

Precision Irrigation in the Southeast



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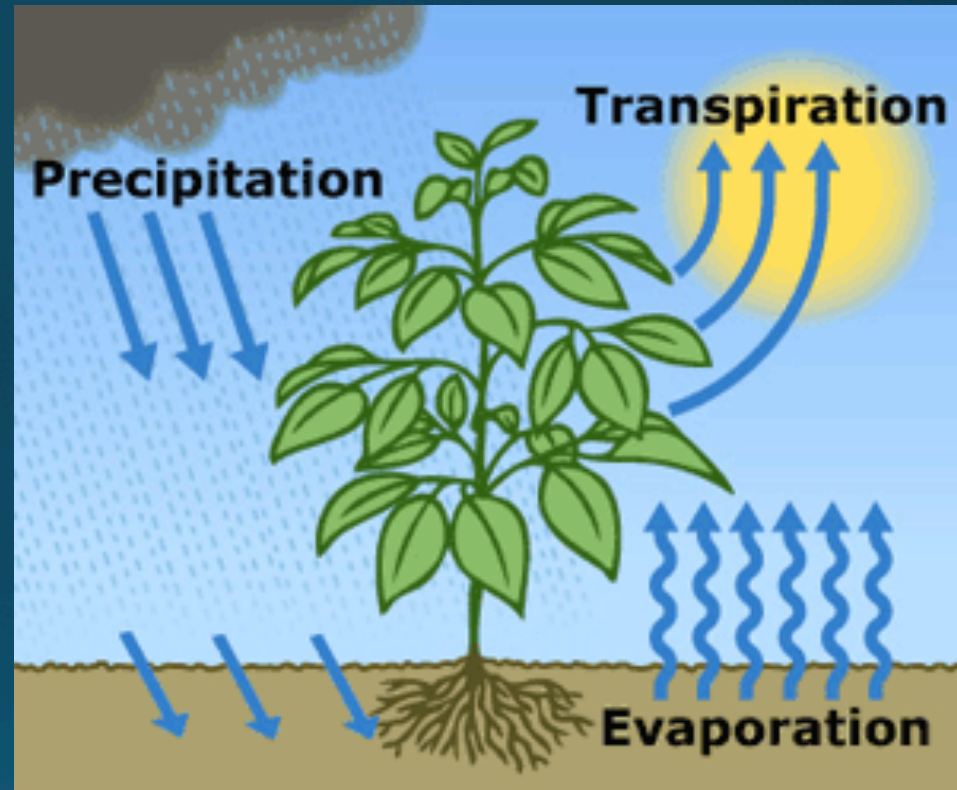
Outline

- Introduction
- Concepts evapotranspiration and soil water holding capacity
- Crop water requirements vs. nutrient management
- Precision irrigation (PI) concepts
- Soil moisture sensor wireless network for center pivots
- Smartphone irrigation
- Final remarks

Evapotranspiration (ET)

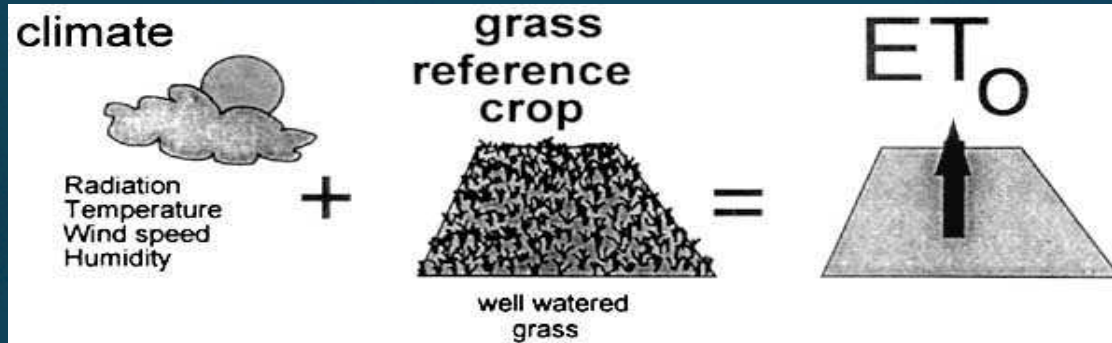
Definition:

The loss of water from a vegetated surface through the combined processes of soil and plant evaporation and plant transpiration

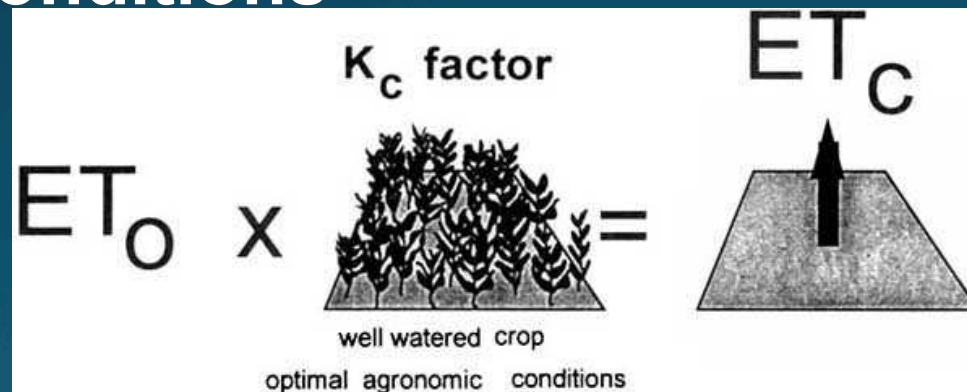


Reference ET vs. Crop ET

Reference ET (ET_o): The evapotranspiration from a hypothetical grass reference crop.

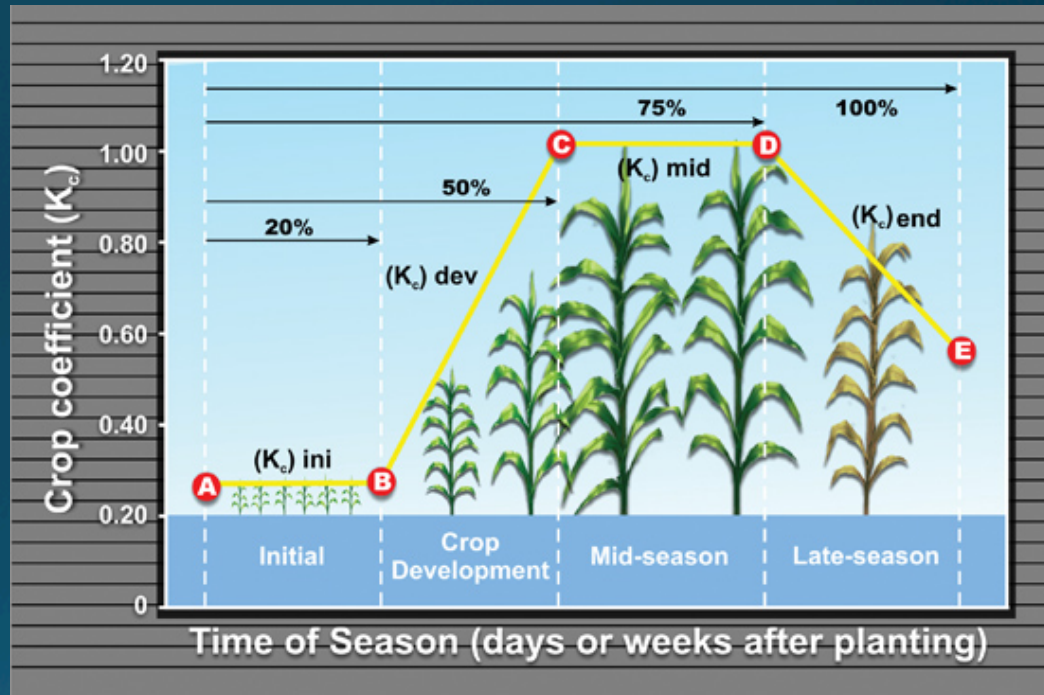


Crop ET (ET_c): The crop evapotranspiration under standard conditions

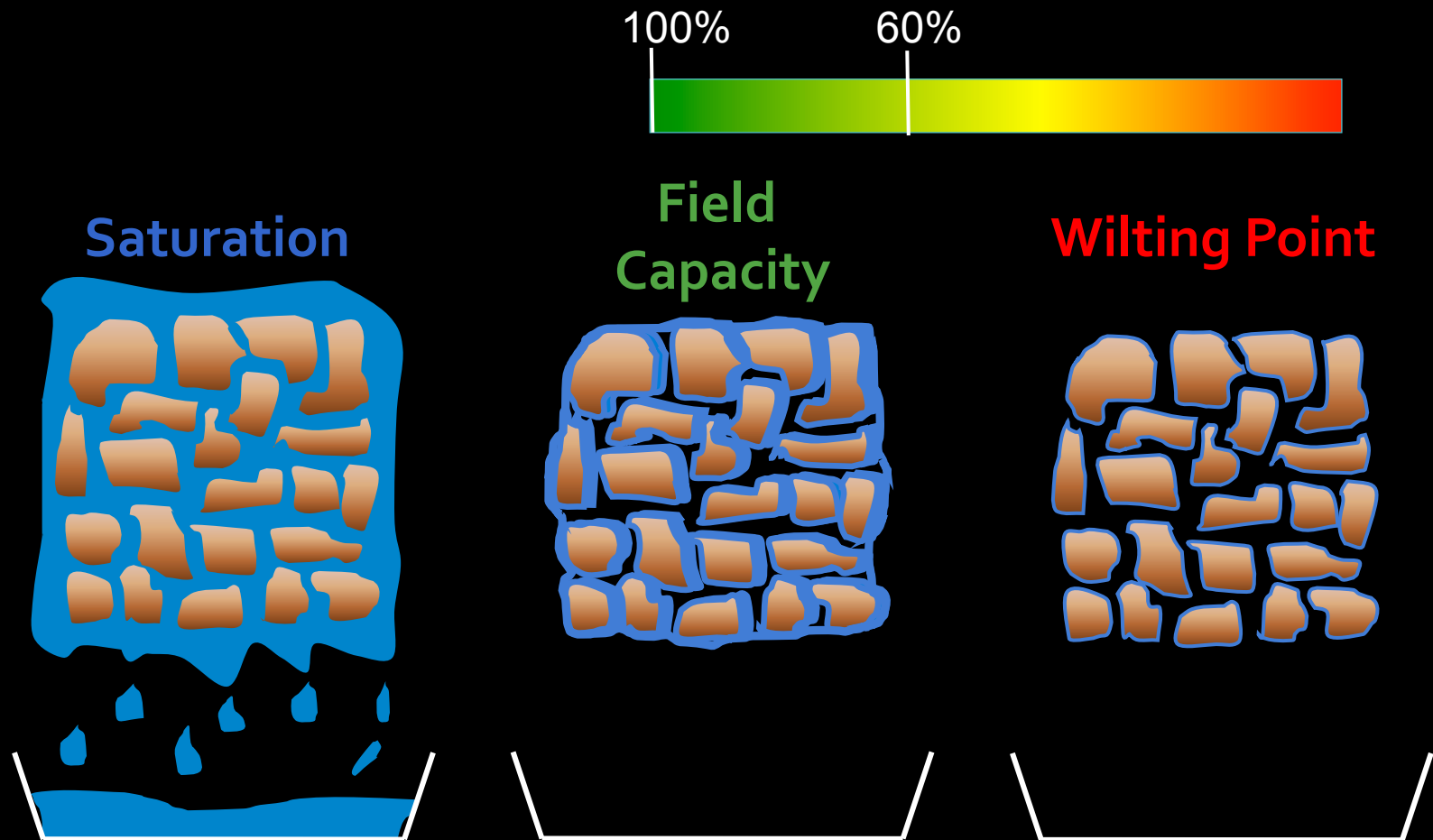


Crop Evapotranspiration

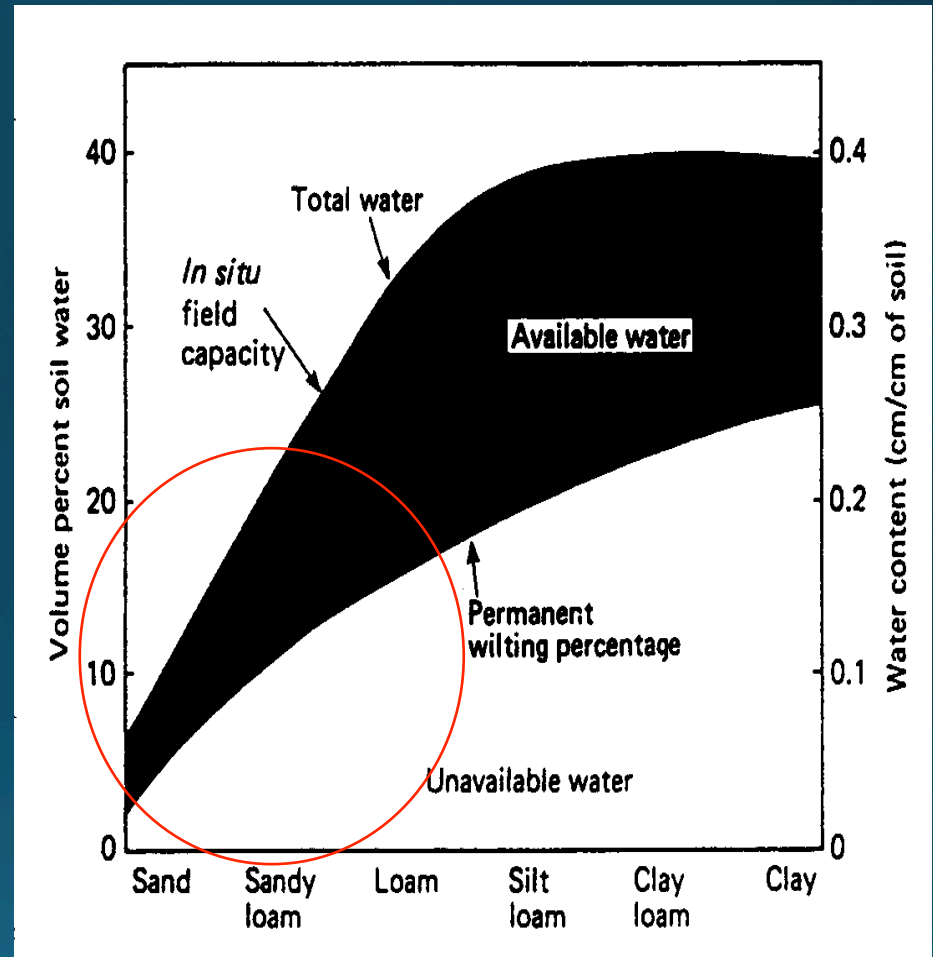
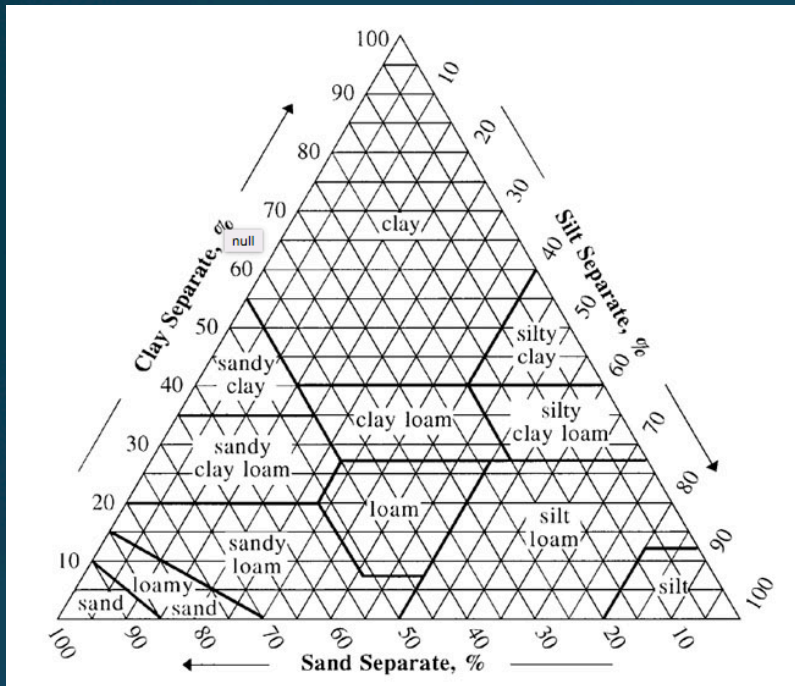
- ET provides reference measure of water use based on plant water demand
- Scalable for specific crop, growth stage, climate, and season of year
- $ET_c = ET_o * K_c$



Soil Moisture and Water Availability to Crops



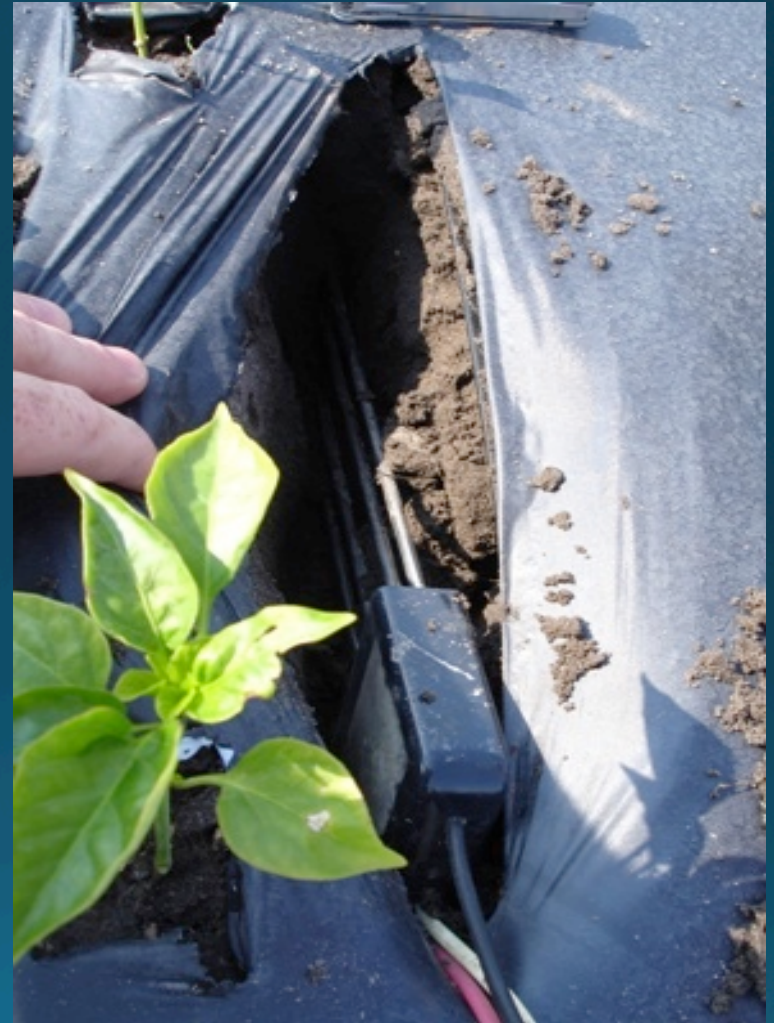
Effect of soil texture and soil tension on soil water availability



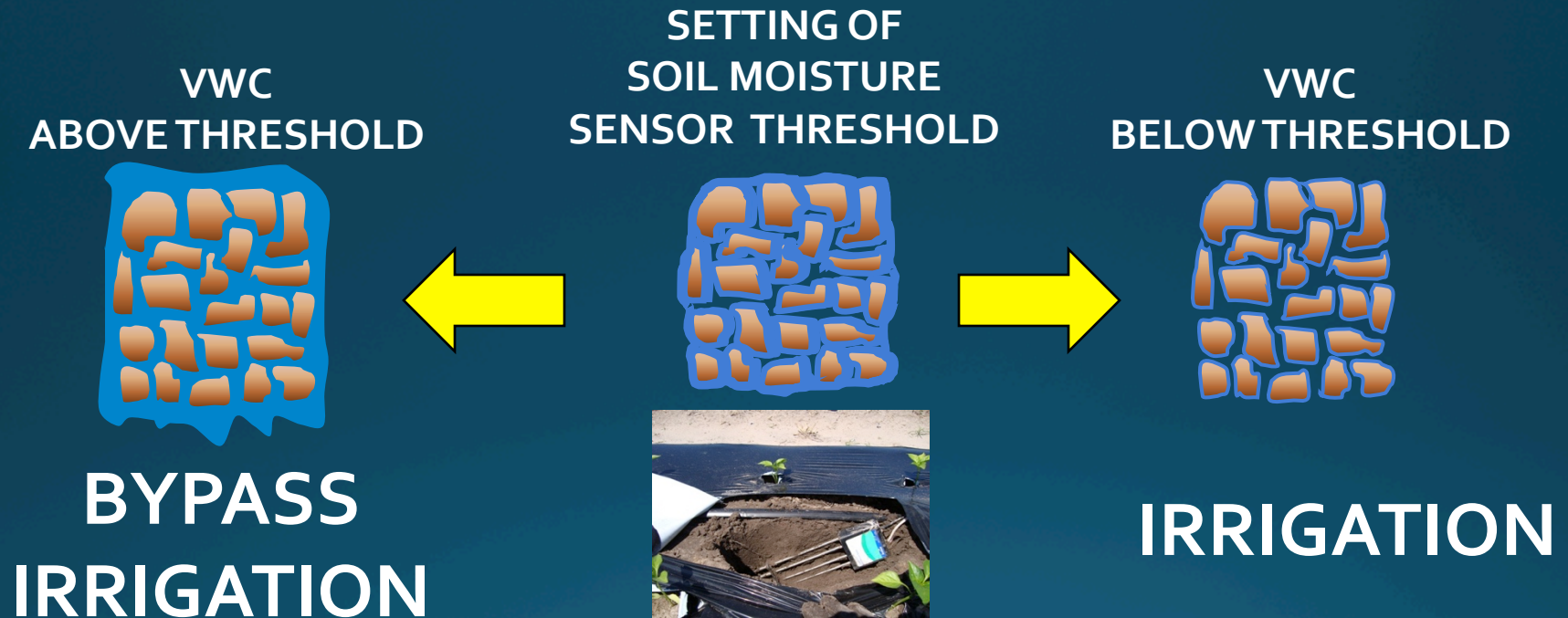
<http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey>

Kramer and Boyer (1995)

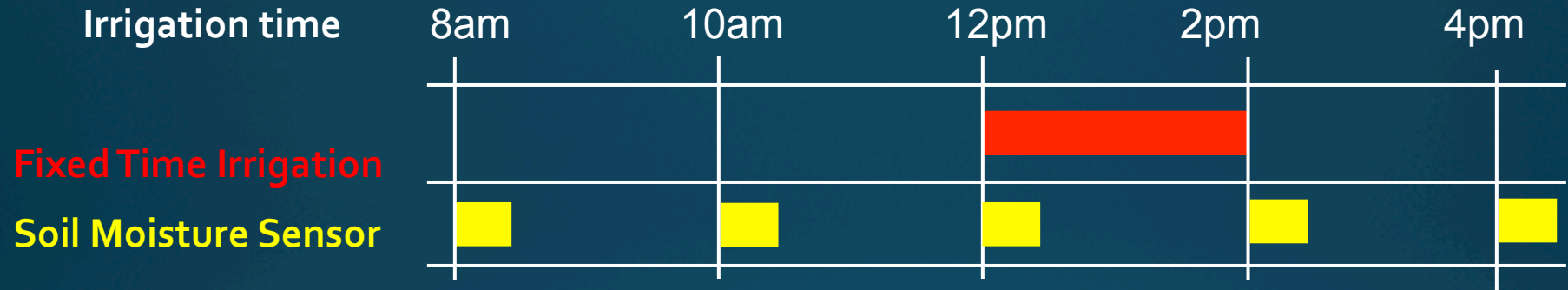
Soil moisture sensor for automated irrigation control



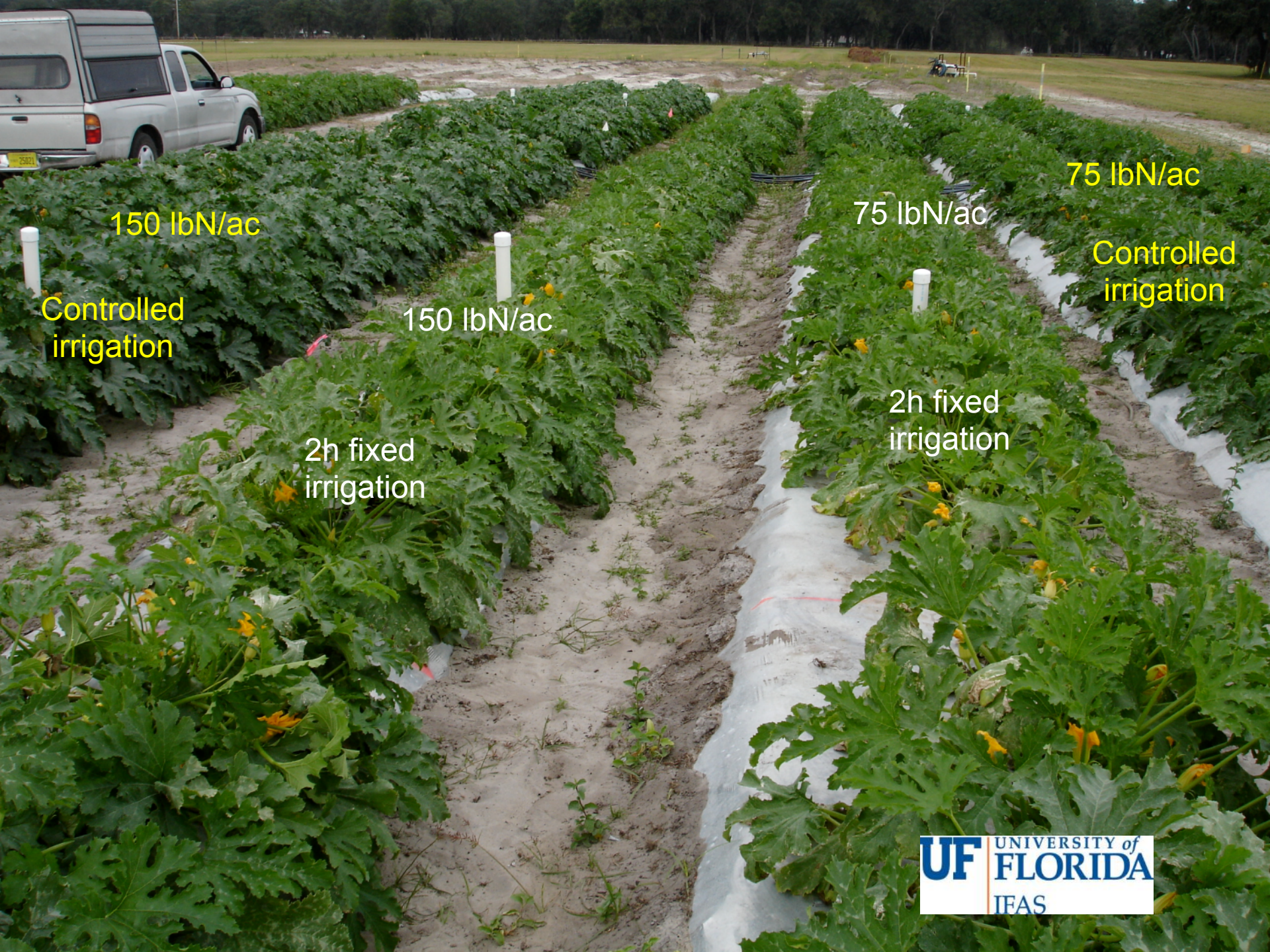
Soil moisture sensor for automated irrigation control



Zucchini Irrigation and Fertilization



- ✓ N-rates of 75, 150 and 225 lb/ac weekly fertigation with calcium nitrate



150 lbN/ac

Controlled
irrigation

150 lbN/ac

2h fixed
irrigation

75 lbN/ac

2h fixed
irrigation

75 lbN/ac

Controlled
irrigation

Irrigation vs. N-fertilization on zucchini

	75 lbN/ac	150 lbN/ac	225 lbN/ac	Average
	Zucchini marketable yield (lb/ac)			
Controlled irrigation – up to 5 irrig. windows/day				24,649 A 100%
Fixed irrigation of 2h/day				18,316 B 74%
Average				



Effect of irrigation on solute displacement

**soil sensor
based
irrigation**

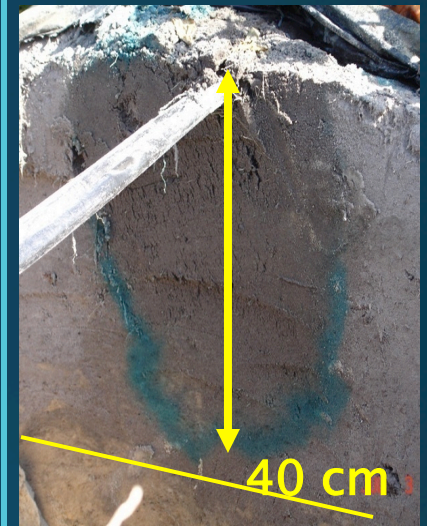
24 hrs



3 days



7 days



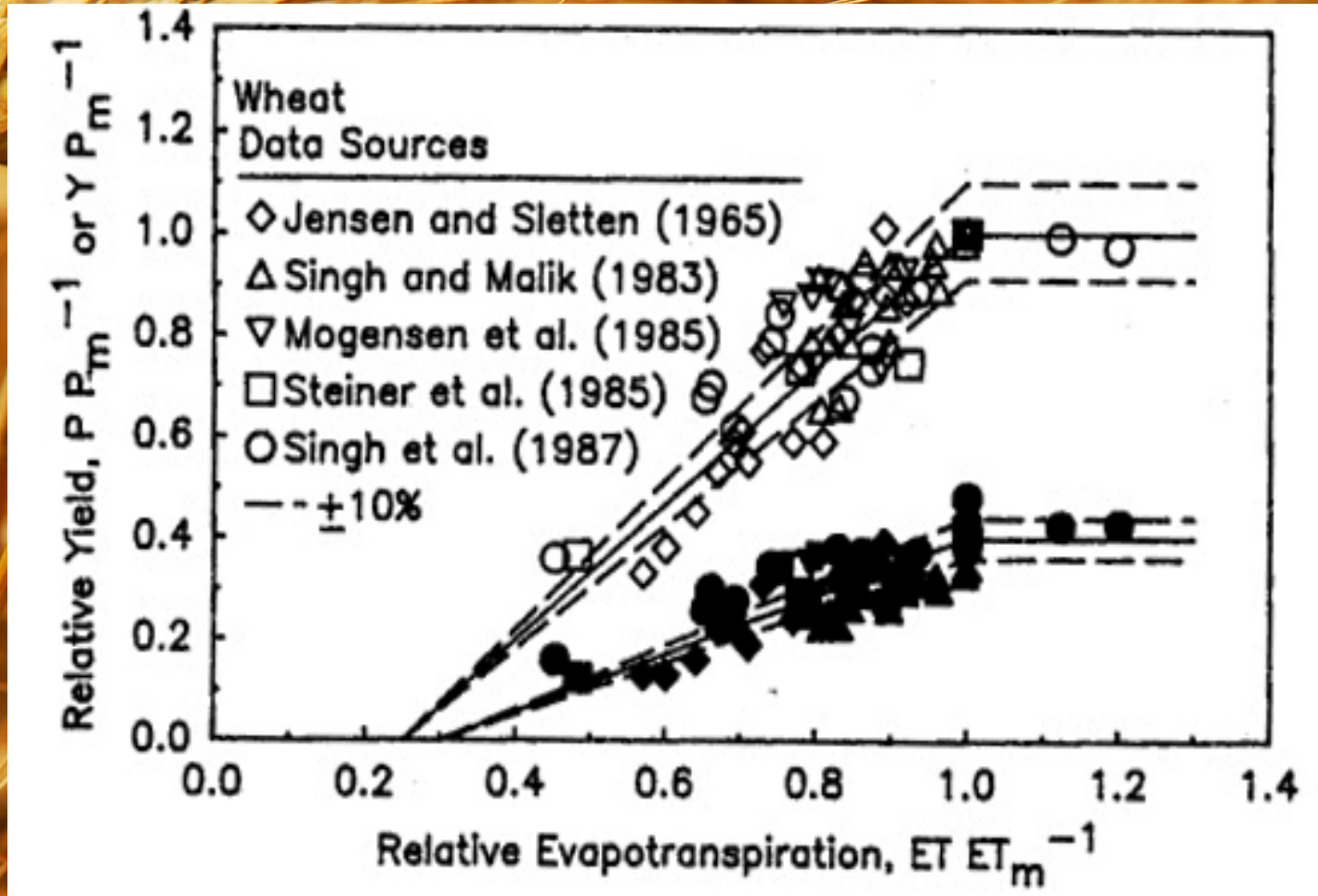
**fixed TIME
irrigation
schedule**

Photo: L.Zotarelli



Relationship between ET and yield

Wheat



Relationship between ET and yield

Corn in New Mexico

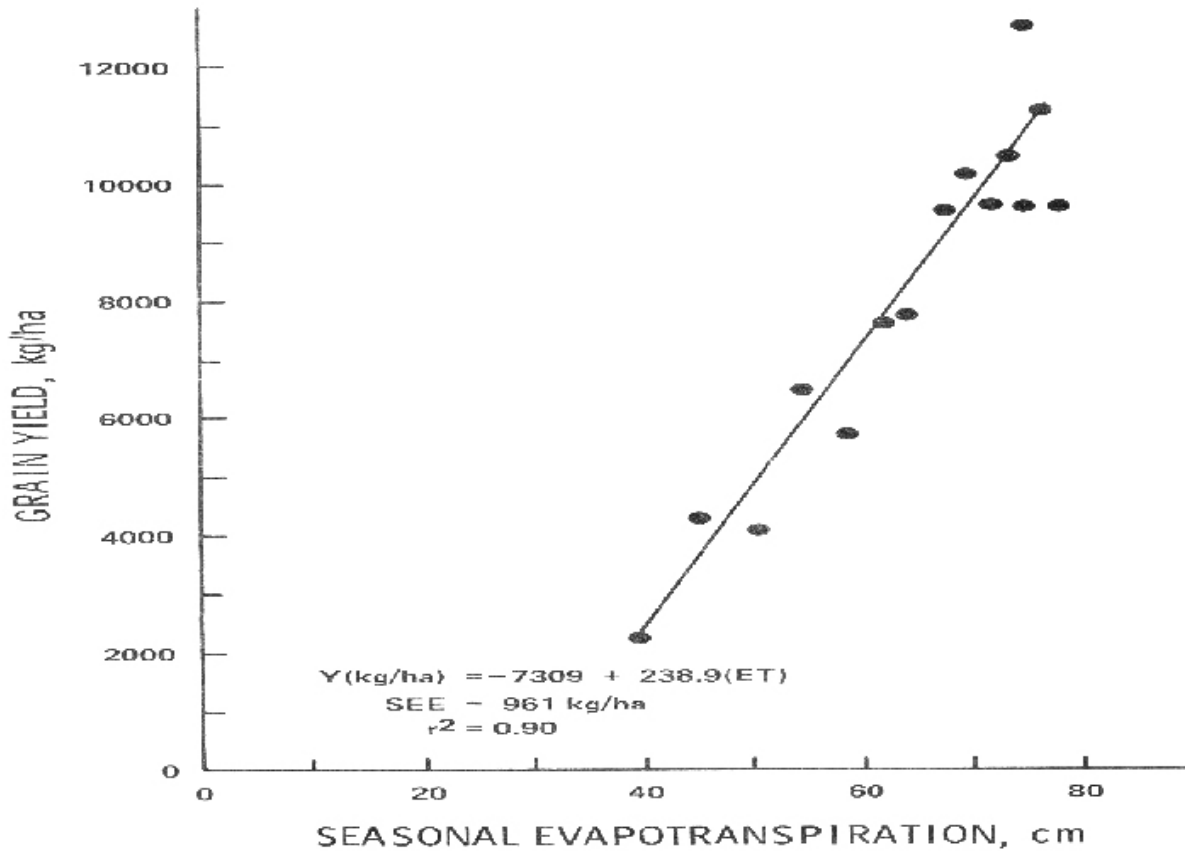
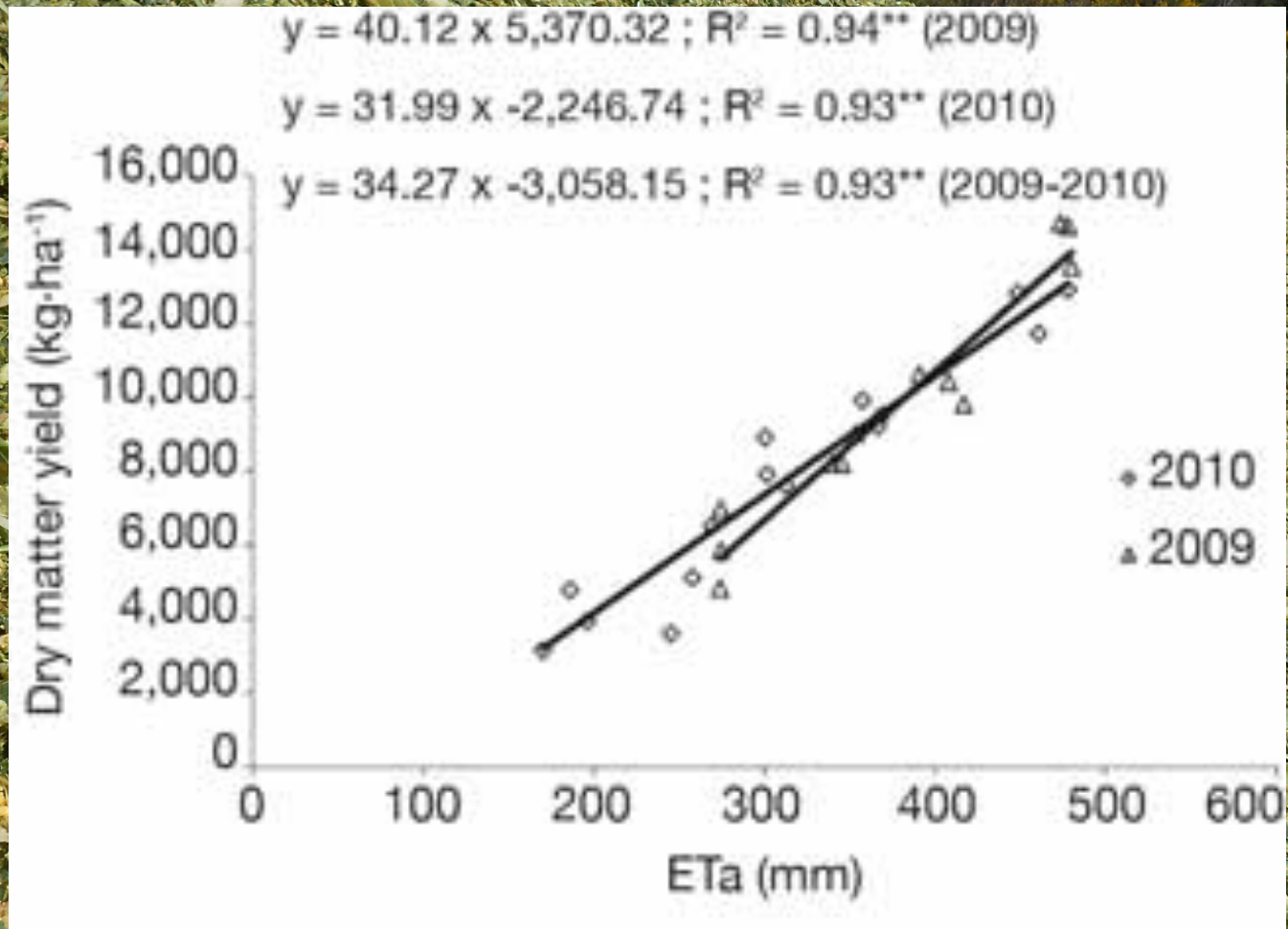


Figure 13. The water-production function of the high-N corn SLS plot, 1982.

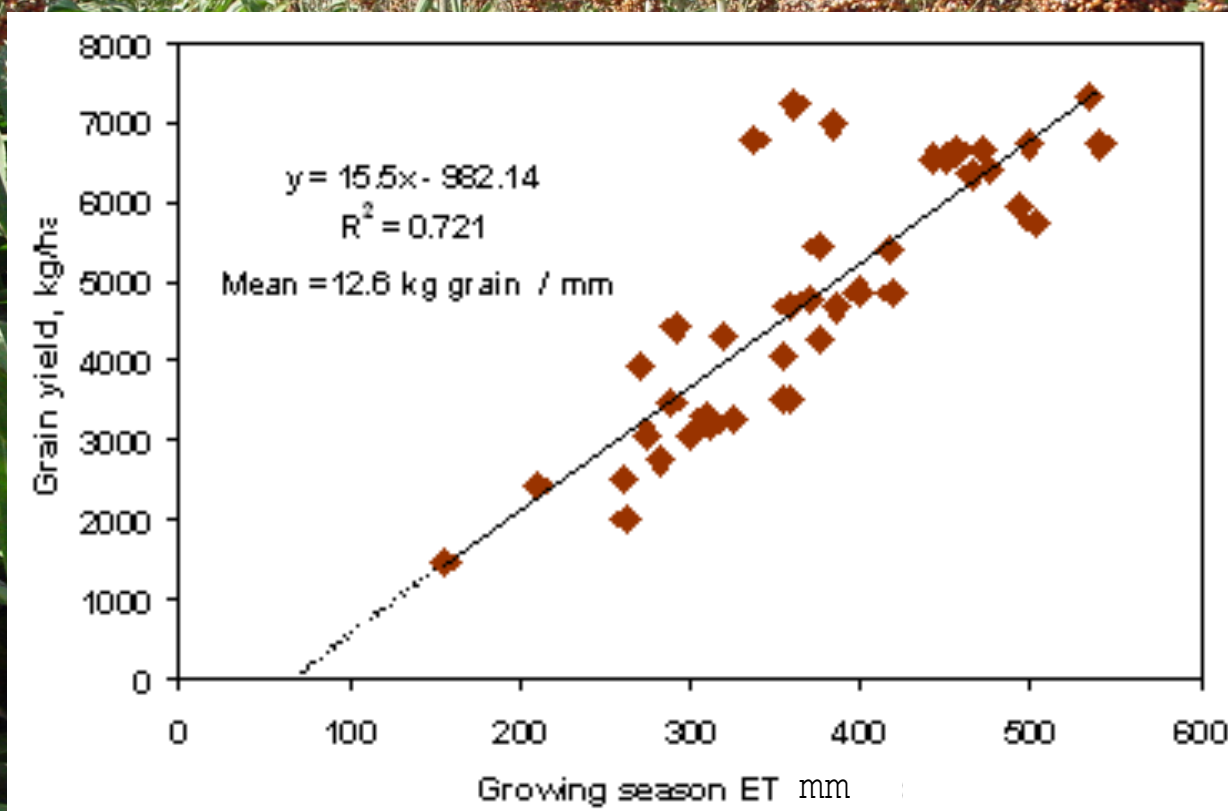
Relationship between ET and yield

Silage in Australia



Relationship between ET and yield

Sorghum in Texas



Precision Irrigation

Potato - Hastings, FL – 9” in 3 days

Defined as site specific irrigation management that relies on the variable application of water, emerges as potential solution to increase productivity and reduce environmental impact of irrigated agriculture.

Kassman (1999) and Monaghan et al (2012)

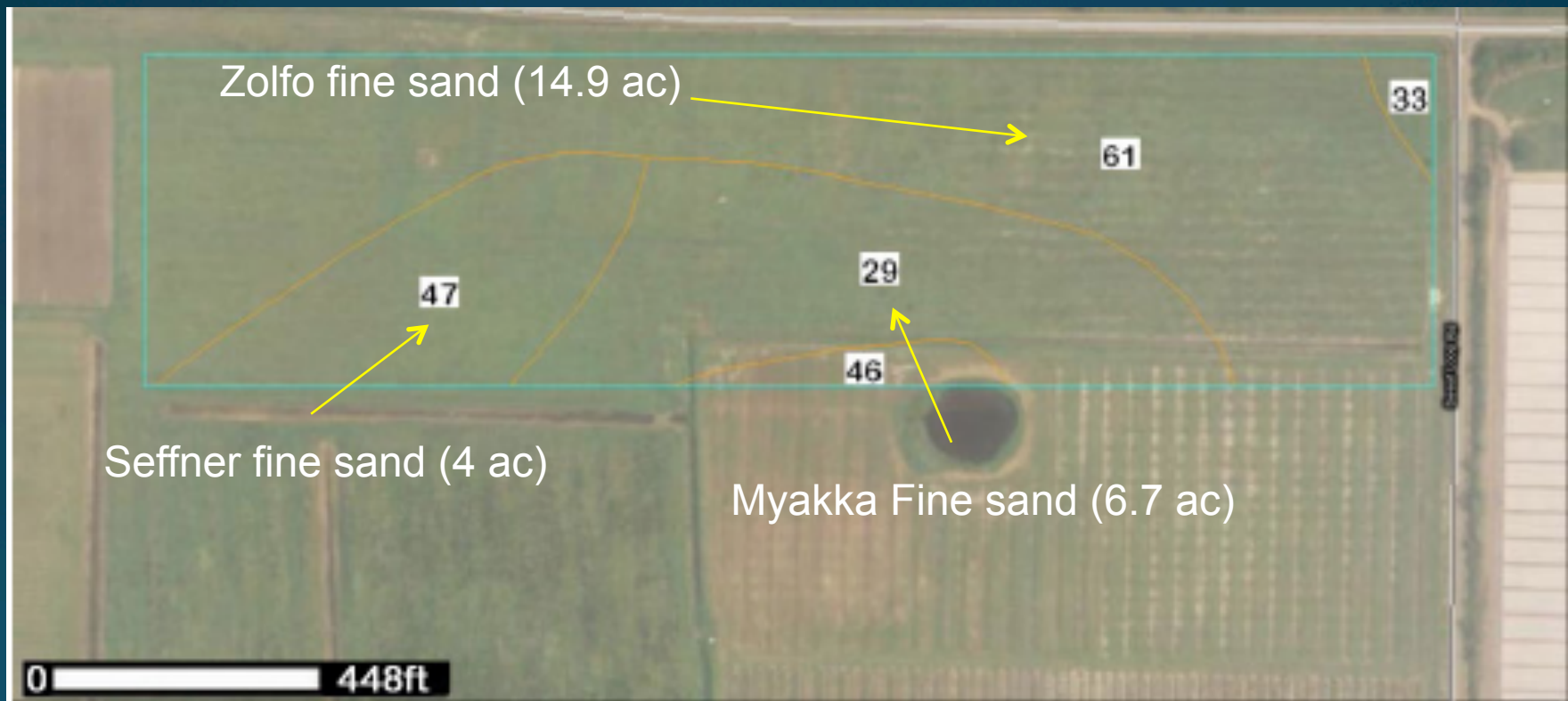
Challenges

- Spatial and temporal variation in soil moisture and crop growth
- We rely on limited *in situ* points of measurements
- It is important to understand the heterogeneity of soil water across the field



How uniform is my field?

Soil series - Pasture field 26.6 acres in FL



Wet soil conditions

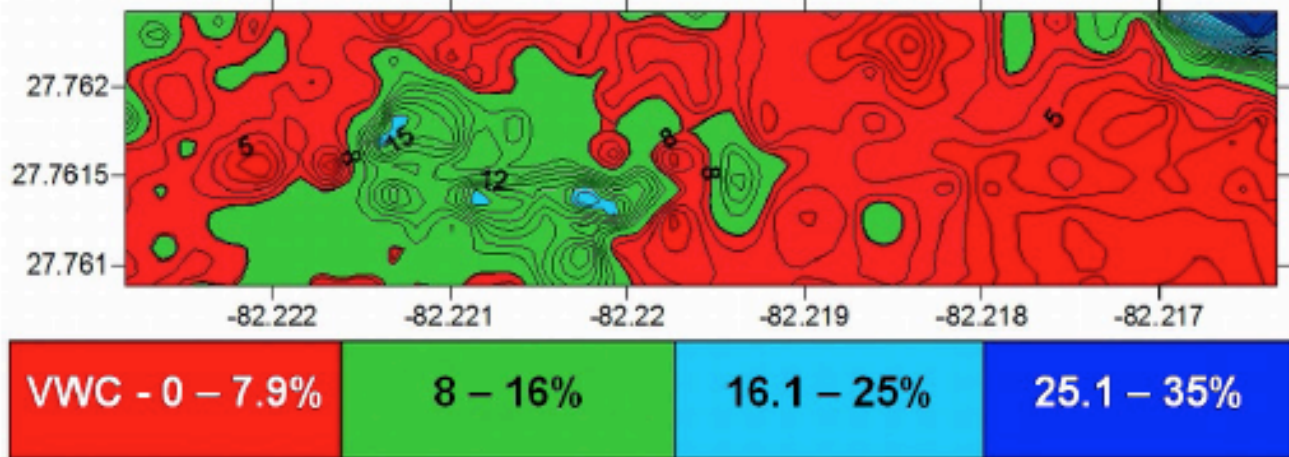


Figure 4. Soil moisture distribution maps under different conditions for pasture in Hillsborough County, Florida. The graphs represent soil moisture spatial distribution using the kriging interpolation method: a) (top graph) dry conditions, b) (center graph) medium conditions, and c) (bottom graph) wet conditions. The X-axis represents longitude, and the Y-axis represents latitude.

Irrigation Management Zones

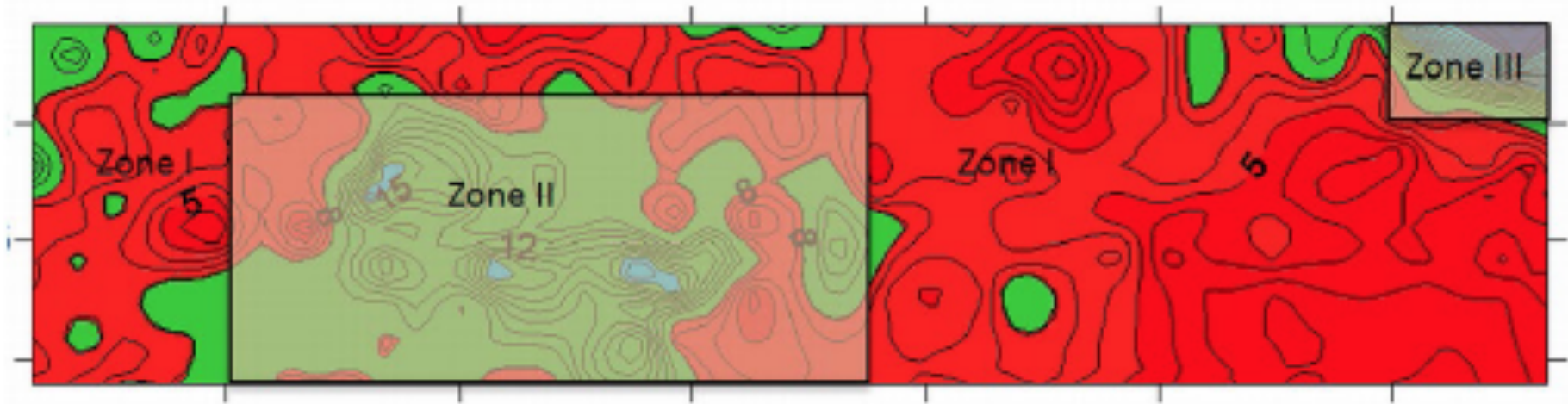


Figure 5. Suggested distribution of management zones according to soil moisture homogeneity.

Based on: soil survey, moisture maps, aerial photos, visual inspection of the field

VRI – Sprinkler Irrigation

University of Georgia – Smart Sensor Array

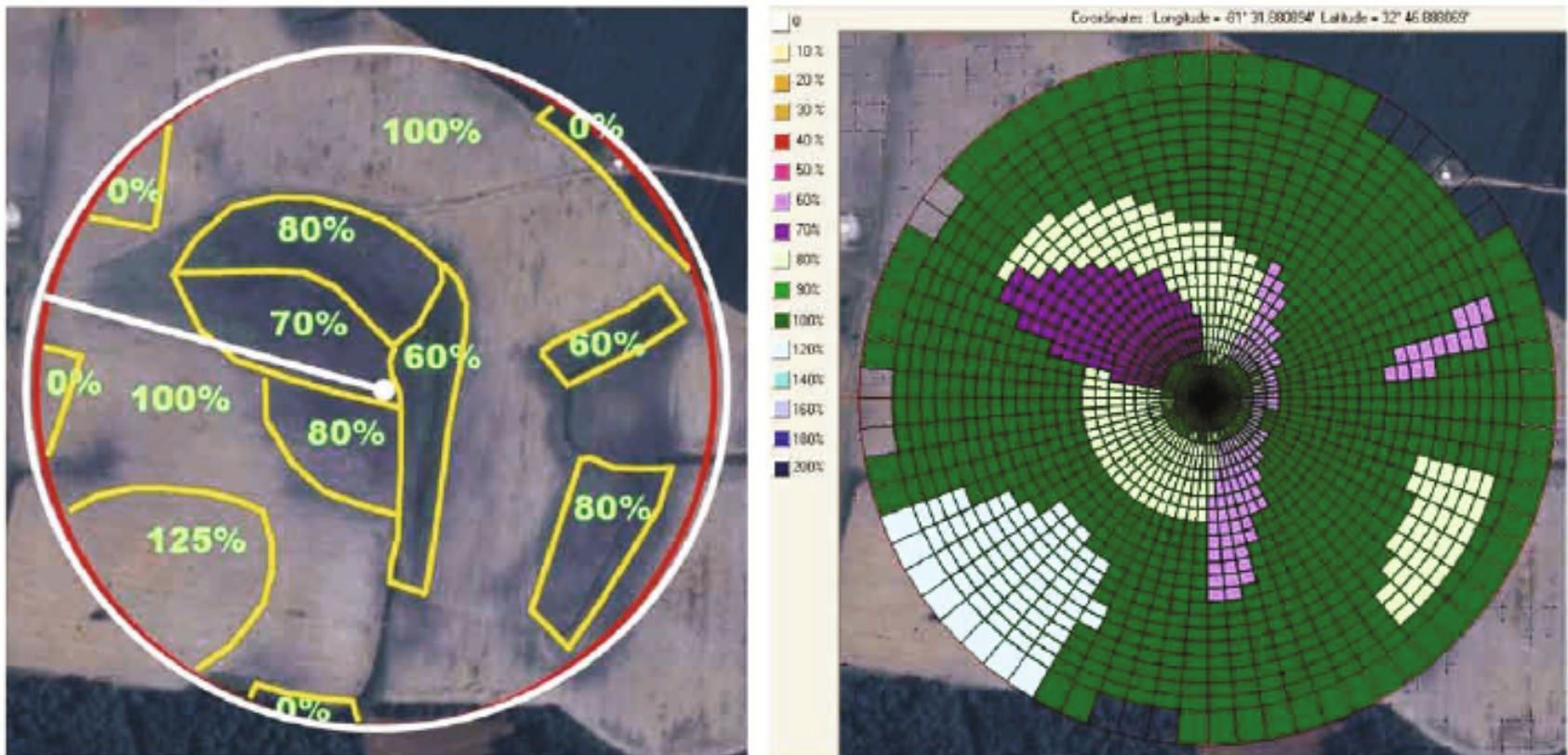


Figure 3. Irrigation application rates assigned to different areas under a 48 ha center pivot irrigation system (left) and variable rate irrigation implementation of the application map (right).

Wireless Sensor System

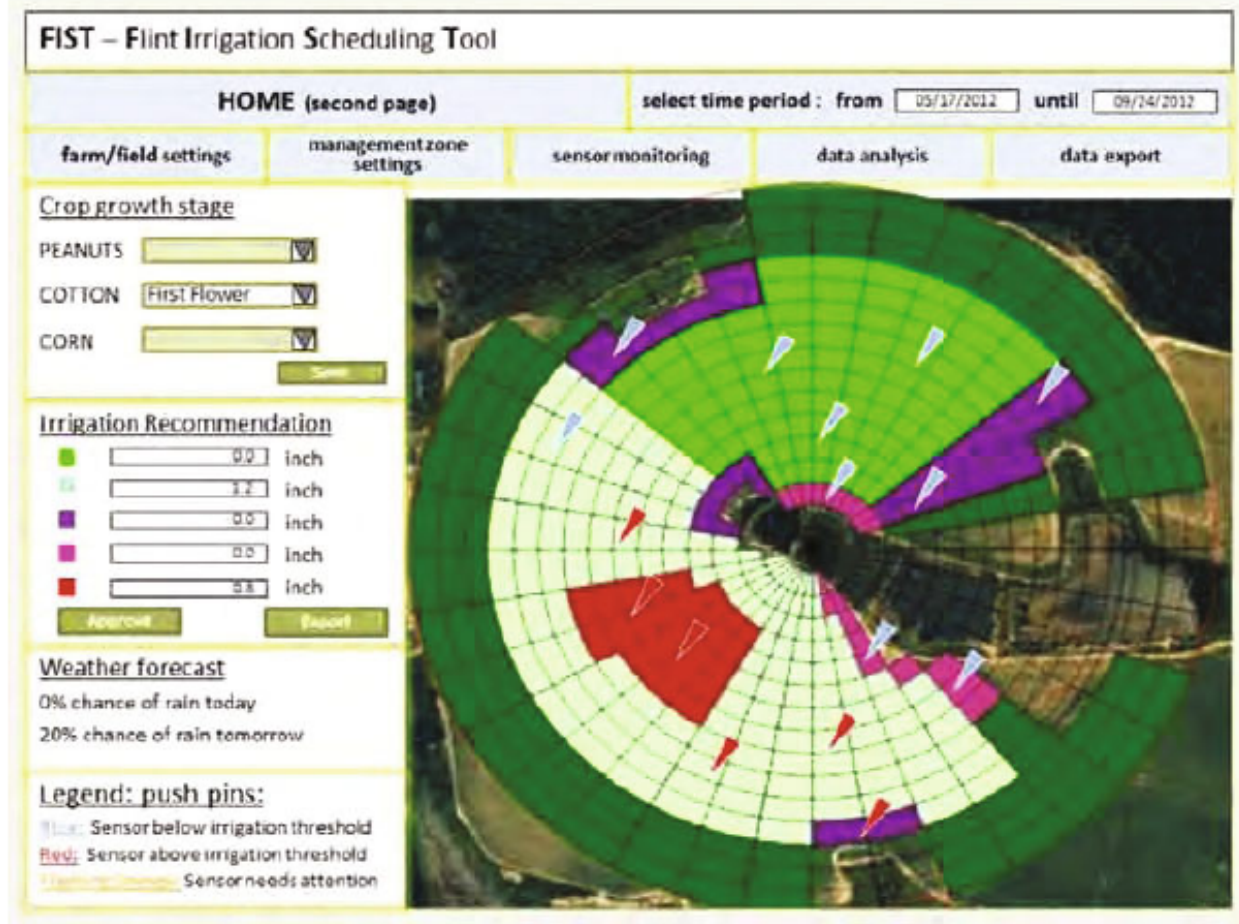


Figure 4. Flint Irrigation Scheduling Tool (FIST) flow diagram (top) and FIST dashboard (bottom).

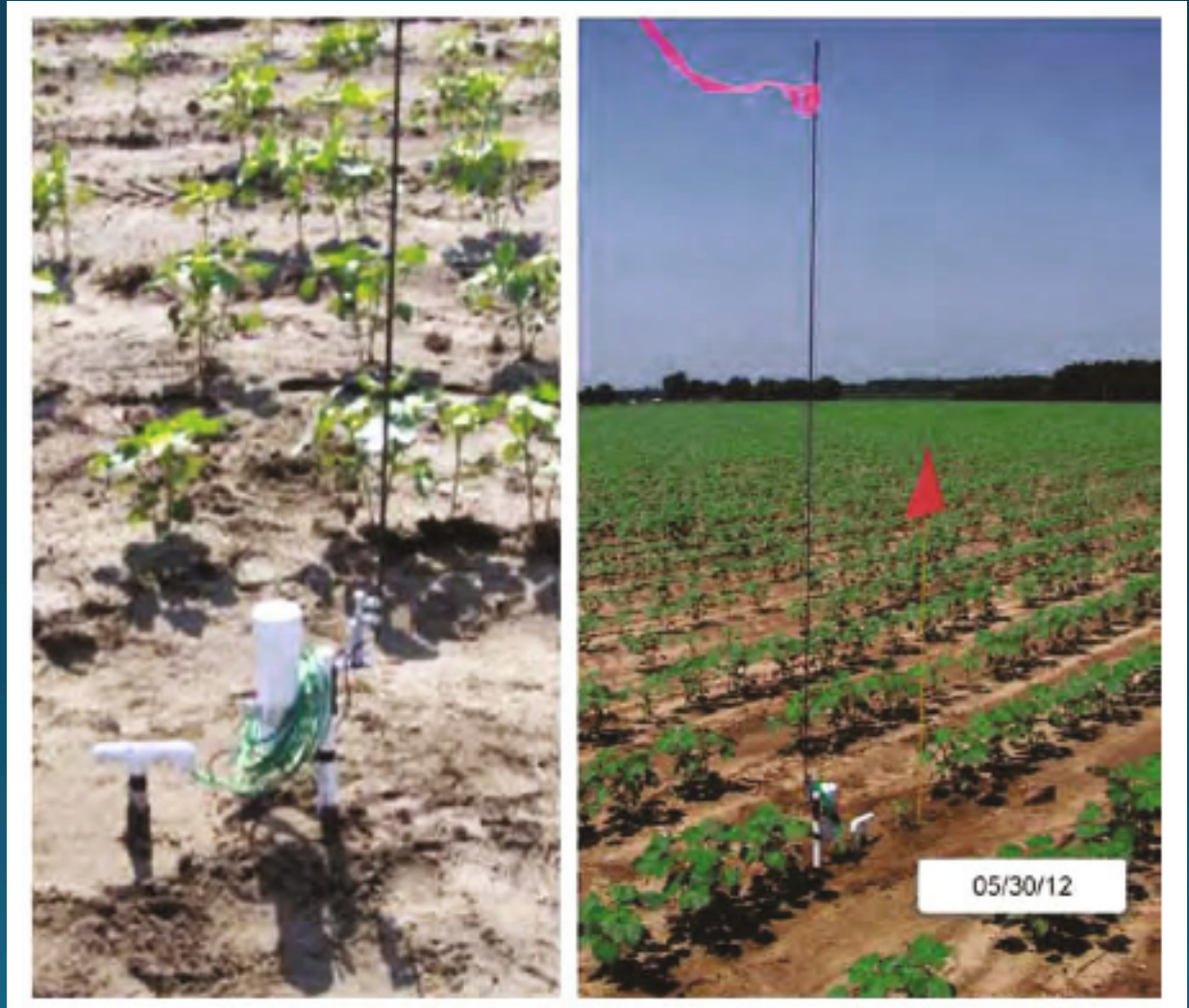
Wireless Sensor System

E.g. University of Georgia – Smart Sensor Array



Wireless Sensor System

University of Georgia – Smart Sensor Array



Online Irrigation Tools



Florida Automated
Weather Network

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[Latest Observations](#)

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[NWS Forecast](#)

[My Florida Farm Weather](#)

FAWN Freeze Alert System

Receive weather alerts on your
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FAWN
@UF_FAWN

26 Nov

Temperature

Wet Bulb Temp

Wind

Daily Min Temp

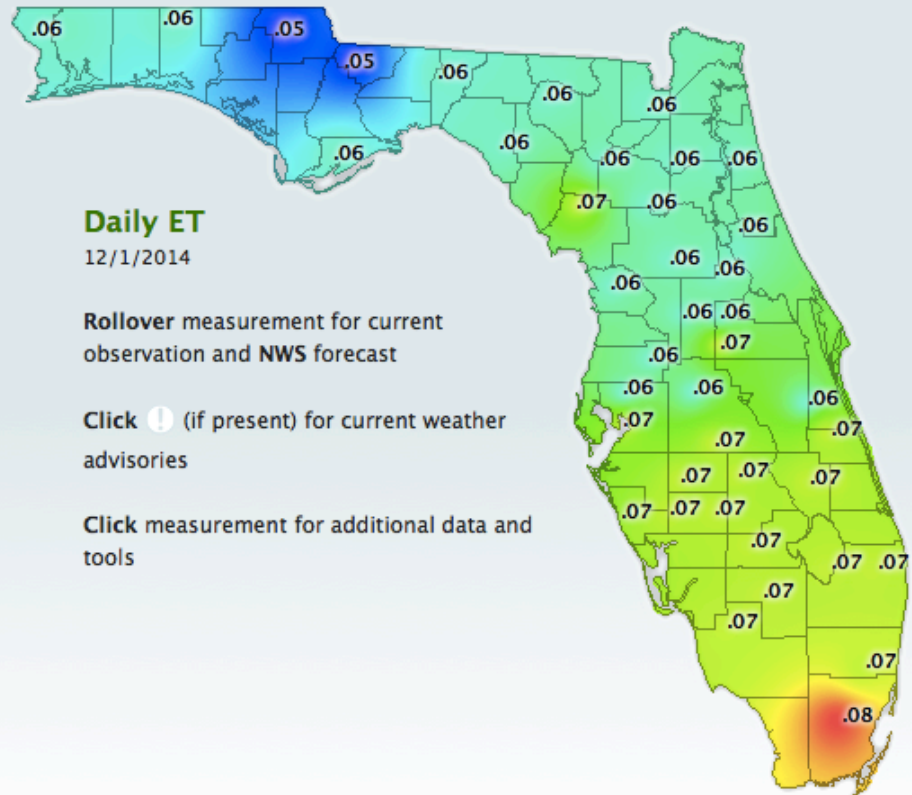
Daily Avg Temp

Daily ET

Daily Total Rain

Weekly Total Rain

FCST Min Temp



Online Irrigation Tools



Florida Automated
Weather Network

HOME DATA ACCESS **TOOLS** CLIMATE ABOUT NEWS DONATE SPONSORS

Irrigation

New! Your Virtual Lawn Tool

This tool can help you evaluate the effectiveness of your watering plan.

Vegetable Irrigation

Indicates frequency and duration of irrigation events.

Strawberry Irrigation

Indicates frequency and duration of irrigation events.

Evapotranspiration (ET)

Penman-Montieth ET for last 7 days from all FAWN stations.

Citrus Irrigation

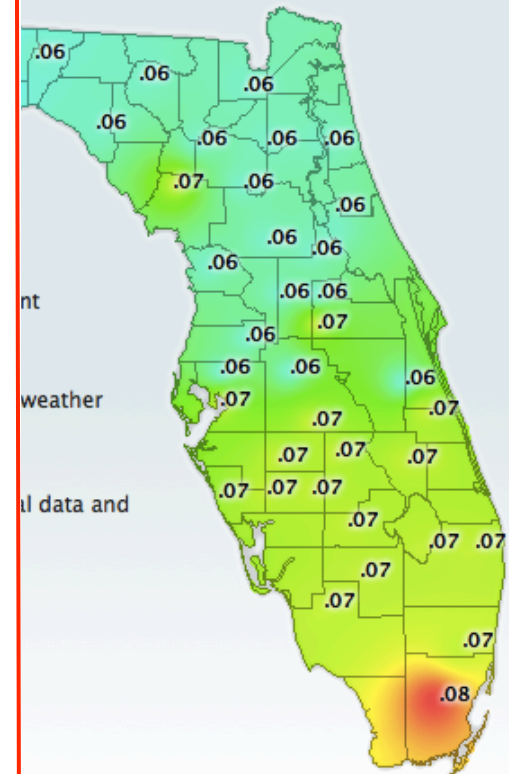
Indicates frequency and duration of irrigation events.

Urban Irrigation Scheduler

Operation run times for residential Irrigation controllers.

Home Irrigation Presentation

The Basics of Home Irrigation.



FAWN Freeze Alert Sys

Receive weather alerts on your
phone and/or by email

Tweets



FAWN

@UF_FAWN

Citrus MicroSprinkler Irrigation Scheduler

Please enter the specifications of your irrigation system and click [Create Schedule] to create a 2-week irrigation schedule.

Tree Row Distances	Between-Row: <input type="text" value="15"/> ft (10 - 40) In-Row: <input type="text" value="10"/> ft (4 - 30)
Emitter	Diameter: <input type="text" value="10"/> ft (1 - 25) Rate: <input type="text" value="5"/> gals/hr (1 - 30) Pattern: <input type="text" value="360"/> deg (0 - 360) System Efficiency: <input type="text" value="85"/> % (50 - 100)
Other Variables	Soil Type (Field Capacity): <input type="text" value="Apopka (.09"/> Irrigation Depth: <input type="text" value="24"/> in. Irrigation Trigger Depth: <input type="text" value="6"/> in. FAWN Station: <input type="text" value="Apopka"/> ET: 0.1663"

Inputs:

Grove information

Irrigation system info

Weather station, soil depth

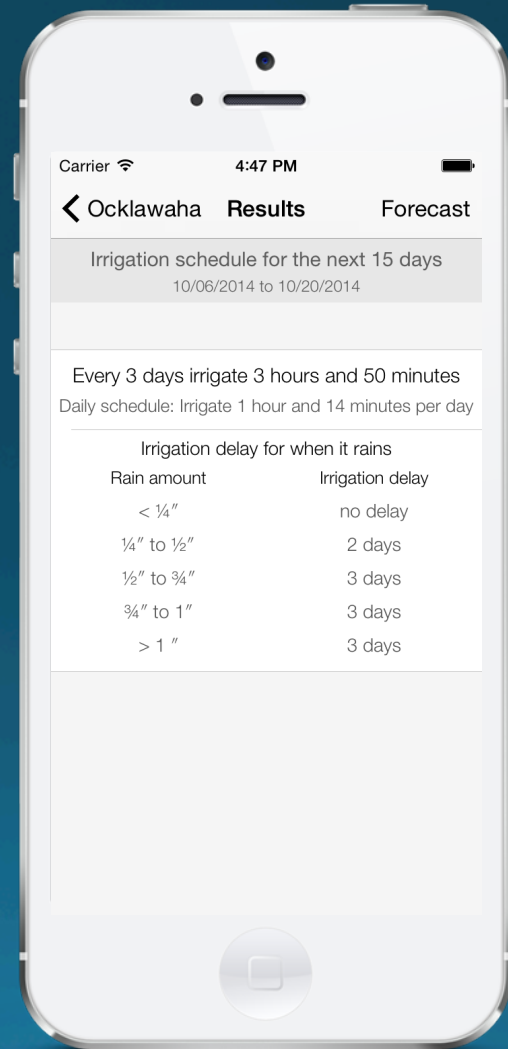
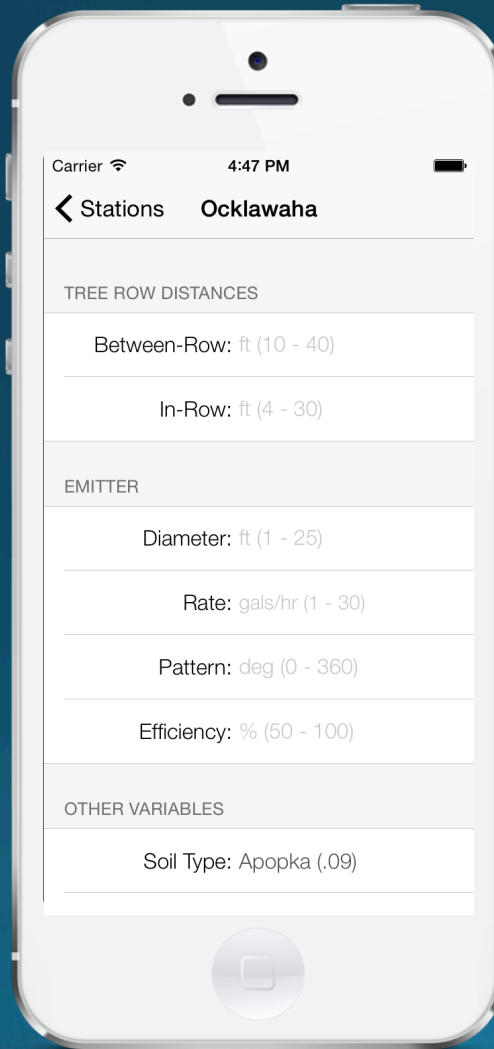
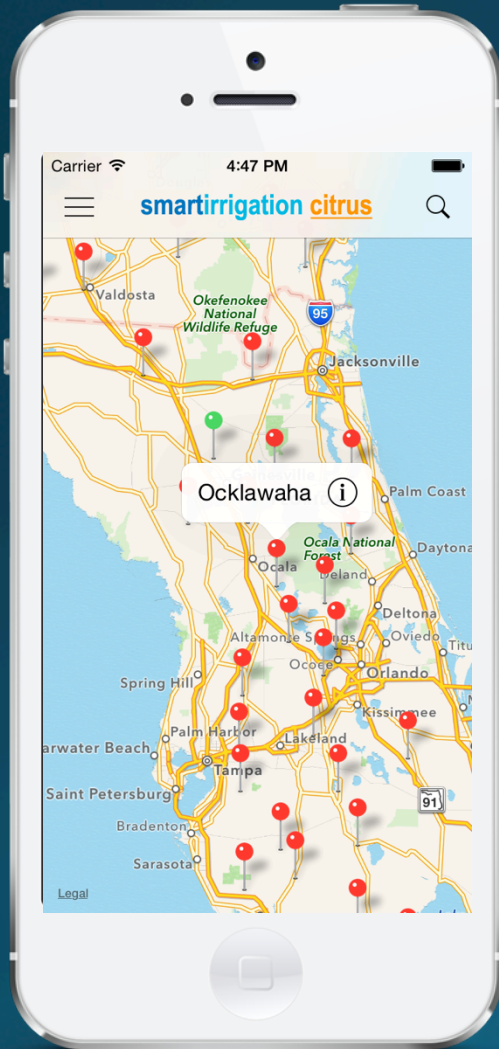
Crop Evapotranspiration

Irrigation Scheduling

If rains!!!!



Citrus app



Available now

The premiere suite of UF/UGA irrigation apps

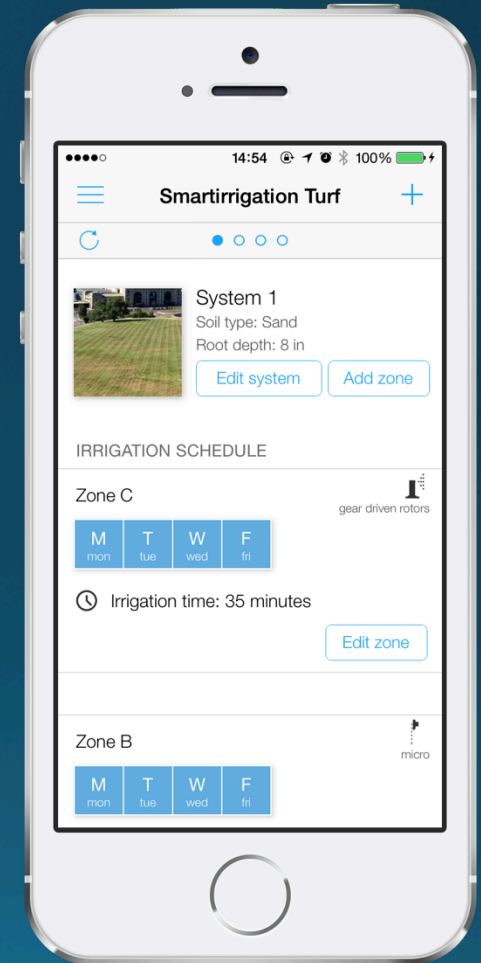


762 users

iOS
Android

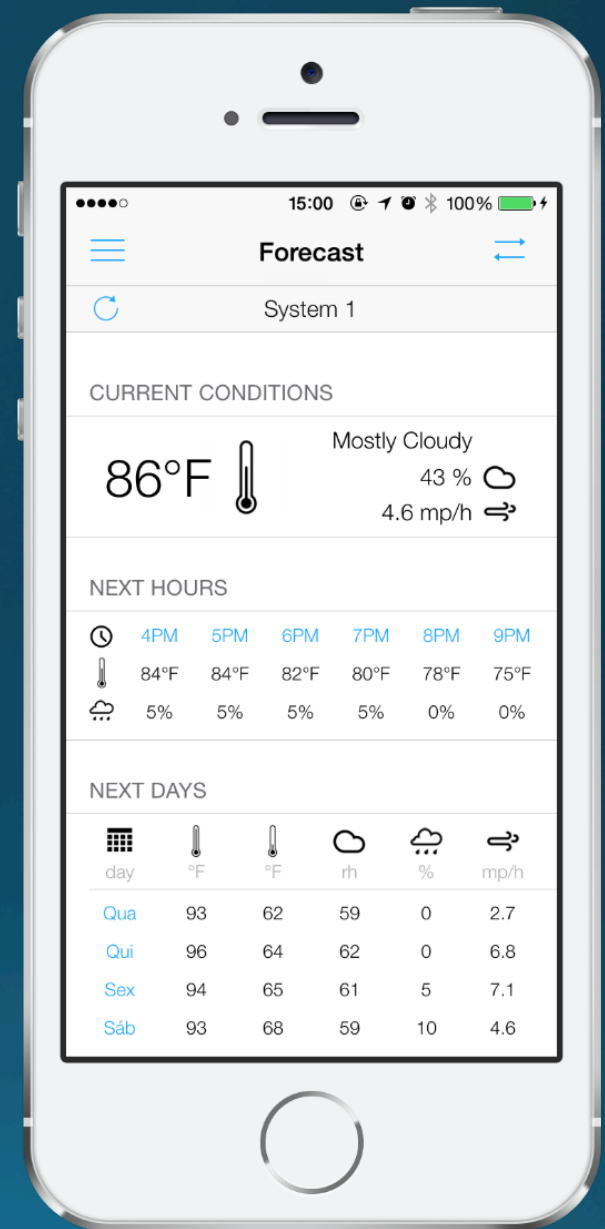
Irrigation schedule generation

- Average ET of previous 5 days
- Updated every 15 days unless ET changes are $>50\%$
- For all apps except cotton, schedule is provided in minutes and/or irrigation depth



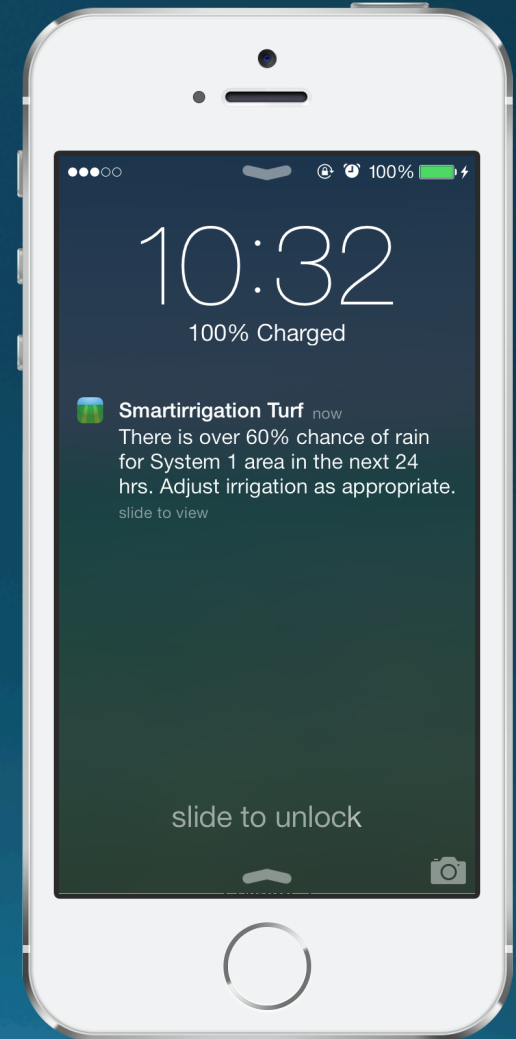
Data resources

- Florida Automated Weather Network (42) & Georgia Environmental Monitoring Network (81)
 - Currently used for ET scheduling (FAO Penman Monteith), rainfall data
 - Crop coefficients are internal for each app and applied using calendar, GDDs or plant growth stage
- National Weather Service
 - Currently used for forecast data



Notifications: user interaction

- Forecasted probability of rainfall
- Rainfall measured at nearest weather station
- Change in irrigation schedule



Take Home Message

- Direct relationship between yield and crop evapotranspiration
- Soil and crop water demand cannot be ignored when irrigating or using precision irrigation
- Irrigation directly impact nutrient availability and crop nutrition
- When using Precision Irrigation
 - Get to know your field
 - Establishment of Irrigation Management Zones (IMZ)
 - Use the technology available

Acknowledgements

- International Plant Nutrition Institute
- InfoAg organization
- Steve Phillips
- University of Florida – IFAS
- Horticultural Sciences and Agric. & Biol. Eng. Depts
- Univ. of Georgia – Dr. Vellidis

Thank you!

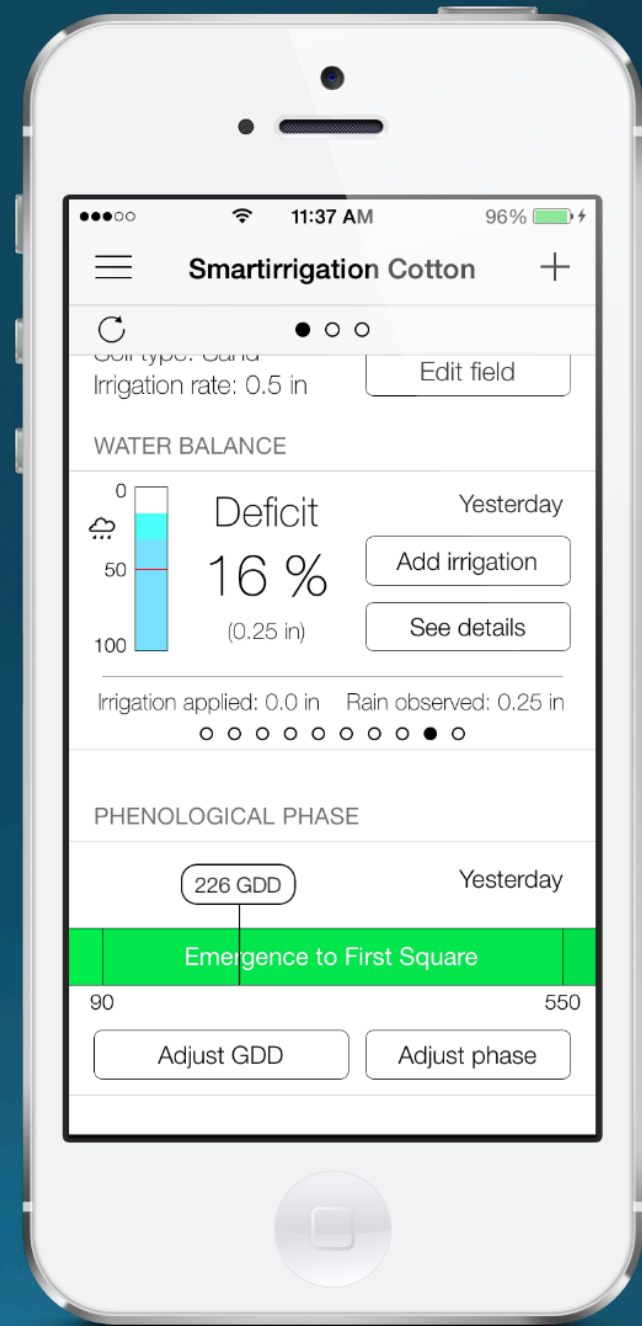
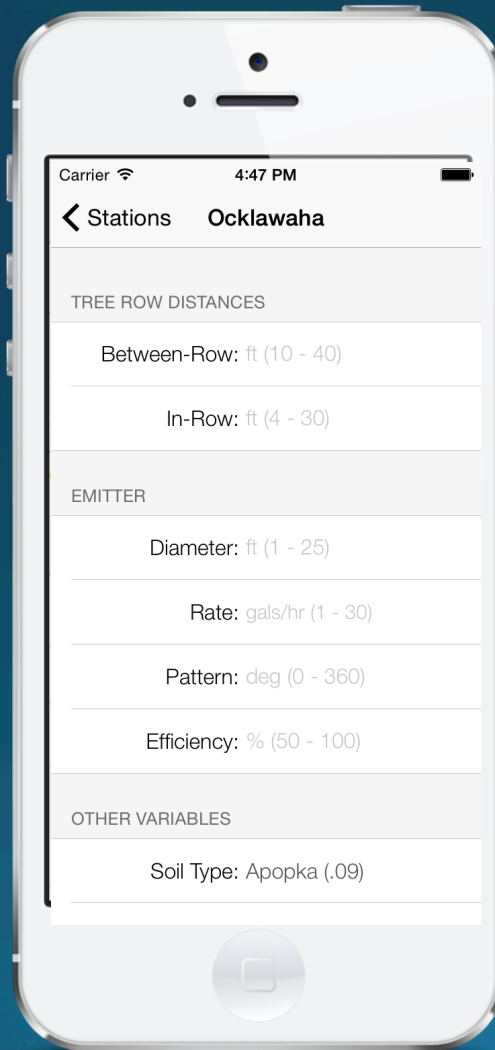
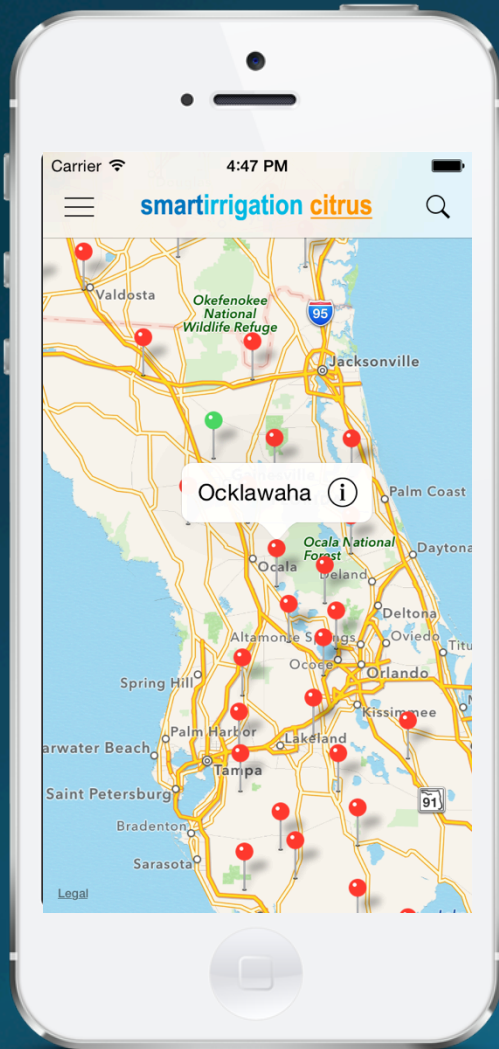
IRRI





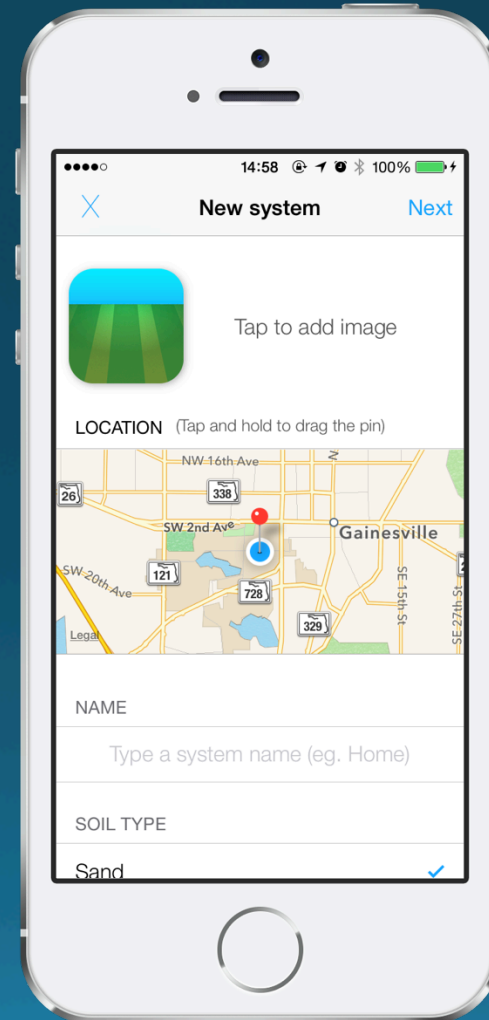
UF UNIVERSITY of
FLORIDA
IFAS

Irrigation app



Location specific

- User location, with movable pin



Rainfall

- **Citrus**
 - Irrigation delay based on rainfall depth
- **Cotton**
 - Provided by station but modified by grower
- **Strawberry**
 - Not included; plastic mulch with irrigation everyday
- **Turf**
 - Notifications of rainfall and forecasted events



Soil water holding capacity

- Field capacity and wilting point boundaries used
- Soils represented by standard classes (clay, sand, etc.) and local soil names (Gladeland, Krome)
- No irrigation schedule recommendation exceeds water holding capacity
 - Notification that an error occurred in entry information
 - More days needed to meet losses

Irrigation systems

- Citrus

- Micro-sprinkler

- Cotton

- Irrigation deficit, pivot

- Strawberry, Vegetables

- Drip

- Turf

- Pop-up heads (sprays, micro, multi-stream, gear driven rotors, impact)



Credits: S. M. Gutierrez



Cotton app



Comparison of different irrigation scheduling methods

Scheduling methods	Weather	Plant	Soil	Irrigation frequency
Soil moisture sensors	Indirect measurement by SMS	Indirect measure by SMS	Determined by user, needed to schedule irrigation amount for selected deficit	User selected, may be bypassed by controller
ET calc. FAWN	FAWN	Kc selected by user	Determined by user to use with calculation	User defined
Apps	FAWN	Kc embedded	Select soil type in app	User defined

