Irrigation Scheduling with The Crop Water Use App

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Fisher Delta Research Center
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Irrigation is a Big Investment
Proper Irrigation Management is Key

http://crops.missouri.edu/irrigation/
Evapotranspiration (ET)

Cotton

Days after planting

Emergence
Squaring
First white bloom
Peak bloom
First open boll
Harvest
Newman - TAES

< 0.10 per day
0.10 to 0.25 per day
0.25 to 0.40 per day

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
June 4 - 1.5” rainfall  
June 17 - Irrigated 1”  
June 27 - Irrigated 1”  
June 29 - 2” rainfall  
July 6 - Irrigated 1”  
July 12 - 1.5” rainfall  
July 18 - Irrigated 1”  
July 24 - Irrigated 1”  
July 30 - Irrigated 1”  
Aug 3 - 1.5” rainfall  
Aug 12 - 1” rainfall

Initial funding in part by the Missouri Soybean Merchandising Council and continued support by University of Missouri Extension and MU Commercial Ag Extension Program. Contact Joe Henggeler, MU Extension irrigation Specialist, for questions concerning this chart at HenggelerJ@missouri.edu.

Chart created 7/26/2012
Arkansas Irrigation Scheduler

Projected Temperatures


The last entry was Aug 1

Below are the listed deficits.

<table>
<thead>
<tr>
<th>Date</th>
<th>Juli 29</th>
<th>Jul 30</th>
<th>Jul 31</th>
<th>Aug 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>marsh</td>
<td>1.75</td>
<td>0</td>
<td>1.01</td>
<td>0</td>
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</tbody>
</table>

Projected Temperatures


Irrigation information from Aug 1

The following information assumes no rainfall and the estimated temperatures for the next ten days.
The field(s) which should be irrigated and the suggested date(s) for irrigation are:

Field: marsh  Date: Aug 2

Note on Furrow Irrig.: The program assumes that a furrow irrig. soaks into and across the rows and brings the deficit back to zero. This will probably occur with each irrig. on cracking clay soils even if only every other middle is irrigated. The first furrow irrig. on other soil types will also probably replace the deficit to zero, but subsequent furrow irrigations may not. Under different field and soil conditions each furrow irrigation may not soak into and across rows enough to bring the deficit to zero. If this is observed in the field, the effect can be reduced by starting the next furrow irrigation a couple of days before the irrigation starting deficit.
## Pros and Cons

<table>
<thead>
<tr>
<th>Method</th>
<th>Phone or Computer Required</th>
<th>User Friendly</th>
<th>Automatic enters ET and rain</th>
<th>ET from current weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodruff chart</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Ark Irrigation Scheduler</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Crop Water app</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Missouri Fields with Crop Water Use App

- 178 fields in 2015
- 398 fields in 2016 (Aug 2)
- Currently use the MU Ag Weather Network
  - Creates issues for out of state users
    - Weather station proximity
    - Electronic ET gauges (atmometers)
MP800, Crop Water Use Program for Irrigation

Crop Water Use Program for Irrigation

Water is an important factor that can affect crop yields. University of Missouri Extension developed an online application to help farmers produce higher crop yields by improving irrigation management. The Crop Water Use application can be run on an office computer or smartphone. To register, go to http://cropwater.org. This guide explains how to track soil moisture in fields for optimum yields and water conservation and gives information about how to use the application to that end.

Farmers with irrigation are usually able to harvest consistent yields, even in times of drought. Irrigation helps in periods of short-term crop water stress, which are common in Missouri summers in July or August. Farmers can prevent yield losses and conserve water resources with access to information on daily crop water use and by better understanding how much soil water can be stored for root uptake between rainfall and irrigation events in specific fields on their farms.

How does the application work?
The Crop Water Use program is designed to simplify calculations required for tracking soil moisture in fields. The application saves farmers time by automatically entering weather information for each field and making daily calculations used for irrigation planning.

In the New Field setup, farmers enter locations (latitude/longitude) and soil types for each field. This is a one-time job. Each growing season, farmers enter the crop and planting date for each field. The program predicts when fields need irrigation based on estimated soil water balance. The main information that the application needs from a farmer during the growing season is actual irrigation dates and rates.

The application estimates crop water use from weather data using an equation for calculating evaporation from soil and plants called evapotranspiration, or ET. The application also calculates daily soil water balances for each field. Reports include indexes to help farmers determine when to irrigate.

University of Missouri Extension automatically downloads data each day from a network of agricultural weather stations across Missouri. ET is calculated from temperature, humidity, wind and solar radiation. This application uses the standardized short crop Penman-Monteith Evapotranspiration equation, or ETo, which was developed by a committee of the American Society of Civil Engineers. ET is the amount of combined water lost from a reference crop, such as grass, and soil evaporation.
Search YouTube for “Crop Water Use App”
Subscribe to channel “Dr. Gene Stevens” for all updates
To register go to cropwater.org on your PC or mobile device.

PC is easier to navigate during registration.
Enter the field name and location.

Field Name:
Marsh Field 6 Triangle

Find location using Google Maps

Latitude North (decimal degrees):
36.4109

Longitude West (decimal degrees):
-89.6936

For calculating irrigation trigger, choose:

- Soil Texture - not selected

OR

- 82081 - Dubbs silt loam, 0 to 1 ...

Submit

Lat/Lon Help  Soil Help

Field Lat/Long is used to estimate rainfall from National Weather Service grid. The units must be in decimal degrees.

Click on the Tech Support button for PDF help documents.
Click **Find Location using Google Maps**.

Find your field and **push finger** in field center.

Then click **Use the marker coordinates**.
Zoom to your region, frame field with aoi (area of interest) and click Soil Map tab.

https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
Crop: Cotton

Plant date: **for direct input please use format mm/dd/ccyy or ccyy-mm-dd (e.g. 4/15/2014 or 2014-04-15)**

05/05/2017

Soil water deficit on planting date:

0"

Rooting depth:

18"

Irrigation Method:

Sprinkler = Yes

Default Irrigation:

0.75"

Maximum Allowable Field Water Depletion:

50%

NWS Rainfall (est):

Yes  No
Soil Water Balance

Evapotranspiration

Runoff
Infiltration

Effective Rooting Depth

Groundwater
Cotton root video
Rooting Depth Evaluations

Irrigate More Frequently

Irrigate Less Frequently
2016 Cotton Rooting Depth Trigger

Lb Lint per Acre

Rooting Depth (in)

Number of Irrigations

AB

D

CD

A

AB

BC

0

6

12

18

24

30

-95

-80

+98

+55

-69

1
Rooting Depth Evaluations

Irrigate More Frequently

6”

12”

18”

8” ERD in previous research

Irrigate Less Frequently
2017 Furrow Rice Rooting Depth Trigger

Number of Irrigations

<table>
<thead>
<tr>
<th>Rooting Depth Trigger (in)</th>
<th>Rice Grain Yield (bu/ac)</th>
<th>Number of Irrigations</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>C</td>
<td>15</td>
</tr>
<tr>
<td>12</td>
<td>A</td>
<td>11</td>
</tr>
<tr>
<td>18</td>
<td>B</td>
<td>7</td>
</tr>
</tbody>
</table>
Current Recommended Rooting Depth Triggers

- Cotton: 18-24”
- Soybean: 20”
- Corn: 22-24”
- Rice: 12”
Daily monitor fields with top two buttons

Field Status & Farm Summary
Field Status
In-Depth Monitoring for Individual Fields

Marsh Field 4 Pivot E 1/2
Crop: Corn
Planting date: April 25, 2016
Soil texture: sandy loam
Rooting depth: 22.5 in

Mon July 18, 2016 - Soil Water Balance (est)
Last water event: 0.09 on Sat 7/16
Current Water Balance: -1.00 in

Dry  Wet

Irrigation trigger: -1.1025 in (red line)
<table>
<thead>
<tr>
<th>Name</th>
<th>Today</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marsh Field 4 soybean</td>
<td>-0.84</td>
<td>OK</td>
<td>OK</td>
<td>*</td>
<td>***</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
</tr>
<tr>
<td>Pivot Field 5 corn</td>
<td>-1.15</td>
<td>***</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
</tr>
<tr>
<td>Rhodes Field 1 cotton</td>
<td>-0.17</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>*</td>
<td>**</td>
<td>***</td>
<td>XXX</td>
</tr>
<tr>
<td>Rhodes Field 14 cotton</td>
<td>0</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>**</td>
<td>***</td>
</tr>
<tr>
<td>Lee Field 12 soybean</td>
<td>-1.27</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
</tr>
<tr>
<td>Lee Field 10 Corn</td>
<td>-1.16</td>
<td>**</td>
<td>***</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
<td>XXX</td>
</tr>
</tbody>
</table>
The app assumes no rain in the next week and uses historical average ET for the future.

Swipe from right to left to see other days.
To add irrigations or input rainfall gauge amount click

Add Irrig/Rain
Click a **blue** cell for rainfall or **green** cell for irrigation next to the appropriate date.

Entering a rainfall amount overrides National Weather Service (NWS) values.
If irrigation amount is different from default enter it.

Field name: Lee Field 12-1a

Date: 7/21/2015

Irrigation in inches:

2.5

Submit

Check all other fields that received the same irrigation on this date:

Be sure to click Submit after clicking Done!
To save time, you have the option to enter the same rate on several fields.

We are currently working on a glitch. On some phones the first field on the list is checked automatically. Uncheck it if it was not actually irrigated.
You can print out a report from beginning to end of season by clicking Report.
## Crop Water Use Application

**University of Missouri-Extension Horizon Point**

Crop Water Use Application

**Farmer:** Gene Stevens  
**Release Version:** March, 2015

**Field:** Lee Field 12-1b  
36.3943N 89.6117W  
**Soil Type:** sandy loam  
**24in root depth:**  
**50% allow depletion:**

<table>
<thead>
<tr>
<th>Date</th>
<th>Cum GDD60</th>
<th>Rainfall inch</th>
<th>Irrigation inch</th>
<th>ET crop inch</th>
<th>Soil H₂O Balance</th>
<th>Mgt Allow Deficit %</th>
<th>Dry Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thu</td>
<td>8-May</td>
<td>26</td>
<td>0.00</td>
<td>0.00</td>
<td>-0.04</td>
<td>3</td>
<td>OK</td>
</tr>
<tr>
<td>Fri</td>
<td>9-May</td>
<td>46</td>
<td>0.48</td>
<td>0.00</td>
<td>0.10</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>Sat</td>
<td>10-May</td>
<td>69</td>
<td>0.00</td>
<td>0.00</td>
<td>0.03</td>
<td>2</td>
<td>OK</td>
</tr>
<tr>
<td>Sun</td>
<td>11-May</td>
<td>96</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td>5</td>
<td>OK</td>
</tr>
<tr>
<td>Mon</td>
<td>12-May</td>
<td>121</td>
<td>0.25</td>
<td>0.00</td>
<td>0.10</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>Tue</td>
<td>13-May</td>
<td>139</td>
<td>0.4</td>
<td>0.00</td>
<td>0.09</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>Wed</td>
<td>14-May</td>
<td>142</td>
<td>0.9</td>
<td>0.00</td>
<td>0.03</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>Thu</td>
<td>15-May</td>
<td>146</td>
<td>0.19</td>
<td>0.00</td>
<td>0.04</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>Fri</td>
<td>16-May</td>
<td>153</td>
<td>0.01</td>
<td>0.00</td>
<td>0.04</td>
<td>2</td>
<td>OK</td>
</tr>
<tr>
<td>Sat</td>
<td>17-May</td>
<td>161</td>
<td>0.01</td>
<td>0.00</td>
<td>0.03</td>
<td>0</td>
<td>OK</td>
</tr>
<tr>
<td>Sun</td>
<td>18-May</td>
<td>172</td>
<td>0.00</td>
<td>0.00</td>
<td>0.05</td>
<td>8</td>
<td>OK</td>
</tr>
<tr>
<td>Mon</td>
<td>19-May</td>
<td>191</td>
<td>0.00</td>
<td>0.00</td>
<td>0.05</td>
<td>12</td>
<td>OK</td>
</tr>
<tr>
<td>Tue</td>
<td>20-May</td>
<td>217</td>
<td>0.00</td>
<td>0.00</td>
<td>0.07</td>
<td>17</td>
<td>OK</td>
</tr>
<tr>
<td>Wed</td>
<td>21-May</td>
<td>243</td>
<td>0.00</td>
<td>0.00</td>
<td>0.06</td>
<td>23</td>
<td>OK</td>
</tr>
<tr>
<td>Thu</td>
<td>22-May</td>
<td>272</td>
<td>0.00</td>
<td>0.00</td>
<td>0.07</td>
<td>28</td>
<td>OK</td>
</tr>
<tr>
<td>Fri</td>
<td>23-May</td>
<td>299</td>
<td>0.00</td>
<td>0.00</td>
<td>0.06</td>
<td>34</td>
<td>OK</td>
</tr>
<tr>
<td>Sat</td>
<td>24-May</td>
<td>324</td>
<td>0.02</td>
<td>0.00</td>
<td>0.06</td>
<td>37</td>
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<tr>
<td>Sun</td>
<td>25-May</td>
<td>350</td>
<td>0.00</td>
<td>0.00</td>
<td>0.06</td>
<td>43</td>
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<tr>
<td>Mon</td>
<td>26-May</td>
<td>379</td>
<td>0.00</td>
<td>0.00</td>
<td>0.07</td>
<td>49</td>
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<tr>
<td>Tue</td>
<td>27-May</td>
<td>404</td>
<td>0.29</td>
<td>0.00</td>
<td>0.14</td>
<td>37</td>
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</tr>
<tr>
<td>Wed</td>
<td>28-May</td>
<td>427</td>
<td>0.01</td>
<td>0.00</td>
<td>0.04</td>
<td>40</td>
<td>OK</td>
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<td>Thu</td>
<td>29-May</td>
<td>450</td>
<td>0.19</td>
<td>0.00</td>
<td>0.05</td>
<td>27</td>
<td>OK</td>
</tr>
</tbody>
</table>
NWS forecast and real-time weather from ag stations.

Tracks crop heat units

Shows calculations for soil H2O deficit.

Gene Stevens and Matt Rhine contact information.

Links to MU bulletin and YouTube videos.

Crop Water Use Application
### Lee Field 9-1

- **Crop:** Cotton
- **Planting date:** May 14, 2015
- **Soil texture:** silt loam
- **Cum GDD60:** 510

### Sat June 20, 2015

<table>
<thead>
<tr>
<th>Planting to</th>
<th>Grow D Day 60</th>
<th>Scout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence</td>
<td>50 to 60</td>
<td></td>
</tr>
<tr>
<td>First Square</td>
<td>480 to 530</td>
<td></td>
</tr>
<tr>
<td>First Bloom</td>
<td>775 to 850</td>
<td></td>
</tr>
<tr>
<td>Cutout</td>
<td>1285 to 1360</td>
<td></td>
</tr>
<tr>
<td>Harvest Ready</td>
<td>2200 to 2600</td>
<td></td>
</tr>
</tbody>
</table>


- Square retention during this period should range from 70 to 80%. Monitor retention during scouting.
- Irrigate to prevent water stress beginning at first square to establish plant structure and yield potential.
- Start PGR applications at 9 to 10 nodes-with a height-to-node ratio of no less than 2 on cotton that is stress-free and well-fertilized.
- Preserve beneficial insects. Avoid pesticide “convenience” applications.
### GDD Recommendations

#### Cotton

**Lee Field 9-1**
- **Crop:** Cotton
- **Planting date:** May 14, 2015
- **Soil texture:** silt loam
- **Cum GDD60:** 2350

**Mon Oct 5, 2015**

<table>
<thead>
<tr>
<th>Planting to</th>
<th>Grow D Day 60</th>
<th>Scout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence</td>
<td>50 to 60</td>
<td></td>
</tr>
<tr>
<td>Fst Square</td>
<td>480 to 530</td>
<td></td>
</tr>
<tr>
<td>Fst Bloom</td>
<td>775 to 850</td>
<td></td>
</tr>
<tr>
<td>Hrv Ready</td>
<td>2200 to 2600</td>
<td></td>
</tr>
</tbody>
</table>


#### Soybeans

**Lee Field 9-1**
- **Crop:** Soybean
- **Planting date:** May 14, 2015
- **Soil texture:** silt loam
- **Days from Planting:** 48

**Sun May 17, 2015**

<table>
<thead>
<tr>
<th>Planting to</th>
<th>Days</th>
<th>Scout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence</td>
<td>5 to 7</td>
<td></td>
</tr>
<tr>
<td>Full canopy</td>
<td>45 to 55</td>
<td></td>
</tr>
<tr>
<td>Flowering</td>
<td>50 to 70</td>
<td></td>
</tr>
<tr>
<td>Pod fill</td>
<td>70 to 100</td>
<td></td>
</tr>
<tr>
<td>Phy Maturity</td>
<td>100 to 130</td>
<td></td>
</tr>
</tbody>
</table>

*Source: W. Becker. The use of evapotranspiration estimates as a guide for scheduling irrigation in Missouri.*

#### Corn

**Lee Field 9-1**
- **Crop:** Corn
- **Planting date:** May 14, 2015
- **Soil texture:** silt loam
- **Cum GDD50:** 2500

**Sun May 17, 2015**

<table>
<thead>
<tr>
<th>Planting to</th>
<th>Grow D Day 50</th>
<th>Scout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>V6</td>
<td>475</td>
<td></td>
</tr>
<tr>
<td>VT (tassel)</td>
<td>1150</td>
<td></td>
</tr>
<tr>
<td>Silking</td>
<td>1400</td>
<td></td>
</tr>
<tr>
<td>R5 (dent)</td>
<td>2450</td>
<td></td>
</tr>
</tbody>
</table>

*Source: R. Hoeft et al., Modern corn and soybean production.*
What if I’m not from Missouri?

Choose MO loc and soil → Atmometers can be used to input local ET.

Current MU Research:
Atmometer runs
15% Lower ET
What if I’m not from Missouri?

Irrigation apps for several crops at
smartirrigationapps.org

Use the NOAA FRET estimation of ET
Predicts future ET across the US
Tends to slightly overestimate future ET
potentially faster irrigation triggers

NATIONAL WEATHER SERVICE

USDA
United States Department of Agriculture
National Institute of Food and Agriculture

UF/IFAS
UNIVERSITY OF GEORGIA
Summary

• Cotton rooting depths have been recorded as deep as 40” here at the Lee Farm
  – Managing irrigation at this soil depth is inefficient due to the small number of roots at this depth

• Our current rooting depth target for cotton is 18” when using the CWU app
  – Provided the highest yield in 2016, among highest in 2017

• While many treatments triggered the same number of irrigations during the season, these were all applied at different times
  – Irrigating timing significantly affected yield
Summary

• Previous research has shown rice to have an effective rooting depth of 8 inches, with fewer roots found in the 12-15” depth.

• A 6” irrigation trigger most closely resembles our early sprinkler irrigation schedule which has proven yield potential
  – Significant yield loss may be attributed to nitrogen leaching under frequent furrow irrigation

• 12” irrigation trigger may allow you to irrigate less while maintaining yield
  – Highest yields in 2017

• An 18” trigger may not adequately provide for plant needs
Thank you!

To register go to cropwater.org