

# Assessment of Satellite-Derived Crop ET Compared to Low Cost In-situ ET sensor for Precision Irrigation in Alfalfa

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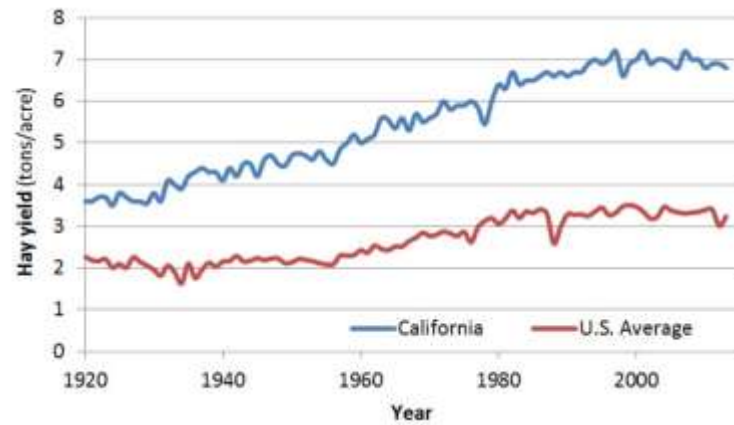
Stanislaus, San Joaquin & Merced

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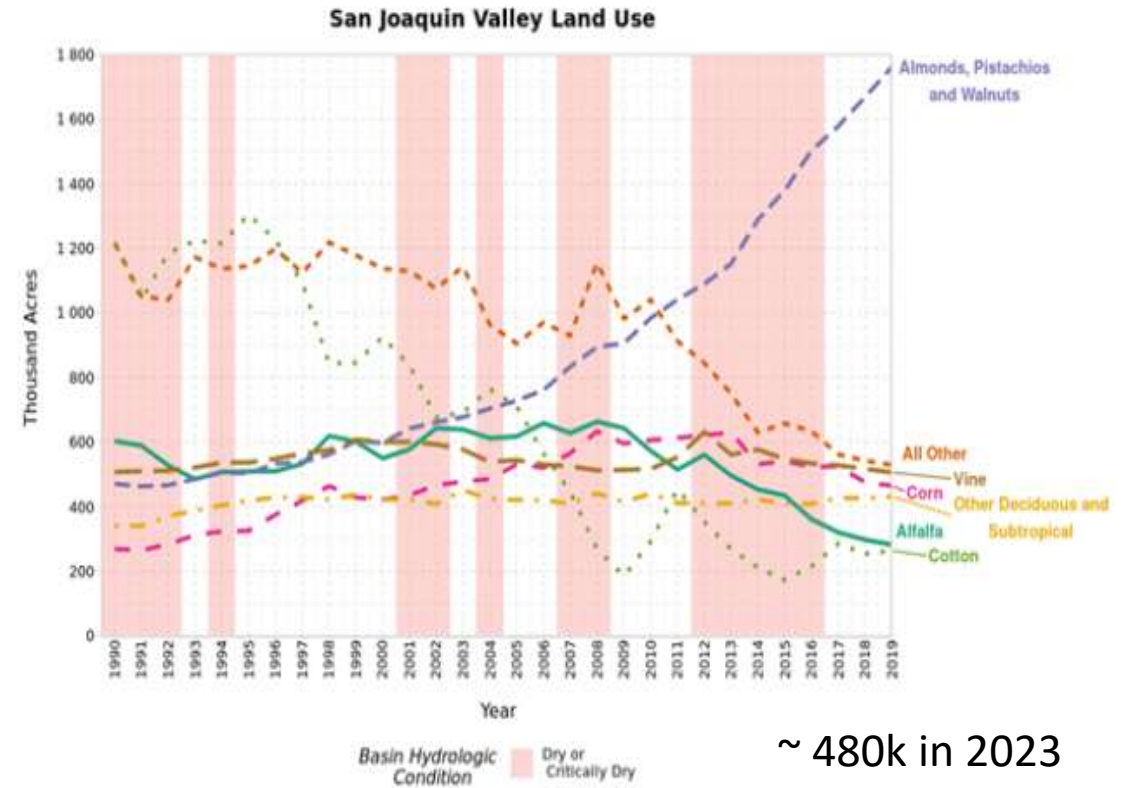
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Advances in Irrigation and Water Management  
Workshop December 10<sup>th</sup>, 2024

# Overview of alfalfa production in California



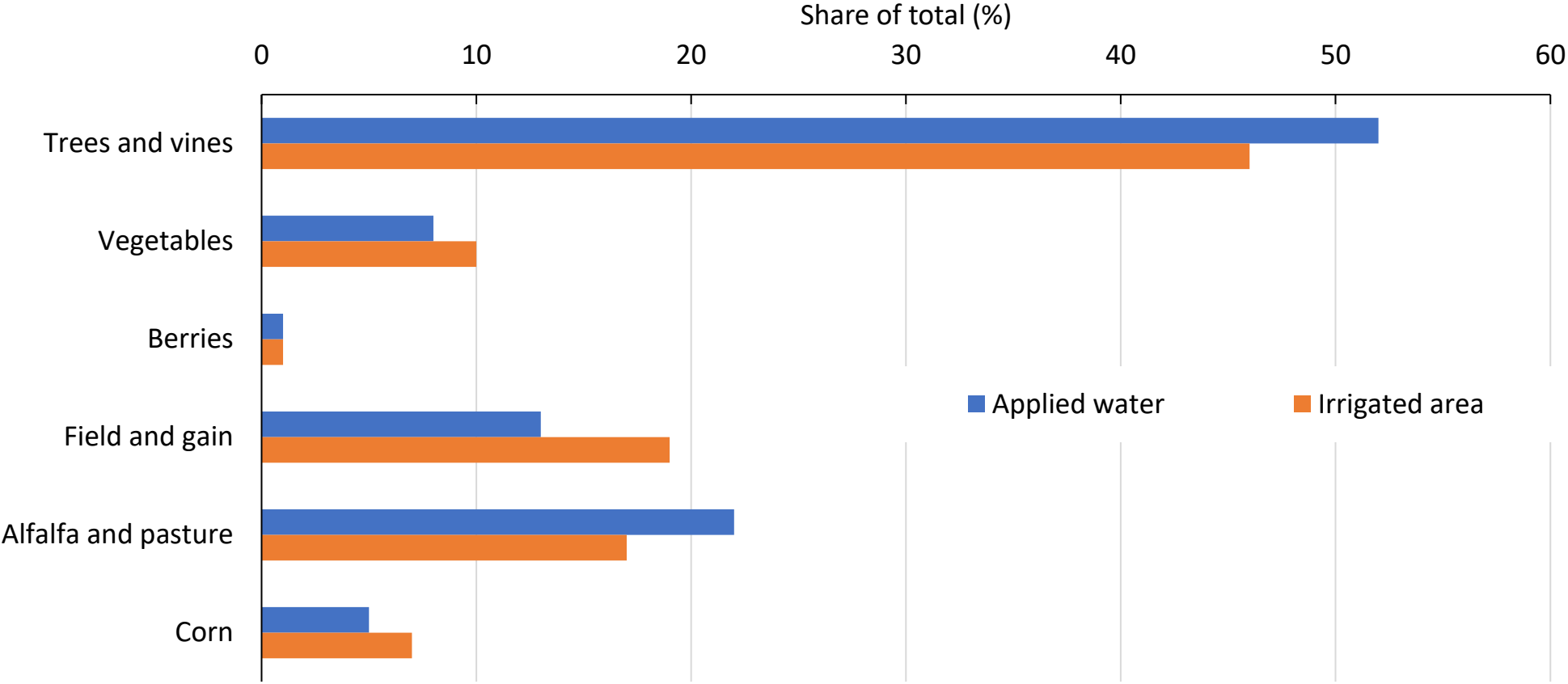
Source: Geisseler and Horwath (2016)



~ 480k in 2023

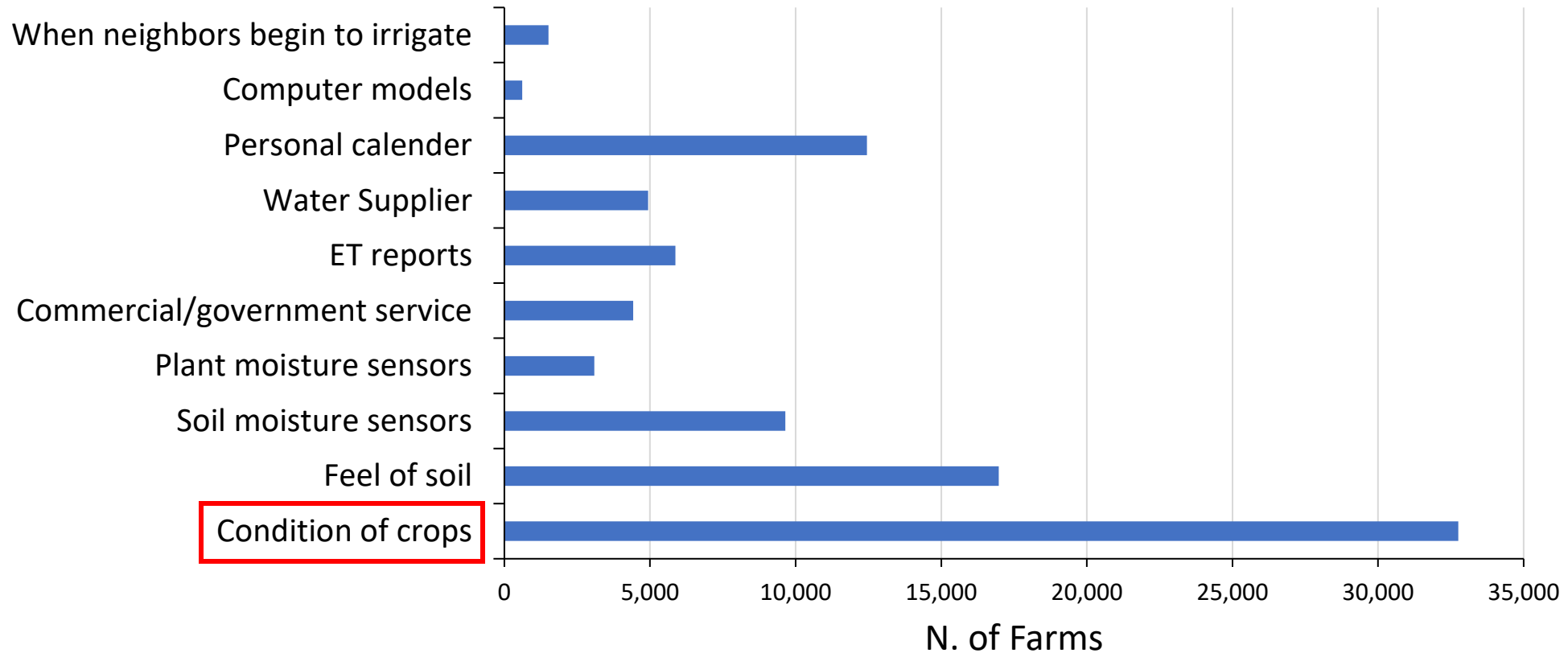
<https://californiawaterblog.com/2021/09/05/lessons-from-three-decades-of-evolution-of-cropland-use-in-the-central-valley/>

# Agriculture Water Use in California



Data source: DWR, USDA NASS

# Methods Used in Deciding When to Irrigate in California



# When Can I safely turn it off? For how long?

## ❖ Soil-based

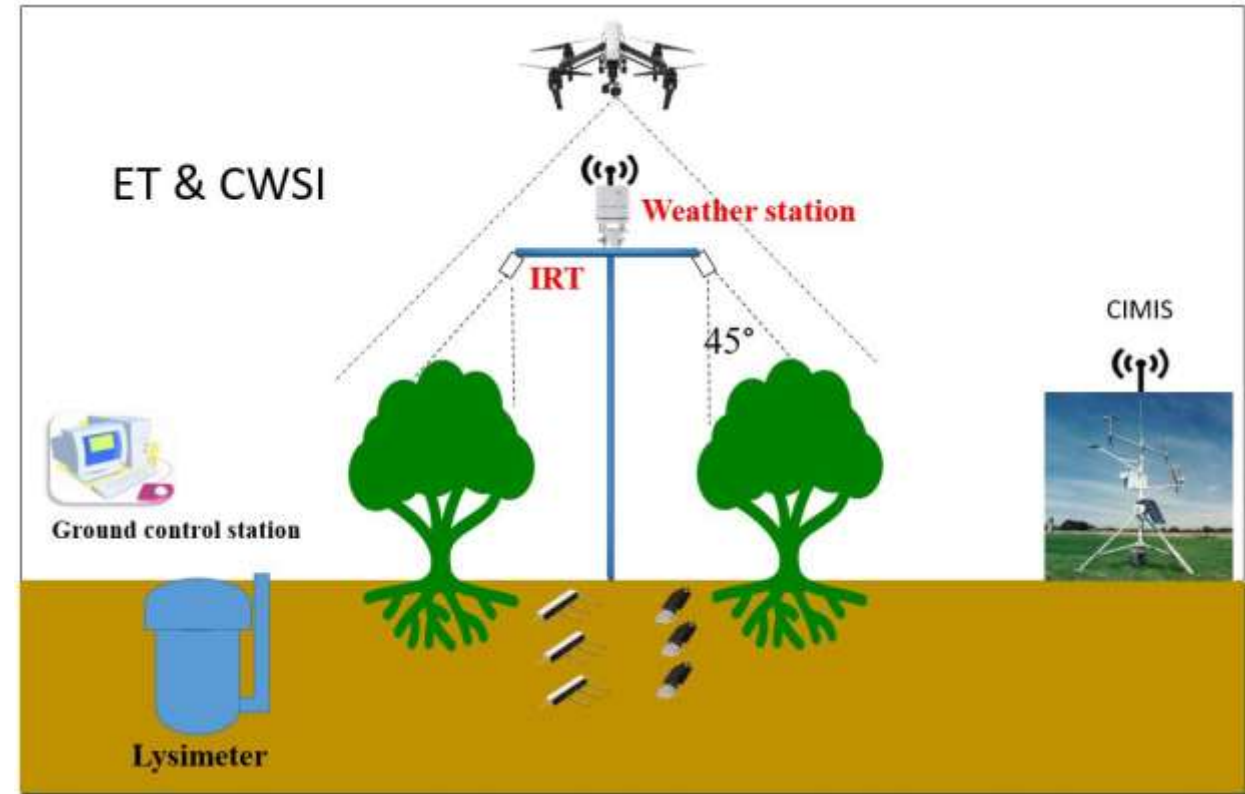
- Soil moisture sensors

## ❖ Weather-based

- ET and crop coefficients

## ❖ Plant-Based

- Stem/leaf water potential and sap flow gauges
- Canopy temperature



# CIMIS Calculated ET

$ET_o$  = Evapotranspiration rate of a reference crop (tall grass).  
Function of the weather

X

$K_c$  = crop coefficient for a given stage of growth as a ratio of short grass water use. Function of the plants

=

$ET_c$  = Crop water use



The screenshot displays the CIMIS (California Irrigation Management Information System) website. At the top, there is a navigation bar with links for HOME, STATIONS, DATA, SPATIAL, and RESOURCES. Below this, a 'Notices' section contains a message about the FTP update to SFTP. To the right, there are tabs for Station List, Station Location Map, Siting, Sensors, and Maintenance. A text box explains that the Bing Map shows CIMIS station coordinate points. Below the text, there are radio buttons for 'Active Stations' (selected) and 'Inactive Stations'. The main part of the screenshot is a map of California and Nevada with numerous blue circular markers representing station locations. A 'Road' dropdown menu is visible in the top right corner of the map area.

# Stanislaus County



## Weekly Crop Water Use Report

### Weekly Crop Water Use Report

This is an email list that will primarily be used to send out water use surveys to clients of Roger Duncan and Kari Arnold.

[Subscribe](#)

Issue	Articles	Type	Date Added
<a href="#">Evapotranspiration Report - 11/2/2023</a>	<p>Hello All:</p> <p>Please find the attached document to provide the previous week's estimated water use report in terms of evapotranspiration for almonds, peaches, walnuts, established vineyard, alfalfa, and pasture in Stanislaus County. This report may be used as a guide</p>	PDF	11/3/23

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# OPENET

<b>Model Acronym</b>	<b>Model Name</b>
ALEXI/DisALEXI	Atmosphere–Land Exchange Inverse/Disaggregation of the Atmosphere–Land Exchange Inverse
eeMETRIC	Google Earth Engine implementation of the Mapping Evapotranspiration at high Resolution with Internalized Calibration
geeSEBAL	Google Earth Engine implementation of the Surface Energy Balance Algorithm for Land
PT-JPL	Priestley–Taylor Jet Propulsion Laboratory
SIMS	Satellite Irrigation Management Support
SSEBop	Operational Simplified Surface Energy Balance



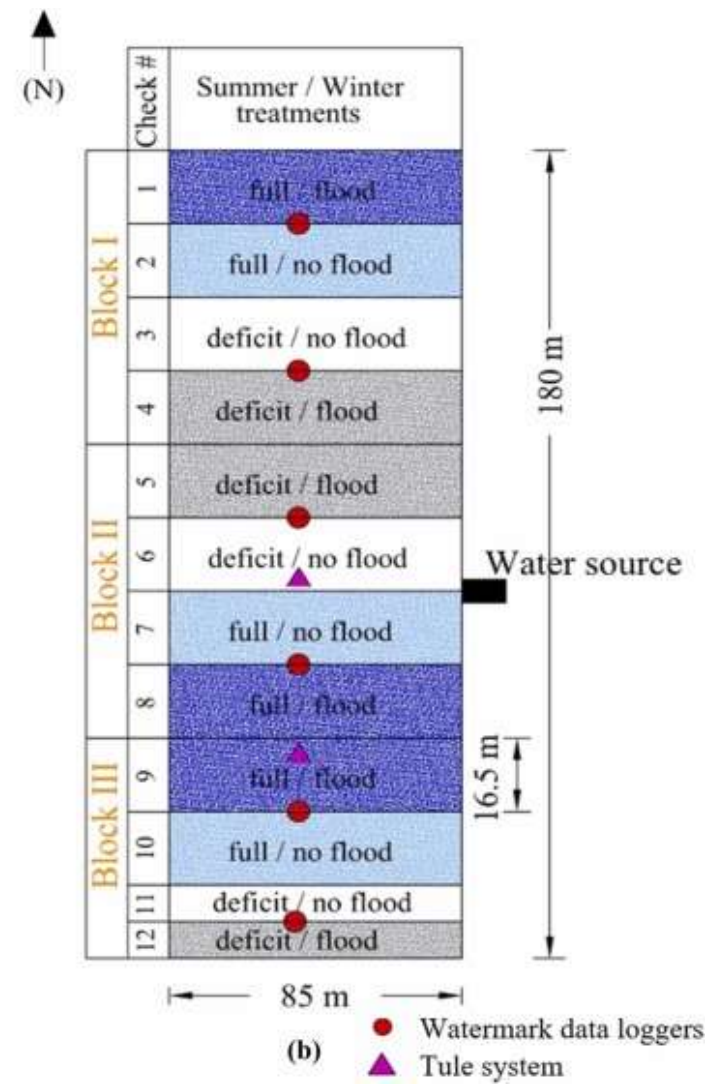
# How OPENET works?

- Daily ET is estimated by interpolation between satellite (Landsat) overpasses, typically occur every 8 or 16 days
- Fraction of reference  $ET_0$  for each clear overpass =  $\frac{\textit{Satellite-derived ET}}{ET_0 \textit{ for that date}}$
- This ratio is then linearly interpolated between the clear overpass dates
- Interpolated values are then multiplied by the daily  $ET_0$  to generate a continuous daily time series of  $ET_a$  for each pixel
- This approach incorporates adjustments for vegetation changes and daily weather variations

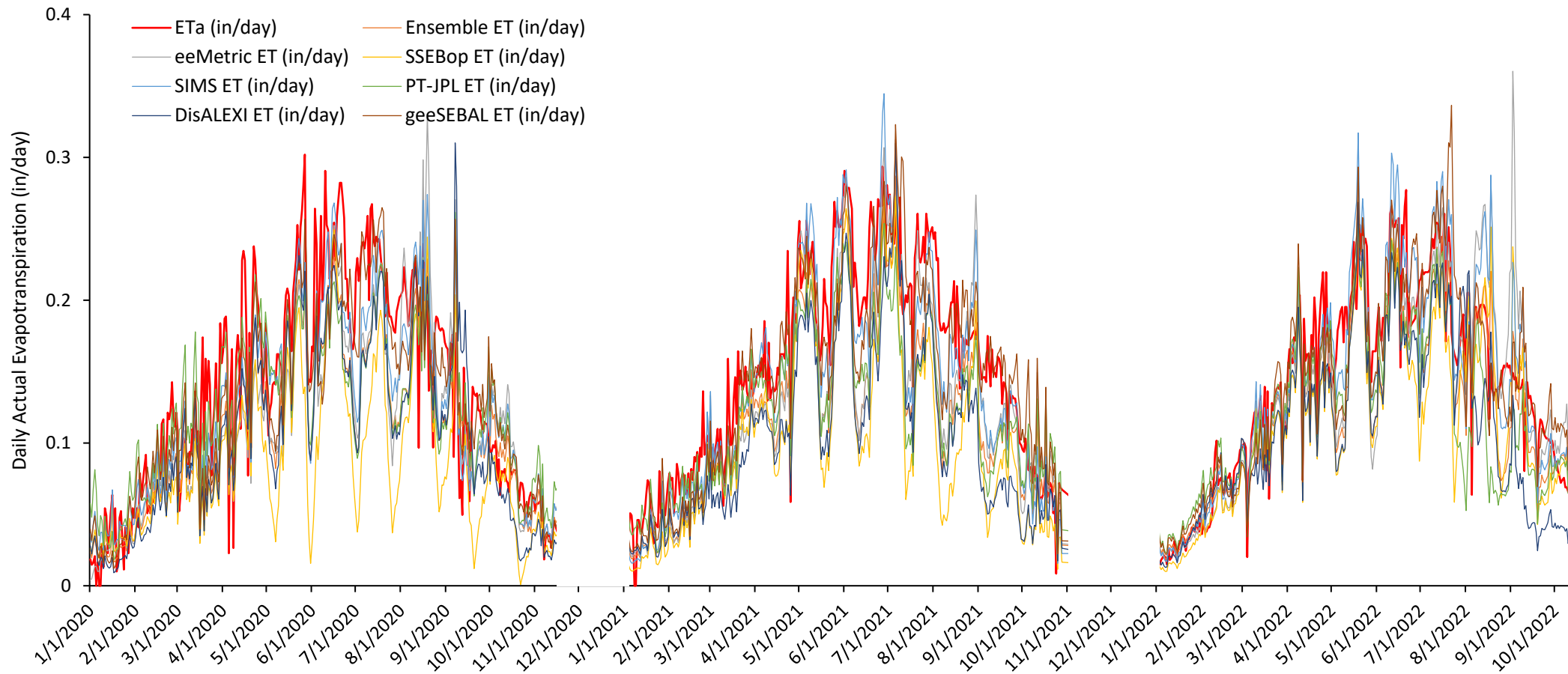


(a)

**Alfalfa: 3.7 acres**  
 Planted in 2019  
 Flood Irrigation



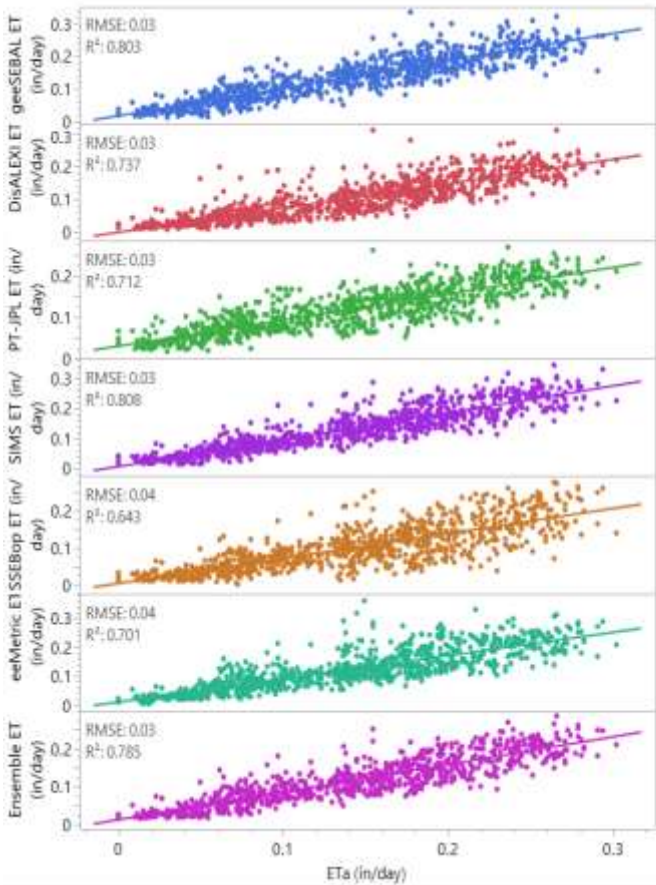
# Daily ET<sub>a</sub> for different models



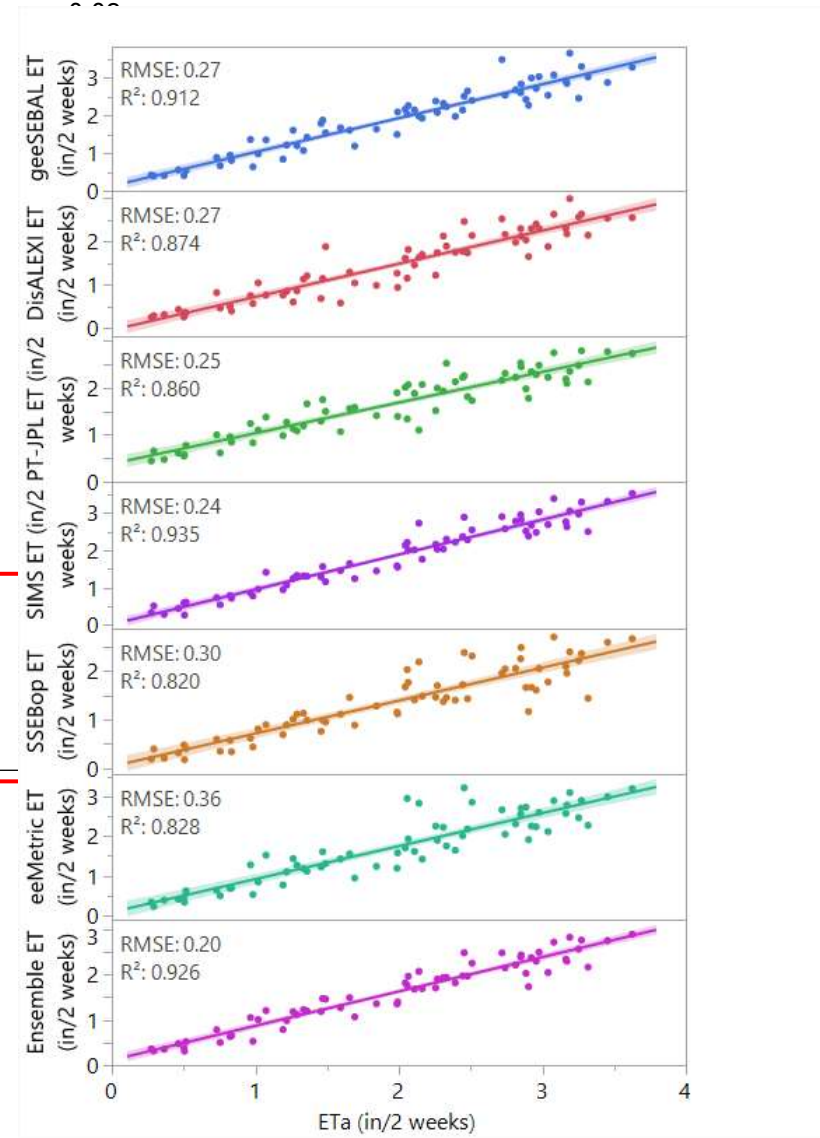
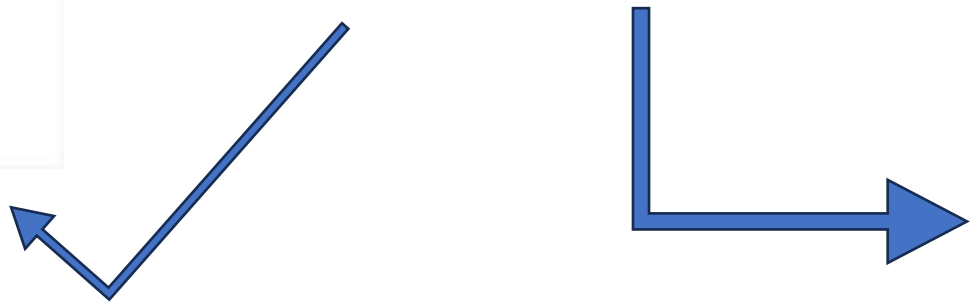
# Seasonal ET

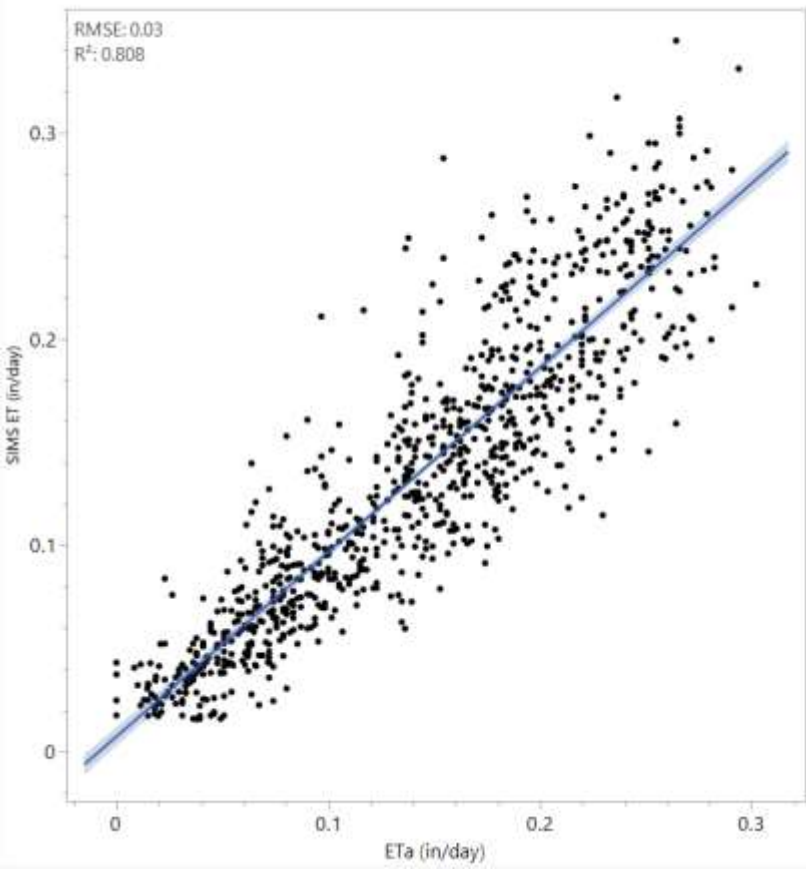
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	ETa	Ensemble	eeMetric	SSEBop	SIMS	PT-JPL	DisALEXI	geeSEBAL
2020	43.4	34.9	36.3	27.7	39.7	39.1	33.5	40.7
2021	45.3	35.0	38.0	29.8	41.2	35.7	30.5	43.4
2022	39.7	35.1	38.4	32.1	40.6	33.9	31.0	40.2

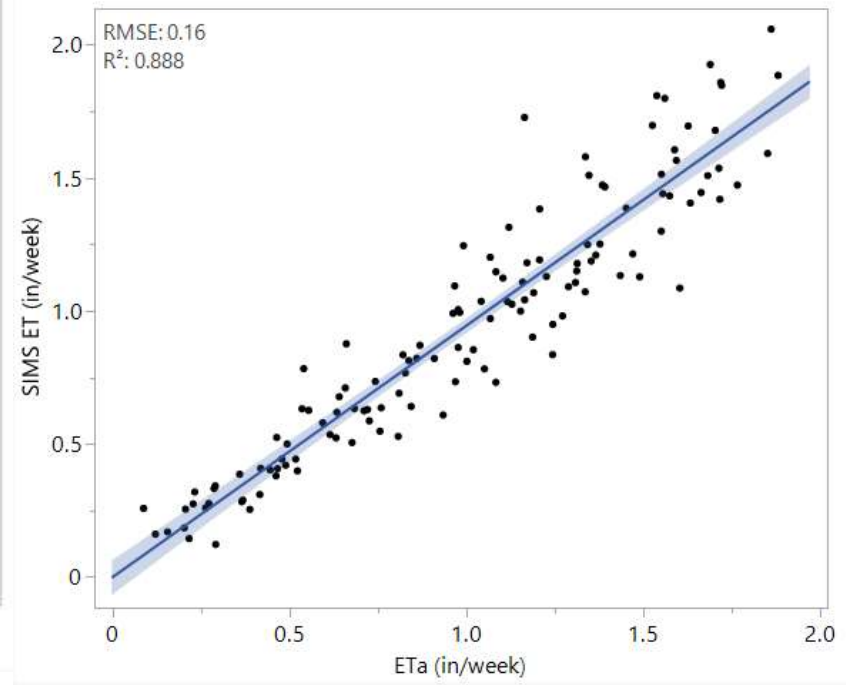


	Ensemble	eeMetric	SSEBop	SIMS	PT-JPL	DisALEXI	geeSEBAL
2020 (n=321)							
R <sup>2</sup>	0.75	0.64	0.56	0.77	0.65	0.70	0.79
MAE	0.04	0.04	0.05	0.03	0.04	0.04	0.04
MBE	0.03	0.02	0.05	0.01	0.01	0.03	0.03
MPE	19.59	16.47	36.08	8.44	9.82	22.73	22.73
2021 (n=301)							
R <sup>2</sup>	0.82	0.79	0.71	0.86	0.78	0.79	0.79
MAE	0.04	0.03	0.05	0.02	0.04	0.05	0.05
MBE	0.03	0.02	0.05	0.01	0.03	0.05	0.05
MPE	22.73	16.16	34.12	9.12	21.07	32.61	32.61
2022 (n=284)							
R <sup>2</sup>	0.82	0.72	0.75	0.84	0.76	0.77	0.77
MAE	0.02	0.03	0.03	0.02	0.03	0.04	0.04
MBE	0.02	0.00	0.03	0.00	0.02	0.03	0.03
MPE	11.64	3.23	19.30	-2.19	14.68	21.92	21.92
<b>Combined (n = 906)</b>							
R <sup>2</sup>	0.78	0.70	0.64	0.81	0.71	0.74	0.74
MAE	0.03	0.03	0.05	0.02	0.03	0.04	0.04
MBE	0.03	0.02	0.04	0.01	0.02	0.04	0.04
MPE	18.24	12.26	30.20	5.39	15.29	25.96	25.96

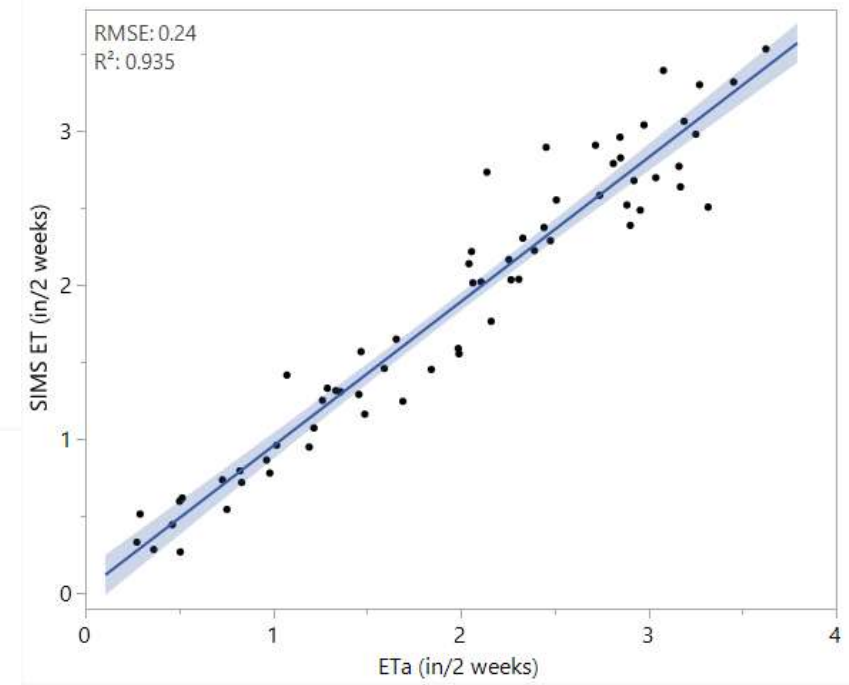




Daily



weekly



Bi-weekly

# Summary

- Most of the models had a general tendency to overestimate actual ET
- The SIMS model had the best agreement with low-cost ET sensor while SSEBop model showed the lowest agreement
- Actual ET measurement using eddy covariance system could improve the understanding of OpenET models in irrigation management decision in alfalfa
- Further validation through replication across multiple sites is essential to confirm these findings so growers can confidentially incorporate them in their irrigation management decision



Thanks!  
Gracias!

**Questions!**

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Contact:

