Irrigation, Pumps, & Wells

Joe Henggeler, Associate Professor
Biological Engineering Department,
University of Missouri
Presentation Topics

- Water use reporting.
- Irrigation IQ.
- Load management.
- Multiple Inlet Flow.
- Dropping water table.
- Study findings.
  - Diesel/propane flexible; electricity isn’t.
  - For open flow, find the RPM with the cheapest water.
  - Well installation is important.

- For our new wells.
Where does Bootheel Water Come From?
Where does Bootheel Water Come From?
Where does Bootheel Water Come From?
Where does Bootheel Water Come From?
Where does Bootheel Water Come From?
Where does Bootheel Water Come From?
Where does Bootheel Water Come From?
Where does Bootheel Water Come From?
Where does Bootheel Water Come From?
Where does Bootheel Water Come From?

“Water-saving rice irrigation and ... future irrigation demand in Mississippi”
Where does Bootheel Water Come From?

“Why should we improve water management in rice production”

“Water-saving rice irrigation”

“Demand in Mississippi”

“Future irrigation”
Where does Bootheel Water Come From?

"Water-saving techniques improve water management in rice production."

"Why should we conserve water in rice production?"

"Curbing water usage to preserve this precious commodity."

"Mississippi River Valley alluvial aquifer."

"Water demand in Mississippi... future irrigation."
Load Management – acres & Q

Savings Incurred from Load Management

<table>
<thead>
<tr>
<th>Size (acres)</th>
<th>Flow Rate (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>1,500</td>
<td>1,500</td>
</tr>
<tr>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>2,500</td>
<td>2,500</td>
</tr>
<tr>
<td>3,000</td>
<td>3,000</td>
</tr>
</tbody>
</table>

Savings Using Load Management

- $0.00-$5.00
- $5.00-$10.00
- $10.00-$15.00
- $15.00-$20.00
- $20.00-$25.00
- $25.00-$30.00
- $30.00-$35.00
Multiple Inlet Flow
Dropping Water Table

The chart shows the depth to the water table over time from January to December of 2012. The graph includes lines for average depth (Avg), shallowest depth (Shallowest), deepest depth (Deepest), and the specific data for 2012 (2012). The depth is measured in feet (ft) on the y-axis, and time is on the x-axis, from 1-Jan to 31-Dec.
Dropping Water Table

Cost of Water vs. Additional Drop in Water Table

- Diesel:
  \[ y = 0.0463x + 1.8433 \]
  \[ R^2 = 0.9859 \]

- Electric:
  \[ y = 0.0298x + 1.0116 \]
  \[ R^2 = 0.8844 \]

Cost of Water ($/acre-inch)

Additional Drop in Water Table (feet)
Pump Testing in Missouri
Pump Testing in Missouri

**Engine Speed**
- 1250 RPM
- 1350 RPM
- 1450 RPM
- 1550 RPM

**W. Table Drop**
- 0 feet
- 12 feet
- 18 feet
- 30 feet
Pump Testing in MO & Efficiency

- Pivots
  - Electric or diesel.

- Flood
  - Diesel.

- Flood
  - Electric.
Pump Testing in Missouri
Pump Testing in Missouri

**Diesel Use Rate vs. RPM**

\[ y = 5 \times 10^{-6}x^2 - 0.0098x + 6.0133 \]

\[ R^2 = 1 \]

**Flow Rate vs. RPM**

\[ y = -0.0021x^2 + 8.0792x - 5.6447 \]

\[ R^2 = 0.9866 \]

**NE Pumping Plant Performance Criteria vs. RPM**

\[ y = -3 \times 10^{-6}x^2 + 0.0079x - 4.9233 \]

\[ R^2 = 0.7505 \]

**Cost of Water vs. RPM**

\[ y = 6 \times 10^{-6}x^2 - 0.0153x + 11.612 \]

\[ R^2 = 0.9458 \]
Pump Testing in Missouri

Pump Affinity Laws

\[ y = -3 \times 10^{-5} x^2 + 0.1156 x - 66.057 \]

\[ R^2 = 0.9953 \]

Total Dynamic Head vs. RPM

- 30.0
- 32.5
- 35.0
- 37.5
- 40.0
- 42.5
- 45.0

RPM

1,200 1,300 1,400 1,500 1,600

Total Dynamic Head (feet)
Pump Testing in Missouri

Pump Affinity Laws

![Graph showing TDH (feet) vs. RPM with two lines: one for "As Tested" and one for "Affinity Laws". The graph illustrates the relationship between TDH and RPM.]
**Pump Testing in Missouri**

**Drop in Water Table**

**PIVOT SYSTEM**

Flow Rate vs. Additional Water Table Drop for an Electric Pumping Plant:

\[ y = -3.3826x + 551.2 \]

\[ R^2 = 0.769 \]

11% reduction

**FURROW SYSTEM**

Flow Rate vs. Additional Water Table Drop for an Electric Pumping Plant:

\[ y = -30.046x + 1279.5 \]

\[ R^2 = 0.9677 \]

75% reduction
Pump Testing in Missouri

Cost of Water vs Pumping Plant Efficiency:
Diesel

Cost of Water vs Pumping Water Level:
Diesel

\[ y = 0.0005x^2 - 0.0074x + 1.3739 \]
\[ R^2 = 0.7065 \]
Pump Testing in Missouri

Cost of Water vs Specific Capacity:
Diesel

\[ y = -3 \times 10^{-6}x^2 - 0.0032x + 2.1891 \]
\[ R^2 = 0.4491 \]
Pump Testing in Missouri

Cost of Water vs Specific Capacity: Diesel

\[ y = -3E-05x^2 - 0.0032x + 2.1891 \]
\[ R^2 = 0.4491 \]
What We Need to Do

1) Report your water usage.
2) Irrigation IQ.
3) Load management.
4) Multiple Inlet Flow.
5) Dropping water table.
6) Study findings.
   1) Diesel/propane flexible; electricity isn’t.
   2) For open flow, find the RPM with the cheapest water.
   3) Well installation is important.
7) For our new wells.
Thanks