Grain Sorghum and Corn Productivity under Limited Irrigation

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Irrigation’s Contribution to an Economy

- Irrigation utilizes 86% of withdrawal from the Ogallala Aquifer in Oklahoma (OWRB, 2012)
- Corn production was increased to 26.8 million bushels on 145,000 acres in 2010 (NASS, 2010)
  - Worth $118 million at today’s price of $4.44
- Provides feed for the 1.25 million hogs and 660,000 cattle
could easily be worth $200 million at 7.5/bushel

jason, 10/23/2013
USDA Estimates are that **20 inches** are required to optimize yields

Dependent on rainfall, Evapotranspiration, and initial soil moisture

Oklahoma Mesonet: 15-year Average water Deficient curve ET-Rainfall

Cumulative Water Deficit (inches)

- **30 inches**
Declining Water Availability

- USGS estimated that the aquifer drop by 100 ft between 1940-1990.
- The same report estimated that it would drop by 20-25 ft by 2020 (Luckey, et al. 2000).
- Producers have started to experience the effects of this decline as pumping capacities decrease.
Irrigation system must be able to meet peak water use rate or crop will be lost.

0.3 inches/day ≈ 800 gpm on a 125-acre pivot
Irrigation Required to Prevent Water Deficit for corn

- Based on 15-years of weather data from Mesonet

<table>
<thead>
<tr>
<th>Date</th>
<th>3.2 gpm/acre (400)</th>
<th>4.8 gpm/acre (600)</th>
<th>6.4 gpm/acre (800)</th>
<th>8 gpm/acre (1000)</th>
<th>9.6 gpm/acre (1200)</th>
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Deviation from Field Capacity (inches)
Potential Solutions

- **Drill additional wells:**
  - Costly, Risky, decreases the life expectancy of the regional production system.

- **Decrease acreage irrigated/well**
  - Decreases regional grain production

- **Improve efficiency of center pivot systems**
  - Most pivots in the region utilize Low Elevation Spray Application (LESA), with application efficiencies of 85-90%.
  - Conversion to Low Energy Precision Application (LEPA) may increase this to 95-98%
Potential Solutions

- **Adopt new crop rotation**
  - Must have a strong market and decrease risk associated with limited water
  - Grain sorghum is a good alternative to corn

- **Adopt new irrigation systems**
  - Must result in significant increases in efficiency and be cost affective
  - Subsurface drip irrigation has become a viable alternative
Grain Sorghum as an Alternative

- Well adapted to the region
- Can serve as a replacement for corn in the animal production system
  - Historically, it was perceived as having a lower quality, however, feed mills and animal producers are becoming more accepting.
- Sorghum ($4.44) prices are comparable to corn ($4.44)
- Water requirements for optimum yield are much lower and production costs are lower as well.
Irrigation Required to Prevent Water Deficit for Sorghum

Based on 15-years of weather data from Mesonet
Why Don’t we see more Irrigated Sorghum

- Easy answer is Yield
- Historically, Sorghum yields are easily 50% of corn yields
- However, sorghum yields are slowly increasing
- Also, under limited irrigation it may become advantageous to grow sorghum
Sorghum is much more productive at low water availability.
# 2005-2012 Average Corn and Grain Sorghum Yields (Variety trials)

<table>
<thead>
<tr>
<th></th>
<th>Yield (bu/ac)</th>
<th>Irrigation Inches</th>
<th>$/inch</th>
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<tbody>
<tr>
<td>Ave. Corn</td>
<td>176</td>
<td>19</td>
<td>41</td>
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<tr>
<td>Max. Corn</td>
<td>288</td>
<td>25.5</td>
<td>50</td>
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<tr>
<td>Ave. Sorghum</td>
<td>137</td>
<td>8.5</td>
<td>72</td>
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<tr>
<td>Max. Sorghum</td>
<td>186</td>
<td>12</td>
<td>69</td>
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</table>
add column for $/acre
Warren, Jason, 1/2/2013
Current Research

- **Objective:**
  - Evaluate yield response of corn and sorghum under a range of irrigation rates
- **Utilize Subsurface Drip Irrigation**
**Irrigation Rates**

- Application of these rates will be initiated based on guidance from AquaPlanner.

<table>
<thead>
<tr>
<th>Well Capacity Gallons/ min.</th>
<th>Application rates</th>
<th>Minimum Irrigation Interval</th>
<th>Application Rate</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Inches</td>
<td>Days</td>
<td>GPM/ acre</td>
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<tr>
<td>800</td>
<td>1.5</td>
<td>4.4</td>
<td>6.4</td>
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<tr>
<td>600</td>
<td>1.5</td>
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<td>400</td>
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<tr>
<td>100</td>
<td>1.5</td>
<td>35.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Treatments are meant to simulate a center pivot system irrigating a 125 acre circle with specific well pumping capacities. GPM, Gallons/minute.
Example of Aquaplananner Output
Soil Data Collection

- Soil cores (8 ft or bedrock) will be collected prior to planting and post harvest from each plot.
- 1 ft increments will be analyzed for moisture and bulk density.
- This along with the irrigation log and weather station data will be used to calculate a water balance for each treatment.
Preliminary Data from 2012

In-Season Water Applied (inches) vs. Yield (bu/acre)
2013 grain yields have yet to be harvested
  › Will allow for direct comparisons and calibration of crop models
Sorghum is certainly more productive at low irrigation rates
At what irrigation capacity does it truly become advantageous to produce Sorghum?
Questions

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