ENVIRONMENTAL FARMING ACT SCIENCE ADVISORY PANEL (EFA SAP)
CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

MEETING AGENDA

February 23, 2016
10 AM to 4 PM
Stanislaus County Agricultural Commissioner Office
3800 Cornucopia Way
Room G
Modesto, CA 95358
916-654-0433

REMOTE ACCESS

Please join the webinar (registration required):
https://attendee.gotowebinar.com/register/6887826093800006913
Webinar ID: 155-775-155
Call-in information
1-877-238-3903
Passcode: 6655460
Some presentation materials will be posted at the following link prior to the meeting:
https://www.cdfa.ca.gov/EnvironmentalStewardship/Meetings_Presentations.html

EFA SAP MEMBERSHIP

Don Cameron, Member and Chair
David Bunn, Resources Agency, Member — Jocelyn Bridson, MSc, Member
David Mallory (CalEPA), Acting Member — Jeff Dlott, PhD, Member
Luana Kiger, MSc, Subject Matter Expert
Doug Parker, PhD, Subject Matter Expert

1. Introductions	Chair Cameron
2. Updates	
• Minutes from previous meetings	Chair Cameron
• Healthy Soils Initiative	Dr. Gunasekara
3. The State Water Efficiency and Enhancement Program (SWEEP)	
• Update on program	Dr. Gunasekara
• ARB QM Methodology and Tool	Cari Anderson (ARB) Bailey Smith (ARB)
• Opportunities for additional enhancements – subsurface drip irrigation in field crops 1. Dr. Daniel Putnam – UC ANR, UC Davis 2. Dr. Daniel Munk – UCCE, UC Davis 3. California Ag Solutions – Mikel Winemiller	Chair Cameron
4. Public Comments on SWEEP	Chair Cameron
5. Next meeting and location	Chair Cameron

Amrith (Ami) Gunasekara, PhD, CDFA Liaison to the Science Panel

All meeting facilities are accessible to persons with disabilities. If you require reasonable accommodation as defined by the American with Disabilities Act, or if you have questions regarding this public meeting, please contact Amrith Gunasekara at (916) 654-0433.
More information at: http://cdfa.ca.gov/Meetings.html and http://www.cdfa.ca.gov/EnvironmentalStewardship/Meetings_Presentations.html

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE (CDFA)
ENVIORNMENTAL FARMING ACT SCIENCE ADVISORY PANEL

Byron Sher Auditorium
California Environmental Protection Agency
1001 I Street
Sacramento, CA 95814

July 17, 2015

MEETING MINUTES

Panel Members

Don Cameron, Member and Chair
Mike Tollstrup, Member
Jeff Dlott, PhD., Member
Bruce Gwynne (Alternate), Natural Resources Agency
Jocelyn Bridson, MSc., Member (via webcast)

Subject Matter Experts

Doug Parker, PhD., Subject Matter Expert
Luana Kiger, MSC, Subject Matter Expert

State Agency Staff

Amrith Gunasekara, PhD. (CDFA)
Jenny Lester Moffitt, Deputy Secretary (CDFA)
Evan Johnson (CalRecycle)
Carolyn Cook (CDFA)

AGENDA ITEM 1

The meeting was called to order at 10:10 AM by the Chair, Mr. Don Cameron. Panel Chairman Mr. Cameron introduced the Healthy Soils Initiative (HSI) as an issue of relevance to all farmers. Introductions were made. Members present at the meeting include Mr. Cameron, Dr. Dlott, Mr. Tollstrup, and Mr. Gwynne (alternate for Dr. Bunn from Natural Resources Agency). A quorum was established.

AGENDA ITEM 2
Welcome Address- CalRecycle Deputy Director, Howard Levenson and CDFA Deputy Secretary Jenny Lester Moffitt

Deputy Secretary Moffitt welcomed the panel and audience to the meeting and provided background information on the Healthy Soils Initiative. CDFA was charged with leading the Healthy Soils Initiative as described in the Governors January 2014-15 budget proposal and under the authority of the Environmental Farming Act of 1995. Dr. Levenson welcomed the group on behalf of EPA and Cal Recycle.

AGENDA ITEM 3
PREVIOUS MEETING MINUTES

CDFA staff presented the minutes from the previous May 14, 2015 meeting. The motion was made to accept the minutes as presented by Mr. Tollstrup, and seconded by Mr. Gwynne. The motion was moved by all members present and was accepted without further changes.

STATE WATER EFFICIENCY AND ENHANCEMENT PROGRAM (SWEEP)

Dr. Gunasekara provided an update on the State Water Efficiency and Enhancement Program (SWEEP). $10 million are available through the current fiscal year for grants to farmers to install irrigation systems that reduce water use and reduce greenhouse gas emissions. The application period closed on June 29, 2015. 345 applications were received, totaling $30.3 million in requests. The program was oversubscribed by 300%. A technical review period of the application had begun. Dr. Gunasekara noted that he would continue to update the Science Panel members at each meeting on SWEEP since the program continues to receive funding.

VACANT POSITION ON EFA SAP

Dr. David Bunn, Director of the Department of Conservation, has been appointed to serve on the EFA SAP from the Natural Resources Agency. Bruce Gwynne was filling in for Dr. Bunn at this meeting.

AGENDA ITEM 4 – HEALTHY SOILS INITIATIVE

A. IMPACT OF SOIL ORGANIC MATTER ON NUTRIEINT CONSERVATIO AND SOIL HEALTH – DR. WILLIAM HORWATH

Dr. Horwath provided an overview of soils, soil organic matter (SOM) and its role in soil health. Dr. Horwath also discussed the microbial environment and its contribution to building SOM. He also discussed the abiotic contribution to building SOM such as climate and moisture. His presentation included a case study and research studies which attempted to build SOM. Dr. Horwath facilitated questions from the Science Panel members and the public following his presentation.

MICROBIAL COMMUNITIES, COMPOST AND IMPLICATIONS FOR SOIL HEALTH – DR. GARY ANDERSEN

Dr. Gary Anderson of U.C. Berkeley presented on thermophilic aerobic decomposition (composting) and discussed some benefits of compost to soil health. Dr. Anderson's research team has been studying which microbes are active in compost production. They are using microchip technology to detect different bacteria and archaea and understand how the different microbial species play different roles in the compost process and who dominants when and at what stages of the composting cycle. Dr. Anderson answered questions from the Science Panel members and the public following his presentation.

<u>CALRECYCLE EFFORTS TO DATE ON COMPOST – DR. HOWARD LEVENSEN</u>

Dr. Howard Levenson of CalRecycle provided an update on current policies and progress on promoting composting in California. He noted that California has policy drivers for increasing composting, including a statewide goal of 75% of solid waste diverted from landfills by 2020. Since organic waste makes up one-third of solid waste, composting will be a critical component of meeting that goal. Dr. Levenson noted that CalRecycle is engaged on several research initiatives on compost and suggested future research needs. Dr. Levenson answered questions from the Science Panel members and the public following his presentation.

<u>A TOOL FOR INCENTIVIZING SOIL HEALTH IN AGRICULTURE (COMET-PLANNER) – DR. ADAM CHAMBERS</u>

Dr. Adam Chambers provided an overview of a new tool (Comet-Planner) developed to quantify the GHG benefits of various farm management practices. Dr. Chambers showed how to use the tool and find background information and quantification methodology for each practice. He noted that soil health is an important priority and there is the goal of 111-124 $MMTCO_2e$ reduction by 2025. USDA NRCS used historical accomplishments in soil health through EQIP since 1997 to extrapolate what can be accomplished by 2025. Dr. Chambers facilitated questions from the Science Panel and the public following his presentation.

<u>PUBLIC COMMENT AND DISCUSSION</u>

Daniel Morash, California Safe Soil: They are exploring California aerobic enzymatic digestion. Additionally, unless we can prove the value of these products to farmers then projects won't be successful. Need research to back up and prove benefits to farmers.

Niles Brinton, Char Born: Commented that he was encouraged by the initiative. He suggested that the addition of biochar to compost can reduce off-gassing of ammonia and methane. The finished compost product also has a higher nitrogen content, possibly leading to less fertilizer demand. Biochar is a needed solution for dealing with woody biomass waste (ex; forest).

Pablo Garza, Nature Conservancy: Excited regarding the Healthy Soils Initiative and potential incentives for landowners, but also concerned about application of compost on rangelands because it can lead to a decline in biological diversity. Requested that rangelands are discussed in the subcommittee on compost application rates.

Calla Rose Ostrander, Rathmann family foundation: Has maps and materials to share with the panel on various waste sources. Wants to promote a systems approach and management of organics in a way that protects air and water quality and gets organics back on land.

Cole Smith, UC Cooperative Extension: Inquired on the next steps in education and outreach. Hard to organize and disperse scientific information to the public.
Dr. Gunasekara responded that CalRecycle and CDFA can reach out to UC Extension and try to involve them in the discussion.

Pelayo Alvarez, Carbon Cycle Institute: Inquired on the timeframe of the Healthy Soils Initiative. Inquired on how public input will be collected and how the public can participate.
Dr. Gunasekara replied that this meeting is part of the public process in the development of the program. The EFA SAP meeting will continue to be the public venue for Healthy Soils discussions and open to the public. Interagency coordination is also occurring; there is a 2-page document available on goals for the initiative on CDFA Environmental Stewardship webpage.

Adam Kotin, CalCAN: Inquired if there have been further conversations on goals for the initiative or opportunities for public involvement.
Dr. Gunasekara responded that there would be further public and stakeholder conversations on the potential of setting SOM goals.

Nick Lapis, Californians Against Waste: The 2-page document on the initiative includes interesting short term and long term goals. Commented that it would be helpful to know how we are going to reach these goals.
Dr. Gunasekara responded that this meeting is part of reaching the goals. Multiple agencies are participating. Different agencies will take different actions. CDFA is using SAP to determine what to focus on.

AGENDA ITEM 5 – ADJOURN

Chair Cameron adjourned the meeting at 2:47 PM.

Respectfully submitted by:

Amrith Gunasekara, Ph.D. Date

THE HEALTHY SOILS INITIATIVE
An Update

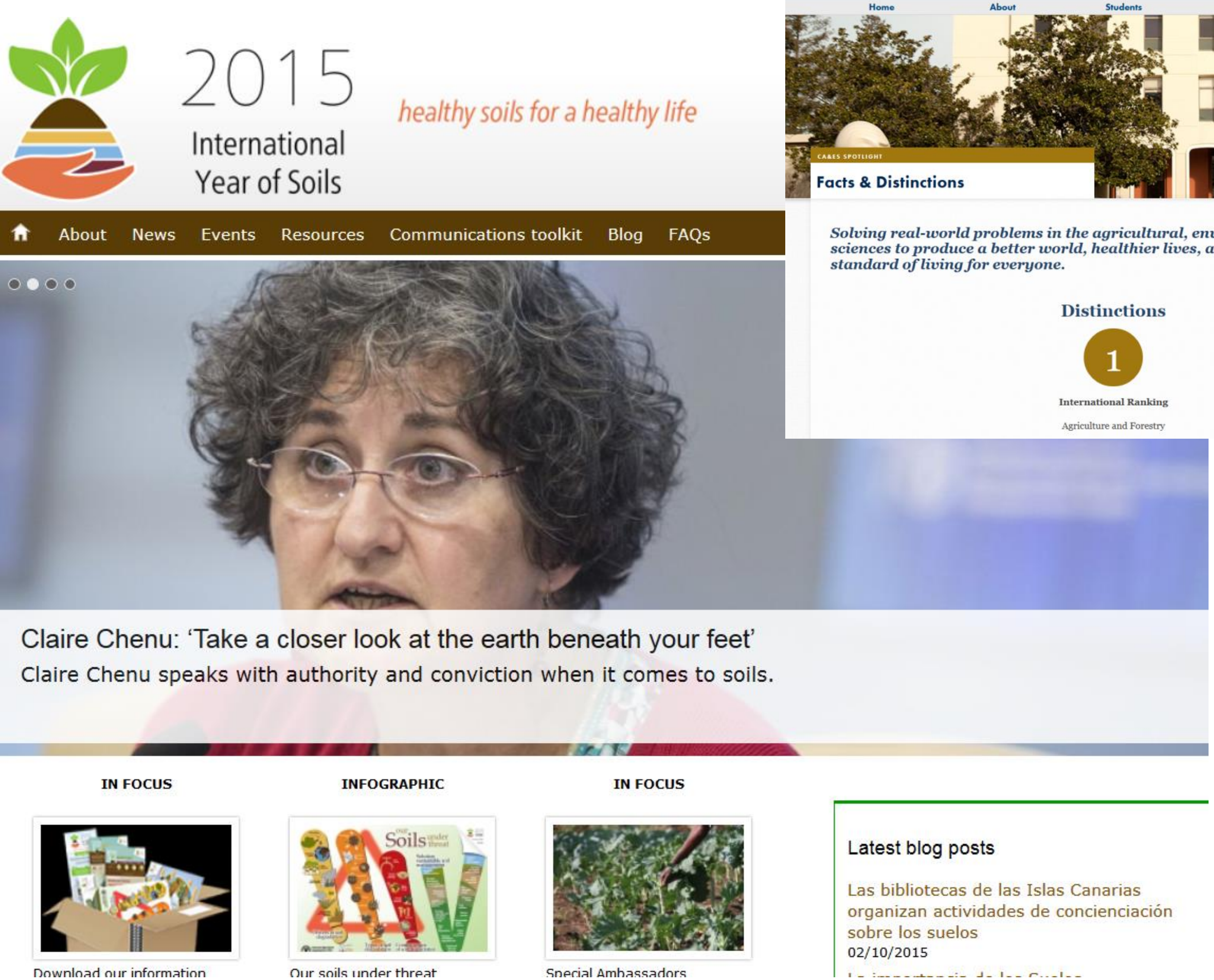
February 23, 2016

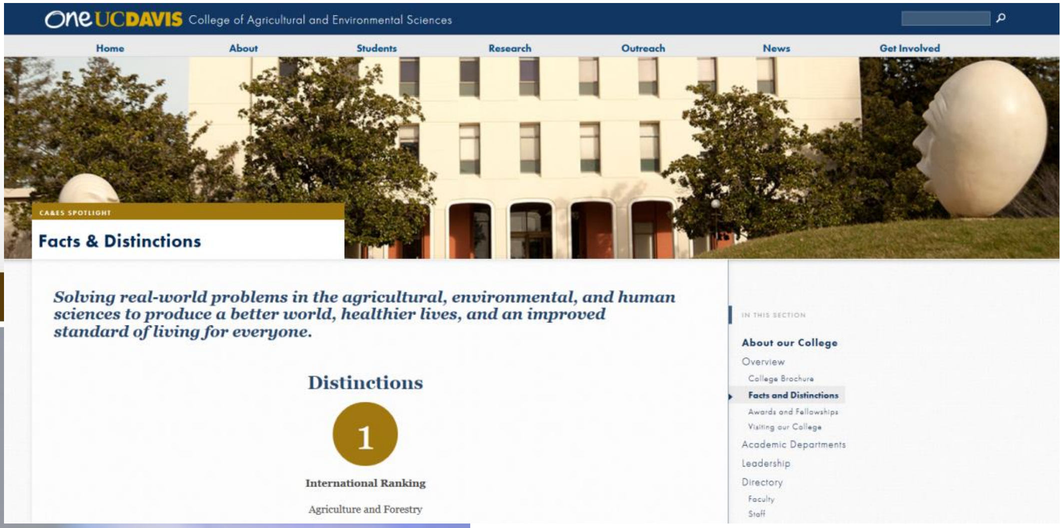
Environmental Farming Act Science Advisory Panel

Amrith (Ami) Gunasekara, PhD
Science Advisor to the Secretary

cdfa
CALIFORNIA DEPARTMENT OF
FOOD & AGRICULTURE

INTERNATIONAL YEAR OF THE SOIL





http://www.fao.org/soils-2015/en/


Soil Health
Reduced Fumigant and Synthetic Inputs
Build Soil Organic Matter
Sequester and Reduce GHGs
Improved Plant Health and Yields
Improved Water Quality
Reduced Salinity
Water Retention
Reduced Sediment Erosion and Dust

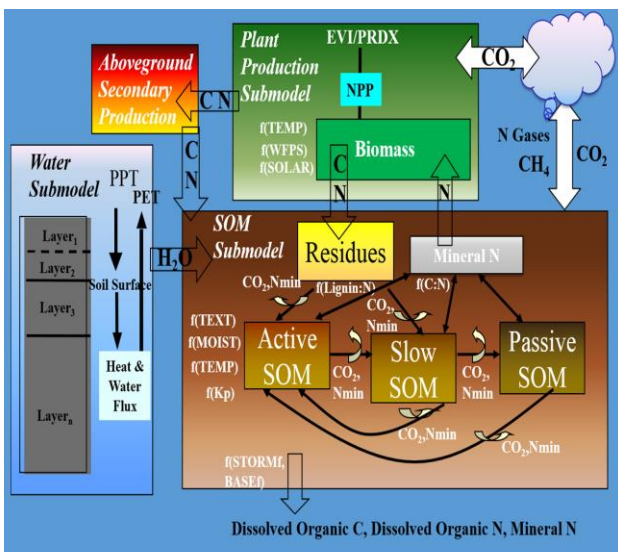
GOVERNORS JANUARY BUDGET

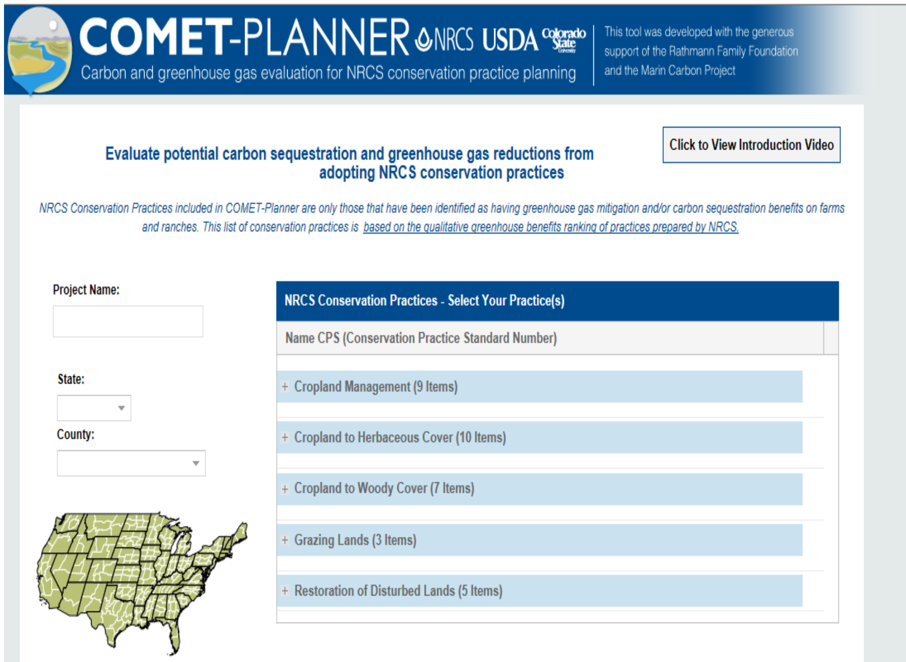
- $20 million for CDFA HSI in budget proposal
- For new incentive program and demonstration projects
- Proposing to use Comet-Planner
  - (ARB needs to approve QM)
- Program framework to be developed
  - starting in July, 2016
  - Required public comment and feedback
- Plan to use EFA SAP for feedback and public comment

Healthy soil = adequate soil organic matter or humus

NRCS Practice Standards for Greenhouse Gas Emission Reduction and Carbon Sequestration

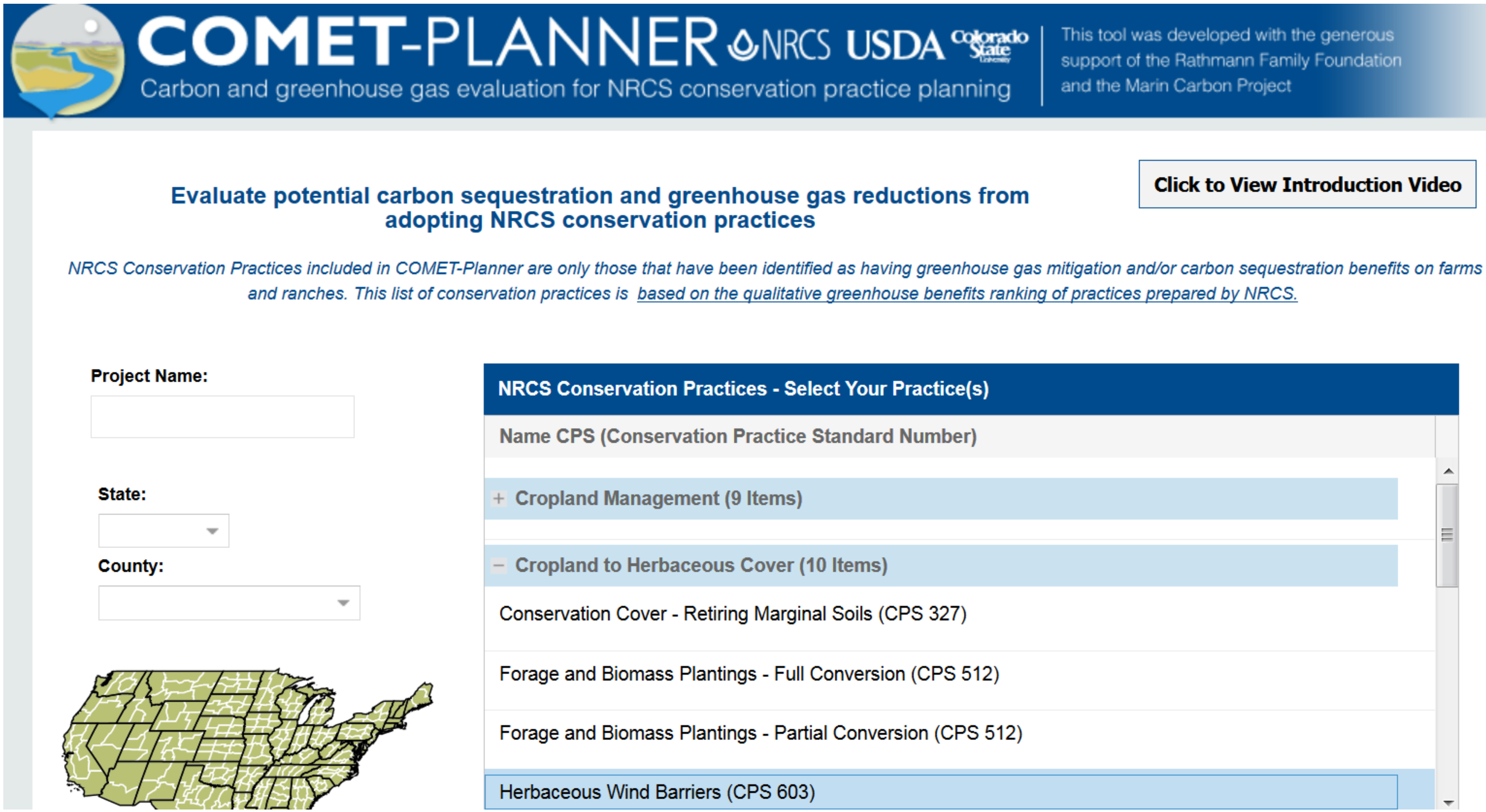
Qualitative Ranking N=Neutral	Practice Code	Practice Standard and Associated Information Sheet	Beneficial Attributes
GHG Benefits of this Practice Standard	327	Conservation Cover (Information Sheet)	Establishing perennial vegetation on land retired from agriculture production increases soil carbon and increases biomass carbon stocks.
	329	Residue and Tillage Management, No Till/Strip Till/Direct Seed (Information Sheet)	Limiting soil-disturbing activities improves soil carbon retention and minimizes carbon emissions from soils.
	366	Anaerobic Digester (Information Sheet)	Biogas capture reduces CH_4 emissions to the atmosphere and provides a viable gas stream that is used for electricity generation or as a natural gas energy stream.
	367	Roofs and Covers	Capture of biogas from waste management facilities reduces CH_4 emissions to the atmosphere and captures biogas for energy production. CH_4 management reduces direct greenhouse gas emissions.
	372	Combustion System Improvement	Energy efficiency improvements reduce on-farm fossil fuel consumption and directly reduce CO_2 emissions.
	379	Multi-Story Cropping	Establishing trees and shrubs that are managed as an overstory to crops increases net carbon storage in woody biomass and soils. Harvested biomass can serve as a renewable fuel and feedstock.
	380	Windbreak/Shelterbelt Establishment (Information Sheet)	Establishing linear plantings of woody plants increases biomass carbon stocks and enhances soil carbon.
	381	Silvopasture Establishment	Establishment of trees, shrubs, and compatible forages on the same acreage increases biomass carbon stocks and enhances soil carbon.
	512	Forage and Biomass Planting (Information Sheet)	Deep-rooted perennial biomass sequesters carbon and may have slight soil carbon benefits. Harvested biomass can serve as a renewable fuel and feedstock.





INCENTIVE PROGRAM

- Comet-Planner



http://www.comet-planner.com/

4. What is CDFA going to do?

INCENTIVE PROGRAM

- Comet-Planner

County:

Fresno

Windbreak/Shelterbelt Establishment (CPS 380)

Windbreak/Shelterbelt Renovation (CPS 650)

Riparian Forest Buffer (CPS 391)

Hedgerow Planting (CPS 422)

Alley Cropping (CPS 311)

Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions[1]
(tonnes CO_2 equivalent per year)

NRCS Conservation Practices (Click Practice Name for Documentation)	**Enter Acreage**	**Carbon Dioxide (CO_2)**	**Nitrous Oxide (N_2O)**	**Methane (CH_4)**	**Total CO_2-Equivalent**
Windbreak/Shelterbelt Renovation (CPS 650) [delete]	10 ac	2	0	0	2
	Total	**2**	**0**	**0**	**2**

http://www.comet-planner.com/

INCENTIVE PROGRAM

- Comet-Planner

How are your carbon sequestration and greenhouse gas emission reduction estimates calculated?

Emission reduction coefficients were derived from recent meta-analyses and reviews. Coefficients were generalized at the national-scale and differentiated by dry and humid climate zones. More information on quantification methods can be found in the COMET-Planner Report .

Each emission reduction is calculated using the following equation:

Emission reduction = Area (acres) * Emission Reduction Coefficient (ERC)

	Emission Reduction Coefficients (ERC) (tonnes CO_2 equivalent per acre per year)		
	Greenhouse Gases		
	Carbon Dioxide (CO_2)	Nitrous Oxide (N_2O)	Methane (CH_4)
NRCS Conservation Practices			
Windbreak/Shelterbelt Renovation (CPS 650)	0.21	0.00	N.E.[2]

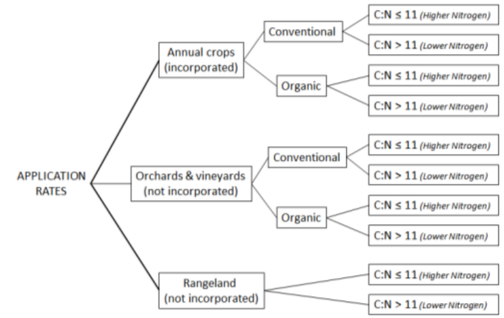
Recommended use of COMET-Planner

This evaluation tool is designed to provide generalized estimates of the greenhouse gas impacts of conservation practices and is intended for initial planning purposes. Site-specific conditions (not evaluated in this tool) are required for more detailed assessments of greenhouse gas dynamics on your farm. Please visit COMET-Farm if you would like to conduct a more detailed analysis.

Please contact Amy Swan (Amy.Swan@colostate.edu) for more information

http://www.comet-planner.com/

From August 28 meeting:
Ten rates to define based on crop + management + compost type



COMPOST USE

- Not in Comet-Planner (yet)
- Set up scientific subcommittee of the CDFA EFA SAP to determine agronomic application rates for compost so it can be included in any future CDFA incentive program
- Discussed interagency the available nitrogen component
- Results presented at last meeting and included white paper report for public comment
- Established public comment period from January 18th to February 12th (4 weeks)
- Received 20 comment letters – CDFA will review and provide edited report and suggestions from EFA SAP consideration at next meeting.

Thanks…

Important Contacts:

Kelly Gravuer (UC Davis and CDFA)

PhD Candidate

kelly.gravuer@cdfa.ca.gov

Geetika Joshi, PhD.

Environmental Scientist (CDFA)

Geetika.Joshi@cdfa.ca.gov

Amrith Gunasekara, PhD

Liaison to EFA SAP

Amrith.gunasekara@cdfa.ca.gov

SWEEP
An Update

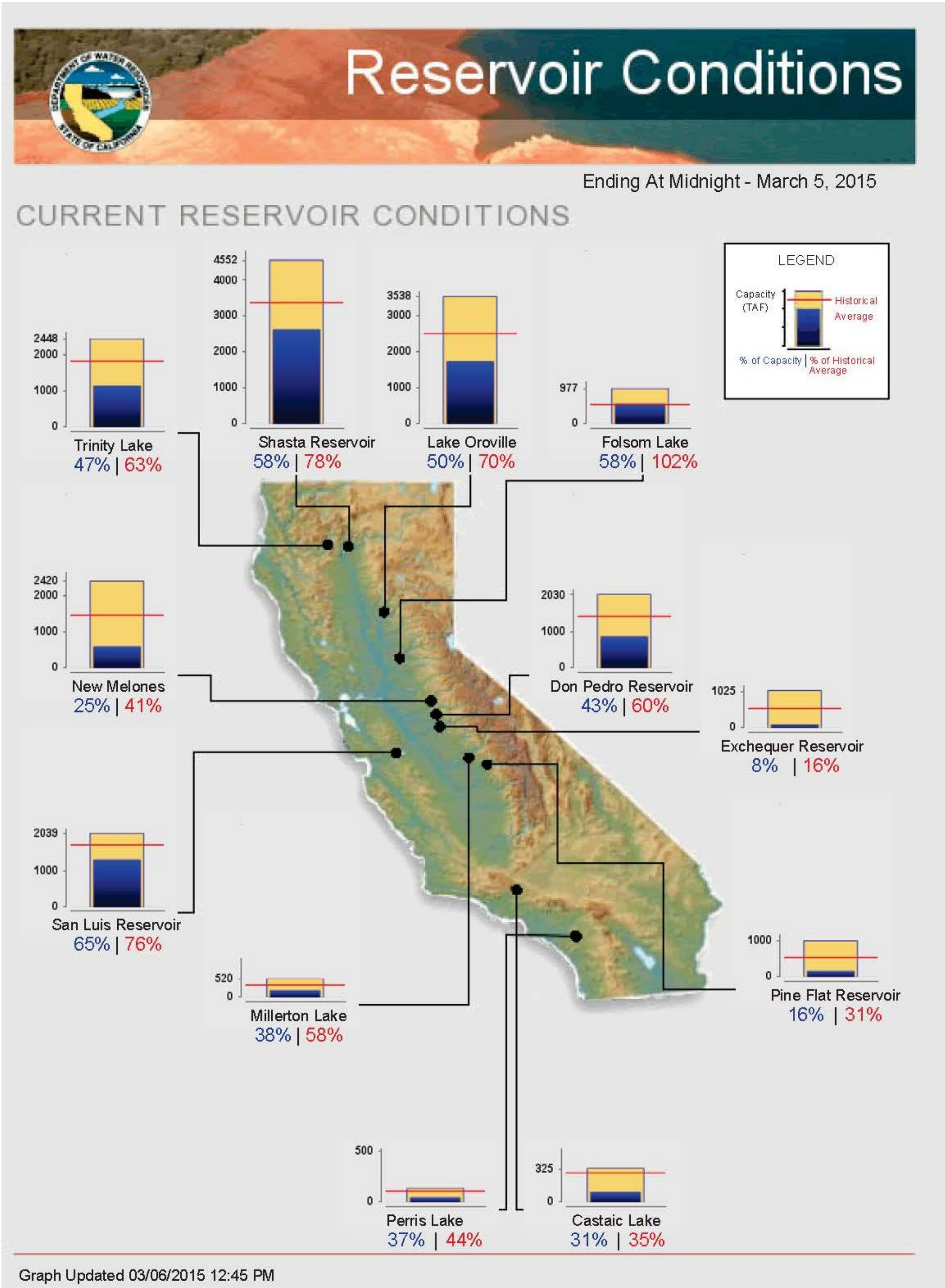
Amrith (Ami) Gunasekara, PhD
Science Advisor

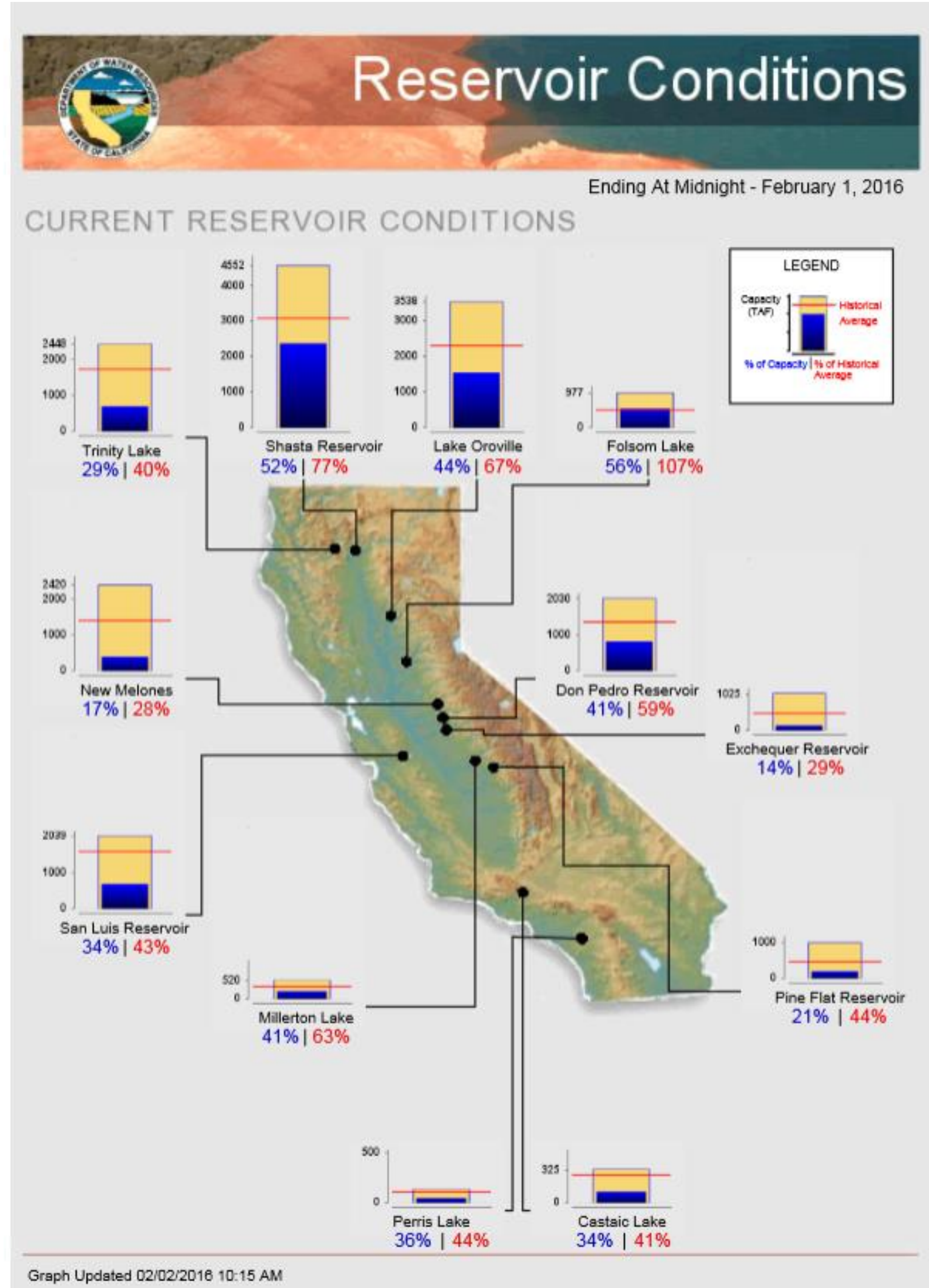
Carolyn Cook, MSc
Senior Environmental Scientist

cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
STATE WATER RESOURCES CONTROL BOARD

CALIFORNIA DEPARTMENT OF WATER RESOURCES

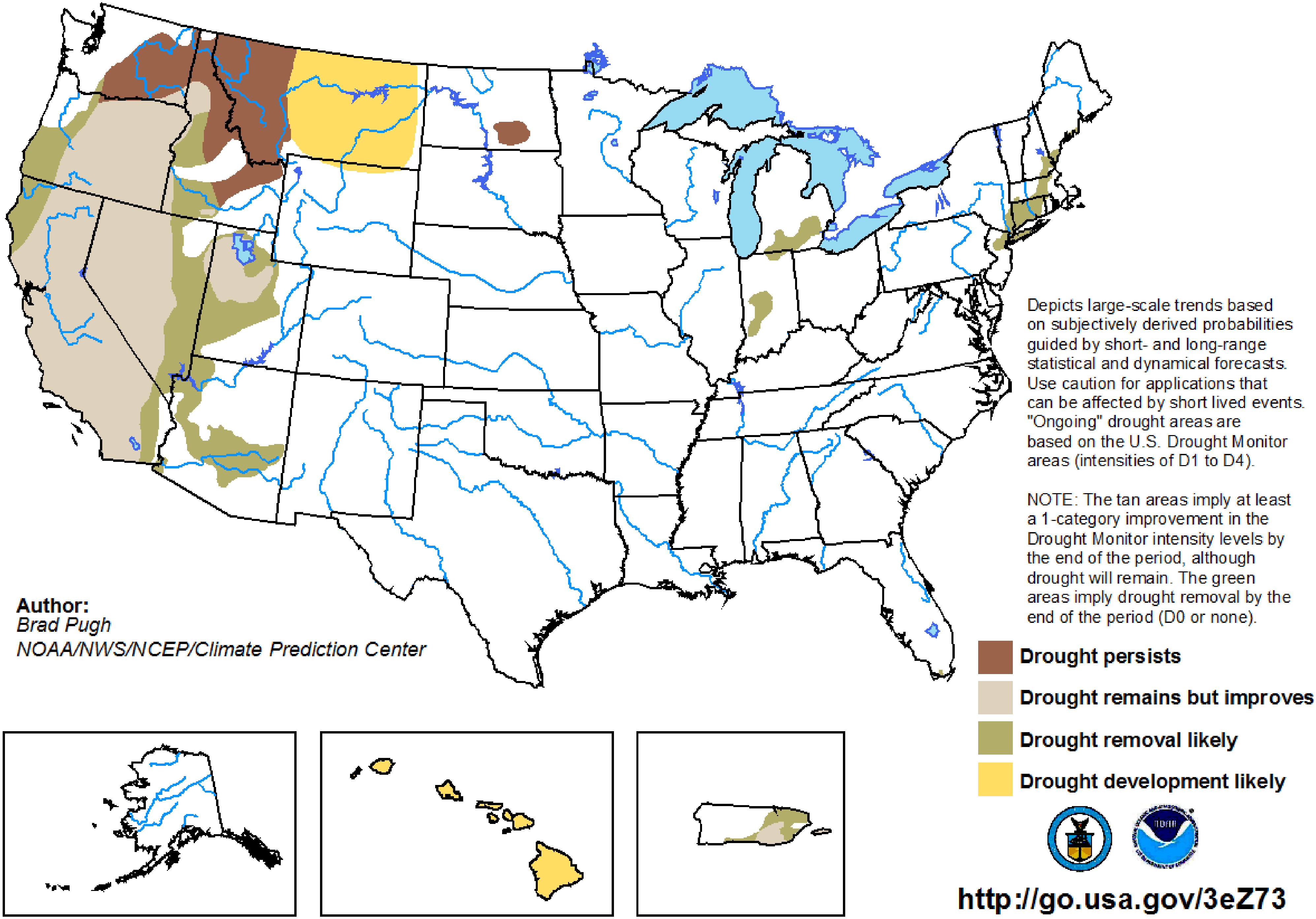

Reservoir Conditions
Ending At Midnight - March 5, 2015
CURRENT RESERVOIR CONDITIONS
LEGEND
Capacity (TAF)
Historical Average
% of Capacity | % of Historical Average
Trinity Lake
47% | 63%
Shasta Reservoir
58% | 78%
Lake Oroville
50% | 70%
Folsom Lake
58% | 102%
New Melones
25% | 41%
Don Pedro Reservoir
43% | 60%
Exchequer Reservoir
8% | 16%
San Luis Reservoir
65% | 76%
Millerton Lake
38% | 58%
Pine Flat Reservoir
16% | 31%
Perris Lake
37% | 44%
Castaic Lake
31% | 35%
Graph Updated 03/06/2015 12:45 PM

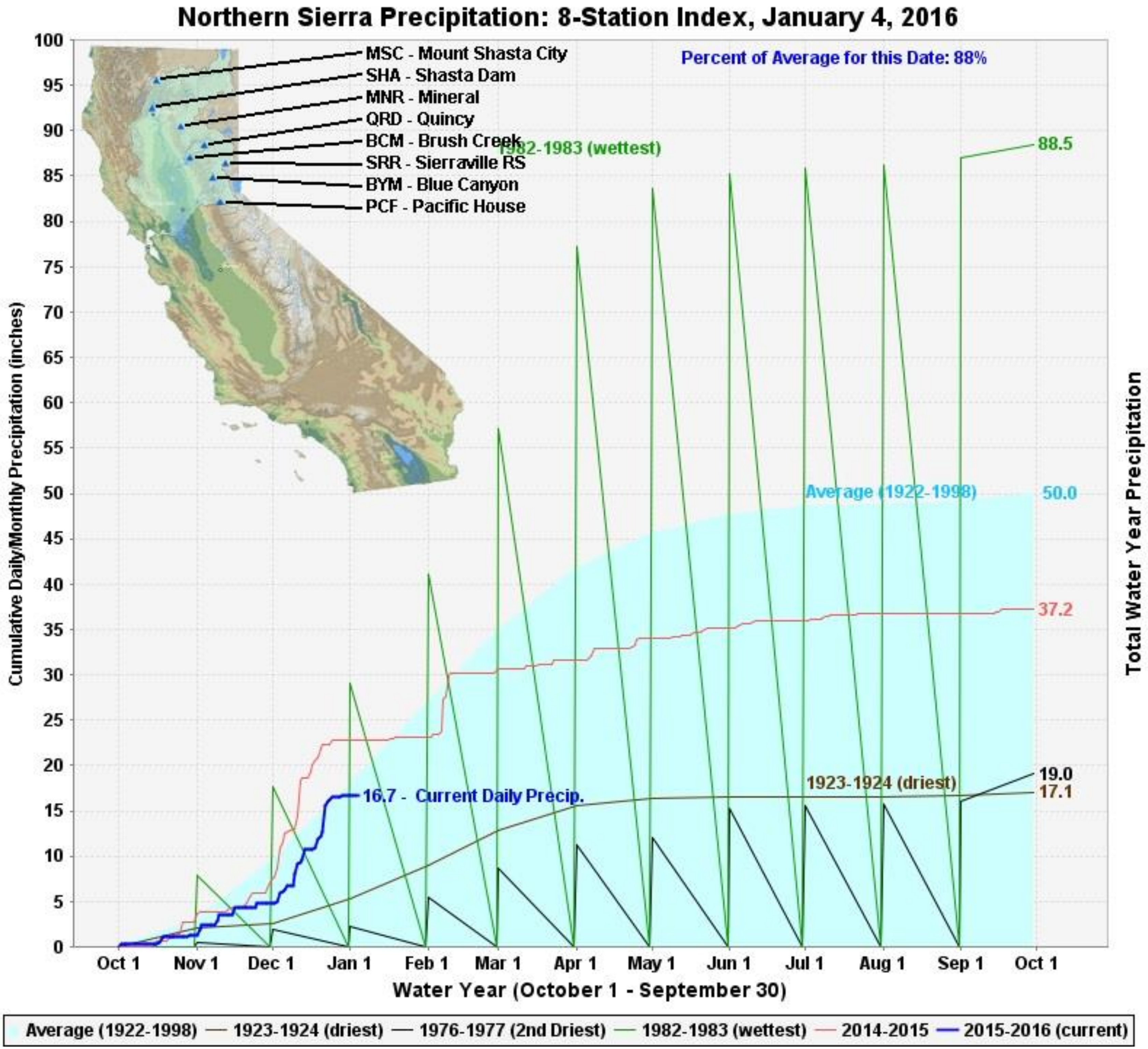

Reservoir Conditions
Ending At Midnight - February 1, 2016
CURRENT RESERVOIR CONDITIONS
LEGEND
Trinity Lake
29% | 40%
Shasta Reservoir
52% | 77%
Lake Oroville
44% | 67%
Folsom Lake
56% | 107%
New Melones
17% | 28%
Don Pedro Reservoir
41% | 59%
Exchequer Reservoir
14% | 29%
San Luis Reservoir
34% | 43%
Millerton Lake
41% | 63%
Pine Flat Reservoir
21% | 44%
Perris Lake
36% | 44%
Castaic Lake
34% | 41%
Graph Updated 02/02/2016 10:15 AM

Source: DWR

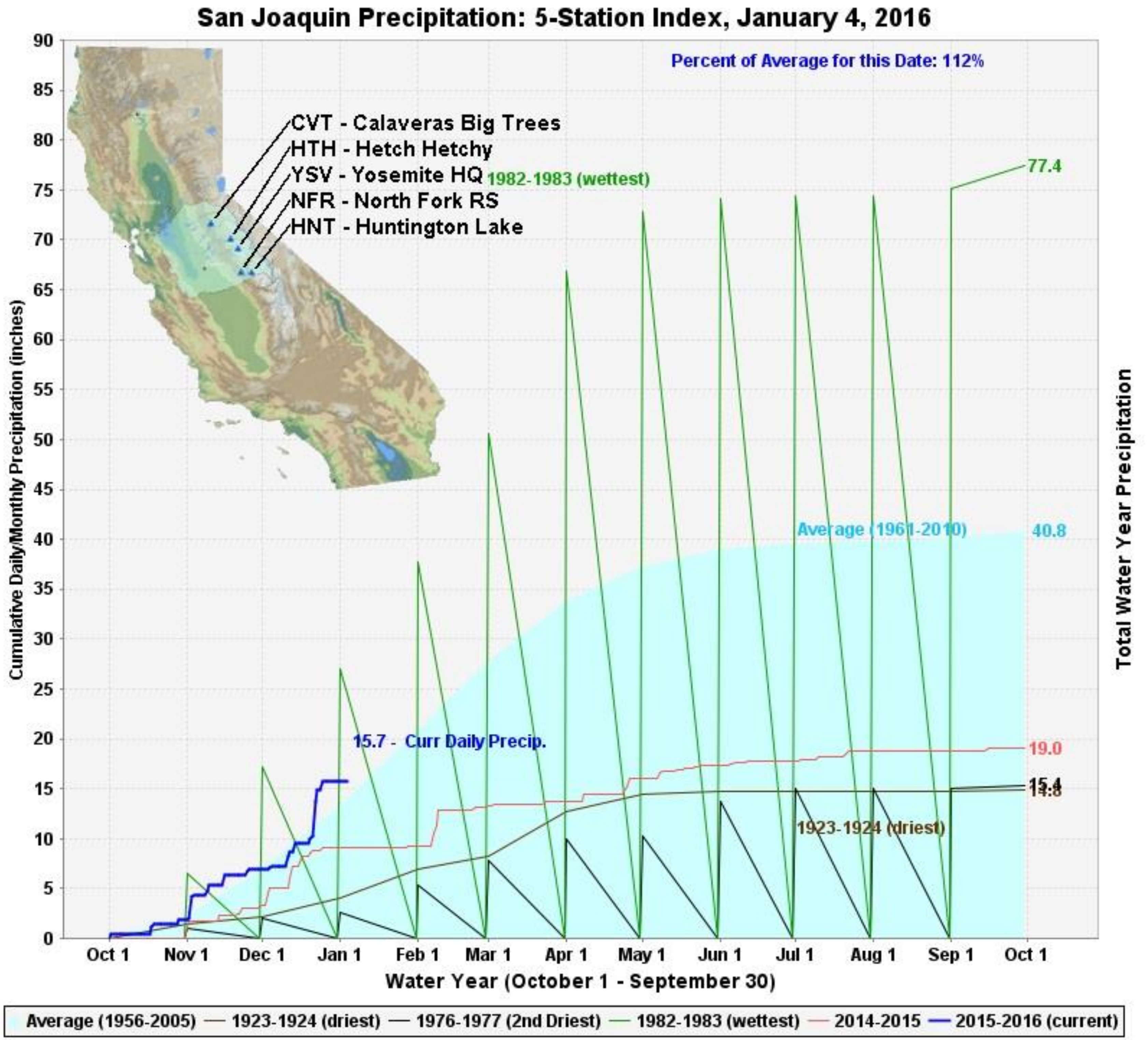
U.S. Seasonal Drought Outlook
Drought Tendency During the Valid Period

Valid for December 17 - March 31, 2016
Released December 17, 2015




Northern Sierra Precipitation: 8-Station Index, January 4, 2016
Percent of Average for this Date: 88%
MSC - Mount Shasta City
SHA - Shasta Dam
MNR - Mineral
QRD - Quincy
BCM - Brush Creek
SRR - Sierraville RS
BYM - Blue Canyon
PCF - Pacific House
1982-1983 (wettest)
88.5
Average (1922-1998)
50.0
37.2
1923-1924 (driest)
19.0
17.1
16.7 - Current Daily Precip.
Cumulative Daily/Monthly Precipitation (inches)
Total Water Year Precipitation
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Water Year (October 1 - September 30)
Average (1922-1998)
1923-1924 (driest)
1976-1977 (2nd Driest)
1982-1983 (wettest)
2014-2015
2015-2016 (current)

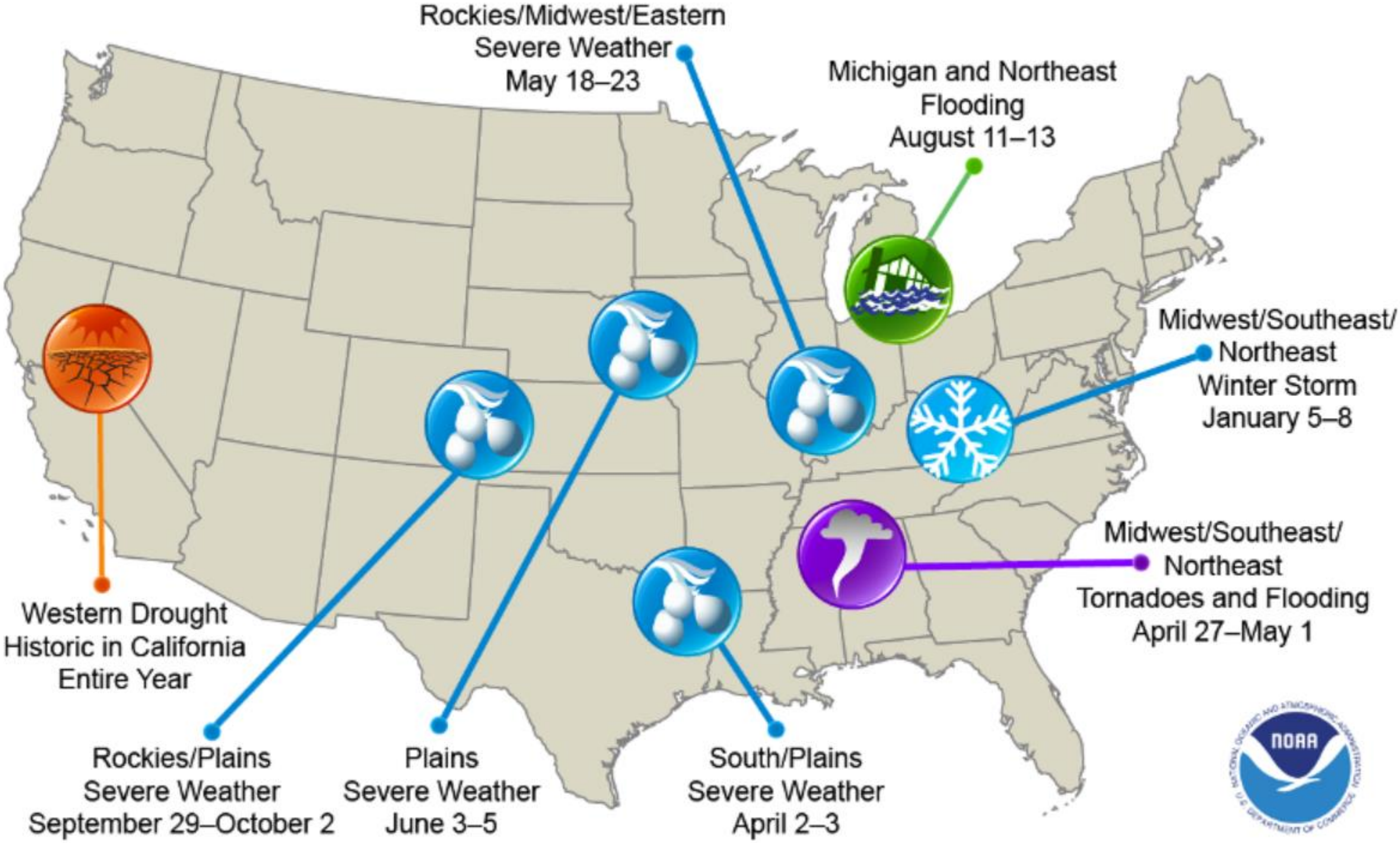
Source: DWR



San Joaquin Precipitation: 5-Station Index, January 4, 2016
Percent of Average for this Date: 112%
CVT - Calaveras Big Trees
HTH - Hetch Hetchy
YSV - Yosemite HQ
NFR - North Fork RS
HNT - Huntington Lake
1982-1983 (wettest)
77.4
Average (1961-2010)
40.8
15.7 - Curr Daily Precip.
19.0
15.4
14.8
1923-1924 (driest)
Cumulative Daily/Monthly Precipitation (inches)
Total Water Year Precipitation
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Water Year (October 1 - September 30)
Average (1956-2005) — 1923-1924 (driest) — 1976-1977 (2nd Driest) — 1982-1983 (wettest) — 2014-2015 — 2015-2016 (current)

Source: DWR

U.S. 2014 Billion-Dollar Weather and Climate Disasters



This map denotes the approximate location for each of the eight billion-dollar weather and climate disasters that impacted the United States during 2014.

Smith and Katz. http://www.ncdc.noaa.gov/billions/

STATE WATER EFFICIENCY AND ENHANCEMENT PROGRAM (SWEEP)

- Emergency drought legislation bill (SB 103) signed by Governor Brown on March 1, 2014.
  - $10 million – for 2014-15
- AB 91 allocated additional funds in March 27, 2015.
  - $10 million – for 2015-16
- SB 101signed by Governor in September 24, 2015, allocated additional funds
  - $40 million – for 2016-17

…..from the **California Climate Investments** fund (Cap and Trade Revenue $) for the California Department of Food and Agriculture to invest in irrigation and water pumping systems that **reduce water use, energy use and greenhouse gas emissions**.

STATE WATER EFFICIENCY AND ENHANCEMENT PROGRAM (SWEEP)

“coordination with the Department of Water Resources and the State Water Resources Control Board…."

"…to provide financial incentives to agricultural operations to invest in water irrigation treatment and distribution systems that reduce water and energy use, augment supply and increase water and energy efficiency in agricultural applications.“

The SWEEP was implemented under the authority of the Environmental Farming Act of 1995.

Division 1, Part 1, Chapter 3, Article 8.5, Sections 560-568

Section 566 (a)
The department shall establish and oversee an environmental farming program. **The program shall provide incentives to farmers whose practices promote the well-being of ecosystems, air quality, and wildlife and their habitat**.

SWEEP by the NUMBERS

- SWEEP 2014-15 funded $17.8 million for 233 different projects
- Total requested was $63.7 million for 798 applications
- Total matching funds was $10.5 million

  - 67% - Soil moisture monitoring systems for better scheduling
  - 37% - Micro-irrigation/drip systems
  - 26% - Energy efficient pumps (switch to electric or solar)
  - 28% - Use of ET data and scheduling
  - 15% - Use of variable frequency drive (VFD) pumps
  - 5% - Use of low pressure irrigation systems

- Cap at $200,000

- Most recent numbers – 299 applications for $ 34.8 million

- More $ available in April 2016 ($19 million)

SWEEP by the NUMBERS

<u>2014-15 GHG and Water Estimates</u>

• GHG reductions = Estimated 54,600 Tonnes CO_2e/yr (life of practice is 10 years)

Equivalent to removing the following number of vehicles from the road (based on 4.7 Tonnes of CO2e/yr per vehicle – U.S. EPA from 21.6 miles per gallon and 11,400 miles per year) = 11,630 vehicles/yr

• Water savings = Estimated 37,400 acre feet/yr

Number of 15,000 gallon (average pool size) pools per year = 814,000 pools per year

Number of 1 gallon bottles = 12.2 billion

NEW REQUIREMENTS AND STAFF

- Post-project quantification of GHGs and Water Savings = 3 yrs
- All growers must maintain records to support savings = 3 yrs

- Will continue to contract with RCDs on verification

- Two additional staff starting on March 2, 2016 – Responsible for Northern and Southern Regional SWEEP Coordinators
  - CDFA staff will partner with RCD staff on verifications
  - Lead Technical Staff on projects
  - Assisting in leading public workshops
  - Conduct post project GHG and water quantification

- Growers must use QM methodology and tool

California Environmental Protection Agency

Air Resources Board

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Home | Reducing Air Pollution | Air Quality | Business Assistance | Laws & Regulations | Health

Sunday, February 21, 2016

This page last reviewed February 19th, 2016

Up Links

- Reducing Air Pollution - ARB Programs
  - Climate Change
    - Cap-and-Trade Program
      - **Auction Proceeds**

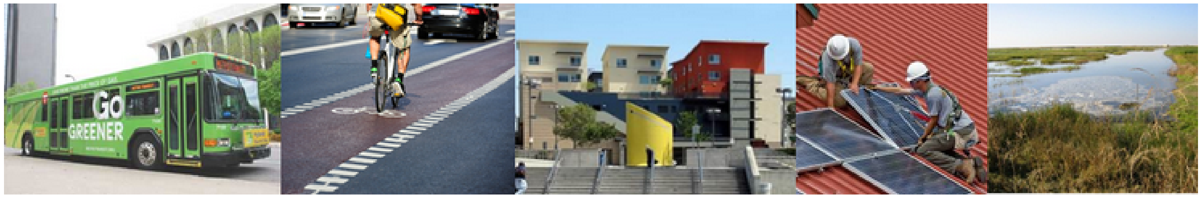
Program Links

- Workshops / Meetings
- Archived Announcements

Resources

- Contact Us
- Events Calendar
- Join the Auction Proceeds Email List
- Live Webcasts
- RSS / Newsfeed

California Climate Investments



What's New?

- ARB CVRP Market Sustainability Metrics Work Group Meeting Feb. 19 - Sacramento
- CVRP Long-Term Program Considerations Work Group Meeting Feb. 23 - Sacramento
- Light Duty Pilot Project Work Group Teleconference Feb. 25
- TIRCP Pre-application Meetings Feb. 22 - 26
- AHSC Notice Of Funding Availability (NOFA) - Concept applications due March 16
- FY 2016-17 TIRCP Funding Available - Project Applications due April 5

California Climate Investments

Climate Change Events Calendar

What's New Archive

Background and Resources

- State Budget Appropriations
- Investment Plan
- Implementing Legislation
- Annual Report to the Legislature
- Expenditure Records
- CalEnviroScreen
- CalEPA Identifies Disadvantaged Communities

Current Activities

- Funded Programs and Upcoming Events
  - Transportation
  - Energy
  - Resources and Waste

ARB Guidance for Agencies

- Guidance and Maps for Investments to Benefit Disadvantaged Communities
- Funding guidelines for administering agencies
- Quantification Materials
- ARB Workshops and Public Meetings

www.arb.ca.gov/cc/capandtrade/auctionproceeds/auctionproceeds.htm

This page last reviewed February 9, 2016

Cap-and-Trade Auction Proceeds Quantification Materials

The Air Resources Board (ARB) is required to develop quantification methods for agencies receiving Greenhouse Gas Reduction Fund (GGRF) appropriations per SB 862 (Senate budget and Fiscal Review Committee, Chapter 36, statutes of 2014). For Fiscal Year (FY) 2013-14, some administering agencies developed interim GHG quantification methodologies in consultation with ARB. For FY 2014-15, ARB prioritized the development of quantification methods based on program timelines, with an initial focus on programs using GHG emission reductions as part of the criteria to score projects in a competitive process. The tables below provide links to the GHG quantification methods developed by ARB in consultation with administering agencies. As the GGRF program continues, quantification methodologies for all programs will continue to be developed or updated and posted below as necessary.

Note: These quantification methods have been developed specifically for the Greenhouse Gas Reduction Fund Programs and are not intended for use in other programs.

For questions about any of the quantification methods below, please email us at GGRFProgram@arb.ca.gov
To help us serve you better, please provide the following information: name and company/industry, contact information, and question or comment.

Transportation and Sustainable Communities

Agency / Department	Quantification Materials
High-Speed Rail Authority (HSRA)	*High-Speed Rail (HSR)* • Quantification Methodology for FY 2014-15 (PDF)
California State Transportation Agency (CalSTA)	*Transit and Intercity Rail Capital Program (TIRCP)* • Quantification Methodology for FY 2016-17(PDF) • TIRCP GHG Emission Reduction Calculator for FY 2016-17 (.xlsm) Archived Versions: • Quantification Methodology for FY 2014-15 (PDF) • Frequently Asked Questions (PDF) - April 2015
Department of Transportation (Caltrans)	*Low Carbon Transit Operations Program (LCTOP)* • Quantification Methodology for FY 2015-16 (PDF) • Greenhouse Gas Emission Reduction Calculator for FY 2015-16* (.xlsm)

http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm

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Clean Energy and Energy Efficiency

Agency / Department	Quantification Materials
Community Services and Development (CSD)	*Low-Income Weatherization Program* • Quantification Methodology for FY 2014-15 (PDF) *Low-Income Weatherization Program - Large Multi-Family* • Quantification Methodology for FY 2014-15 (PDF)
Department of Food and Agriculture (CDFA)	*Dairy Digester Research and Development Program* • Quantification Methodology for FY 2014-15 (PDF) *State Water Efficiency and Enhancement Program* • Quantification Methodology for FY 2015-16* (PDF) • SWEEP GHG Emission Reduction Calculator for FY 2015-16* (PDF) Archived Versions: • Interim Quantification Methodology for FY 2015-16 (PDF) • Interim Quantification Methodology for FY 2013-14/2014-15 (PDF) *Accepting public comments on the draft FY 15-16 quantification methodology and calculator through February 23, 2016.
Department of Water Resources (DWR)	*Water-Energy Efficiency* • Interim Quantification Methodology for FY 2013-14/2014-15 (PDF)

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THANKS……

Important Contacts:

Carolyn Cook, MSc

carolyn.cook@cdfa.ca.gov

Amrith Gunasekara, PhD

Liaison to EFA SAP

amrith.gunasekara@cdfa.ca.gov

Subsurface Drip Irrigation Applications in Annual Cropping Systems

Daniel Munk

University of California Cooperative Extension

Outline

- Does SDI save water?
- Under what conditions?
- How does SDI impact farm GHG emissions?
  - Historical perspective
  - Costs and benefits
  - Current applications
  - Future and long term management issues

Early CA Research

- Mid- 1980's and through 1990's
  - Product improvements in drip tape design for large scale agriculture
  - Intended to eliminate evaporation and improve WUE
- Research interest accelerates
  - USDA ARS, UCCE
  - Large and small scale trials in the SJV
  - Contrasts with furrow/flood (sprinkler)

Early CA Research

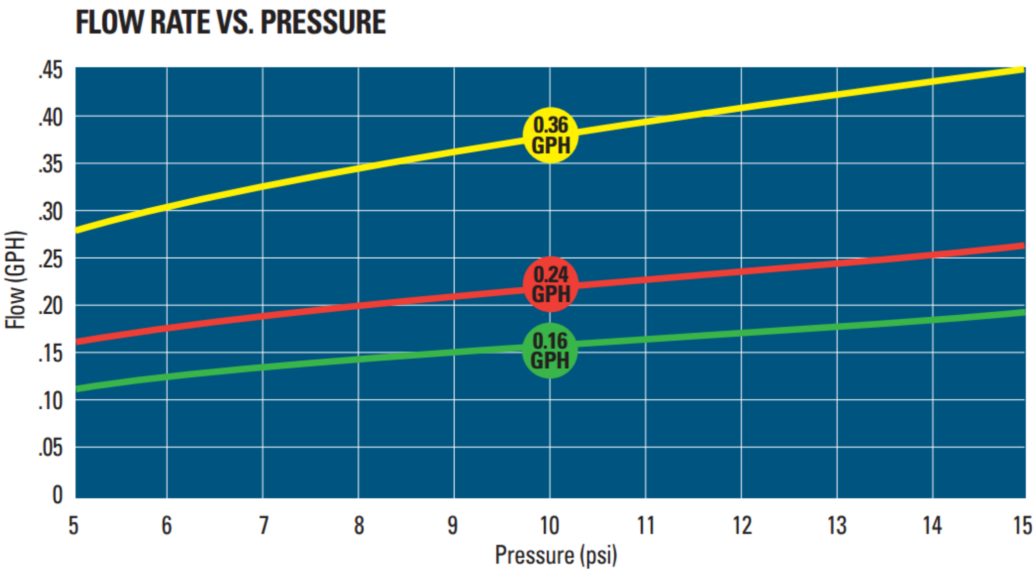
- Primary research findings
  - Reduced water application requirements
  - Reduced Deep percolation
  - Yield improvements depend on
  - Increased water use efficiency
  - Improved crop quality
  - Not highly sensitive to tape depth, emitter spacing

Early SDI grower experience

- Expensive systems
- Complex systems
  - Design and proper installation
  - Maintenance
  - Water application schedules
- Throughout the 90's numerous growers convert a limited number of systems with SOME success

Design improvements

- Improved emitter uniformity and pressure compensation
- Reduced plugging caused by soil and root intrusion



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HEALTHY FOOD SYSTEMS • HEALTHY ENVIRONMENTS • HEALTHY COMMUNITIES • HEALTHY CALIFORNIANS

Field Application Improvements

- GPS guidance systems aid in preserving alignment of bed relative to tape position.

    - Tape damage due to tillage
    - Problems with germination and early season access to plant water and nutrients

Field Application Improvements

- Low DU issues addressed by increasing tape diameter. 5/8 to 7/8”
- 12-14’ spacing w/ 0.22 gal/min/100 ft.
- Tape retrieval systems
- System maintenance
- Tape retrieval systems
- Cleaning and recycling used tape

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Interest Grows

Percent Plantings- Tulare Basin

	2001	2010
Corn	0	10
Cotton	1	21
Melons	3	65
Onions & Garlic	0	56
Processing Tomatoes	4	96

Source: DWR Irrig. Survey

Common SDI Applications

- Central Coast
  - Lettuce - Buried 2 to 3" (20% +)
  - Strawberries – w/ plastic mulch
  - Peppers
- San Joaquin Valley
  - Processing Tomatoes
  - Processing Onions and Garlic
  - Peppers
  - Cucurbits
- Sacramento Valley
  - Processing Tomatoes
  - Sunflowers

Moving forward: Barriers to further widespread adoption

- ❑ Cost of technology in lower value crops
  - Payoff likely to occur during life of system but hard to justify expense in short term
- ❑ On-farm expertise needed to manage and maintain systems properly
  - Staff training programs in place, but more are needed

Expanding applications

- Motivated by drought, higher water costs and limited water access
- State acreage has grown to about 650,000 acres (Netafim)

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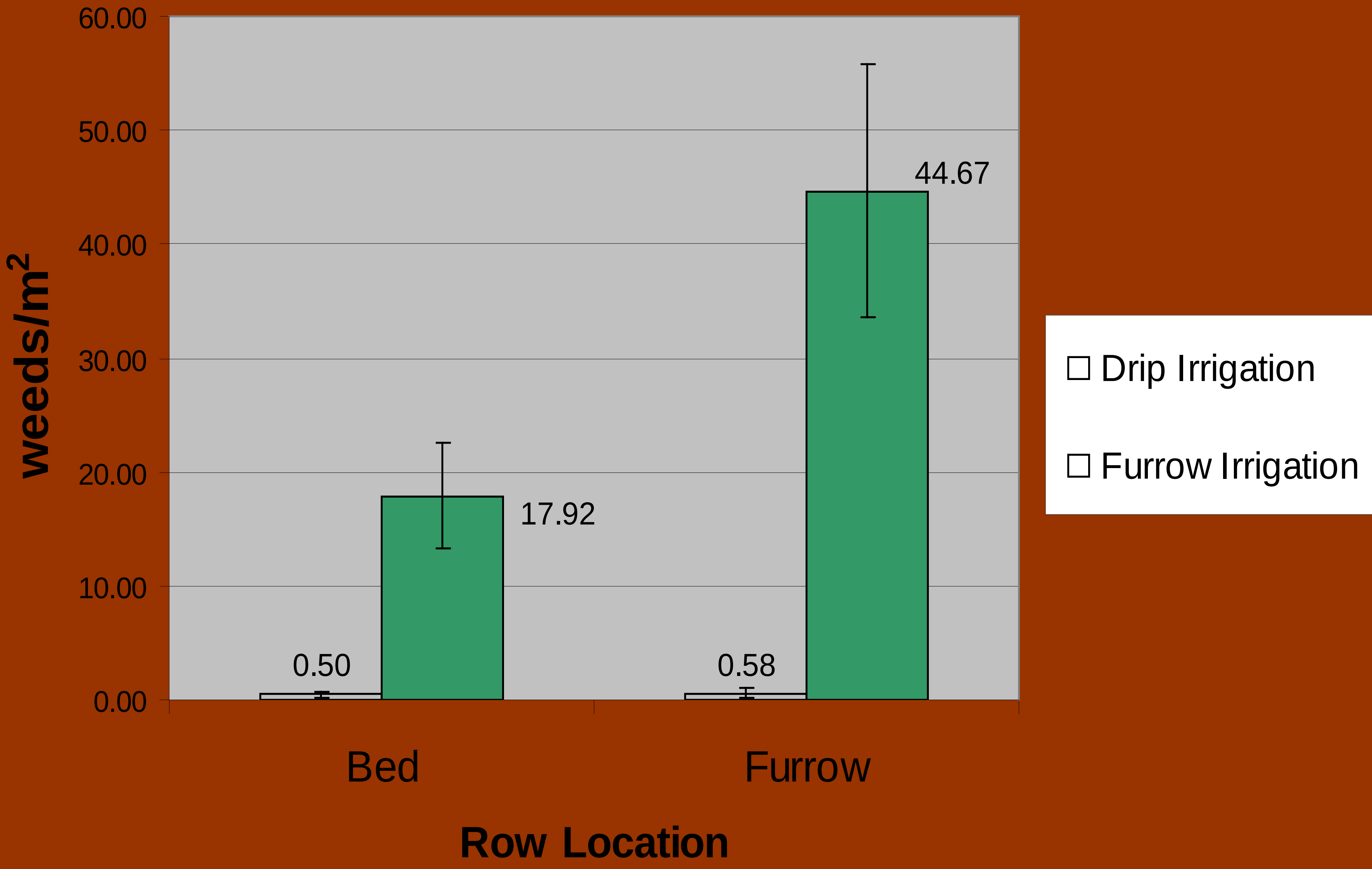
Weed Populations Under Different Irrigation



Long Term SDI versus Furrow Comparison Trials – Shafter REC (USDA-DeTar et al)

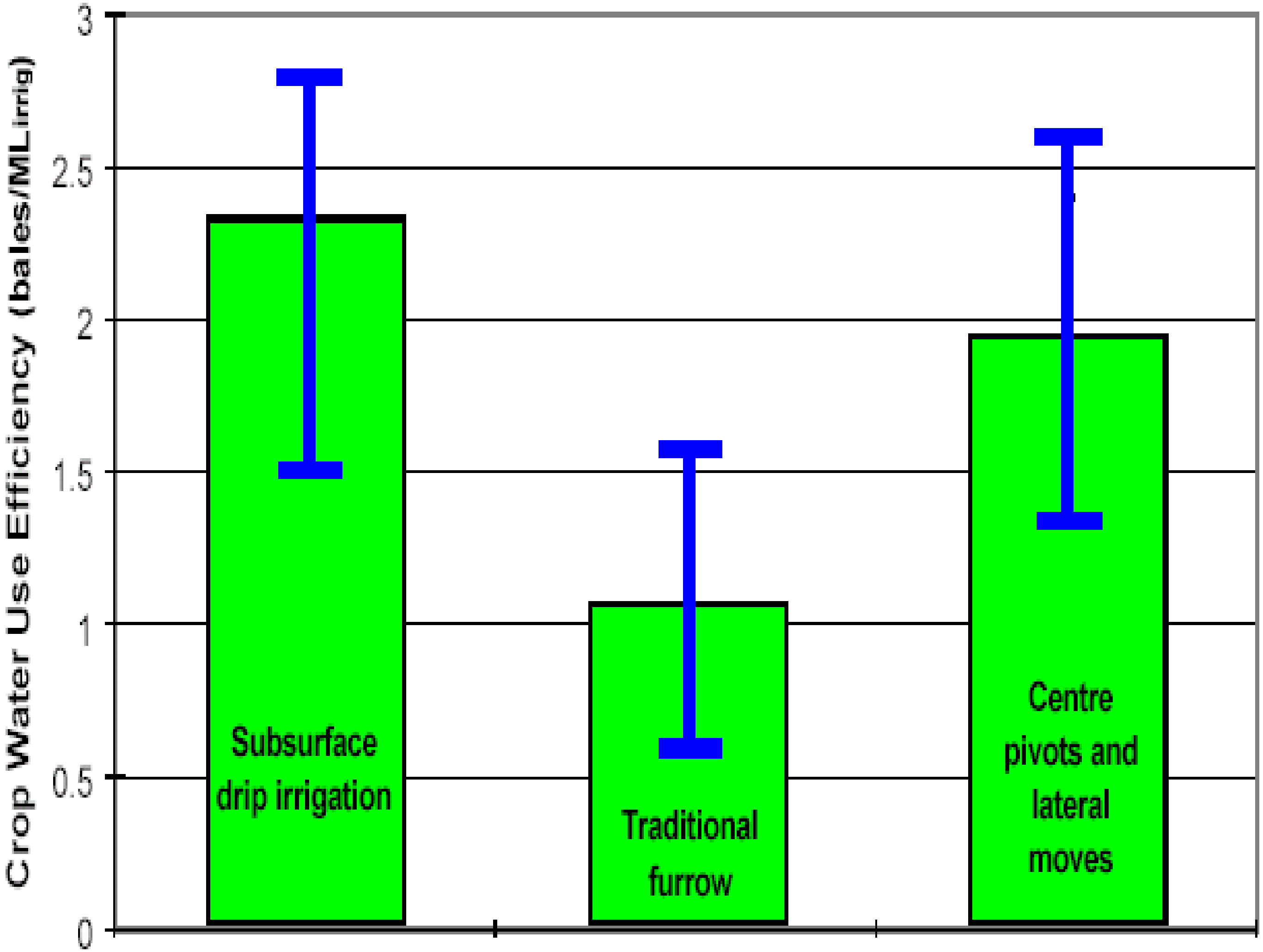
	Cotton Lint Yields (lbs / acre)			
	Year1- SDI	Year 1- Furrow	Year 2- SDI	Year 2- Furrow
Good Soil	1704	1738	1613	1608
Poor Soil	1637	1445	1517	1325
	Net Water Applied (inches)			
Good Soil	24.1	41.8	26.3	38.5
Poor Soil	22.9	45.9	25.7	41.1
*sandy loam soils / poor =nonuniform, declining infiltration rates, variable root development				

Considering the economics of converting from surface to drip

<u>Example: Sonora Chile Pepper Evaluations (New Mexico) – Las Cruces</u>

- YIELDS - 25 PERCENT ↑
- FERTILIZER COSTS – 26 PERCENT ↓
- OTHER CHEMICALS – 18 PERCENT ↓
- CAPITAL COSTS – 47 PERCENT ↑
- FIXED COSTS – 19 PERCENT ↑
- SEED COSTS – 20 PERCENT ↓
- OVERALL NET OPERATING PROFIT – 12 PERCENT ↑

Irrigation Water Use Index

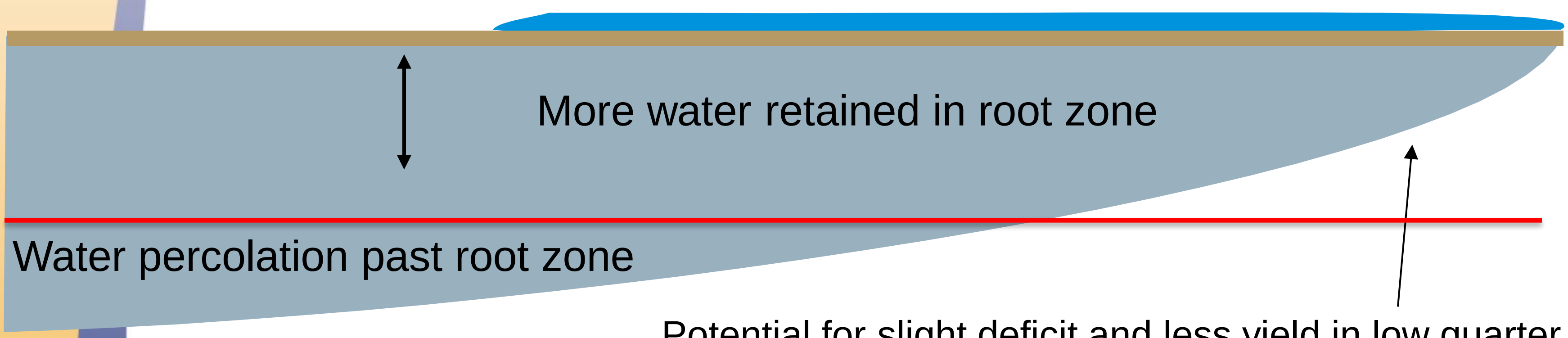


Irrigation system design: Furrow

Distribution at the end of the set

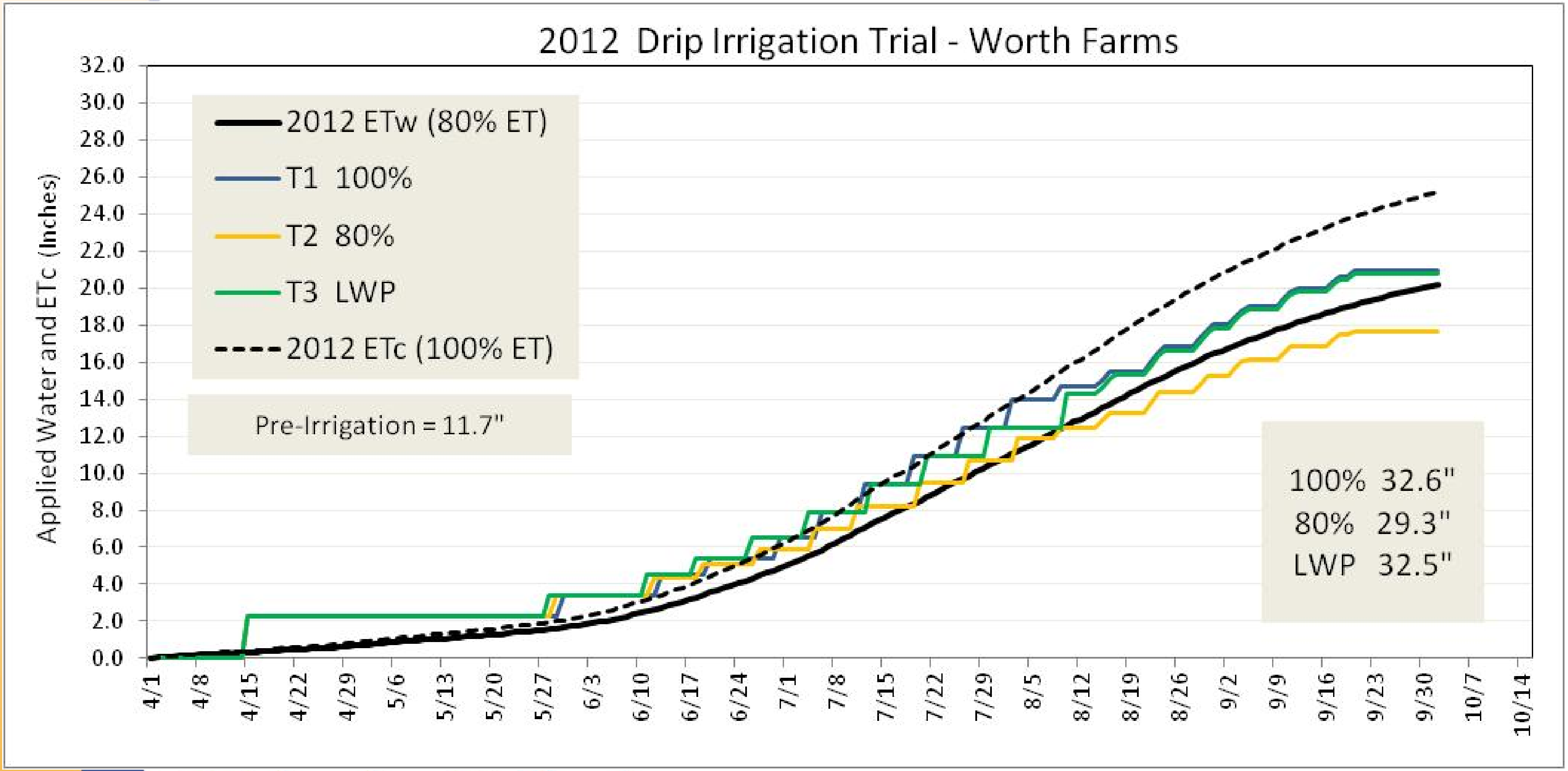
For efficient furrow irrigation:

70 - 80 % of applied water retained in root zone

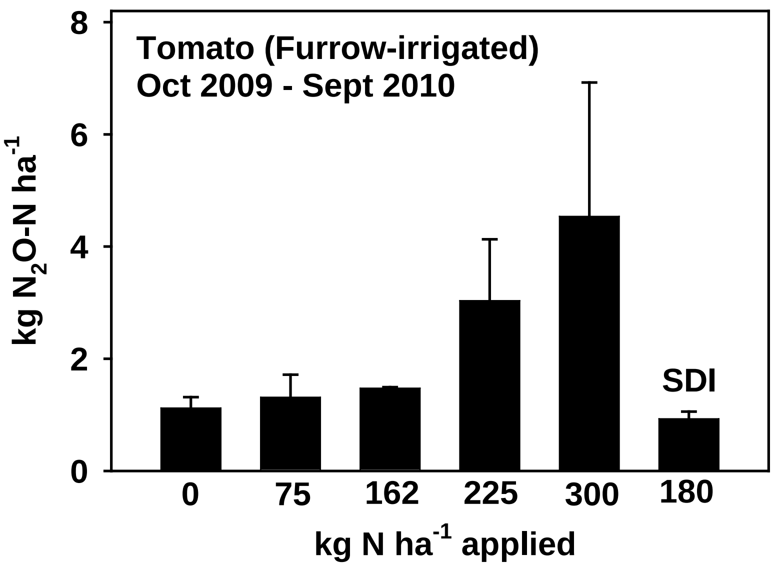


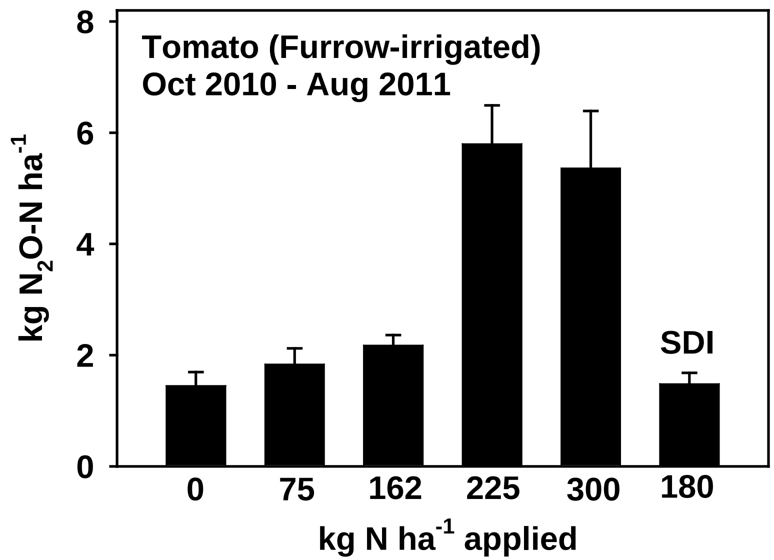
Potential for slight deficit and less yield in low quarter of field

Applied in-season irrigation and 100% and 80% ETc throughout the 2012 growing season



Processing Tomatoes: Annual N_2O Emissions Fertilizer Rate & Irrigation Effects





Crop N off-take: 150 to 230 kg N ha^{-1}

Emission Factors: tomato and lettuce

Lettuce				
kg N ha^{-1}	85	170	225	340
2009/10	.83	.41	.44	.40
2010/11	.76	.46	.41	.31
Tomato				
kg N ha^{-1}	75	162	225	300
2009/10	1.75	.91	1.35	1.51
2010/11	2.45	1.34	2.58	1.79

Note: Both low and high fertilizer N can cause increased N_2O emissions

Summary

- SDI, though a considerable investment for growers, can and often does result in:
  - Increased yields that depend on crop type and farming system elements
  - Lower water application rates
  - Higher water use efficiency
  - Improved fertilizer application efficiency
  - Improved weed control
  - Lower N2O emissions

When compared to other irrigation systems*

Summary

- Current limitations to adoption are related to the high initial capital costs of the system as well as the knowledge of system operations and maintenance including development of appropriate irrigation schedules.

- Many of the benefits associated with SDI are offset when systems are not properly maintained and water schedules are not fully optimized emphasizing the need for appropriate operator training.

- Salinity management planning will need to be addressed in many SDI systems.


That's all Folks!

Subsurface Drip Irrigation (SDI) in Alfalfa

Daniel H. Putnam

(Collaborators: Ali Montazar, Khaled Bali, James Radawich, Roger Baldwin, Daniele Zaccaria)

University of California, Davis

dhputnam@ucdavis.edu

http://alfalfa.ucdavis.edu

Drip irrigated alfalfa field, California

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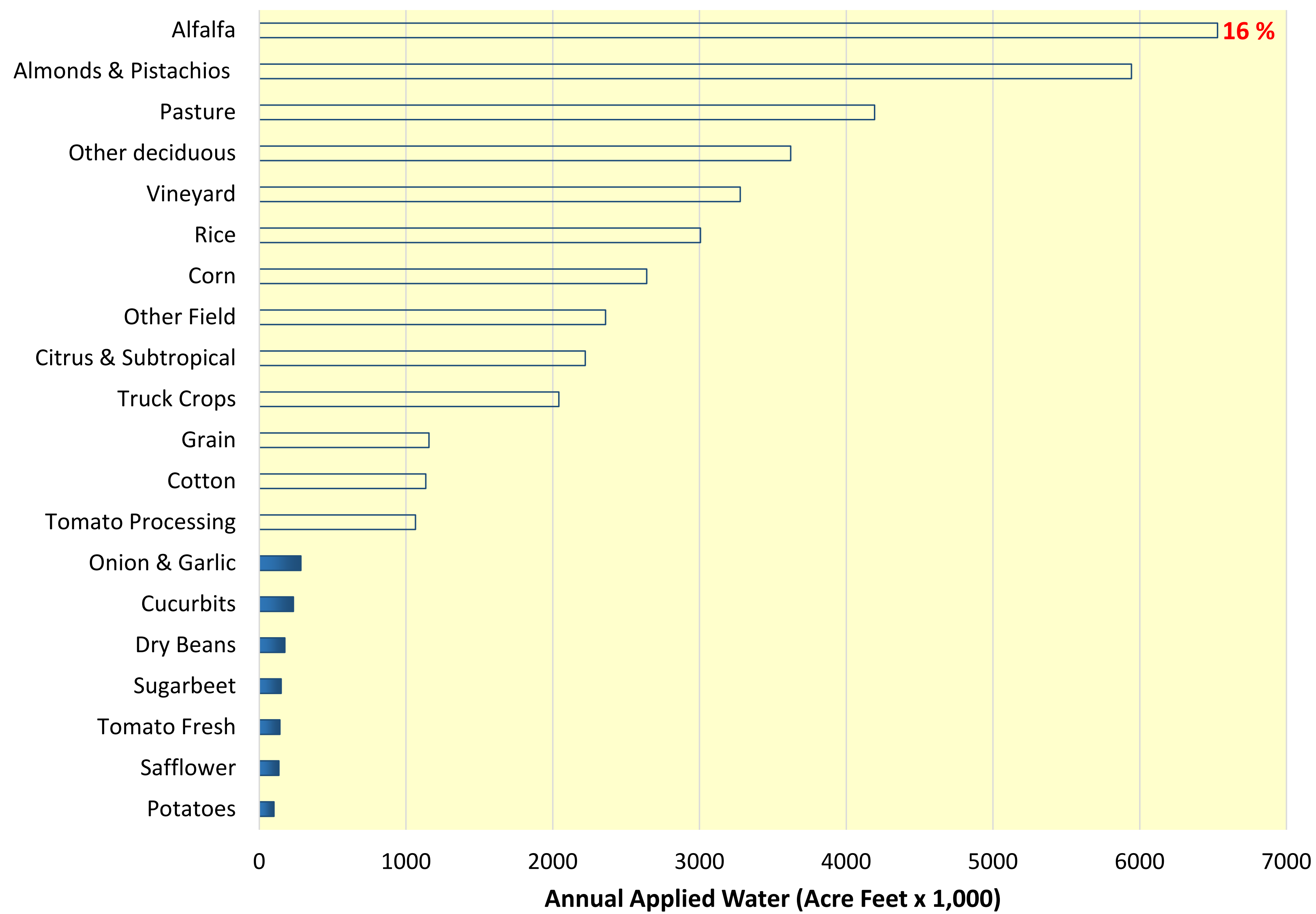
Web Resources for SDI & Alfalfa

- Training: 2014 Symposium Long Beach: http://alfalfa.ucdavis.edu/+symposium/2014/index.aspx
- Irrig. Training: 2015 Sympoisum Reno http://alfalfa.ucdavis.edu/+symposium/2015/workshop.aspx
- SDI in Alfalfa (UC): http://alfalfa.ucdavis.edu/+symposium/2014/index.aspx
- Netafim: http://ucanr.edu/sites/adi/files/204432.pdf
- Toro: http://driptips.toro.com/drip-irrigation-testimonials-case-studies/alfalfa/

The Key ‘Public’ Issues

- Can a given technology improve yield/productivity per unit water?
- Save water per unit area?
- Per unit energy?
- Per unit greenhouse gas?
- Provide other public benefits
  - Surface water quality
  - Groundwater quality
  - Weed & Pest Management

Water Use by California Crops (4-Year Ave. 2006-2009)

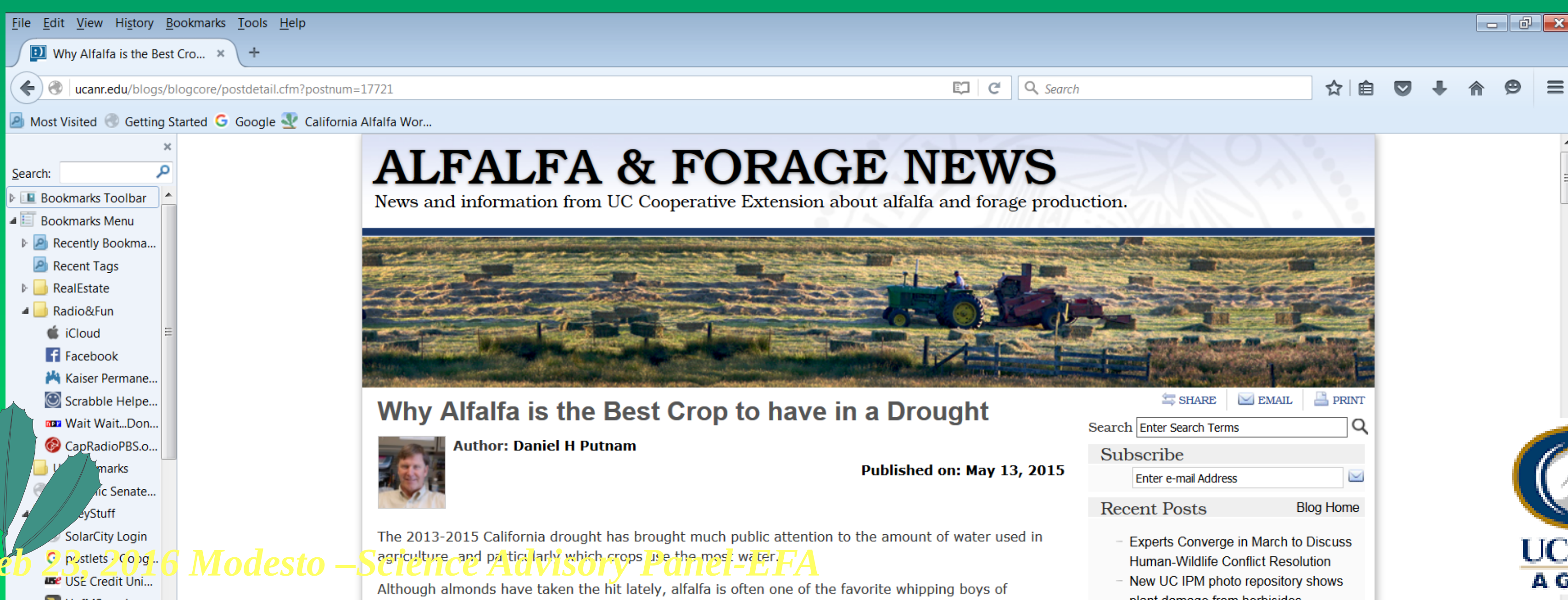


Future trends for Alfalfa?

- Dethroned as #1 acreage crop (~2012)
- 'Tug of war' between
  - Restrictions on acreage/production due to competition from other crops, water limitations
  - Strong demand from Western Dairies, Exports, horses, other livestock
- Need for:
  - Higher yields on limited land availability (this is a GLOBAL issue)
  - Lower water use
  - Water transfers
  - 'Sustainable intensification'
- Alfalfa will remain a major crop for many years to come

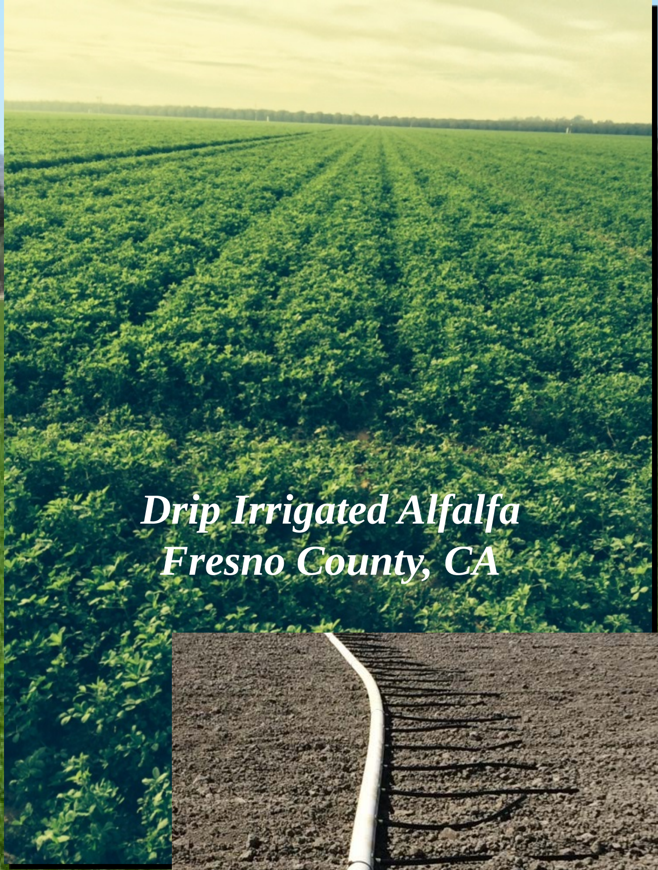
Why alfalfa is the best crop to have in drought (alfalfa blog)

- Deep Roots, use of residual moisture
- Perennial, don't have to re-establish
- High Water Use Efficiency
- High flexibility with summer deficits
- Lower risk if things go wrong



Why an interest in SDI in Alfalfa?

- Possibility of Higher Yields
- Higher Hay price
- The Water Squeeze
- Water Savings/water productivity
- Better Water Management
- Soil Fertility Management
- Labor Savings
- Crop Rotation possibilities
- Problems with current (surface) system
- Profitability



Drip Irrigated Alfalfa
Fresno County, CA

Drip Irrigated Alfalfa – Seeley, CA

UC SDI Studies:

- "Case Studies" of grower's experiences across a range of environments (18-20)
  - Documenting successes/failures
  - Costs/benefits
- Controlled Studies on UC Facilities:
  - SDI compared with Flood
  - Variety interactions (with AZ, NMSU)
  - Deficit Irrigation with drip
  - Spacing Studies, understanding optimum irrigation management
  - Gopher Management

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Field Visits (AZ, CA)

El Centro Trials

Davis Trials

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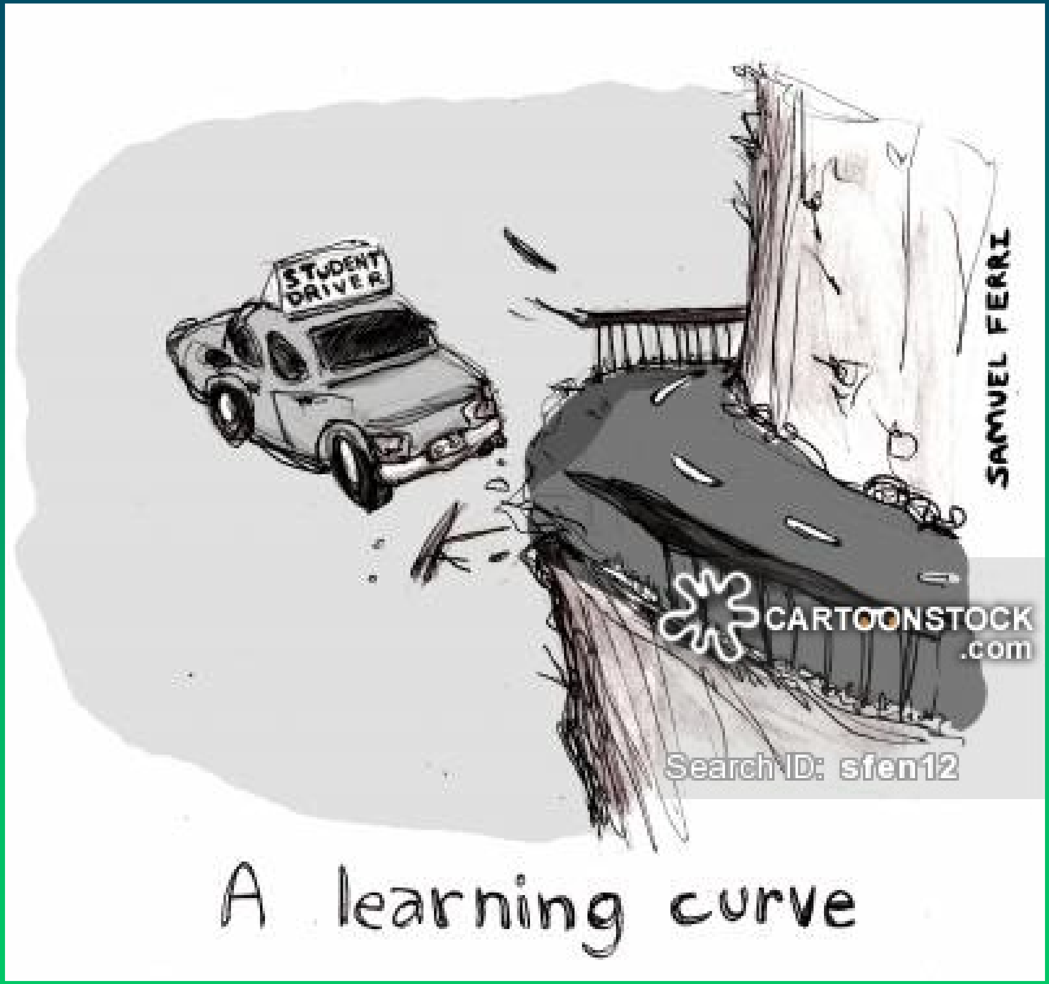
We hope not this:



To consider SDI in alfalfa:

- <u>Must</u> improve yields over surface irrigation to justify cost
- Must understand source of water, water quality, delivery
- Must be prepared for higher level of management

Sample Costs for SDI
(compared with surface irrigation)

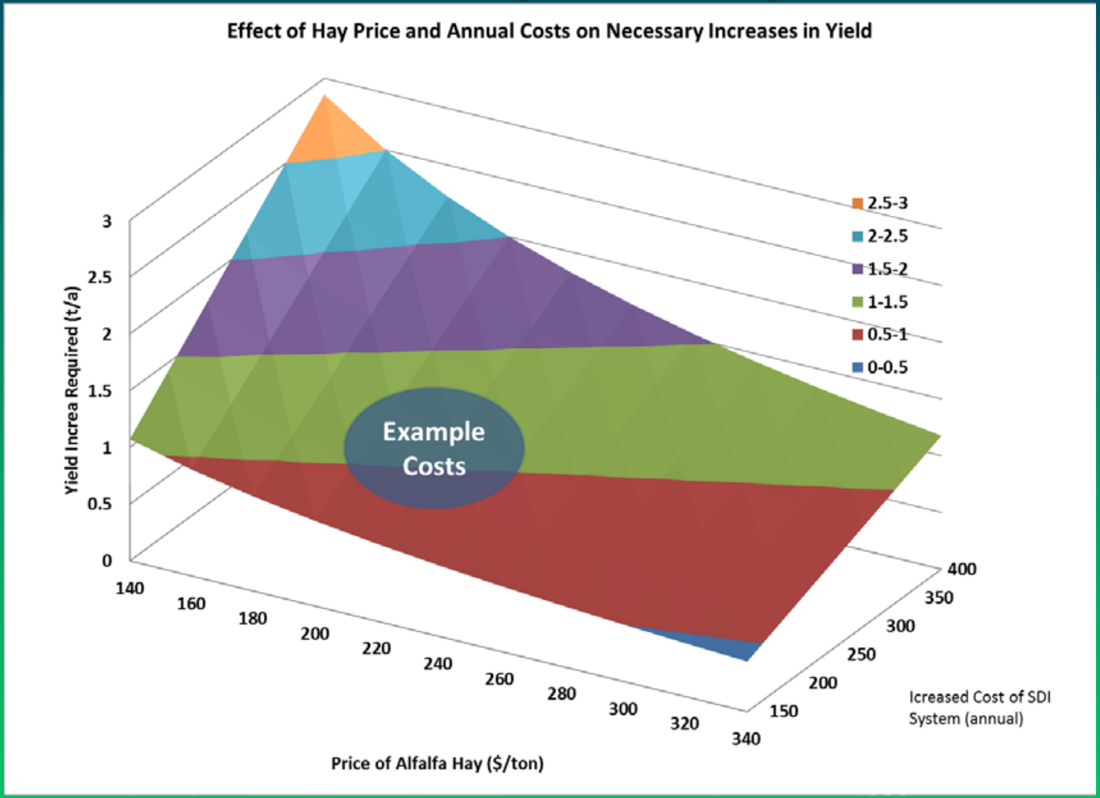
Item	Partial Budget ($/a)	Annualized Costs ($/a)
Drip Tape (40") – 6 yr.	$450 (400-500)	75
Drip Tape Installation– 6 yr.	$200 (100-300)	33.33
Irrig. Infrastructure (valves/pipes, pump) -15 yr.	$1400 (800-1800)	93.33
Water Cost (-8% SDI)	-$42 (+10% to -20%)	-$42
Energy Cost (vs. surface)	$118	$118
Labor Irrig. Management	-$66	-$66
Labor for Rodent mgt. & repair	$75	$75
Remove Driplines—6 yr.	100 (80-120)	16.67
Total Sample costs	$2,050 initial + $185/yr	302.50/year

Note: Actual costs may be higher or lower than these amounts

Key Recommendations

What is needed to Justify SDI?

(Fixed costs)



- **Assumptions: 15 yrs. infrastructure (pumps, filters, etc.)**
- **6 years drip lines**
- **Does not consider support by NRCS or state agencies**

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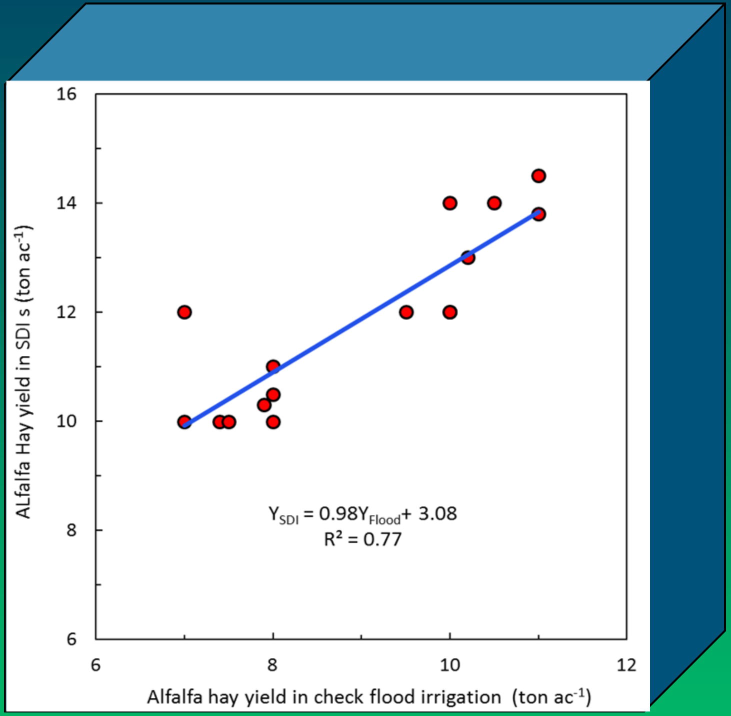
Are these yield improvements possible?

- Yield Increases appear real
- Confirmed by controlled studies (Lamm et al. 2012, UC studies)
- Growers report approximately 3.1 t/a improvement over flood.
- 20-35% range
- Why is that?



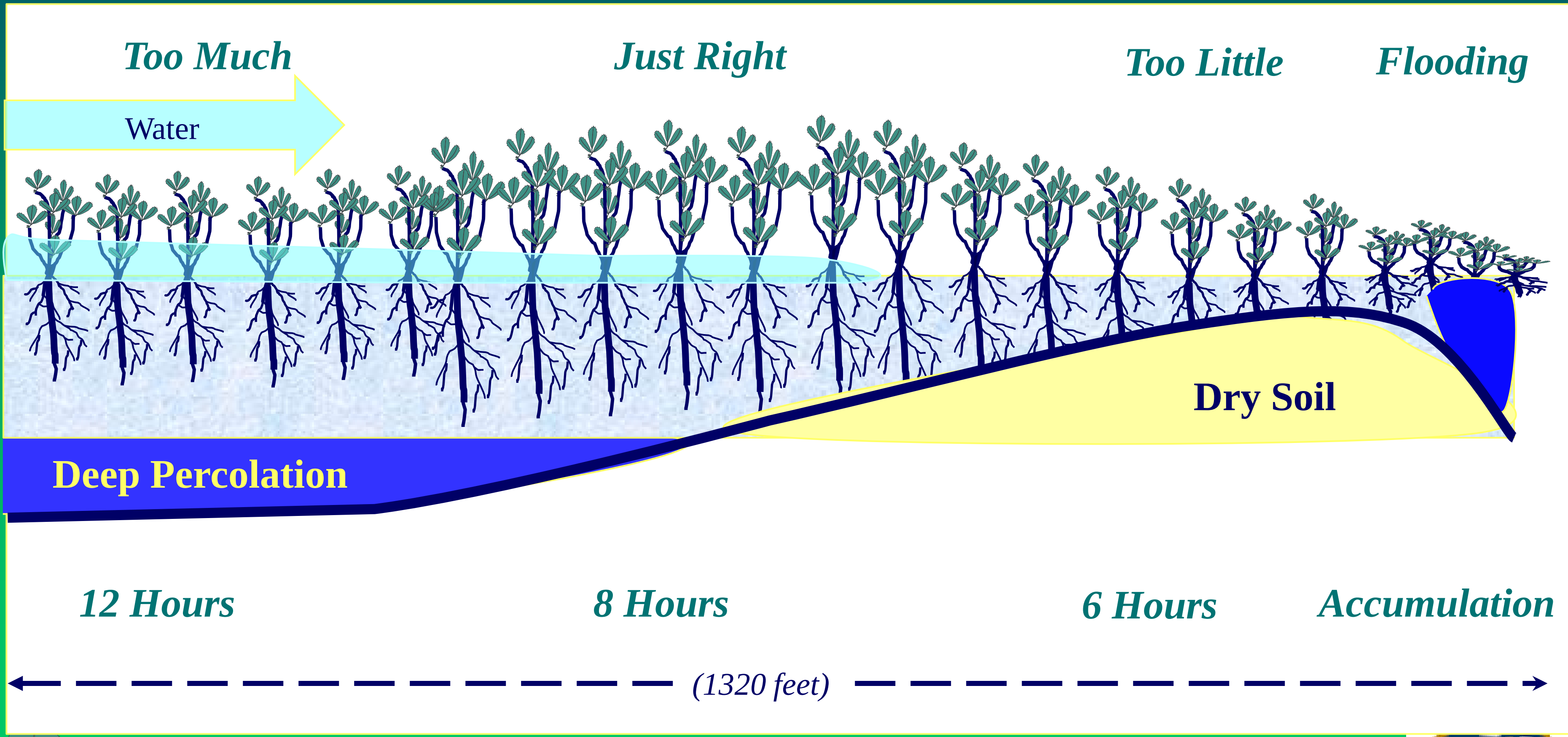
Why would we expect improved yields in SDI vs. surface?

- **1. Superior Distribution Uniformity (in Space)**
  - **Less difference between top and bottom of field**
  - **Well known problems with surface systems**

Innate Problems with Flood Irrigation

(Distribution uniformity can be poor due to soil infiltration rate, flow, and set duration)

In a 12 hour irrigation set:



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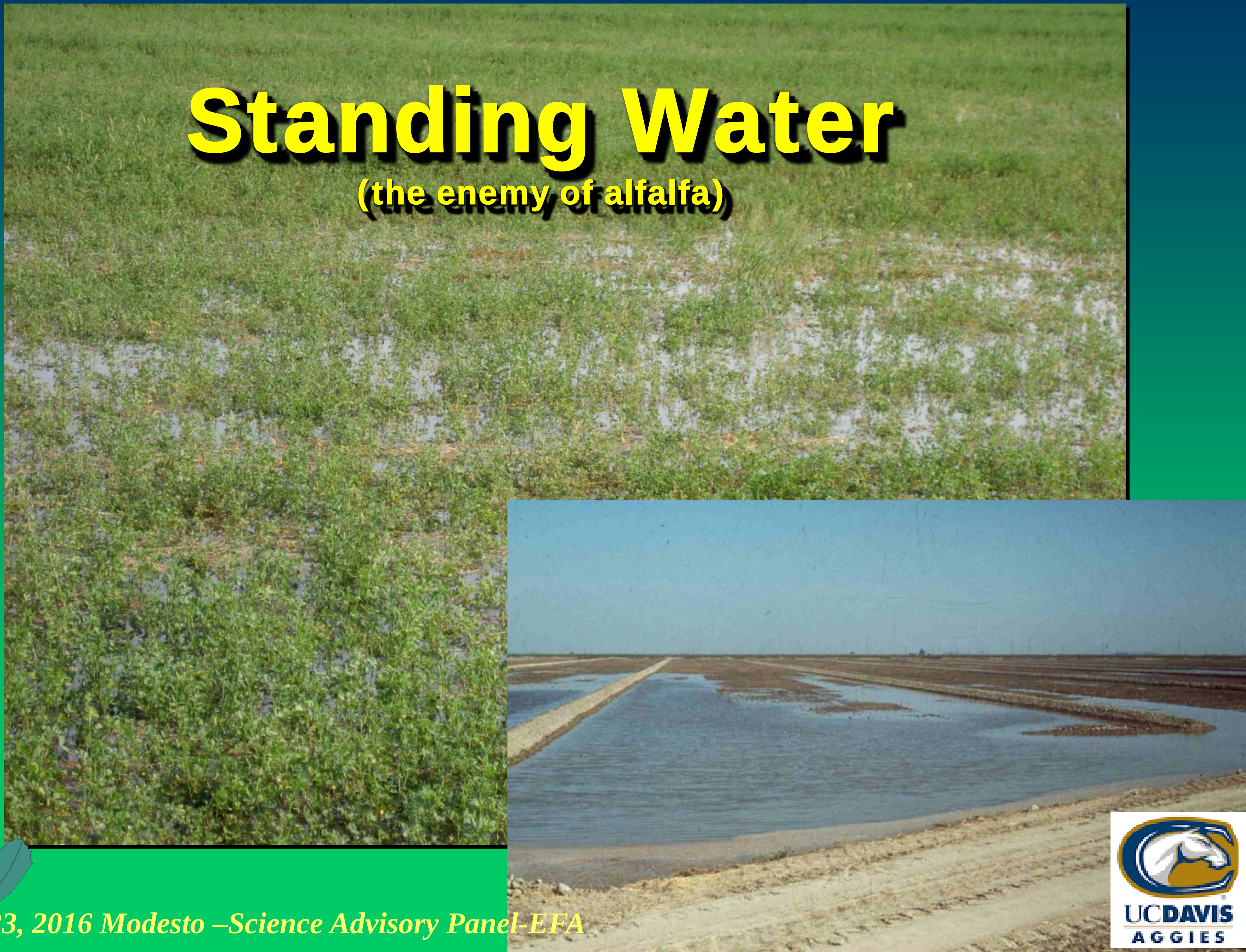
Standing Water

(the enemy of alfalfa)

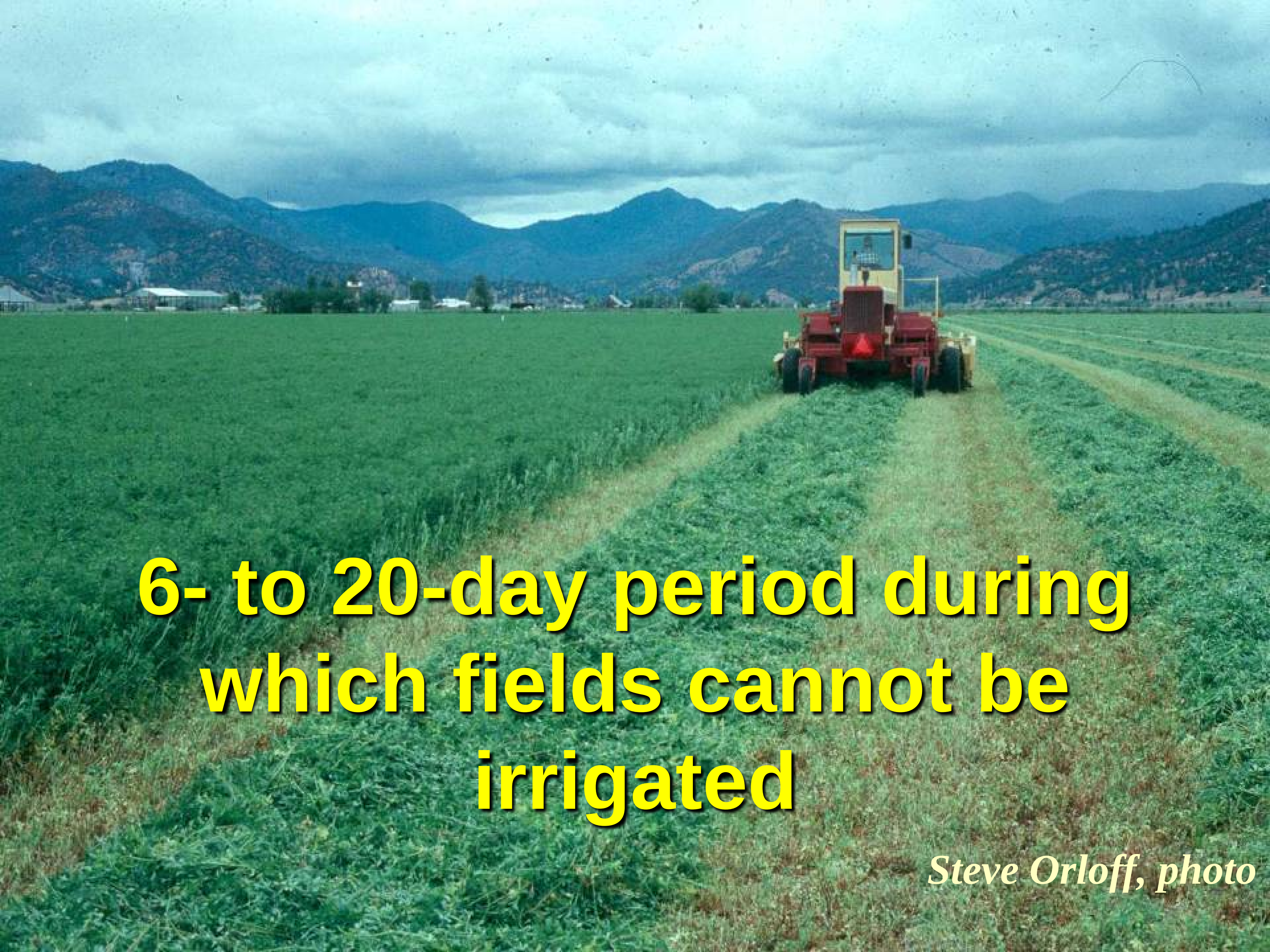


Tail –End Damage

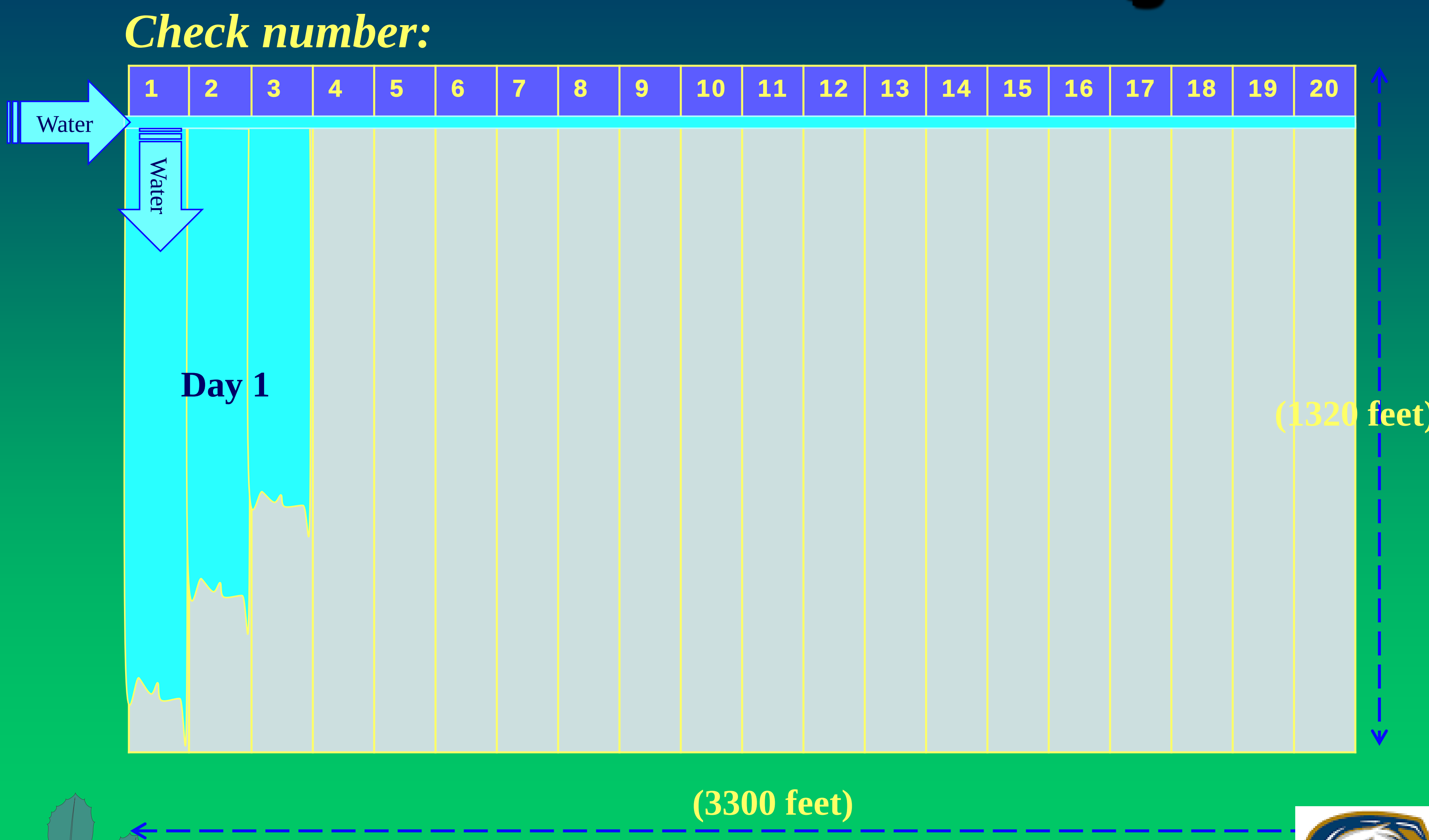
Weeds intrude in damaged areas

Why would we expect improved yields in SDI vs. surface?

- **2. Distribution Uniformity (in Time)**
  - Ability to ‘charge’ a field within hours, not days
  - Most Flood-irrigated (and some sprinkle irrigated) fields require 4-12 days to irrigate, depending upon flow available.
  - Problem for 30-day growth cycle
  - Differences in yield between sections of field in surface systems
  - Loss of Stand in flooded fields vs. drip (observed in second year at El Centro)


6- to 20-day period during which fields cannot be irrigated
Steve Orloff, photo

Innate Problems with Flood Irrigation



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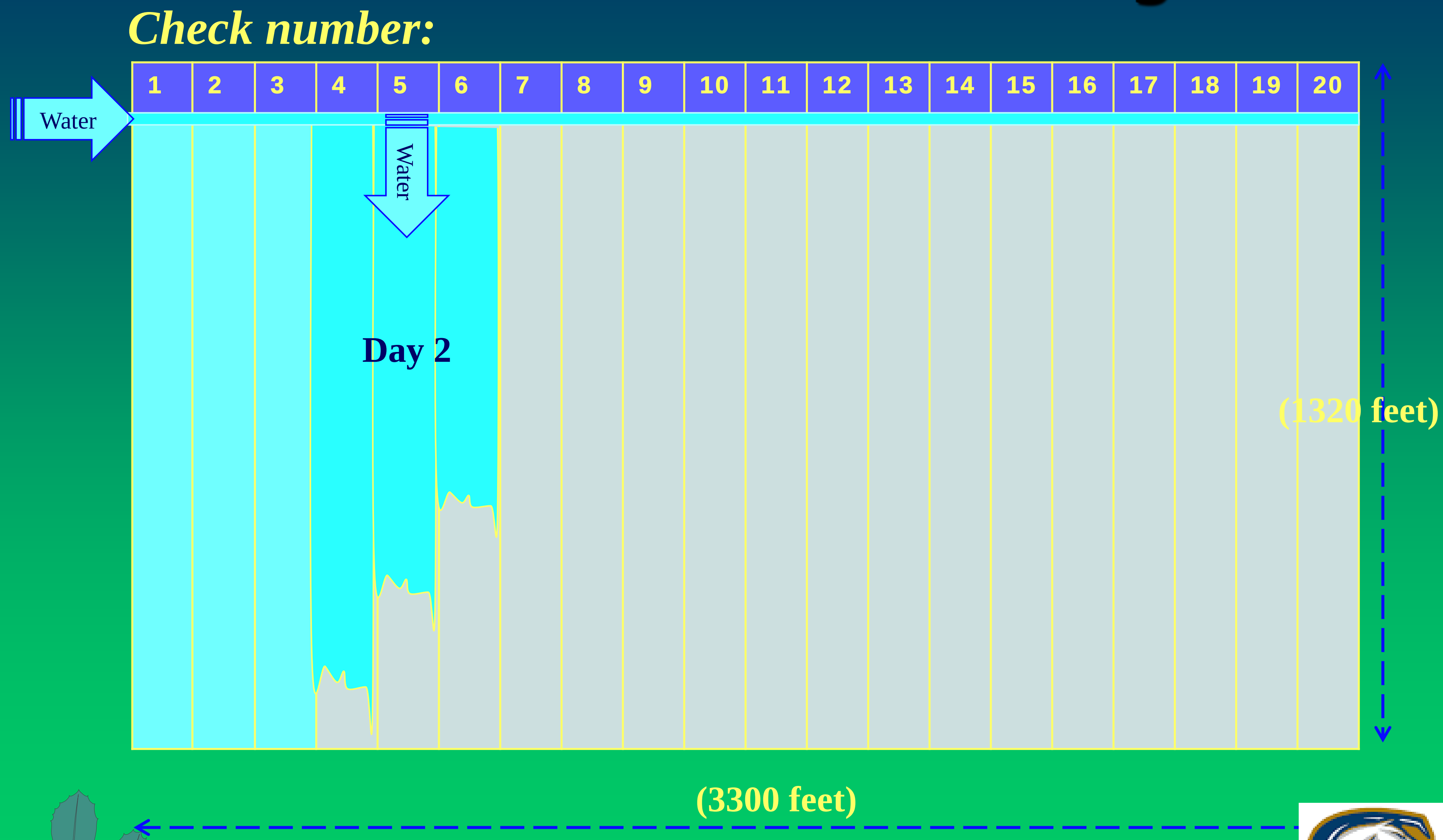
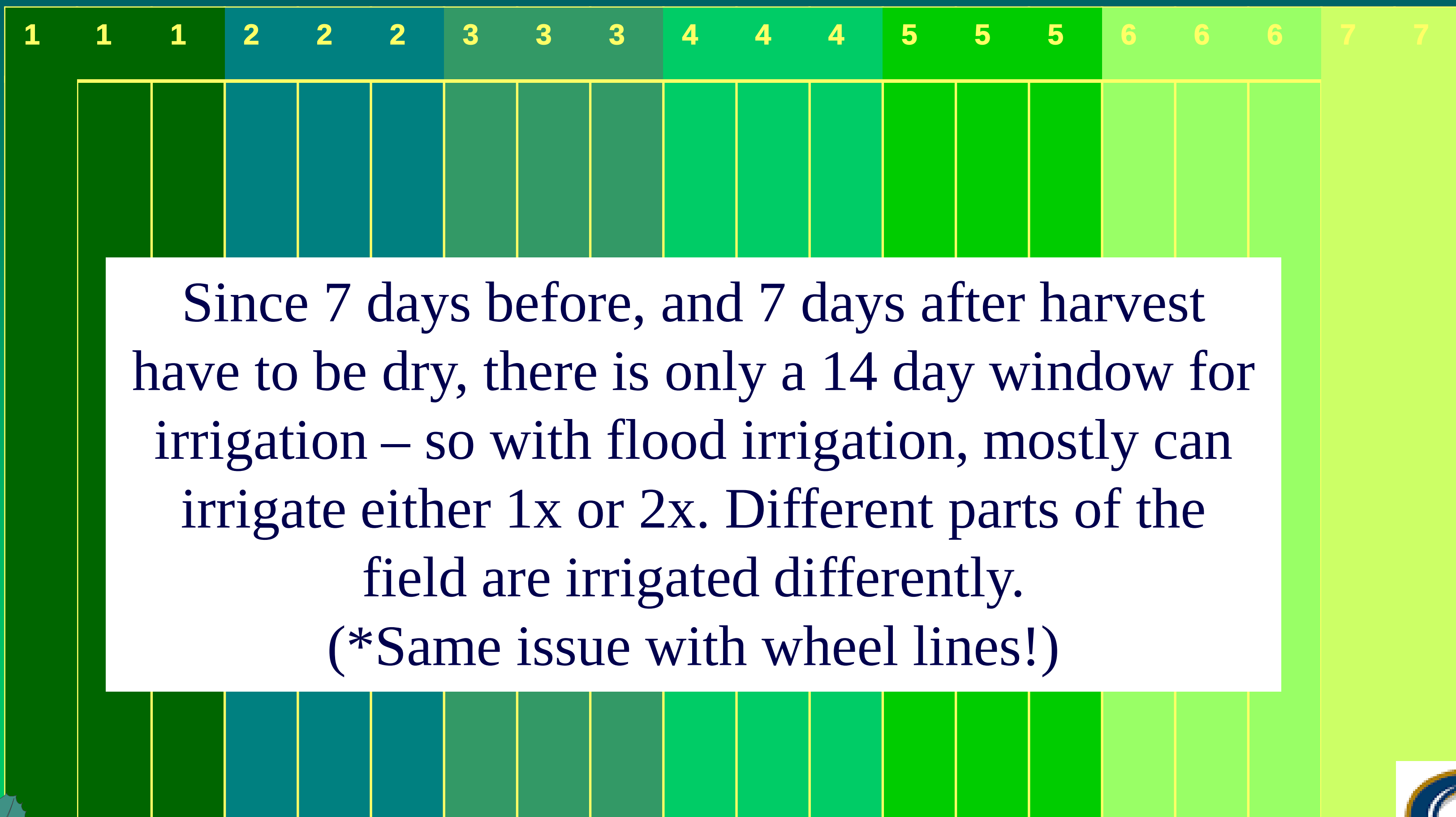
Innate Problems with Flood Irrigation



Innate Problems with Flood Irrigation

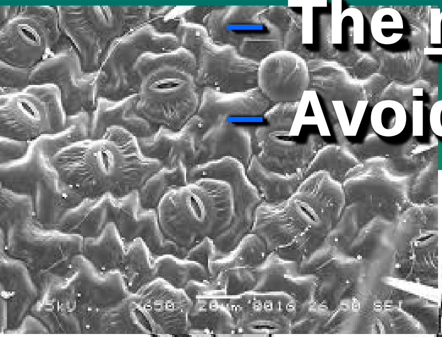
In a 28 day growth cycle, some parts of the field get water 7-8 days later.

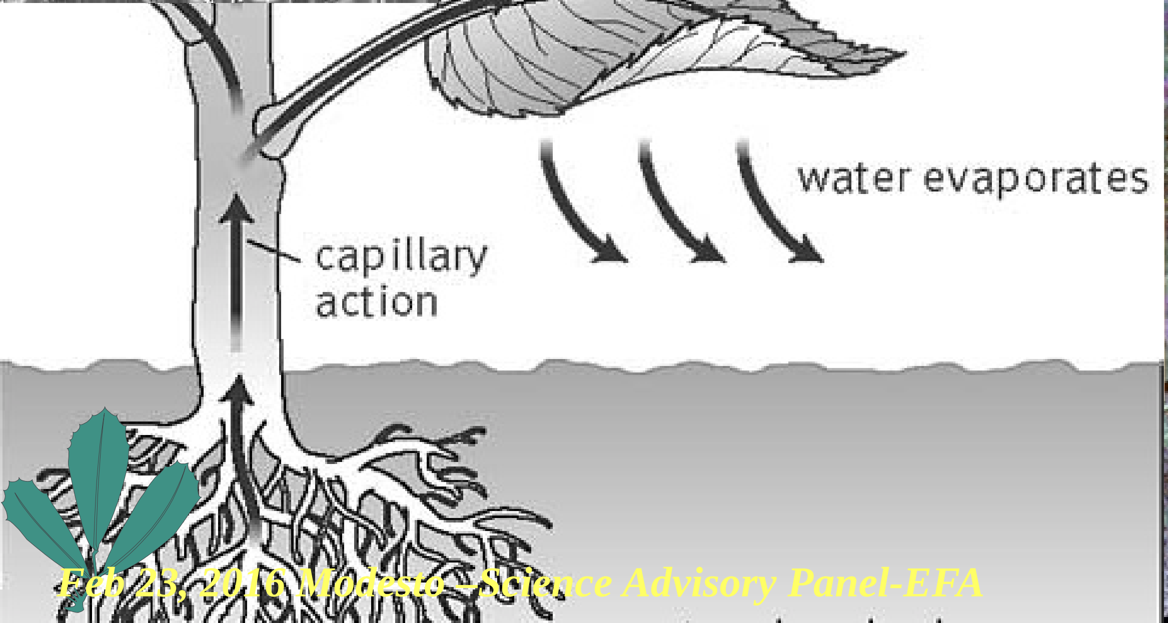


Since 7 days before, and 7 days after harvest have to be dry, there is only a 14 day window for irrigation – so with flood irrigation, mostly can irrigate either 1x or 2x. Different parts of the field are irrigated differently.
(*Same issue with wheel lines!)

Why Increased Yields with SDI?

- 3. Ability to Maintain Turgor
- Avoid temporary droughts
  - The <u>moment</u> turgor is lost, growth ceases
  - Avoid wetting-drying patterns (flood/drying)





Why Increased Yields?

- 4. Manipulating Irrigation Schedules to match ET
  - Essentially any schedule desired
  - Can irrigate every day
  - Many hours, few hours
  - Maintaining turgor
  - Irrigating close to harvests (during??)

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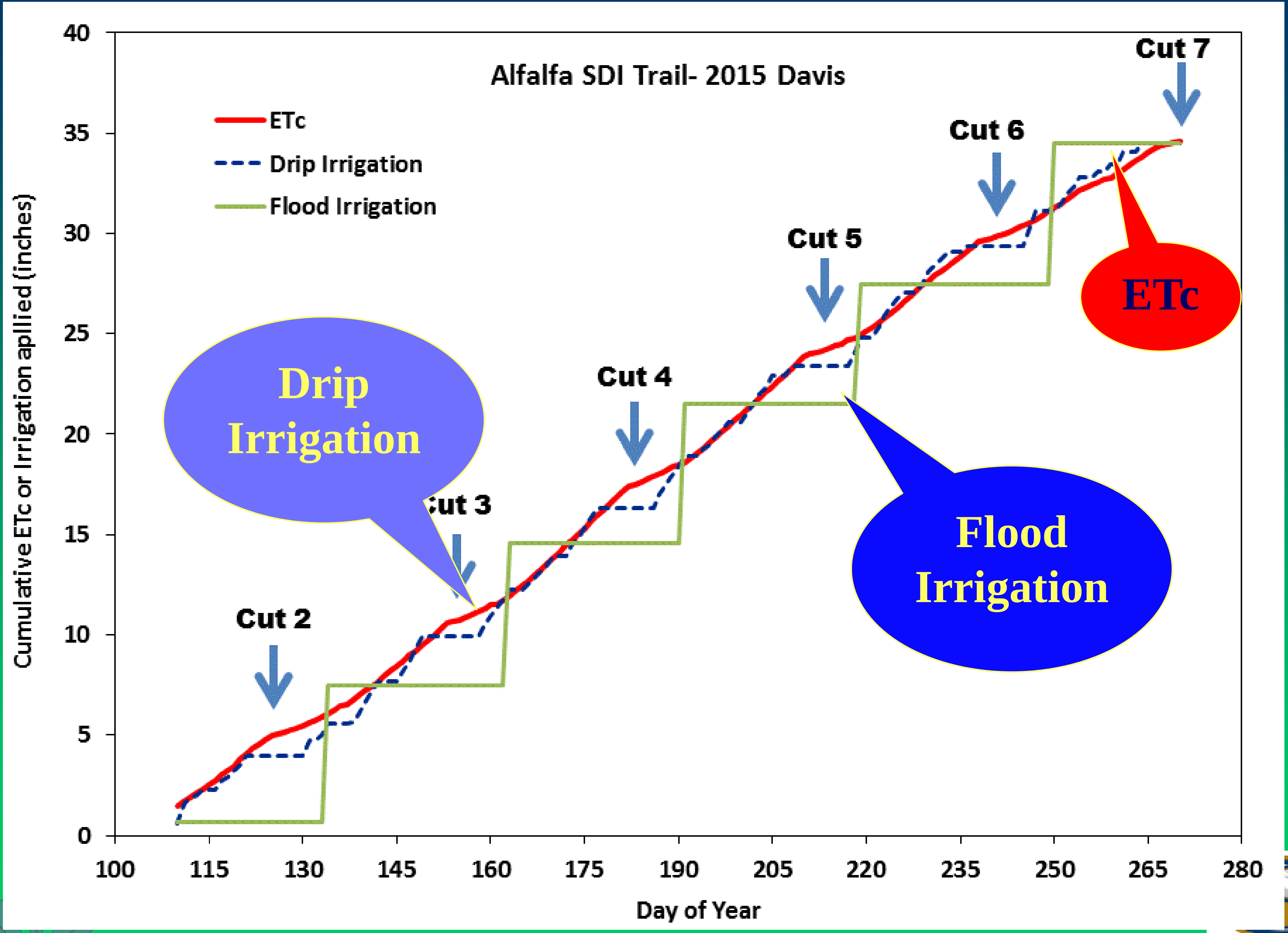


Alfalfa SDI Trail- 2015 Davis
ETc
Drip Irrigation
Flood Irrigation
Cut 2
:ut 3
Cut 4
Cut 5
Cut 6
Cut 7
Drip Irrigation
Flood Irrigation
ETc
Cumulative ETc or Irrigation apllied (inches)
Day of Year
0
5
10
15
20
25
30
35
40
100
115
130
145
160
175
190
205
220
235
250
265
280

Innate Problems with Flood Irrigation

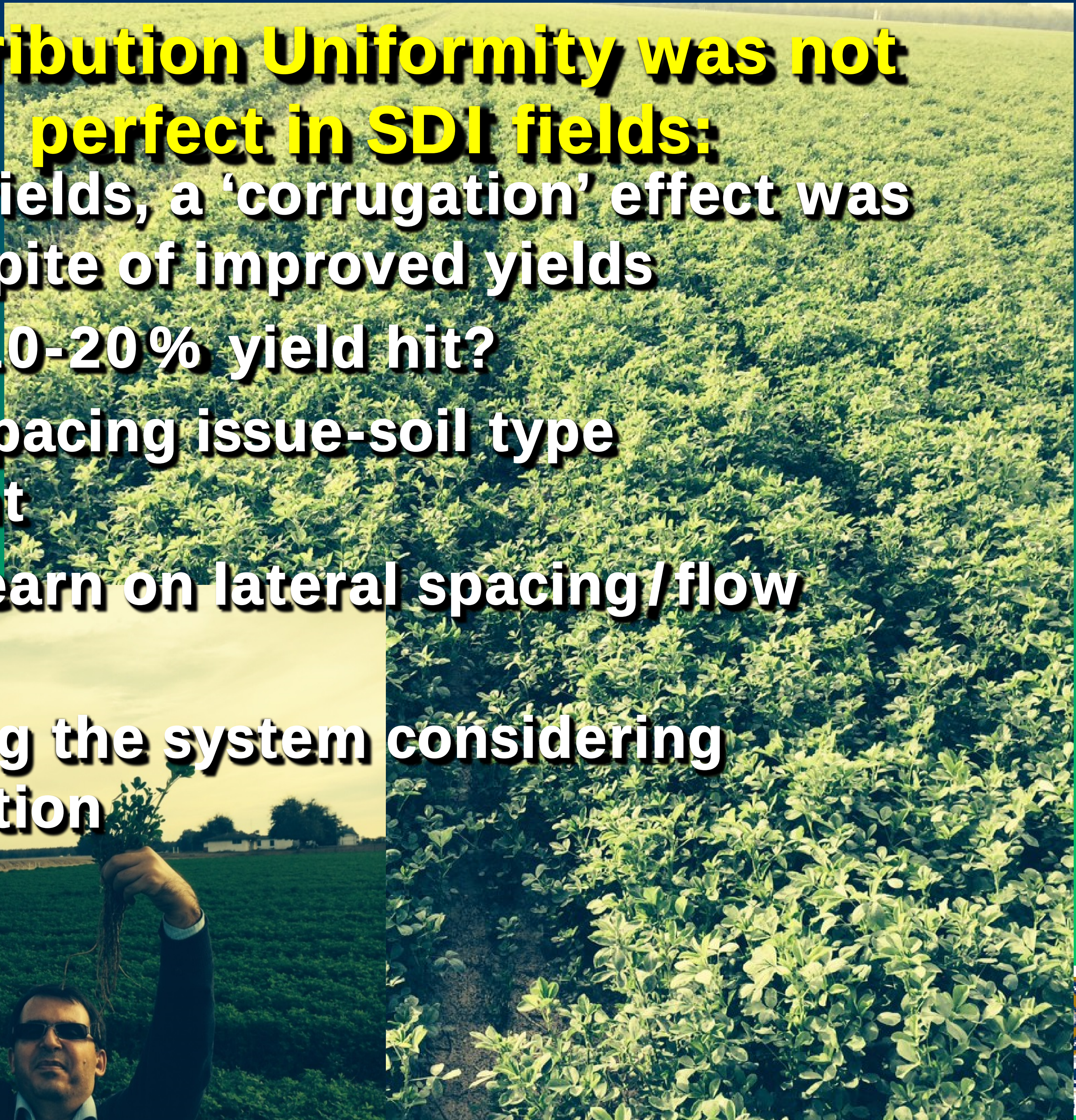
- Flood irrigation events can only irrigate between 4” to 8” of water at once, necessary just to push water down the field.
- Typically only 1 or 2 irrigations are feasible in a 14 day irrigation window.
- So: 1 irrigation may apply too little, and 2x may apply too much water for a 28 day ET demand – resulting either in excess or deficit irrigations.

Can a system follow ET?

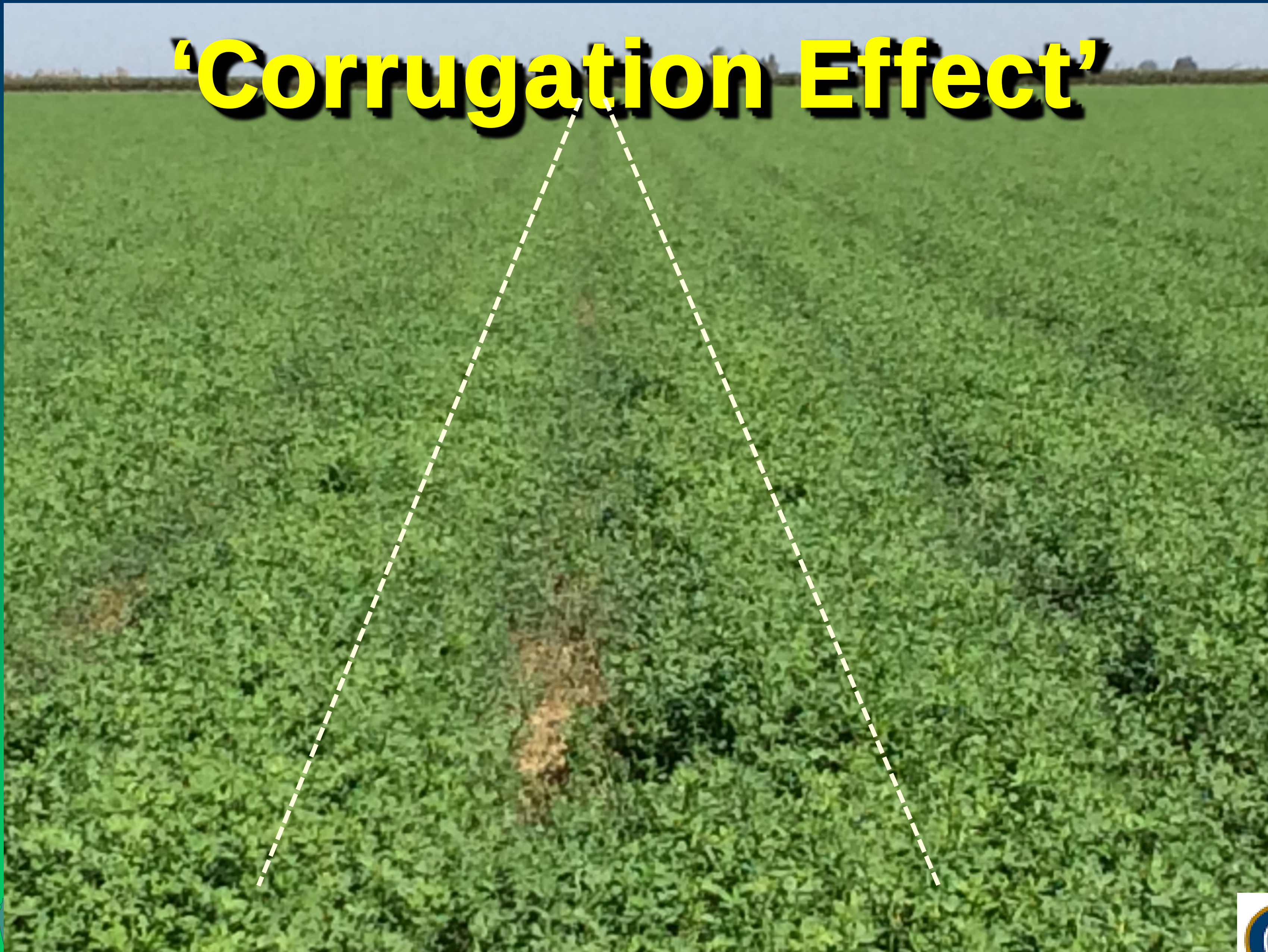
- Is it restricted in terms of applying small amounts?
- Can it recharge the profile?

Distribution Uniformity was not perfect in SDI fields:

- In many fields, a ‘corrugation’ effect was seen, in spite of improved yields
- Perhaps 10-20% yield hit?
- Likely a spacing issue-soil type dependent
- More to learn on lateral spacing/flow rates
- Optimizing the system considering cost/rotation

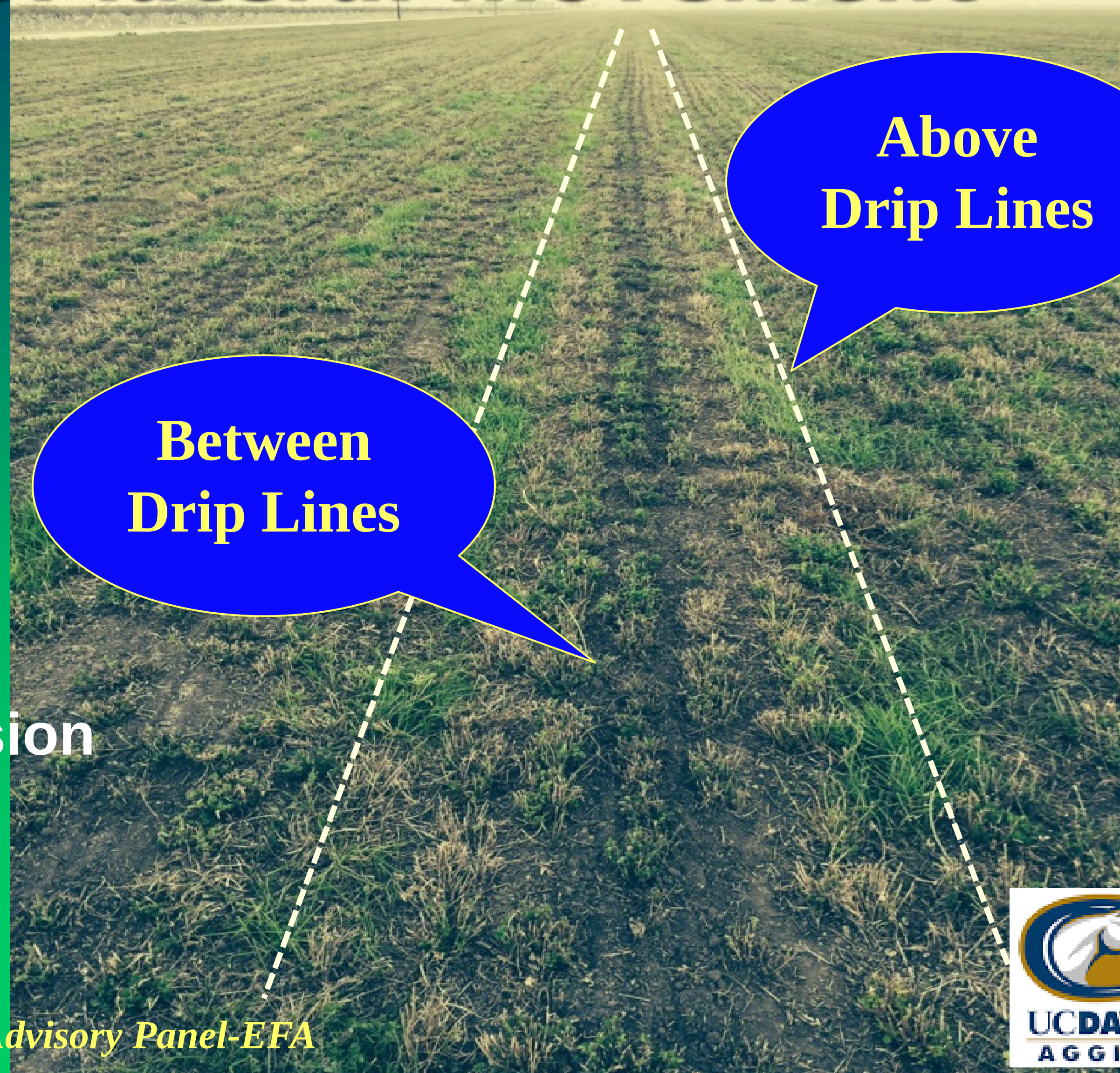


‘Corrugation Effect’




Between
Drip Lines
Above
Drip Line
1 SUBJECT
70
Sheets
10.5" x 8" • College Ruled

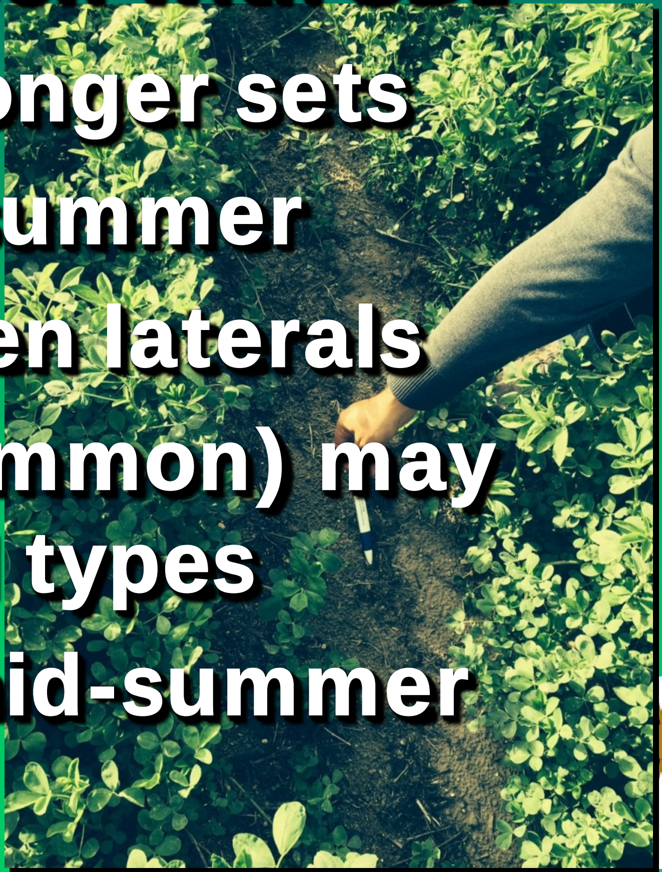
Over Irrigating to compensate for lack of lateral movement



Standing Water,
Loss of Stand,
Grassy Weed Intrusion

What we've learned:

- Growers were sometimes unable to fully charge fields with moisture at the beginning of the season with SDI
- Try to overcome it with longer sets
- Also a problem over the summer
- Problems subbing between laterals
- 40" spacing (the most common) may not be ideal for many soil types
- Inability to recharge in mid-summer



Different Rooting Patterns

Khaled Bali, photo

Key Recommendations

- Do not take an 'absolute' view of application technology
- Sprinklers best for germination.
- Surface flood irrigations may be helpful in addition to SDI

Recommend to Maintain the ability to Flood irrigate:

- Fully re-charge fields periodically (particularly at beginning of season)
- Assists with gopher management
- Assists with salinity management
- Maintain Wildlife Habitat
- Note: Consider less than 40” spacing strategies (e.g. 30”)

Key Recommendations

What we've learned:

- **Rodents are perhaps THE major challenge for SDI in alfalfa**

Rodent Discovery Method

Gopher Management

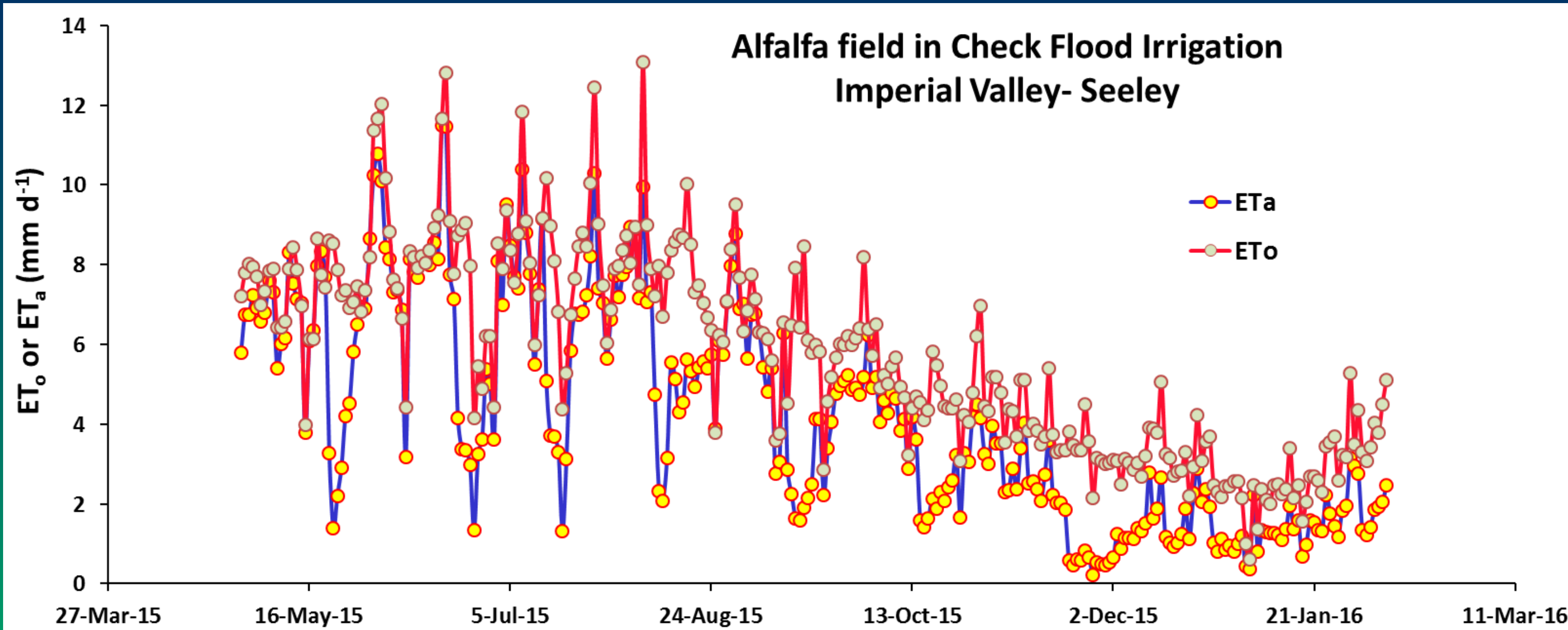
- No one solution
- An Integrated Approach
  - Primarily increased awareness/scouting
  - Allocate the time and labor to this function
  - Trapping
  - Baits
  - Occasional flood irrigations
  - Exclosures (barriers)?
  - Repellents (Pro-Tech T)?
  - Predators (owl boxes)?
- 'Professionalize' rodent management

Rodent Control is Key

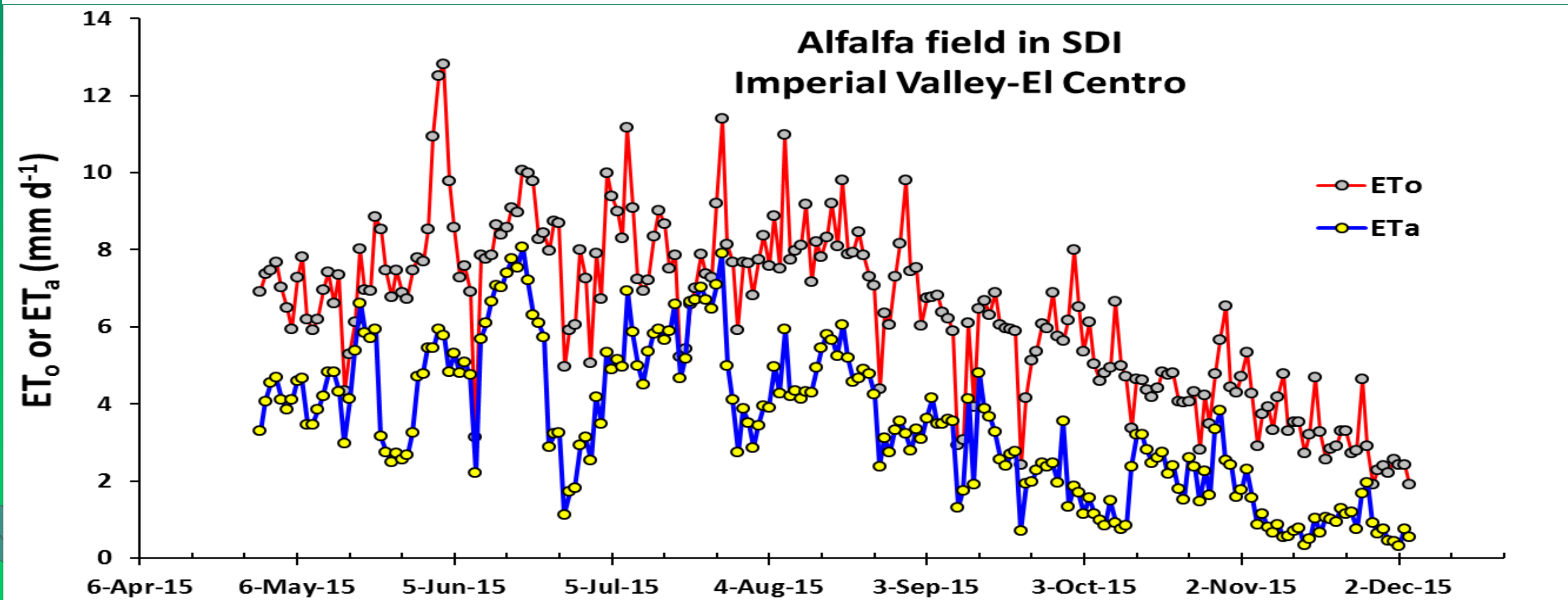
- A number of growers have walked away from SDI as a consequence
- Cannot be tolerated
- Future Research
  - Professional monitoring & control
  - Protected drip tape
  - Barriers (exclusions)
  - Further work on baits, repellents

Can you save water?:

- Yes, under some conditions
- Yield is directly related to ET (higher yield, higher ET!), so may not save water.
- But can save on evaporation
  - ET question is still pending
- 7% savings in Brawley (heavy soil)
- 20% under other situations
- Growers have reported water savings.
  - Soil type (savings on light soils)
  - Efficiency of flood system
  - Are they adequately irrigating for full yields?
- WUE – yield per unit water

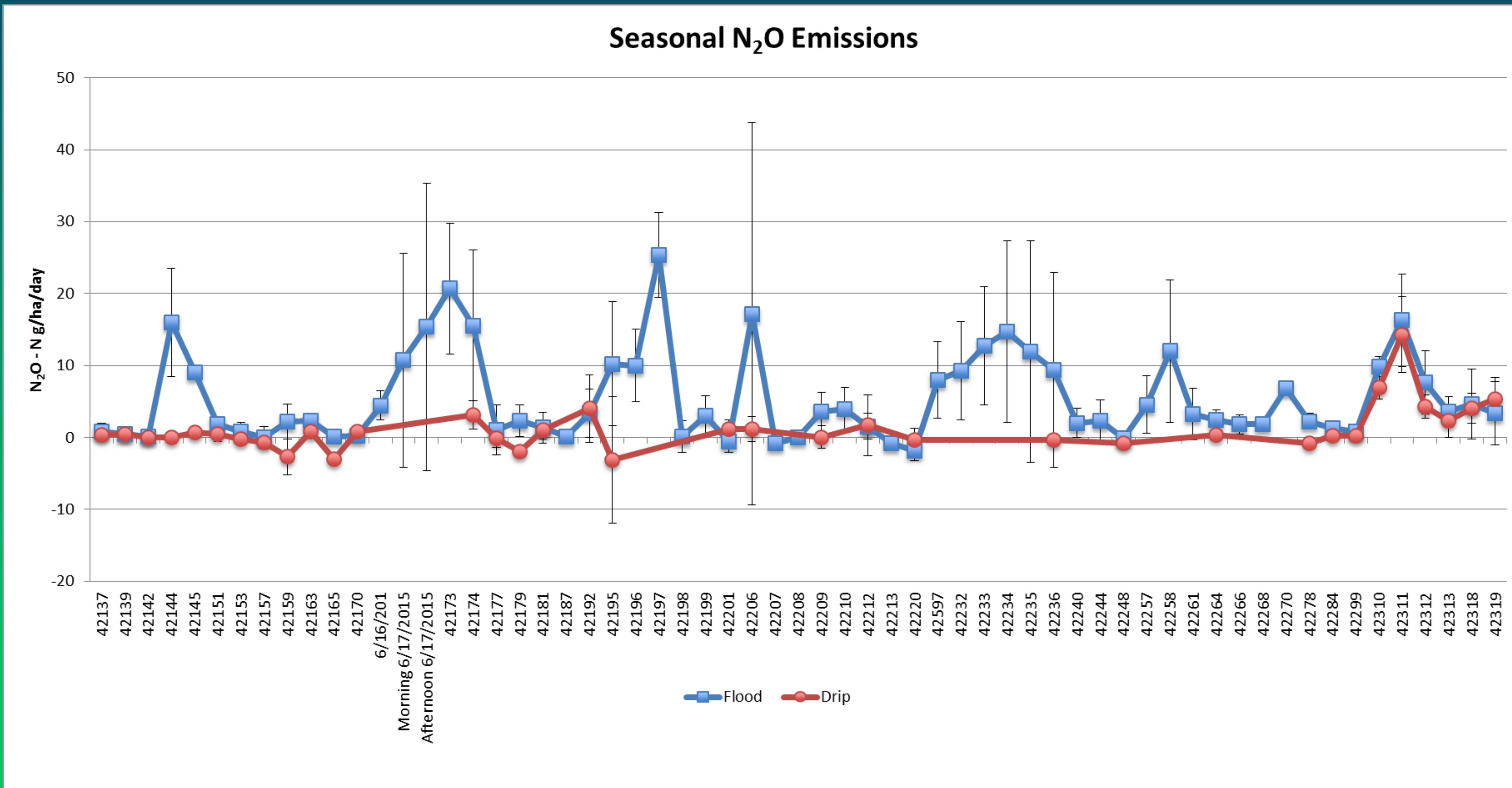


Alfalfa field in Check Flood Irrigation
Imperial Valley- Seeley
ETa
ETo
ET$_o$ or ET$_a$ (mm d^{-1})
14
12
10
8
6
4
2
0
27-Mar-15
16-May-15
5-Jul-15
24-Aug-15
13-Oct-15
2-Dec-15
21-Jan-16
11-Mar-16



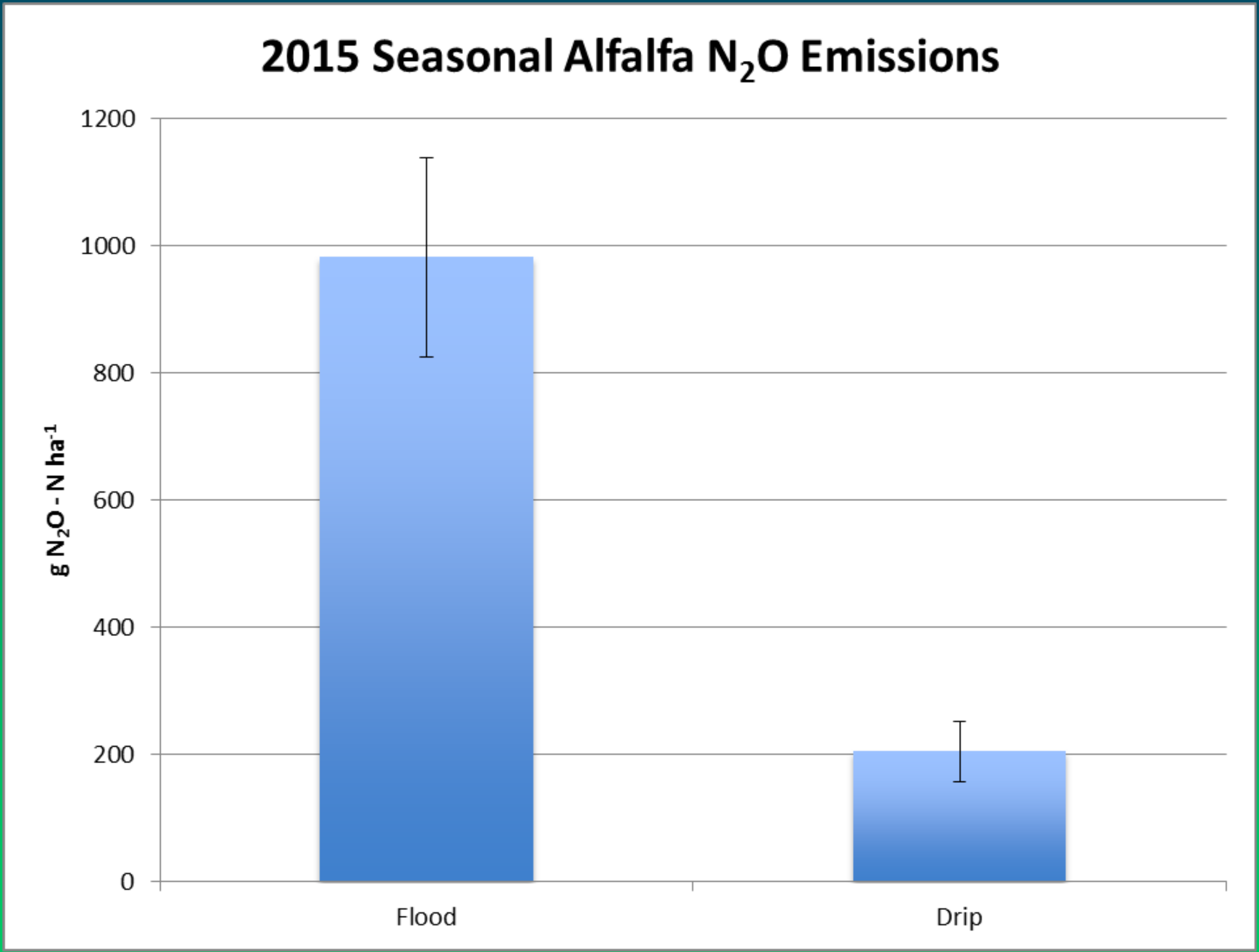
Alfalfa field in SDI
Imperial Valley-El Centro
ETo
ETa
ET$_o$ or ET$_a$ (mm d^{-1})
14
12
10
8
6
4
2
0
6-Apr-15
6-May-15
5-Jun-15
5-Jul-15
4-Aug-15
3-Sep-15
3-Oct-15
2-Nov-15
2-Dec-15

GHG emissions



Data: Ryan Byrnes, Martin Berger, Will Horwath

GHG Emissisons



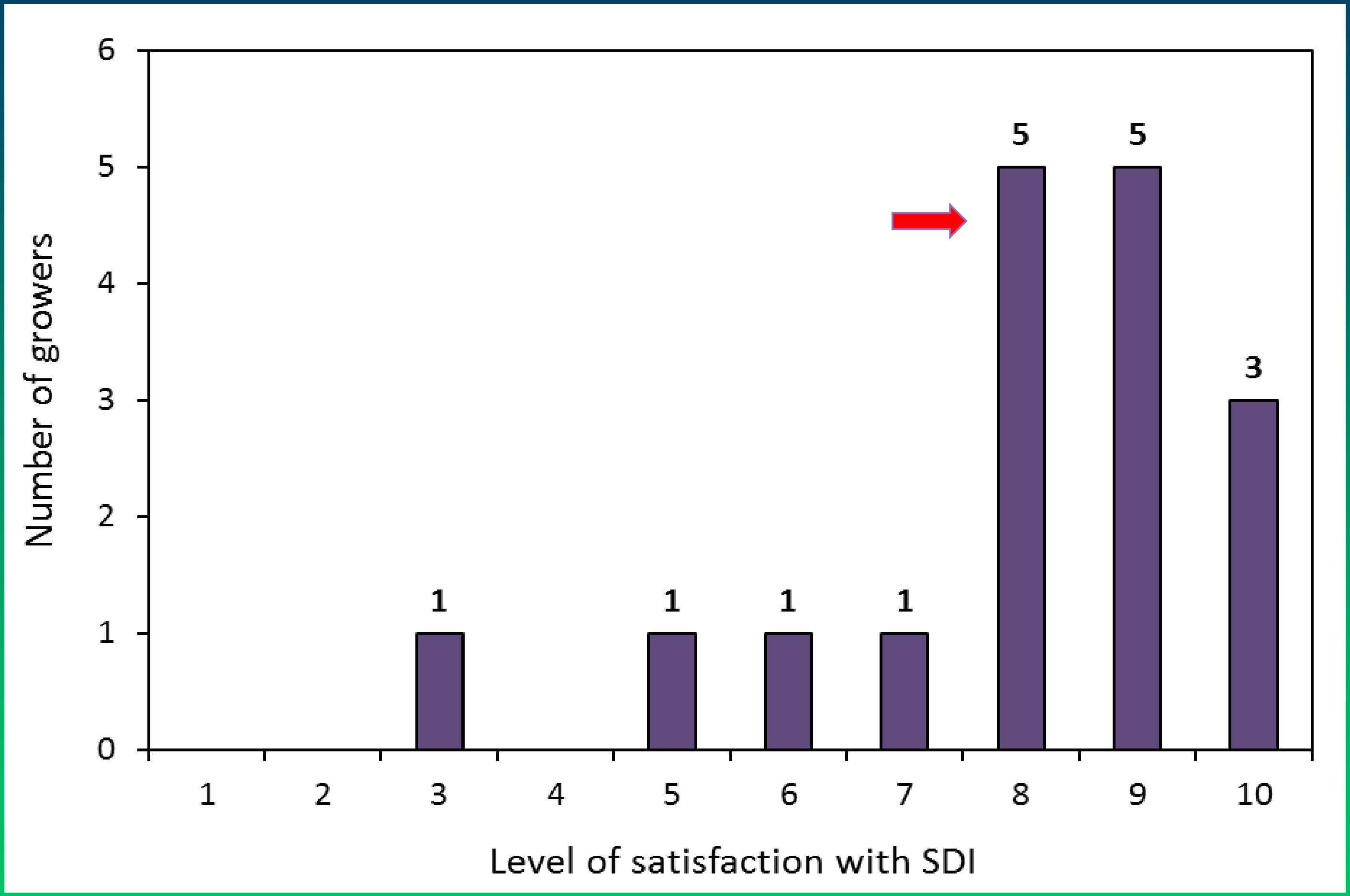
Data: Ryan Byrnes, Martin Berger, Will Horwath

Crop Rotation Considerations

- Rotation with tomato, row crops with alfalfa with drip lines remaining
- Assist in covering costs
- Explore spacing issues (60? 40? 30?)
- Double 30s?
- Different rooting patterns for row crops vs. alfalfa

Labor is perhaps one of the primary limitations of surface irrigation

GROWER ASSESSMENT OF SDI - 2014

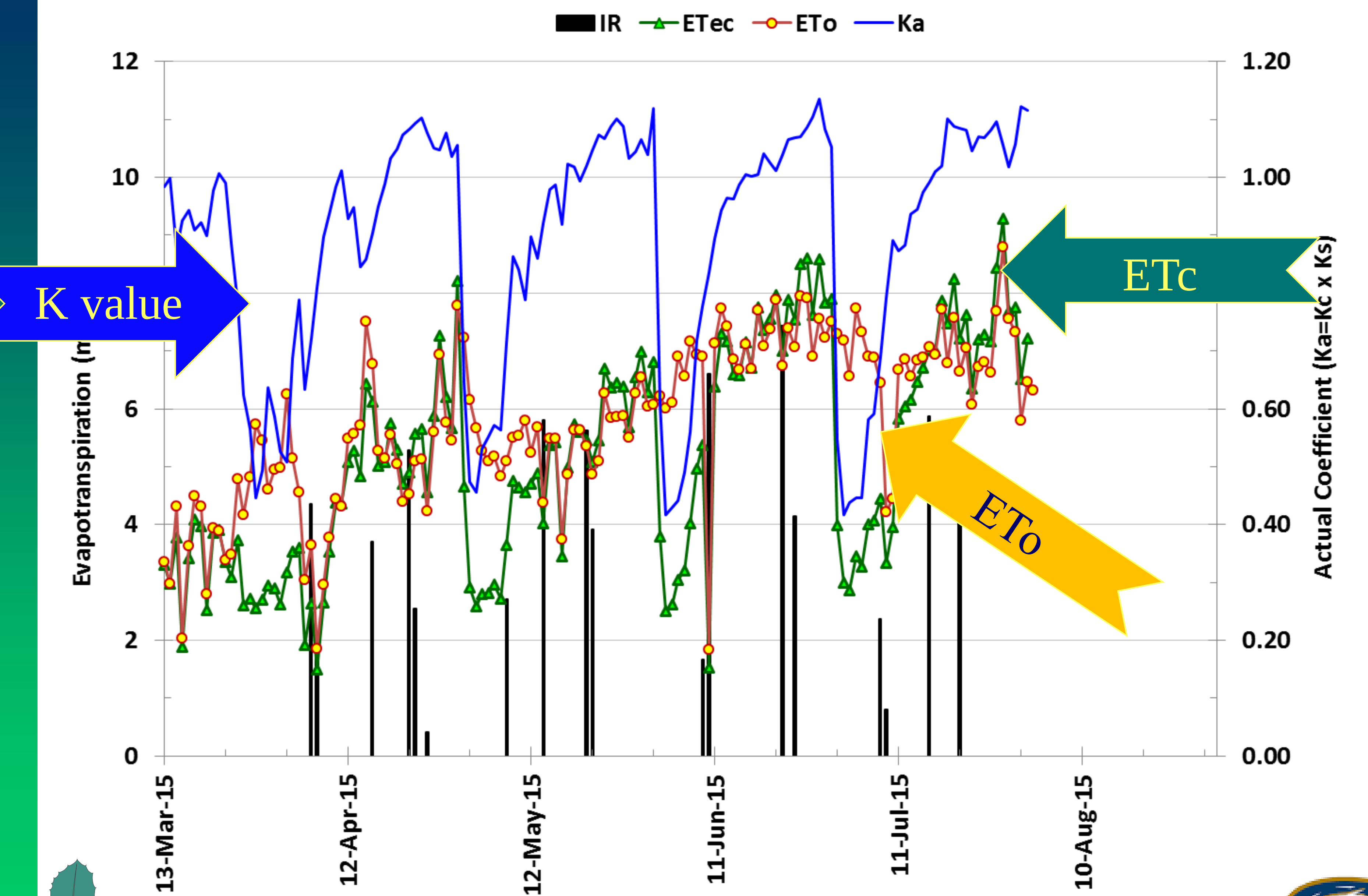


- 82% Of growers (so far) are highly satisfied
- 18% are medium to less satisfied with SDI

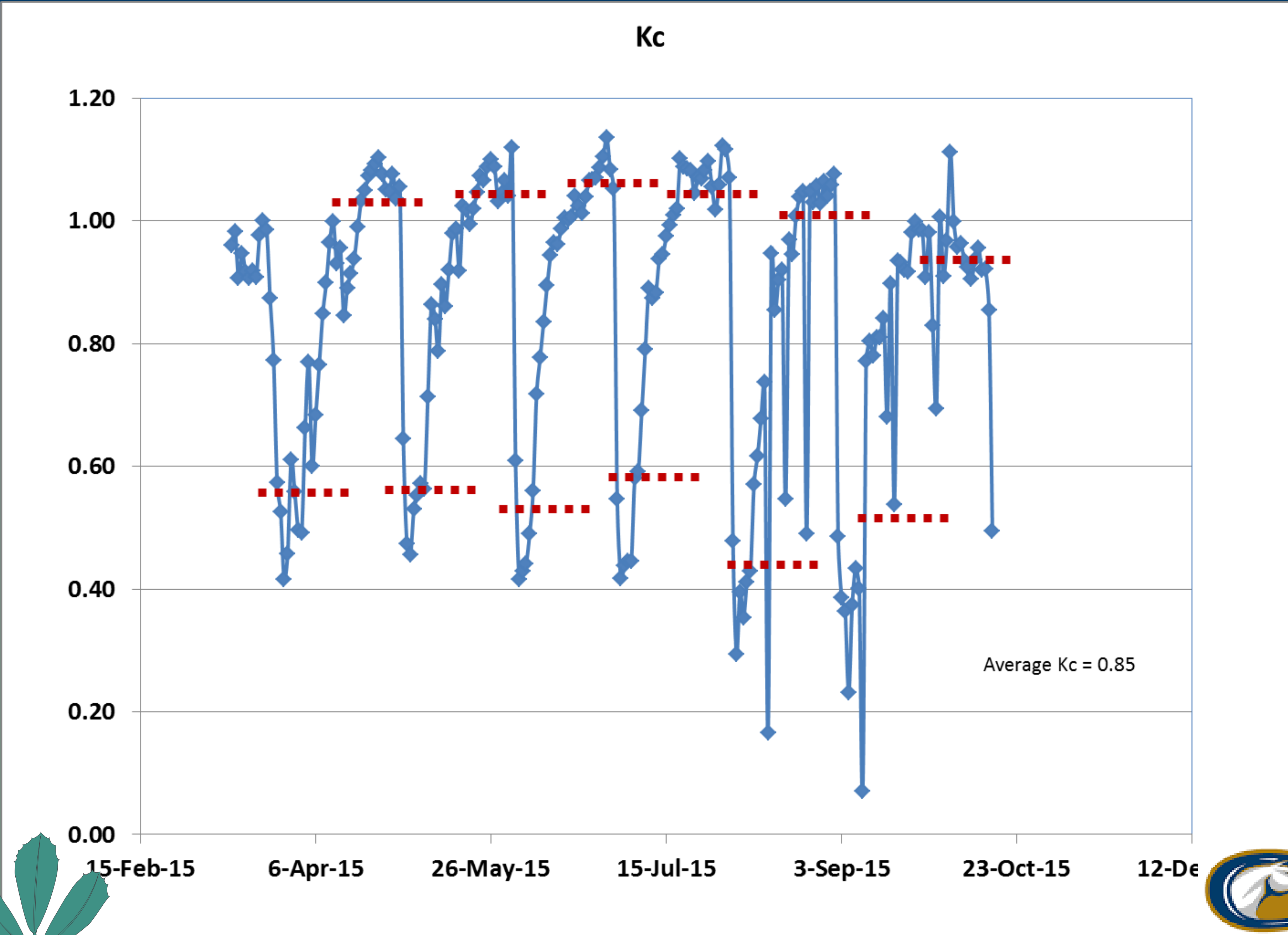

Variety X Water Deficits under drip Irrigation
-El Centro & Davis

What should one do when there's not enough water?

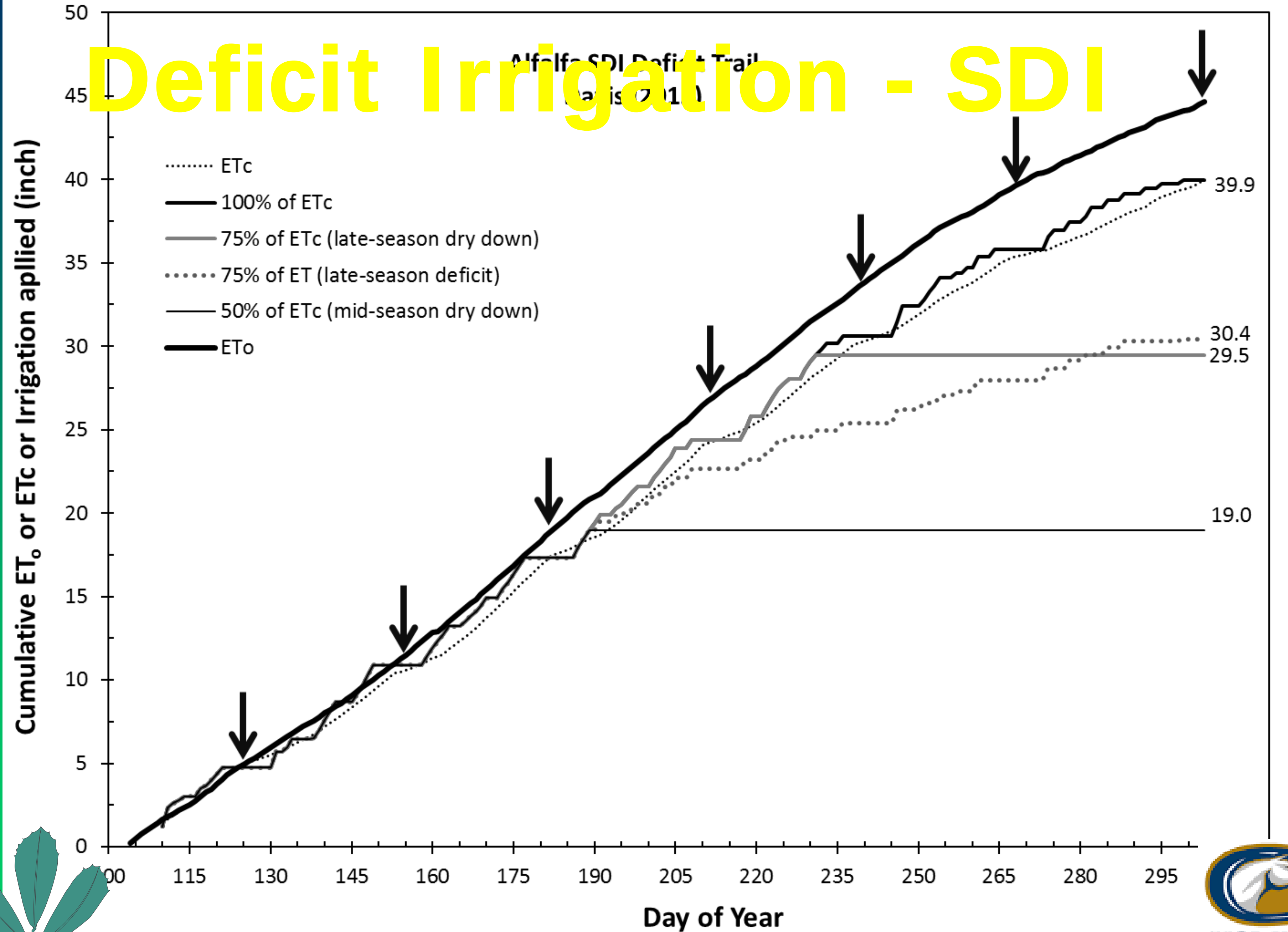
- Curl up in a ball?
- Partial Season irrigations?

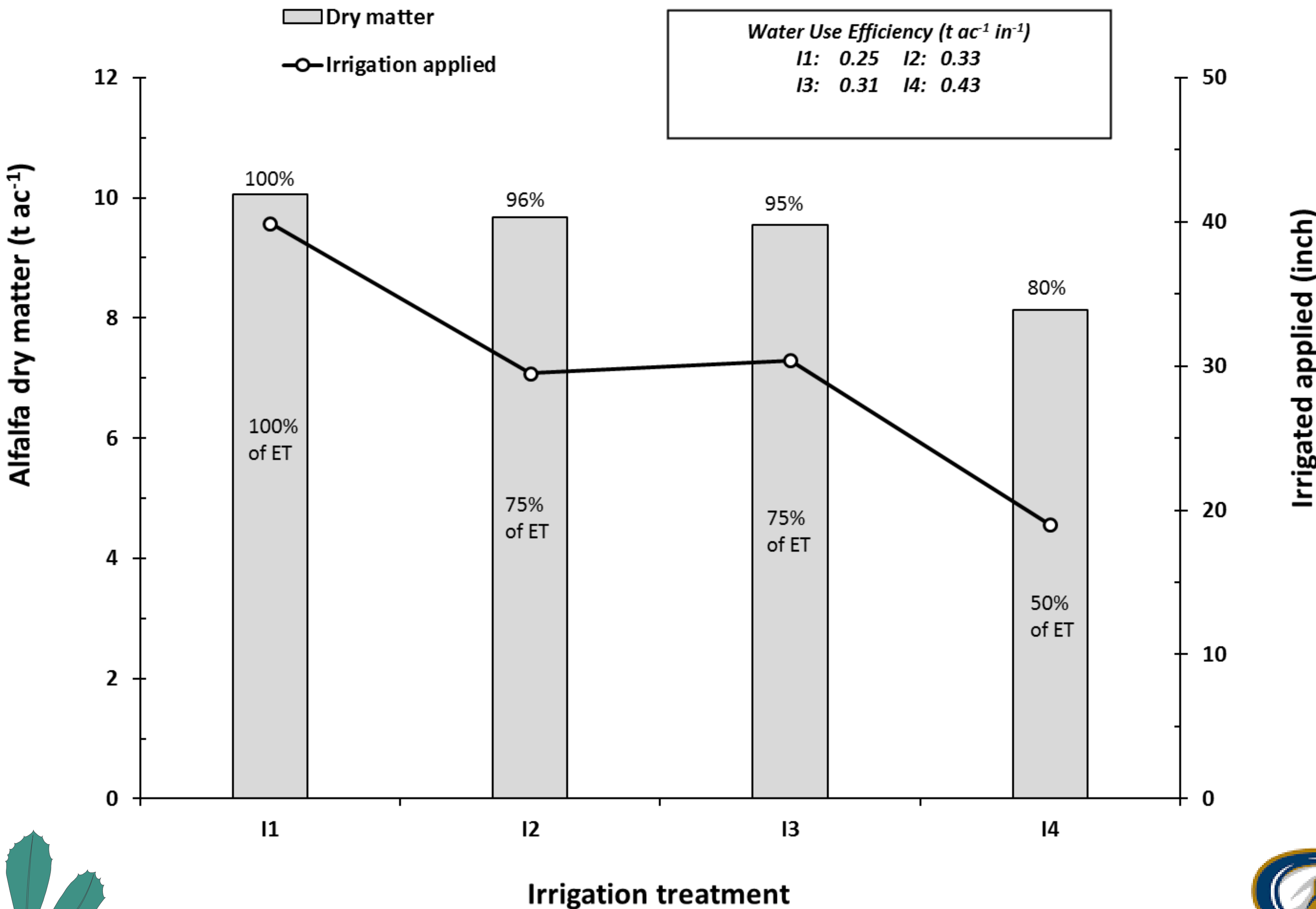


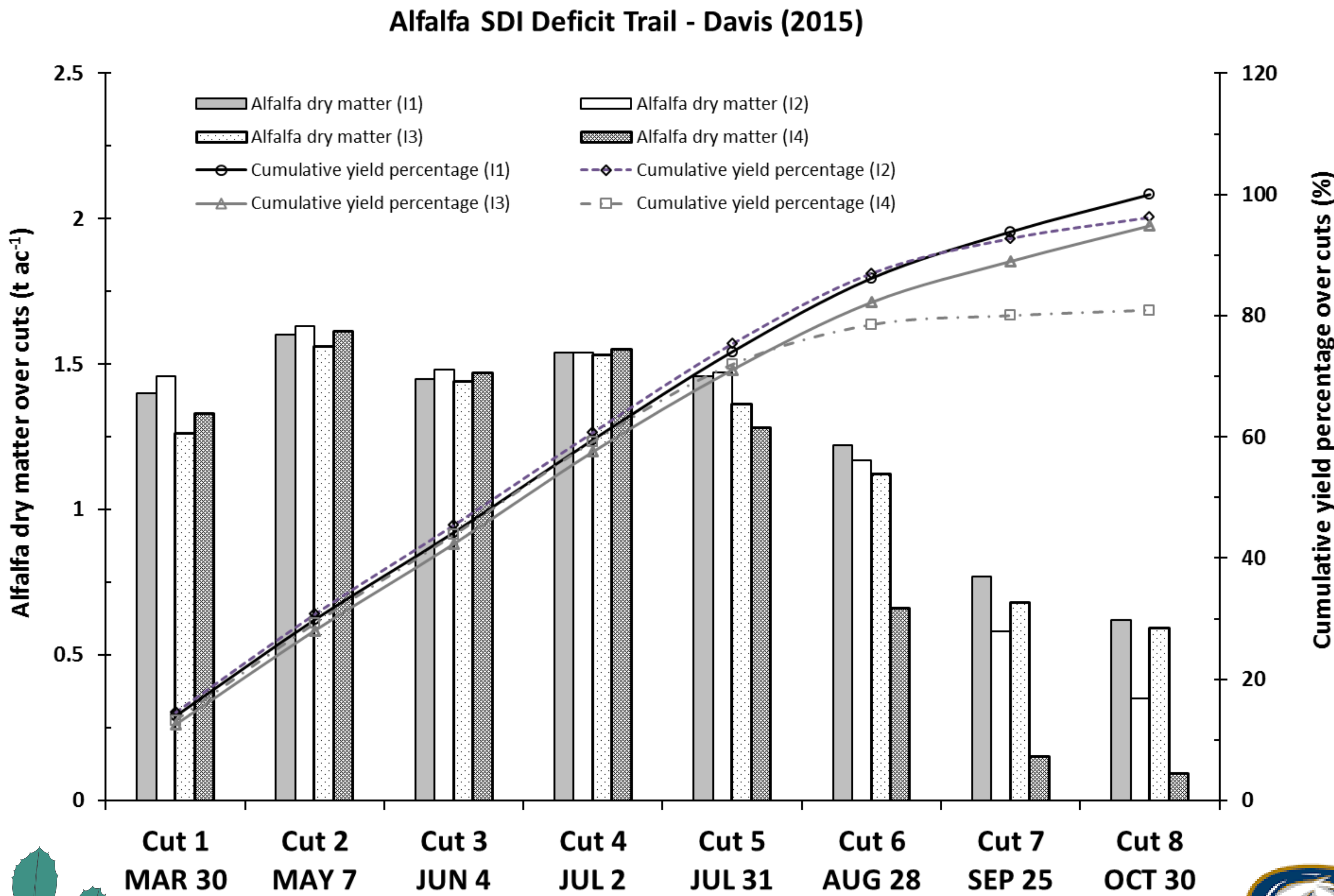
IR
ETec
ETo
Ka
Evapotranspiration (m
Actual Coefficient (Ka=Kc x Ks)
12
10
6
4
2
0
1.20
1.00
0.60
0.40
0.20
0.00
13-Mar-15
12-Apr-15
12-May-15
11-Jun-15
11-Jul-15
10-Aug-15
K value
ETc
ETo


Kc
1.20
1.00
0.80
0.60
0.40
0.20
0.00
15-Feb-15
6-Apr-15
26-May-15
15-Jul-15
3-Sep-15
23-Oct-15
12-De
Average Kc = 0.85

Deficit Irrigation - SDI




Dry matter
Irrigation applied
Water Use Efficiency (t ac-1 in-1)
I1: 0.25 I2: 0.33
I3: 0.31 I4: 0.43
Alfalfa dry matter (t ac-1)
Irrigated applied (inch)
100%
96%
95%
80%
100% of ET
75% of ET
75% of ET
50% of ET
I1
I2
I3
I4
Irrigation treatment
0
2
4
6
8
10
12
0
10
20
30
40
50


Alfalfa SDI Deficit Trail - Davis (2015)
Alfalfa dry matter (I1)
Alfalfa dry matter (I2)
Alfalfa dry matter (I3)
Alfalfa dry matter (I4)
Cumulative yield percentage (I1)
Cumulative yield percentage (I2)
Cumulative yield percentage (I3)
Cumulative yield percentage (I4)
Alfalfa dry matter over cuts (t ac-1)
Cumulative yield percentage over cuts (%)
2.5
2
1.5
1
0.5
0
120
100
80
60
40
20
0
Cut 1 MAR 30
Cut 2 MAY 7
Cut 3 JUN 4
Cut 4 JUL 2
Cut 5 JUL 31
Cut 6 AUG 28
Cut 7 SEP 25
Cut 8 OCT 30

Deficit Irrigations:

- Feasible with all types of irrigation systems
- May be higher yielding with SDI
- Emphasize Early Irrigation to maximize yield and WUE
- Economics must work (economic water transfers)
- Alfalfa is the best crop to have in a drought

UC DAVIS AGGIES

A Balance Sheet

Consideration	SDI	Flood	Notes
Water Use per Acre	(+)	(-)	Generally favors SDI, although will depend upon soil type and efficiency of flood system.
Water Use per unit prod.(ton)	(+)	(-)	Clearly favors SDI given innate advantages in water application.
Energy Use per acre	(-)	(+)	Gravity-fed systems are almost always superior in energy flux per unit area
Energy Use per unit prod. (ton)	(+)	(-)	Improving yield is likely to lower energy use per unit production, depends upon extent
GHG per unit production	(+)	(-)	Not fully known but likely to be lower in SDI, due to higher yields and lower direct emissions
Irrigation Mgt.	(+)	(-)	Clear advantages to SDI, if managed correctly
Refill profile	(-)	(+)	Flood irrigation is likely superior
Germination	(-)	(+)	Sprinklers are preferred, flood works, SDI no
Salinity	(-)	(+)	Salinity may be an issue with SDI-mitigated
Wi[illegible]e	(-)	(+)	Favors flood but can be mitigated

A Balance Sheet

Consideration	SDI	Flood	Notes
Yield	(+)	(-)	Mechanisms for yield increases appear genuine
Stand Longevity	(+)	(-)	Evidence for superior stand longevity
Controlling Fertilizers	(+)	(-)	Delivery directly to root system, prevention of losses (N, P).
Weed Intrusion	(+)	(-)	Evidence for less weed pressure due to dry surfaces and less stand decline
Surface runoff (pesticides etc.)	(+)	(-)	SDI eliminates surface runoff which protects surface water quality
Oxygen to Root system	(+)	(-)	On many heavy soils likely better O2 to roots
Labor	(+)	(-)	Labor savings in SDI irrigations, but greater management for repairs, gophers are needed
Rodent Management	(-)	(+)	Rodents are a problem in all systems, but flood irrigation keeps populations in check.
Flexibility with Deficit Irrigation	(+)	(+)	Both systems can be deficit irrigated. May improve yields under SDI, but higher costs

Summary

- SDI is worth supporting, in my view – a number of public benefits
- Not appropriate for all farms-must have yield potential and higher level of management
- Variation in price is an economic limitation
- Improved yields (9-15 t/a range) 2-3 tons/a improvement in CV and desert regions
- Possibility of improved stand longevity, less weeds, Labor savings
- Water benefits, ability to do deficit irrigation
- Sustained effort required to solve problems:
  - *Rodent management*
  - *Scheduling/spacing*
  - *Water quality*

Questions?

Wagner farm, WA state, photo