Linking Climate to Groundwater Conservation

Climate Outlook Forum, Clovis NM  April 26, 2017

Chuck West
Texas Tech University

How do we deal with declining water supplies in an agriculturally productive region?
Ogallala Aquifer supports ~30% of U.S. crop and livestock production.

Increases U.S. agricultural production by more than $12 billion annually.

USDA-NASS, 2016
Hotspots of groundwater depletion

Figure 11. Water-level changes in the High Plains aquifer, predevelopment (about 1950) to 2013.

McGuire, 2014

Haacker et al., 2015
Importance of Potential ET in Understanding Water Deficit
Potential Evapotranspiration (PET) drives water demand

Water supply = PET minus Rainfall
Irrigation from the Ogallala balances the water deficit
In Lubbock, PET exceeds rainfall in every month.
Potential ET depends on:

- temperature
- wind run
- humidity
- solar radiation
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- humidity
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August Reference $E_{t_0}$ (in./mo.)
Historical temps are increasing

OAR Monthly Nighttime Temperature Trends
(1901 to 2015)

Xiaomao Lin
What is are reasonable concepts of sustainability?

- Just economics?
- More than transition with soft-landing?
  - How to factor climate into improved efficiency and risk reduction?

Climate models predict:

- warmer temperatures
- higher evaporation rates
- stronger droughts
- more heavy rain events
The Ogallala Water Coordinated Agricultural Project

Optimizing Water Use for Agriculture and Rural Communities

Colorado State University: Meagan Schipanski (Dir.)
Amy Kremen (Manager) 40 scientists

Kansas State
Nebraska
Oklahoma State
New Mexico State
Texas Tech
Texas A&M
West Texas A&M
USDA-ARS

OgallalaWater.org

Optimizing Water Use to Sustain Food Systems
Goal: Optimize groundwater use in crop and livestock production systems and rural communities in the Ogallala Aquifer region

- Improving water use efficiency through irrigation management technologies
- Improving and increasing adoption of irrigation scheduling
- Improving management of limited-irrigation and dryland systems
- Increasing water holding capacity through soil health management
- Outreach and Extension

Connecting resources
USDA Climate Hubs
USDA NRCS
TAWC
Saturated thickness variability
Methods of water conservation -

- Irrigation scheduling – irrigate at 60-80% of PET
- Developing improved irrigation water management technologies e.g. LEPA, SDI, VRI, monitoring soil moisture and plant stress ...
- Adoption of conservation practices e.g. Minimum till, rain capture and retention, runoff reduction, staggering planting dates, irrigate smaller areas,
- Integrating forages and livestock grazing into cropping system
- Adopting drought-tolerant crop varieties and alternative crops
Crop breeding for water use efficiency
### Irrigation water use by sorghum and corn silages – 4 yr mean

Bean and McCullem Texas A&M AgriLife-Amarillo

<table>
<thead>
<tr>
<th>Silage crop</th>
<th>Silage yield tons/acre</th>
<th>Irrigation applied inches/yr</th>
<th>Water use efficiency tons/ac-in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>22.4</td>
<td>14.9</td>
<td>1.57</td>
</tr>
<tr>
<td>Corn</td>
<td>22.5</td>
<td>22.9</td>
<td>1.03</td>
</tr>
</tbody>
</table>

**Take-home message:** can produce as much silage with forage sorghum as with corn at 2/3 the amount of irrigation.
Texas Alliance for Water Conservation
Partners with producers, USDA-NRCS, Texas A&M AgriLife, Water districts

• Demonstrate how to reduce water use
• Identify profitable crop and irrigation systems
• Provide online tools for decision-making on water use and economic options
• Involves 34 producer fields in nine counties
## Irrigation water use by major crops in TAWC project – 8 yr mean

<table>
<thead>
<tr>
<th>Crop</th>
<th>Irrigation applied</th>
<th>Water use efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain sorghum</td>
<td>12 inches/yr</td>
<td>760 lbs/ac-in.</td>
</tr>
<tr>
<td>Corn grain</td>
<td>18 inches/yr</td>
<td>610 lbs/ac-in.</td>
</tr>
<tr>
<td>Corn silage</td>
<td>22 inches/yr</td>
<td>2990 lbs/ac-in.</td>
</tr>
<tr>
<td>Cotton lint</td>
<td>13 inches/yr</td>
<td>120 lbs/ac-in.</td>
</tr>
</tbody>
</table>
Corn response to water received

The graph illustrates the correlation between grain yield in bushels per acre (bu/acre) and water received, expressed as a percentage of crop water demand. The data points are differentiated by year: black diamonds represent 2006-2010, 2012, and 2013, while red diamonds indicate 2011. The trend line shows the general increase in grain yield as water received increases. Two vertical lines highlight specific water percentages.
Crop Evapotranspiration
Long-term Average (1997-2011)

(Rajan and Maas)
Daily Crop Water Demand by Crop (Site 35 - 2014)
Sorghum Evapotranspiration Long-term Average (1997-2011)

Planting Dates
- 1-May
- 15-May
- 1-June
- 15-June

Crop Evapotranspiration (in/day)

Day of Year

(Rajan and Maas)
Why forages and cattle?

• Grassland is native ecosystem.
• Perennials build soil organic matter, reduce erosion.
• Beef cattle and hay are high-value commodities.
• Require modest water inputs.

Forages and livestock provide a profitable means of transitioning to low water-input and dryland agriculture in the Texas High Plains.
Texas Tech University – Sustainable Land & Water

Thank you