Perspectives on Irrigation and Water Issues in Urban and Rural Southwest Texas

Daniel I. Leskovar, Ph.D.
Professor Vegetable Stress Physiology & Center Director of AgriLife Research at Uvalde
d-leskovar@tamu.edu

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Southwest Texas Limitations

- Water Demands – Limitations
- Drought
- High temperatures
- Narrow market windows
- Competition from CA and MX (Less $)
- Low Prices & Increased inputs costs
- Labor Skills and Availability
- Food safety – Regulations

Our Strengths

- Rechargeable water resources
- Excellent soil and water quality
- Mild winter climate – Long growing season
- Efficient irrigation technologies
- Balanced crop rotation systems
- Solid Ag-based regional economy
- Dynamic corridors (San Antonio-Austin-Laredo)

From Farm to Table

Engaged producers

- Seed quality
- Plasticulture-Labor
- Mechanization
- Branding
- Packaging
Improved Productivity

From less efficient Irrigation Systems

Adoption of Precision Irrigation Technologies

Hydroponic Systems

Irrigation Technologies & Water Savings

Our Team & Programs

<table>
<thead>
<tr>
<th>Crop</th>
<th>Conventional</th>
<th>Improved</th>
<th>Water Saving (%)</th>
<th>WUE (%)</th>
<th>Technology Applied</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>16.7</td>
<td>12.4</td>
<td>26</td>
<td>25</td>
<td>Deficit irrigation</td>
<td>Lamm et al. (1995)</td>
</tr>
<tr>
<td>Cotton</td>
<td>67.3</td>
<td>24.2</td>
<td>64</td>
<td>25</td>
<td>From Each to Alternate furrow</td>
<td>Kanber et al. (2012)</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>23.9</td>
<td>14.8</td>
<td>53</td>
<td>55</td>
<td>From Furrow to SDI+Mulch</td>
<td>Leskovar et al. (2001)</td>
</tr>
<tr>
<td>Tomato</td>
<td>25.0</td>
<td>27.0</td>
<td>–</td>
<td>43</td>
<td>From Furrow to SDI</td>
<td>Ayars et al. (1999)</td>
</tr>
<tr>
<td>Cool season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>7.1</td>
<td>5.9</td>
<td>17</td>
<td>21</td>
<td>Bed planting &amp; CV</td>
<td>Fahong et al. (2004)</td>
</tr>
<tr>
<td>Lettuce</td>
<td>10.7</td>
<td>6.3</td>
<td>42</td>
<td>22</td>
<td>From Furrow to Drip</td>
<td>Hanson et al. (1997)</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>19.8</td>
<td>13.5</td>
<td>32</td>
<td>33</td>
<td>From Center pivot to Drip</td>
<td>Alam et al. (2000)</td>
</tr>
<tr>
<td>Onion</td>
<td>24.0</td>
<td>21.1</td>
<td>12</td>
<td>–</td>
<td>SDI + Kc vs. Kc (FAO)</td>
<td>Leskovar et al. (2012)</td>
</tr>
</tbody>
</table>

Our Team & Programs

- Horticulture – Vegetable Stress Physiology (D. Leskovar)
- Horticulture – Ornamentals, Nutrition (R. Cabrera)
- Ag Economics – Extension (M. Palma)
- Horticulture Extension – Fruits and Vegetables (L. Stein)
- Agricultural Systems – Forages (D. Forbes)
- Wildlife Management (S. Cooper)
- Agronomy - Crop Physiology, Water & Soil Science (TBN)
**Water Conservation Programs**

- **Stress management**
  - Deficit irrigation
  - ET and crop coefficients
  - Growth regulators

- **Irrigation technologies**
  - Drip, SDI
  - LEPA, Center Pivot
  - Hydroponics

- **Landscape water use**
  - Gray waters

- **Cropping systems**
  - Vegetables-Row-Grains-Forages
  - Tillage systems
  - Cool season crops

- **Drought tolerant crops**
  - Improved root systems
  - Heat tolerant (leaf adaptation)
  - Native plants

- **Wildlife water use**
  - Rainwater harvest

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**Water Conservation & Irrigation Management for Vegetable Crops**

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**Irrigation, Environment & Genetics for High Value Vegetables**

- Genotype selection
- Growth regulation - Drought
- Subsurface Drip
- Center Pivot

**Developing growth-stage specific crop coefficients (Kc) to improve irrigation efficiency**

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**In-ground Lysimeter**

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Daily Water Use

Crop Coefficients (Kc)

Uvalde – Onion

<table>
<thead>
<tr>
<th>Growth stage</th>
<th>GAP</th>
<th>Kc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence</td>
<td>0</td>
<td>0.50</td>
</tr>
<tr>
<td>2 leaves</td>
<td>30</td>
<td>0.60</td>
</tr>
<tr>
<td>3-4 leaves</td>
<td>60</td>
<td>0.70</td>
</tr>
<tr>
<td>5-6 leaves</td>
<td>100</td>
<td>0.80</td>
</tr>
<tr>
<td>7-9 leaves</td>
<td>120</td>
<td>0.85</td>
</tr>
<tr>
<td>Beginning of bulbing</td>
<td>160</td>
<td>0.90</td>
</tr>
<tr>
<td>Bulb fully developed</td>
<td>200</td>
<td>0.90</td>
</tr>
<tr>
<td>Leaf stage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FAO

<table>
<thead>
<tr>
<th>Growth stage</th>
<th>Kc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>0.70</td>
</tr>
<tr>
<td>Mid</td>
<td>1.05</td>
</tr>
<tr>
<td>End</td>
<td>0.75</td>
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</tbody>
</table>

Crop Coefficients (Kc) for Spinach in South Texas

<table>
<thead>
<tr>
<th>Lysimeter</th>
<th>FAO</th>
<th>Growth Stage</th>
<th>Crop Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergence</td>
<td>0.40</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>2 – 3 leaf</td>
<td>0.50</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>4 – 6 leaf</td>
<td>0.60</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>7 – 9 leaf</td>
<td>0.70</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>10 – 12 leaf</td>
<td>0.80</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>13 – 15 leaf</td>
<td>0.90</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>16 – 18 leaf</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>19 - harvest</td>
<td>1.10</td>
<td>1.10</td>
<td></td>
</tr>
</tbody>
</table>

Irrigation - Spinach

Ascorbic Acid & Carotenoids

Root Growth Research

Hydrodynamic Eluviation

Minirhizotron
Water Conservation & Irrigation Management Systems for Agronomic, Vegetables and Forage Crops

Tillage methods for water conservation

- Strip-tillage - soil surface is cooler, retains moisture and allows greater water infiltration.
- Conventional tillage – incorporates all plant residue into soil. Increases evaporation, soil temperature and reduces water infiltration

Tillage, cover crops and Irrigation

- Strip-tillage to reduce soil water evaporation, lower soil temperature, promote water infiltration.
- Cover crop provides base for strip-tillage. Can provide nitrogen, increase organic matter, and be grazed to provide income
- Irrigation management to apply only what the crop needs, when it needs it. Based on ET and crop coefficients (Kc)

Management systems for water conservation

- Combining tillage treatments and irrigation strategies into a management system.
- Irrigation treatments
  - 100% ET
  - 70% ET
  - PA (primed acclimation) Crop receives 70% ET until initiation of flowering, thereafter 100% ET.

Management systems for water conservation

Change season of production

- Most water used in summer months when temperature and evapotranspiration highest.
- Changing season of production to fall, winter and spring months will reduce water requirements.
- Cool season grains (wheat, oats, rye), forages and vegetables
Water Conservation, Irrigation and Fertilizer Management for Ornamental Crops

Ornamental Horticulture – Background
- Green Industries: Nursery, greenhouse, sod, landscaping.
- Economic output: Total $15 billion ($2 billion farmgate) and >170,000 jobs (Palma and Hall, 2008; TNLA).

Ornamental Horticulture – Issues
- Intensively managed activities, using massive inputs of water, fertilizers, chemicals and labor.
- Dwindling water supplies, severe droughts, water competition and pollution concerns significantly challenge its future.

Irrigation Water in Texas

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Total Acreage</th>
<th>Average annual irrigation rate (inches)</th>
<th>Total Annual Water Use (million acre-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated agriculture</td>
<td>5.5 million</td>
<td>17”</td>
<td>7.707</td>
</tr>
<tr>
<td>Green Industries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursery-Greenhouse-Sod</td>
<td>59,212</td>
<td>84”</td>
<td>0.414</td>
</tr>
<tr>
<td>Golf Courses</td>
<td>135,000</td>
<td>36”</td>
<td>0.405</td>
</tr>
<tr>
<td>Irrigated Landscapes*</td>
<td>1.4 million</td>
<td>30”</td>
<td>3.499</td>
</tr>
</tbody>
</table>

Notes:
- Estimated value does not include irrigated state/federal parks & right-of-ways.
- Average annual US household landscape water use is about 12,000 gallons (or 5,000 ft²).
- Total water use for Texas in 2010 was 18 million acre-ft (TWDB, 2012).

Data from Cabrera, 2012

Ornamental native plants with gray waters?

Evaluating graywater irrigation effects and use of water use efficient native and adapted plants.

Water Conservation for Wildlife
**Water Conservation for Wildlife On the Ranch**

“Guzzlers”

Harvest and store rainwater and dew to provide a steady supply of drinking water for wildlife.

**Water Conservation for Wildlife In the Garden**

Rainwater harvesting can supply waterers, birdbaths, small ponds and damp areas for urban animals too.

**Rainwater Harvesting and Drip Irrigation of Wildlife Food Plots**

Food plots with supplemental irrigation from harvested rainwater produced 3x the biomass of food for wildlife than non-irrigated plots.

**Rainwater Harvesting Garden**

WGCD Demonstration site at Uvalde – Showcasing rainwater harvesting and drip irrigation combined with native and adapted plants to provide wildlife habitat and reduce demand on groundwater resources.

Demonstration includes comparing the success of various soaker hoses, drip tape, drip emitters and sprinklers in a garden setting. Plus attractive garden and wildlife forage plants.

**Water Conservation with South Texas Native Plants**

Plants native to south Texas require less water and fertilizer than non-natives

They provide ground cover for lawns, visual appeal for urban landscapes, forages for grazing, and food and shelter for wildlife.
Native grasses for turf, landscaping, grazing, and wildlife habitat.

- Cotton-top
- Little bluestem
- Eastern gamagrass
- Sideoats grama
- Buffalo grass

Native flowers for landscaping and wildlife habitat.

- Comanche sleeping plant
- Clammy weed
- Wine cup
- Purple prairie clover
- Indian blanket

Research & Education Needs

- Deficit irrigation to mitigate drought/water limitations
- Irrigation management for high value crops
- Integrated cropping systems for low ETc seasons
- Validation on estimates of gray water use for native plants
- Selection of low-water requirement plants
- Promote adoption of these technologies in Texas

Thank you!