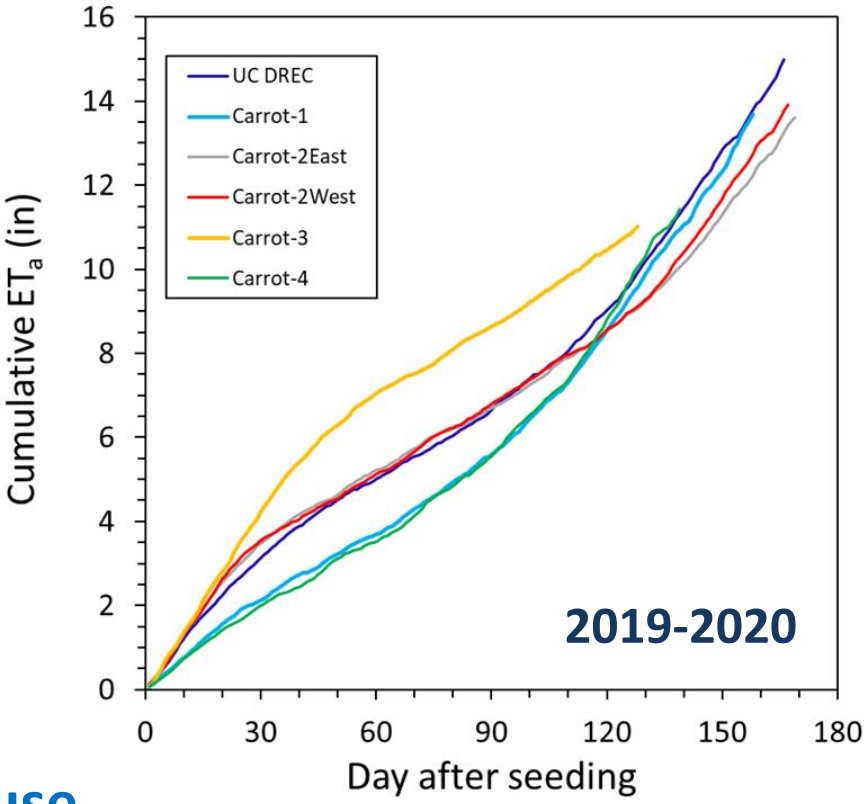
Canopy Growth Curve





Carrot crop water use (actual ET)





"Variable seasonal crop water use depending on early/late planting, length of season, variety, soil types, and irrigation practice"

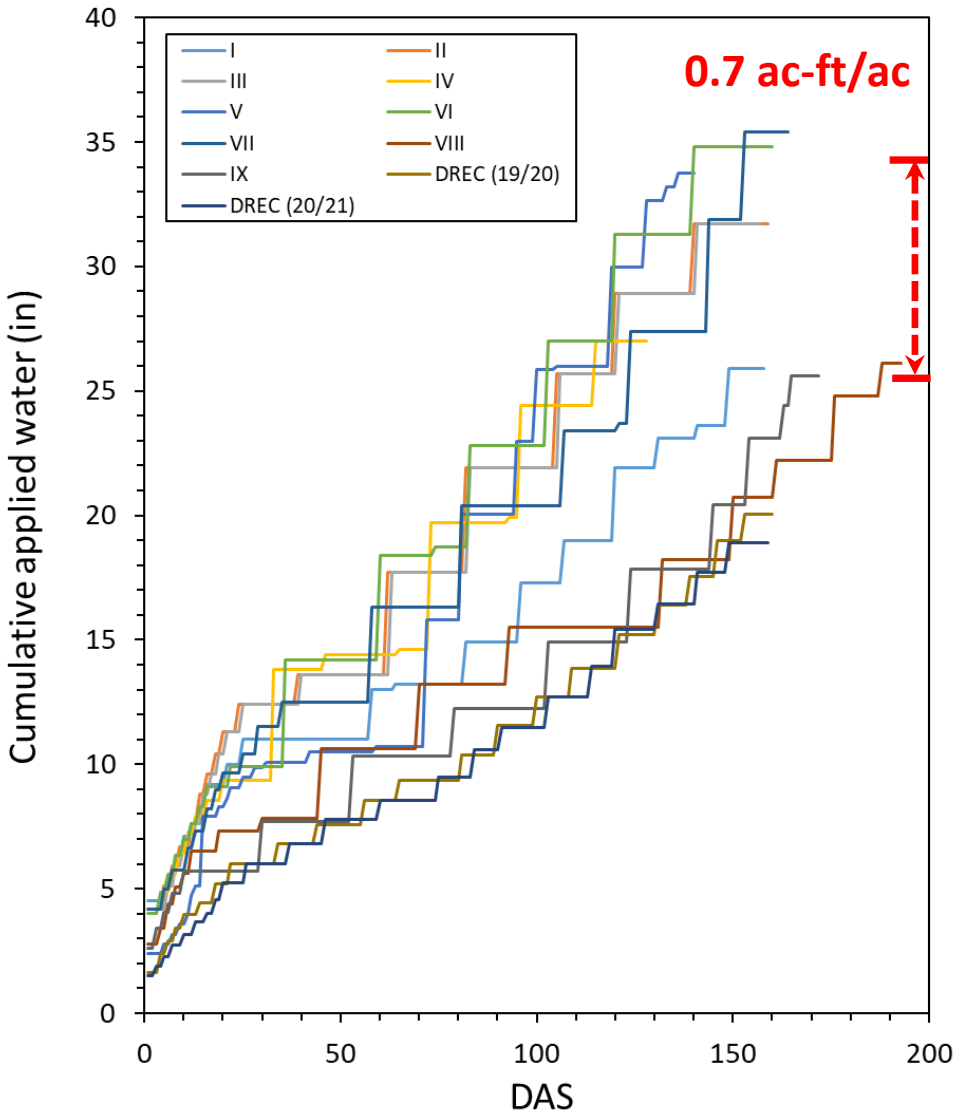
ET_a varied 12 -19 inches

In a typical 160-day season (October Planting):

“an average 16 inches as seasonal crop water use”

Approximately 50% of crop water needs occurred during the first 100 days after seeding and the other 50% during the last 60 days before harvest.

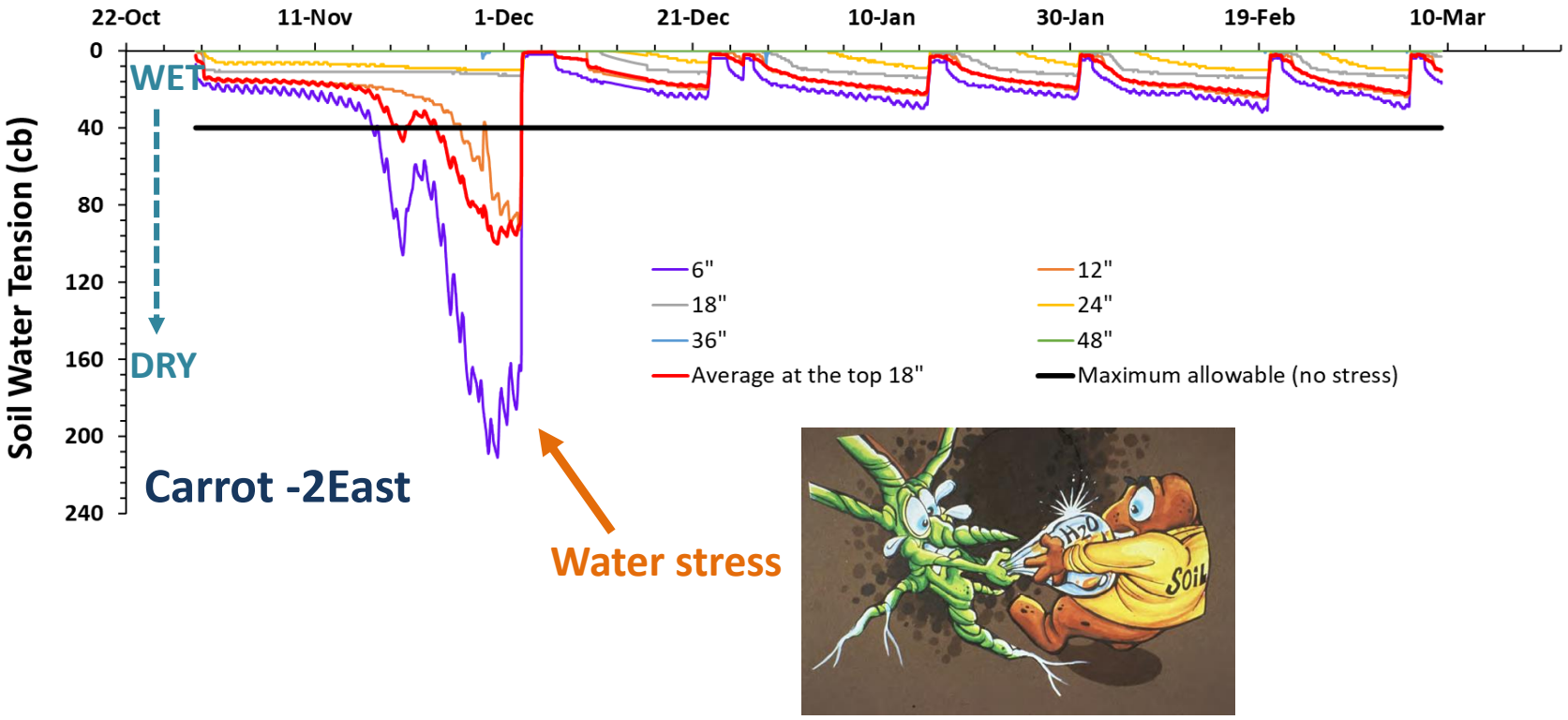
Applied water in carrot fields



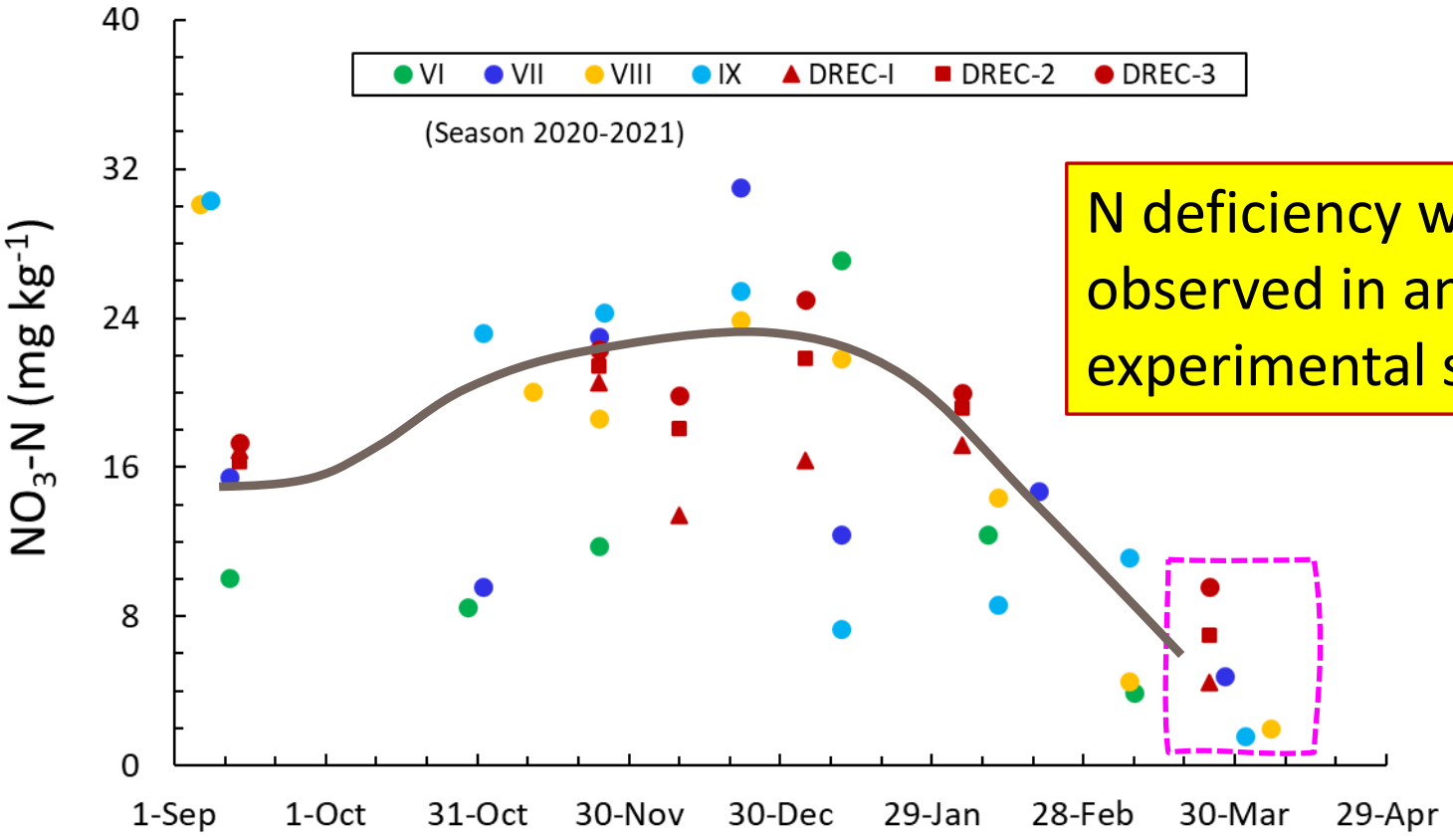
- **W**ide range of applied water in carrots.
- **P**otential overirrigating during plant germination.
- **P**otential water conservation through irrigation practices (sprinkler vs. furrow).

An average of 0.7 ac-ft/ac

Soil Water Status
(furrow irrigated field)

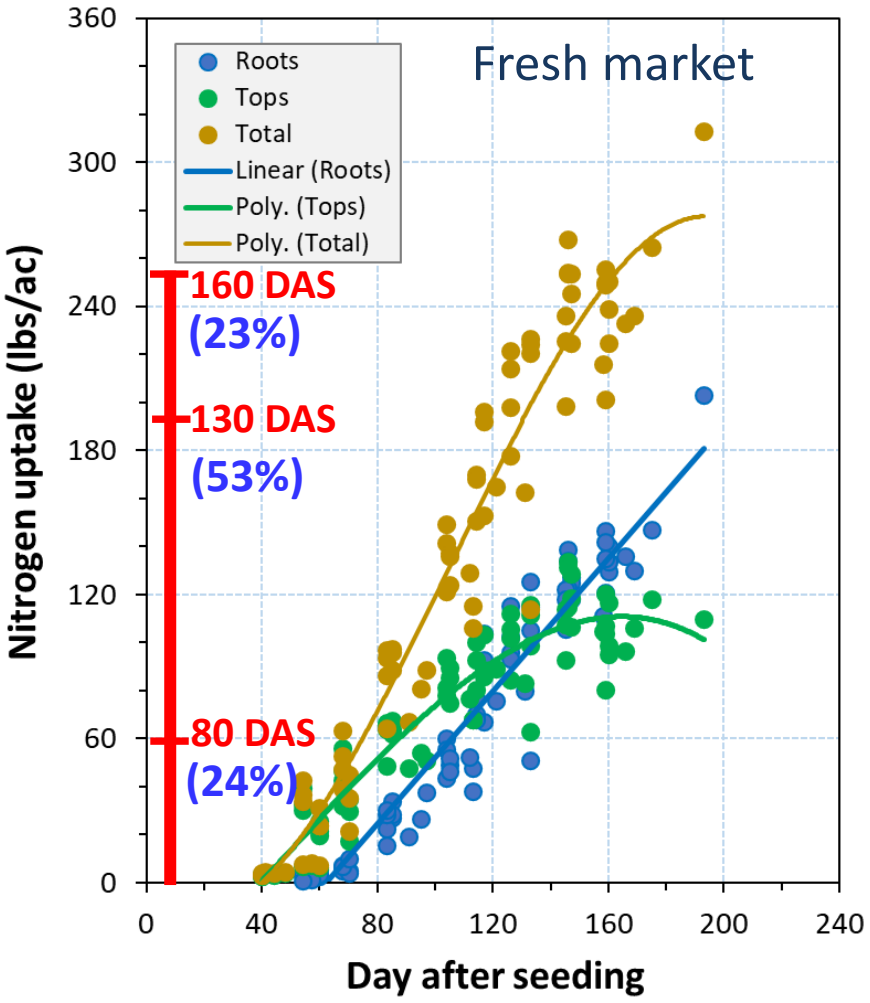


Soil nitrate-N concentrations (top 1 foot)

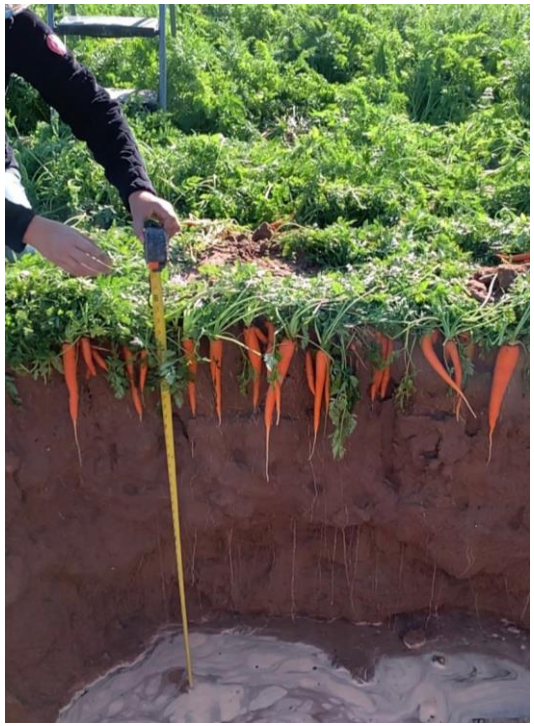


N deficiency wasn't observed in any of the experimental sites.

Nitrogen uptake curve



- **A** wide range of N accumulated in roots and tops at harvest
- **A** linear regression model for N uptake in roots after 60 to 73 DAS
- **N** uptake in tops increases gradually (quadratic regression), and levelled off or declines slightly late in the season (beyond 130 to 145 DAS)



Fibrous roots at 5'
below the soil surface

Carrot field after harvest

Plant residues (Top) could contribute as a source of N for following season.

"42-44%
total N Uptake remained in the carrot foliage at harvest."

Mean fresh storage root yields (± standard deviation)

Experimental Site		N Applied (lb/ac)	Mean ± SD (t/ac)
Fresh market carrots	DREC-1 (20–21)	176.3	47.5 ± 3.7
	DREC-1 (19–20)	183.2	50.1 ± 4.8
	I	197.2	47.1 ± 4.0
	DREC-2 (20–21)	207.6	48.0 ± 3.4
	DREC-2 (19–20)	213.8	51.1 ± 4.3
	VIII	229.1	60.2 ± 5.9
	III	247.8	54.8 ± 4.6
	II	262.2	53.3 ± 3.1
	DREC-3 (20-21)	266.3	45.7 ± 4.2
	DREC-3 (19-20)	272.6	49.4 ± 4.8
	Significance	L	NS
		Q	NS
		R^2	-
Processing carrots	IV	189.1	38.0 ± 4.5
	VI	197.1	43.1 ± 3.9
	VII	221.2	46.2 ± 4.3
	IX	230.8	48.9 ± 5.1
	V	237.5	43.7 ± 4.7
	Significance	L	NS
		Q	NS
		R^2	-

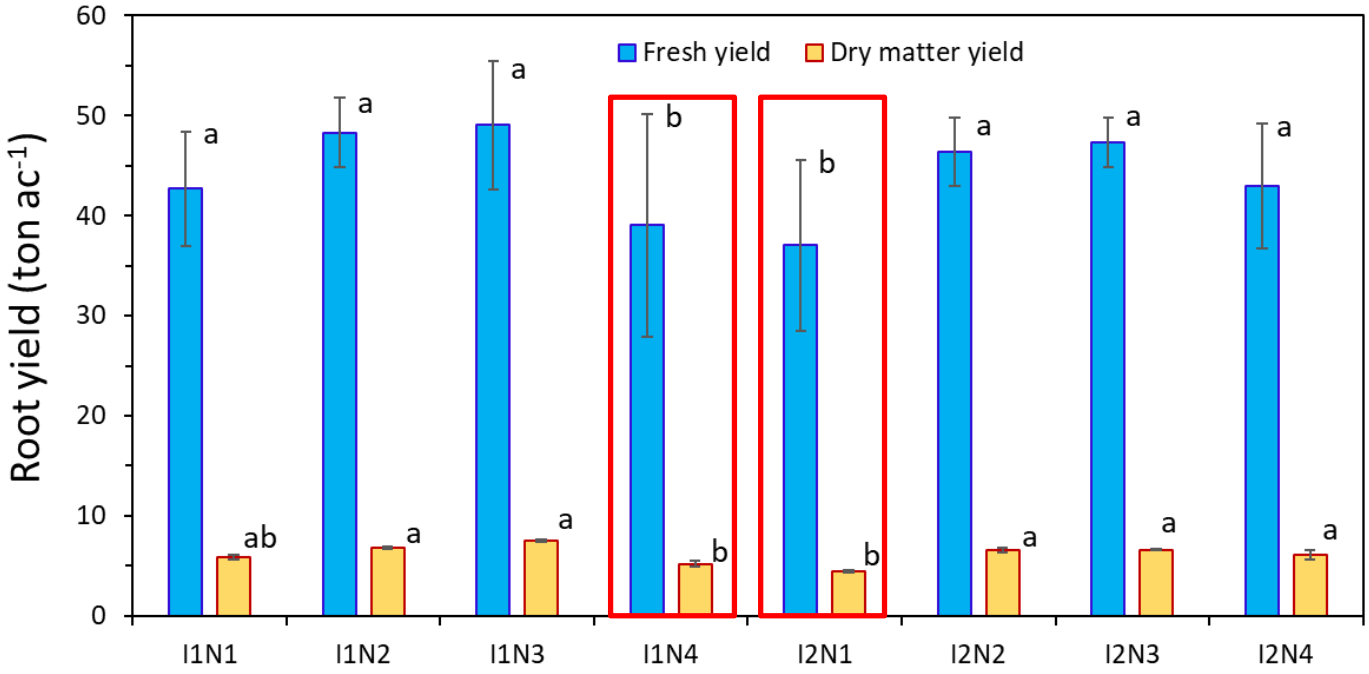
First two-year

Positive impact of N application on yield!

But

No significant relation found!

Effect of irrigation regimes and N rates root yields



2021-2022

N1: 140 lbs.ac^{-1}

N2: 185

N3: 235

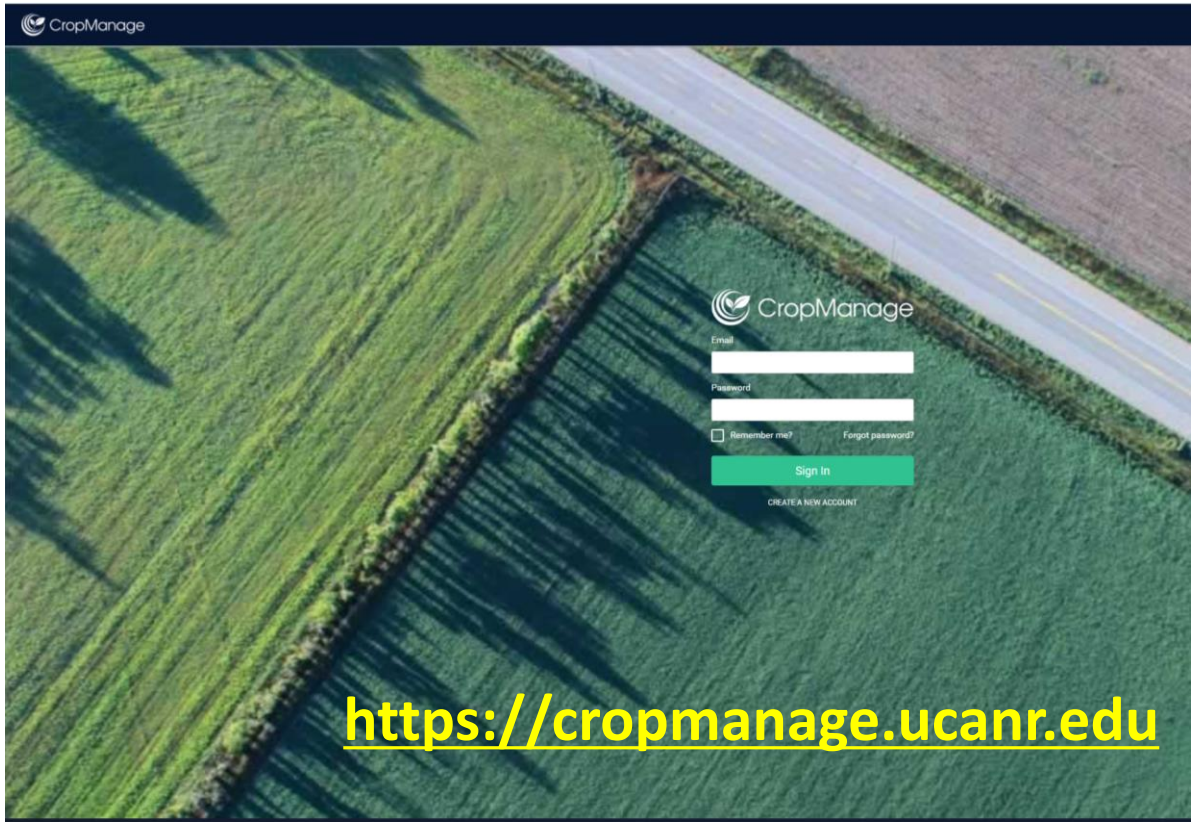
N4: 275

I1: 100%ET

I2: 125%ET

Fresh and dry matter root yields were significantly lower in I1N4 and I2N1 treatments ($p < 0.05$).

We developed **CropManage** carrot module.



CropManage is a free online decision tool for irrigation and fertilizer management (administrated by UC ANR).

Take-Home Message

- Positive impact of N application on root yield, but no significant relation.

- Nitrogen application rates greater than 140 lbs. ac^{-1} couldn't have a significant impact on root yield in a well-managed irrigated field. However, higher N rates are likely necessary in over irrigated carrot fields and/or fine sandy soils to maximize root yield.

Take-Home Message

- In a typical 160-day season (October Planting), carrot has an average crop water consumption of 16 inches.

- There is potential water conservation using solid-set sprinkler irrigation vs. furrow irrigation system.

- The Carrot CropManage Module could be considered as a robust irrigation and nutrient management decision support tool to assist growers in implementing better irrigation scheduling and N rates in carrots.

Thank You (Q & A)

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SWEEP pilot program for southern desert region: new incentive program for water savings focused irrigation projects

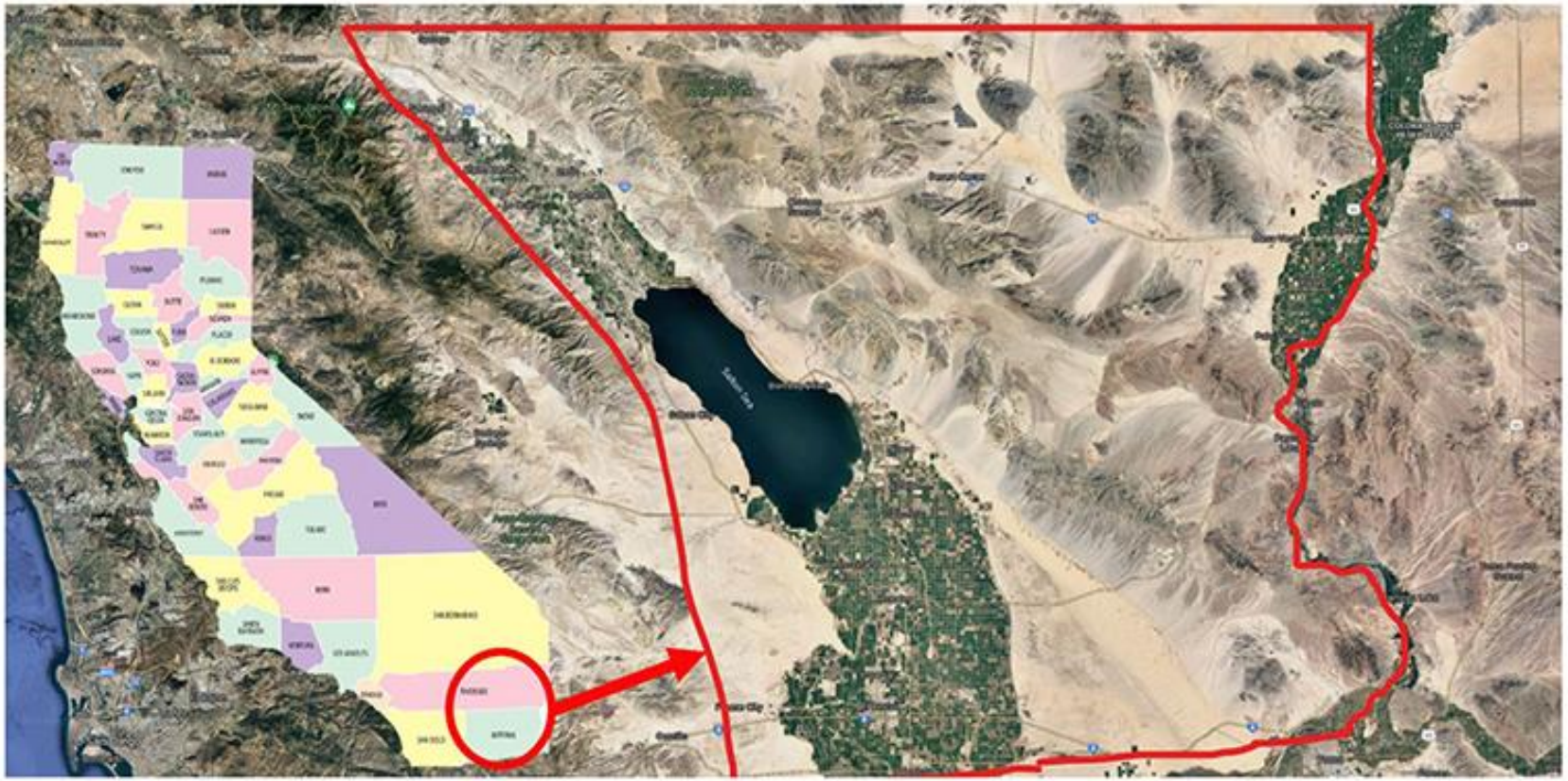
Ali Montazar
Irrigation and Water Management Advisor
UC Cooperative Extension

SWEEP Pilot Program is a financial incentive for California agricultural operations (the southern desert region) to invest in irrigation systems that **save water** without increasing greenhouse gas (GHG) emissions.

"Compete within the region"

"Project Eligibility & High Score"

Southern Desert Region



The area outlined consists of both Imperial and Riverside Counties and is east of the Santa Rosa and San Jacinto Mountains.

Water Savings projects

(1) Irrigation Scheduling Sensors

- Soil moisture or plant sensors
- Electronic data output and telemetry
- Weather station
- Evapotranspiration (ET) based irrigation scheduling
- California Irrigation Management Information System (CIMIS)

Tools for Irrigation Water Management

- Flowmeter
- Soil moisture sensing
- ET (evapotranspiration) information

Having each of these tools could result 5% water saving; totally about 15%.

Measurements actual water use by water supplier would work.

(2) Irrigation Method

Conversion to a more water efficient irrigation method or improvement of existing method to conserve water

"Adding/repairing a pipeline, lining water ways or outlets, and installing drip line or other forms of irrigation line"

(3) Irrigation Infrastructure

Land leveling, increasing flow rates, replacing on farm water delivery gates and installing a tail water recovery system.

Energy Use Reductions or Greenhouse Gas Emission Offsets

(1) Fuel Conversion and/or Renewable Energy

"Interconnection to the electricity grid is eligible for SWEEP funding"

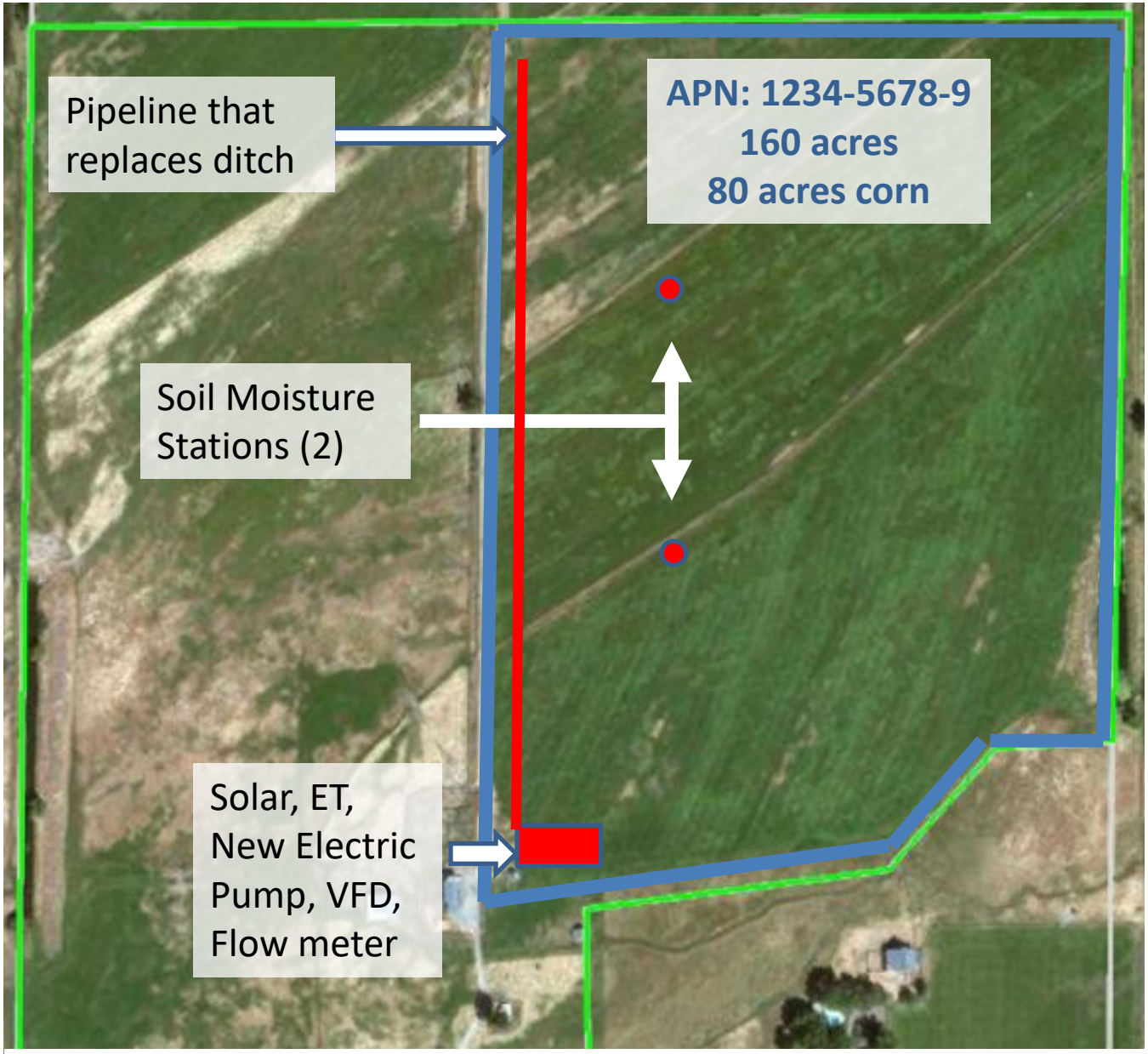
(2) Improved Energy Efficiency of Pumps and the Addition of Variable Frequency Drives (VFD)

- Retrofitting or replacing pumps
- Mobile diesel pumps are eligible for retrofit or replacement

(3) The Commitment to Use Utility-provided Renewable Energy to Offset an Increase in Pumping Energy Use.

(4) Low Pressure Systems: the conversion of a high-pressure sprinkler system to a low-pressure micro-irrigation system or lower pressure sprinkler system

(5) Reduced Pumping through Water Savings Strategies improved irrigation scheduling may lead to reduced pump operation times



Project Design

SWEEP Irrigation Water Savings Assessment Tool

SWEEP Irrigation Water Savings Assessment Tool

The "before" scenario tab represents the baseline situation on the field. Complete this tab to represent the "pre-project" conditions. An *estimate* of baseline water use will be calculated based upon the field location, soil type, and irrigation method.

Applicant: **Application ID:** **Date:**

Field or Ranch Name: **Impacted Acres:**

Predominant Soil: Sand, Loamy Sand, Sandy Loam, Fine Sandy Loam, **Loam**, Silt, Clay Loam, Clay

Crop: **Alfalfa**, Almonds, Apple, Artichokes, Asparagus, Avocado, Barley (planting 11/3…), Barley (planting 4/3…)

Baseline, Township, Range: Humboldt, **Mt. Diablo**, San Bernadino; 15S, 16S, 17S, 18S; 20E, 21E, 22E, **23E**

Practice:
- **SURFACE IRRIGATION (Landleveling (previously leveled)**
- SURFACE IRRIGATION (Unleveled)
- SPRINKLER IRR. (Hand Move/Side Roll)
- SPRINKLER IRR. (Solid Set, Undertree)
- DRIP IRRIGATION

Estimated "before" water use 75.7 Ac-in/Ac

Notes:
The outputs of this tool are intended as estimates only for the purpose of understanding the potential for various irrigation practices and management techniques to save water.

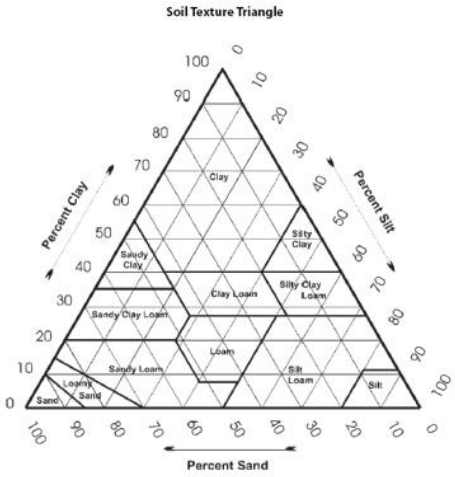
Before and after practice water use estimated as crop ET adjusted by appropriate system efficiencies. Water provided by effective rainfall and water required for other beneficial uses are not considered because the effect on water savings is negligible.

Data Sources:
Crop ET from NRCS CA Consumptive Use database, representative planting and harvesting dates, UC crop coefficients and CIMIS normal ETo data.

"Predominant Soil" menu: If the actual infiltration rate of a soil at a practice site is significantly different than would be expected for its texture, then select a soil texture that best represents the actual infiltration rate.

For a more detailed explanation of how this tool works, see the **"Background Info and Assumptions"** tab.

ET Zone 18



"Before"

Instructions | **Before** | After | Water Savings Estimate | Background Info and Assumptions

SWEEP Irrigation Water Savings Assessment Tool

SWEEP Irrigation Water Savings Assessment Tool

The "after" scenario tab represents the desired situation on the field. Complete this tab to represent the "post-project" conditions. An *estimate* of projected water use will be calculated based upon the field location, soil type, irrigation method, and change in the level of irrigation management. See the instruction tab for more information on the levels of water management.

Predominant Soil
Sand
Loamy Sand
Sandy Loam
Fine Sandy Loar
Loam
Silt
Clay Loam
Clay

Crop
Alfalfa
Almonds
Apple
Artichokes
Asparagus
Avocado
Barley (planting 11/
Barley (planting 4/3(

Baseline, Township, Range
Humboldt
Mt. Diablo
San Bernadino
15S
16S
17S
18S
20E
21E
22E
23E

Practice
SPRINKLER IRR. (Solid Set, Undertree) (Replace surface irrigation)
SPRINKLER IRR. (Solid Set, Undertree)(Replace hand move sprinkler)
DRIP IRRIGATION (No change)
DRIP IRRIGATION (Replace surface irrigation)
DRIP IRRIGATION (Replace under tree, solid set sprinkler or drip)

Water Management
No Change in IWM plan
Increase IWM by 1 Level
Increase IWM by 2 Levels
Increase IWM by 3 Levels

Estimated "after" water use 53.0 Ac-in/Ac

Notes:
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Data Sources:
Crop ET from NRCS CA Consumptive Use database, representative planting and harvesting dates, UC crop coefficients and CIMIS normal ETo data.

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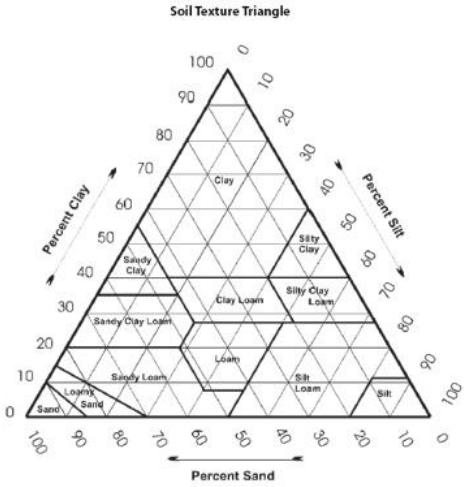
ET Zone 18



"After"

Instructions | Before | After | Water Savings Estimate | Background Info and Assumptions

"Applicants may attach supplementary information that will allow technical reviewers to refine water savings estimates."

I28

SWEEP Irrigation Water Savings Assessment Tool

Estimated "Before" Scenario Water Use	75.71	ac-in/ac
Estimated "After" Scenario Water Use	53.00	ac-in/ac
Annual Estimated Water Savings	22.71	ac-in/ac
Percent Water Savings	**30.00**	%

Energy Use Documentation

Energy Supporting Document (for 12 months)

Utility bills, actual fuel receipts, and/or field operational logs "justify why there is no energy use."

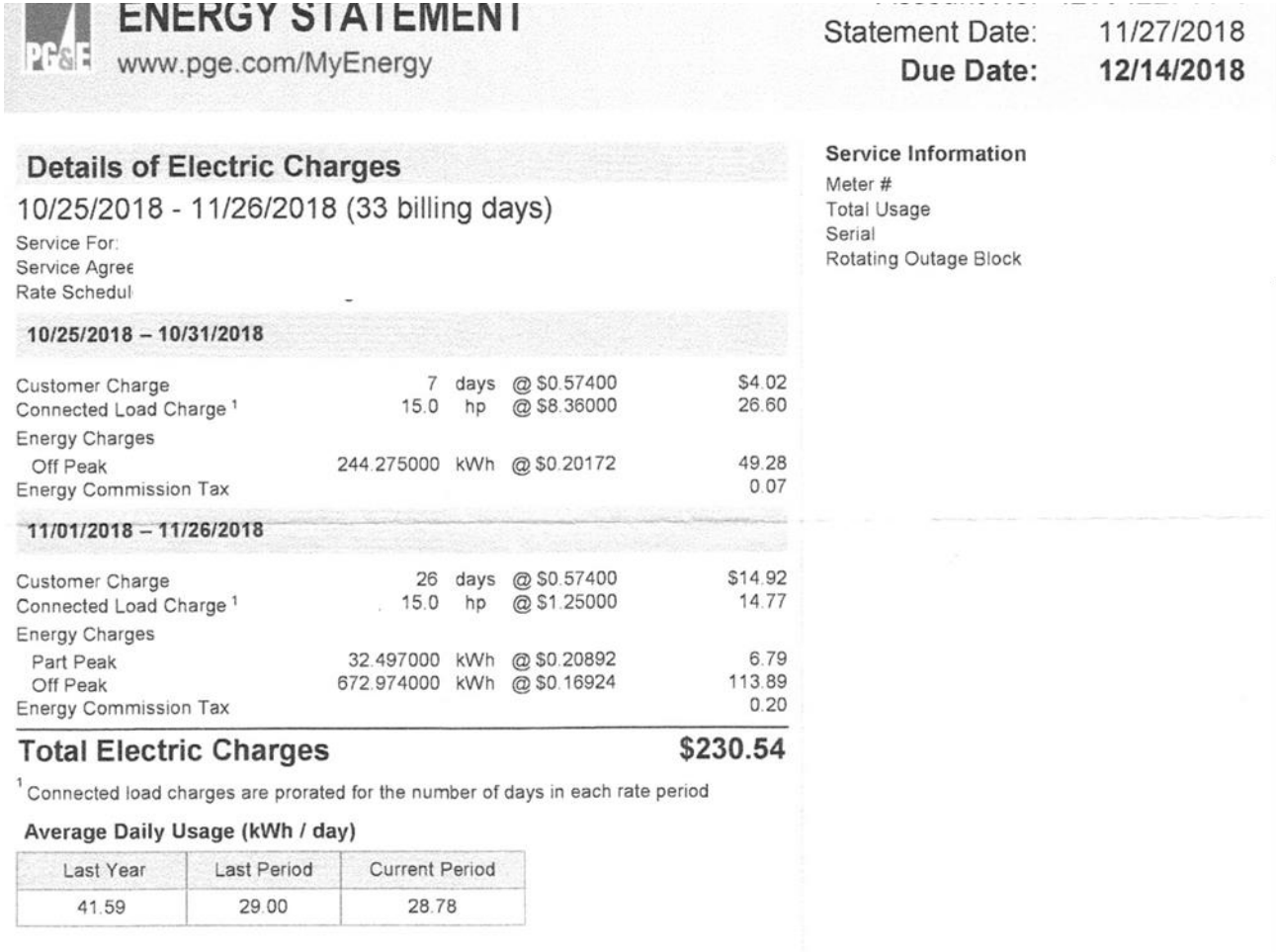
Crop rotation: up to three years of supporting documents may be provided to substantiate a representative baseline of energy use from pumping.

Pump and motor specifications for proposed pumps.

Energy Supporting Document (for 12 months)

Summary

Nov-18	949.746 kWh
Dec-18	0 kWh
Jan-19	0 kWh
Feb-19	887.097 kWh
Mar-19	5.899 kWh
Apr-19	672.219 kWh
May-19	522.063 kWh
Jun-19	702.259 kWh
Jul-19	1209.373 kWh
Aug-19	1080.009 kWh
Sep-19	781.742 kWh
Oct-19	714.11702 kWh
Total	7524.52402 kWh



ENERGY STATEMENT

www.pge.com/MyEnergy

Statement Date: 11/27/2018

Due Date: 12/14/2018

Details of Electric Charges

10/25/2018 - 11/26/2018 (33 billing days)

Service For:
Service Agree
Rate Schedul

Service Information
Meter #
Total Usage
Serial
Rotating Outage Block

10/25/2018 – 10/31/2018

Customer Charge	7	days	@ $0.57400	$4.02
Connected Load Charge [1]	15.0	hp	@ $8.36000	26.60
Energy Charges				
Off Peak	244.275000	kWh	@ $0.20172	49.28
Energy Commission Tax				0.07

11/01/2018 – 11/26/2018

Customer Charge	26	days	@ $0.57400	$14.92
Connected Load Charge [1]	15.0	hp	@ $1.25000	14.77
Energy Charges				
Part Peak	32.497000	kWh	@ $0.20892	6.79
Off Peak	672.974000	kWh	@ $0.16924	113.89
Energy Commission Tax				0.20

Total Electric Charges **$230.54**

[1] Connected load charges are prorated for the number of days in each rate period

Average Daily Usage (kWh / day)

Last Year	Last Period	Current Period
41.59	29.00	28.78

Budget Worksheet

- Itemize all allowable costs related to project in categories
  - Supplies
  - Equipment
  - Labor
  - Other
- Must be consistent with project design
- Use the USDA NRCS EQIP Payment schedules as a guide, to the extent feasible, to determine reasonable costs

Budget Worksheet

Budget Worksheet

Organization Name:		Total Grant Request:	$0.00
		Matching Funds:	$0.00

Budget Category	Irrigation System Improvements			$0.00	Irrigation Water Management			$0.00
	This project type can include costs such as the drip or micro sprinkler system or central pivot irrigation, etc.				*This section can include costs such as flowmeter, soil moisture sensors, ET sensors, weather station, telemetry, etc.*			
	Description		QTY	Subtotal	Description		QTY	Subtotal
$0.00 Total Supplies **SUPPLIES AND EQUIPMENT:** *Itemize costs to purchase materials necessary for project implementation. Supplies are items costing <$5,000 per unit and equipment are items costing => $5,000 per unit.*								
$0.00 Total Other **OTHER:** *Itemize cost of all other expenses not covered in other budget categories (e.g. equipment rentals, county permits, subscription software,*								
$0.00 Total Labor #DIV/0! cover by grant **LABOR:** *Itemize costs for any work on the project that will be performed by individuals associated with a contractor. Do not include non-labor costs (i.e., project management) and fees associated with project oversight, including travel costs to/from the project site.*	Description of Services	Cost/hour	Hours	Subtotal	Description of Services	Cost/hour	Hours	Subtotal
				$0.00				$0.00
				$0.00				$0.00
				$0.00				$0.00
				$0.00				$0.00
				$0.00				$0.00
				$0.00				$0.00
				$0.00				$0.00
				$0.00				$0.00
				$0.00				$0.00
				$0.00				$0.00
				$0.00				$0.00
MATCHING FUNDS: Funds that are coming from a source outside of the project grant and committed during the grant duration. Specify whether matching funds are in the form of	Description	Cash or In-Kind?		$0.00	Description	Cash or In-Kind?		$0.00

Budget Worksheet

Pump and Energy Improvements			$0.00
This project type can include costs such as installing a new motor, retro-fitting pump / bowl, VFD, etc.			
Description		**QTY**	**Subtotal**
Description of Services	**Cost/hour**	**Hours**	**Subtotal**
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
Description	**Cash or In-Kind?**		**$0.00**

Solar / Renewable Energy Projects			$0.00
(size kW)			
Renewable energy projects must include costs breakdown for PV panels, inverters, racks, etc. in this section.			
Description		**Qty**	**Subtotal**
Description of Services	**Cost/hour**	**Hours**	**Subtotal**
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
Description	**Cash or In-Kind?**		**$0.00**
Renewable rebates and incentives			

Other Management Practices			$0.00
This section can include costs related to innovative projects that does not fit in the previously mentioned project types but can still reduce water usage and reduce GHG emissions.			
Description		**QTY**	**Subtotal**
Description of Services	**Cost/hour**	**Hours**	**Subtotal**
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
			$0.00
Description	**Cash or In-Kind?**		**$0.00**

Quote for flowmeter & soil moisture

FGS Irrigation Department. We appreciate this opportunity to serve you and are pleased to present this estimate. FGS recommends that any chemical injection systems be installed with a reduced pressure backflow device(s) between the water source(s) and the injection point(s). Additional labor, material, and ditching charges may be made if unforeseen soil conditions are encountered. Responsibility for special order items are assumed by the customer at the time of sale.

Actual material and/or labor used will be billed.

Estimate Details

Item	Material Description	Tax Code	Quantity	Unit Price	Amount
0001	101413 BOLT HEX HD 5/8" x 2-1/2" PLTD NC	22	8 EA		
0002	105842 FLANGE STEEL 4.00"	22	2 EA		
0003	106227 GASKET FLANGE FULL FACE 4.00"	22	2 EA		
0004	125167 METER FLOW 4.00" FLNG ACRE FT / GPM	22	1 EA		
0005	DO206 MISC HARDWARE	22	1 EA		
0006	127808 MONITOR WATERMARK W/SENSOR CELL SERVICE	21	1 EA		
0007	101449 NUT HEX HEAD NC PLTD 5/8"	22	8 EA		
				Material	2,835.49
				Labor	1,045.49
				Freight	0.00
				Total Tax	159.38
				Total Amount USD	**4,040.36**
	Thank you for your order				

Quote for Solar System

Email:

FOR:
Attention:

FROM:

GROUND MOUNT

RE: Service account number
Annual kWh usage 7,524
Average cost per kwh $0.400
Inverter Efficiency 97.0%
Module Rating 410

To annually produce the kWh's that are used requires
11 modules, and would have a rated capacity of KW- **4.510**

Cost	$23,587.30
You pay	$23,587.30
Federal tax credit (26%)	-$6,132.70
	$17,454.60
Accelerated 5-year depreciation (39% tax rate)	-$9,199.05
	$8,255.56
$2,996.40 is the value of electricity generated per year, times 3 years, to recover the total investment at todays rates	-$8,989.20
AND BE MONEY AHEAD	**$733.65**

FUTURE PAYBACK AFTER TOTAL INVESTMENT RECOVERY

7,491 kWh's produced annually, multiplied by $0.80 equals the future savings per year, ***after*** recovery of the total investment.	$5,992.80
$ 149,820.00 is required to be invested at 4% tax-free, to yield the same amount.	$5,992.80

#Panel?
#Convertor?
Installation costs?

Allowable Costs

- All components of irrigation systems
- Sensor hardware and telemetry
- Software associated with sensors and weather stations
- Flow meters
- Permits
- Installation of photovoltaic panels to power irrigation systems

Unallowable Costs

- Project design costs (e.g., engineering)
- Costs associated with technical assistance
- Post-project service charges and maintenance costs associated with the irrigation system
- Non-labor costs (e.g., management) and fees associated with project oversight
- Labor costs in excess of 25 percent of the total SWEEP grant request
- Any labor provided by the applicant or applicant's employees (such costs could be categorized as "in-kind")
- Supplies and equipment costs not related to irrigation or water distribution systems
- Tools and equipment with useful life of less than two years
- Costs associated with drilling of new or expanding groundwater wells
- Purchase of trees, crops, or seeds

Scoring Categories

Criteria	Maximum Points
Merit and Feasibility	16
Quantity of Water Savings & Calculations	12
Assurance of No GHG Emission Increase	12
Budget	10
Total	**50**

You need at least 25 points

Farmers who identified as belonging to a **socially disadvantaged group** will receive **priority for founding** if they meet a **minimum score of 25 points.**

Tips for Strong Projects

- Review SWEEP YouTube Videos
- FAQ https://www.cdfa.ca.gov/oefi/sweep/
- Review previously funded projects
- Multiple practices/improvements
- Reasonable costs for crop production system
- Reasonable water saving without GHG increase
- Simple explanation/clarifications for each part
- Minimum score is 25 out of 50 (easier than before/ compete within the region)

Timeline

Program Application Activity	Timeframe*
Release Request for Grant Application (RGA)	September 13, 2022
Grant application due	November 8, 2022
Administrative and technical review	November-December 2022
Announce and award funding	January 2023
Grant Execution	See Award Process
Award Project Implementation	May 1, 2023 – November 1, 2024

Online application

cdfa CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

Programs | Services | Meetings | Laws/Regs | Statistics | Publications | Search

Figure 1. The area outlined consistes of both Riverside and Imperial counties and is east of the Santa Rosa and San Jacinto Mountains.

Application Materials:

- 2021 SWEEP Pilot Request for Grant Applications (RGA)
- 2021 SWEEP Pilot Budget Worksheet
- SWEEP Irrigation Water Savings Calculator
- 2021 SWEEP Pilot Technical Assistance Providers

CDFA Informational Webinar:

- SWEEP Pilot Informational Webinar

Frequently Asked Questions can be referenced below. Review the FAQ document before submitting questions to CDFA. SWEEP Pilot questions can be submitted to cdfa.sweeptech@cdfa.ca.gov before October 10, 2022 at 5pm PT. Questions will be standardized and answered in an updated FAQ document that will be released October 17, 2022.

- 2021 Pilot Frequently Asked Questions

SWEEP Pilot Application 2021

SWEEP Irrigation Water Savings Calculator

SWEEP GHG Calculator

Application Portal

Resources

UC Community Education Specialist

Technical Assistance Providers

SWEEP flyer 2022

SWEEP Pilot Flyer

2021 SWEEP Public Comments

2021 SWEEP RGA Public Comment Summary

Past Solicitations

List of Agricultural Management Practices Incentivized by SWEEP

Irrigation Technical Resources

SWEEP Sub-Advisory Group

Related Grant Opportunities

Healthy Soils Incentives Program

Conservation Agriculture Planning Grant Program

Grant Opportunities for Producers

https://www.cdfa.ca.gov/oefi/sweep/

Thank You (Q & A)

Contact information for technical assistance/application:

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Community Education Specialist
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