Overview of Sensor-based Irrigation Scheduling

2012 Precision Cotton Irrigation Workshop - Tunica, MS

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Cotton Inc
Smartfield
Greenway Equipment & Solstice Crop Management
John Deere Water

University of Tennessee
West Tennessee REC
Deficit Irrigation by Starting at Different Growth Stages

1. First Square
2. First Bloom
3. Two Weeks after Bloom

West Tennessee Location

Chris Main – WTREC
Owen Gwathmey – WTREC
David Verbree - WTREC
Also Different Rates of Deficit Irrigation

1.5” per week

1.0” per week

0.5” per week

Deep Silt Loam – 8 inches of Available Water
2006 to 2011 Results

- 5 out of 6 years optimal yield w/ irrigation at post bloom
- 4 out of 6 years optimal yield w/ 1.0 in/wk or less
- 5 out of 6 years reduced yield w/ 1.5 in/wk at square

Gross Return from a 200 ac field

- $251,000 increase from optimal irrigation over rain-fed
- 2.5 in/yr of under irrigation lost $91,000
- 2.5 in/yr of over irrigation lost $120,000
Sensor Types - Soil Tension

- Ceramic tip & gauge
- 0 to 60 cbars (wet)
- Very accurate
- Hydraulic Contact w/ Soil

- Electrodes in granular matrix
- 0 to 200 cbars
- OK accuracy
- Hydraulic Contact w/ Soil
Sensor Types – Soil Water Content

- Radiation Source
- License & Training
- Most Accurate
- Easy to Calibrate
- All Soils
- Can’t Remain in the Field
- Access Tube
- Fit not Critical
Sensor Types – New Soil Water Content

- Capacitance
- Attenuate the Frequency
- Vertical Access Tube
- Very Sensitive
- Air Gaps cause Problems

- or Dielectric Constant
- Wave Propagation
- Wire Guides into Side Wall
- Calibration Transfers
- Air Gaps cause Problems
Sensor Type and Installation

- Auger for Cylindrical Shapes
- Slurry
- Force Fit
- Neutron Probe Loose Fit Allowed

- Excavation for Odd Shapes
- Hand Pack
- Insert into Sidewall
- Limited Depth to Arm Length
Methods of Obtaining Soil Water Data - In-field Data Collection

$300 to $1000 for two sensors and hand reader
Methods of Obtaining Soil Water Data – Edge of Field Logging

$500 to $2,000 for at least two sensors, a logger and wires or a transmitter

Wired

Wireless
Methods of Obtaining Soil Water Data – Office Computer and Smart Phone Access

$1,500 to $5,000 per monitoring site plus $125 to $400 for communication and data hosting fees
Methods of Obtaining Soil Water Data – Capacitance Probes have Similar Configurations
## Methods of Obtaining Soil Water Data – Communications Options

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<tr>
<th>Telemetry System</th>
<th>Considerations</th>
<th>Annual Cost</th>
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<tr>
<td>Satellite</td>
<td>Complete coverage</td>
<td>Intermediate to High</td>
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<td></td>
<td>Highly dependable</td>
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<tr>
<td>Cell Modem</td>
<td>Reliable</td>
<td>Intermediate</td>
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<td></td>
<td>Requires cell signal</td>
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<tr>
<td>Radio</td>
<td>Requires some technical skill to install</td>
<td>Low</td>
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<td>Less dependable</td>
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Methods of Obtaining Soil Water Data – Portable Sensors and Data Loggers

Neutron Probe

$4,000 to $8,000

TDR Capacitance
Locating Sensor Systems by Crop and Soil Type

- **Upland Soil**
  - Hill Tops – Deep, Well Drained
  - Side Slopes - Shallow with Run-off
  - Drainages – Deep, Poorly Drained

- **Mississippi Bottom Soil**
  - Sand to Clay side-by-side

- **Schedule Irrigation by:**
  - Lowest Water Holding Capacity
  - Predominant Soil Type
  - Variable Rate Irrigation
Locating Sensor Systems by Irrigation Type

- Not at center point or under the end-gun. Outer spans.
- Not in low areas where system drains.
- Head and tail of the furrows due to disuniformity.
Locating Sensors to Protect your Investment by Avoiding Field Operations

- In no-till, sensors & underground wire can be permanently installed.
- In tilled, sensors, wires, loggers and transmitters will be installed after N injection and removed before harvest. (non-cylindrical are harder to remove)
- Avoid sprayer wheel tracks, muddy wires can pick-up wires
- Radio antennas need to be lowered or be flexible (whip type) while cell phone and satellite can be below the canopy.
- Accessible locations for repair
Interpreting Sensor Results

Tension vs Water Content

- **Tension (cbar)** has a more similar meaning between soil types.
- In sandy soil, stay above 50 to 60 cbar.
- In silt loam, allow tension to approach 60 cbar during square. At bloom maintain 60 to 80 cbar if dry but 100 to 120 cbar if intermittently rainy.

- **Water content (%)** need to establish field capacity and a trigger point for each soil.
- Can see water movement from rainfall and irrigation with 10 or 5 sensor probes.
- Change in water content directly related to the amount of irrigation and rainfall.
- Some portion of the root zone must have readily available water.
Interpreting Sensor Results
Soil Tension Example

2007 Deficit Irrigation of Cotton
Average of Sensors, Jackson, TN

Tension in cbars

-200.0
-150.0
-100.0
-50.0
0.0


GS1 100% 10.2" +765lbs
GS2 100% 7.7" +919lbs
GS3 100% 6.7" +927lbs
GS3 66% 4.5" +705lbs
Dryland 923 lbs
Interpreting Sensor Results
Soil Water Content Example

Mixed Soil - Rainfed

Mixed Soil – Bloom
1.0 inches/week
Smartfield Canopy Temperature in Deficit Cotton Experiment
Canopy Temperature – SmartField
July 20 to 26, 2011

Sand - Rainfed

Sand – Square
0.5 inches/week

Sand – Square
1.0 inches/week

Sand – Square
1.5 inches/week
Canopy Temperature – SmartField
July 20 to 26, 2011

Mixed - Rainfed

Mixed – Square
0.5 inches/week

Mixed – Square
1.0 inches/week

Mixed – Square
1.5 inches/week
Conclusion

- Cotton Water Management is Important for Optimizing your Investment in Irrigation.
- Sensor-based System can help you make Optimal Irrigation Decisions.
- Choosing a System and using it Effectively involve Several Factors
  - Type of Sensor
  - Method of Data Collection
  - Cost (initial, amortized and recurring)
  - Proper Location and Installation
  - Ability to Interpret the Results