# 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

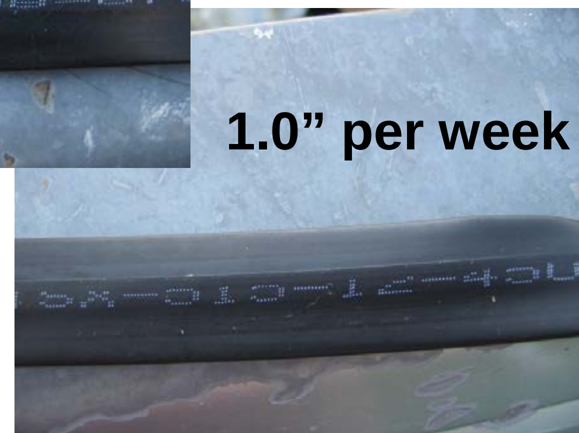
# Deficit Irrigation by Starting at Different Growth Stages

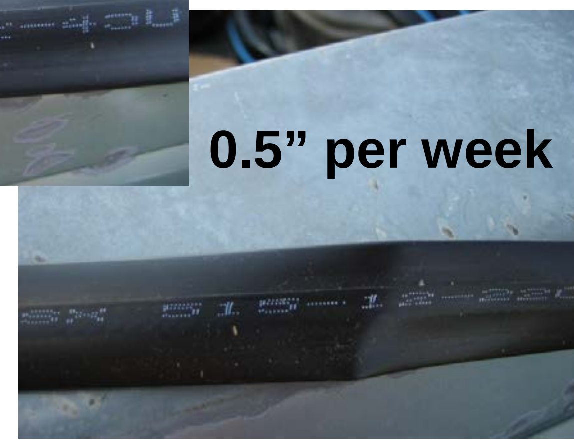

1. First Square
2. First Bloom
3. Two Weeks after Bloom

West Tennessee Location

Chris Main – WTREC
Owen Gwathmey – WTREC
David Verbree - WTREC

# Also Different Rates of Deficit Irrigation


**Deep Silt Loam – 8 inches of Available Water**

# 2006 to 2011 Results

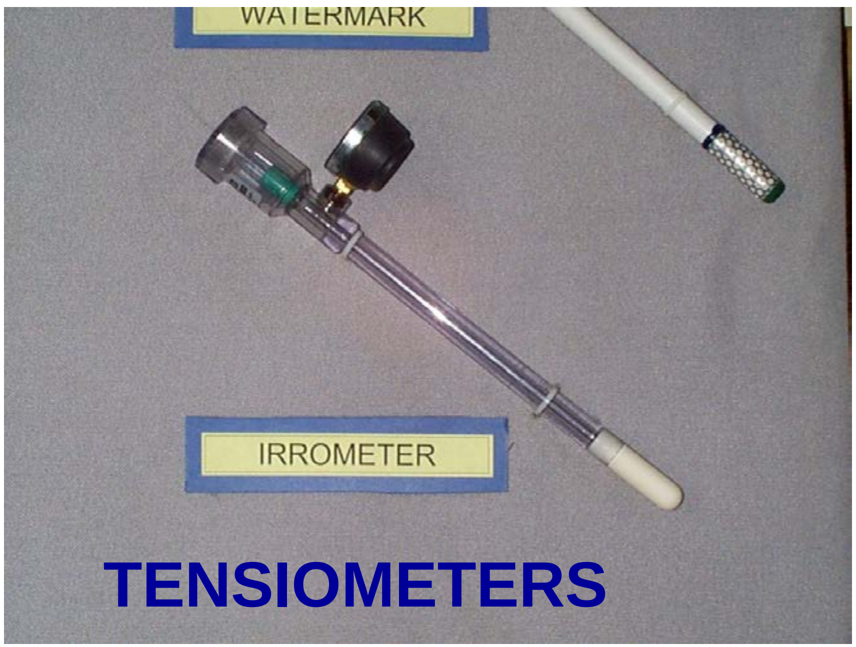
- 5 out of 6 years optimal yield w/ irrigation at post bloom
- 4 out of 6 years optimal yield w/ 1.0 in/wk or less
- 5 out of 6 years reduced yield w/ 1.5 in/wk at square

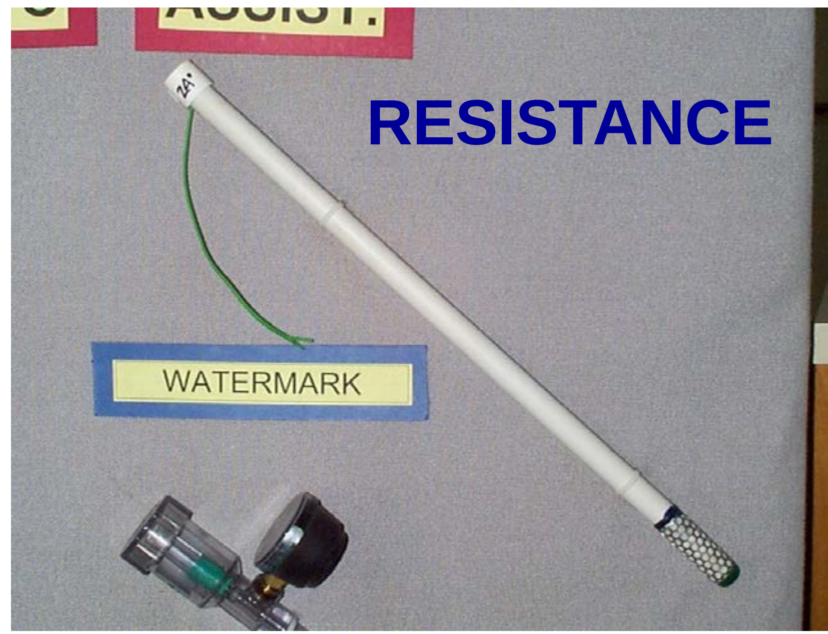
- **Gross Return from a 200 ac field**
- $251,000 increase from optimal irrigation over rain-fed
- 2.5 in/yr of under irrigation lost $91,000
- 2.5 in/yr of over irrigation lost $120,000

# 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

**NEUTRON SCATTERING**

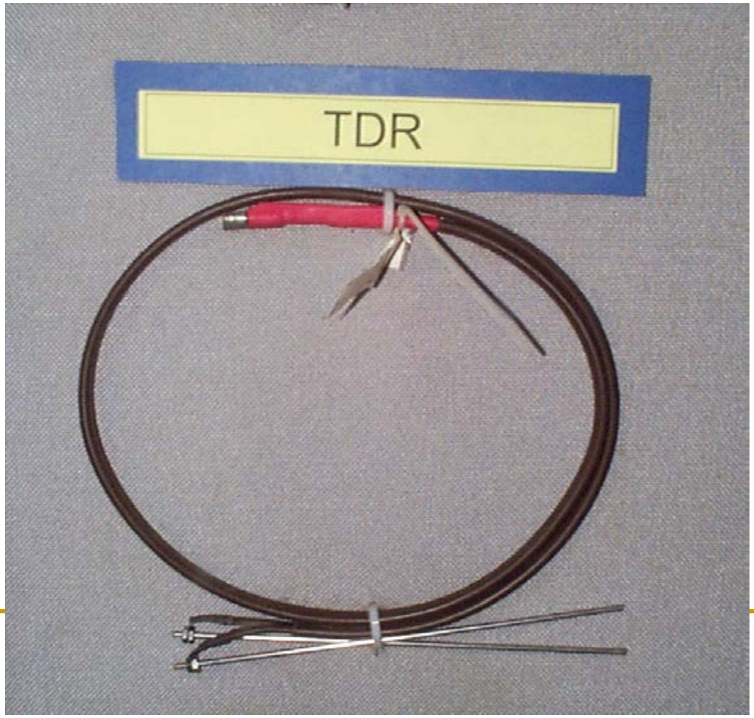
- Radiation Source
- License & Training
- Most Accurate
- Easy to Calibrate
- All Soils
- Can't Remain in the Field
- Access Tube
- Fit not Critical

# 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

**FDR - Frequency**




**TDR – Time**

# 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**

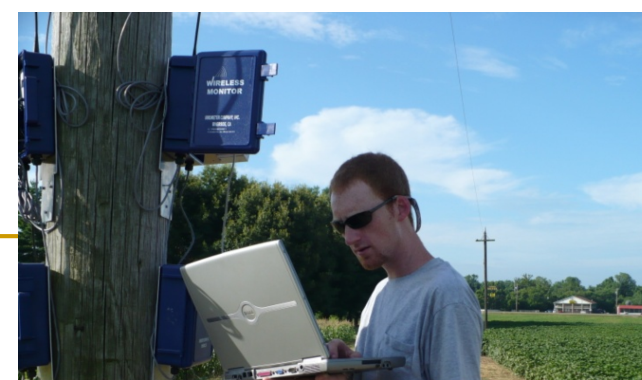
$300 to $1000 for two sensors and hand reader

# 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

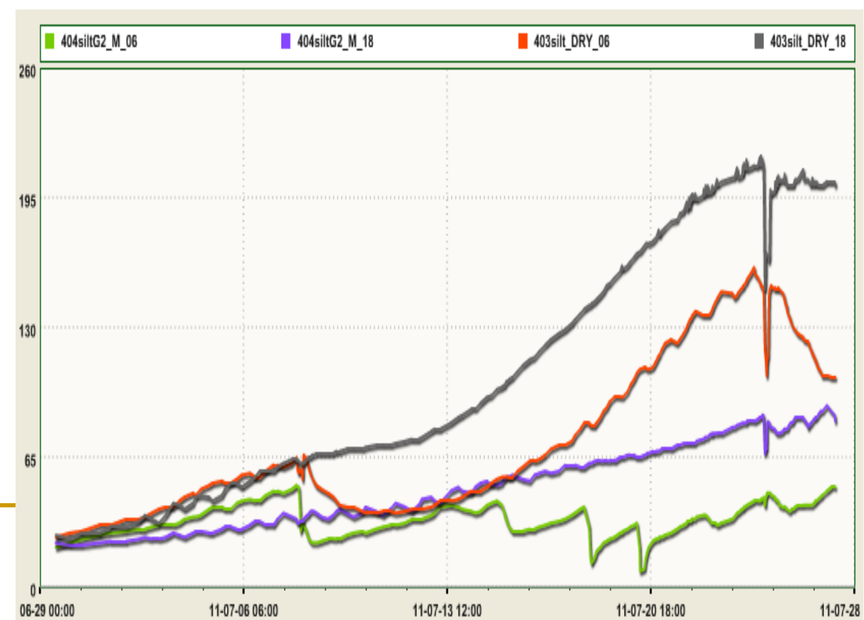
Wired

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**

| Telemetry System | Considerations | Annual Cost |
| --- | --- | --- |
| Satellite | Complete coverage<br>Highly dependable | Intermediate to High |
| Cell Modem | Reliable<br>Requires cell signal | Intermediate |
| Radio | Requires some technical skill to install<br>Less dependable | Low |

# Methods of Obtaining Soil Water Data – **Portable Sensors and Data Loggers**

Neutron Probe

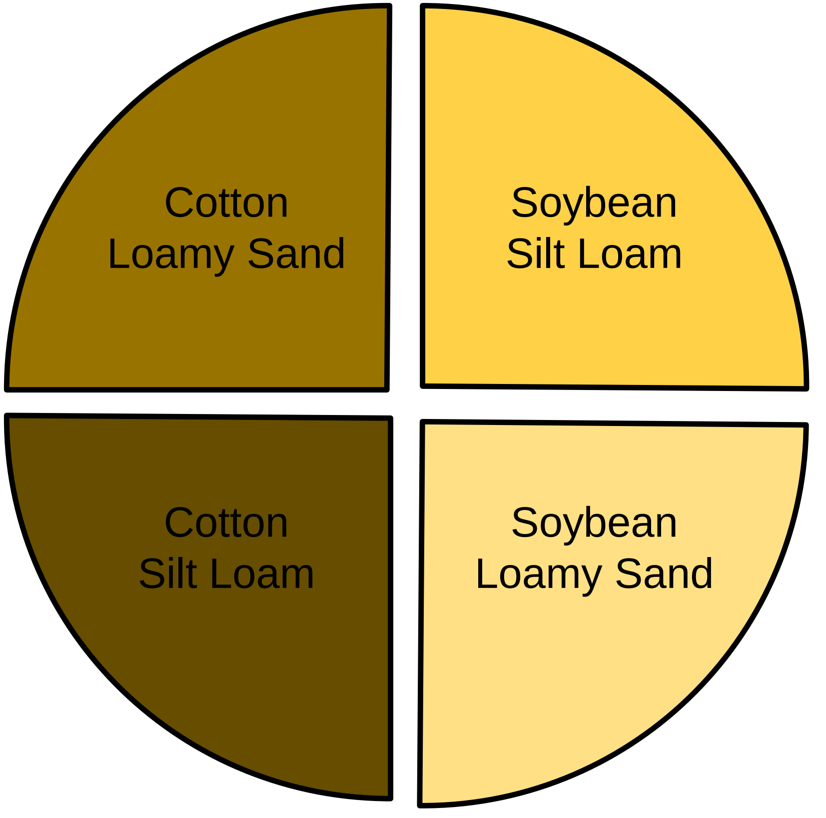
$4,000
to
$8,000

TDR Capacitance

# Locating Sensor Systems by Crop and Soil Type

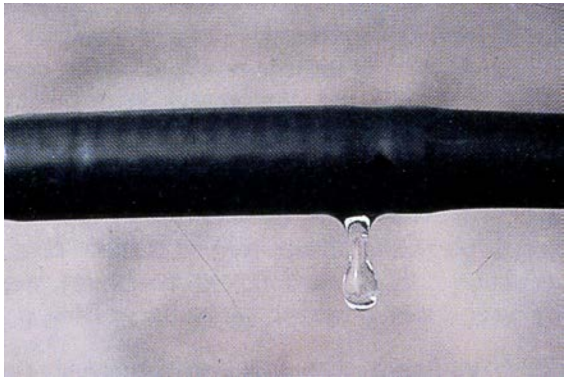
- Upland Soil
  - Hill Tops – Deep, Well Drained
  - Side Slopes - Shallow with Run-off
  - Drainages – Deep, Poorly Drained
- Mississippi Bottom Soil
  - Sand to Clay side-by-side

- Schedule Irrigation by:
  - Lowest Water Holding Capacity
  - Predominant Soil Type
  - Variable Rate Irrigation



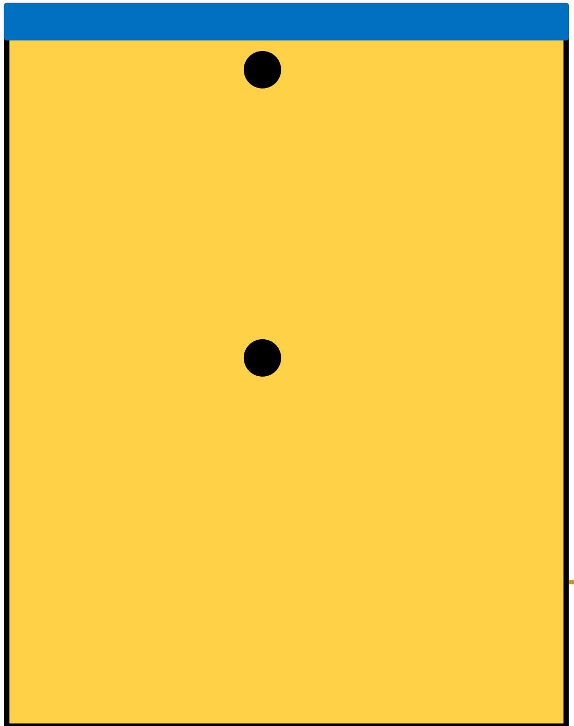
# Locating Sensor Systems by Irrigation Type

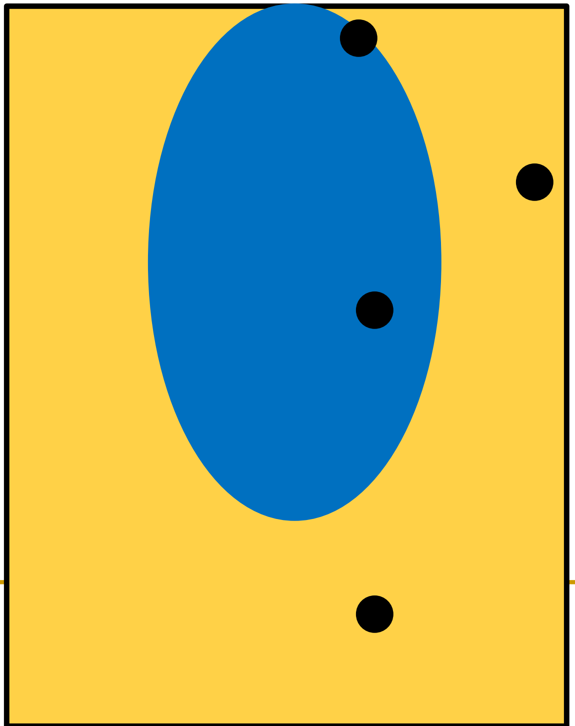
Not at center point or under the end-gun. Outer spans.

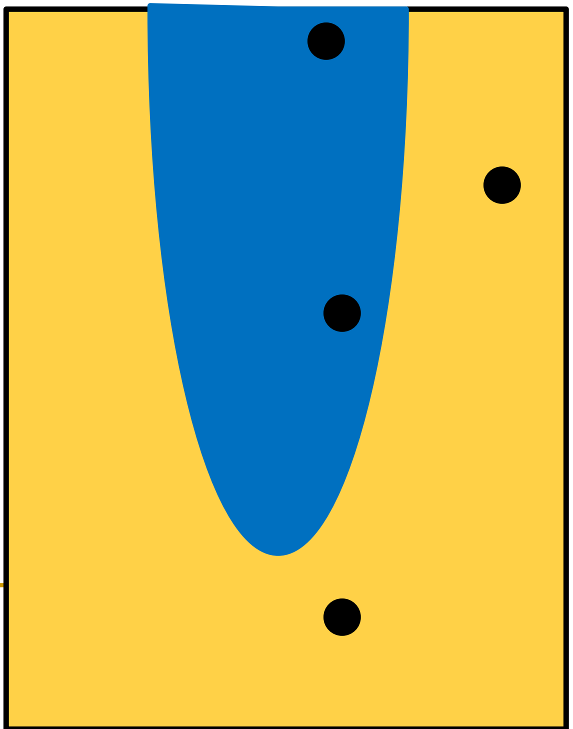


Not in low areas where system drains.

Head and tail of the furrows due to disuniformity.







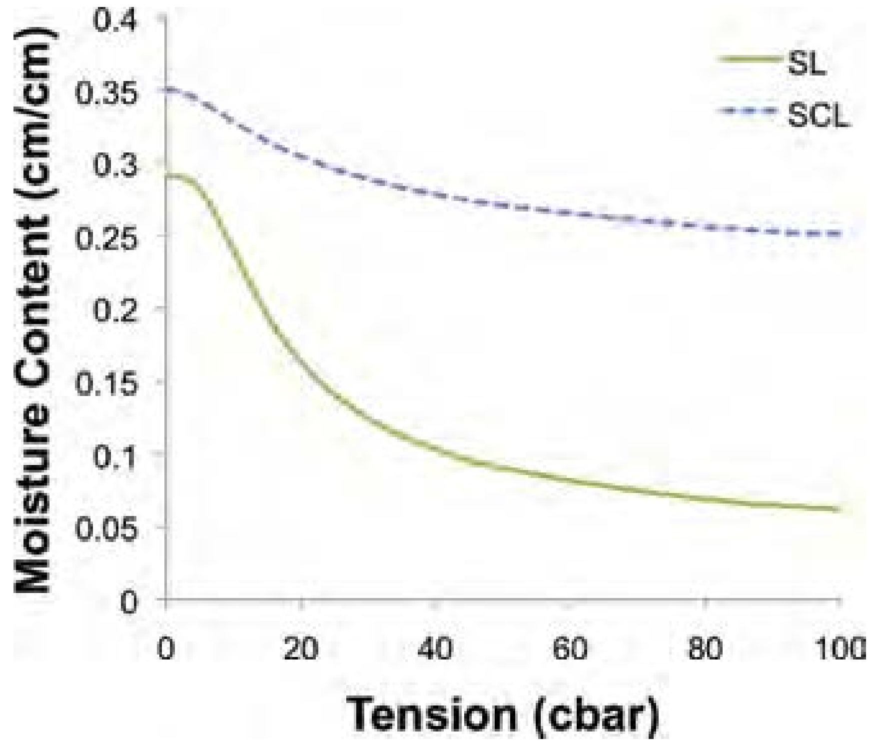
# Locating Sensors to Protect your Investment by Avoiding Field Operations

- In no-till, sensors & under ground 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

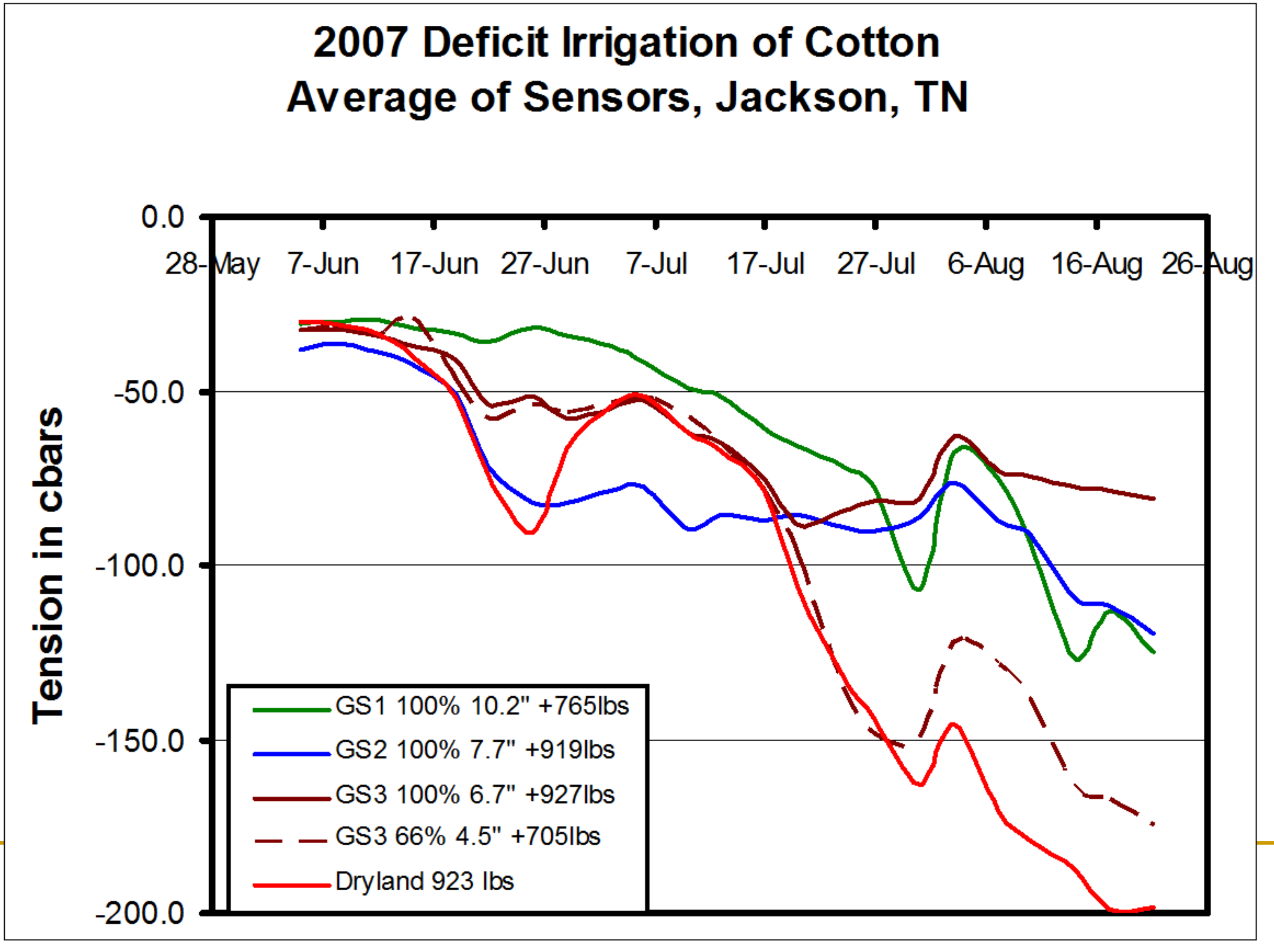
# Interpreting Sensor Results Tension vs Water Content

- **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 to120 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 most have readably available water.

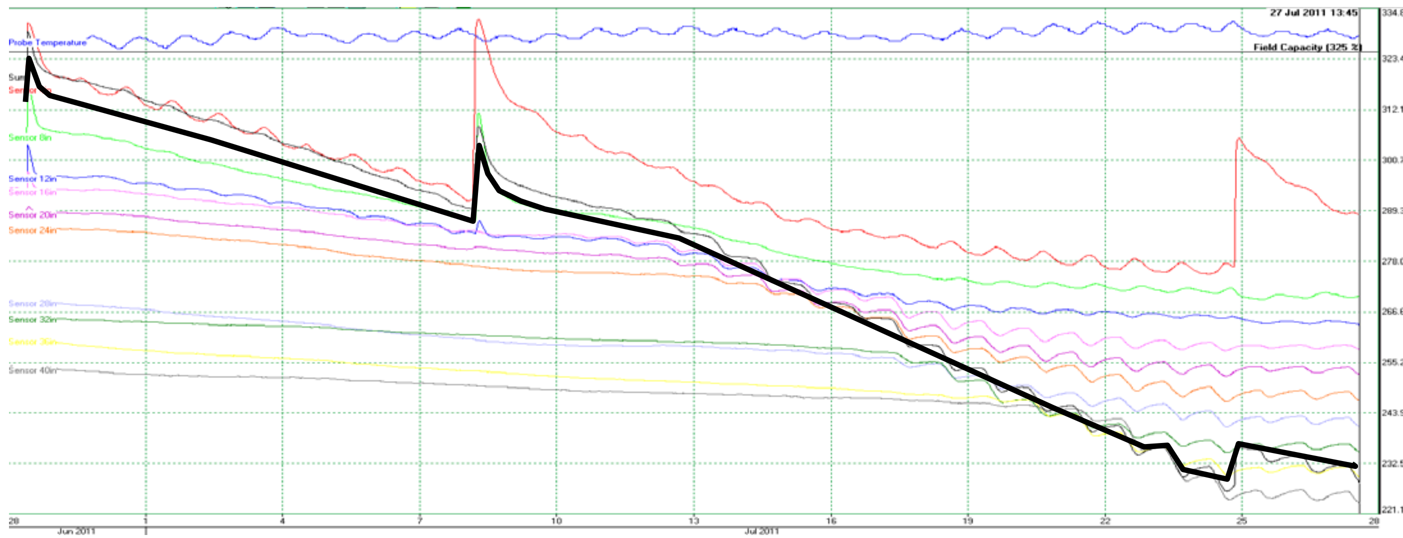


# Interpreting Sensor Results
# Soil Tension Example

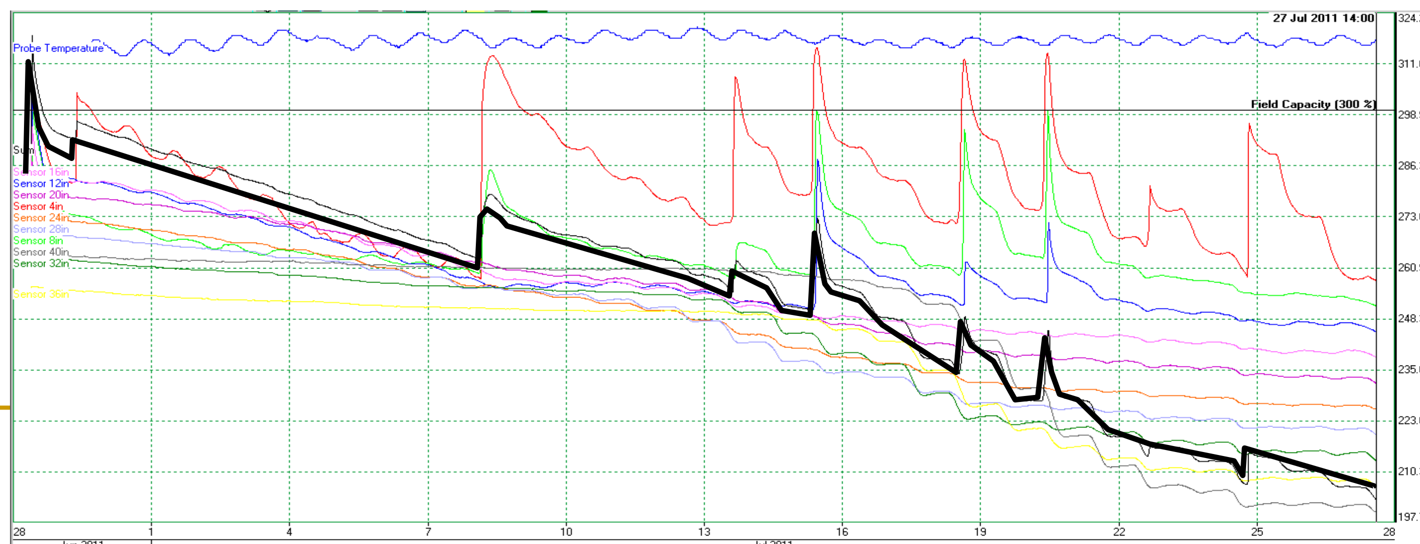


# Interpreting Sensor Results
# Soil Water Content Example

Mixed Soil - Rainfed




Mixed Soil – Bloom
1.0 inches/week

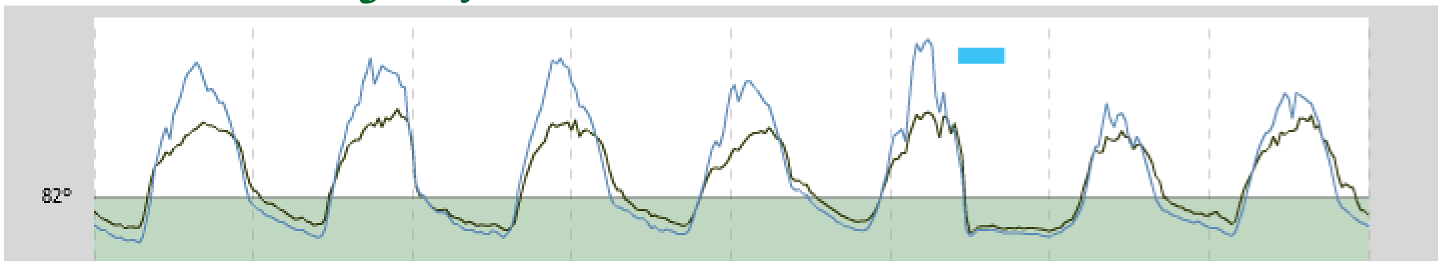


# Smartfield Canopy Temperature in Deficit Cotton Experiment

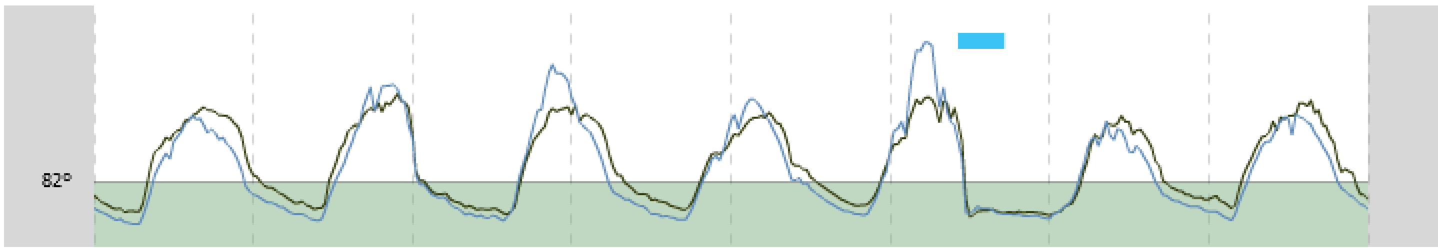

# Canopy Temperature – SmartField

## July 20 to 26, 2011

Sand - Rainfed




Sand – Square
0.5 inches/week




Sand – Square
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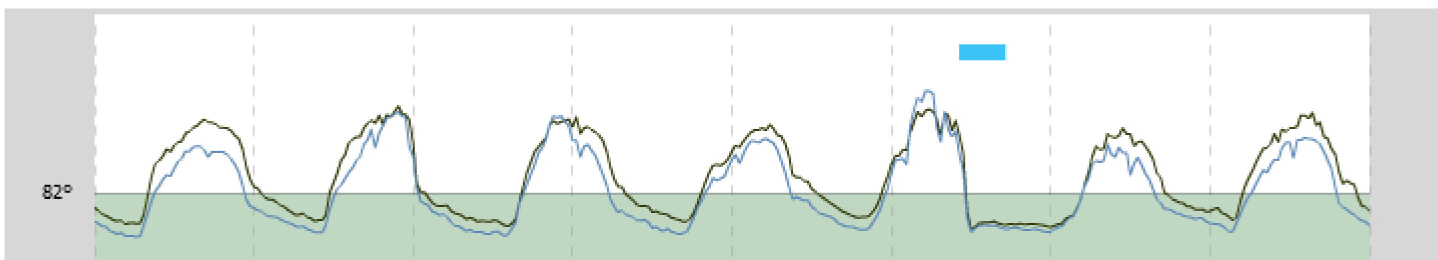


Sand – Square
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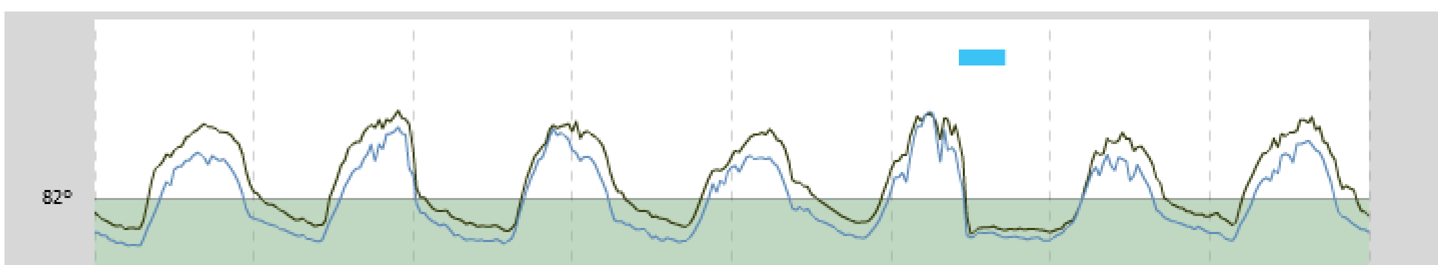

# Canopy Temperature – SmartField

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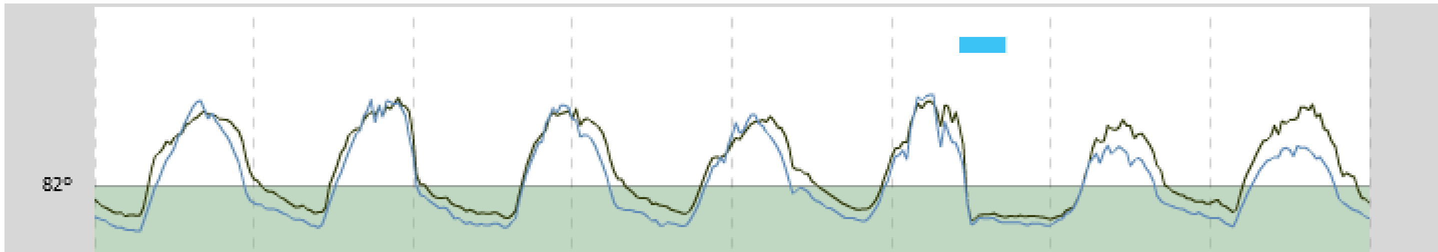
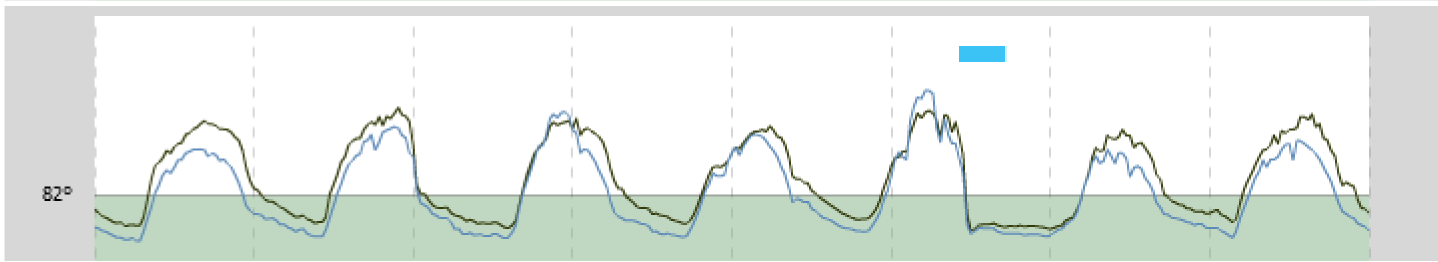
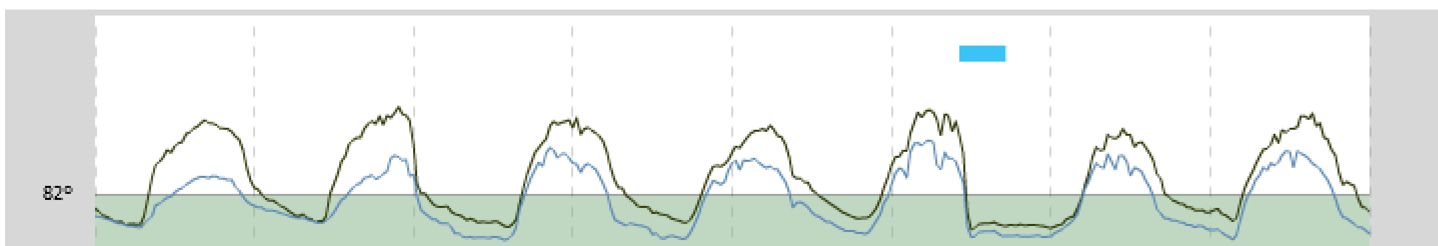


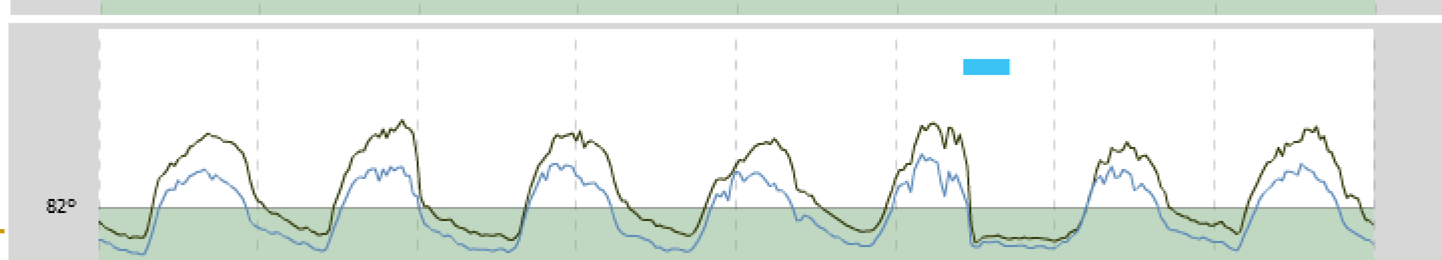

Mixed – Square
0.5 inches/week




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