Optimizing Irrigation Practices: The Role of Soil Moisture Sensors in Florida Agriculture

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UF Water Institute Symposium

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Background

- Irrigation is the Largest consumer of water resource
- Irrigation schedule : when to irrigate and how long to irrigate
    1. Feel method
    2. Callender method: Once for every # of days
    3. Checkbook method
    4. Sensor based irrigation
    5. Precision irrigation (based on field conditions, considering the soil types, crop –growth stage)

Irrigation practices need to be based on real time data to avoid over or under irrigation conditions- How?

Florida Ag Soil Moisture Network

- To promote Irrigation Best Management Practices
- Provide technical support to obtain the maximum yield with less water using current irrigation practices
- Network - Producers, Extension Specialists, Extension Agents
- Counties covered: Martin, Manatee, Putnam, Lee, Hendry, Collier, Palm Beach, Marion, Hillsborough, Lake, Sumter
- Crops: Corn, peanuts, peaches, watermelon, strawberry, citrus, nursery, cabbage, tomatoes, potato, blueberry, mango, dragon fruit, beans, cilantro, celery, spinach, pepper, sugarcane, squash, pumpkin, stevia, and sod

FASMN Objectives

1. Continue expanding the Florida Ag. soil moisture sensor network.
2. Assisting the agents and growers in investigating soil moisture sensors as a water-conserving technology
3. Quantify the operational and financial benefits and challenges of soil moisture sensor technologies in different management practices.
4. Providing information on sensor costs and cost-share funding availability.
5. Compare different SMS technology with research-level instrumentation and laboratory analysis to assess operational performance

Technology Transfer Model

Agent joins network

Agents self-select to participate and begin learning about the technology.

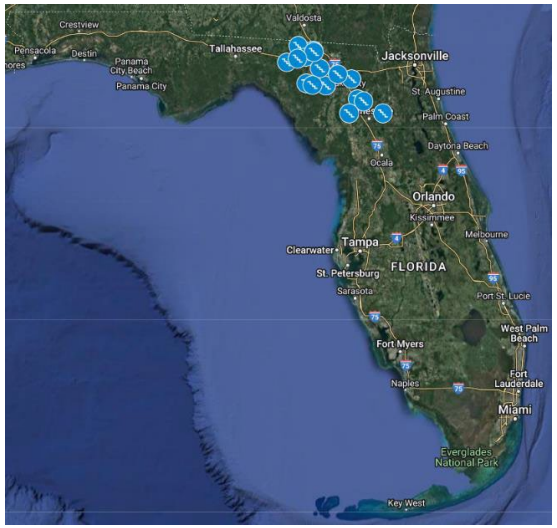
Farmer recruitment

Agents recruit participating farmers.

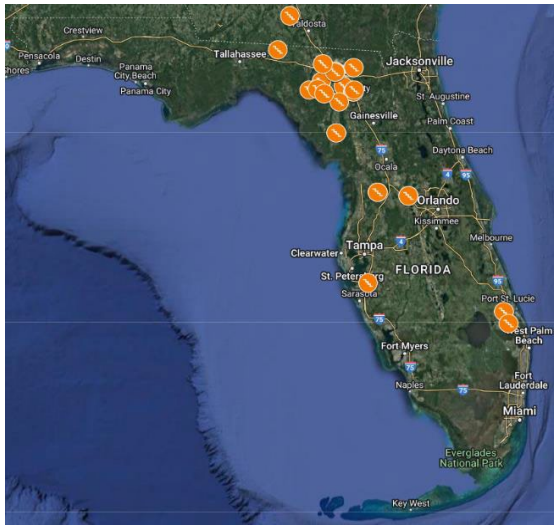
Applied learning

Agents, specialists, & farmers discuss sensor data & how it can be applied real-time.

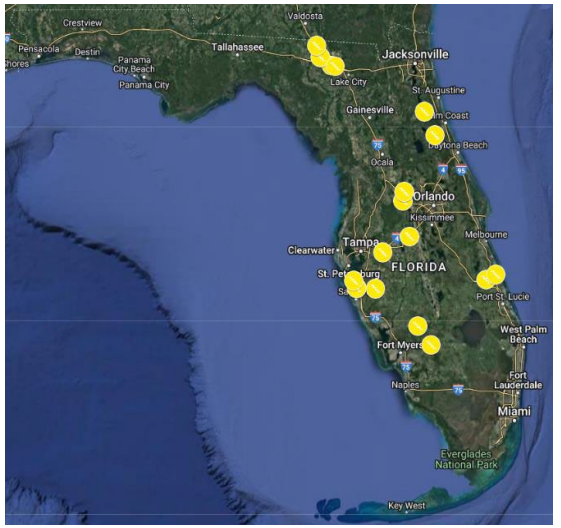
Network Reach/Expansion



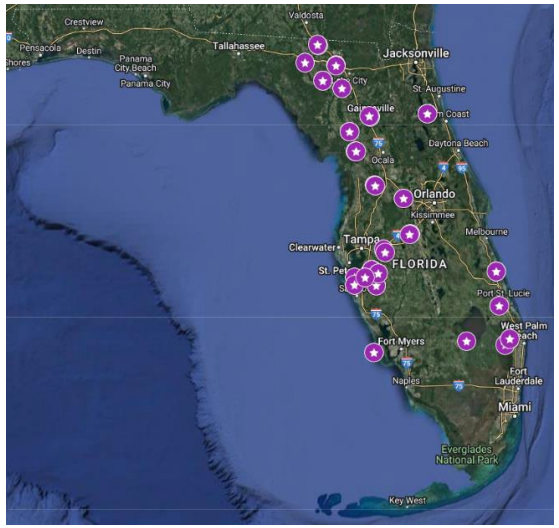
2018-2019 – 16 units



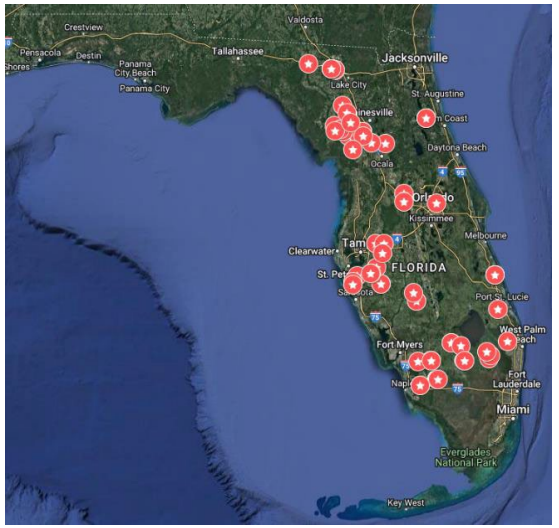
2019-2020 – 26 units



2020-2021 – 18 units

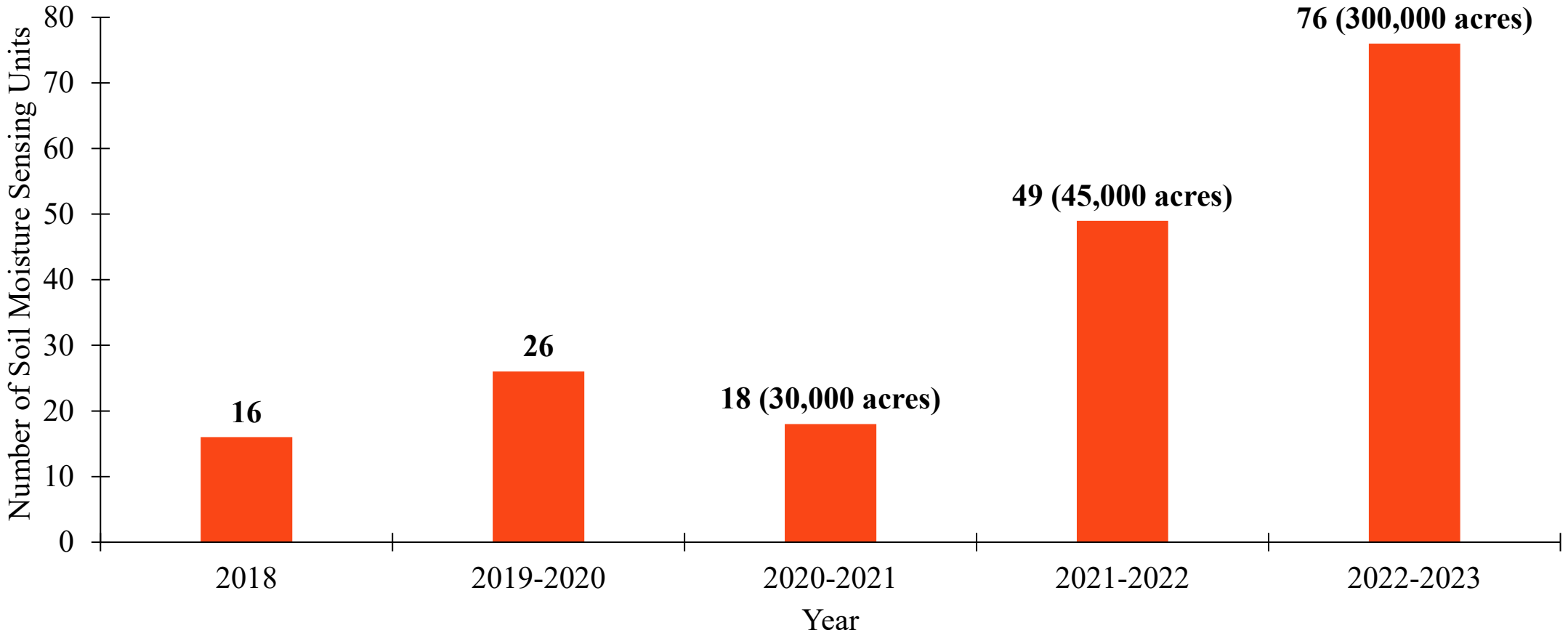


2021-2022 – 48 units

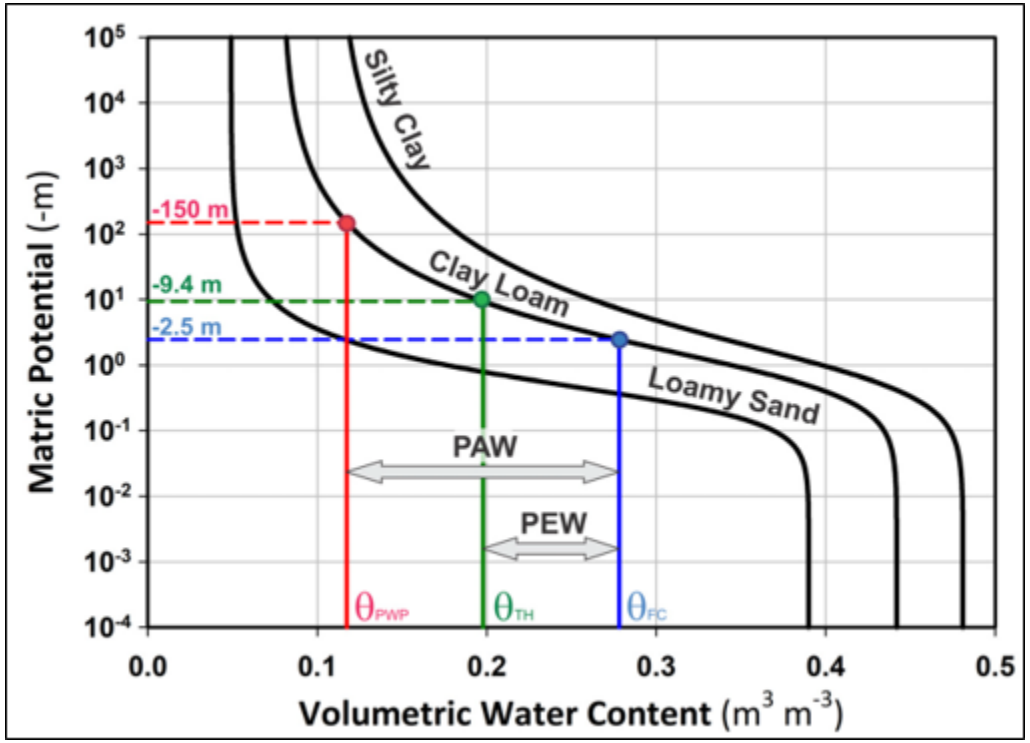


2022-2023 – 76 units

Network Reach/Expansion



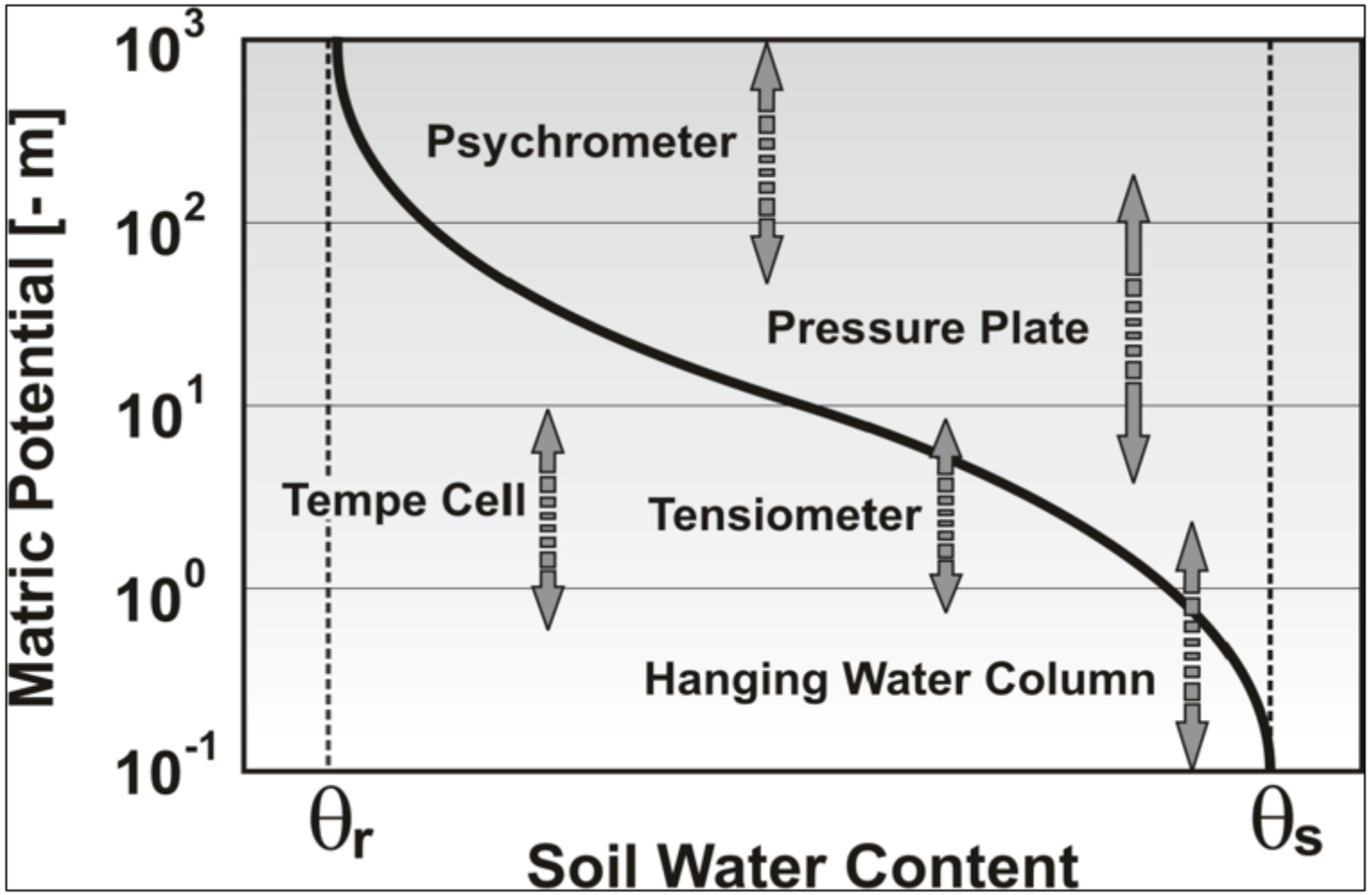
Soil Moisture Characteristic Curve



- It is the relationship between the water content and the soil water potential, ψ
- Used to study the characteristic for different types of soil
- Field capacity: the soil is wet and contains all the water it can hold against gravity
- Permanent Wilting Point: the soil is dry and the plant can no longer extract any more water

(Babaeian and Tuller, 2023)

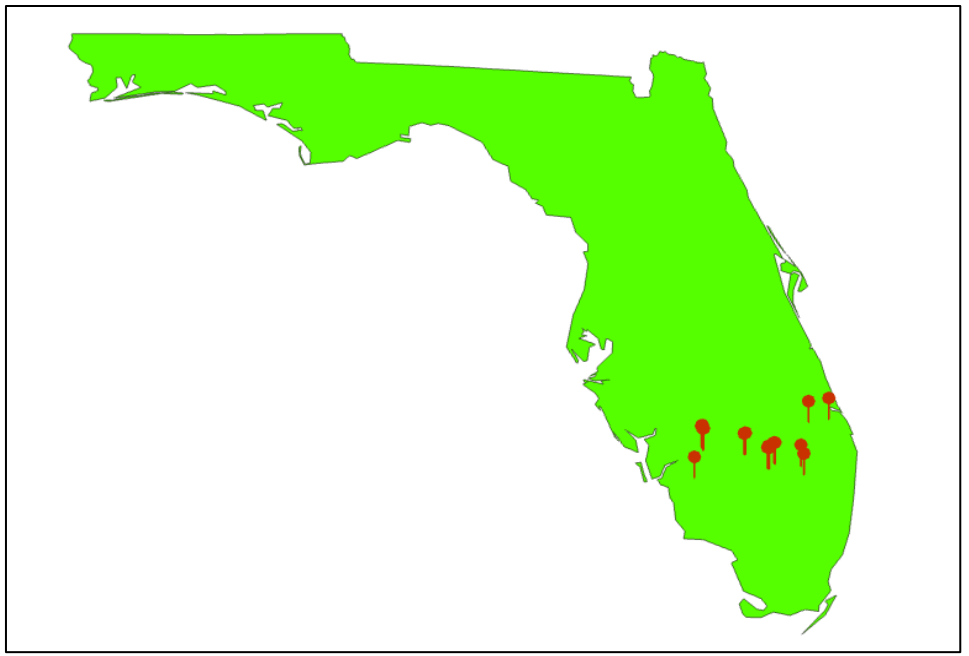
Soil Moisture Characteristic Curve

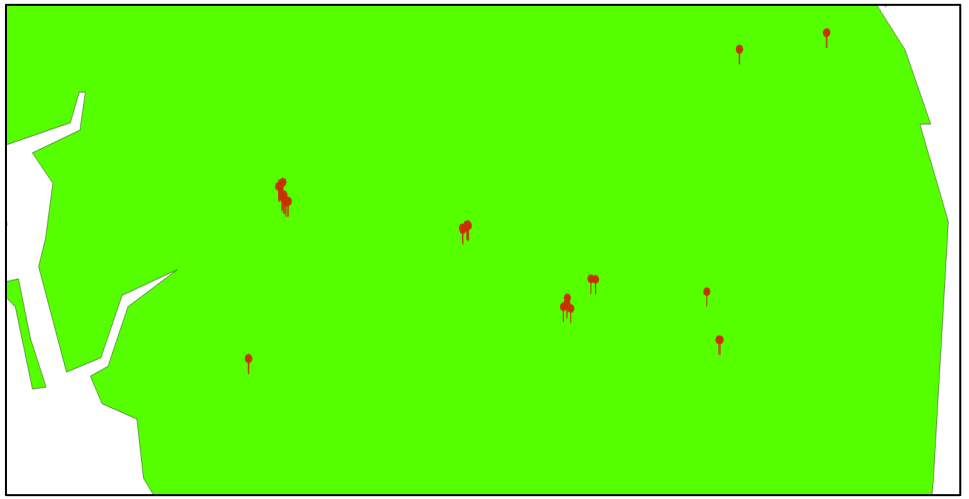


(Tuller, 2003)

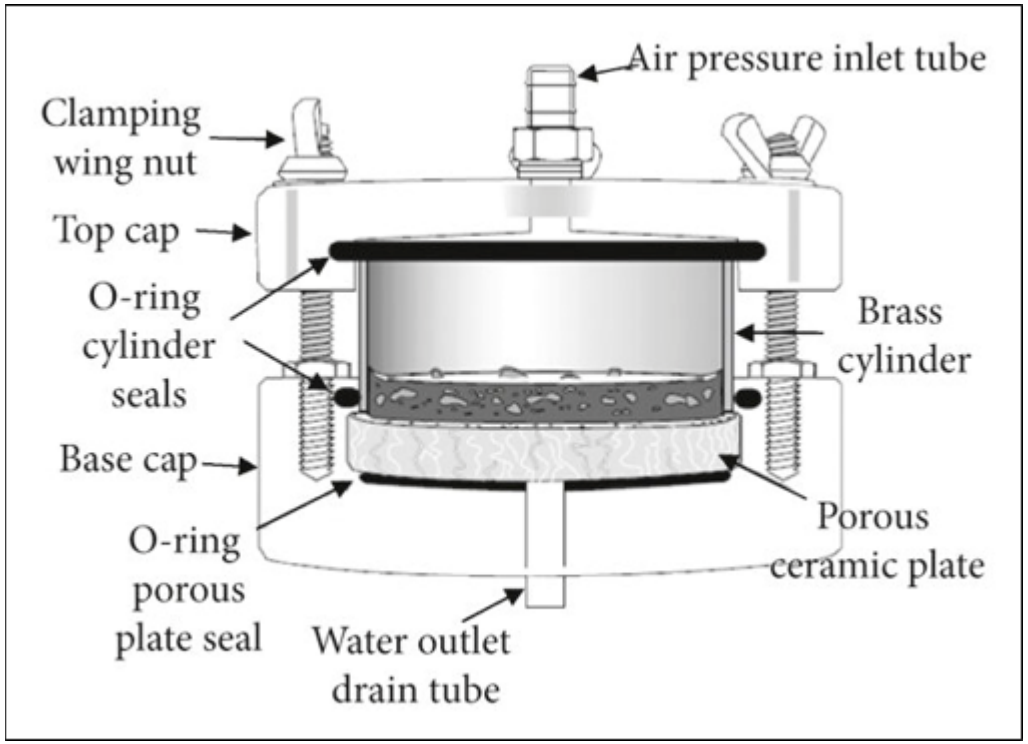
Soil sampling

- 100 soil core samples were collected from across the state
- Cores were collected at 4 in and 10 in depth
- Soil types: Sandy soil, loamy soils, muck soil and sandy loam soils





Tempe Cell


Air pressure inlet tube
Clamping wing nut
Top cap
O-ring cylinder seals
Brass cylinder
Base cap
O-ring porous plate seal
Porous ceramic plate
Water outlet drain tube


METTLER TOLEDO
706.3 g

Pressure plate apparatus

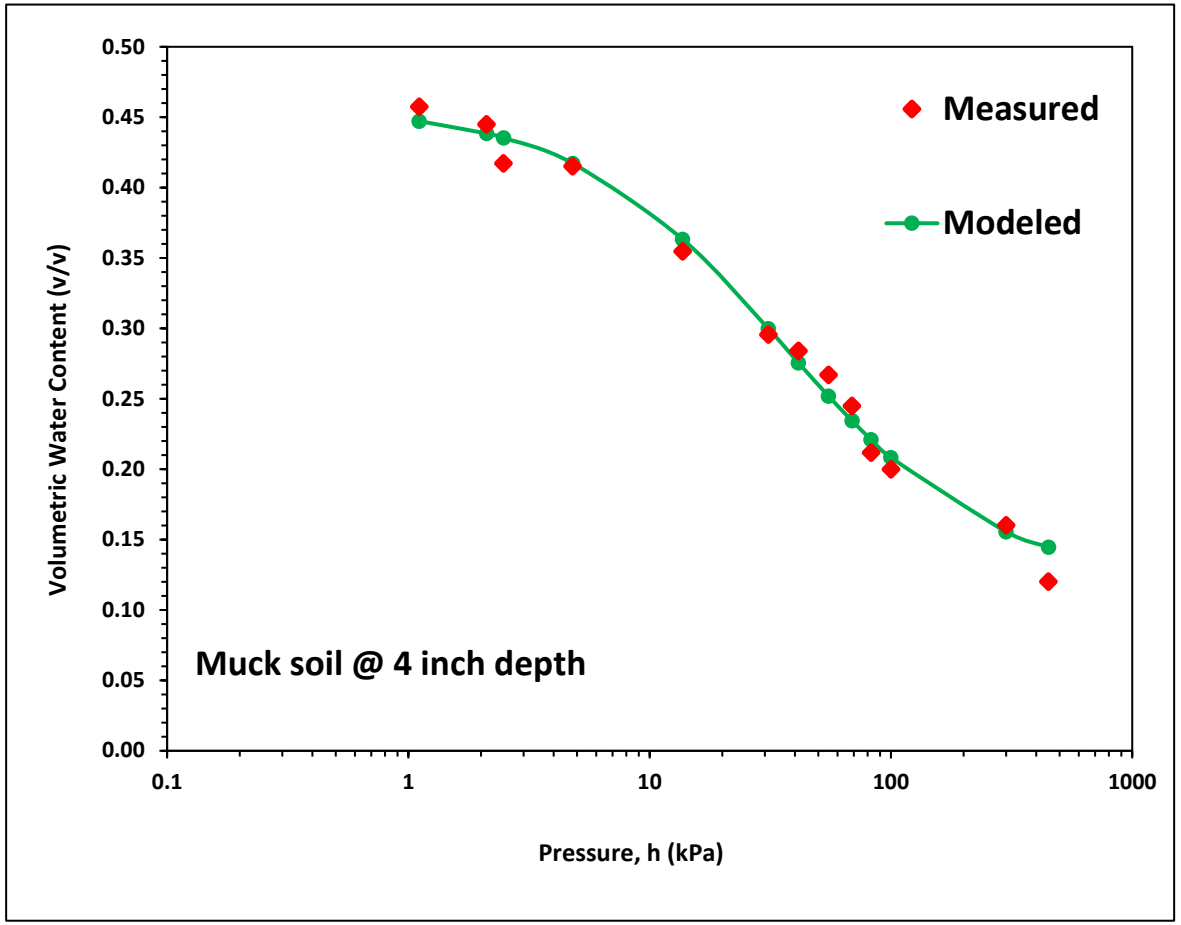
Van Gunechtun equation for developing SM characteristic curve

$$\theta = \theta_r + \frac{(\theta_s - \theta_r)}{[1+(\alpha * h)^n]^m}$$

$$m = 1 - \frac{1}{n}$$

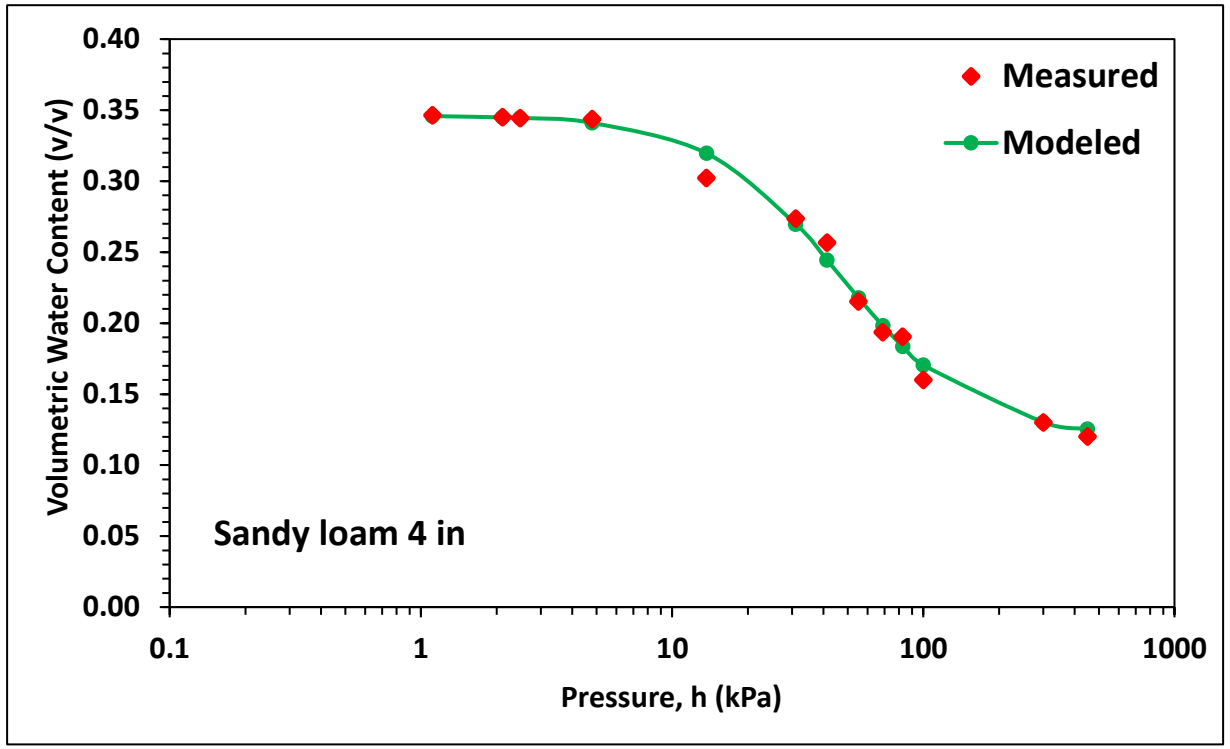
- Residual water content (θ_r)
- Saturated water content (θ_s)
- m is an empirical parameter (0 to1)
- n is an empirical parameter (>1)
- α is parameter that referred to as the inverse of the air entry suction (0-1)
- Used solver to obtain the modeled values

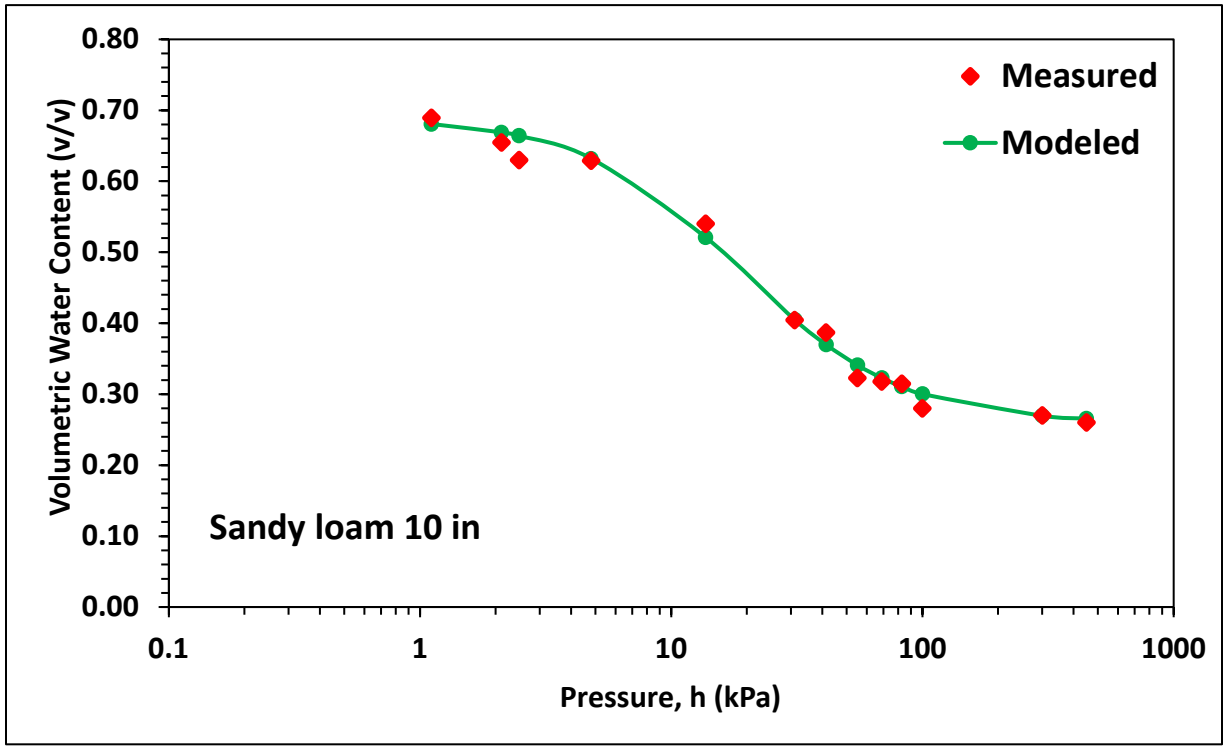
Soil Moisture Characteristic Curve



- Field capacity : 0.29
- Permanent Wilting Point: 0.127
- Plant available water: 0.16
- Alpha = 0.028
- n = 2

Soil Moisture Characteristic Curvec





- Field capacity: 0.26
- Permanent Wilting Point: 0.120
- Plant available water: 0.14
- Alpha = 0.0214
- n = 2.64

- Field capacity: 0.39
- Permanent Wilting Point: 0.26
- Plant available water: 0.13
- Alpha = 0.052
- n = 2.36

Technology Transfer Model

Agent joins network

Agents self-select to participate and begin learning about the technology.

Farmer recruitment

Agents recruit participating farmers.

Applied learning

Agents, specialists, & farmers discuss sensor data & how it can be applied real-time.

Integrating knowledge

Farmers use sensor data to modify irrigation management.

Outcomes

Farmers & agents increase KASA
Farmers adopt technology
Improved water use efficiency
Improve water quality

Network Impact

1. The network is bringing cultural and behavioral changes in technology implementation resulting in water conservation, nutrient, and energy savings.
2. About 80% of the participants who participated (around 1026 since 2020) in extension activities have gained additional knowledge on soil moisture technologies and irrigation management.
3. Because of the continuous educational effort by the network, since 2020, the Suwannee River Water Management District alone has approved funding for 601 soil moisture probes as a part of the cost-share programs, representing 49,000 acres.
4. Since 2020, the St. Jones River Water Management District has approved 207 soil moisture sensor probes as a part of the cost-share program.
5. On average, the water conservation that was estimated by network ranged from 0.5 inches to 1.5-inchs per growing season depending on the crop type and climatic conditions.

Success story

- Southwest Florida (Craig Frey, Anna Meszaros, Christian Kammerer)
  - ✓**28 sensors** in different crop including dragon fruit, beans, cilantro, celery, baby spinach, pepper, watermelons, sugarcane, squash, and pumpkin were installed in 2023.
  - ✓Covered over approximately **200,000 acres**.
  - ✓Participant growers purchased/cost-share **30 new sensors.**
  - ✓One grower save approximately **3 million gallon of water.**




Hendry County

- **Extension Agent: Craig Frey**
- **Celery and Seed company**

Summary

- Using soil moisture measurements is one of the best and simplest ways to get feedback to help make improved water management decisions.
- Florida Agricultural Soil Moisture Sensor Network one-on-one educational opportunities between agents and growers about this beneficial and cost-saving technology
- Development of soil moisture characteristic curves for different soil types helps in sensor calibration.

Acknowledgement

- Florida Department of Agriculture and Consumer Services(FDACS)
- Growers
- UF/IFAS

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Thank You..

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