US EPA ARCHIVE DOCUMENT

University of California
Agriculture and Natural Resources

RESEARCH AND EXTENSION EFFORTS RELATED TO DROUGHT AND IRRIGATION

9th Annual California Bioresources Alliance Symposium
UC Davis – June 3-4, 2014

Daniele Zaccaria, Ph.D.
UC Cooperative Extension Specialist, LAWR
Ph.: 530-219 7502 Email: dzaccaria@ucdavis.edu

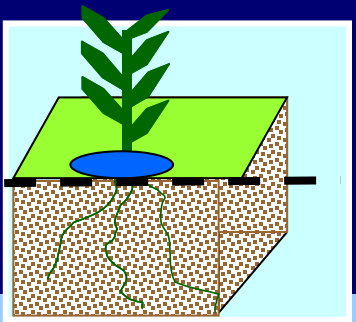
Support growers using effectively the limited water resource

Increasing Resource-efficiency

Minimizing Resources Degradation

WAYS TO ACHIEVE THE GOAL

1. Better understanding of crop water use (ETc) & yield response to water
2. Increasing **W.U.E./W.P.** along the entire agricultural water supply chain
3. Creating the conditions enabling uptake of innovations in Ag. Water Manag.

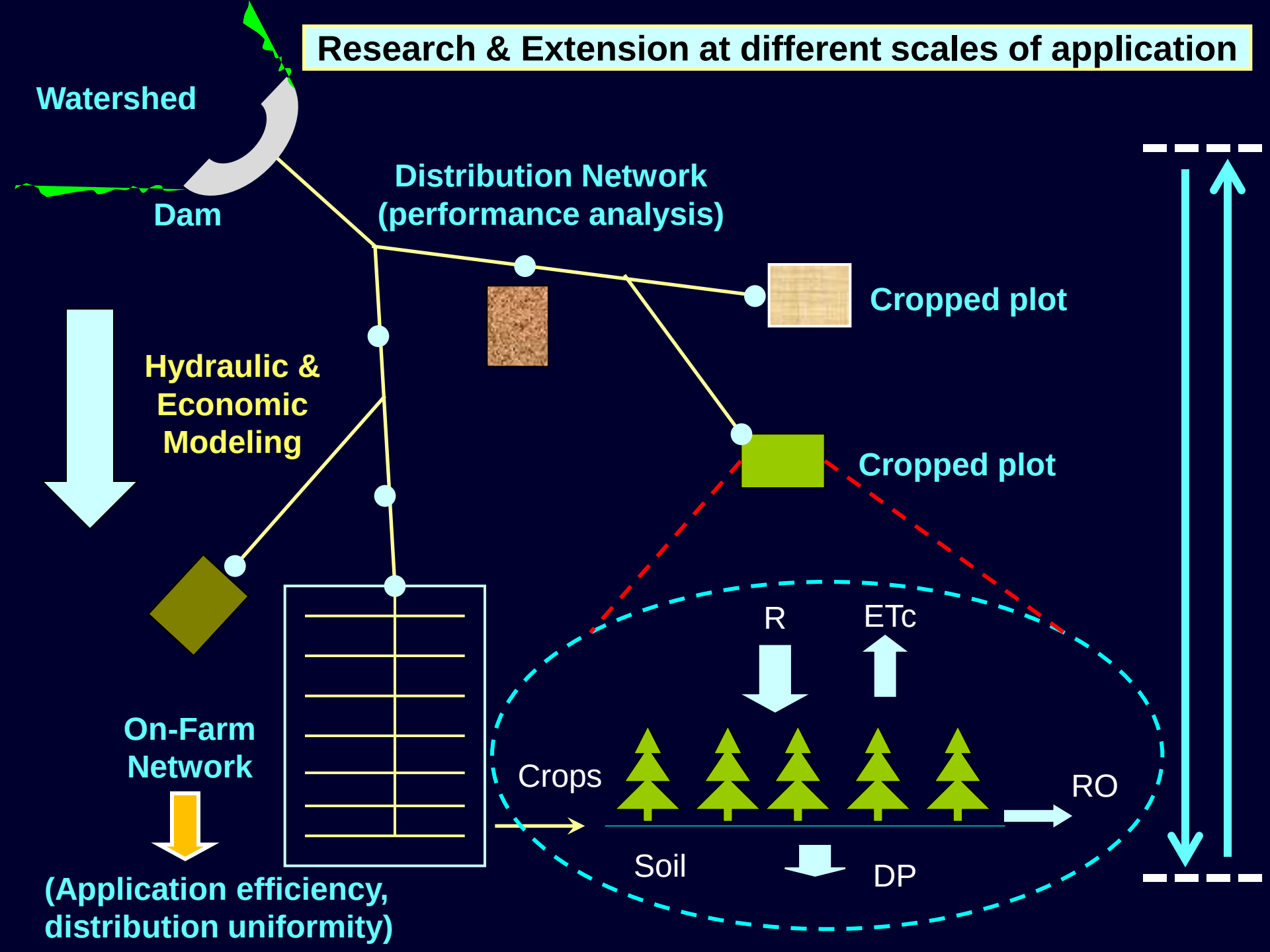


$$\frac{W_{reservoir\ \ out}}{W_{reservoir\ \ in}} \times \frac{W_{farm\ gate}}{W_{reservoir\ \ out}} \times \frac{W_{field}}{W_{farm\ gate}} \times \frac{W_{root\ \ zone}}{W_{field}} = \frac{W_{root\ \ zone}}{W_{reservoir\ \ in}}$$

Storage efficiency	Conveyance efficiency	Farm efficiency	Application efficiency	Overall efficiency

[Source: HSIAO T., 2005]

Research & Extension at different scales of application



CURRENT DROUGHT DREW THE ATTENTION ON ADAPTIVE PRACTICES TO COPE WITH LIMITED SUPPLY

COME UP WITH MORE ACCURATE ESTIMATIONS OF CROP WATER NEEDS

ADAPT IRRIGATION SYSTEMS & PRACTICES TO USE LESS WATER PER CROPPED ACRE FOR SIMILAR YIELD

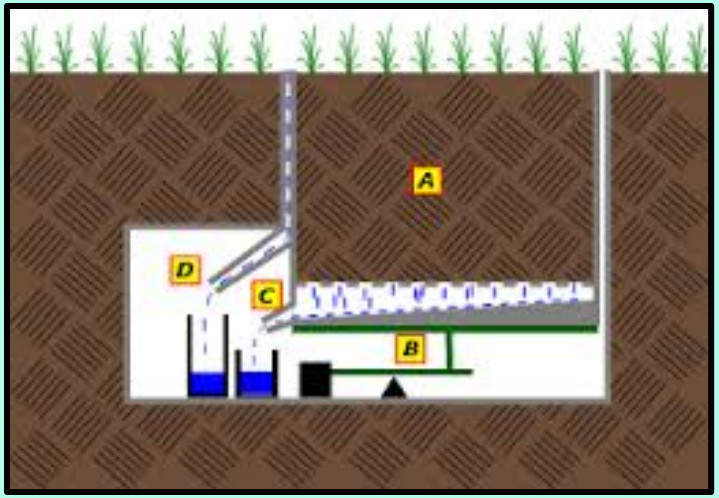
ACHIEVE BETTER CONTROL OF IRRIGATION APPLICATIONS (amount, timing, and application modes)

As a result, team efforts with several faculty and extensionists have generated a set of applied-research and extension projects

APPLIED-RESEARCH PROJECTS

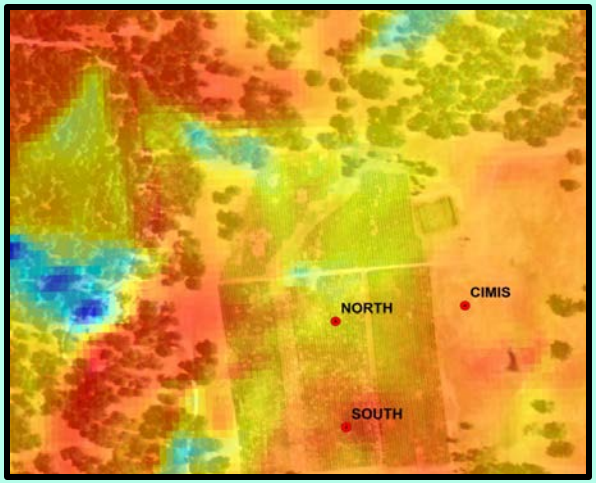
(DWR) Measuring alfalfa water use (ETr) by Weighing Lysimeters, Surface Renewal and Eddy Covariance methods

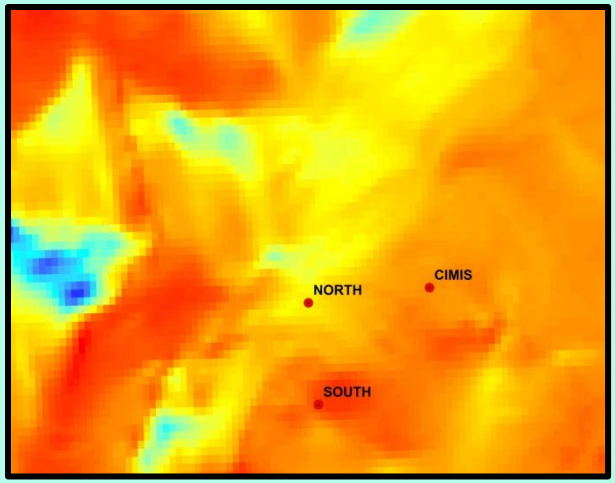
D. Zaccaria, R. Snyder, D. Putnam, K. Little

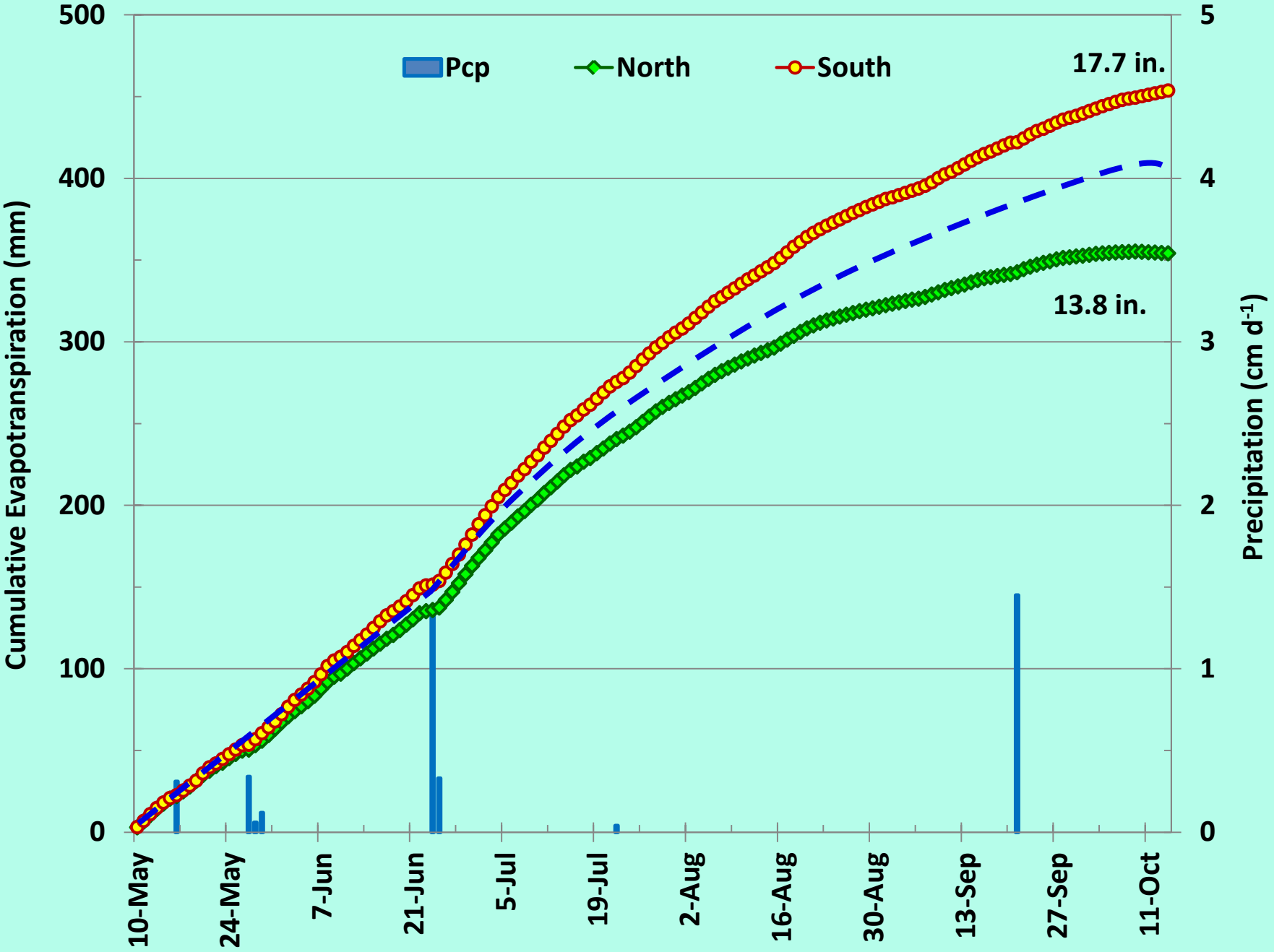


Measuring actual water use (ETc) of vineyards with different slopes & aspects

R. Snyder, D. Zaccaria, K. Shackel, L.Wunderlich

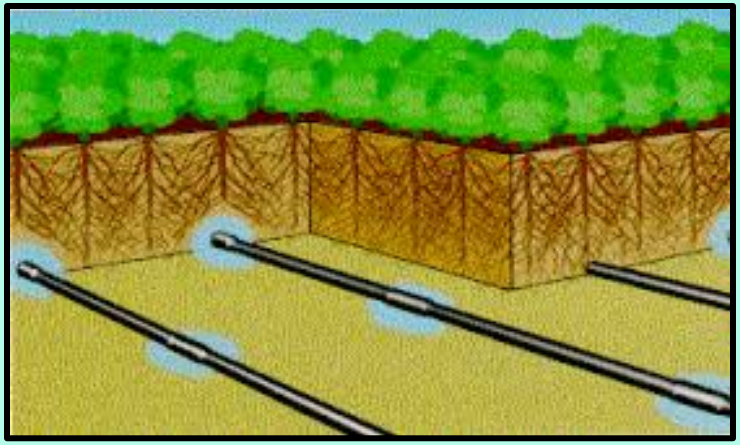





Pcp
North
South
17.7 in.
13.8 in.
Cumulative Evapotranspiration (mm)
Precipitation (cm d-1)
500
400
300
200
100
0
5
4
3
2
1
0
10-May
24-May
7-Jun
21-Jun
5-Jul
19-Jul
2-Aug
16-Aug
30-Aug
13-Sep
27-Sep
11-Oct

(DWR-ANR) Subsurface Drip Irrigation for Alfalfa to Improve W.U.E. and Protect Water Quality

D. Putnam, R. Baldwin, K. Bali, D. Zaccaria



<u>Project Objectives</u>:

1) To develop and improve pocket gopher management strategies which would enhance the viability of SDI in alfalfa.

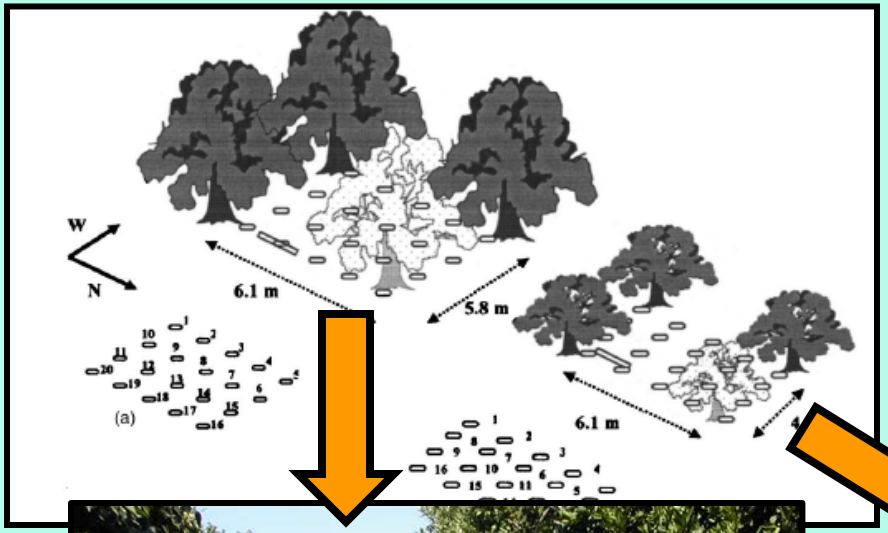
2) To develop a documented learning network for growers who are implementing SDI in alfalfa fields.

3) To compare SDI methods with check flood irrigation in terms of water use, yield, viability, and efficiency (and water quality)

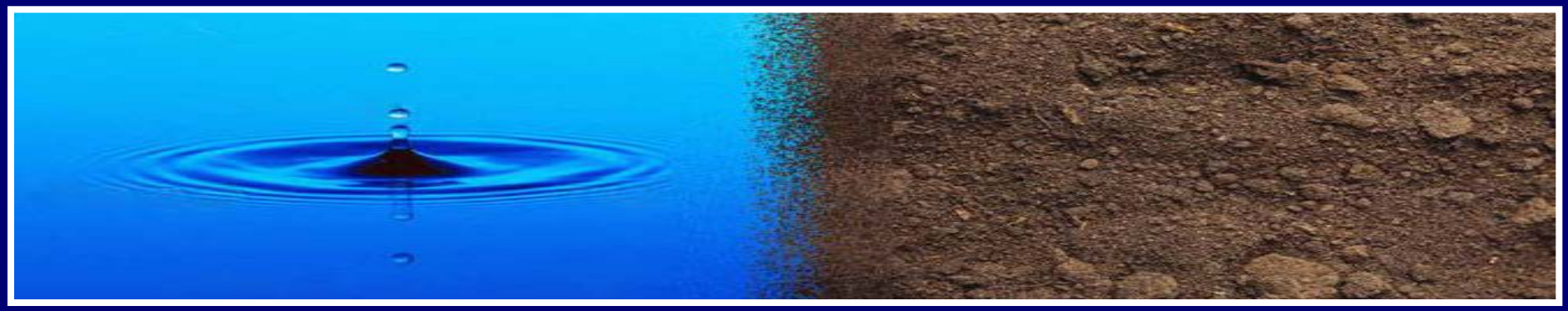
Measuring Actual Water Use in Citrus Orchards

R. Snyder, N. O'Connell, B. Faber, D. Zaccaria, B. Lampinen

Large canopy vs. High-density



East-West vs. North-South rows



EXTENSION EFFORTS

ANR Project with DWR

"Developing Updated Drought Management Information"

IrRIC

Irrigation Research & Information (Web) Center – LAWR- UC Davis

IRRIGATION RESEARCH & INFORMATION CENTER
DEPT. OF LAND, AIR AND WATER RESOURCES

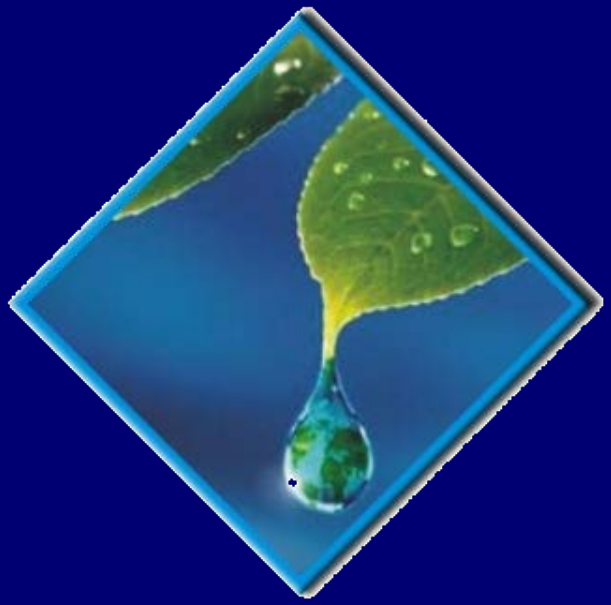
- **SPONSORSHIP**
- **DROUGHT TIPS**
- **DROUGHT WEBINAR SERIES**

ANR DROUGHT WEB CLEARINGHOUSE

ANR–DWR Project *"Updating Drought Management Information"*

- **<u>Rationale</u>:** a) Drought cannot be considered as "unexpected"
  b) Increase in frequency and severity in years to come

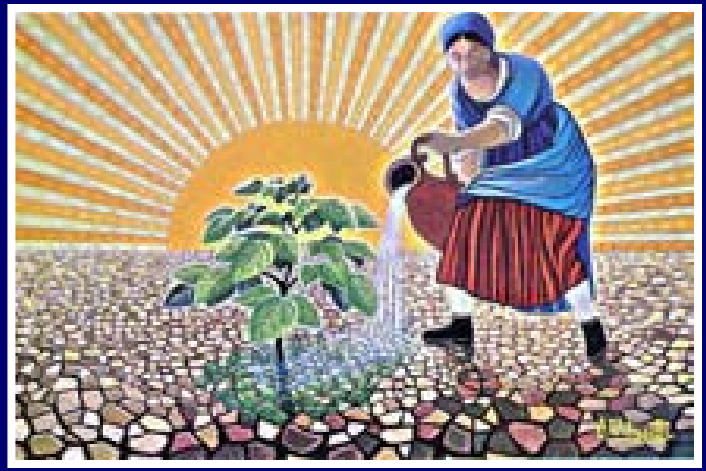
- **<u>Objectives</u>:** #) Updating information on drought management
  #) Making updated information available to large audience



ANR-DWR Project

"Developing Updated Drought Management Information"

78 + FACT SHEETS ('70s & '90s) ON WATER MANAGEMENT UNDER DROUGHT



drought tips

Number 92-28

Citrus Irrigation Scheduling During a Drought

Drought Tactics for Apricots

Drought Strategies for Wine Grapes

Deciding How Much to Plant During A Drought

Irrigation Scheduling of Surface-Irrigated Crops During a Drought

Insights: Water & Drought Online Seminar Series

Main Objective

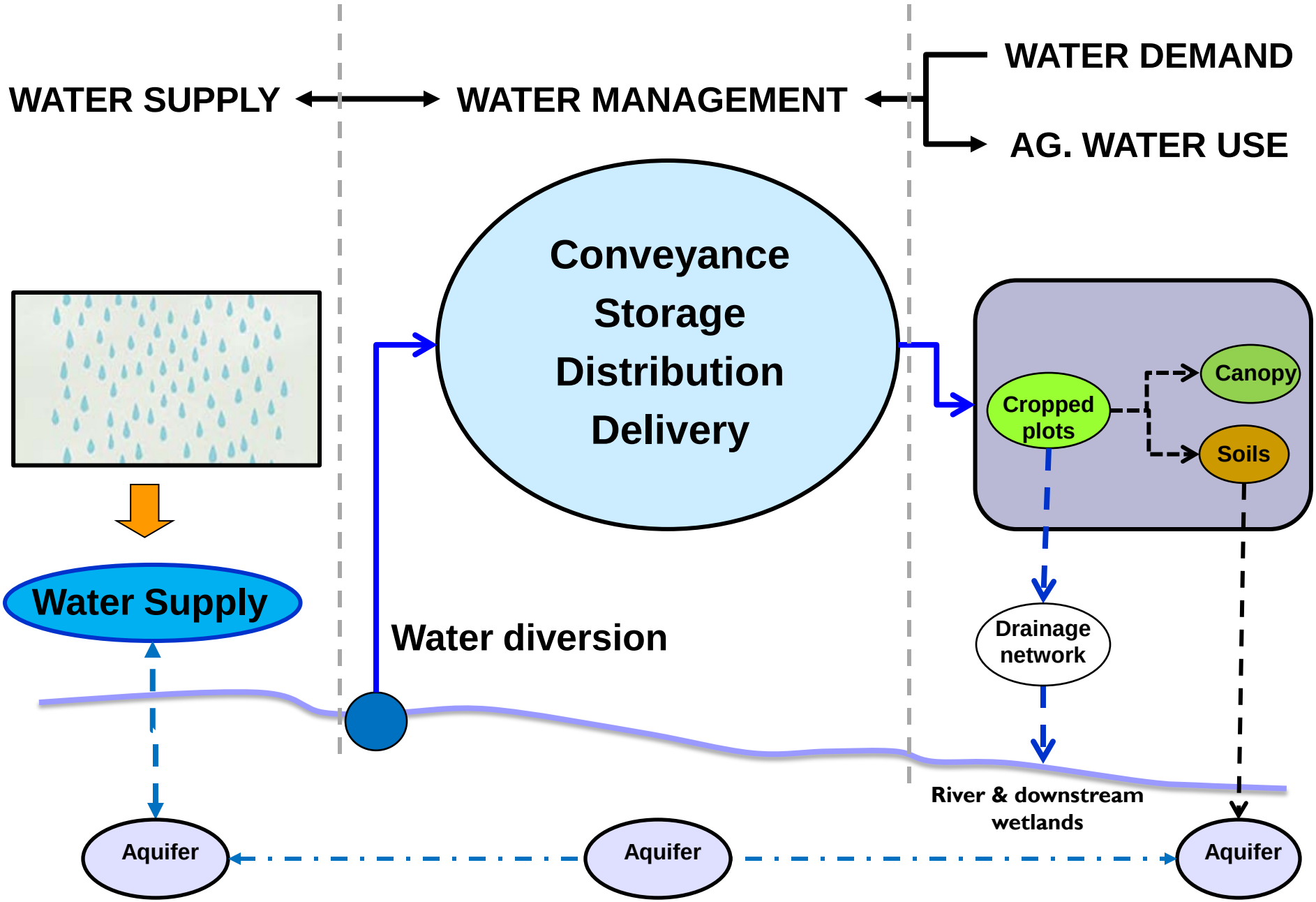
widely disseminate to growers, planners & resource managers

- ✓Suggestions for actions
- ✓Adaptive measures
- ✓Crop management/irrigation practices

to mitigate the adverse impacts of droughts

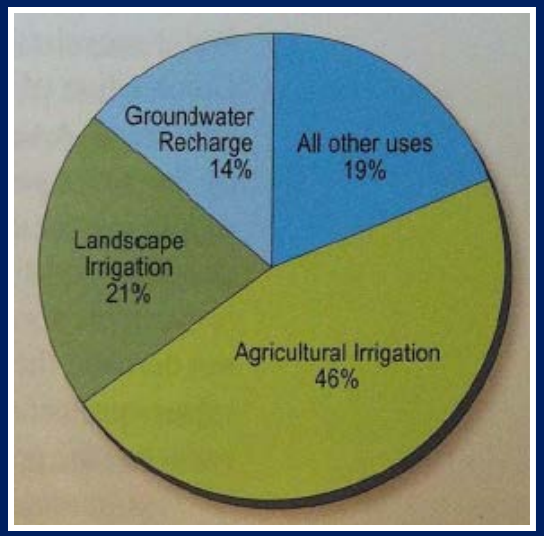
http://ucanr.edu/insights

SUPPLY CHAIN OF AG. WATER USE



Three specific aspects caught my attention during this drought:

1) **Large potential for water re-use in agriculture**
2) **In most studies, partial irrigation (DI) is often decoupled from nutrient management**
3) **Need to integrate the economic, ecologic and efficiency components of water use**



California Water Facts (2010)	**MAF/Yr**
Urban water use	8.5
Agricultural water use	33
Total water use (current)	41.5
Recycled water use	**0.65 (7% = 0.65/8.5 MAF)**
WW Discharge to ocean	**3.5**

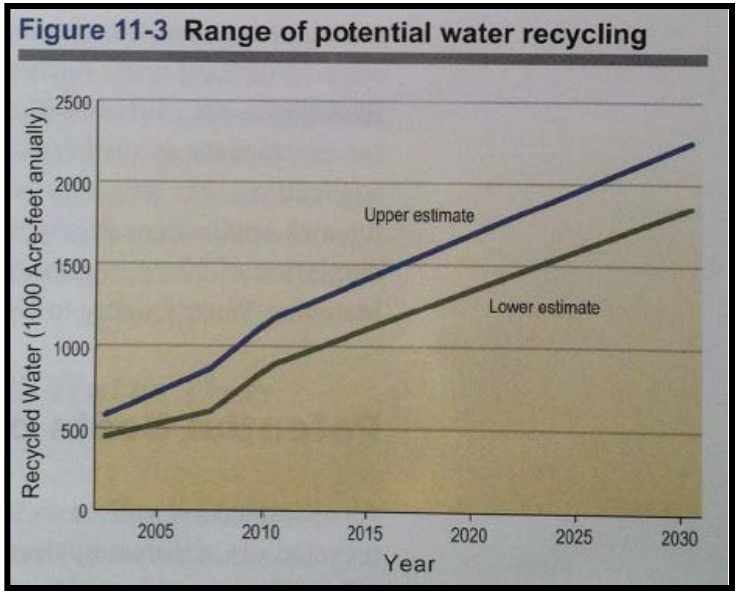
Pros:

✓A reliable supply of water

✓**A drought mitigation water supply**

✓A green alternative for disposal of wastewater

✓A source of nutrient for crops and landscapes



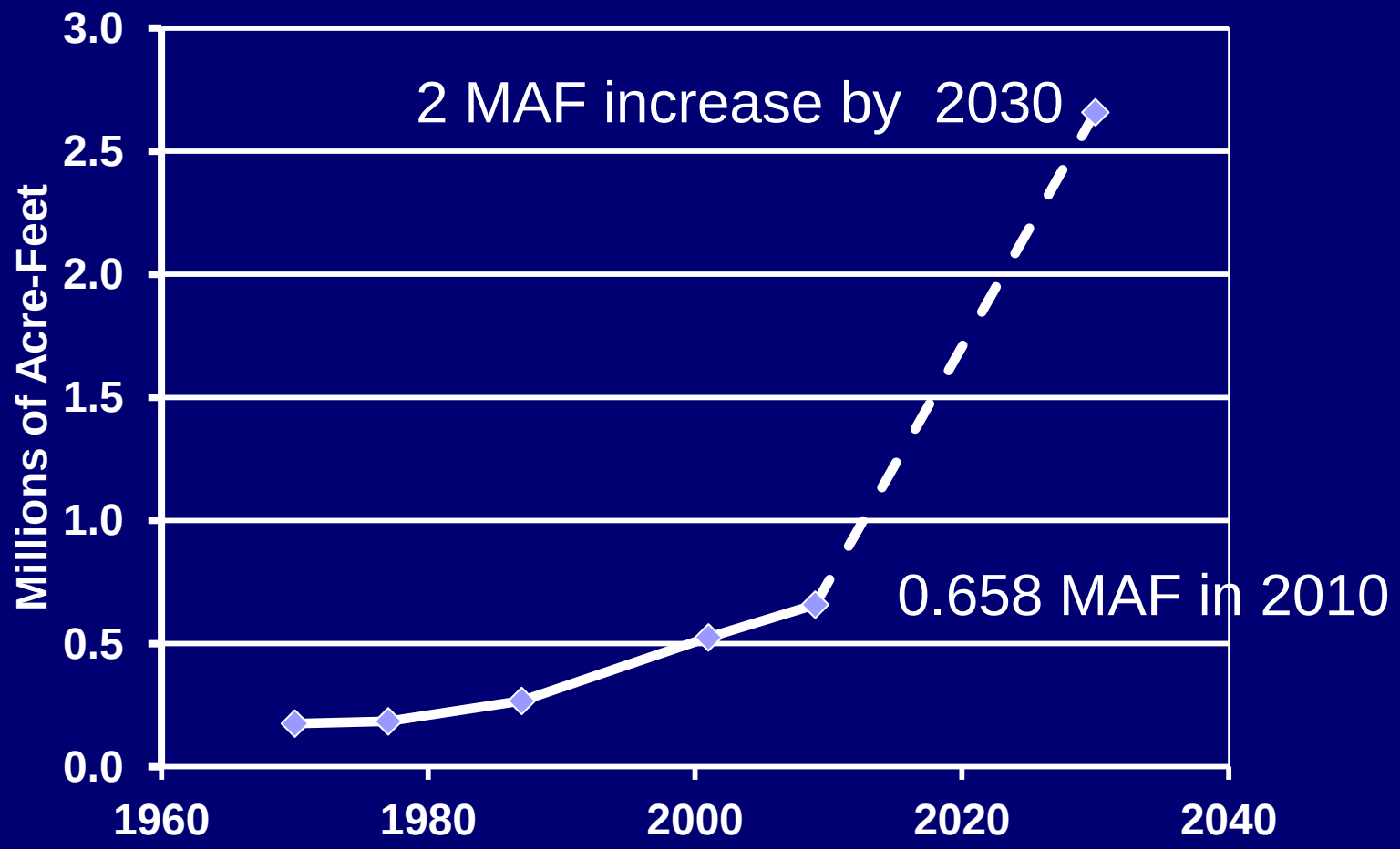
Constraints:

✓Capital + operational cost range from 300 to 1300 $/ac-ft

✓**Need separate distribution systems (purple pipes)**

✓Public acceptance => the “yuck” factor

Recycled Water Use Trend In California



State has a goal of 2.5 MAF by 2030, and we are currently not on pace to meet this goal.

Assessing the suitability of using recycled water form the Napa Sanitation District (NSD) for irrigation of vineyards

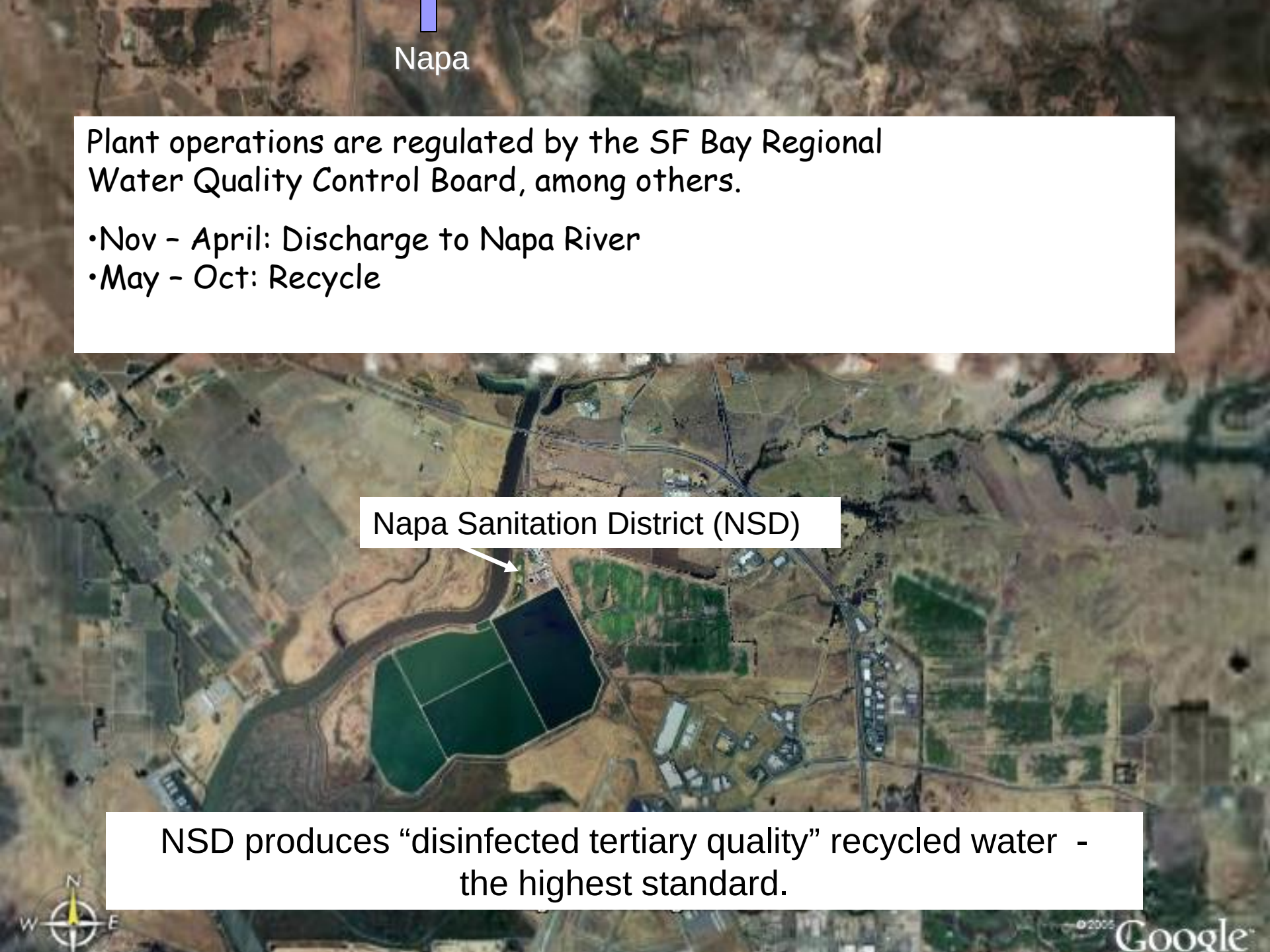
Authors: Ed Weber
Steve Grattan
Blaine Hanson
Rollie Meyer
Terry Prichard
Larry Schwankl

*University of California, Davis (2004-2006)

http://californiaagriculture.ucanr.edu • JULY–SEPTEMBER 2014

Recycled water causes no salinity or toxicity issues in Napa vineyards

by Edward Weber, Stephen R. Grattan, Blaine R. Hanson, Gaetano A. Vivaldi, Rolland D. Meyer, Terry L. Prichard *and* Larry J. Schwankl



Plant operations are regulated by the SF Bay Regional Water Quality Control Board, among others.

- Nov – April: Discharge to Napa River
- May – Oct: Recycle

NSD produces “disinfected tertiary quality” recycled water - the highest standard.

NSD Study - Conclusions

- NSD recycled water is suitable for vineyard irrigation.
- Salts, boron, chloride and trace elements are all below levels of concern.
- The nitrogen levels may be of concern to some growers (too much canopy vigor), while others will see it as an added benefit.
- The use of recycled water is not restricted in the National Organic Program standards, therefore, growers can use this water in organically certified vineyards.

NSD Study - Conclusions

- NSD recycled water is a dilute fertilizer solution. At typical irrigation rates (100 gallons per vine per season), the following amounts will be applied:

	Lbs/acre
Phosphorus (P_2O_5)	2.2-3.4
Potassium (K_2O)	25-37
Nitrogen	14-21

2-3 lbs of P removed

15-25 lbs of K removed

9-15 lbs of N removed

COVER CROPS
(non-legumes)

Research Article

Rapid nutrient load reduction during infiltration of managed aquifer recharge in an agricultural groundwater basin: Pajaro Valley, California

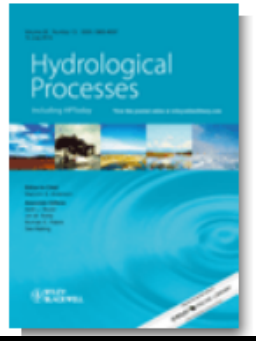
C. M. Schmidt[1,*], A. T. Fisher[1], A. Racz[1], C. G. Wheat[2], M. Los Huertos[3] and B. Lockwood[4]

Article first published online: 18 NOV 2011

DOI: 10.1002/hyp.8320

Copyright © 2011 John Wiley & Sons, Ltd.

Issue



Hydrological Processes

Volume 26, Issue 15, pages 2235–2247, 15 July 2012

Environmental Science & Technology

Environ. Sci. Technol. | Environ. Sci. Technol. Lett.

Browse the Journal | Articles ASAP | Current Is

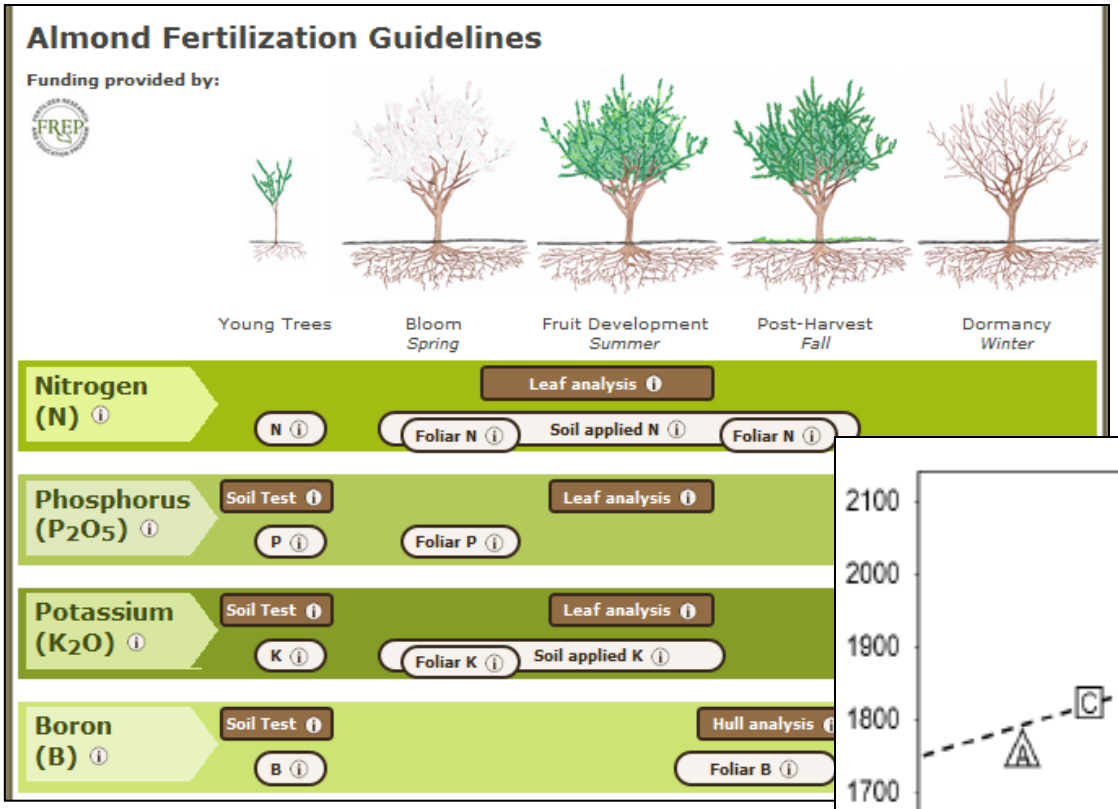
Article | Previous Article

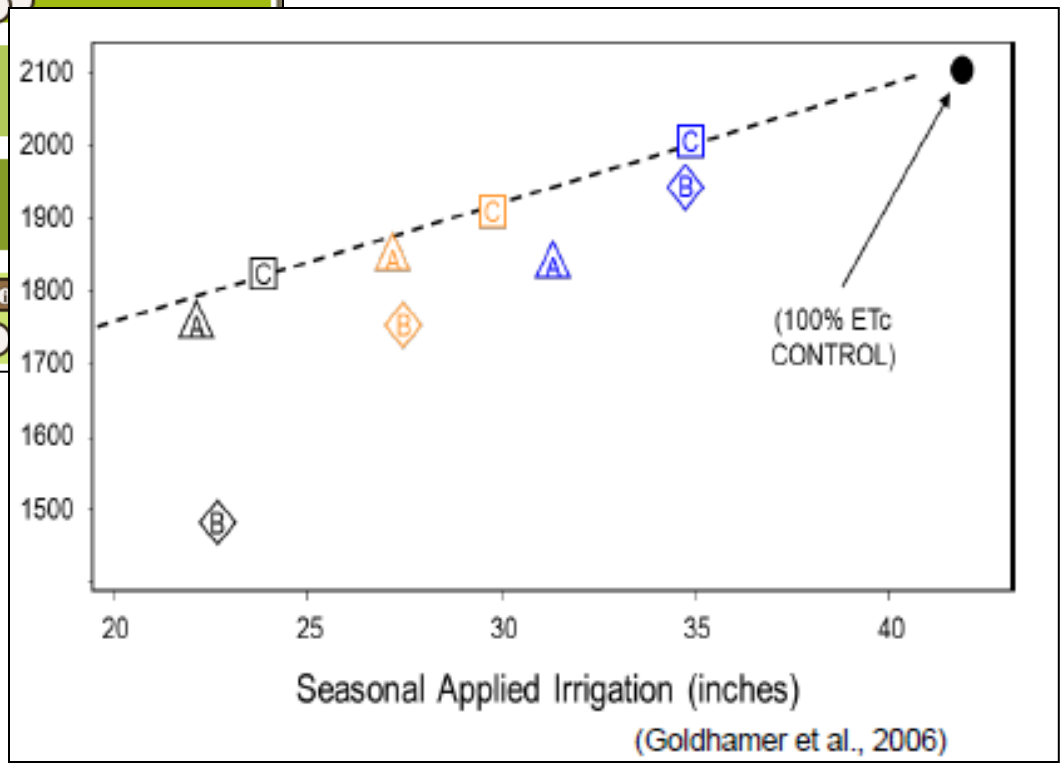
Linking Denitrification and Infiltration Rates during Managed Groundwater Recharge

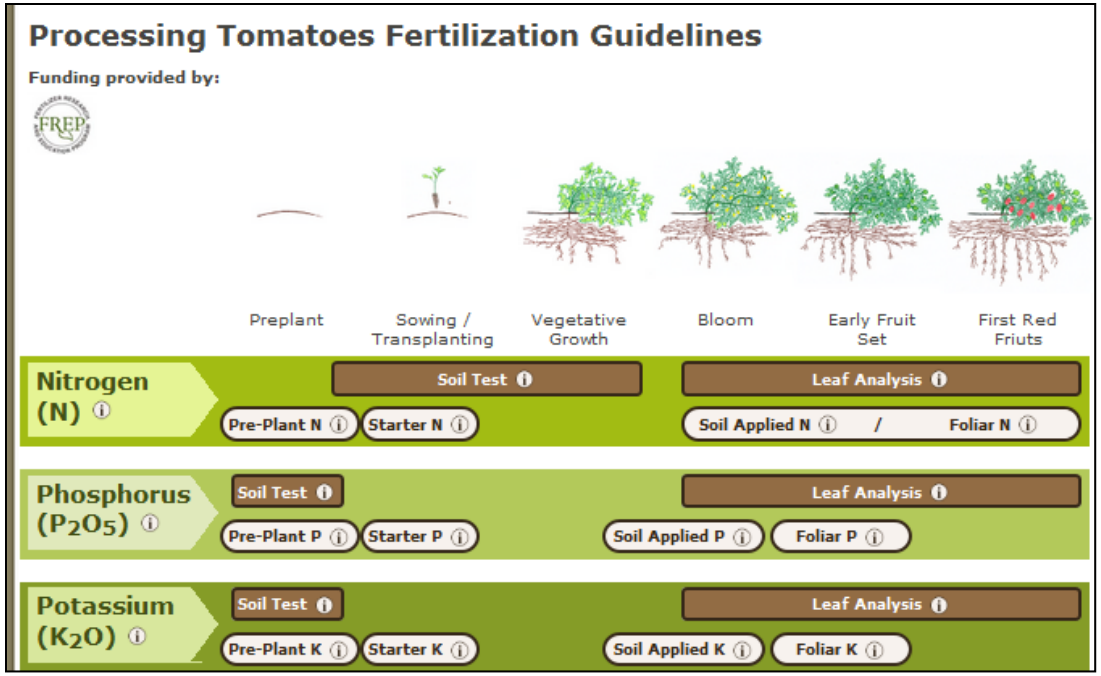
Calla M. Schmidt †*, Andrew T. Fisher †, Andrew J. Racz †, Brian S. Lockwood ‡, and Marc Los Huertos §
University of California, Santa Cruz, Santa Cruz, California 95064, United States

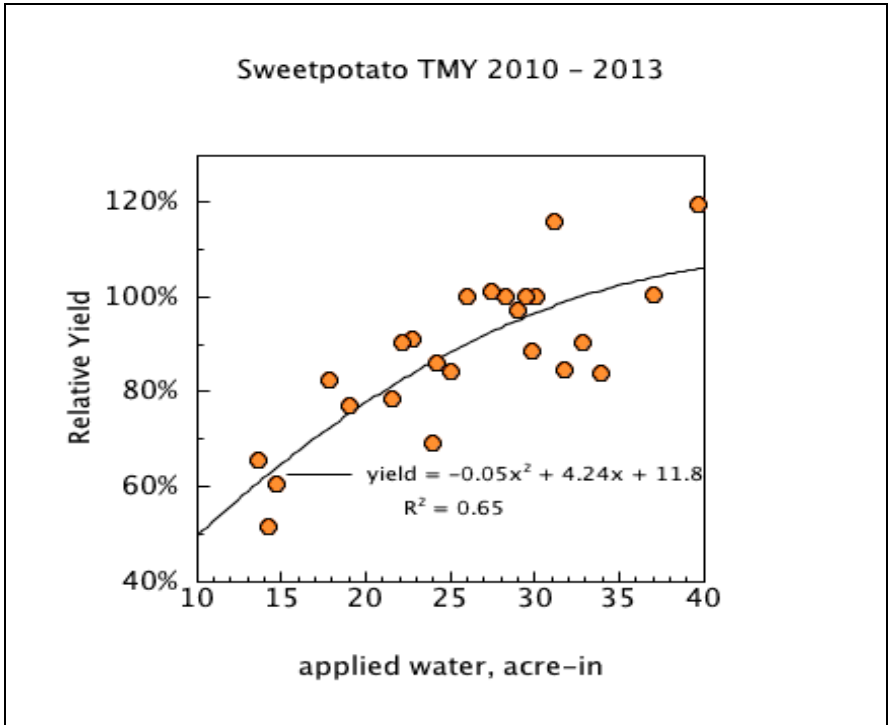
ACS ActiveView PDF | Abstract
Hi-Res Print, Annotate, Reference Quic
PDF [3392 KB] | Supporting Figures

2) In most studies, partial irrigation (DI) is decoupled from nutrient management =>> interlinks to be explored

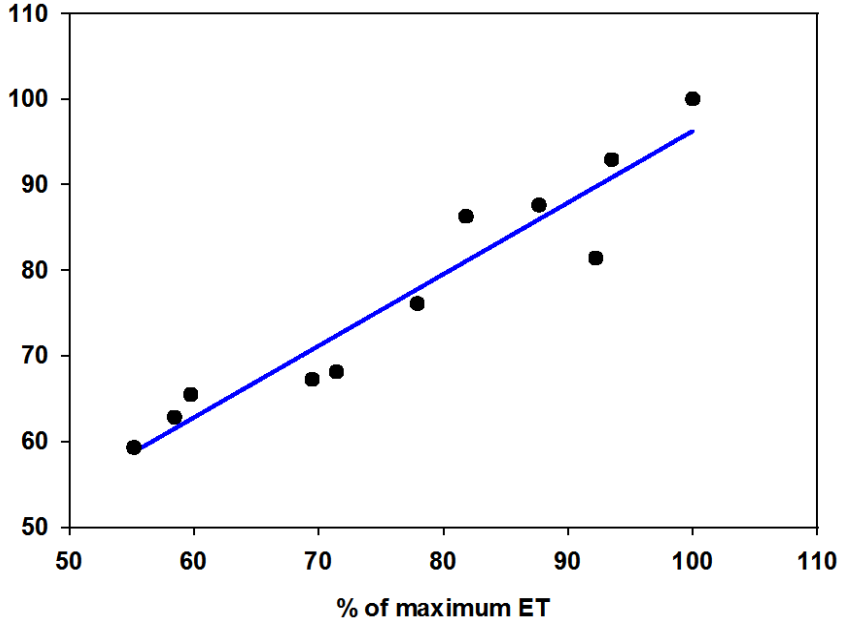








Yield – ET relationship for tomato



(CDFA-FREP) Impacts of Irrigation Amounts and Nitrogen Fertilizers on Sweetpotato Production and Storage

S. Stoddart & D. Zaccaria

Objectives:

✓Evaluate the affect of irrigation volumes (75%, 100% and 125 % of ETc) and nitrogen rate (75, 125, 175 lbs per acre) on the yield and long-term storage of sweetpotato.

✓Evaluate the affect of compost on soil nitrogen and sweetpotato crop response to additional N fertilizers.

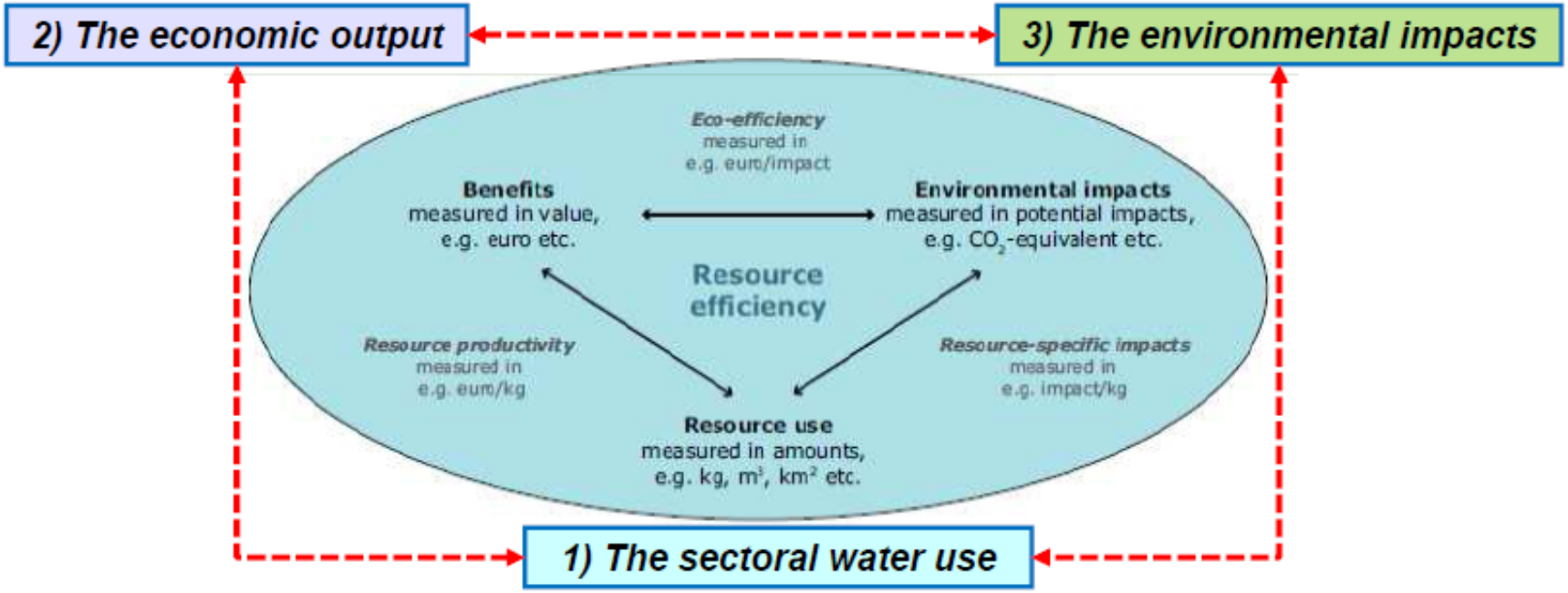
✓Evaluate the use of banded application (5-10 tons/A) of compost (versus broadcast applications) to provide nutrients and organic matter at reduced rates.
Water is distributed through the compost

3) Need to integrate the economic, ecologic and efficiency components of water use

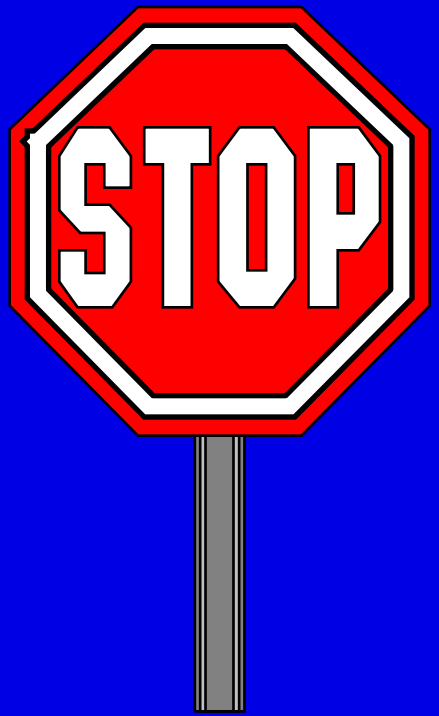
Resource-efficiency indicators relate resource inputs to monetary outputs

$$Eco-efficiency_{WATER} = \frac{Agricultural\ Economic\ Output}{Demand\ on\ the\ Environment} = \frac{Value\ of\ production}{(Extracting\ resources\ \&\ Emitting\ pollution)}$$

There is the need to quantify 3 parameters and explore the relevant inter-linkages



THANK YOU !!



Ir-RIC – IRRIGATION RESEARCH & INFORMATION CENTER

COMING SOON!!!

IRRIGATION RESEARCH & INFORMATION CENTER
DEPT. OF LAND, AIR AND WATER RESOURCES

Search IrRIC

Login

HOME | PEOPLE | IRRIGATION SUBJECTS | PROJECTS | RESOURCES | EDUCATION & TRAINING

Hosted & Maintained by:

UC Davis - Department of Land, Air and Water Resources

Organized by:

Stephen Grattan, Daniele Zaccaria, Pia Van Benthem

NEWS

EVENTS

Welcome to concrete5!

Content Management is easy with concrete5's in-context editing. Just login

SPOTLIGHT

CONTACT

Three specific aspects caught my attention during this drought:

1) Potential for water re-use in agriculture
2) Disconnection of most the studies on partial irrigation (DI) with those on nutrient management =>> room to be explored
3) Need to integrate the economic, ecologic and efficiency component of water use

<u>Project Objectives</u>:

1) investigating relations between canopy features (tree density, canopy size, and orientation) and light interception in traditional and high-density citrus orchards;

2) characterizing the relationship between canopy, light interception, and water use (ETc and Kc) in such orchards;

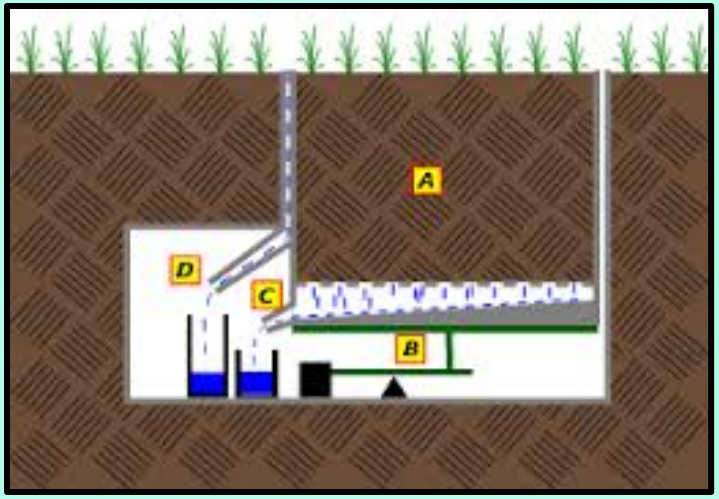
3) provide citrus growers with a simplified method to schedule irrigations in citrus orchards in the climate of the San Joaquin Valley;

4) evaluating irrigation systems performance, and irrigation practices with citrus growers to enhance irrigation adequacy and distribution uniformity;

RESEARCH PROJECTS/PROPOSALS

(DWR) Measuring alfalfa water use (ETr) by weighing lysimeter, Surface Renewal and Eddy Covariance methods

D. Zaccaria, R. Snyder, D. Putnam, K. Little



OBJECTIVES

1) Measure ET of alfalfa by weighing lysimeters, eddy covariance and surface renewal methods, under optimal agronomic conditions and typical weather conditions of the Central Valley of California.

2) Determine the values of crop coefficient (K_{cr}) relative to ET_r and ET_o for the different growth stages of alfalfa.

3) Improve our knowledge of alfalfa evapotranspiration (and yield) to improve irrigation scheduling for alfalfa growers in California.

Background info: Daniele Zaccaria

- Born and raised in southern Italy
- BS: Agricultural Sciences, Major Ag. Engineering
- M.S. in Land & Water Resources Management
- Ph.D. Irrigation Engineering @ Utah State University
- CE specialist in Agricultural Water Management (July, 2013)
- Email: dzaccaria@ucdavis.edu
- http://www.caes.ucdavis.edu/about/directory/fsd/zaccaria

Matching WATER SUPPLY and WATER DEMAND in space, time & quality

WATER DEMAND

Increasing

WATER SUPPLY

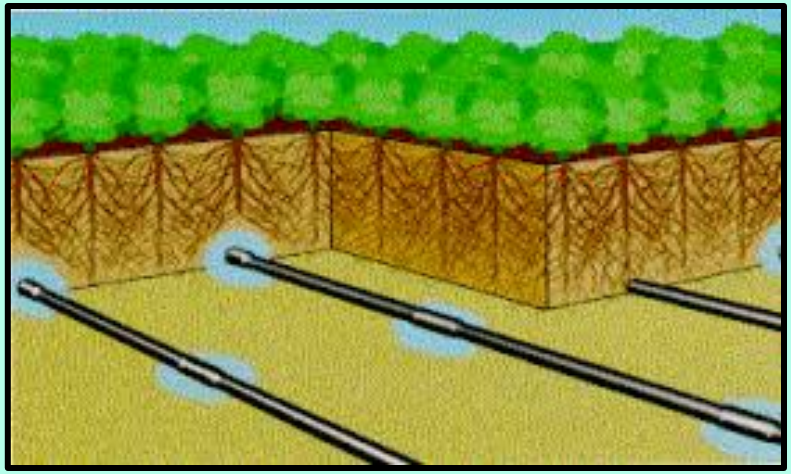
Fixed & Limited

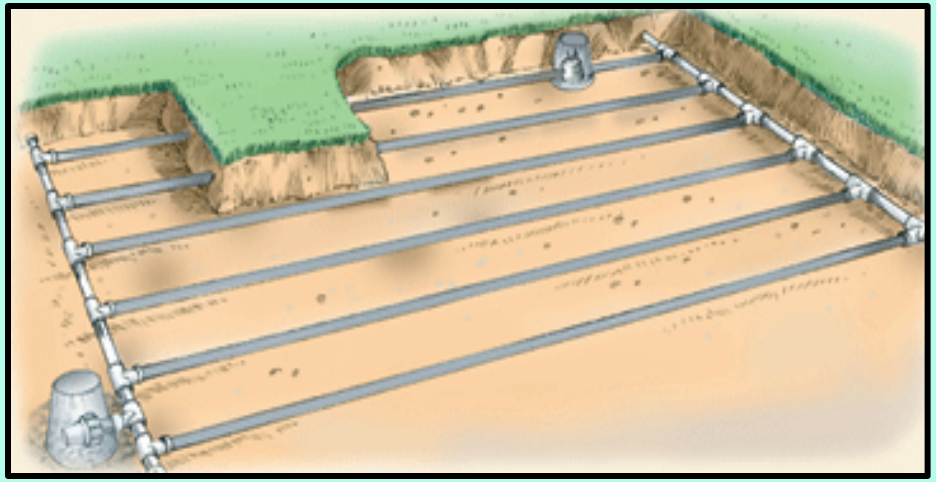
Climate changes
UNCERTAINTY
+
DROUGHT

FIND THE MAGIC SOLUTION !!

(DWR-ANR) Subsurface Drip Irrigation for Alfalfa to Improve W.U.E. and Protect Water Quality

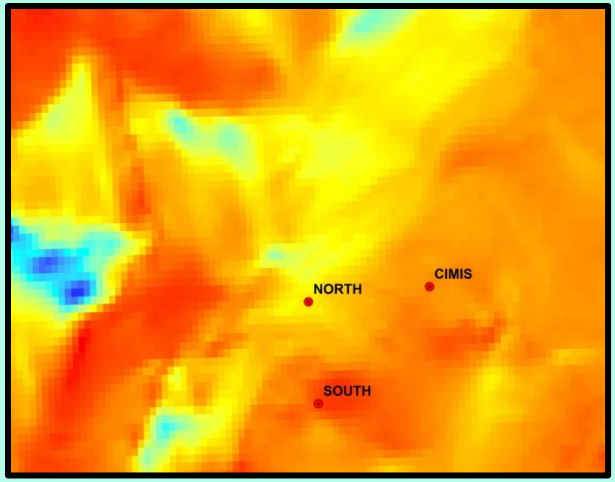
D. Putnam, R. Baldwin, K. Bali, D. Zaccaria

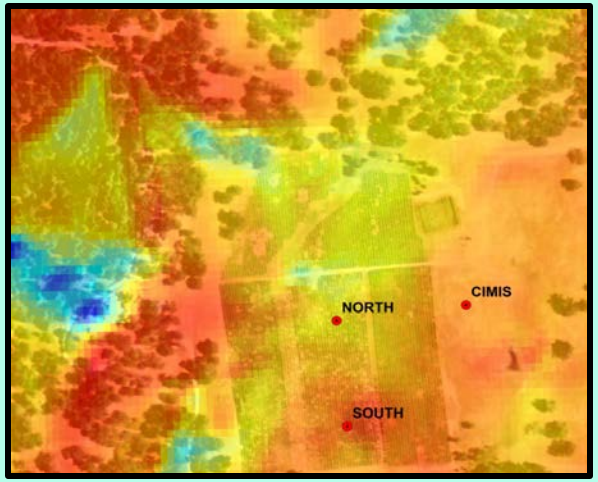




Measuring actual water use (ETc) of vineyards with different slopes & aspects

R. Snyder, D. Zaccaria, K. Shackel, L. Wunderlich





<u>Project Objectives</u>:

1) Assessing difference in water use by vineyards with north-facing and south-facing aspects, under normal water management practices, using the surface renewal method.

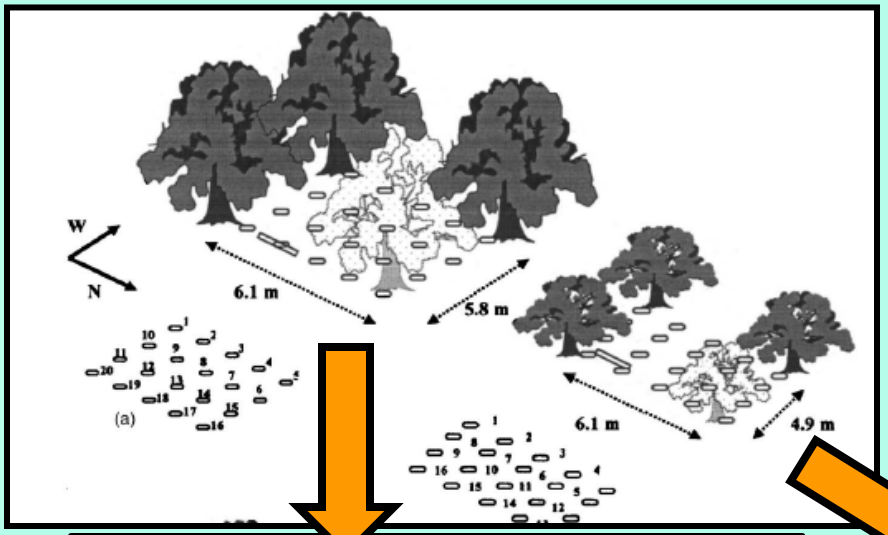
2) Measuring the Kc of north and south-facing vineyards in the different growing stages;

3) Correlating the vineyards water use with the cumulative solar radiation and light interception by the canopy in north and south-facing vineyards

(DWR?) Water use in citrus orchards

R. Snyder, N. O'Connell, B. Faber,
D. Zaccaria, B. Lampinen

Large canopy vs. High-density



East-West vs. North-South rows

University of California
Agriculture and Natural Resources | California Institute for Water Resources
Developing research-based solutions to water-related challenges

http://ucanr.edu/insights

- Home
- About the Institute
- Programs
- Research and Outreach Projects
- Tools and Resources
- Publications
- Keep in Touch

QUICK LINKS

- Drought resources
- Nitrogen Hazard Index
- Rosenberg Forum
- Follow us on Twitter
- Join our email list

Insights: Water and Drought Online Seminar Series

Events | Information | Experts | Media Coverage | Story Highlights

This new online seminar series from the University of California, Agriculture and Natural Resources, with support from the California Department of Water Resources, brings timely, relevant expertise on water and drought from around the UC system and beyond directly to interested communities.

Groundwater and surface water interactions under water shortage

Thomas Harter, UC Cooperative Extension Specialist, UC Davis

Salinity management under drought for perennial crops

Steve Grattan, UC Cooperative Extension Specialist, UC Davis

Salinity management under drought for annual crops

Steve Grattan, UC Cooperative Extension Specialist, UC Davis

ET-based irrigation scheduling and management considerations under drought

Richard Snyder, UC Cooperative Extension Specialist, UC Davis