Avocado Decision Support Tools Now Available

By Tim Spann, PhD
Research Program Director

The California Avocado Commission (CAC) is pleased to announce that the avocado decision support tools (DST) are now available online for California avocado growers. The DSTs can be accessed through CaliforniaAvocadoGrowers.com or directly at CaliforniaAvocadoGrowersDST.com.

What are DSTs?

In broad terms, DSTs are software developed to help users make better decisions more quickly, typically for very complex situations. Specific to avocados, DSTs are statistical models that have been developed to guide growers through decisions about fertilization to maximize yield.

This project began in 2012 with a concept from Dr. David Crowley, professor of environmental sciences at UC Riverside (now retired), who proposed using artificial neural network analysis to:

- Determine optimal leaf nutrient values for maximum yield of avocado
- Rank nutrient deficiencies or excesses based on their yield impact

By achieving these two goals, growers would have better information to help them interpret and act on their annual leaf tissue analyses. To make these complex statistical models accessible to growers, they would be imbedded in a user-friendly web interface.

The Data Collected

The project CAC funded with Dr. Crowley consisted of 12 sites in groves ranging from San Diego to San Luis Obispo counties. In each grove, numerous sensors were placed in one or more plots of 15 Hass trees on any available rootstocks – Dusa, Duke 7, Toro Canyon, Thomas and Mexican seedling had sufficient representation to be included in the analysis. For every tree in the test plots, the following data were recorded:

- All water applied as irrigation or received as rainfall
- All fertilizer applications
- Annual leaf tissue analyses and soil sampling
- Irrigation water quality analysis
- Total yield per tree as well as fruit quality and size data

In addition to the data collected specifically for this study, data from nearly 30 years of avocado fertilizer trials conducted by Dr. Carol Lovatt, retired professor of plant physiology at UC Riverside, also was added to the analysis. This helped to expedite the project and allowed the data analysis to be completed by December 2016 instead of 2018 as originally proposed.

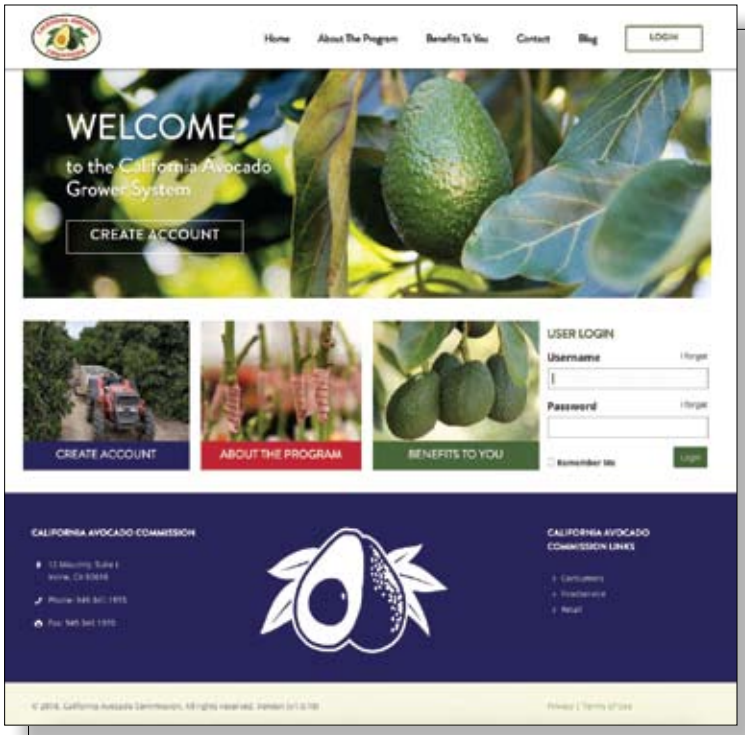
Optimum Avocado Leaf Nutrient Values

Prior to this research, the leaf nutrient values used for avocado were based on those developed for citrus. The citrus values were modified over the years by various plant testing laboratories based on their experience. However, a specific

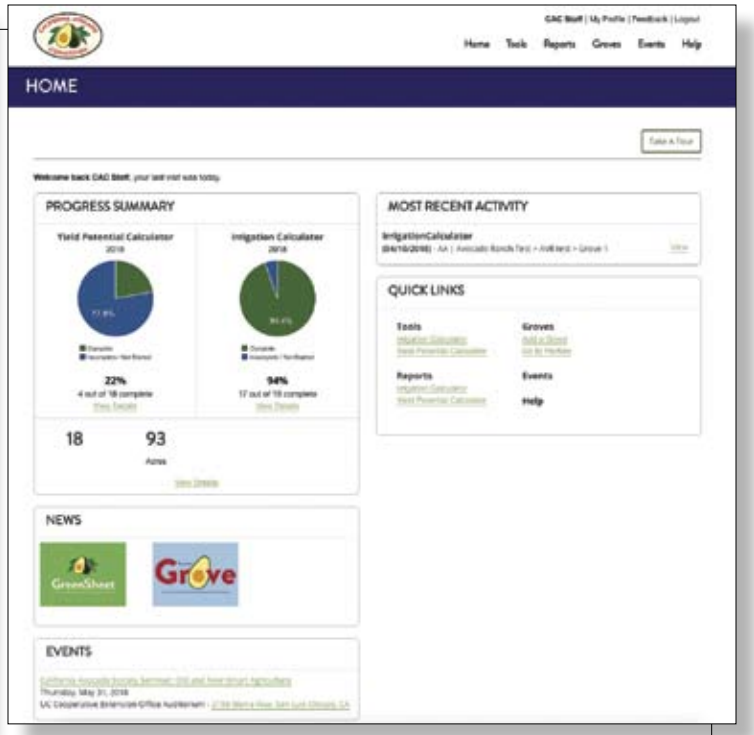
Old optimum leaf nutrient levels for avocado based on modified citrus values, and the new values developed by the decision support tools research project.

Nutrient	Old Optimum Range[1]	New Optimum Range
N%	1.6 – 2.0	2.25 – 2.90
P%	0.10 – 0.25	0.10 – 0.15
K%	0.75 – 2.0	0.70 – 0.90
Ca%	1.0 – 3.0	1.8 – 2.0
Mg%	0.25 – 0.80	0.6 – 0.9
S[2]	0.20 – 0.60 (%)	0.45 – 0.53 (ppm)
B ppm	50 – 100	38 – 60
Zn ppm	30 – 150	50 – 80
Mn ppm	30 – 500	110 – 145
Fe ppm	50 – 200	45 – 80
Cu ppm	5 – 15	4 – 7

[1] Old optimum ranges shown here are those published at http://ucavo.ucr.edu/General/LeafAnalysis.html.
[2] For sulphur, the old optimum range was based on percent sulphur in the leaf tissue, the new range is based on ppm.



From the homepage for the avocado decision support tools, CaliforniaAvocadoGrowersDST.com, a grower can create an account, find out more about the program or login to their account.



Each user will have a unique homepage associated with their account that has a quick summary of their grove, shortcuts to various reports, and links back to useful information and calendar events on CaliforniaAvocadoGrowers.com.

study to develop optimum leaf nutrient values based on yield data had never been conducted for avocado. The table on page 14 shows the old leaf nutrient recommendations and the new values developed from the DST research.

For a more detailed discussion on how these new optimum ranges were developed, please see "Decision Support Tools for Avocado Fertilization & Salinity Management: Preview to the Final Project Report" in the Fall 2015 issue of *From the Grove*.

California Avocado Grower System

The DST website houses what we are calling the California Avocado Grower System (CAGS). Currently, this system has two tools available for use — an irrigation calculator and a yield potential calculator. These tools are described in more detail later in this article.

Growers will need to create an account the first time they access the site. In order to restrict the use of the site to the California growers who paid for its development, you will need your CAC Grower ID number to create your account. You can find your CAC Grower ID on official Commission mailings (e.g., ballots, crop surveys, etc.). If you need assistance locating your CAC Grower ID, please contact CAC at 949-341-1955.

During the account setup process, you will need to enter grove identification information. If you have more than one grove you can add them to your profile after the initial setup process is complete. A common question is: how is a "grove" defined in the DST system? Since you will be entering leaf analysis data for each grove, you should think of the grove as whatever unit from which you collect your leaf samples. Thus, if you have a 40-acre "grove" and you collect your leaf samples from four 10-acre blocks within that grove, consider those four blocks as individual groves and name them accordingly.

Once you have created your account and established your first grove in the system you are ready to start using the system. You can begin with either the Yield Potential Calculator or the Yield Impact Calculator.

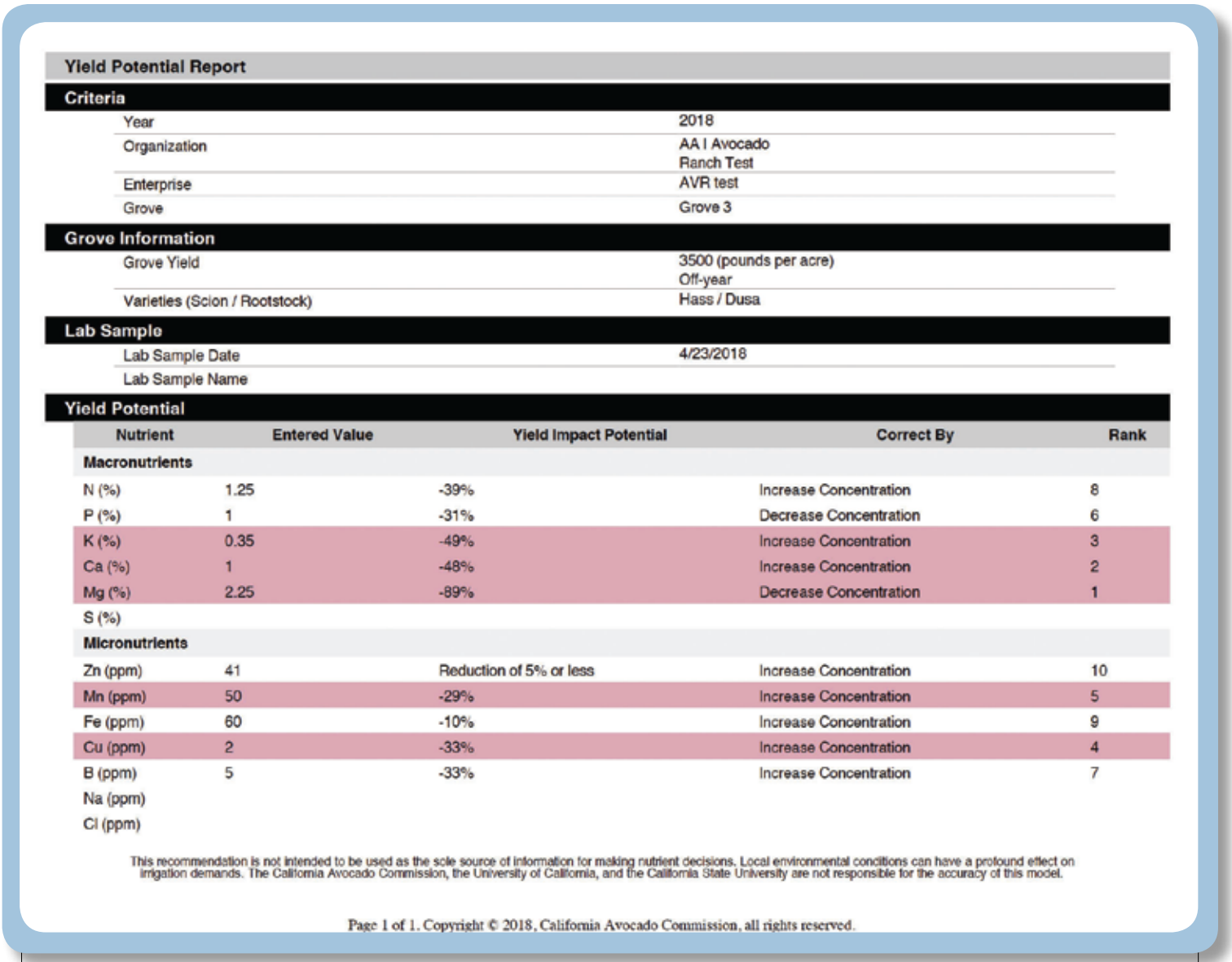
Yield Potential Calculator

Based on the new optimum leaf nutrient ranges for maximum yield, the various statistical relationships among the nutrients were used to develop the "Yield Potential Calculator" tool within the CAGS.

After your initial grove setup, select the Yield Potential Calculator from the Tools menu. You can select the grove you want to run the calculator on from the groves you've set up in your profile. Once you've selected the grove, you will need to complete the information under the Inputs tab:

- Grove yield in pounds per acre
- Off or on yield for your grove
- Scion and rootstock varieties

As mentioned earlier, the model was developed for Hass



Yield Potential Report

Criteria

Year	2018
Organization	AA I Avocado Ranch Test
Enterprise	AVR test
Grove	Grove 3

Grove Information

Grove Yield	3500 (pounds per acre) Off-year
Varieties (Scion / Rootstock)	Hass / Dusa

Lab Sample

Lab Sample Date	4/23/2018
Lab Sample Name	

Yield Potential

Nutrient	Entered Value	Yield Impact Potential	Correct By	Rank
Macronutrients				
N (%)	1.25	-39%	Increase Concentration	8
P (%)	1	-31%	Decrease Concentration	6
K (%)	0.35	-49%	Increase Concentration	3
Ca (%)	1	-48%	Increase Concentration	2
Mg (%)	2.25	-89%	Decrease Concentration	1
S (%)				
Micronutrients				
Zn (ppm)	41	Reduction of 5% or less	Increase Concentration	10
Mn (ppm)	50	-29%	Increase Concentration	5
Fe (ppm)	60	-10%	Increase Concentration	9
Cu (ppm)	2	-33%	Increase Concentration	4
B (ppm)	5	-33%	Increase Concentration	7
Na (ppm)				
Cl (ppm)				

This recommendation is not intended to be used as the sole source of information for making nutrient decisions. Local environmental conditions can have a profound effect on irrigation demands. The California Avocado Commission, the University of California, and the California State University are not responsible for the accuracy of this model.

Page 1 of 1. Copyright © 2018, California Avocado Commission, all rights reserved.

A sample report from the yield potential calculator, showing the yield impact potential and ranking of each nutrient.

on five different rootstocks. If you select a variety other than Hass or a rootstock other than the five used to develop the model, the system will warn you that the information may not be accurate.

Next you will enter your leaf tissue analysis results for the grove. You will need to enter the date of the sample and then the value for each of the nutrients. If your test results don't include one of the nutrients listed, just leave it blank. **Do not enter a '0' or the system will calculate erroneous results.**

Next, click on the reports tab to see the results. Most growers are familiar with receiving a report from their laboratory of choice that is color coded in some way to indicate which nutrients are within the optimum range and those that are outside the optimum range. However, the grower is then left to determine — based on their experience, consultation with consultants and grove managers, or maybe just by guessing — which of those deficiencies or excesses is most critical to improving their yield. This is where the yield potential calculator will help.

Yield Impact Potential: For each nutrient, the yield impact potential – that is, how much reduction from maximum yield that nutrient deficiency or excess is causing – will be reported. If the nutrient value falls within ± 5 percent of the optimum range, the report will indicate that no change is needed. For those nutrients whose value is more than 5 percent from the optimum, a percentage value will be given. For example, if the yield impact potential is "-48%," this means that the nutrient deficiency or excess is potentially causing yield to be 48 percent below maximum.

It is important to understand that these values are named "yield impact potential" because they are just that, potential yield losses. They are not absolutes. Many factors interact with plant nutrition — chief among them irrigation — that may or may not result in these calculated yield penalties being realized.

Rank: Also provided for each nutrient is a ranking. The rank indicates, in order of importance, how critical each nutrient deficiency or excess is to yield. These rank values may or may not directly correlate to the yield impact potential depending on the other factors involved in the model.

A barrel with staves of varying lengths is often used to visualize these rankings. The capacity of the barrel is limited by the length of the shortest stave, and the capacity cannot be increased unless the shortest stave is lengthened. Likewise, avocado yield is limited by the most limiting nutrient. If nutrient deficiencies or excesses are corrected without correcting the most limiting nutrient, yield is unlikely to improve.

Thus, the goal of the yield potential calculator is to help growers understand the yield-limiting factors, in terms of nutrition, and know which of those limiting factors to address first, second, third and so on. As mentioned previously, other factors besides nutrition affect yield so this analysis must be viewed as just one piece of the puzzle in your grove management practices.

You can download the yield potential calculator reports as either a PDF file or an Excel compatible CSV file if you want to store a copy of your results outside of the CAGS.

A sample weekly irrigation inputs page of the irrigation calculator. This page shows how much irrigation is needed to meet evapotranspiration and to refill available soil moisture. From this page you can enter your actual irrigation run time, soil moisture and rainfall data if available.

Irrigation Calculator

Prior to using the irrigation calculator there is some basic setup you will need to do. The first step is to select the grove from your profile that you want to use the irrigation tool for. Next you will need to tell the system what weather data to use to calculate evapotranspiration (ETc) and rainfall. The system can use CIMIS (California Irrigation Management Information System) data from a nearby station that you select from a dropdown menu, or it can use spatial CIMIS data which interpolates weather data for your specific location based on CIMIS station and satellite data. To use the spatial CIMIS data you will need to enter your grove's latitude and longitude. The spatial CIMIS data has a resolution of about one mile so your coordinates do not have to be highly precise.

After you have set up your weather information you will need to provide basic grove details. This includes the age of the grove and your tree spacing. Note that the grove acreage will be automatically filled in based on the profile you created for that grove.

Next you have the option of entering more detailed information about your grove that will expand the information in your report. This advanced setup information includes details about your trees' rooting depth, soil texture and soil moisture holding capacity.

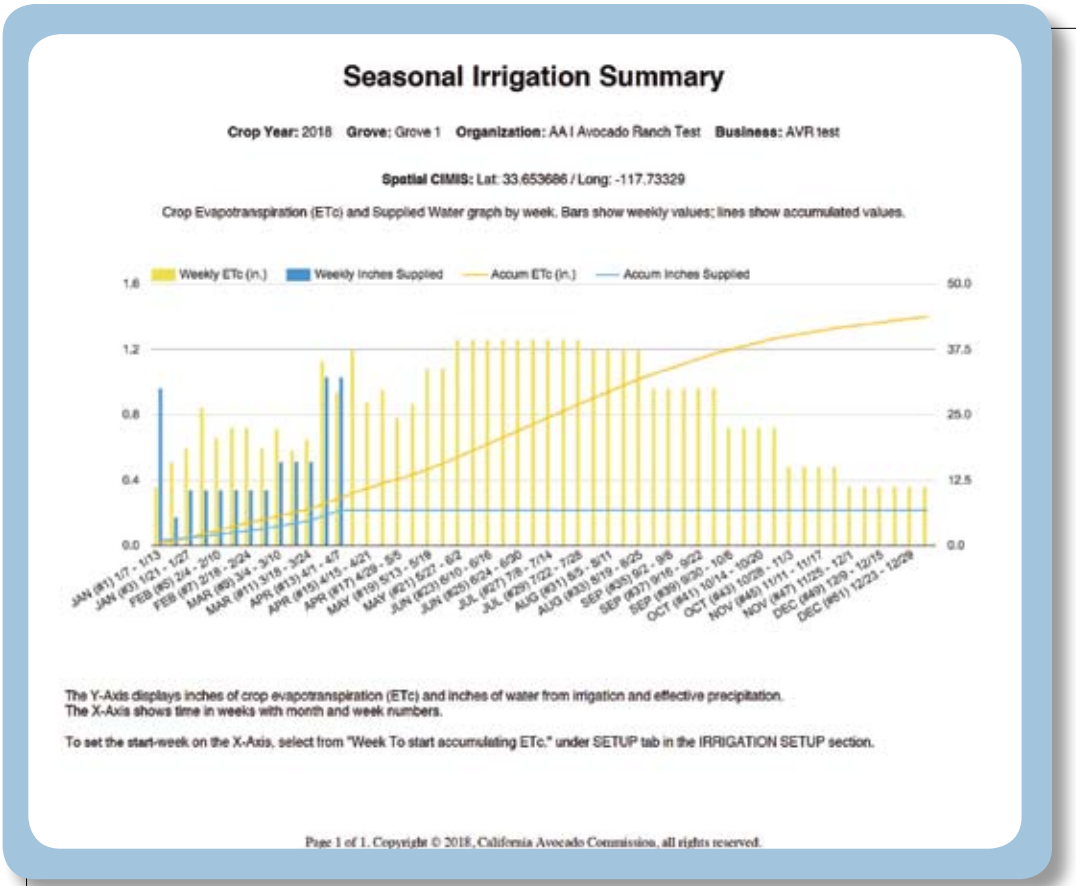
Lastly, you will enter your irrigation system information. This includes:

- Type of emitters you have (microsprinkler or drip)
- Typical irrigation set run times
- Number of emitters per tree
- Emitter output in gallons per hour
- Your system's distribution uniformity (DU)

If you do not know your system's DU many of the state's resource conservation districts (RCD) provide DU testing for free. To find your local RCD office, go to www.CARCD.org and navigate to About Us, RCD Directory.

You can now click on the Weekly Inputs tab. Here you will see the calculated run times necessary to meet that week's ETc and to refill the available soil moisture (ASM; if you entered your soil details in the advanced setup step), as well as the calculated depleted ASM. On this page you can enter your actual system run time, actual soil moisture data if you have soil moisture sensors in your grove, as well as actual rainfall if you have a rain gauge. Entering soil moisture data and/or rainfall data here will override the calculated ASM and CIMIS data. Here you also have the opportunity to enter a description of your trees' observed drought status — minimal, mild, moderate or severe.

On the Reports tab you can now look at a cumulative seasonal irrigation summary. This shows you the actual ETc value for each week and your actual water applied (based on irrigation and rainfall). You also will see an accumulated ETc and



Seasonal Irrigation Summary

Crop Year: 2018 **Grove:** Grove 1 **Organization:** AA I Avocado Ranch Test **Business:** AVR test

Spatial CIMIS: Lat: 33.653686 / Long: -117.73329

Crop Evapotranspiration (ETc) and Supplied Water graph by week. Bars show weekly values; lines show accumulated values.

The Y-Axis displays inches of crop evapotranspiration (ETc) and inches of water from irrigation and effective precipitation.
The X-Axis shows time in weeks with month and week numbers.

To set the start-week on the X-Axis, select from "Week To start accumulating ETc." under SETUP tab in the IRRIGATION SETUP section.

Page 1 of 1. Copyright © 2018, California Avocado Commission, all rights reserved.

A sample seasonal irrigation report. The blue bars show actual irrigation applied and the yellow bars show evapotranspiration for each week. The yellow and blue lines show cumulative evapotranspiration and irrigation, respectively.

inches-of-water-applied line. Weekly ETc values and accumulated ETc for future weeks are based on historical data and will be updated each week as real-time data are received by the system.

Like for the yield potential calculator, you can download detailed and summary reports from the irrigation calculator as PDF files or Excel compatible CSV files if you wish to keep a copy of your reports outside the CAGS.

It is our hope California avocado growers will find these new tools helpful in improving their grove management practices. If these tools prove successful and growers utilize them, the system could be expanded in the future to add more features to the existing tools or to develop new tools to help with other grove management tasks.

Despite the potential benefits the CAGS and other technologies offer to growers, remember the best tools you have for becoming a better grower are attached to the ends of your legs — get out in your grove, observe what's going on and be an active grower.

(Funding for this project was provided by the California Department of Food and Agriculture Specialty Crops Block Grant program Agreement No. SCB16030.)

Upcoming DST Grower Seminars:

CAC is hosting a series of seminars to help growers learn how to access and use the online DST system. Mark your calendars and plan to attend one of the meetings below:

Tuesday, July 10, 2018

9:00am - 12:00pm
Pala Mesa Resort
2001 Old Hwy 395
Fallbrook, CA

Wednesday, July 11, 2018

9:00am - 12:00pm
Ventura County Ag Museum
926 Railroad Ave
Santa Paula, CA

Thursday, July 12, 2018

9:00am - 12:00pm
San Luis Obispo County Farm Bureau
4875 Morabito Pl
San Luis Obispo, CA