Estimating the area of irrigation during extended drought conditions

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Irrigation systems in Kansas are generally not designed to meet peak crop ET but at a level that optimizes water resource usage.
Design criteria includes expected precipitation, soil water holding capacity and crop water needs.
## Crop Water Use and Critical Growth Stages

**Table 2.** Seasonal Crop Water Use (ET), Typical Irrigation Capacity Requirement, Daily Peak Water Use, Critical Growth Stages, Typical Root Depth, and Typical Manage Depth for Various Crops Common to the Central Plains Region. (Shawcroft, R. W., Central Plains Proceedings, 1989)

<table>
<thead>
<tr>
<th>CROP</th>
<th>Seasonal crop water use (ET) (inches)</th>
<th>Typical irrigation capacity required (in. per day)</th>
<th>Daily peak usage</th>
<th>Critical growth stages</th>
<th>Typical root depth (feet)</th>
<th>Typical manage depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>32–48*</td>
<td>0.40</td>
<td>0.55</td>
<td>after harvest</td>
<td>6–10</td>
<td>3–4</td>
</tr>
<tr>
<td>Corn</td>
<td>24–30</td>
<td>0.35</td>
<td>0.50</td>
<td>tasseling, silking</td>
<td>4–6</td>
<td>3</td>
</tr>
<tr>
<td>Dry Beans</td>
<td>16–24</td>
<td>0.30</td>
<td>0.40</td>
<td>early bloom</td>
<td>3–4</td>
<td>2–3</td>
</tr>
<tr>
<td>Wheat</td>
<td>16–22</td>
<td>0.29</td>
<td>0.40</td>
<td>boot-heading</td>
<td>4–6</td>
<td>3</td>
</tr>
<tr>
<td>Sorghum</td>
<td>16–22</td>
<td>0.31</td>
<td>0.40</td>
<td>boot-heading</td>
<td>4–6</td>
<td>3</td>
</tr>
<tr>
<td>Sunflowers</td>
<td>16–20</td>
<td>0.26</td>
<td>0.30</td>
<td>flowering, maturity</td>
<td>4–6</td>
<td>3–4</td>
</tr>
<tr>
<td>Soybeans</td>
<td>18–24</td>
<td>0.31</td>
<td>0.40</td>
<td>germination bloom-podding</td>
<td>4–6</td>
<td>3</td>
</tr>
<tr>
<td>Vegetable Crops</td>
<td>16–20</td>
<td>0.29</td>
<td>0.30</td>
<td>reproductive stages</td>
<td>1–3</td>
<td>1</td>
</tr>
</tbody>
</table>

*Forage crops generally respond directly to the amount of water available. Alfalfa can use large amounts of water when growing seasons are long.*
Example of daily fluctuation of ETr

Calculated Corn ET KSU-NWREC Colby, Kansas

<table>
<thead>
<tr>
<th>Period</th>
<th>July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>72-04</td>
<td>0.267</td>
<td>0.249</td>
</tr>
<tr>
<td>2004</td>
<td>0.245</td>
<td>0.229</td>
</tr>
</tbody>
</table>
Irrigation capacity is a measure of the ability of an irrigation system to supply water relative to the crop water use rate. It is typically expressed in inches per day (really acre-inches per acre per day).
Irrigation Capacity (IC)

\[
IC = \frac{GPM(1\frac{ac - in}{hr}/450gpm) \times 24\frac{hrs}{day}}{acres} = \frac{in}{day}
\]

Guidelines:  
High Soil Holding Capacity  
\[IC = 0.25\ in/day\]

Low Soil Holding Capacity  
\[IC = 0.32\ in/day\]
Corn, Colby Kansas Normal Probability, 1972-95
Full sized 126 acre sprinkler
(F.R. Lamm)

- 600 gpm at 100% AE
- 600 gpm at 85% AE
- 400 gpm at 100% AE
- 400 gpm at 85% AE
- 300 gpm at 100% AE
- 300 gpm at 85% AE
- 240 gpm at 100% AE
- 240 gpm at 85% AE
Drought brings a double whammy of decreased precipitation and increased crop water use (assuming warmer temperatures and more days of clear sky).
Inseason Precipitation (inches)

KSU Northwest Research-Extension Center
Colby, Kansas

Longterm (1972-2002) Rain
Rain in 2000
Rain in 2001
Rain in 2002
Inseason Precipitation (inches)

KSU Northwest Research-Extension Center
Colby, Kansas

Longterm (1972-2002) Rain
Rain in 2000
Rain in 2001
Rain in 2002

Days after corn emergence

Days after corn emergence
IF irrigation capacity is too low, Then crop failure is possible even with irrigation.

Center Pivot Irrigated Corn, Northwest Kansas, 2002.
So when drought conditions become severe enough to cause yield limiting water stress to the point of total crop failure, how should you adjust the irrigation strategy with the goal of salvaging a portion of the crop.
Reduce Irrigated Acres

Match water supply to crop need.

Physically constrained:
Consider Irrigation Capacity

Water right constrained:
Consider Irrigation Application Depth
Match IC to crop water use rate to determine the acres that can be served:

Rearranging the IC equation to determine acres:

\[
\text{Acres} = \frac{\text{GPM}}{450} \times \text{Hrs} \times \text{IC}
\]
Irrigated Acres:

Acres covered =

\[
\frac{300 \text{ gpm} \times 1 \text{ ac-in/hr}}{450 \text{ gpm} \times 24 \text{ hrs/day}} = 0.25 \text{ in/day}
\]

= 64 acres
Match remaining allowed pumping to meet the estimated crop water need to determine area that can be served:

\[
\text{Acres} = \text{Remaining Ac-Ft} \times 12 \text{ ac-in/ac-ft}
\]

Remaining water use need
Reduce Irrigated Acres

Total volume available: 110 acre-foot
Desired irrigation depth: 13.5 acre-inches/acre

\[
\frac{110 \text{ acre-ft} \times 12 \frac{\text{ac-in}}{\text{ac-ft}}}{13.5 \text{ ac-in/ac}} = 98 \text{ acres}
\]
Irrigation Tools

KanSched: an ET based irrigation scheduling tool
Crop Water Allocator (CWA)
Crop Yield Predictor (CYP)
KSU Bulletins (Predicting the Final Irrigation for Corn, Soybean and Grain Sorghum)
K-State Research and Extension
Website:
www.ksre.ksu.edu

General Irrigation: www.ksre.ksu.edu/irrigate

Subsurface Drip Irrigation: www.ksre.ksu.edu/sdi

Mobile Irrigation Lab:
www.mobileirrigationlab.com