Irrigation Technologies

Inge Bisconer
Technical Marketing and Sales Manager
Toro Micro-Irrigation

For the Irrigation Association's Drought Summit
December 9, 2016
Las Vegas, NV

Agenda

1. Introduction
2. Water and Irrigation Technology Stats
3. Benefits of Efficient Irrigation
4. Where to Invest?

Inge Bisconer Background

Inge Bisconer, MBA, CID
Technical Marketing and
Sales Manager,
Toro Micro-Irrigation

- California farm background
- B.S. from UC Davis
- MBA from University of Phoenix
- 35 years in irrigation/water industry
- Past president, California Irrigation Institute
- Past chair, Irrigation Association Drip/Micro CIG
- Member, California Ag Irrigation Association
- Associate Faculty, MiraCosta College
- Author, Toro Micro-Irrigation Owner's Manual
- Presenter, The Grange Network Webinars
- Co-host, The Water Zone radio show
- Recipient of IA's 2016 Industry Achievement Award

TORO

CAIA California Agricultural Irrigation Association

California Irrigation Institute
The oldest independent forum on irrigation and water in California

Grange Network

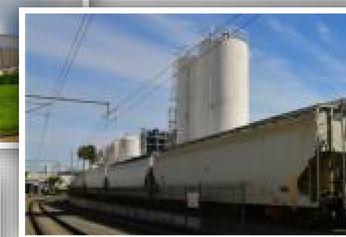
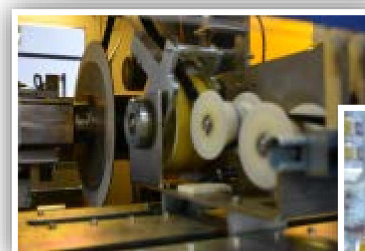
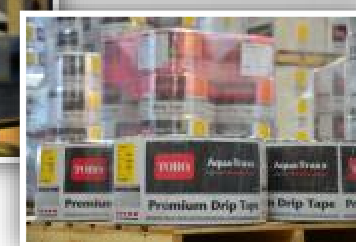
Irrigation Association

2016 Award Winner
Industry Achievement

The Toro Company / Micro-Irrigation Division

Toro Irrigation/Micro-Irrigation

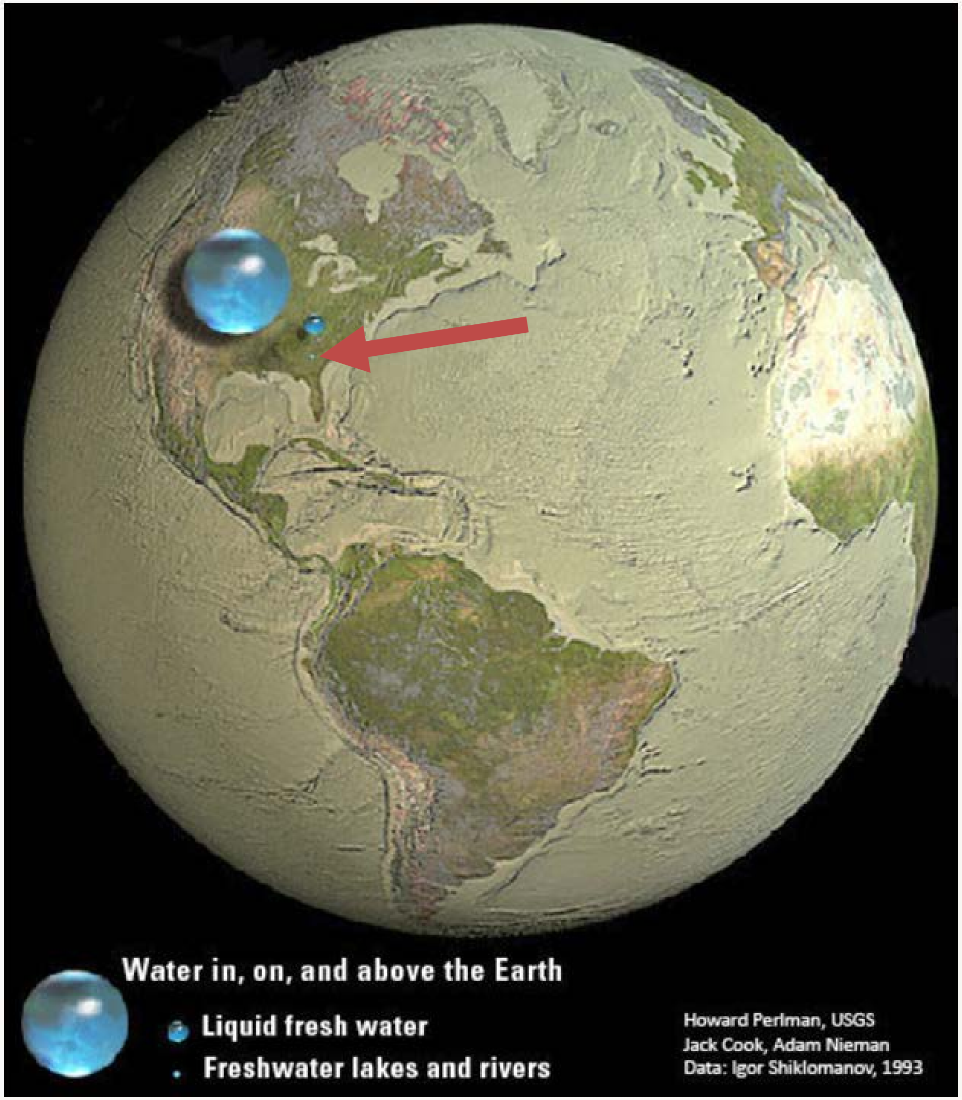
1. Residential/Commercial headquarters in Riverside, CA
2. Agricultural drip headquarters in El Cajon, CA

The Toro Company

1. Founded 102 years ago in July 1914
2. World headquarters in Bloomington, MN
3. NYSE listed, $6.3 billion market cap
4. 17 locations worldwide, active in 80 countries


Relative Amount of Freshwater on Earth



http://12.000.scripts.mit.edu/mission2017/irrigation/

TORO

Where is Earth's Water?

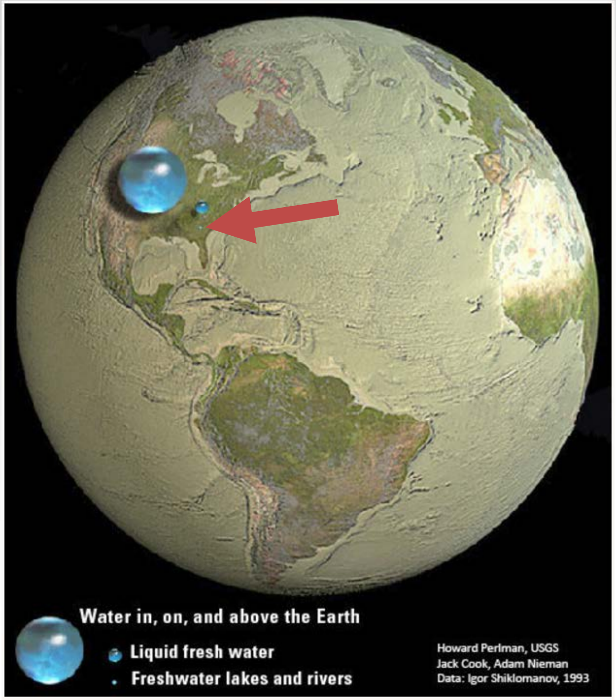


Figure 1: Relative amount of freshwater on the Earth [45]

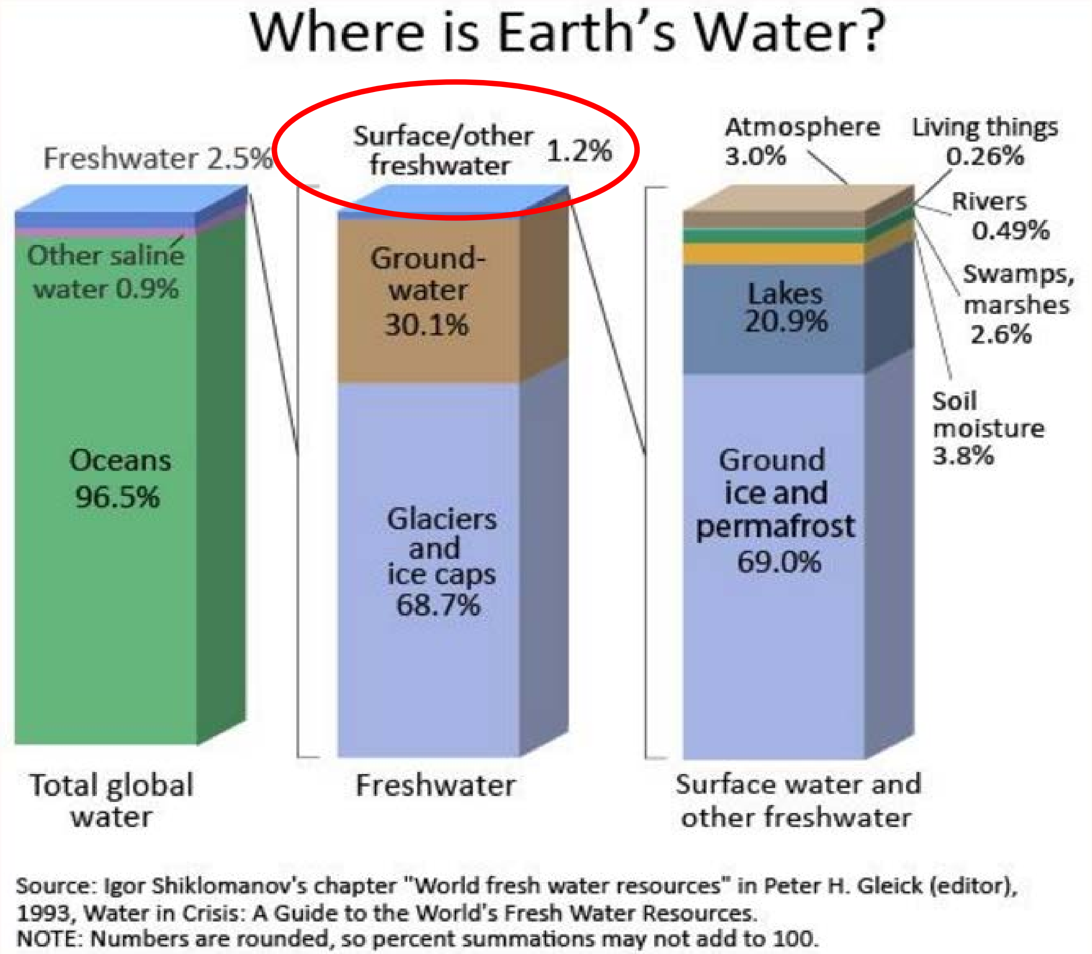


Figure 3: Breakdown of earth's freshwater reserves [6]

http://www.watereducation.org/general-information/earths-water-supply

TORO

Global Freshwater Withdrawals and Irrigation Methods

Flood ~60%

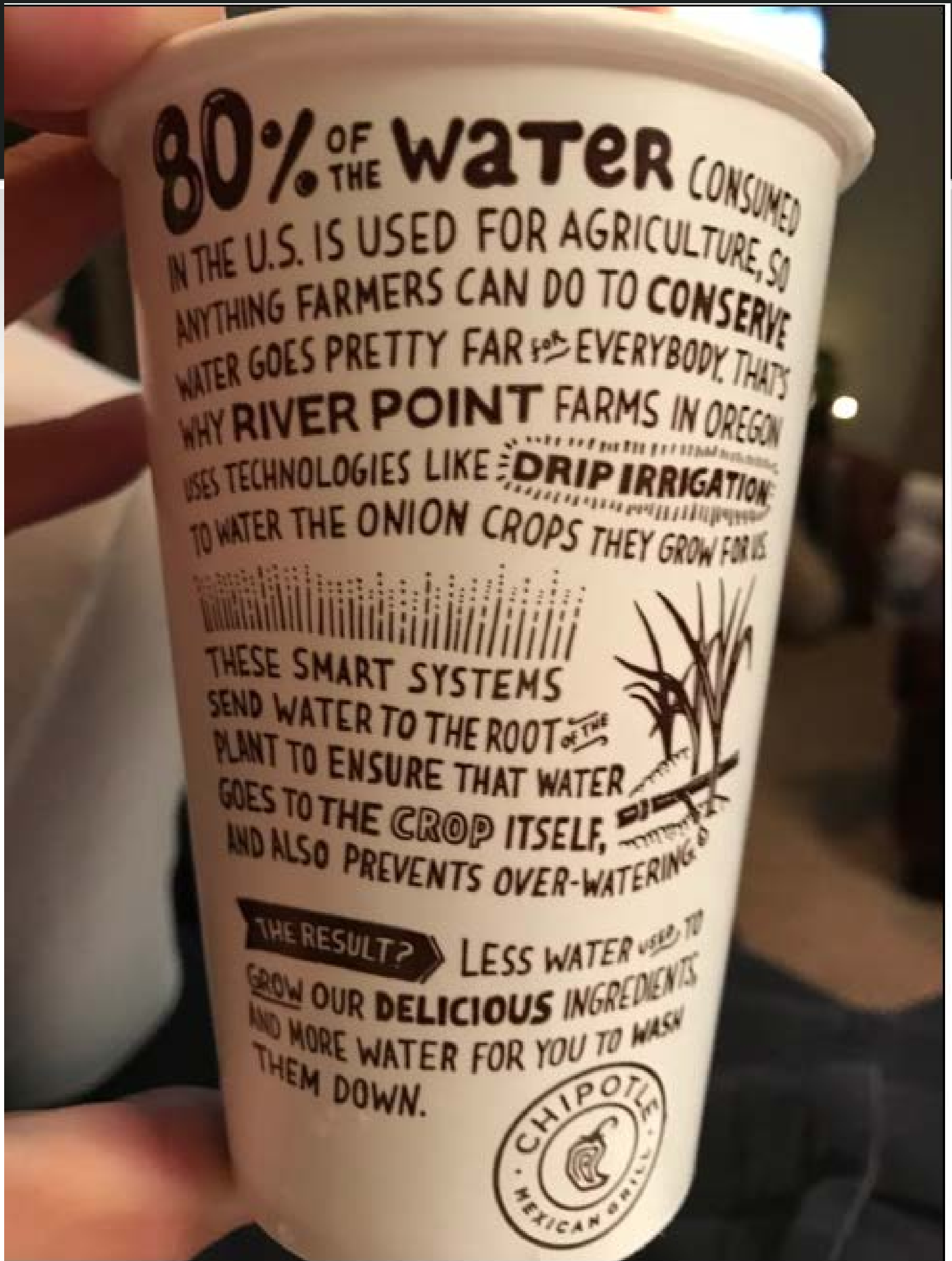
Sprinkler ~30%

Drip/Micro < 10%

TORO

Chipotle

"80% of the Water Consumed in the U.S. is used for Agriculture…"



TORO

DWR: Where Does California's Water Go?

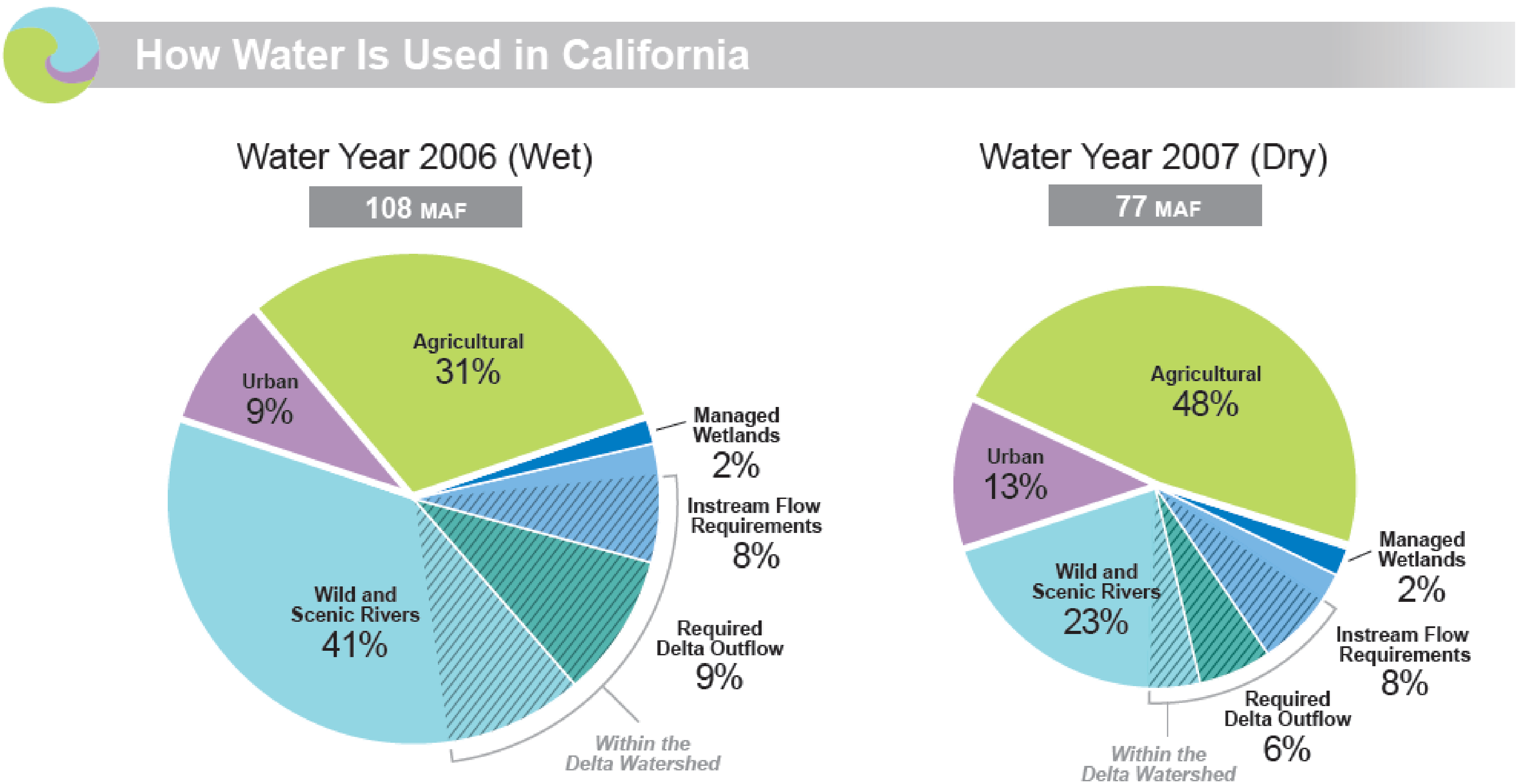
Source: The Delta Plan, Figure 3-1

https://mavensnotebook.com/the-notebook-file-cabinet/californias-water-systems/

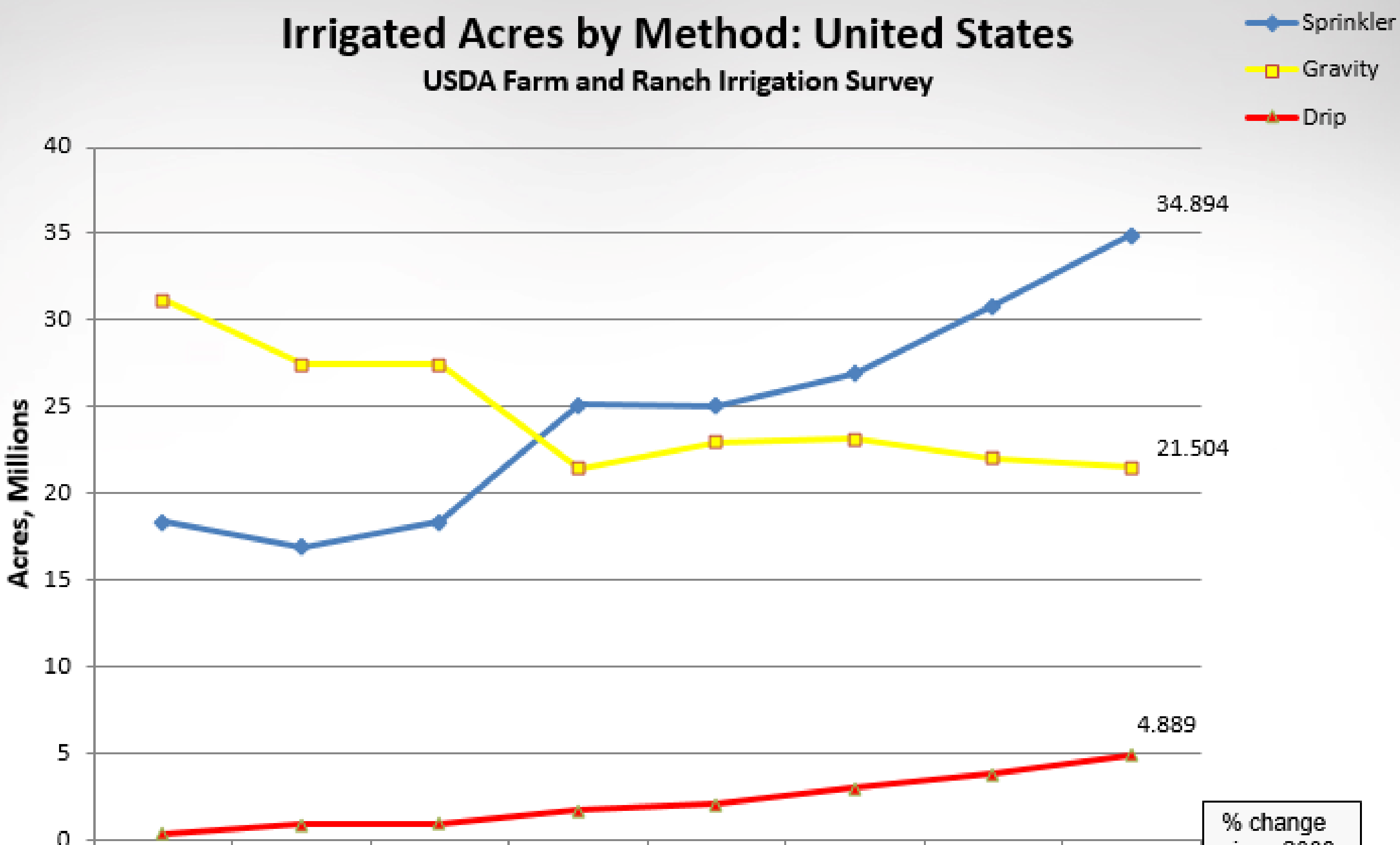
Source: Adapted from DWR 2009, USGS 2010 Delta Plan, 2013, Figure 3-1, Chapter 3, Page 67

TORO.

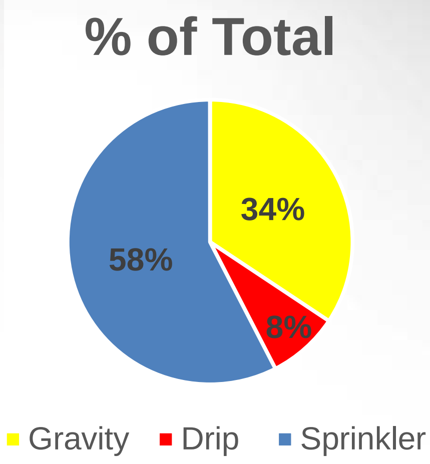
DWR: How is California's water used?



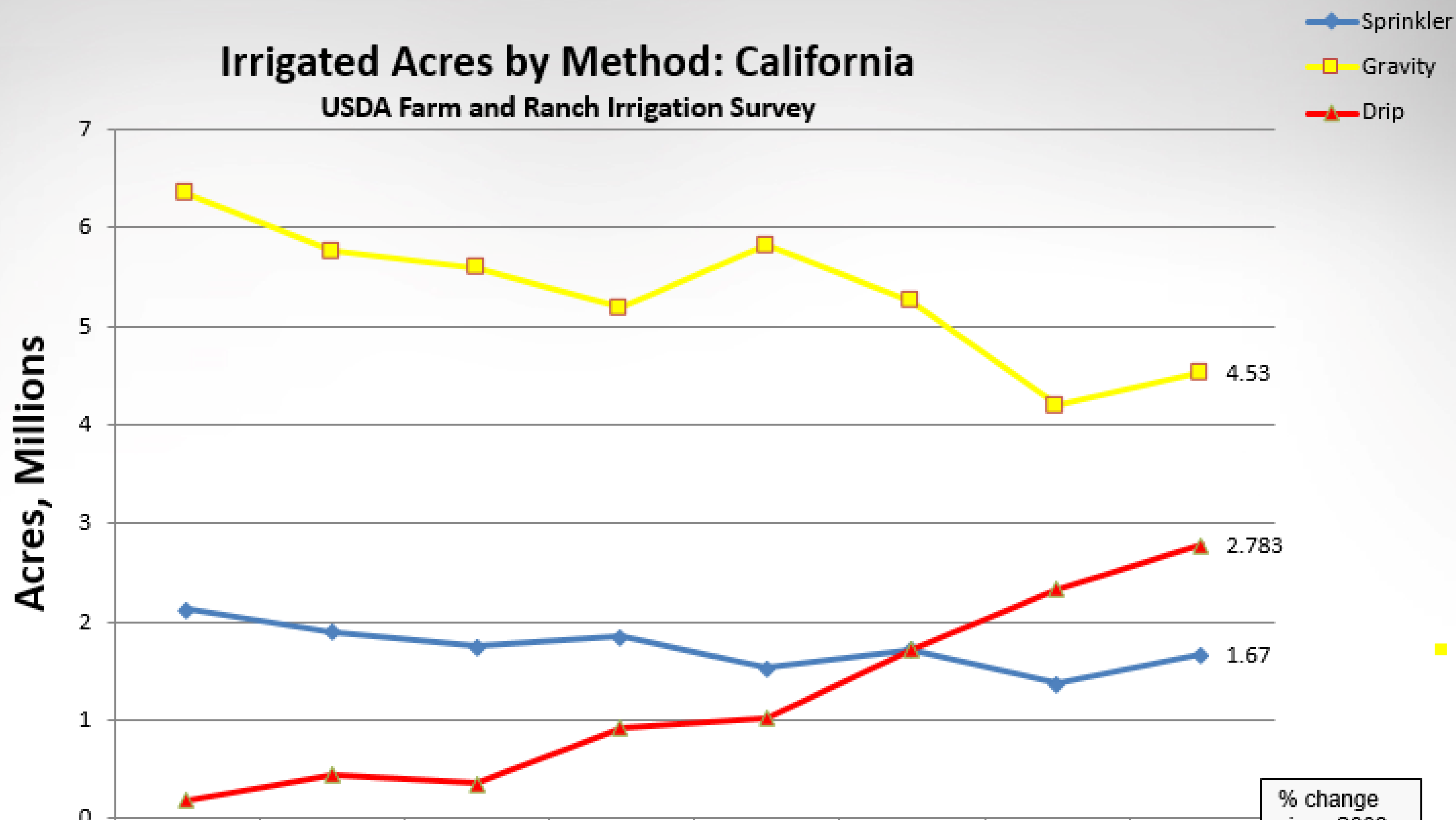
US Method of Irrigation – 1978 to 2013



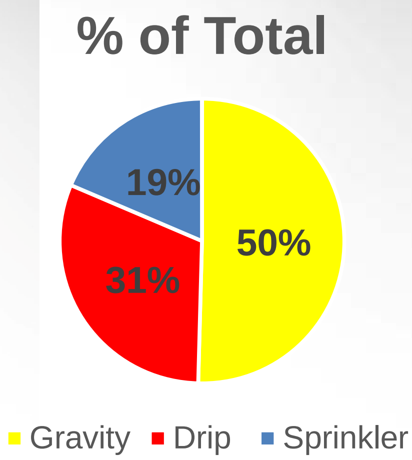
	1978	1984	1988	1994	1998	2003	2008	2013	% change since 2008
Sprinkler	18.38	16.877	18.423	25.087	25.081	26.889	30.877	34.894	-2%
Gravity	31.21	27.457	27.414	21.456	22.963	23.106	22.018	21.504	13%
Drip	0.321	0.837	0.867	1.751	2.101	2.963	3.756	4.889	30%
Total	49.911	45.171	46.704	48.294	50.145	52.958	56.651	61.287	



CA Method of Irrigation – 1978 to 2013

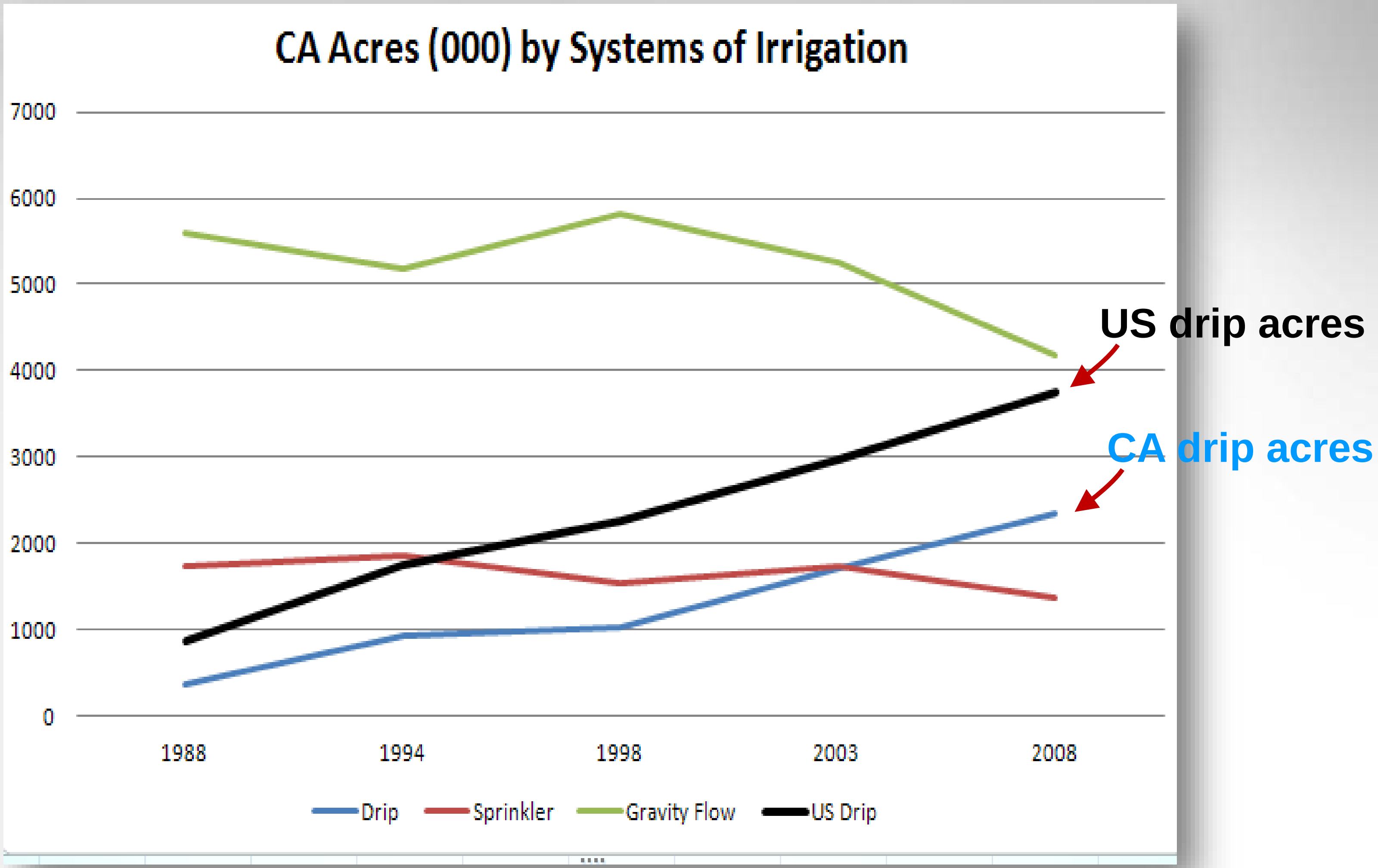


	1978	1984	1988	1994	1998	2003	2008	2013	% change since 2008
Sprinkler	2.14	1.9	1.75	1.85	1.53	1.72	1.37	1.67	22%
Gravity	6.35	5.77	5.59	5.19	5.82	5.26	4.19	4.53	8%
Drip	0.19	0.45	0.36	0.93	1.02	1.72	2.34	2.783	19%
Total	8.68	8.12	7.7	7.97	8.37	8.7	7.9	8.983	



US Method of Irrigation -1988 to 2008

Based on 2008 Farm and Ranch Irrigation Survey (FRIS).



Presented by Dave DeWalt, NASS, at 2014 CII.

Ag Irrigation Technologies: Drip, Flood and Sprinkler

TORO

Other Ag Irrigation Technologies

- Sensing (moisture, weather, solar radiation, temperature, flows, and pressures etc.)
- Automation (in field and off farm)
- Big data (internet of things, NASA, etc.)
- Wireless communication in the field (valves, filters, web or app based information or controls etc.
- UAV and drone usage (aerial imagery)

Water Use Efficiency, WUE

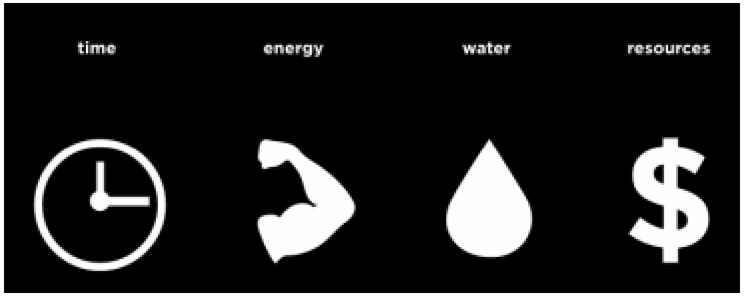
Water Use Efficiency = Yield / Water Input

WUE =

Resource Use Efficiency, RUE

Resource Use Efficiency = Yield / All Farm Inputs

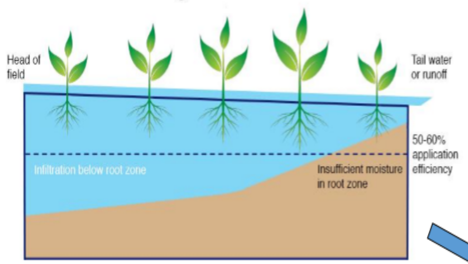
RUE =



Flood Irrigation: Uniformity Improvements

Rubicon Farm Connect

Traditional flood irrigation



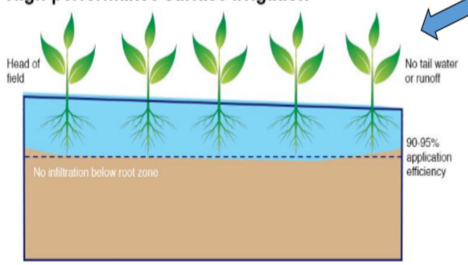
Modernised supply infrastructure
- On demand service, consistent delivery, high flow rates with larger channels and outlets

Science & Modelling
- Determine time to cut-off, adaptive modelling and reduction of waterlogging

Engineering & Technology
- Automation, sensors, software, communication and hardware

Agronomy & Management
- Determination of crop water demand and quantitative irrigation scheduling

High-performance surface irrigation



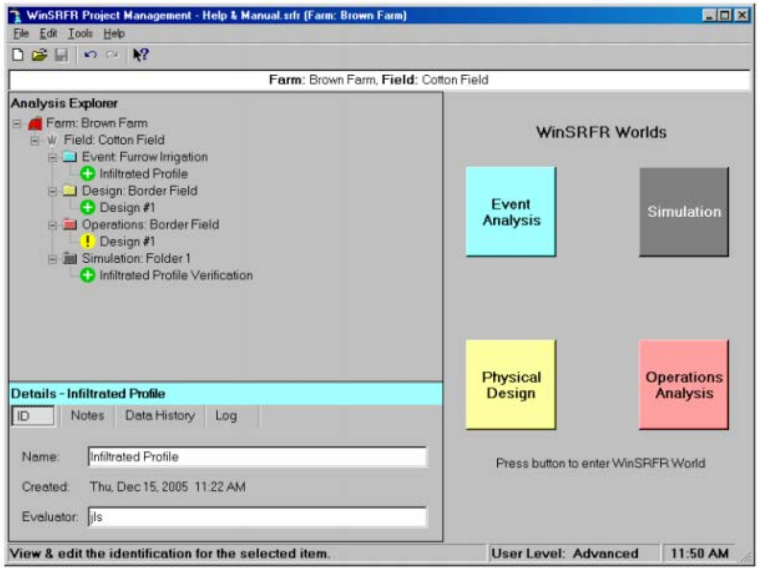
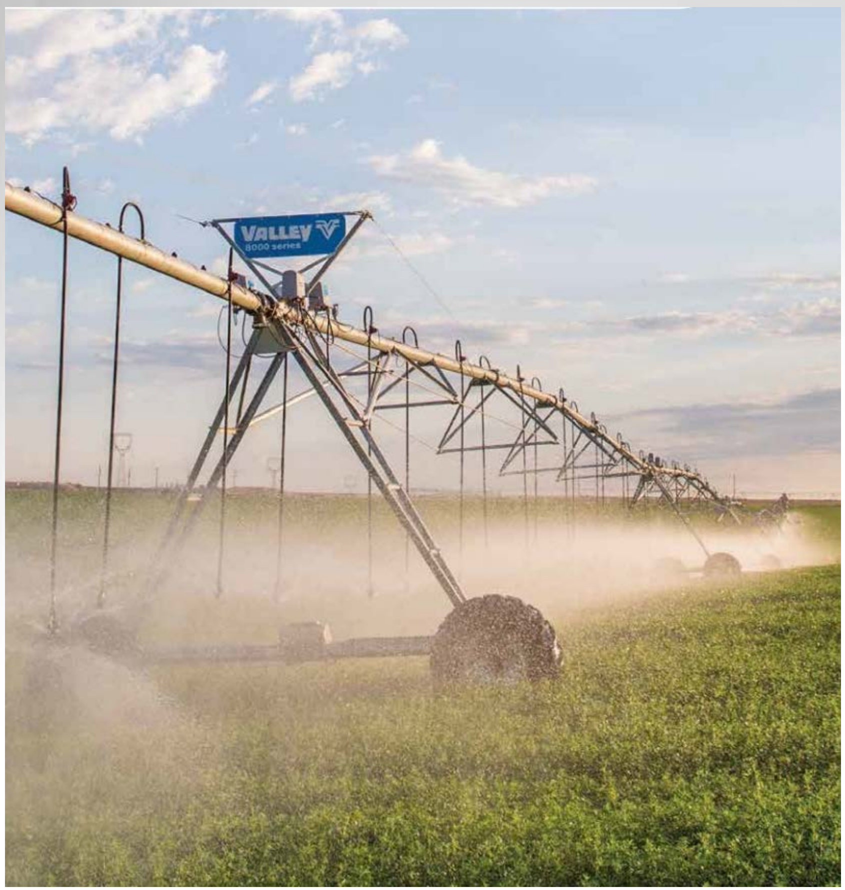


Figure 1.1 - WinSRFR Project Management Window

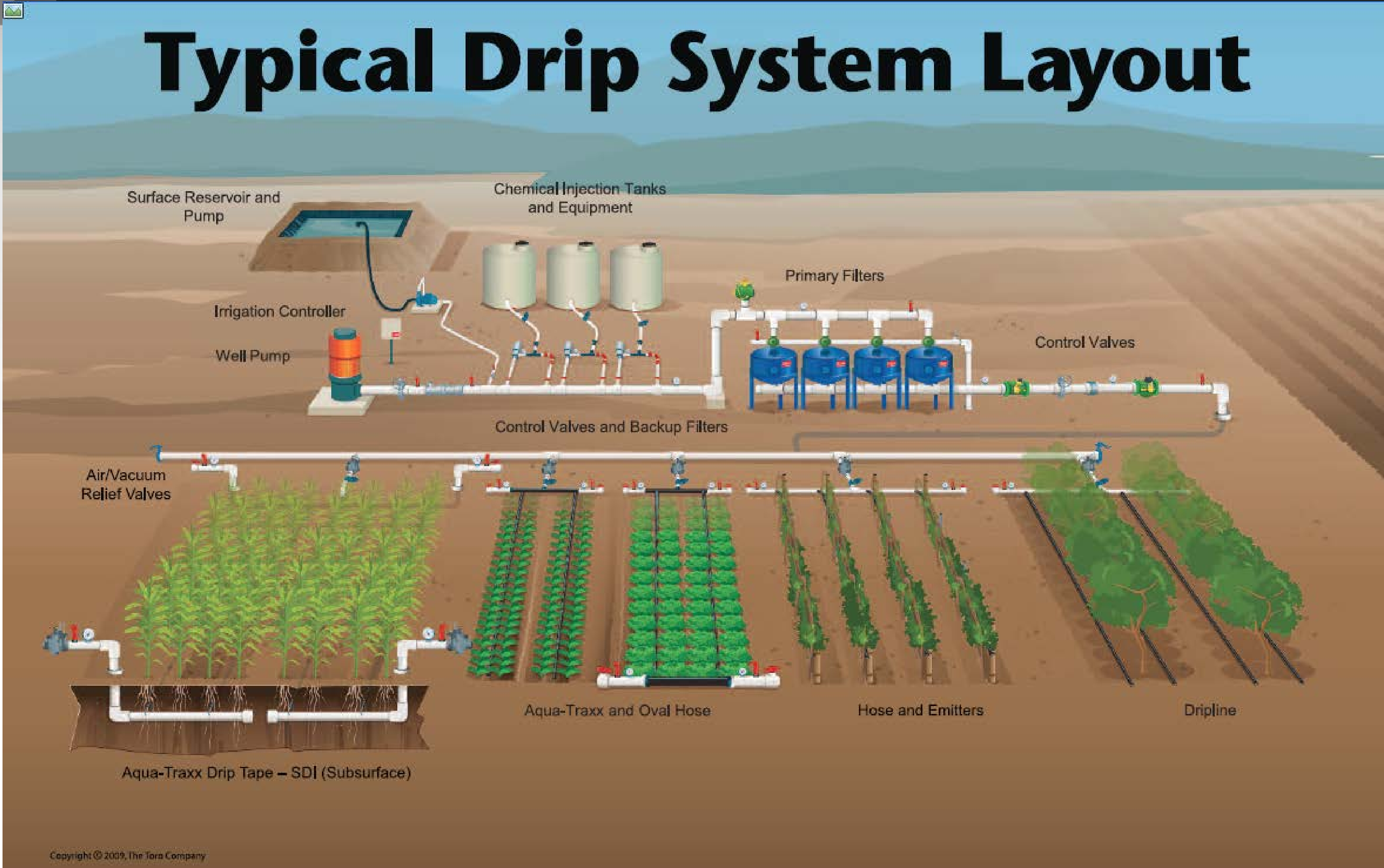
Center Pivot Irrigation: Uniformity Improvements



University of California Cooperative Extension Specialist Jeff Mitchell is leading a study of overhead irrigation systems to see how the technology will work in various crops grown in in the Golden State. Results are mostly encouraging for many of the crops studied

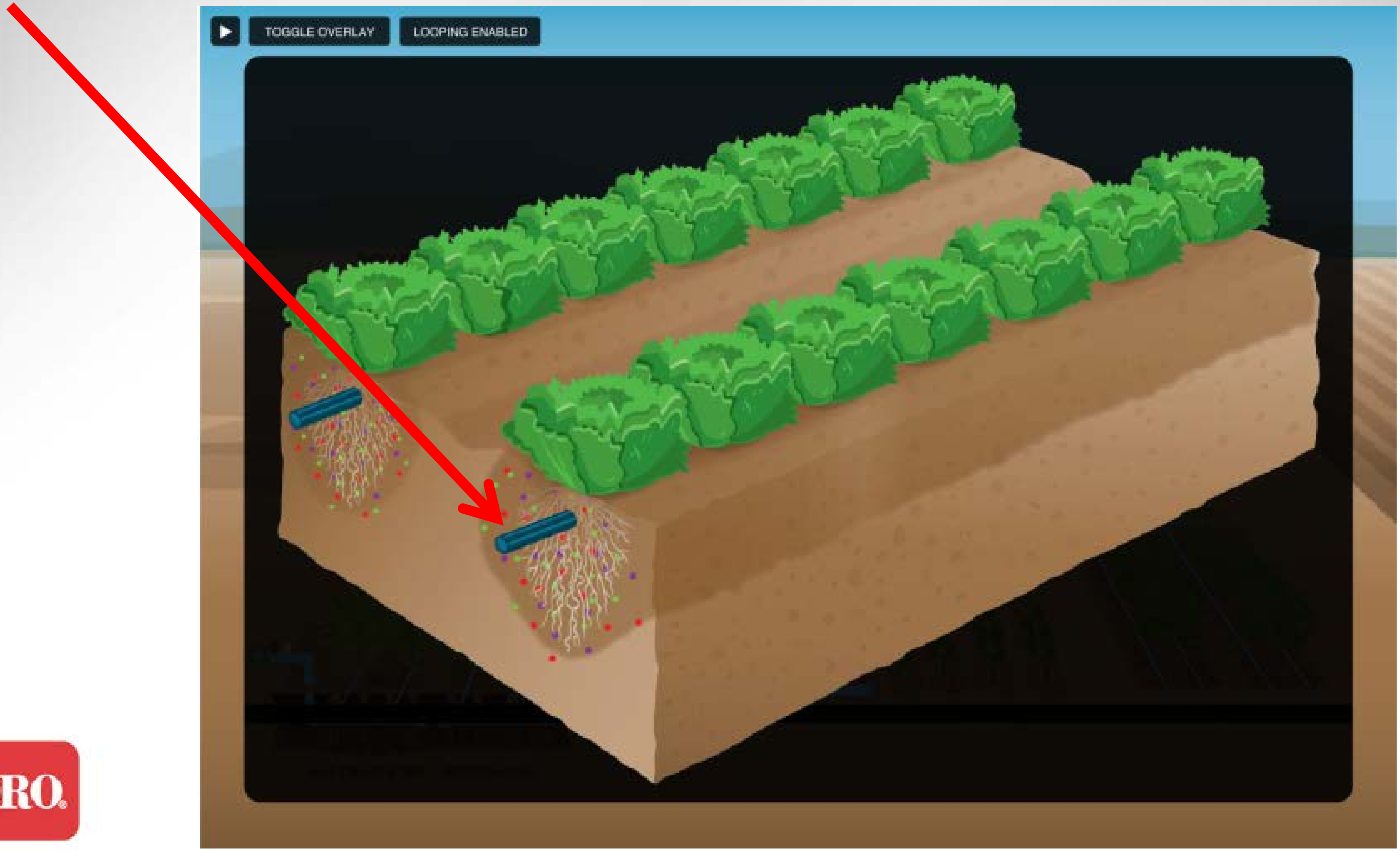
TORO

http://www.toro.com/en-us/Agriculture/Pages/drip-irrigation-education/drip-system-layout.aspx



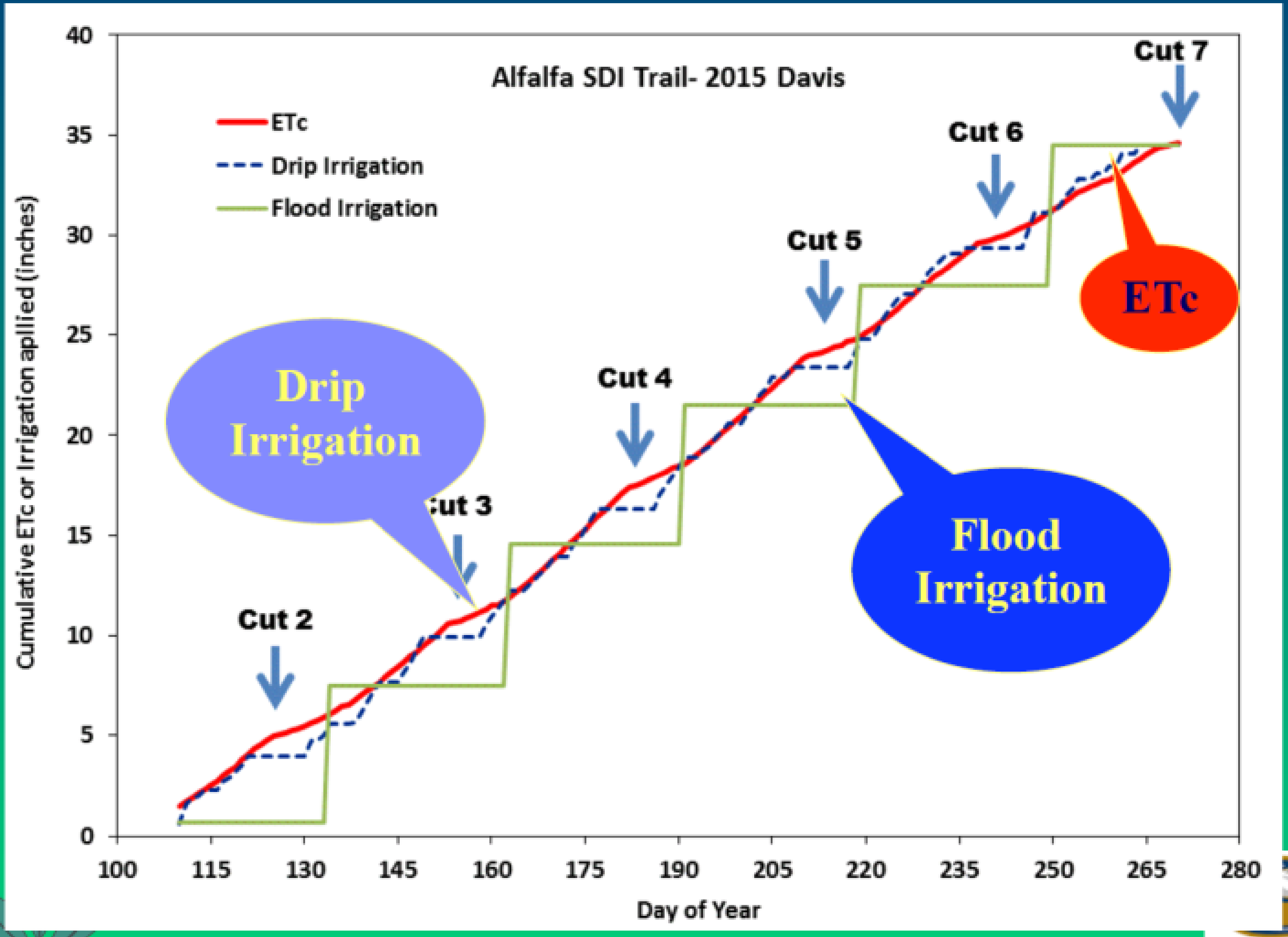
Irrigation Uniformity – Why is it important?

It keeps water and nutrients in the root zone where you want them



Drip can target water uniformly over space….

….AND time.



2015 Western Alfalfa & Forage Symposium

TORO

UC DAVIS AGGIES

Drip Case Study: San Luis Canal Company Conservation Program ($500/Ac self funded)

YIELDS

Crop	Furrow	Drip
Cotton	3.2 bales/ac	3.7 bales/ac
Tomatoes	35 tons/ac	60 tons/ac

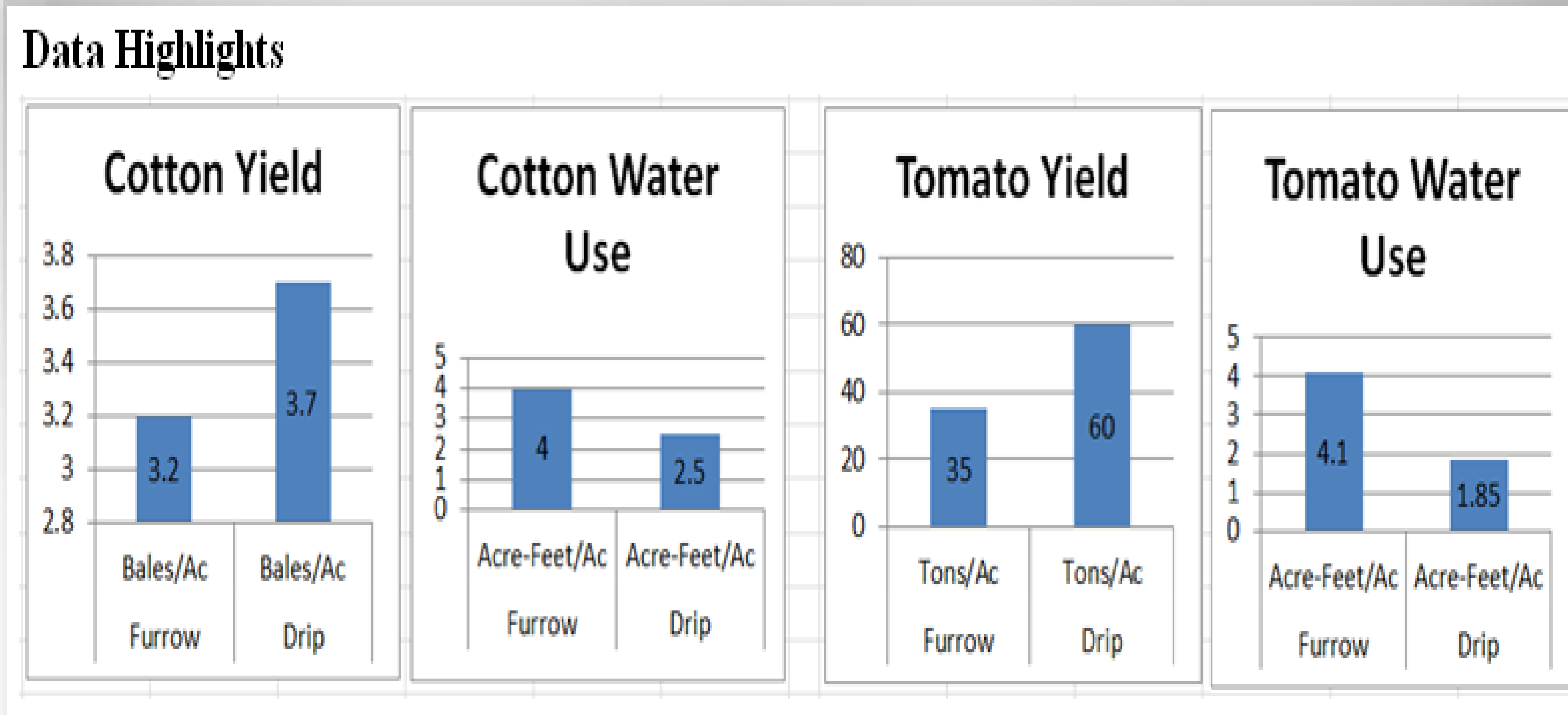
WATER USAGE

Cotton	4.0 af/ac	1.90 af/ac
Tomatoes	5.2 af/ac	1.85 af/ac

TORO®

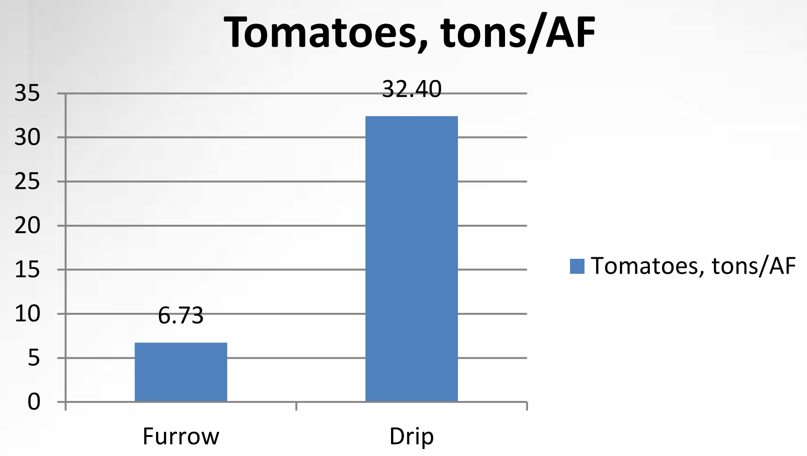
Presented 2/5/2013 at CII by Chase Hurley, G.M. of SLCC – caii.org

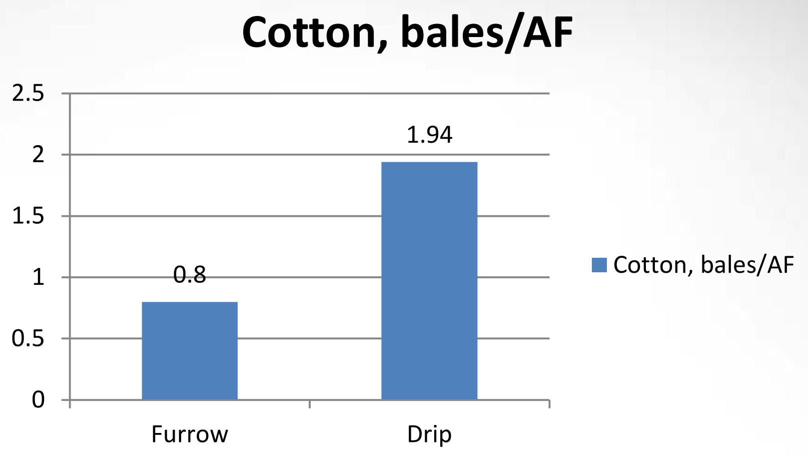
San Luis Canal Company: Average results over 15,000 acres



Source: Chase Hurley, General Manager, San Luis Canal Company

Another way of looking at the data….WUE





New University of California Cooperative Extension (UCCE) Report

Contribution of University of California Cooperative Extension to Drip Irrigation

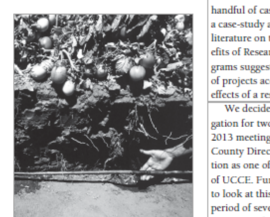
Rebecca Taylor, Doug Parker, and David Zilberman

- The sum of the value of water saving and the additional income from the yield effect lies between $313 million and $1.13 billion, with an average of $748 million.
- Accrediting UCCE one fourth of this value means that UCCE's work in drip irrigation brings the state between $78 million and $283 million annually.
- Considering the entire UCCE budget in 2010 was $99 million, this is a remarkable return on investment

Contribution of University of California Cooperative Extension to Drip Irrigation

Rebecca Taylor, Doug Parker, and David Zilberman

In the 100th anniversary year of University of California Cooperative Extension (UCCE), this study examines the role UCCE has played in the evolution and adoption of one noteworthy technology in California agriculture—drip irrigation. With UCCE personnel responsible for both introducing and continually adapting drip irrigation to numerous California crops and locations, we estimate the value of UCCE's work in drip irrigation brings the state $78 to $283 million annually in water savings and yield increases.



Soil cut away to expose a buried drip irrigation line in a tomato field.

Photo courtesy of Pete Mortimer, USDA ARS

The Cooperative Extension of the University of California (referred to as UCCE) is celebrating its 100th anniversary this year. UCCE is part of the Division of Agricultural and Natural Resources and comprised of 200 locally based farm advisors, 130 campus-based Extension specialists, 57 county offices throughout the state, and nine Research and Extension Centers. While UCCE's specific goals, methods, and name have changed over the last century, its basic vision has endured: "practical education for the people can lead to a better society for all."

In honor of 100 years of UCCE, we embarked on a study to assess the impact of Cooperative Extension in California, focusing on a handful of case studies. We chose a case-study approach because the literature on the distribution of benefits of Research and Extension Programs suggests that a small number of projects account for most of the effects of a research program.

We decided to start with drip irrigation for two reasons: At their fall 2013 meeting, an informal survey of County Directors identified drip irrigation as one of the major success stories of UCCE. Furthermore, it is timely to look at this technology during this period of severe drought in California. Moreover, the history of drip irrigation in California showcases the many roles UCCE plays: identifying, testing and disseminating new technologies, reducing adoption risk, training technology users, and continually collaborating with various clientele.

Drip Irrigation in California

Drip irrigation (and related low-volume irrigation technologies like trickle) requires investment in equipment that increases water-use efficiency (amount of water actually consumed by the crop), and improves the precision of water delivery in terms of the timing and location of irrigation. Its higher water-use efficiency tends to increase yields and frequently saves water used per acre. In choosing drip technology, farmers trade off higher equipment cost for better performance. The impact of drip technologies varies across locations and crops—for example, providing higher gains in sandy areas or on steep hills.

Drip was introduced to California agriculture in 1969, but its take-off was slow. By 1988, only 5% of irrigated acres in California were using drip irrigation, as switching to drip irrigation seemed costly and risky. From the beginning, UCCE farm advisors, specialists, and economists worked to provide information to improve these tough irrigation choices. UCCE initiated field experiments across the state and in numerous crops and raised awareness through research reports, demonstrations, and meetings.

UCCE efforts complemented that of drip manufacturers and distributors, with the private sector handling technical concerns and UCCE identifying how drip irrigation can improve economic and agronomic performance. Drip irrigation has since been widely adopted in the last 25 years, with almost 40% of the irrigated cropland in California now using drip. Below, we detail the different stages of its adoption.

Development, Introduction, and Early Adoption: 1965–1975

Israel introduced modern drip irrigation in 1965. Don Gustafson, a

IA: Incentives for Efficient Irrigation Products and Services

Irrigation Products and Services:

- Increase agricultural yields per unit of input
- Preserve and protect ecosystems
- Enhance the quality of life for citizens through the enhancement and preservation of our nation's landscape systems

The IA supports the development and promotion of environmentally responsible economic and regulatory incentives for:

- Installation of efficient irrigation products and systems
- Retrofits of existing irrigation systems with water-efficient technologies
- Design and maintenance practices that foster and support efficient irrigation


Incentives for Efficient Irrigation Products and Services

The irrigation industry provides a broad range of products and services that enable the efficient use and reuse of water in production agriculture and landscape management.

Irrigation products and services:

- Increase agricultural yields per unit of input
- Preserve and Protect ecosystems
- Enhance quality of life for citizens through the enhancement and preservation of our nation's landscape systems

Fostering the adoption of efficient irrigation technologies and practices is an effective way to improve overall water-use efficiency and water quality, while sustaining these resources for future generations.
Public policy can and does accelerate the adoption of products and services through incentives, including cost sharing, regulatory relief, tax credits, rebates and technical assistance. Examples of successful incentives include the Environmental Quality Incentives Program for agriculture and a wide range of local programs that encourage adoption of efficient irrigation technologies and practices for landscape applications.
The Irrigation Association supports the development and promotion of environmentally responsible economic and regulatory incentives for:

- Installation of efficient irrigation products and systems.
- Retrofits of existing irrigation systems with water-efficient technologies.
- Design and maintenance practices that foster and support efficient irrigation.

Adopted by the IA Board of Directors, July 2011.

Adopted by the IA Board of Directors, July 2011

Where should we spend our incentive dollars?

Cash for Grass?

~ $500,000,000 last year in CA?

OR

Modernizing Ag?

~ $60 million made available last year in CA SWEEP since 2014

TORO

Where should we spend our incentive dollars?

Summary of SWEEP Projects (2014-2016)

Funding Year	2014	2015	2016	Total
Funds Available ($M)	$10	$10	$40*	**$60**
Funds Awarded ($M)	$8.5	$9.4	$16	**$33.9**
Number of Projects	133	99	128	**360**
Total Project Acres	24,000	19,035	27,300	**70,335**
Estimated Annual GHG Reductions (MTCO2E)	51,627	3,068	5,635	**60,330**
Estimated Annual Water Savings (Ac-Ft)	24,529	12,959	22,267	**59,755**

**CDFA anticipates making additional award announcements in fall 2016*

TORO

CA Flood to Drip: Cost/Benefit Analysis

California, 2013 FRIS				
	Sprinkler (pressure) acres	Gravity acres	Drip acres	Total Irrigated Acres
Table 36 data by crop:		Red items have drip opportunity		
Corn for grain or seed	5,340	146,921		152,261
Corn for silage or greenchop	37,526	326,125		363,651
Sorghum for grain or seed	1,755	8,550		10,305
Wheat for grain or seed	121,181	218,007		339,188
Beans, dry edible	16,405	22,450		38,855
Rice		1,051,374		1,051,374
Other small grains	29,285	48,238		77,523
Alfalfa	181,932	482,386		664,318
All other hay	96,984	340,296		437,280
All Cotton	37,371	201,300	36,163	274,834
Vegetable acres	280,298	155,814	581,924	1,018,036
Sweet Corn	110	12,671	15,639	28,420
Tomatoes in the open	24,722	59,991	198,574	283,287
Lettuce and Romaine	74,705	9,370	113,642	197,717
Potatoes	56,873	2610	3618	63,101
All Berries	1040	7	32,396	33,443
Orchards, vineyards, nut trees	289,629	396,150	1,890,822	2,576,601
All other crops	178,064	71,497		249,561
Pastureland	50,264	383,306		433,570
Column Total	**1,483,484**	**3,937,063**	**2,872,778**	**8,293,325**
Method as percent of CA total	1[illegible]%	47%	35%	
Drip Opportunity (red gravity)		**1,467,220**		
US Totals, 2013 FRIS (Table 28 Totals)	34,894,109	21,504,684	4,889,912	55,283,340
Method as percent of US total	63.1%	38.9%	8.8%	
CA as % of US Total	4%	18%	59%	15%

TORO.

Irrigation Methods and Application Uniformity: Drip Micro Payback Wizard Data

IRRIGATION APPLICATION UNIFORMITY COEFFICIENTS:
Averages for Gravity (.67), Sprinkler (.68), Mechanized (.77) and Drip (.88) based on NRCS data below:

Table 1-NM Potential System Efficiency			
Type	Efficiency	Type	Efficiency
(name)	(%)	(name)	(%)
Border, contour levee, field crop	70	Furrow, graded	70
Border, ditch	60	Furrow, level	80
Border, graded	70	Furrow, surge	80
Border, guide	60	Linear move	85
Border, level or basin	80	Sprinkler, biggun or boom	55
Center Pivot, (low pres. drops)	80	Sprinkler, handline or wheelline	65
Center Pivot, (over-pipe impact)	70	Sprinkler, solid set (overhead)	75
Center Pivot, LEPA (drag hose)	90	Sprinkler, solid set (under tree)	75
Flood, contoured ditch	60	Traveling big gun	60
Flood, controlled	60	Trickle, continuous tape	90
Flood, uncontrolled	45	Trickle, micro-spray	85
Furrow, contour	70	Trickle, pt source emitter	90
Furrow, corrugation	70		

http://www.dripmicrowizard.com/#

Flood to Drip: Potential Decreased Water Demand

Converting California Flood Acres to Drip Irrigation: Potential Decrease in Water Demand

CA crops which have been shown to benefit from drip irrigation*	Gravity Acres (2013 FRIS)	Acre-Feet per Acre Used - Gravity**	Total Acre-Feet Used - Gravity	Acre-Feet per Acre Used - Drip*	Total Acre-Feet Used - Drip	Potential decrease in water demand by using drip, Acre-Feet
Corn for grain or seed	146,921	3.00	440,763	2.28	335,421	105,342
Alfalfa	482,386	4.50	2,170,737	3.42	1,651,931	518,806
All Cotton	201,300	2.50	503,250	1.90	382,973	120,277
Vegetable acres	155,814	3.00	467,442	2.28	355,723	111,719
Sweet Corn	12,671	3.33	42,194	2.53	32,110	10,084
Tomatoes in the open	59,991	3.50	209,969	2.66	159,786	50,182
Lettuce and Romaine	9,370	2.10	19,677	1.60	14,974	4,703
Potatoes	2610	2.30	6,003	1.75	4,568	1,435
Orchards, vineyards, nut trees	396,150	3.00	1,188,450	2.28	904,410	284,040
Total Gravity Acres	**1,467,213**		**5,048,485**		**3,841,897**	**1,206,588**
Average AF/AC water yield by converting to drip: (1,467,213 acres/1,206,588 AF savings):						**.82 AF/ AC**

How should we be spending our incentive dollars?

Ag Modernization (upgrade from gravity to drip)

Cost is ~$1,200/Acre / ~0.82 Acre Feet/Acre “saved”

= ~$1,500/Acre Foot of water “saved” = $.0046/gallon = $3.44/CCF = 217 gallons/$

Grass Removal (“cash for grass”)

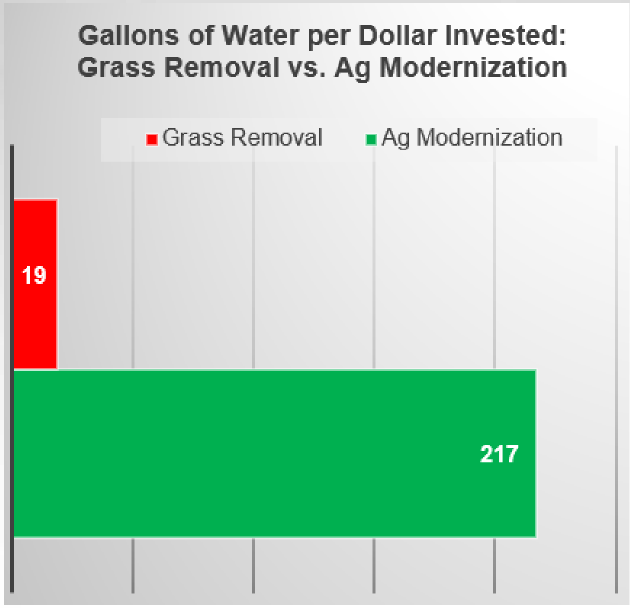
Cost is $2/square foot = $87,120/Acre / ~ 5 Acre Feet of Water “saved” *

= $17,424/Acre Foot of water “saved” = $.0535/gallon = $40.00/CCF = 19 gallons/$

TORO

*http://www.latimes.com/visuals/graphics/la-how-much-is-50-million-square-feet-of-lawn-20150401-htmlstory.html

How should we be spending our incentive dollars?



Ag modernization is 217/19 = **11** times more cost effective per incentive dollar spent.

Other Considerations:

- Ag modernization increases productivity and reduces pollution, inputs
- Grass water waste is primarily caused by poor equipment and mis-management
- Grass provides numerous benefits

TORO

How should we be spending our incentive dollars?

Ag Modernization (upgrade from gravity to drip)

Cost is ~$1,200/Acre / ~0.82 Acre Feet/Acre "saved"

= ~$1,500/Acre Foot of water "saved" = $.0046/gallon = $3.44/CCF = 217 gallons/$

SWEEP Estimate = $60,000,000 to save 60,000 AF = 325 gallons/$

Grass Removal ("cash for grass")

Cost is $2/square foot = $87,120/Acre / ~ 5 Acre Feet of Water "saved" *

= $17,424/Acre Foot of water "saved" = $.0535/gallon = $40.00/CCF = 19 gallons/$

If savings is ~4 AF instead of 5 AF then = 15 gallons/$

TORO

*http://www.latimes.com/visuals/graphics/la-how-much-is-50-million-square-feet-of-lawn-20150401-htmlstory.html

How should we be spending our incentive dollars?

Ag modernization is 325/15 = 21 times more cost effective per incentive dollar spent.

TORO

How should we be spending our incentive dollars?

How do we get the most

SPLASH

for our

CASH$?

TORO

Questions?