
Overview of Sensor-based Irrigation Scheduling

2012 Precision Cotton Irrigation Workshop - Tunica, MS

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Ken Fisher – USDA-ARS Stoneville, 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



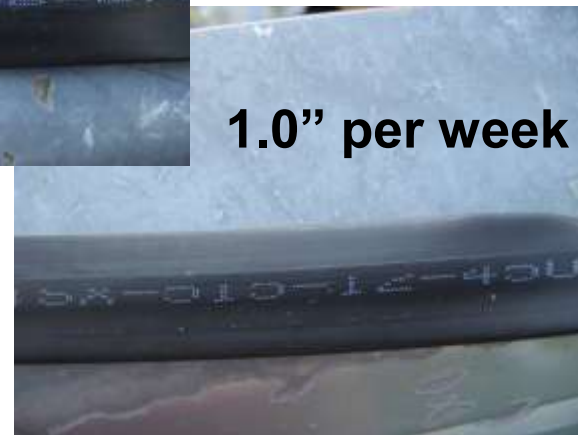
West Tennessee
Location



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

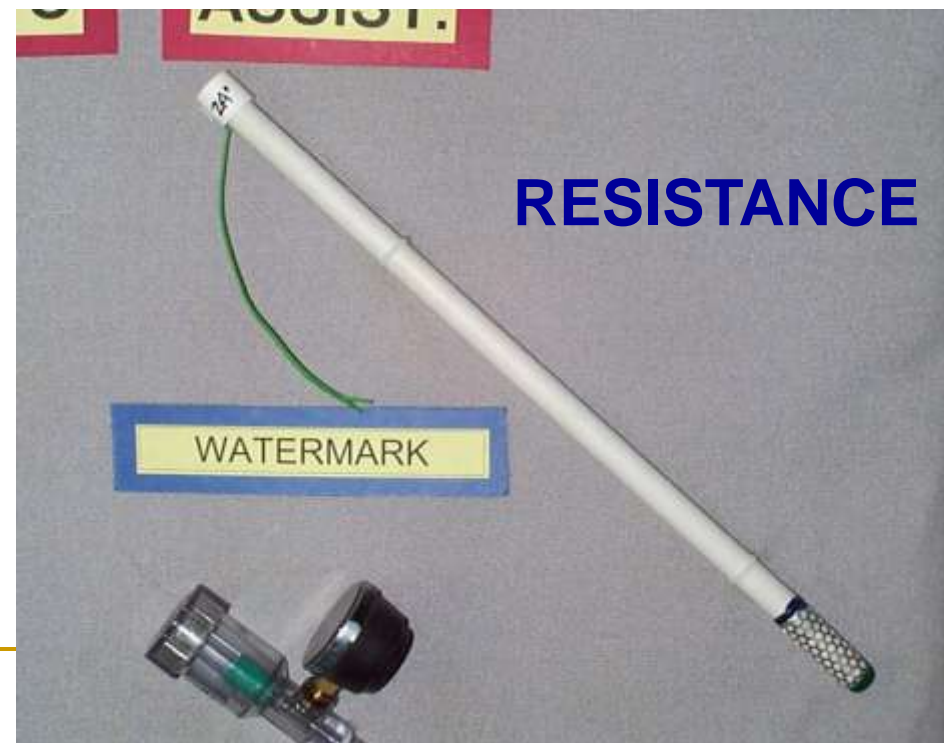
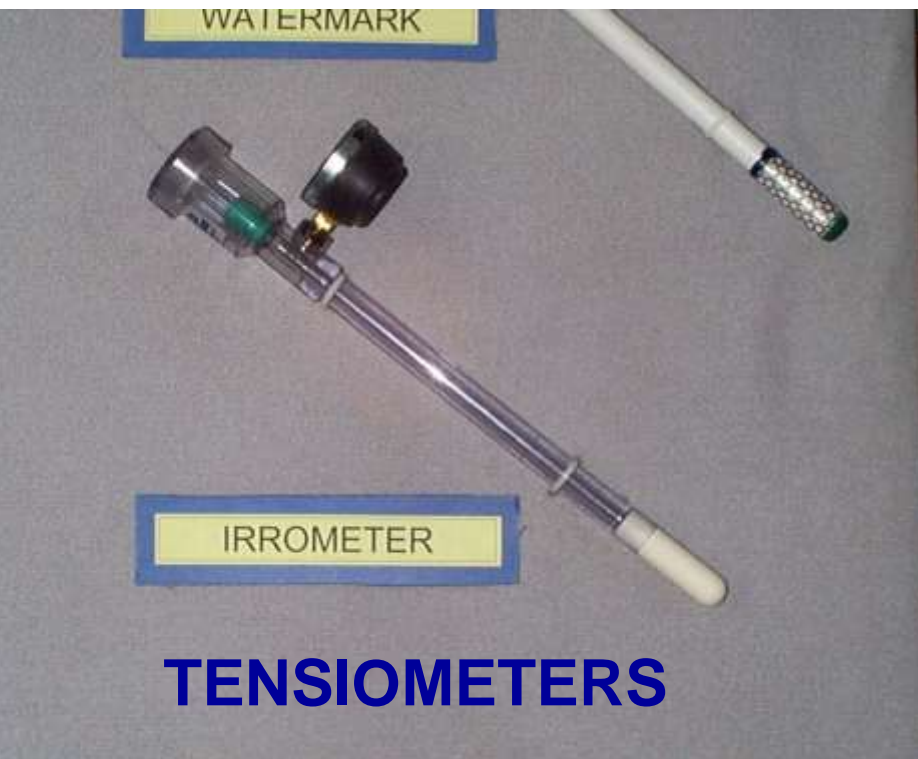
- 5 out of 6 years optimal yield w/ irrigation at post bloom
- 4 out of 6 years optimal yield w/ 1.0 in/wk or less
- 5 out of 6 years reduced yield w/ 1.5 in/wk at square
- **Gross Return from a 200 ac field**
- \$251,000 increase from optimal irrigation over rain-fed
- 2.5 in/yr of under irrigation 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

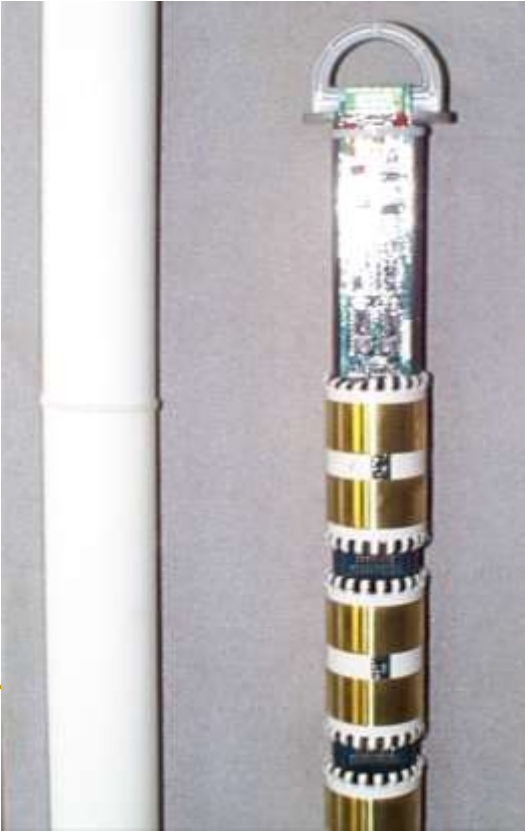
- Radiation Source
- License & Training
- Most Accurate
- Easy to Calibrate
- All Soils
- Can't Remain in the Field
- Access Tube
- Fit not Critical



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

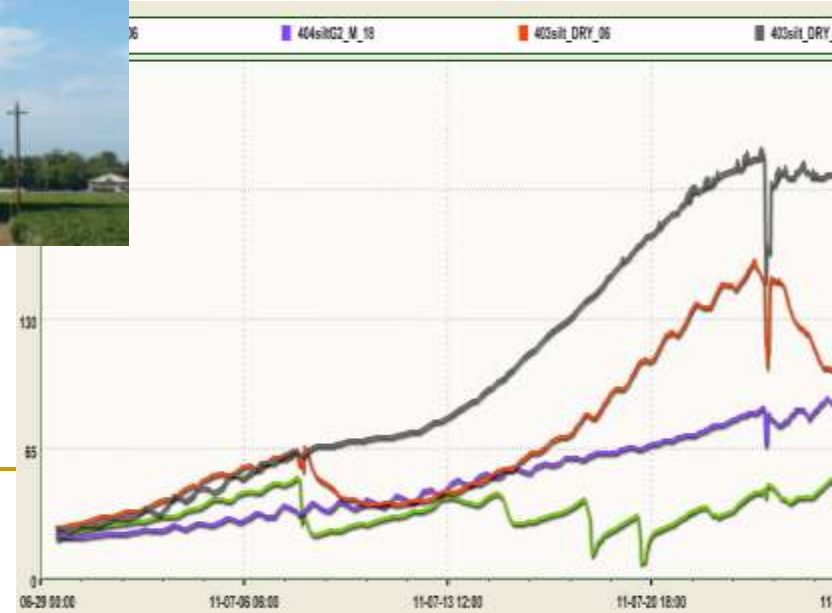


Wireless

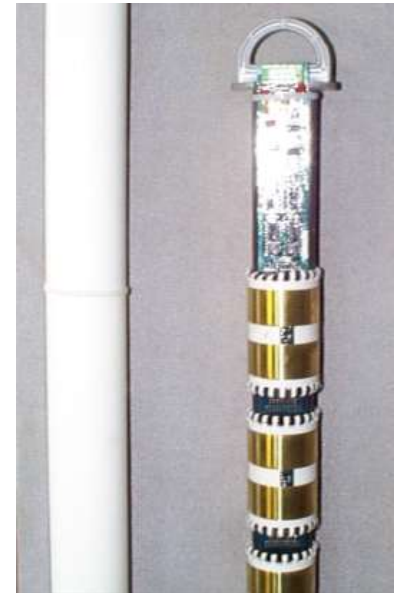


Methods of Obtaining Soil Water Data – Office Computer and Smart Phone Access

\$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 Highly dependable	Intermediate to High
Cell Modem	Reliable Requires cell signal	Intermediate
Radio	Requires some technical skill to install Less dependable	Low

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

Neutron Probe



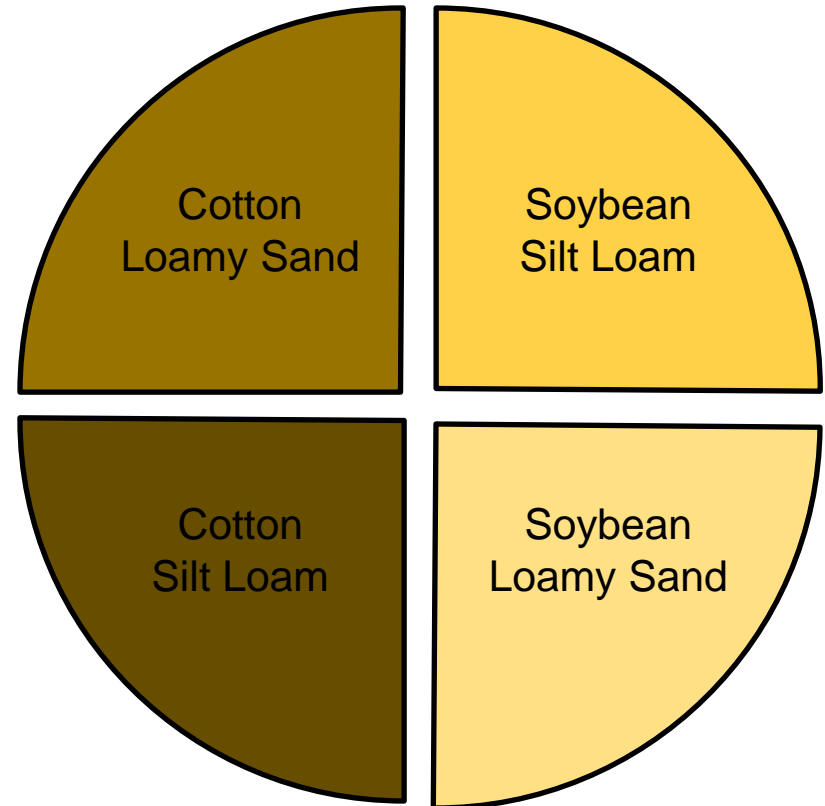
\$4,000
to
\$8,000

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



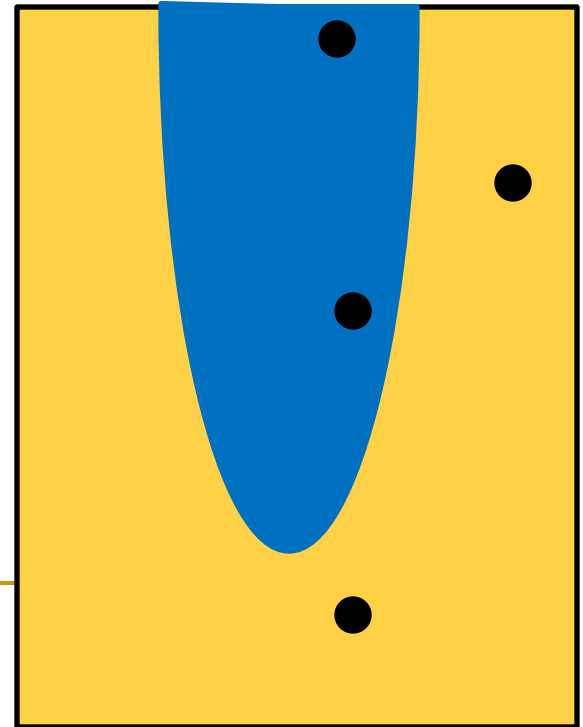
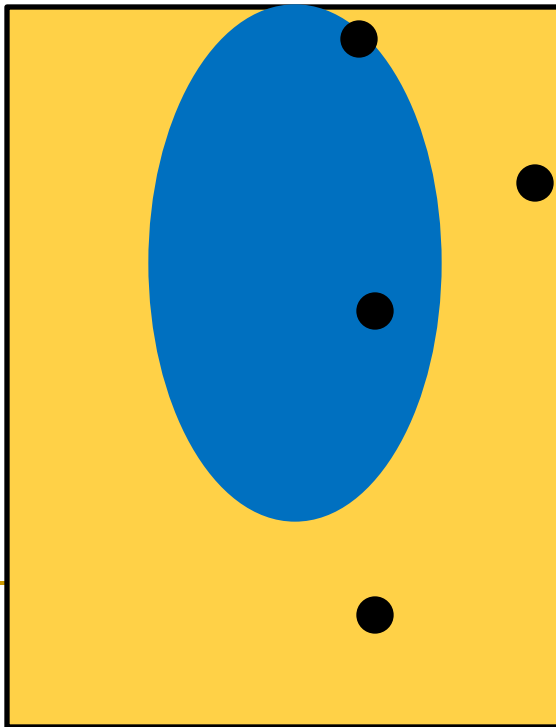
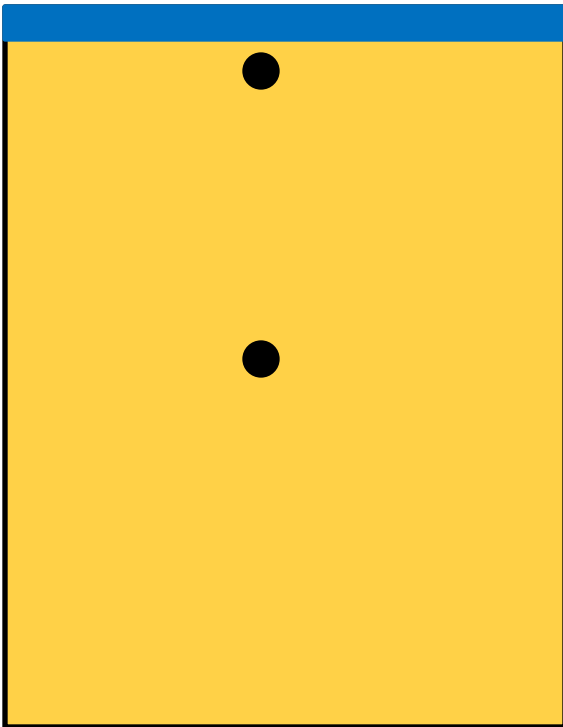
Not at center point or under the end-gun. Outer spans.



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

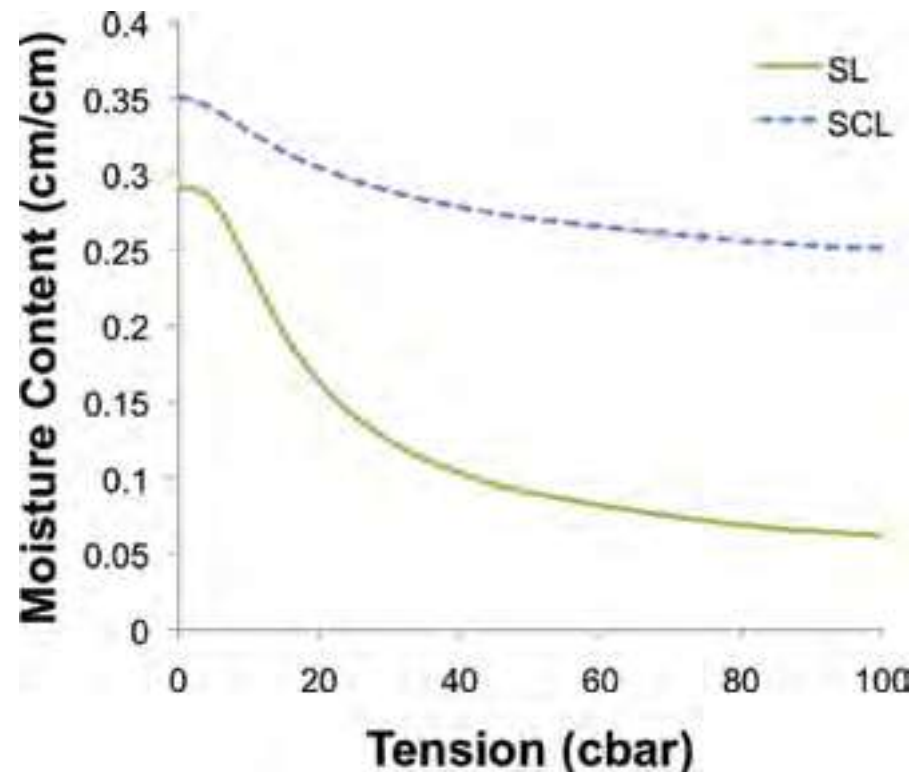
- In no-till, sensors & under ground wire can be permanently installed
- In tilled, sensors, wires, loggers and transmitters will be installed after N injection and removed before harvest. (non-cylindrical are harder to remove)
- Avoid sprayer wheel tracks, muddy wires can pick-up wires
- Radio antennas 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

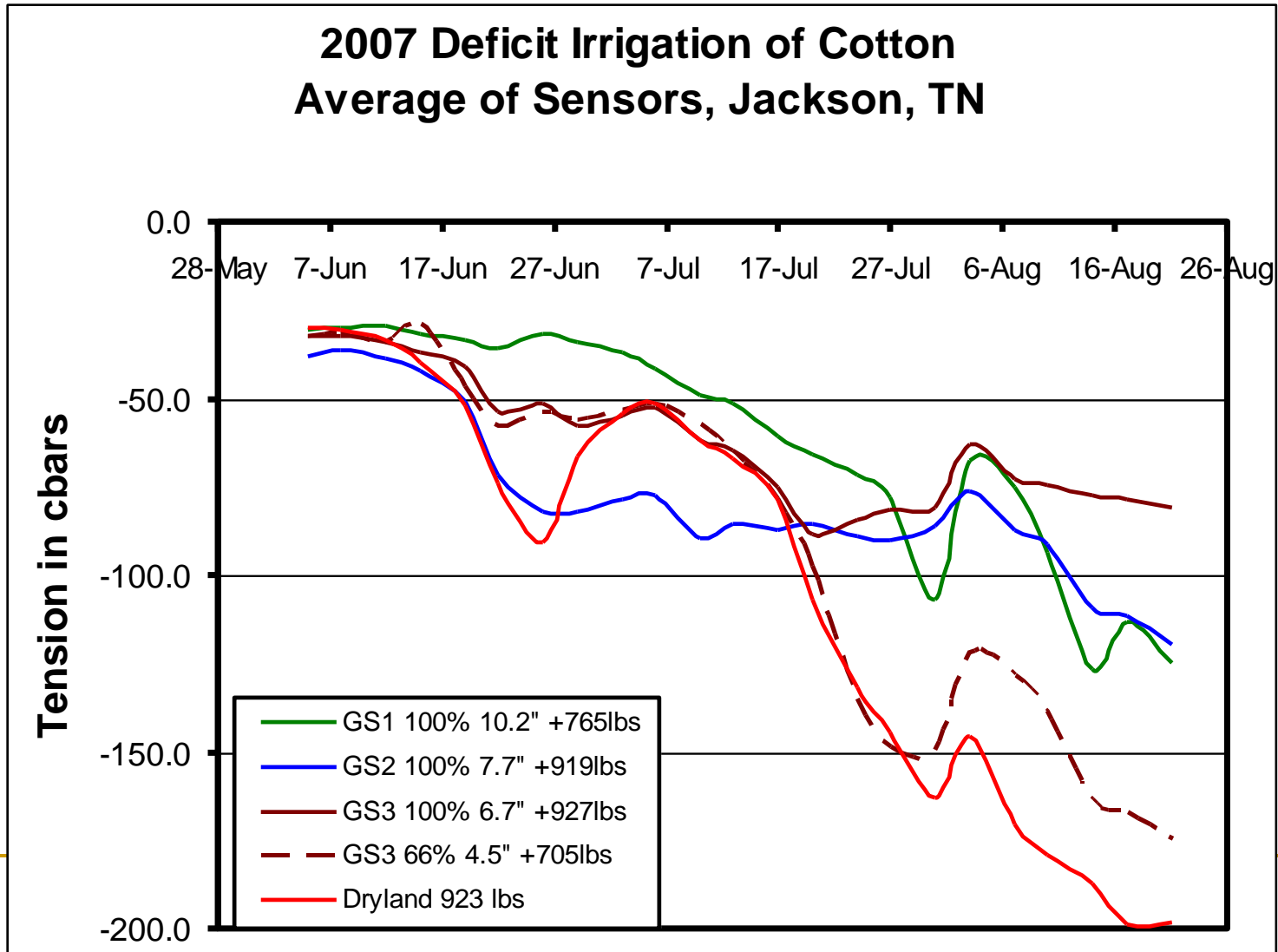
Tension vs Water Content

- **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 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 most have readably available water.



Interpreting Sensor Results

Soil Tension Example



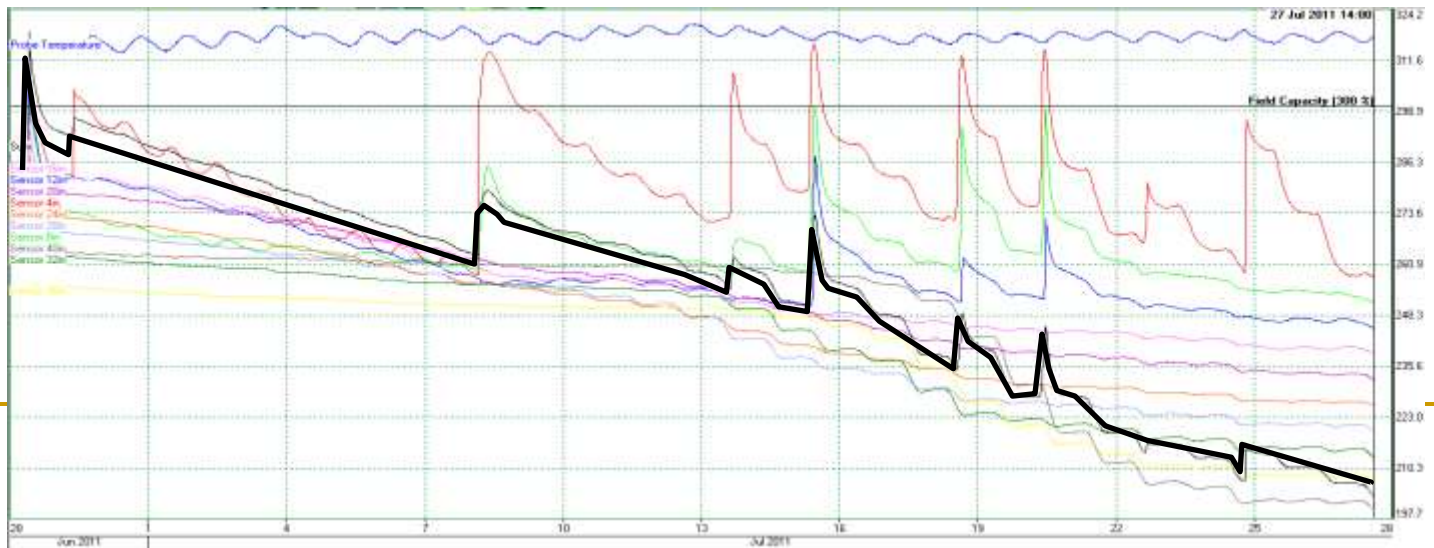
Interpreting Sensor Results

Soil Water Content Example

Mixed Soil - Rainfed



Mixed Soil - Bloom
1.0 inches/week



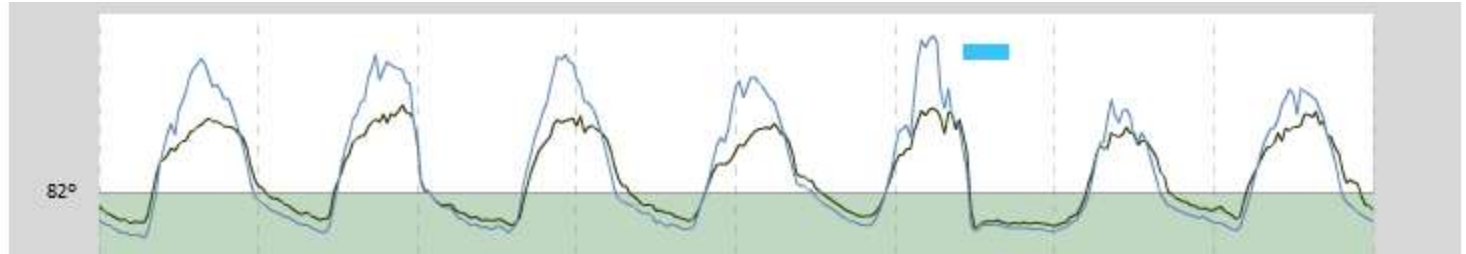
Smartfield Canopy Temperature in Deficit Cotton Experiment



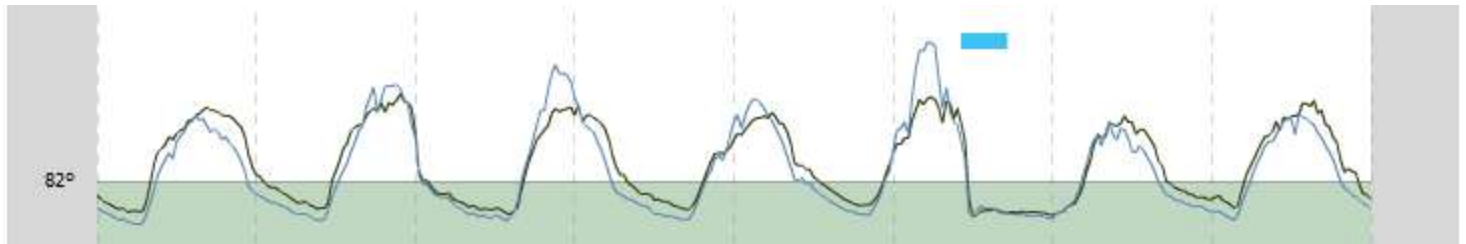
Canopy Temperature – SmartField

July 20 to 26, 2011

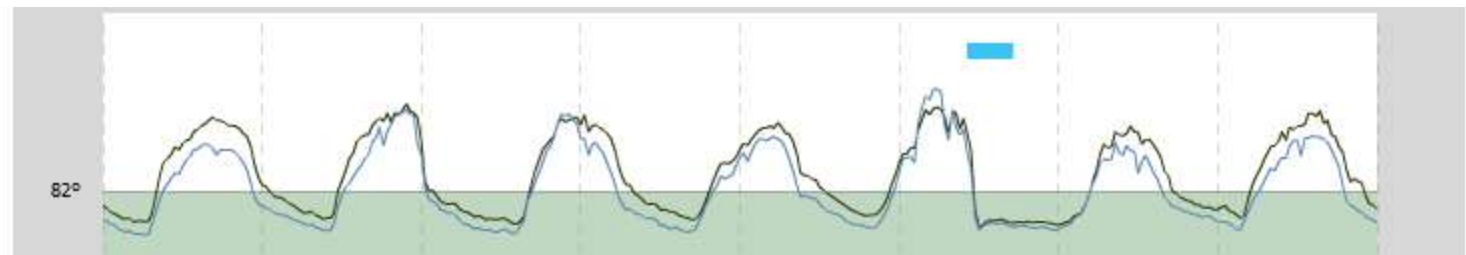
Sand - Rainfed



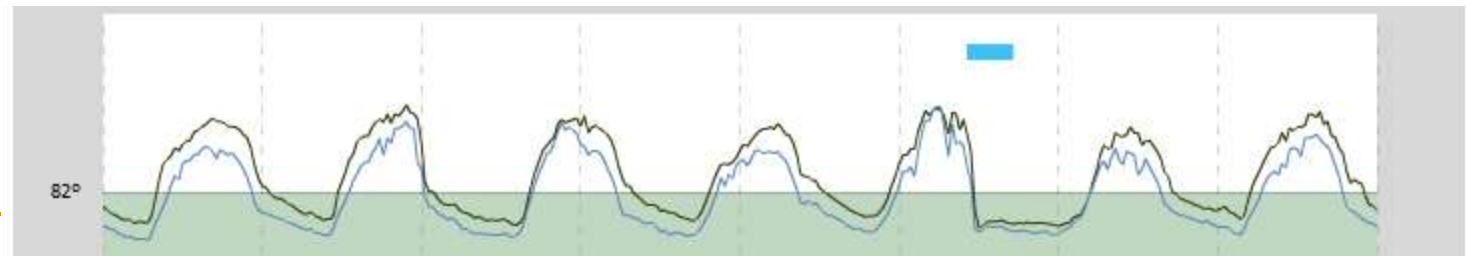
Sand – Square
0.5 inches/week



Sand – Square
1.0 inches/week



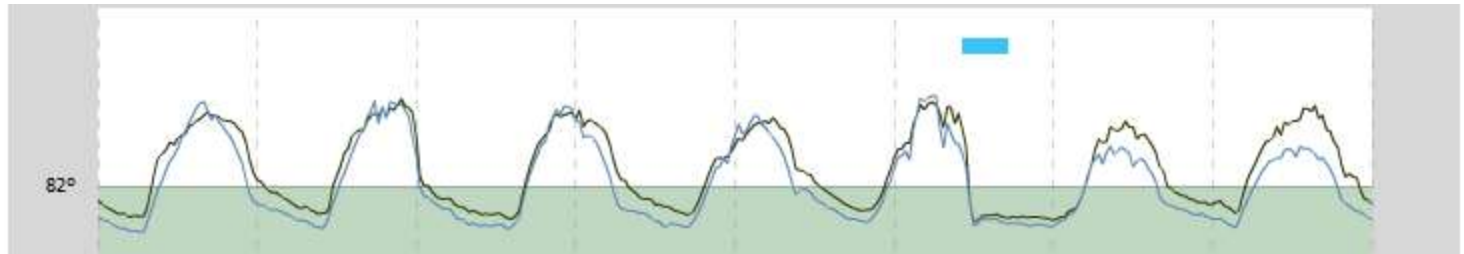
Sand – Square
1.5 inches/week



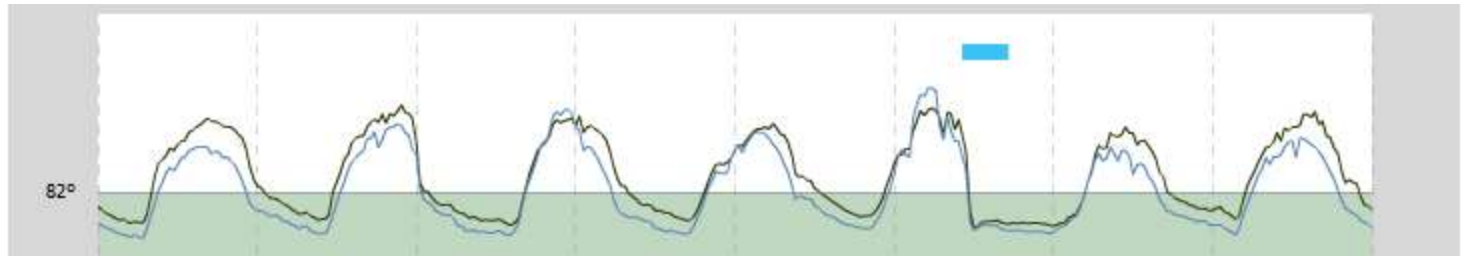
Canopy Temperature – SmartField

July 20 to 26, 2011

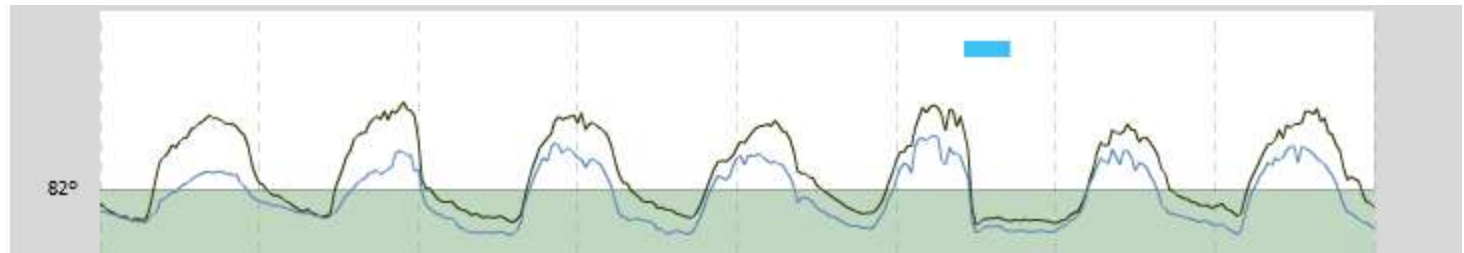
Mixed - Rainfed



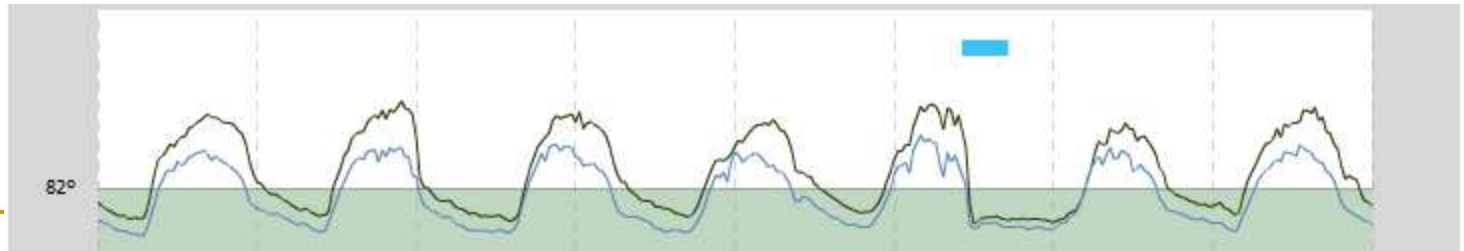
Mixed – Square
0.5 inches/week



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
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