FRESNO STATE Center for Irrigation Technology | APEP Advanced Pumping Efficiency Program | FRESNO STATE Water, Energy and Technology Center

7th Annual Ag Tech Day • October 27, 2023

Showcasing Innovative Technology in Field Demos and Educational Presentations

Hosted by the Center for Irrigation Technology (CIT)

Advanced Pumping Efficiency Program (APEP) • Water, Energy and Technology (WET) Center

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FIELD SITE #1
Flow measurement
Pump efficiency testing

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Speakers

Mike Linares, Krohne Inc.

Benjamin Merritt, Mid Valley Water Well Testing

Site Description

Mike Linares will display and conduct a real-time demonstration of their new ultrasonic clamp-on flowmeter. The OPTISONIC 6300P can be utilized for pump tests, meter verifications, temporary flow measurement, and for determining if Ultrasonic Clamp-on technology is a viable solution when it is not possible to install an inline flow meter, such as when the process can't be taken offline for pipefitting a permanent solution. See attached materials.

Benjamin Merritt from Mid Valley Water Well Testing (an Advanced Pumping Efficiency Program participating pump tester) will conduct a pump test on Fresno State Well 27. He will be sounding the well, reading the smart meter, and using Krohne's flow meter, reading to get Overall Pump Efficiency (OPE).

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“New” KROHNE OPTISONIC 6300P Portable Ultrasonic Clamp-on Flow Meter:

This product is a versatile solution for providing temporary flow measurement for line sizes from ½” to 160”. It is very user-friendly, with a refined setup wizard, that allows for a quick setup. It is available with magnetic fixing units for ferromagnetic pipe material and steel and nylon straps for non-magnetic pipes. The electronic converter is easily configurable via a Blue Tooth interface with an Android mobile phone or tablet. A variety of volumetric flow units are available including, but not limited to a custom unit for your operation. During operation, there is a monitoring screen on the interface with digital values and trends for Volumetric Flow Rate, Velocity, and Signal Strength Parameters. There are multiple configurable totalizers and the ability to log data for prolonged tests. The data log files can be exported straight from the interface in a CSV format for further review and comparison tests. The OPTISONIC 6300P is a great asset that can be utilized for pump tests, meter verifications, temporary flow measurement and for determining if Ultrasonic Clamp-on technology is a viable solution when it is not possible to install an inline flow meter like when the process can’t be taken offline for pipefitting a permanent solution.

ADDITIONAL MATERIAL

White Paper on Irrigation Water highlighting one of KROHNE’s products directed at the Ag/Irrigation Market, the WATERFLUX 3070 magnetic flow meter Highlights, and the Water/Wastewater brochure I mentioned on our call this afternoon. Below are links to the documents online and some other relevant links that might be useful.

Documents

https://cdn.krohne.com/dlc/FL_Water-and-Wastewater_Flyer_en_220328.pdf

https://cdn.krohne.com/dlc/CA_WATERFLUX_Highlight_en_201215.pdf

Solutions

https://www.youtube.com/user/krohnegroup

https://cmp.krohne.com/retrofit-your-magmeter/

Video

https://dam.krohne.com/video/upload/v1613052963/vi-virtual-fair/w-ww/battery-powered-flow-measurement/water-and-wastewater-battery-powered-flow-measurement-en-gb.mp4

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Irrigation Technology in Agriculture: How New Technologies Overcome Challenges

By Mark Trapolino, Agriculture and Irrigation Market Manager, KROHNE, Inc.

As the world's population continues to increase at a fast pace, more food and water will be needed to sustain humanity. In the past 50 years, we have tripled our need for water and food, and there are no signs of this trend slowing down. As a result of these conditions, smart, innovative agricultural practices are needed now more than ever.

Technology can, and already does, aid agriculture in innumerable ways. One prominent part of agriculture that can use technological innovation to increase efficiency and effectiveness is irrigation.

An agricultural irrigation system.

Irrigation is the method in which a controlled amount of water is supplied to plants at regular intervals for agriculture. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against frost, suppressing weed growth in grain fields and preventing soil consolidation. Irrigation systems are also used for dust suppression, disposal of sewage, and in mining. Irrigation is often studied together with drainage, which is the natural or artificial removal of surface and sub-surface water from a given area. Irrigation has been a central feature of agriculture for over 5,000 years and is the product of many cultures. Historically, it was the basis for economies and societies across the globe, from Asia to the Southwestern United States.

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Agricultural irrigation accounts for roughly 80% of the ground and surface water used in the United States and could account for up to 90% of water used in western states. Some 53.5 billion gallons of groundwater are used daily for agricultural irrigation from 475,796 wells. Irrigated agriculture is an indispensable part of the nation's economy as it contributes significantly to the value of U.S. agricultural crop production, as well as supporting livestock and poultry production through irrigated animal forage and feed crops. (United States Geological Survey, 2015) However, all of this freshwater use in irrigation is wasteful. Worldwide, agriculture accounts for 70% of all water consumption, compared to 20% for industry and 10% for domestic use (http://www.worldometers.info/water/, 2018). Roughly 15-35% of irrigation withdrawals are estimated to be unsustainable, and the agriculture industry wastes 60% or 396 trillion gallons, of the 660 trillion gallons of water it uses each year.

Water Measurement

The key to a sustainable agriculture looking to the future is in water use, and current standards have proven too wasteful to rely on in the future. Water metering and measuring technology is at the heart of this issue, but there is not only one method or technology used to measure water flow in irrigation systems. In irrigation systems, water used to irrigate land is carried under pressure to its destination via pipes. Flow occurs in a pipeline when a pressure difference exists between the two ends of the pipe. The rate or discharge that occurs depends mainly on the difference in pressure that exists from the inlet of the pipe to the outlet, the friction or resistance to flow caused by the pipe's length, pipe roughness, bends, restrictions, changes in pipe shape and size, and the cross-sectional area of the pipe. Most flow measurement devices measure flow, or discharge, indirectly. These devices are commonly classified into 2 types – those that measure velocity and those that measure pressure. Regardless of the type of device, the pressure or velocity is measured, and then charts, tables, or equations are used to obtain the discharge, or flow. Some water measuring devices that use measurement of pressure to determine discharge include weirs, flumes, orifices, and Venturi meters. Other devices that work differently from those that measure water pressure include acoustic water meters, magnetic water meters, pitot tubes, and rotameters. All these non-pressure-based devices work differently to determine water discharge.

A well-used KROHNE WATERFLUX 3070 magnetic water meter in the field

In some acoustic or ultrasonic meters such as transit time meters, the velocity of sound pulses in

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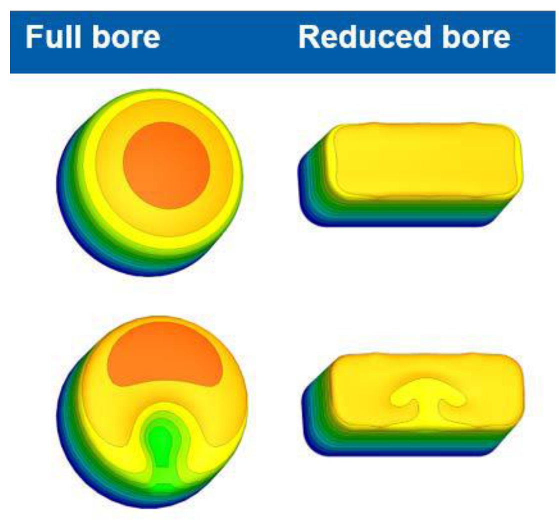
the direction of water flow is compared to the velocity of sound pulses opposite to the direction of flow to determine the mean velocity and, thus, discharge. With Doppler acoustic meters, sound pulses are reflected from moving particles within the water mass, like radar. Pitot tubes measure water flow by relating velocity pressure, V2/2g, to discharge, and rotameters do via flow indicators suspended in tapered sections of pipe. Lastly, in magnetic meters, flowing water acts like a moving electrical conductor passing through a magnetic field to produce a voltage that is proportional to discharge

Ideally, a water meter is accurate, reliable, efficient, and compatible with the rest of the irrigation system it is part of. Accuracy is an obvious characteristic. Water needs to be accurately metered to avoid waste. Water meters need to be reliable for a similar reason – if the meter is breaking down frequently, there is no accurate way to measure water usage, which will result in waste. Water meters need to be efficient in terms of their installation and operation. Special requirements for installation only result in wasted time during the installation process, which, in a general sense, results in more wasted. Lastly, a good water meter is compatible with its irrigation or crop control system. Todays integrated irrigation and crop control systems vary in communication requirements. Using a meter that is compatible with data logging and telemetry software is hugely important in terms of the meter's accuracy, operation, and maintenance.

KROHNE's WATERFLUX 3070 Meter

Of all the types of water meters listed above, magnetic meters are innovating more than others, and are more completely meeting the requirements for an ideal water meter. One particular magnetic meter that is perfect for irrigation applications in agriculture is KROHNE's WATERFLUX 3070. The WATERFLUX 3070 is a battery powered all-in-one (integrated flow, pressure, and temperature measurements) electromagnetic water meter. Unlike mechanical water meters, the WATERFLUX 3070 is maintenance-free and offers a much larger turn down ratio (1000:1). Its measuring tube with a rectangular and reduced cross-section enables a stable measurement even at low flow rates. Due to the optimized flow profile, the WATERFLUX 3070 can be installed virtually anywhere without straight inlet or outlet runs – behind pipe bends, slide valves or a reduction in the pipe. Even burial installation or use in flooded areas is possible.



The above diagram illustrates flow velocity through pipes under ideal conditions (top row), and disturbed flow conditions (bottom row)

The WATERFLUX 3070 has several key advantages for agricultural applications due to its rectangular reduced bore design. This unique reduced bore design acts as its own

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internal flow straightener and results in the meter creating a smaller magnetic field which has less power consumption, extending battery power life to up to 15 years with a KROHNE dual battery pack. The rectangular bore of the WATERFLUX 3070 is also effective in that it contracts flow profile disturbances, has an ideal coil arrangement for a strong and homogenous magnetic field, results in a doubled mean flow velocity, and enables a measurement that is stable and independent of the flow profile.

In all, the WATERFLUX 3070 is:

- Accurate: it features bi-directional flow measurement over a wide dynamic range and its unique rectangular sensor design gives good low-flow performance.
- Reliable: the WATERFLUX 3070 features a robust construction, with its sensor tube coated in Rilsan ® to guarantee a long life and its connection box is made from stainless steel. In addition, the WATERFLUX 3070 features no internal moving parts, making it virtually maintenance-free.
- Efficient: Installing the WATERFLUX 3070 is quick and easy. It has no inlet or outlet installation requirements, features plug-and-play connectors, and can be installed virtually anywhere.
- Technologically compatible: the WATERFLUX 3070 is fully data logging compatible and features multiple power and converter options

To solve the water-use problems currently affecting the agricultural industry, better water metering technology is a necessity. Among the many types of water metering devices, innovative magnetic metering devices like KROHNE's WATERFLUX 3070 check all the boxes for ideal water metering technology, and are showing the way towards more efficient and effective water use in agricultural irrigation applications.

Works Cited

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United States Geological Survey. (2015). Retrieved 2018, from USGS.gov: https://water.usgs.gov/watuse/wuir.html

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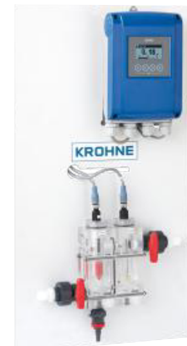

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FIELD SITE #2

Precision irrigation management
Groundwater recharge

Sponsored by IRROMETER®

Speakers

Jacob Moreno, Irrometer

Cordie Qualle, California Water Institute

Site Description

Jacob Moreno will discuss Irrometer Co.'s sensors and devices for monitoring soil moisture and the various products they manufacture and support. His presentation will cover Irrometer Co.'s new IC-10 Soil Moisture Monitoring Unit and the benefits of utilizing soil moisture monitoring, as well showing the ease of use and installation. Additionally, he will demonstrate their remote monitoring software capabilities on a soil sensor site on the Fresno State Farm. See attached materials.

Groundwater recharge technologies include recharge basins, Flood Managed Aquifer Recharge (FloodMAR), and Shallow Subsurface Artificial Groundwater Recharge (SSAGR). Cordie Qualle focuses on the results of SSAGR testing that indicates it is both an efficient and cost-effective technology to deliver recharge water to the aquifer. Materials attached

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JACOB MORENO BIO

Jacob Moreno is going into his 10th year with Irrometer Co. He graduated from Fresno State in 2012 with a Bachelor's Degree in Agricultural Education and a Teaching Credential.

CORDIE R QUALLE PE MCE

Mr. Qualle is currently a part-time lecturer in the Civil and Geomatics Engineering Department of the Lyles College of Engineering at Fresno State. He grew up and has lived most of his life in the San Joaquin Valley. He graduated from Fresno State in 1974 and practiced Civil Engineering in both the public and private sectors for 42 years. He graduated from Norwich University with his Master's in Civil Engineering degree in 2007. He has taught both part-time and full-time in the Civil and Geomatics Engineering Department since 2008. More recently he served as the California Water Institute's Interim Director from 2020 to 2021. He began groundwater research; specifically the use of subsurface groundwater recharge technology in 2017. That research effort resulted in the award of an Agricultural Research Institute Grant (ARI) in 2020. The grant-funded research started with the installation of a subsurface groundwater recharge system at Fresno State in 2020 followed by three years of research on the technology that included two Master in Civil Engineering graduate students who used the research as their Master's projects and four undergraduate students who assisted with the work. The research included numerous private and public research partners in the three years.

GROUNDWATER RECHARGE ABSTRACT

For some farms, communities, and individuals, groundwater is the sole source of clean, affordable water. Groundwater supplies 41 percent of California's average annual water use, or approximately 17.6 million acre-feet of water (Department of Water Resources, Natural Resources Agency 2021). During droughts, groundwater increases to 58 percent of the State's water use (Department of Water Resources, Natural Resources Agency 2021).

Groundwater quality and quantity has diminished in many parts of California due to over reliance on groundwater. This has been particularly true during the recent droughts of 2012-2016 and 2019-2022. The diminished quantity of groundwater has resulted in the decline of water tables, which has resulted in domestic, municipal, and agricultural wells going dry. As a result of the declining groundwater tables throughout the State, the Legislature enacted the Sustainable Groundwater Management Act in 2014 (Department of Water Resources 2023). The purpose of the Act is to arrest groundwater table decline to avoid adverse impacts.

There are tools and technologies available to accomplish SGMA's goal. They include reducing groundwater use through fallowing agricultural land, reducing domestic and municipal uses, and the use of groundwater recharge technologies. Groundwater recharge technologies include recharge basins, Flood Managed Aquifer Recharge (FloodMAR), and Shallow Subsurface Artificial Groundwater Recharge (SSAGR). This presentation focuses on the results from the testing of SSAGR. The research results indicate that SSAGR is both an efficient and cost-effective technology to deliver recharge water to the aquifer.

California Water Institute
Groundwater Recharge Research Project

University's first Subsurface Artificial Groundwater Recharge System on the Fresno State Farm

The scarcity of water in the San Joaquin Valley has become more prevalent and in need of a solution. In the agriculture industry, the unavailability of surface water and the continuous drought resulted to farms pumping from groundwater wells for irrigation purposes. This caused subsidence and an overdraft of groundwater aquifers. The majority of the San Joaquin Valley is farmland and lies on a critically over-drafted basin and it has become vital to the area to manage groundwater.

The Sustainable Groundwater Management Act (SGMA) states that California is required to implement a groundwater recharge plan that promotes the decrease in over pumping and as a result maintain groundwater to a sustainable level in the aquifer.

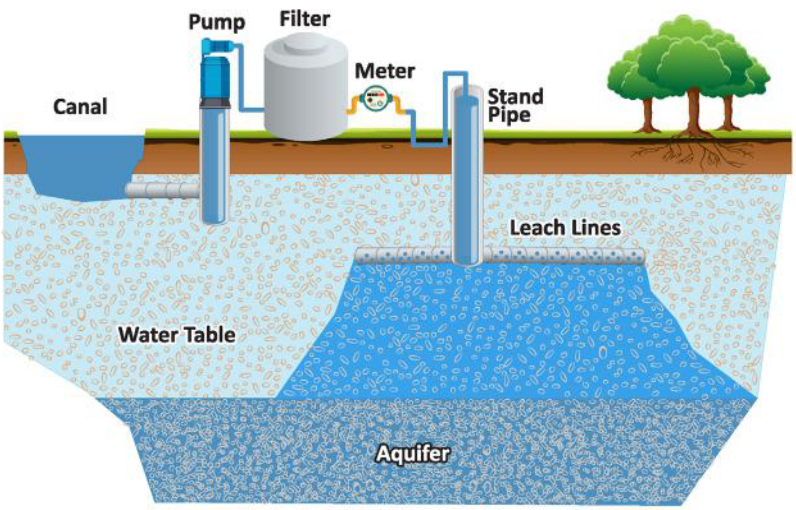
Groundwater usage equal to about 30% of California's water source and can increase during drought seasons. Due to a major concentration of agricultural fields in need of irrigation water, an estimated 70% of groundwater use in California occurs in the Central Valley to meet production needs (Mustafa). Providing solutions that include the recharging of extra available surface water, innovative systems that are economically feasible, and avoid the decrease on one of California's top industries can place California in the forefront on groundwater recharge initiatives.

Groundwater recharge using surface water to percolate deep into the ground where it is stored in the aquifer below the water table, has been done in various forms throughout the Valley such as rivers, lakes, and manmade ponds that are persistent sources of water, but not on existing farmland.

California Water Institute researcher are working on a project which will research how feasible it is for farmers to implement recharge systems within their fields that do not impact their farming operations.

Various recharging techniques are available and currently contributing to the health of groundwater aquifers but have the potential to pose various risks. Recharging techniques such as Flood-Mar and recharge basins/ponds can neglect the importance in water quality of groundwater aquifers.

An innovative approach to groundwater recharge is the application of a recharge system that is installed below the crop's rootzone. The Shallow Subsurface Artificial Groundwater Recharge or system (SSAGR) is comprised of a pipe system with perforations and any runoff water or excess available surface water can be transported and distributed through this pipe system facilitating the percolation of water right into the groundwater aquifer. By installing this system below the crop's rootzone, any amendment (fertilizer, pesticides, etc) placed above the soil will not be transported to the groundwater aquifer. This system is connected to existing filter stations, pumping stations and irrigation systems avoiding potential increases in cost and economic burden to farmers. This method provides the benefit to farmers to continue growing a crop, avoid fallowing agricultural lands and the potential to efficiently groundwater recharge.



Research in economic feasibility, agricultural soil health, impacts on agricultural industry and agricultural water usage should be conducted to demonstrate the benefits of a SSAGR system in agricultural fields.

The SSAGR technology has installed and is being used on the Fresno State farm since August 2021 and preliminary data will be available as soon as October 2021.

More information contact:
Laura Ramos
lramos@csufresno.edu
559-278-7001

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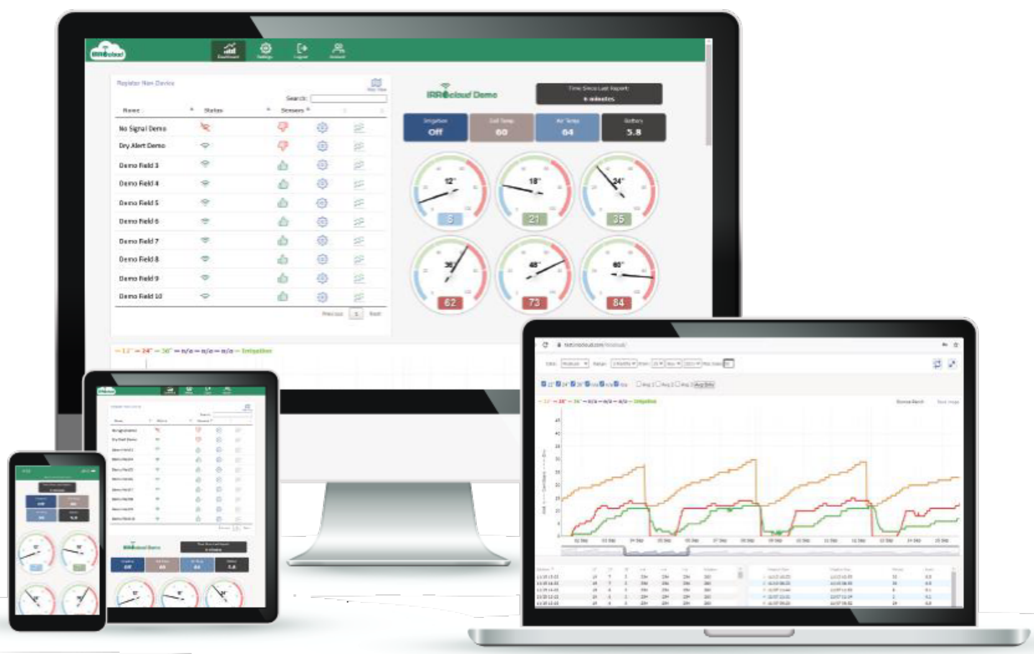

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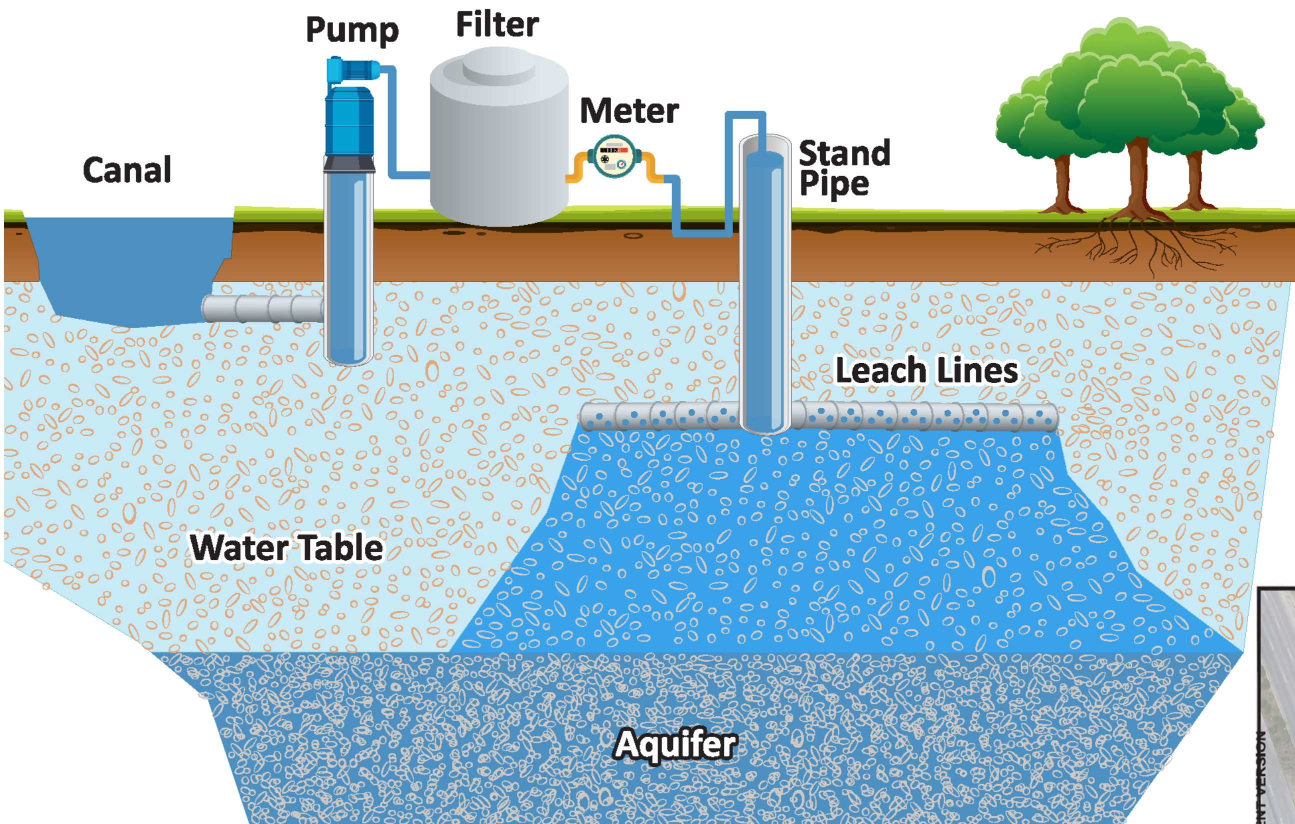
Shallow Subsurface Artificial Groundwater Recharge

CSU Campus Agricultural Research Institute Grant Funded Project

Principal Investigator: Cordie R Qualle, PE MCE
Graduate Assistants: Gabriella Bonilla and Mary Church
Under Graduate Assistants: Sam Hawley, Andrew Guthrie, Stephanie Bartell, and Jonathan Swanson

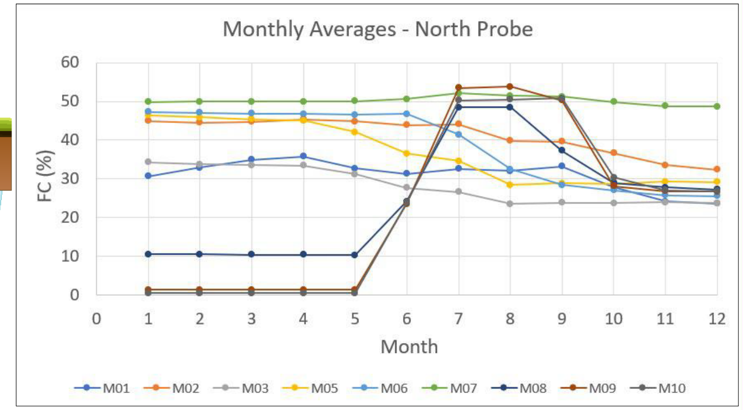
FRESNO STATE
Lyles College of Engineering

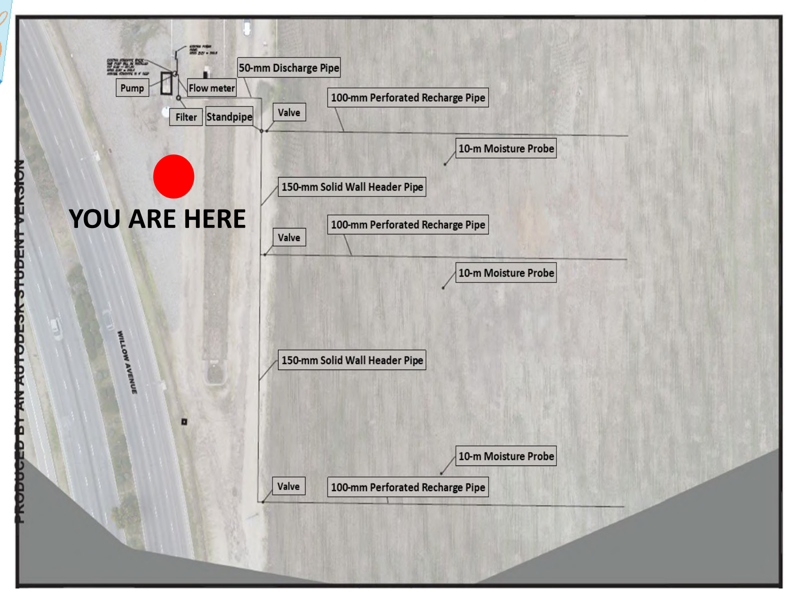


Moister Changes

Soil Moisture Readings (Data from Redtrac)

- Water added for 4 months





SSAGR System installed by Lidco, Inc
Oct 2020

Results

Costs

- $1.08 per Acre-foot of Recharge Water based on a 40 acre installation

Efficiency

- Water Balance analysis resulted in 100% efficiency

Sponsors

Grant Funding

- ARI, Private Donors

Research Partners

- Lidco, Inc, Grundfos Pumps, Redtrac LLC, Fresno State Farm, Moore-Twining Laboratories, Cal West Rain, Davis Instruments, Sentek LLC, TechnoFlow Inc., City of Clovis, CA, Derick Gangbin and Art Hauser LCOE

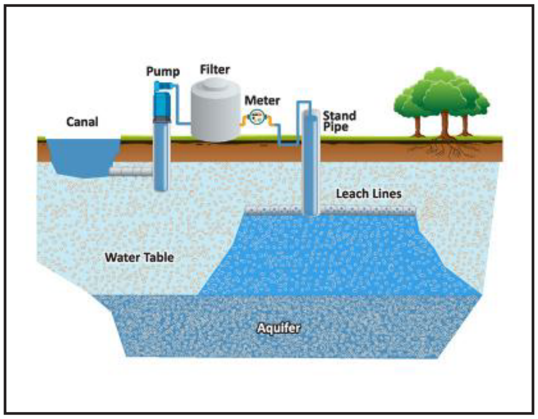
2023

2014

Shallow Subsurface Artificial Groundwater Recharge (SSAGR)

The research found:

- The cost of a full scale SSAGR system is approximately $1/acre-foot of recharge water
- SSAGR did not impact farming operations
- The installation depth can be raised to 8 to 10 feet below ground in orchards
- When SSAGR is installed in permeable soil areas the spacing between perforated pipe can be as close as every row



The SSAGR system located on the Fresno State Farm

The SSAGR system consists of a water source (the Helm Canal), a lift pump, a filter, a flow meter, a discharge pipe system, and perforated subsurface pipes

The system was installed in October, 2020, by Lidco, Inc. before the almond trees were planted

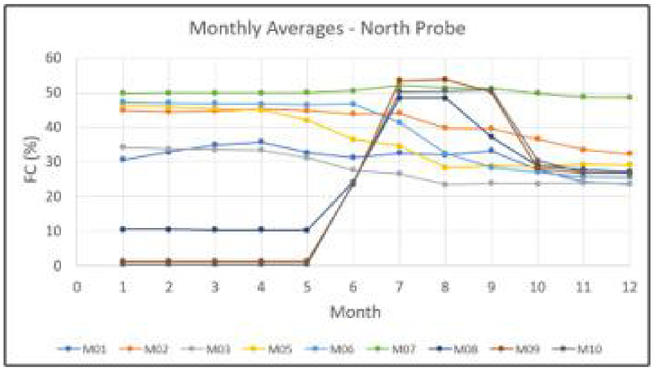
A research project conducted at the Fresno State Farm to investigate the efficiency and cost of SSAGR

SSAGR is an on-farm groundwater recharge technology that does not impact farming operations

The depth of installation was selected to keep the pipes well below the root zone of the trees

The change in water content of the soil adjacent to the perforated pipes was measured using 30 ft deep moisture meter probes

Lidco installed the perforated pipes with 12 feet deep using large trenchers



The change in water content at different depths is shown by the colored lines

Shallow Subsurface Artificial Groundwater Recharge at the Fresno State Farm

Funded by ARI, Research Partners, and Private Donors

Cordie R Qualle, PE MCE

Shallow Subsurface Artificial Groundwater Recharge – SSAGR

- Shallow Subsurface Artificial Groundwater Recharge
  - SSAGR pronounced sagar for short
  - Perforated pipe system installed in vadose zone at 3 m depth
  - Allows the use of active farm land to recharge the groundwater table with excess surface water
  - Recharge can occur without impacting farming practices

Advantages

- Located below the root zone so it does not impact crop health and it does not leach residual chemicals and nutrients into the groundwater
- Located below ground so does not impede access or use of the field due to flooding
- Located below ground so it delivers nearly 100-percent of the recharge water for percolation to the groundwater table
- It can be used to recharge whenever water is available

Disadvantates

- It is expensive, around $35 per gpm of apllied recharge water
- It is best installed prior to planting
- It requires filtration to preserve the recharge capability of the soil
- It consumes energy to run the pump system to filter the water and deliver it to the system

Location

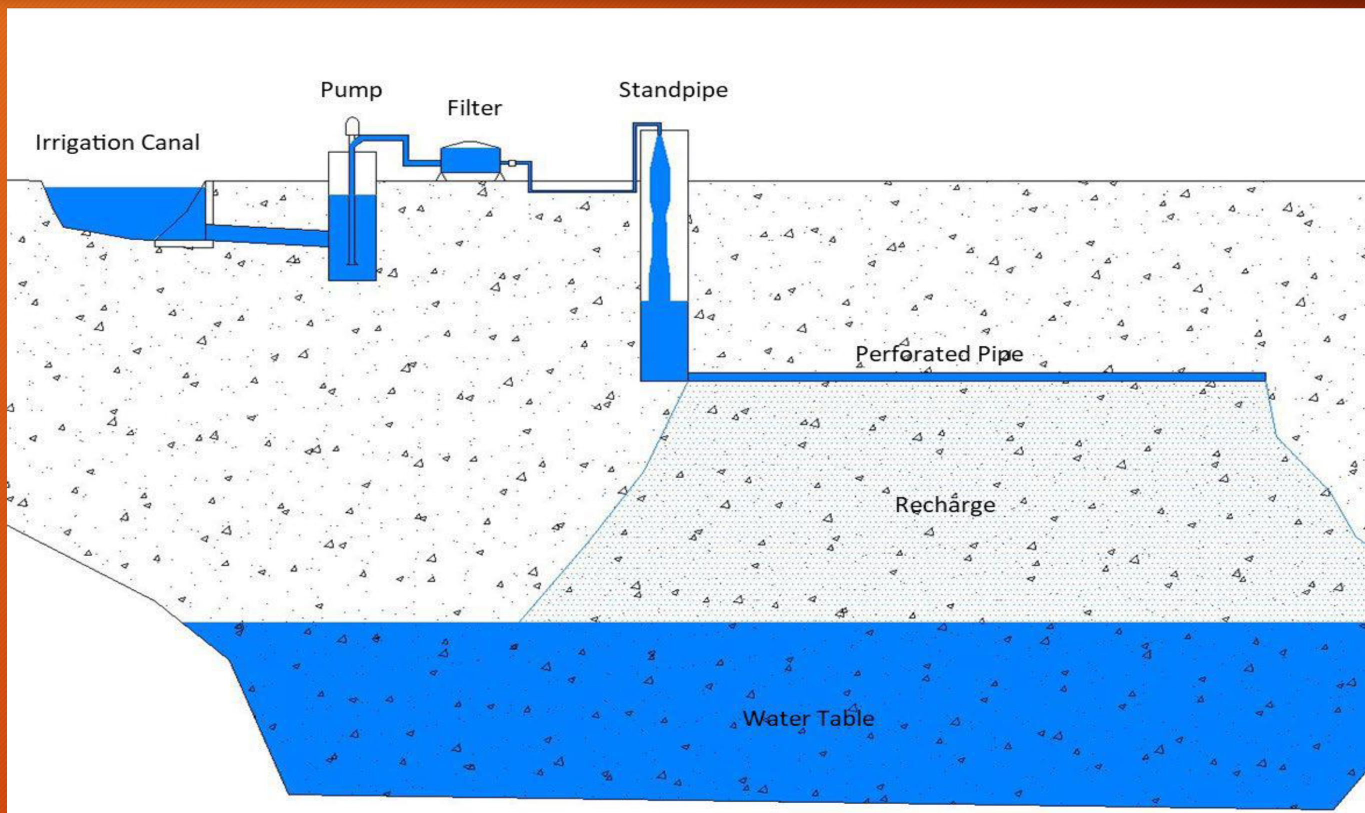
New almond orchard southeast of the intersection of East Bullard Avenue and North Willow Avenue

Installation

- Installed at Fresno State Farm in October 2020 by Lidco, a research partner who provided in-kind match for our ARI grant
- Installed prior to planting the almond trees
- Installed down the drives of each row
- Three perforated pipe laterals were installed with control valves
- Submersible pump provided by Grundfos, a research partner
- Telemetry installed by Davis Instruments, a research partner
- Moisture probes from Sentek, a research partner
- Data analytics from Redtrac, a research partner

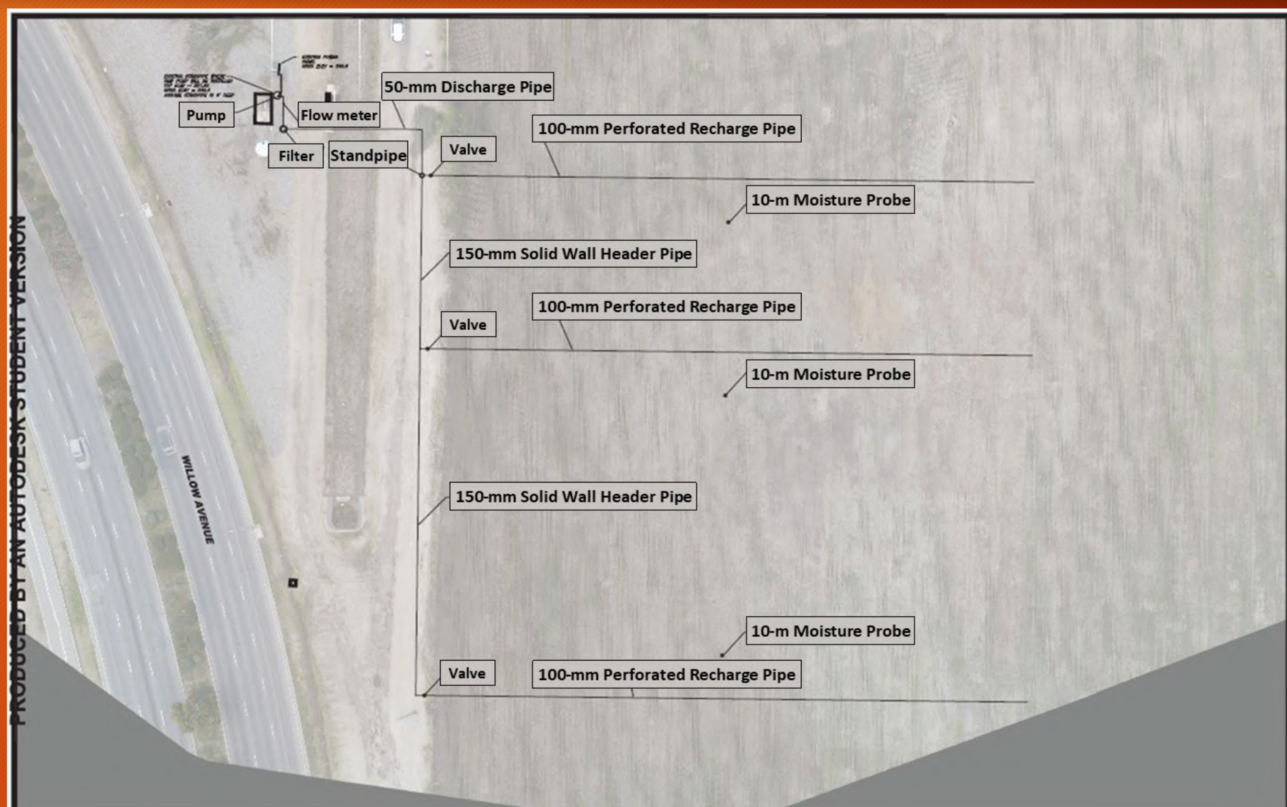
Installation

System



Irrigation Canal
Pump
Filter
Standpipe
Perforated Pipe
Recharge
Water Table

System



50-mm Discharge Pipe
Pump
Flow meter
Filter
Standpipe
Valve
100-mm Perforated Recharge Pipe
10-m Moisture Probe
150-mm Solid Wall Header Pipe
Valve
100-mm Perforated Recharge Pipe
10-m Moisture Probe
150-mm Solid Wall Header Pipe
10-m Moisture Probe
Valve
100-mm Perforated Recharge Pipe
WILLOW AVENUE
PRODUCED BY AN AUTODESK STUDENT VERSION

Research

- Three Goals
  - Perform Water Balance on Recharge to calculate acre-feet of recharge per acre-foot applied
  - Perform an economic analysis of the system to compare with other recharge systems on a cost per acre-foot basis
  - Check installation constraints

Results

- In 2022, we were only able to recharge for three months during the irrigation season
  - Preliminary work done last irrigation season achieved an estimated 100-percent recharge
  - The cost is approximately $1,700/a-f of recharged water
  - Similar recharge basin cost is approximately $10,300/a-f of recycled water
  - Line spacing in highly permeable soils is not critical
  - Estimate that installation depths can be raised to around 8 feet

Research this Year

- The research team
  - Cordie Qualle, PI
  - Andrew Guthrie, MSCE student
  - Sam Hawley, BSCE student
  - Mary Church, consultant
  - Gabriela Bonilla, consultant

Research Partners in the ARI Grant

- Lidco, Inc
- Grundfos Pumps
- Redtrac, LLC
- Fresno State Farm
- Moore-Twining
- Cal West Rain
- Davis Instruments

- Sentek
- City of Clovis, CA
- JCAST
- LCOE
- Private Donors

FIELD SITE #3
Decision support for irrigation management

Sponsored by AVIDWATER

Speakers

Cory Broad, AvidWater

Dr. Mallika Nocco, Conservation Irrigation Lab, UC Davis

Site Description

Cory Broad discusses “Irrigation as a Service” which is based on a new idea for utilizing the latest remote monitoring and control technologies where a third-party company does the irrigation scheduling and management to assist growers with water use efficiency. These capabilities can reduce the need for labor, make growers fixed costs variable, and protect water resources by eliminating inefficient irrigation schedules. See attached materials.

Dr. Mallika Nocco is presenting information about different types of tools and systems for Irrigation Decision Support including evapotranspiration and soil moisture monitoring. See the attached Fact Sheet.

AvidWater
Demonstration Site Sponsor
Website: https://avidwater.com
Contact: Cory Broad
Phone: 559.341.6002
Email: Cbroad@avidwater.com

Conservation Irrigation Lab
Website: irrigationlab.com
Contact: Mallika Nocco
Email: manocco@ucdavis.edu

BIO

Cory Broad, CCA, CA-NSp, PASp, CID, CAIS, Agronomic Sales Manager at AvidWater since graduating from Fresno State in 2013 with a degree in Agricultural Business, Cory has worked in irrigation distribution and manufacturing earning certifications such as Certified Irrigation Designer, Certified Crop Adviser, and Certified Ag Irrigation Specialist. During his career, Cory has focused on irrigation and farm efficiency helping growers convert existing irrigation systems and install irrigation technologies.

Irrigation as a Service: Irrigation as a Service customers have AvidWater agronomists operate the irrigation system, for the grower, for the whole season, per the optimized schedules, while Avidwater field crews can be responsible for infield checks and system monitoring. We utilize industry-leading technology comprised of in-field hardware, AI-assisted software/predictive modeling, and remote sensing to build a fully automated irrigation system, where the schedule is sent wirelessly to the pump station, which allows execution of the most precise irrigation schedules. These capabilities reduce the need for labor, make growers fixed costs variable, and protect water resources by eliminating inefficient irrigation schedules.

BIO

Dr. Mallika Nocco

Mallika Nocco is an Assistant Cooperative Extension Professor in Soil-Plant-Water Relations & Irrigation Management in the Department of Land, Air, and Water Resources at UC Davis. Her areas of expertise are in deficit irrigation, irrigation scheduling, crop water use physiology, soil hydrologic health, and thermal/multispectral aerial imagery for crop water stress evaluation. She works with growers, policymakers, and water districts to develop irrigation management strategies that balance farm livelihoods and water conservation. She is the co-host of the Water Talk Podcast (https://www.watertalkpodcast.com) and director of the Conservation Irrigation Lab (https://www.irrigationlab.com). Contact: Mallika Nocco, manocco@ucdavis.edu, @mallika_nocco on Twitter.

IRRIGATION AS A SERVICE

IRRIGATION AS A SERVICE FOR EFFICIENT AGRICULTURAL IRRIGATION

Irrigation as a Service from AvidWater is a comprehensive solution for efficient irrigation. Hire the AvidWater team to manage, run, inspect, and repair your irrigation system.

Advantages Include

1 **Tailored Irrigation Strategies** – Our team of experts develops customized irrigation schedules based on your specific crop, soil type, soil moisture levels, evapotranspiration rates, and crop water requirements

2 **Advanced Technologies and Data Analysis** – using sensors, weather station data, satellite imaging, and other analytical tools, we make informed decisions to fine-tune your system to ensure optimal water distribution. All this equipment is provided to you as part of the service.

3 **Our service includes continuous monitoring of your irrigation service.** Automated alerts notify us of any issues with the system, like leaks or system malfunctions, allowing us to quickly resolve problems and minimize water loss.

4 **Labor Savings** – Our team provides all these advanced services at a fraction of your labor cost. Using technology to manage water frees your team to focus on other parts of your operation.

Experience the benefits of efficient water management and contribute to a more sustainable future for your farm and environment.

Our Name May Have Changed But Our Commitment To You Remains The Same

In 2017 two of the largest irrigation dealers, Agri-Valley Irrigation and Irrigation Design & Construction, merged their businesses. The merged companies supply unparalleled leadership in design, construction, service, and innovative Ag irrigation technology.

Agri-Valley was founded in 1983, and Irrigation Design & Construction in 2004 were family-owned businesses. They both operate with the philosophy of doing what is right for customers and the industry. As a result, the companies continue to grow daily, providing customers with the best value in the industry.

As these companies worked together over the past six years, it became clear the teams no longer worked as separate entities but as one successful dealer providing innovative solutions to customers. One of the best values of the merger was the synergies of the teams. To honor the teamwork and the rich history Agri-Valley and Irrigation Design & Construction changed its name to AvidWater.

A team of representatives from Agri-Valley and IDC selected the name. It represents both companies and celebrates their rich history while acknowledging the opportunity for more extraordinary solutions for customers due to the merger. AvidWater is excited to show customers the value of one.

AvidWater Locations

Fresno
3168 West Belmont Ave
Fresno, CA 93726
(559) 486-1412

Bakersfield
2650 Enos Lane
Bakersfield, CA 93314
(661) 588-9761

Firebaugh
1972 N Street
Firebaugh, CA 93622
(559) 659-1007

Five Points
21067 S Lassen Ave
Five Points, CA 93624
(559) 884-2506

Merced
522 S HWY 59
Merced, CA 95314
(209) 384-8494

Visalia
30467 Rd 158
Visalia, CA 93292
(559) 734-1923

Brawley
310 N 8th Street
Brawley, CA 92227
(855) 595-4800 Toll Free

Castroville
11455 Wood St #8
Castroville, CA 95012
(831) 632-0477

Woodland
37795 State Highway 16, Suite 3
Woodland, CA 95695
(530) 316-1920

Dos Palos
16490 Indiana Ave
Dos Palos, CA 93620
(209) 387-4500

Linden
13671 E Highway 26
Linden, CA 95236
(209) 931-6407

Newman
808 Merced St
Newman, CA 95360
(209) 862-4900

Patterson
11220 Highway 33
Patterson, CA 95363
(209) 894-5184

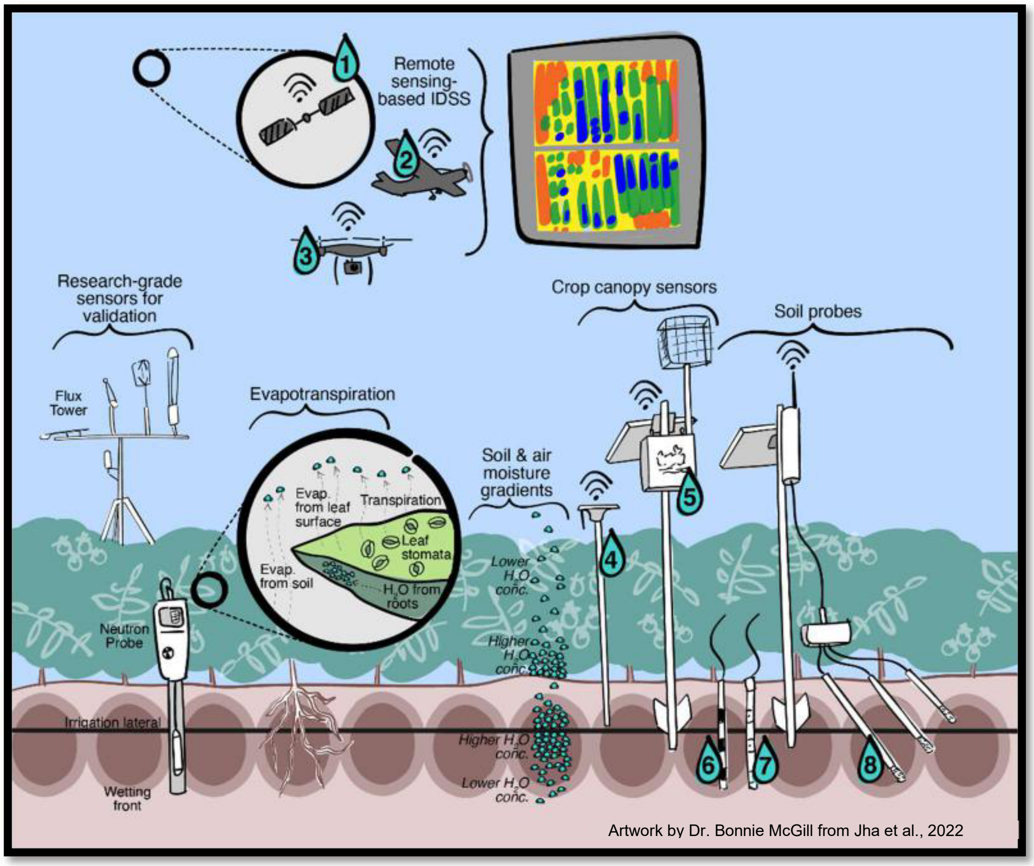
Santa Maria
2341 A Street Bldg #17
Santa Maria, CA 93455
(805) 623-5099

Stockton
1245 W Charter Way
Stockton, CA 95206
(209) 466-6407

NOTES

Irrigation Decision Support System (IDSS)

IDSS are integrated solutions combining and interpreting real-time meteorological, soil moisture and/or crop water stress data using cloud-based telemetric services to help growers make irrigation decisions.



Artwork by Dr. Bonnie McGill from Jha et al., 2022

Why are IDSS important?

- For growers to manage and maximize irrigation water, energy, and N use efficiency.
- To coordinate the development and management of water, land, and energy aimed towards equitable economic welfare and sustainable water use.
- Fundamental support to decide when, where and how much water to apply while simultaneously minimizing energy and resource use.

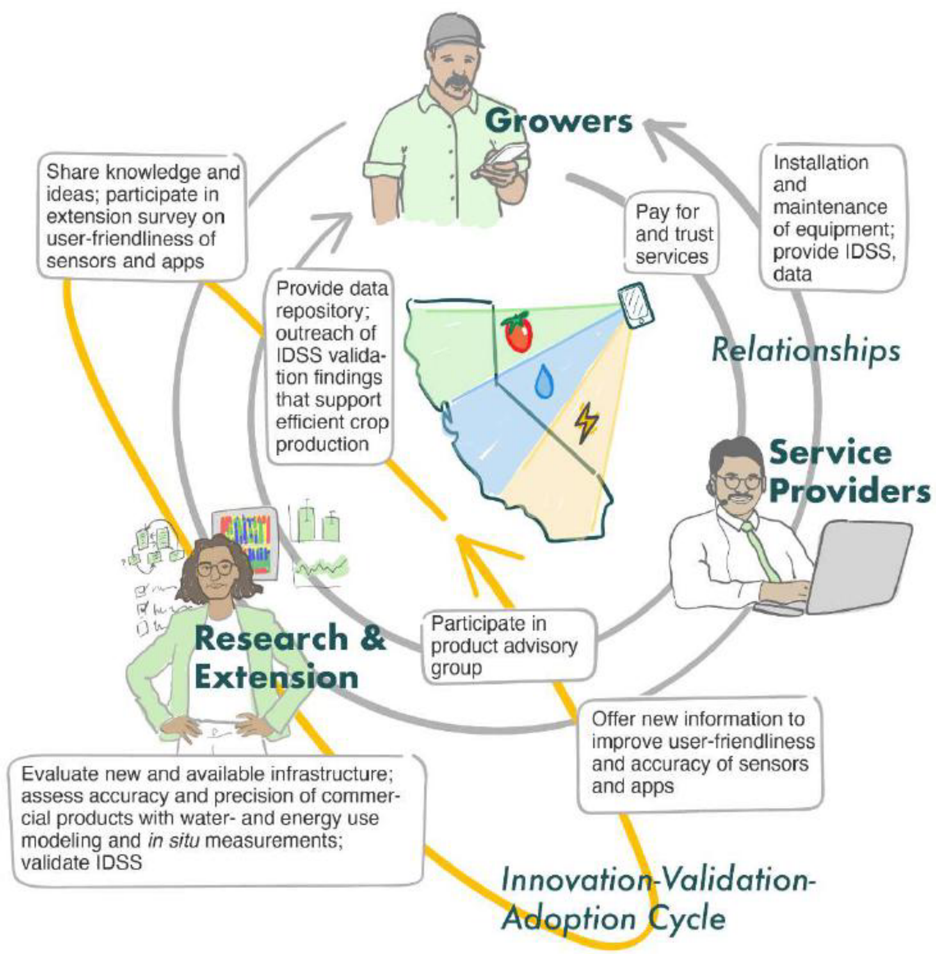
california almonds Almond Board of California

T·REX
Tree crop Remote sensing of Evapotranspiration eXperiment

UC DAVIS UNIVERSITY OF CALIFORNIA

Conservation Irrigation Lab

Innovation-Validation-Adoption of IDSS for food-water-energy nexus



Artwork by Dr. Bonnie McGill, from Jha et al., 2022

IDSS evaluation and integration towards food-water-energy nexus is a cyclical process of innovation by service providers/researchers, validation by extension research professionals, and adoption by growers.

CA's need for IDSS development, evaluation, the T-REX project

The **T**ree **C**rop **R**emote sensing of **E**vapotranspiration e**X**periment (TREX) combines ground, satellite, and drone imagery fill data and knowledge gaps to aid in water management. The Conservation Irrigation Lab will develop user-friendly remote sensing tools to transform imagery to actionable information that can help growers assess stem water potential (SWP) and distribution uniformity (DU) with commercially available unmanned aerial systems. The Conservation Irrigation Lab will also develop and ground truth open-source models that will allow multiple hardware and software technologies to integrate new DU and SWP tools.

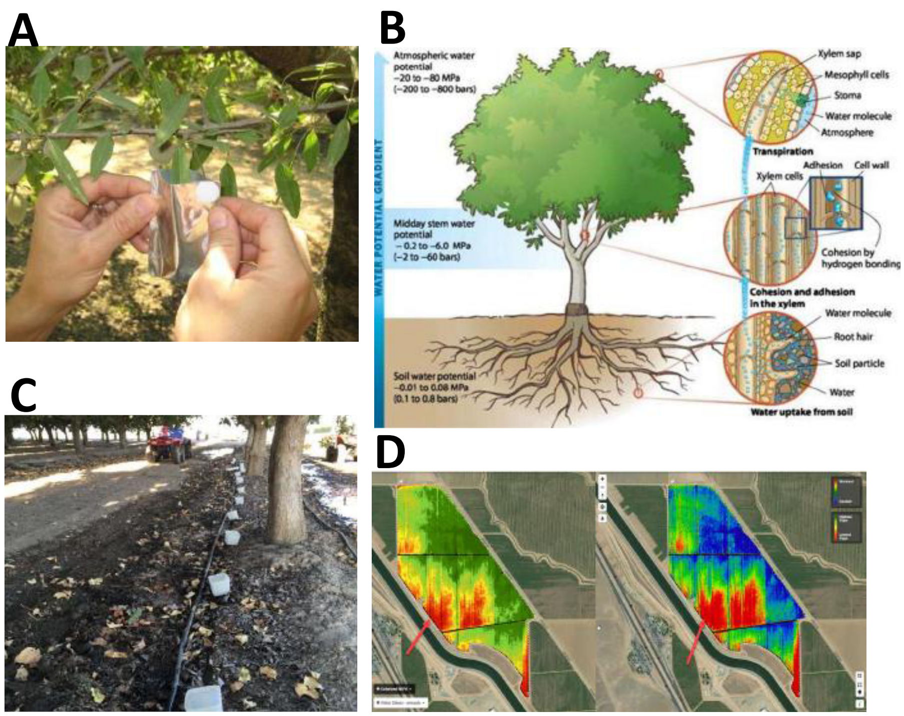
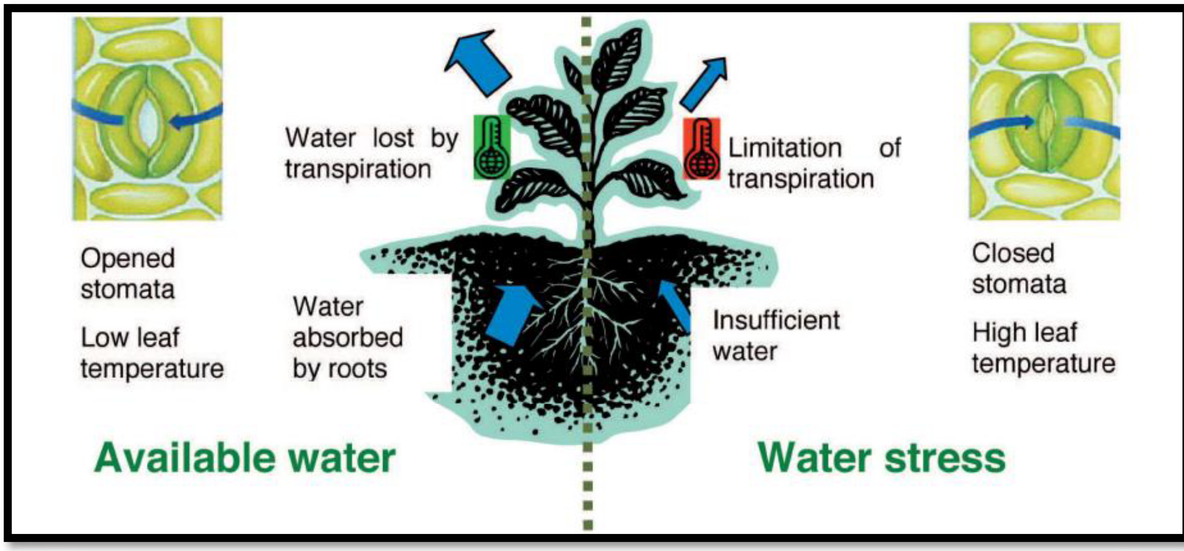
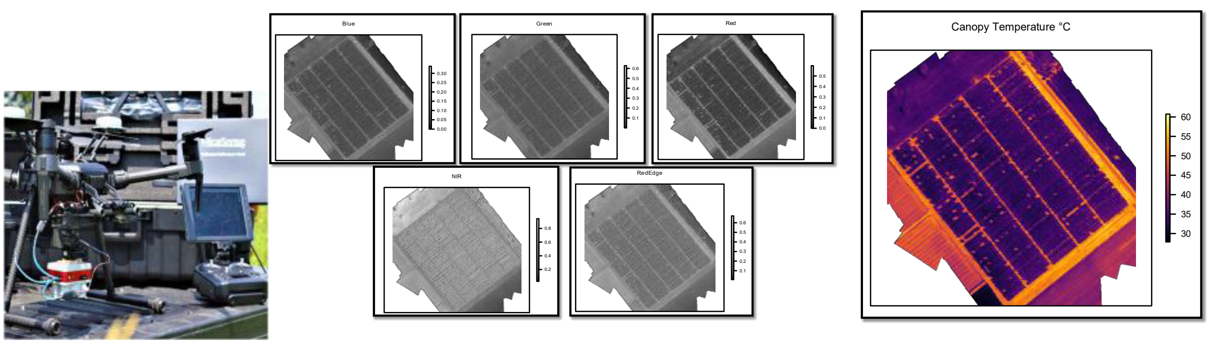


Figure 1. Theory and techniques for measuring SWP and DU. A) Bagging a leaf for SWP measurement in almond tree to assess plant water stress (photo: PMS Instruments). B) Water movement and potential across the soil-tree-atmosphere continuum (source: SacValleyOrchards.com; adapted from Pearson 2008. Upper Saddle River, NJ: Pearson Education Inc). C) Distribution Uniformity assessment using catch cup approach (photo: D. Zaccaria). D) Example of poor distribution uniformity identification using colorized normalized difference vegetation index (NDVI) and thermal imaging in an annual crop (source: Ceres Imagery, Oakland CA).

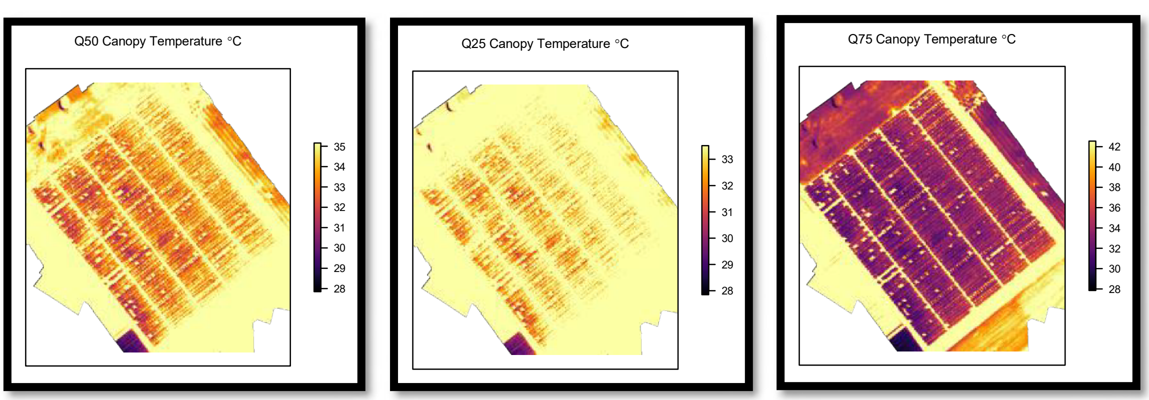
Why is thermal imagery useful for water management? Labbé et al., 2012



Examples of multispectral and thermal imagery reflectance bands from July 9, 2021 flight in Chico, CA. These bands are often combined to calculate different phenological indices (NDVI, EVI)



Quartile breaks across thermal imagery from July 9, 2021 flight in Chico, CA. Crown separation at Q50 has been demonstrated to be a useful predictor of crop water stress (Camino et al., 2018).



To learn more about T-REX, reach out-

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Website-https://www.irrigationlab.com/