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

- 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
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

Water in, on, and above the Earth

Liquid fresh water
Freshwater lakes and rivers

Howard Perlman, USGS
Jack Cook, Adam Nieman
Data: Igor Shiklomanov, 1993

Where is Earth’s Water?

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

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

NOTE: Numbers are rounded, so percent summations may not add to 100.
Global Freshwater Withdrawals and Irrigation Methods

**Global Freshwater Withdrawals**

- **Agriculture**: 70%
- **Industrial**: 20%
- **Domestic**: 10%

**Irrigation Methods**:

- **Flood**: ~60%
- **Sprinkler**: ~30%
- **Drip/Micro**: < 10%
“80% of the Water Consumed in the U.S. is used for Agriculture...”
DWR: Where Does California’s Water Go?

Where California’s Water Comes From
Most of California’s water comes from rain and snow that falls in the northern and eastern parts of the state.

Only Some Is Available to Meet California’s Water Demands
About half of the 200 million acre-feet (MAF) California receives is used by vegetation or goes to evaporation. Another 20 MAF stays in North and Central Coast streams.

Where California’s Water Goes
About 66 MAF is available to meet California’s agricultural, urban, and Central Valley environmental needs.

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

https://mavensnotebook.com/the-notebook-file-cabinet/californias-water-systems/
DWR: How is California’s water used?

How Water Is Used in California

Water Year 2006 (Wet) - 108 MAF
- Agricultural: 31%
- Wild and Scenic Rivers: 41%
- Required Delta Outflow: 9%
- Instream Flow Requirements: 8%
- Managed Wetlands: 2%
- Urban: 9%

Water Year 2007 (Dry) - 77 MAF
- Agricultural: 48%
- Wild and Scenic Rivers: 23%
- Required Delta Outflow: 8%
- Instream Flow Requirements: 6%
- Managed Wetlands: 2%
- Urban: 13%

Within the Delta Watershed
US Method of Irrigation – 1978 to 2013

Irrigated Acres by Method: United States
USDA Farm and Ranch Irrigation Survey

% of Total

- Sprinkler: 58%
- Gravity: 34%
- Drip: 8%

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Drip</td>
<td>0.321</td>
<td>0.837</td>
<td>0.867</td>
<td>1.751</td>
<td>2.101</td>
<td>2.963</td>
<td>3.756</td>
<td>4.889</td>
</tr>
<tr>
<td>Total</td>
<td>49.911</td>
<td>45.171</td>
<td>46.704</td>
<td>48.294</td>
<td>50.145</td>
<td>52.958</td>
<td>56.651</td>
<td>61.287</td>
</tr>
</tbody>
</table>

% change since 2008
- Sprinkler: -2%
- Gravity: 13%
- Drip: 30%
CA Method of Irrigation – 1978 to 2013

Irrigated Acres by Method: California
USDA Farm and Ranch Irrigation Survey

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprinkler</td>
<td>2.14</td>
<td>1.9</td>
<td>1.75</td>
<td>1.85</td>
<td>1.53</td>
<td>1.72</td>
<td>1.37</td>
<td>1.67</td>
</tr>
<tr>
<td>Gravity</td>
<td>6.35</td>
<td>5.77</td>
<td>5.59</td>
<td>5.19</td>
<td>5.82</td>
<td>5.26</td>
<td>4.19</td>
<td>4.53</td>
</tr>
<tr>
<td>Drip</td>
<td>0.19</td>
<td>0.45</td>
<td>0.36</td>
<td>0.93</td>
<td>1.02</td>
<td>1.72</td>
<td>2.34</td>
<td>2.783</td>
</tr>
</tbody>
</table>

% change since 2008

- Sprinkler: 22%
- Gravity: 8%
- Drip: 19%

% of Total
- Gravity: 50%
- Drip: 31%
- Sprinkler: 19%
Based on 2008 Farm and Ranch Irrigation Survey (FRIS).

US Method of Irrigation -1988 to 2008

CA Acres (000) by Systems of Irrigation

US drip acres

CA drip acres

Presented by Dave DeWalt, NASS, at 2014 CII.
Ag Irrigation Technologies: Drip, Flood and Sprinkler
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 = 

[Image of a cornucopia filled with vegetables]
Resource Use Efficiency, RUE

Resource Use Efficiency = \( \frac{\text{Yield}}{\text{All Farm Inputs}} \)

\( \text{RUE} = \) 

![Diagram of time, energy, water, and resources]
Flood Irrigation: Uniformity Improvements

Rubicon Farm Connect

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

Figure 1.1 - WinSRFR Project Management Window
Typical Drip System Layout

- Surface Reservoir and Pump
- Chemical Injection Tanks and Equipment
- Irrigation Controller
- Well Pump
- Primary Filters
- Control Valves
- Control Valves and Backup Filters
- Air/Vacuum Relief Valves
- Aqua-Traxx Drip Tape – SDI (Subsurface)
- Aqua-Traxx and Oval Hose
- Hose and Emitters
- Dripline

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

<table>
<thead>
<tr>
<th>Crop</th>
<th>Furrow</th>
<th>Drip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>3.2 bales/ac</td>
<td>3.7 bales/ac</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>35 tons/ac</td>
<td>60 tons/ac</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crop</th>
<th>Water Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>4.0 af/ac</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>5.2 af/ac</td>
</tr>
</tbody>
</table>

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

Data Highlights

Cotton Yield
- Bales/Ac: 3.2, 3.7

Cotton Water Use
- Acre-Feet/Ac: 4, 2.5

Tomato Yield
- Tons/Ac: 35, 60

Tomato Water Use
- Acre-Feet/Ac: 4.1, 1.85

Source: Chase Hurley, General Manager, San Luis Canal Company
Another way of looking at the data….WUE

Tomatoes, tons/AF

<table>
<thead>
<tr>
<th>Method</th>
<th>Tomatoes, tons/AF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furrow</td>
<td>6.73</td>
</tr>
<tr>
<td>Drip</td>
<td>32.40</td>
</tr>
</tbody>
</table>

Cotton, bales/AF

<table>
<thead>
<tr>
<th>Method</th>
<th>Cotton, bales/AF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furrow</td>
<td>0.8</td>
</tr>
<tr>
<td>Drip</td>
<td>1.94</td>
</tr>
</tbody>
</table>
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.
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

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?

Modernizing Ag?

~ $60 million made available last year in CA SWEEP since 2014
Where should we spend our incentive dollars?

### Summary of SWEEP Projects (2014-2016)

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

*CDFA anticipates making additional award announcements in fall 2016*
## Table 36 data by crop:

<table>
<thead>
<tr>
<th>Crop Description</th>
<th>Sprinkler (pressure) acres</th>
<th>Gravity acres</th>
<th>Drip acres</th>
<th>Total Irrigated Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn for grain or seed</td>
<td>5,340</td>
<td>146,921</td>
<td>152,261</td>
<td></td>
</tr>
<tr>
<td>Corn for silage or greenchop</td>
<td>37,526</td>
<td>326,125</td>
<td>363,651</td>
<td></td>
</tr>
<tr>
<td>Sorghum for grain or seed</td>
<td>1,755</td>
<td>8,550</td>
<td>10,305</td>
<td></td>
</tr>
<tr>
<td>Wheat for grain or seed</td>
<td>121,181</td>
<td>218,007</td>
<td>339,188</td>
<td></td>
</tr>
<tr>
<td>Beans, dry edible</td>
<td>16,405</td>
<td>22,450</td>
<td>38,855</td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td></td>
<td>1,051,374</td>
<td>1,051,374</td>
<td></td>
</tr>
<tr>
<td>Other small grains</td>
<td>29,285</td>
<td>48,238</td>
<td>77,523</td>
<td></td>
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<tr>
<td>Alfalfa</td>
<td>181,932</td>
<td>482,386</td>
<td>664,318</td>
<td></td>
</tr>
<tr>
<td>All other hay</td>
<td>96,984</td>
<td>340,296</td>
<td>437,280</td>
<td></td>
</tr>
<tr>
<td>All Cotton</td>
<td>37,371</td>
<td>201,300</td>
<td>274,834</td>
<td></td>
</tr>
<tr>
<td>Vegetable acres</td>
<td>280,298</td>
<td>155,814</td>
<td>1,018,036</td>
<td></td>
</tr>
<tr>
<td>Sweet Corn</td>
<td>110</td>
<td>12,671</td>
<td>28,420</td>
<td></td>
</tr>
<tr>
<td>Tomatoes in the open</td>
<td>24,722</td>
<td>59,991</td>
<td>283,287</td>
<td></td>
</tr>
<tr>
<td>Lettuce and Romaine</td>
<td>74,705</td>
<td>9,370</td>
<td>197,717</td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>56,873</td>
<td>2610</td>
<td>63,101</td>
<td></td>
</tr>
<tr>
<td>All Berries</td>
<td>1040</td>
<td>7</td>
<td>33,443</td>
<td></td>
</tr>
<tr>
<td>Orchards, vineyards, nut trees</td>
<td>289,629</td>
<td>396,150</td>
<td>2,576,601</td>
<td></td>
</tr>
<tr>
<td>All other crops</td>
<td>178,064</td>
<td>71,497</td>
<td>249,561</td>
<td></td>
</tr>
<tr>
<td>Pastureland</td>
<td>50,264</td>
<td>383,306</td>
<td>433,570</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,483,484</strong></td>
<td><strong>3,937,063</strong></td>
<td><strong>2,872,778</strong></td>
<td><strong>8,293,325</strong></td>
</tr>
</tbody>
</table>

Method as percent of CA total: 18% 47% 35%

Drip Opportunity (red gravity): 1,467,220

US Totals, 2013 FRIS (Table 28 Totals):

<table>
<thead>
<tr>
<th>Crop Description</th>
<th>Sprinkler (pressure) acres</th>
<th>Gravity acres</th>
<th>Drip acres</th>
<th>Total Irrigated Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>California, 2013 FRIS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Method as percent of US total</strong></td>
<td>63.1%</td>
<td>38.9%</td>
<td>8.8%</td>
<td></td>
</tr>
<tr>
<td><strong>CA as % of US Total</strong></td>
<td>4%</td>
<td>18%</td>
<td>59%</td>
<td>15%</td>
</tr>
</tbody>
</table>
### Irrigation Application Uniformity Coefficients:

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

<table>
<thead>
<tr>
<th>Type</th>
<th>Efficiency</th>
<th>Type</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Border, contour levee, field crop</td>
<td>70</td>
<td>Furrow, graded</td>
<td>70</td>
</tr>
<tr>
<td>Border, ditch</td>
<td>60</td>
<td>Furrow, level</td>
<td>80</td>
</tr>
<tr>
<td>Border, graded</td>
<td>70</td>
<td>Furrow, surge</td>
<td>80</td>
</tr>
<tr>
<td>Border, guide</td>
<td>60</td>
<td>Linear move</td>
<td>85</td>
</tr>
<tr>
<td>Border, level or basin</td>
<td>80</td>
<td>Sprinkler, biggun or boom</td>
<td>55</td>
</tr>
<tr>
<td>Center Pivot, (low pres. drops)</td>
<td>80</td>
<td>Sprinkler, handline or wheelline</td>
<td>65</td>
</tr>
<tr>
<td>Center Pivot, (over-pipe impact)</td>
<td>70</td>
<td>Sprinkler, solid set (overhead)</td>
<td>75</td>
</tr>
<tr>
<td>Center Pivot, LEPA (drag hose)</td>
<td>90</td>
<td>Sprinkler, solid set (under tree)</td>
<td>75</td>
</tr>
<tr>
<td>Flood, contoured ditch</td>
<td>60</td>
<td>Traveling big gun</td>
<td>60</td>
</tr>
<tr>
<td>Flood, controlled</td>
<td>60</td>
<td>Trickle, continuous tape</td>
<td>90</td>
</tr>
<tr>
<td>Flood, uncontrolled</td>
<td>45</td>
<td>Trickle, micro-spray</td>
<td>85</td>
</tr>
<tr>
<td>Furrow, contour</td>
<td>70</td>
<td>Trickle, pt source emitter</td>
<td>90</td>
</tr>
<tr>
<td>Furrow, corrugation</td>
<td>70</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Converting California Flood Acres to Drip Irrigation: Potential Decrease in Water Demand

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

Average AF/AC water yield by converting to drip: \( \frac{1,467,213 \text{ acres}}{1,206,588 \text{ AF savings}} = 0.82 \text{ AF/AC} \)
How should we be spending our incentive dollars?

**Ag Modernization (upgrade from gravity to drip)**

Cost is \(~$1,200/Acre \) / \(~0.82 \text{ Acre Feet/Acre} \) “saved”

\[ \approx $1,500/\text{Acre Foot of water “saved”} = $.0046/\text{gallon} = $3.44/\text{CCF} = 217 \text{ gallons/$} \]

**Grass Removal (“cash for grass”)**

Cost is $2/square foot = $87,120/Acre / \(~5 \text{ Acre Feet of Water “saved”} \)

\[ \approx $17,424/\text{Acre Foot of water “saved”} = $.0535/\text{gallon} = $40.00/\text{CCF} = 19 \text{ gallons/$} \]

How should we be spending our incentive dollars?

Ag modernization is \(\frac{217}{19} = 11\) 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
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/$

How should we be spending our incentive dollars?

Ag modernization is
\[ \frac{325}{15} = 21 \] times more cost effective per incentive dollar spent.
How should we be spending our incentive dollars?

How do we get the most SPLASH for our CASH$?
Questions?