Final project report

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Adapting a User-friendly Online Irrigation Calculator for Avocados

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Executive summary:
The Irrigation Calculator has been successfully adapted to avocado production in Ventura County. It can be accessed via desktop/laptop and smart phone through the following page:

https://ucanr-igis.shinyapps.io/irrigation-calc-avo/

The features created for this calculator were discussed among the participants of this project. These changes include but are not limited to creating and incorporating orchard maturity stages and the newly created crop coefficients for each stage, adding a toggle to increase the irrigation recommendation of south facing slopes by 20%, and creating and implementing two options for the application rate calculator (emitter rate and flow rate). For improved accuracy, the calculator also uses weather station data from both CIMIS and additional stations strategically situated by UCCE to capture the region's microclimates.

While beta-testing was limited to only a few growers, usage will be expanded once more ET weather stations are added in the main avocado producing areas. The irrigation recommendations created by this calculator are only as accurate as the data that feeds the calculator. With many micro-climates in Ventura County, and a lack of weather stations along and north of Santa Paula freeway 126, irrigation recommendations made for those areas need to use data from different areas, which can be a source of inaccuracy. This aspect will be addressed in the next couple of years with the expansion of the new network of ET weather stations by UC ANR Ventura (funded by grants from the California Avocado Commission and UC ANR) . Once additional stations are implemented, the irrigation calculator will be programed to access that data. While it is possible to expand the Irrigation Calculator to other regions in California, special attention is required to make sure the local environment is thoroughly assessed so that weather stations are representative of the production fields environments.

Introduction/Background:
Irrigators and farm managers are the frontliners of irrigation management decisions and therefore essential parties for conserving water and optimizing crop yield and plant health.

However, decisions on how long to irrigate a crop are made with no data in most cases. Significant improvements in water use efficiency can be achieved with increased adoption of data-driven irrigation decision frameworks. With weather conditions constantly changing, estimating crop water needs on a weekly basis can be a challenging task in the absence of relevant data such as weather associated with current crop coefficients. To address this issue and to increase adoption of information-driven irrigation decisions, co-PIs Biscaro and Lyons have worked for the last few years to develop a user-friendly online irrigation calculator initially created for strawberry, celery, cabbage, broccoli and cauliflower. This project, funded by the California Avocado Commission, adapted that calculator to avocado production in Ventura County.

Objective:
Improve irrigation efficiency of avocado orchards through a user-friendly calculator that creates ET-based irrigation recommendations with only a few clicks.

Materials and methods:
The calculator has been developed as a mobile-friendly website, so it works with all phones, tablets, and laptops provided the device has an internet connection. The calculator is built using the R programming language, which is open source and widely taught in colleges and universities for continuity and sustainability.

The calculator has been designed for flexibility, such that the crops and locations that are shown can be customized by making small changes to the URL. This also allows variations of the calculator to be quickly created for specific crops and areas.

To make an irrigation recommendation, the calculator must download recent weather data from CIMIS or Western Weather Group. It does this 'on-the-fly' so there is no need to save a copy of the weather data on the website.

The calculator does not require the user to log-in or provide any info, so usage is completely anonymous. Visits to the site are tracked anonymously so that the PIs can monitor usage via a custom dashboard (Figure 5).

Results:
The calculator is designed with a simple user interface that works well on phones (Figure 1). Once the page loads, the user has to make a few selections including the orchard stage, ET zone (which they can select from a map, see Figure 2), application rate, and date of last irrigation or significant precipitation. Information buttons provide additional details on each input. If the user doesn't know the irrigation rate of their system, they can click on the calculator icon to open a mini calculator and estimate the application rate using the emitter or flow rate methods (Figure 3).

When the user clicks 'Calculate', the calculator connects to the weather station(s) for the selected ET zone, downloads the most recent reference ET and precipitation data, and does all the calculations. This normally takes only 1-2 seconds, after which the user sees

the recommended number of minutes to irrigate, with a link to view more details of the calculation (Figure 4). This simple design is intended to allow a user to get an irrigation recommendation quickly and with only a few clicks.

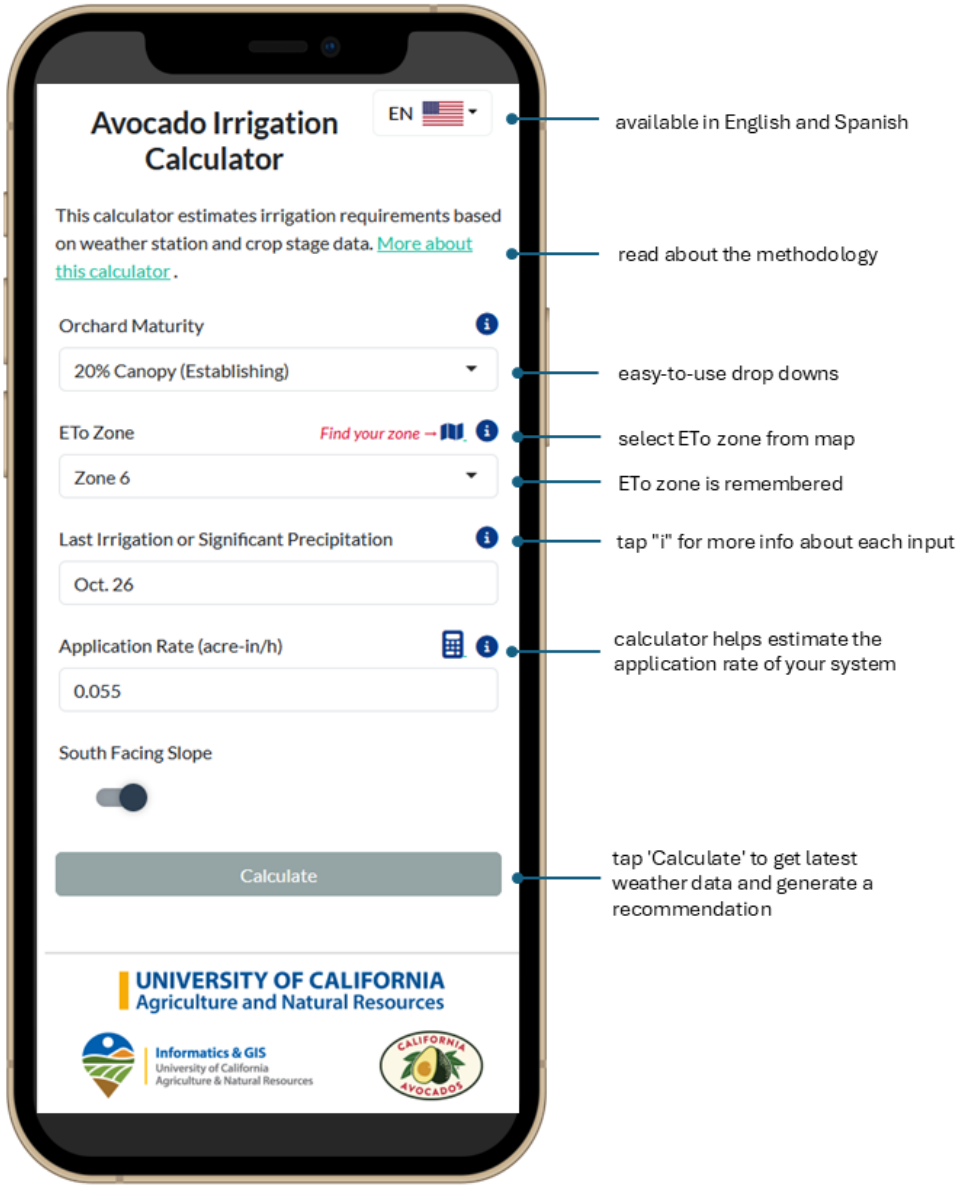

Figure 1. Irrigation Calculator User Interface

Figure 2. ETo Zones Map

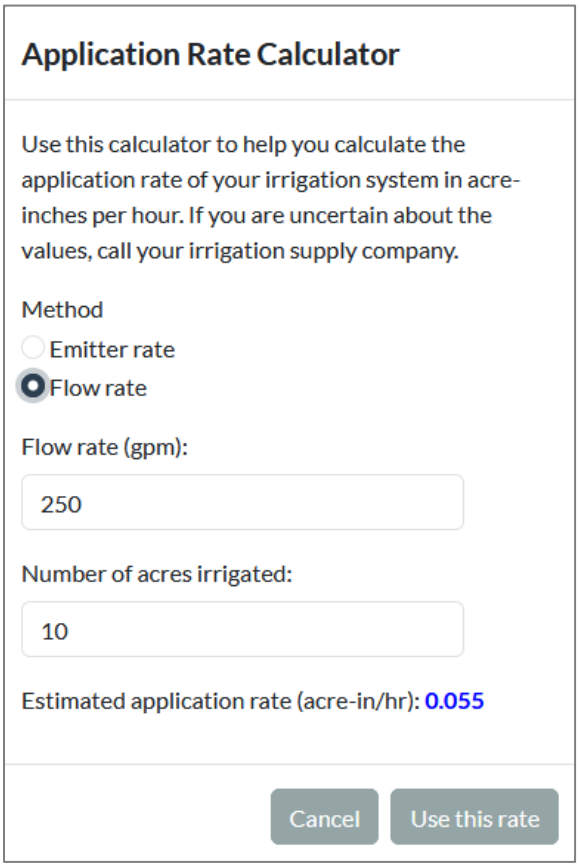

Figure 3. Application Rate Calculator

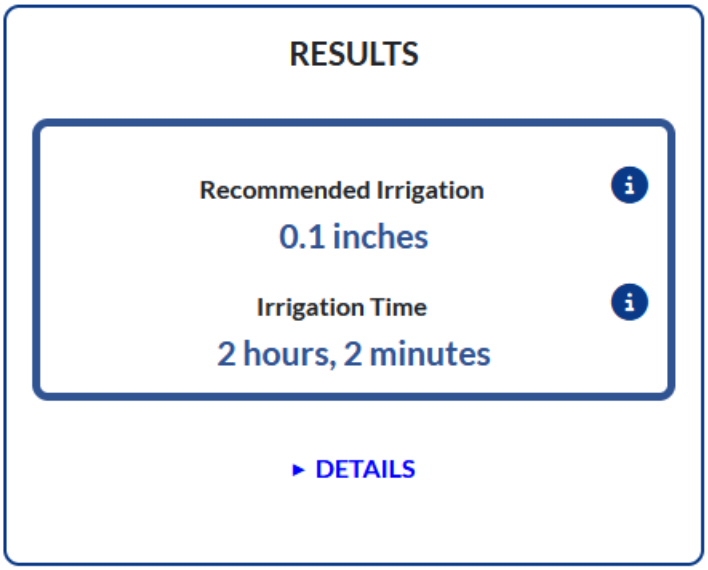

Figure 4. Results

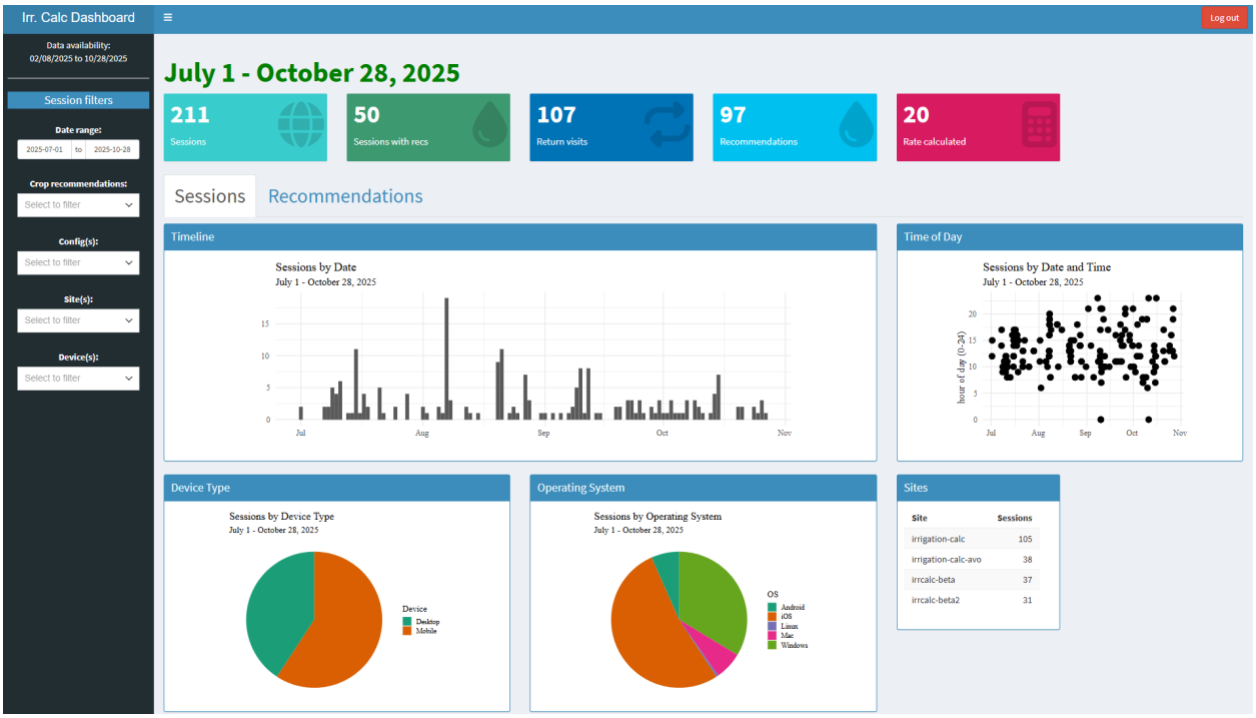

Figure 5. Calculator Usage Dashboard

Discussion:
The irrigation recommendation is calculated by the ET-based method, which estimates the water lost through evapotranspiration since the last irrigation or significant precipitation:

*ETc = ETo * Kc*, where *ETo* = reference evaporation, and K_c = crop coefficient.

In addition, this calculator accounts for an average distribution uniformity (DU) of 85% and a leaching fraction (LF) of 10% for all recommendations.

The precipitation data is adjusted to account for approximate root depth and maximum soil water holding capacity.

The ETo and precipitation data are available hourly, while the crop coefficient is modified based on how large the canopy is.

An additional 20% of the calculated crop ET is used to account for south facing slopes, which receive greater solar radiation and higher water use.

All the parameters used in the calculation can be viewed by clicking on 'Details' under 'Results'.

Limitations:
This calculator is not meant to be used during crop establishment (less than 10% canopy cover) since the applied water in those settings usually surpass crop ET.

This calculator does not provide feedback on when's the right time to irrigate. That information is best obtained with the use of soil moisture sensors such as tensiometers, along with manually checking soil moisture across the field.

The accuracy of this calculator depends on the representativeness of the weather stations' data. Recommendations should be created with data from a weather station located in the same micro-climate of the field.

Areas for future work:
The crop coefficients assessed by Montazar et al. (2025) in two sites located in Ventura County show significant monthly changes. Specific monthly Kc values will be added to the calculator once a summary of that dataset is provided.

Conclusions:
The adaptation of the Irrigation Calculator for avocado production represents a significant advancement toward improving irrigation efficiency in orchards. By integrating recently developed crop coefficients, maturity stages, and slope adjustments, this tool provides growers with tailored, data-driven irrigation recommendations that are easy to access and interpret. Although the current accuracy of the calculator is limited by the spatial

distribution of weather stations, the planned expansion of the UC ANR Ventura ET network will substantially enhance the reliability of its recommendations while increasing its adoption. Continued beta-testing and user feedback will further refine its functionality and usability.

Summary:
This project adapted the UC ANR online Irrigation Calculator for avocado production in Ventura County to help growers make more accurate, data-driven irrigation decisions. The new version incorporates newly developed crop coefficients for different orchard maturity stages, a slope adjustment for south-facing blocks, and flexible options for calculating application rates. The calculator connects to local weather stations to generate evapotranspiration (ET)-based irrigation recommendations quickly and easily. While current accuracy depends on the availability of local weather stations, future expansion of the UC ANR Ventura ET network will improve reliability. The tool offers a practical, science-based approach to improving irrigation efficiency and supporting optimal avocado production.

References:

Montazar, A., Faber, B., Corwin, D., Pourreza, A., Snyder, R.L. (2025). Quantifying Evapotranspiration and Crop Coefficients of California 'Hass' Avocado Affected by Various Environmental and Plant Factors. Agricultural Water Management, 313: 109481. https://www.sciencedirect.com/science/article/pii/S0378377425001957