Irrigation Efficiency Research Update

Tampa Bay Water
Conservation Coordination Committee
May 14, 2014
Clearwater, FL

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Agricultural & Biological Engineering

University of Florida/IFAS

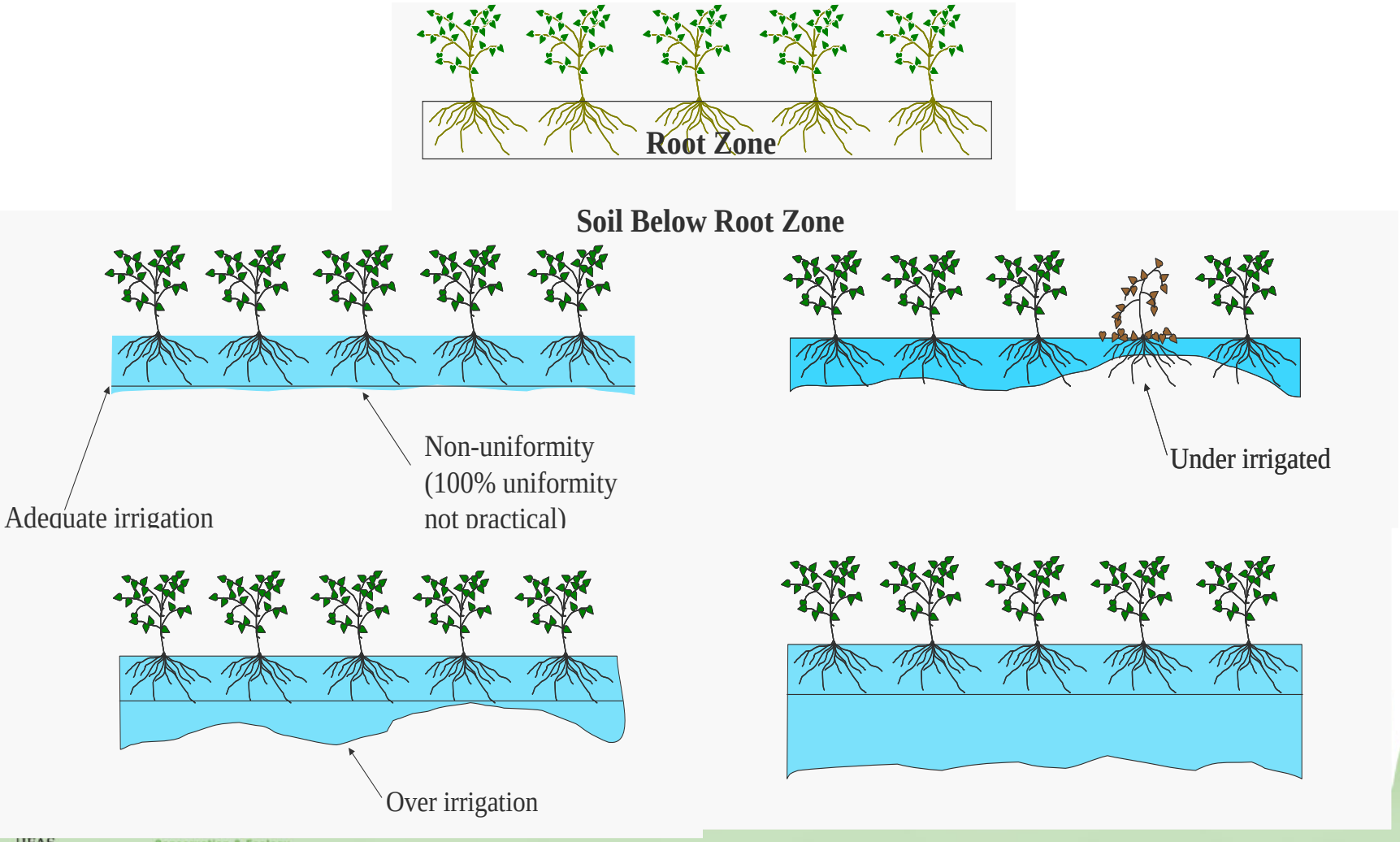
Presentation Highlights

- Background
- Existing research and results
- Where to get existing information
- Future research/application issues

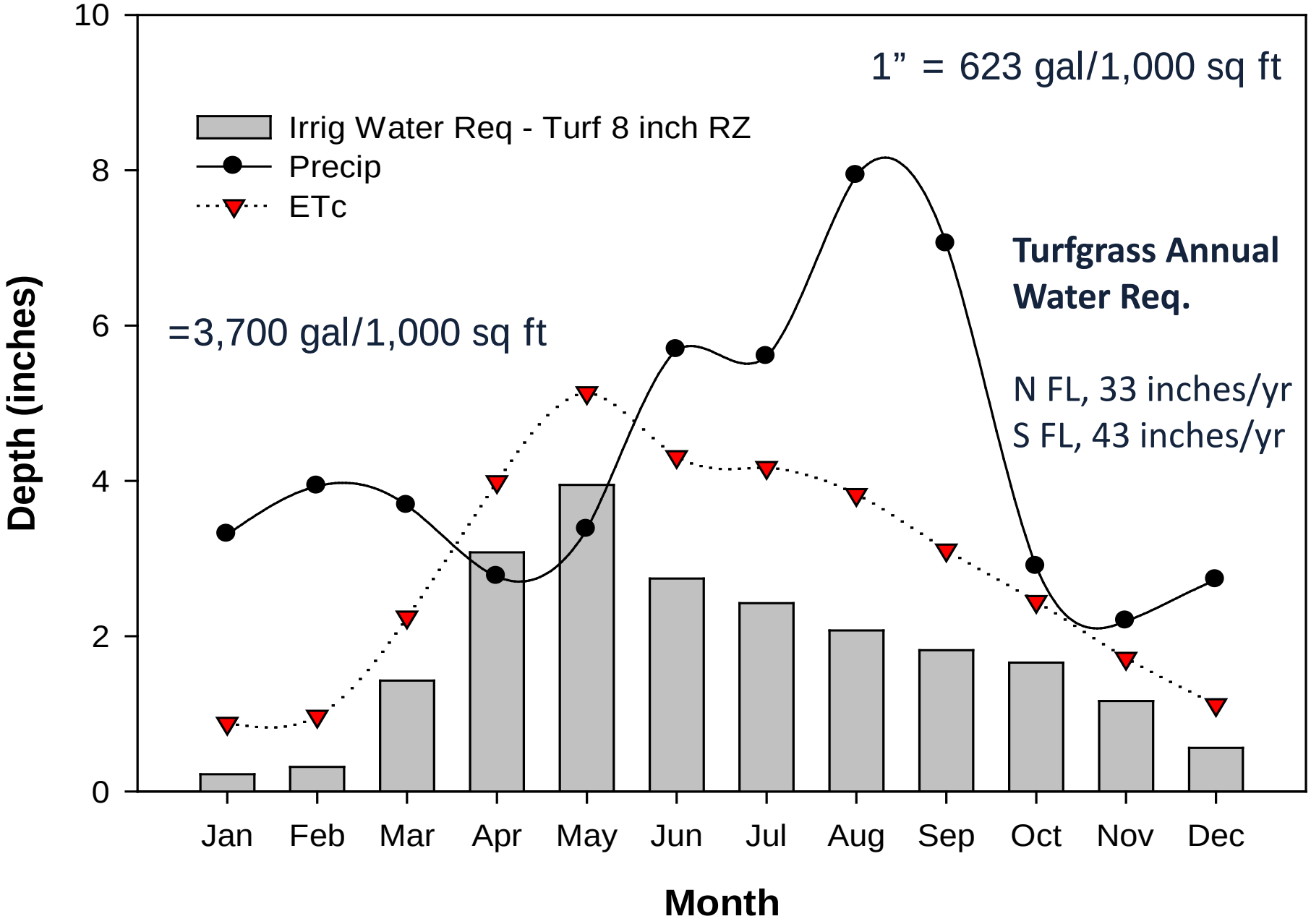
UF/IFAS Center for Landscape Conservation and Ecology

- Mission
  - To protect and conserve Florida's natural resources through research-based sustainable urban landscape practices.
- Vision
  - To be the leading source of science-based information on horticulture and the urban environment in Florida.

Irrigation Efficiency: Design/maint. + Management



Irrigation Requirements



www.abe.ufl.edu/mdukes/publications

Soil Moisture Sensor (SMS) controllers

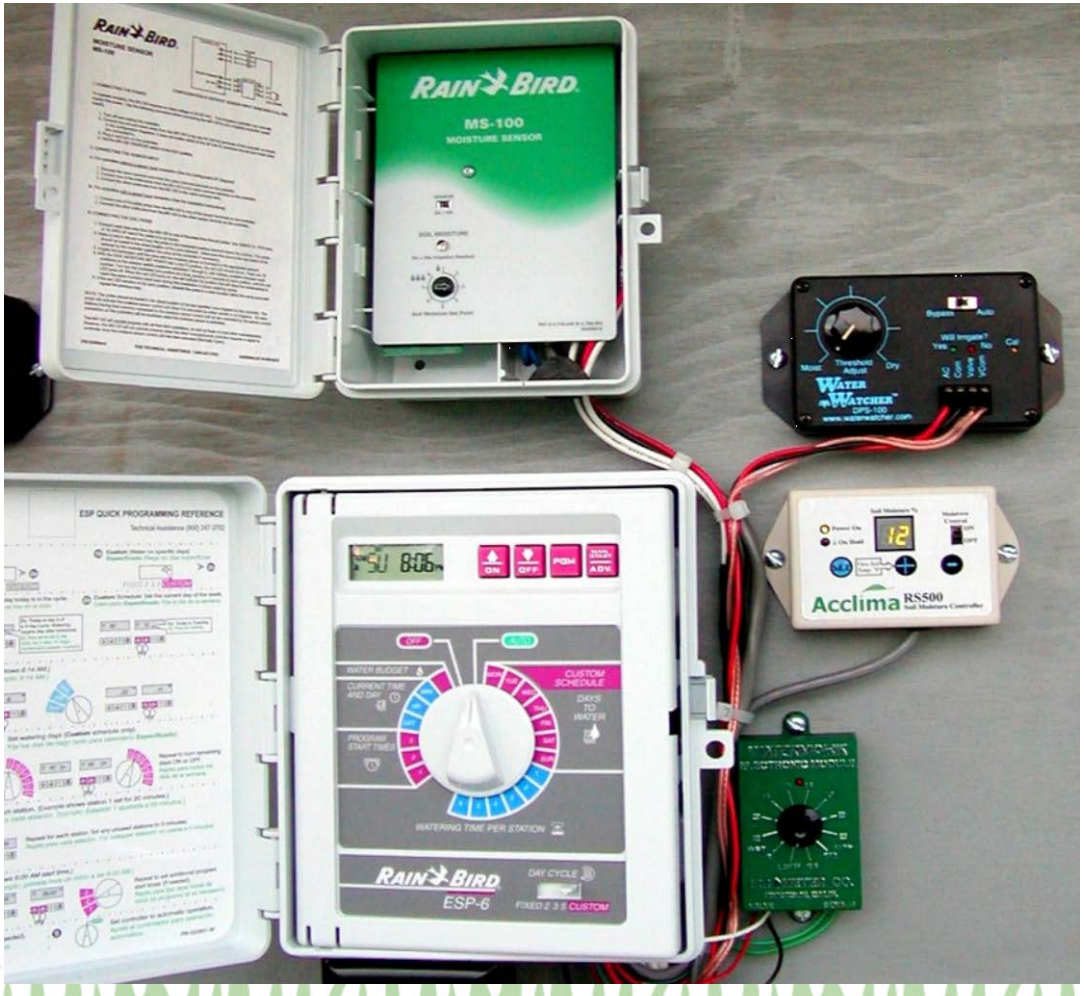
- B187, original SMS project
- B252, SMS reclaimed water project
- Industry
- EPA WaterSense

Soil Moisture Sensor Controller

B187 Phase I, SMS evaluation

- May 2004 – Oct 2007
- Plot testing, Gainesville, bermudagrass
- 4 SMS brands
- 1, 2, 7 d/wk frequency

Gainesville Plots


RAIN BIRD
MS-100
MOISTURE SENSOR
Water Watcher
Acclima RS500
ESP QUICK PROGRAMMING REFERENCE
RAIN BIRD
ESP-6

Gainesville Plots Dry Period

Overall Results

- SMS
  - ~70% savings during normal-wet rainfall
  - ~50% savings during dry conditions
- Savings while maintaining turf quality

B187 Phase II, SMS evaluation on homes

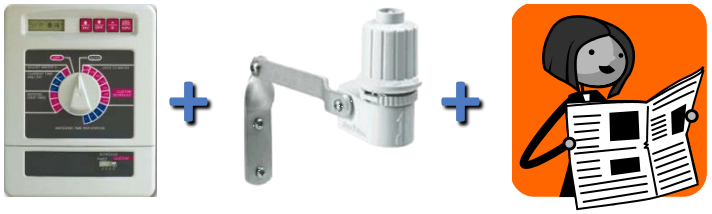
- Palm Harbor area homes targeted
- Irrigation audits performed
- 58 homes
  - SMS (soil moisture sensor)
  - EDU (education)
  - RS (rain sensor)
  - MO (monitoring only)

Experimental Treatments

1. Monitoring only.....

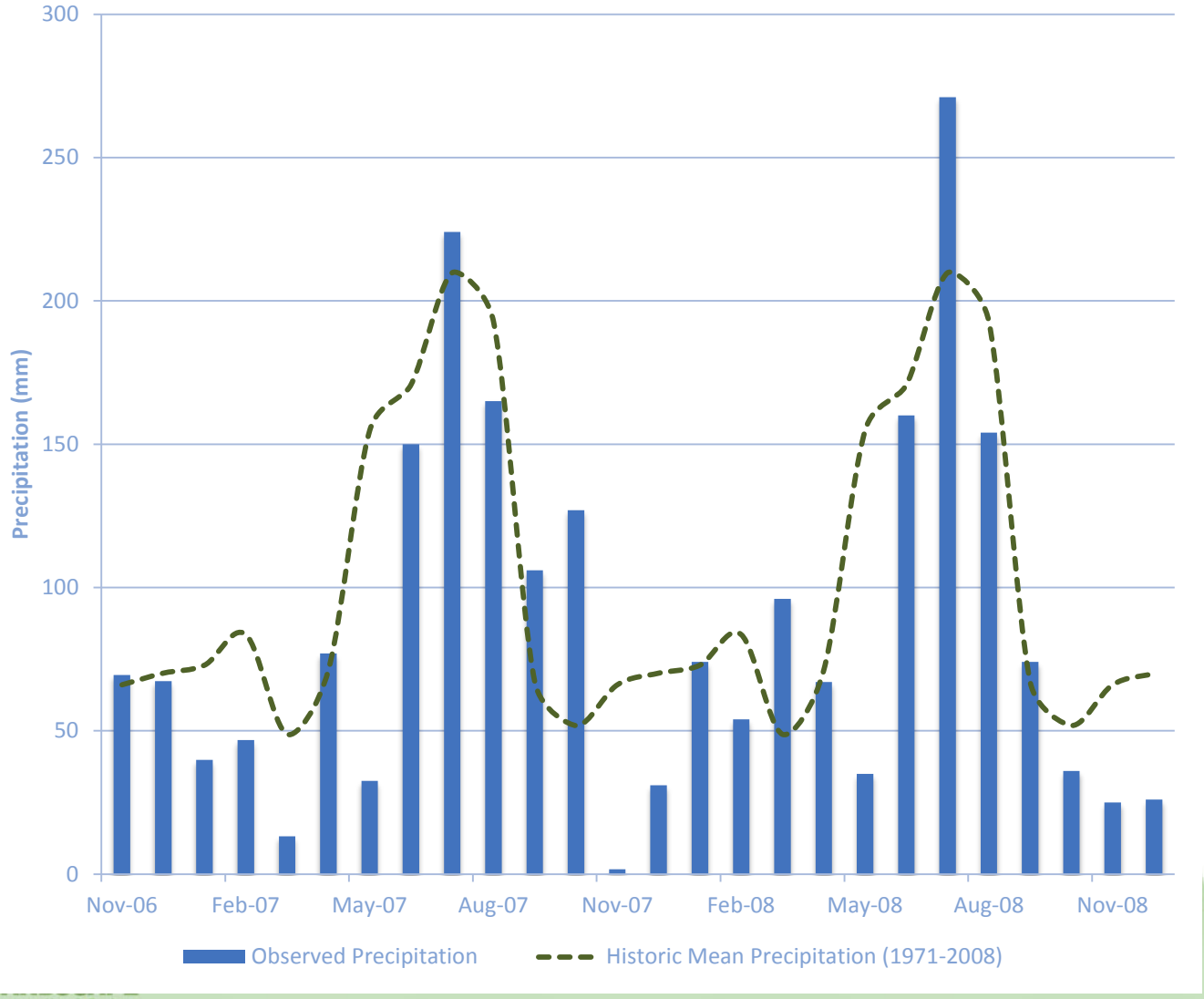
2. Current irrigation system plus rain sensor (1/4” setting).....

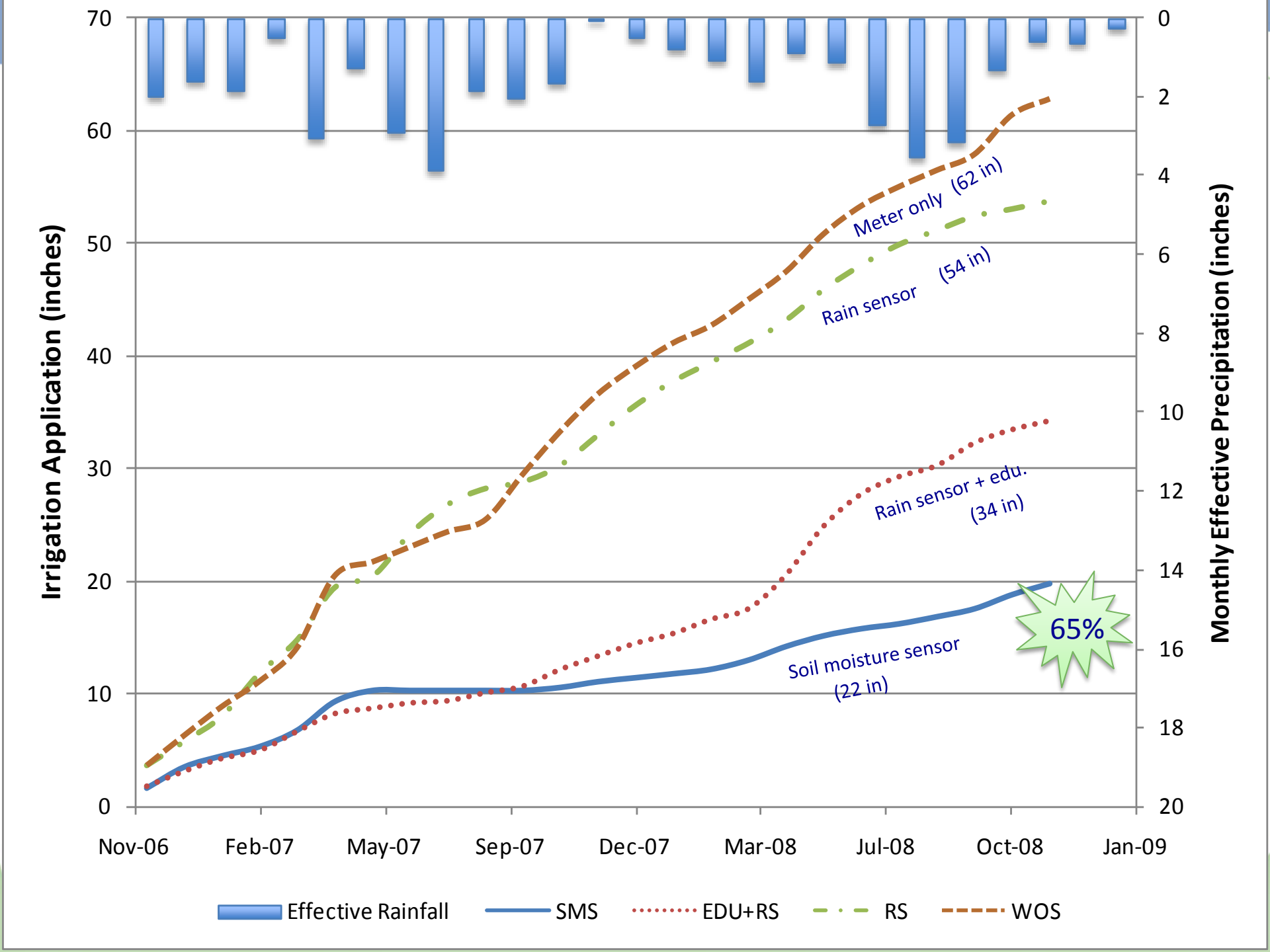
3. Current irrigation system plus rain sensor and educational materials.....



4. Current irrigation system plus a soil moisture sensor.....

Precipitation, Nov 06 – Nov 08




Irrigation Application (inches)
Monthly Effective Precipitation (inches)
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
Nov-06
Feb-07
May-07
Sep-07
Dec-07
Mar-08
Jul-08
Oct-08
Jan-09
Meter only (62 in)
Rain sensor (54 in)
Rain sensor + edu. (34 in)
Soil moisture sensor (22 in)
65%
Effective Rainfall
SMS
EDU+RS
RS
WOS

		Number of Irrigation Events						
		I_{actual}[Z] (#[S]/mth)	N[Y] (#)	Max (#/mth)	Min (#/mth)	Median	Std Dev (#/mth)	I_{gross}[T] (#/mth)
Treatment[R]	SMS	2.3b[Q]	191	11	0	1	3.4	
	RS	5.7a	203	22	0	4	7.1	
	MO	6.0a	182	29	0	4	7.8	4
	EDU	4.5ab	196	20	0	3	6.3	
Season[P]	Spring	6.6a	160	29	0	5	5.6	7
	Summer	4.3b	177	26	0	2	5.0	4
	Fall	3.8b	202	29	0	2	3.6	5
	Winter	4.2b	233	29	0	3	4.7[O]	2

Note: Uppercase superscript letters indicate footnotes.

[Z] Monthly average number of irrigation events applied.

[Y] N = number of observations in the comparison.

[T] Number of irrigation events per month, calculated from the SWB.

[S] Conversion: 1 inch = 25.4 mm

[R] Treatments are: SMS, time-based controller plus soil moisture sensor system; RS, time-based controller plus rain sensor; MO, time-based controller only; EDU, time-based controller plus rain sensor and educational materials.

[Q] Numbers followed by different letters are statistically different at the 95% confidence level within a year.

[P] Seasons defined as: spring, March, April, May; summer, June, July, August; fall, September, October, November; winter, December, January, February.

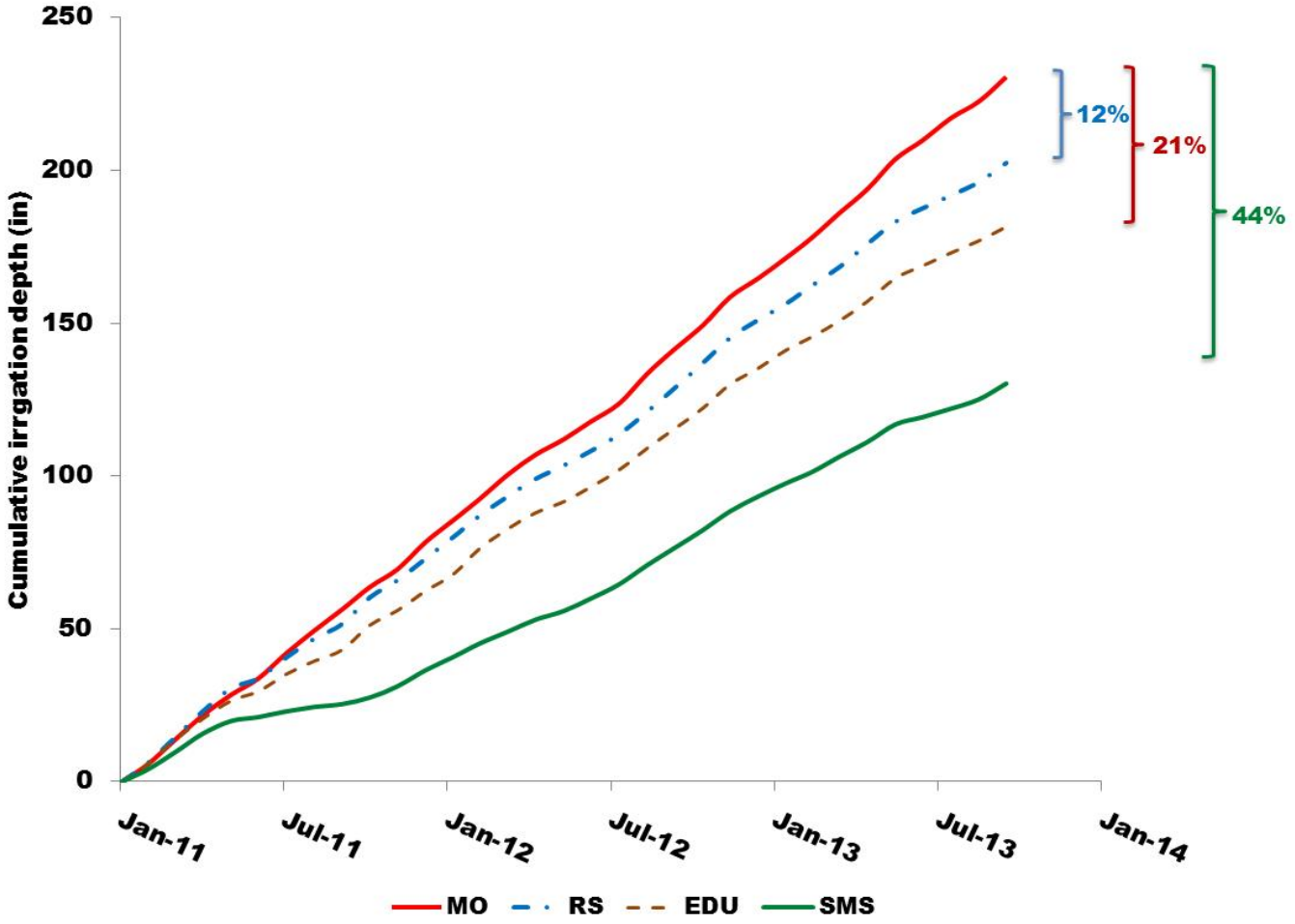
[N] AMRs installed during late Spring 2007.

[O] Winter of 2008 consisted of December 2008 and January 2009 only.

B252, SMS Controllers w/Reclaimed

- 64 homes in Palm Harbor
  - SMS (soil moisture sensor)
  - EDU (education)
  - RS (rain sensor)
  - MO (monitoring only)

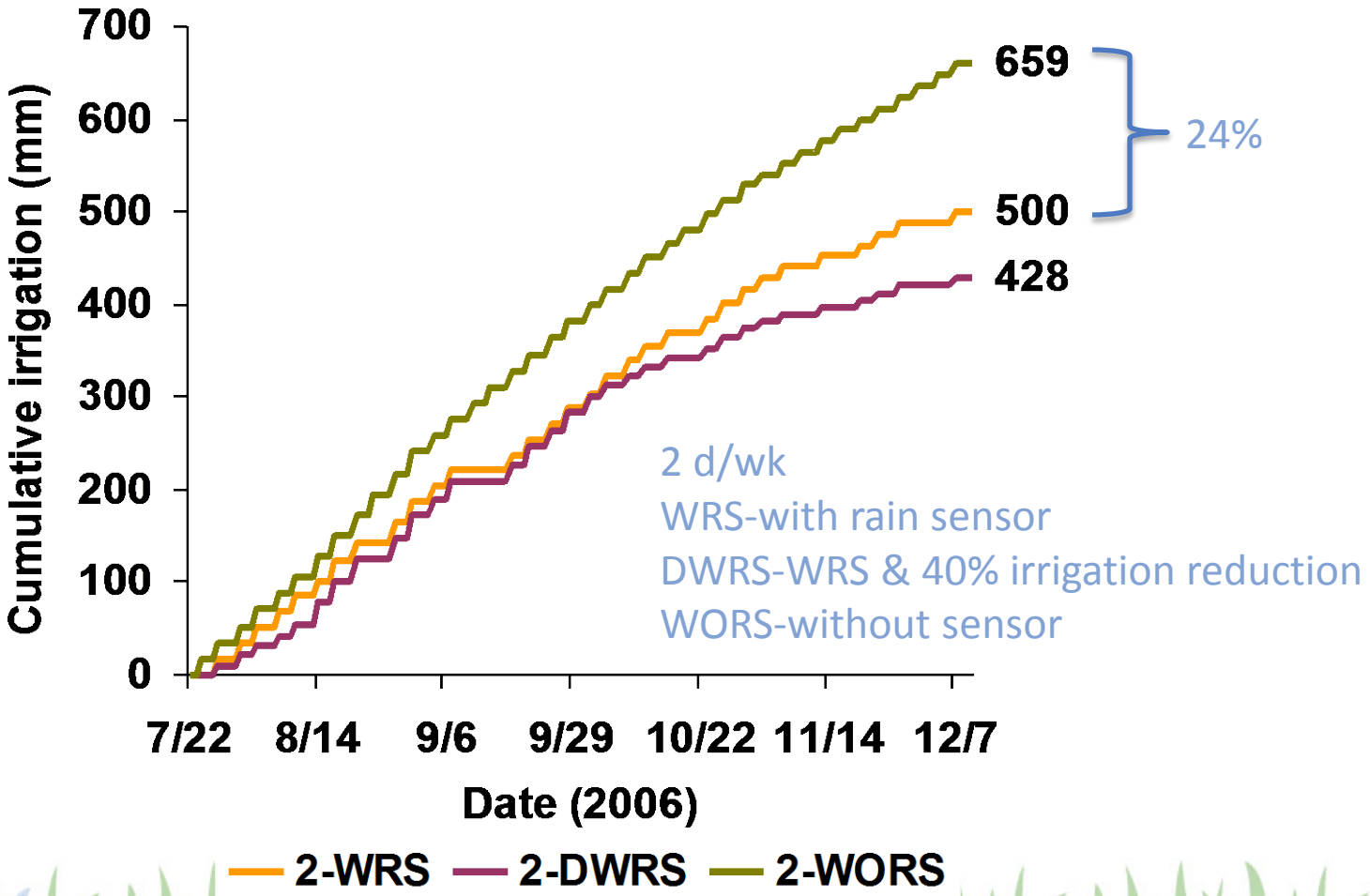
B252, SMS Controllers w/Reclaimed



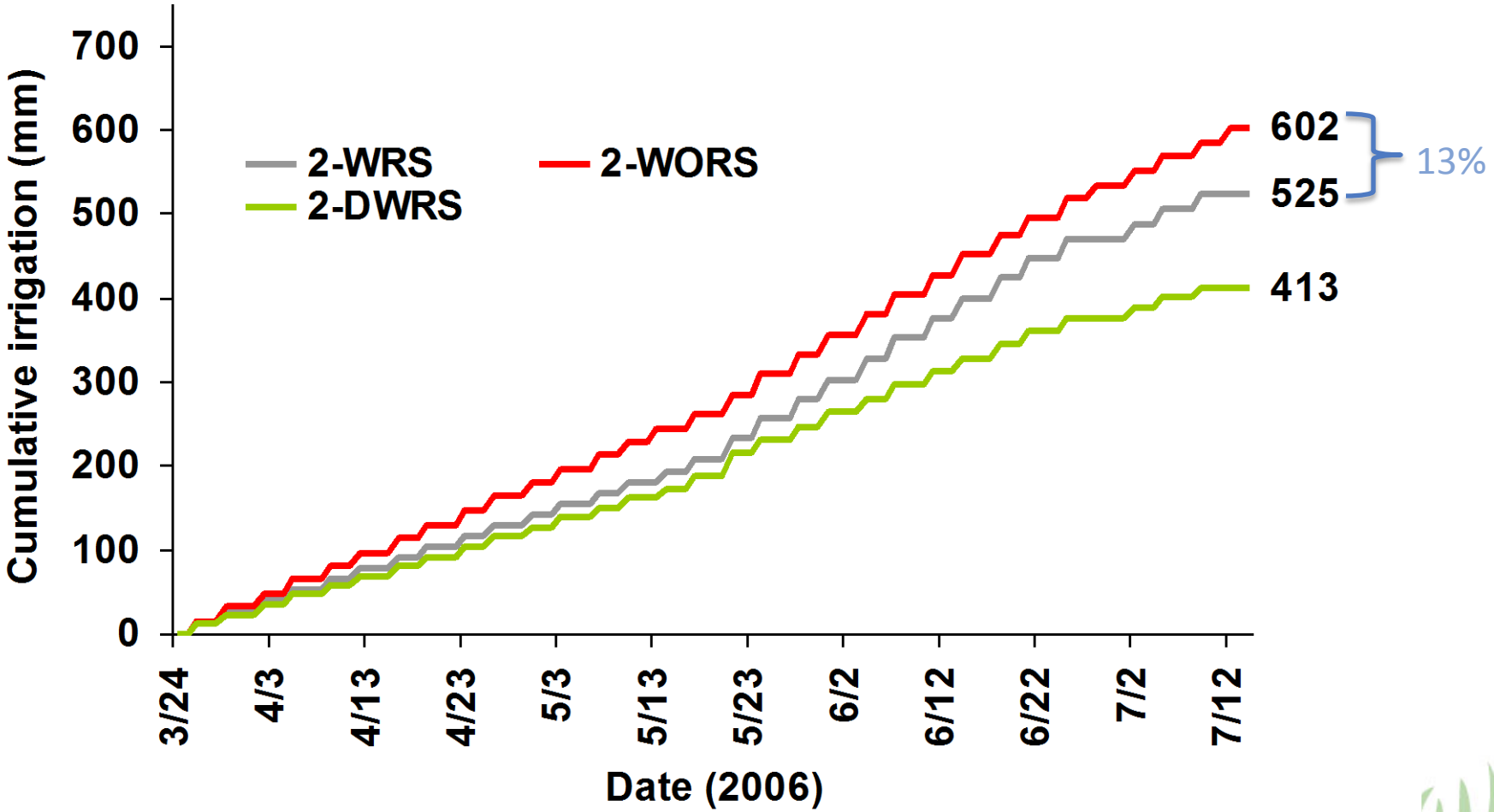
Rain Sensors (RS)

- B187, original SMS project
- B284, maximum deficit project
- B252, SMS reclaimed water project
- IA, Smart Water Application Technologies

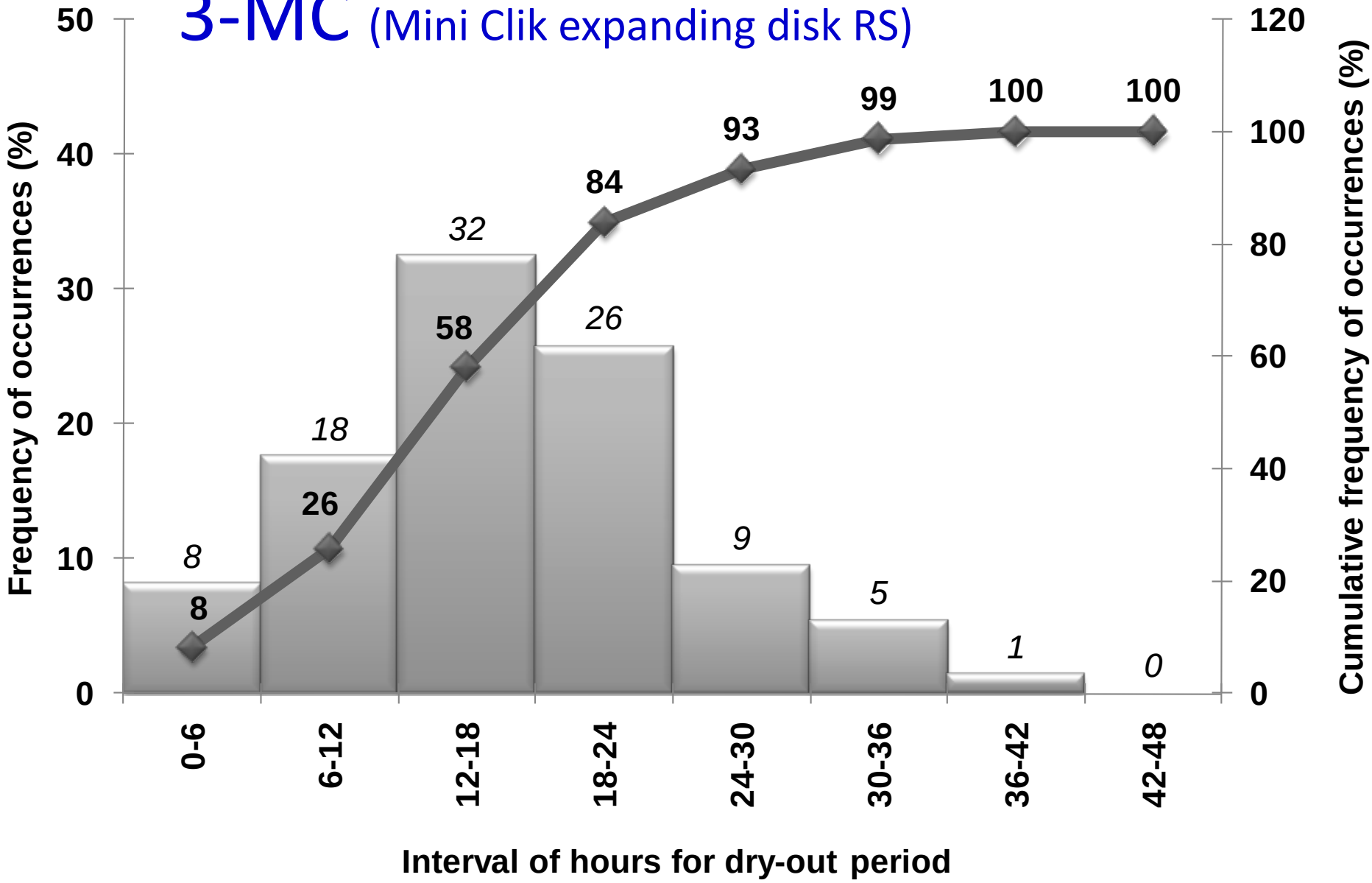
Plot Based RS Performance, Rainy



Plot Based RS Performance, Dry



3-MC (Mini Clik expanding disk RS)



Long Term (3+ yrs) Rain Sensor Testing

IA SWAT Rain Sensor Testing

RS Evaluation at Citra


Sensor Status
Rain
(blinking - bypass on)
Signal
Smart Bypass™
Power
(blinking - attn. reqd.)
RS 1000
Wireless RainSensor™
Irritrol

RS Accuracy & Longevity

- Most are 50% - 70% accurate
- Ex. 0.25” set point triggers at 0.08 to 0.16”
- Accuracy changes -23% to 25% over 3 years
- Annual maint. required for best performance

Evapotranspiration (ET) Controllers

- Hillsborough Co. project
- EPA WaterSense
- Orange County Utilities, *ongoing*

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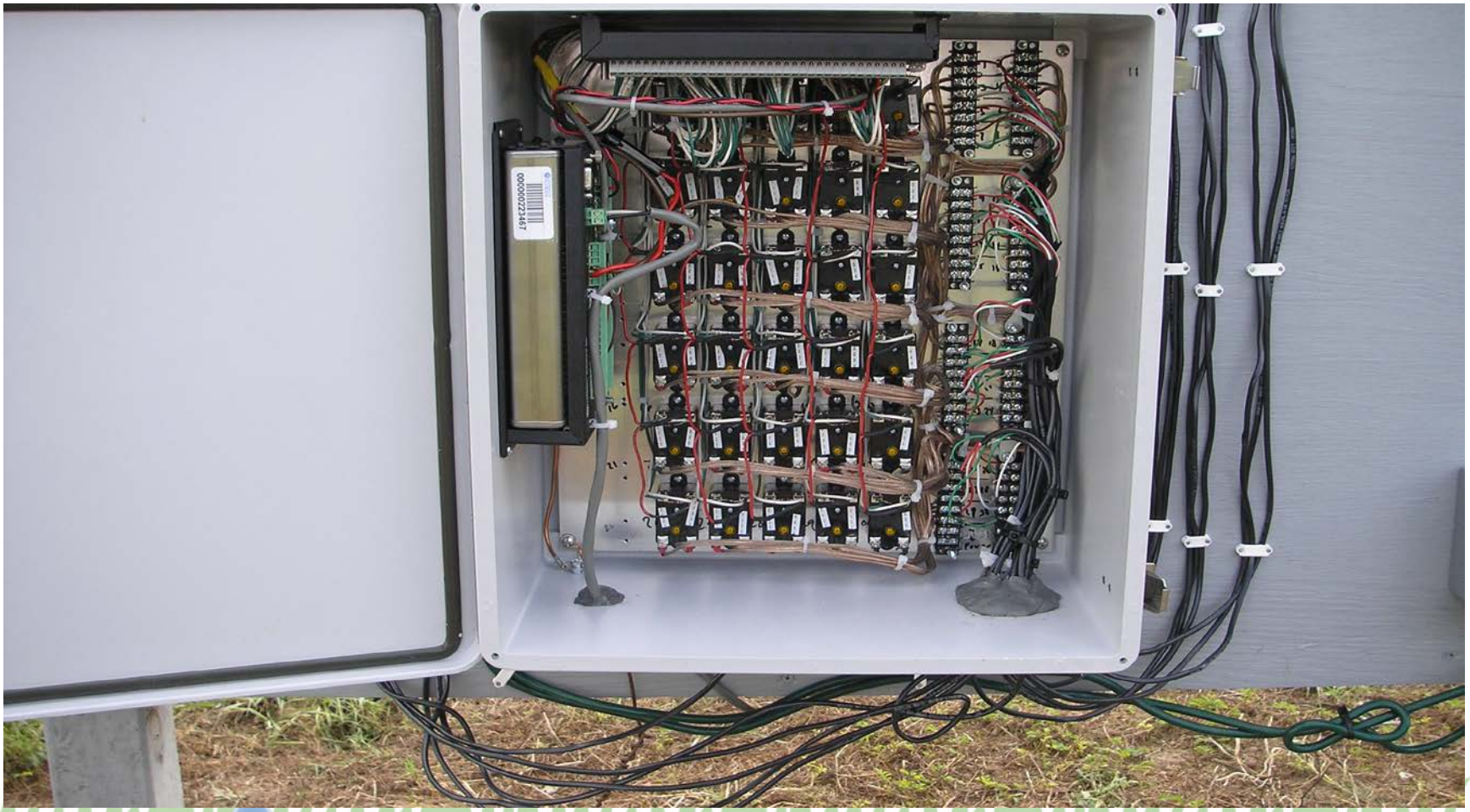
ET Controllers

- Some can determine runtimes and days
- Programming is key!
  - Soil type
  - Plant type
  - Microclimate
  - Application rates
  - Slope

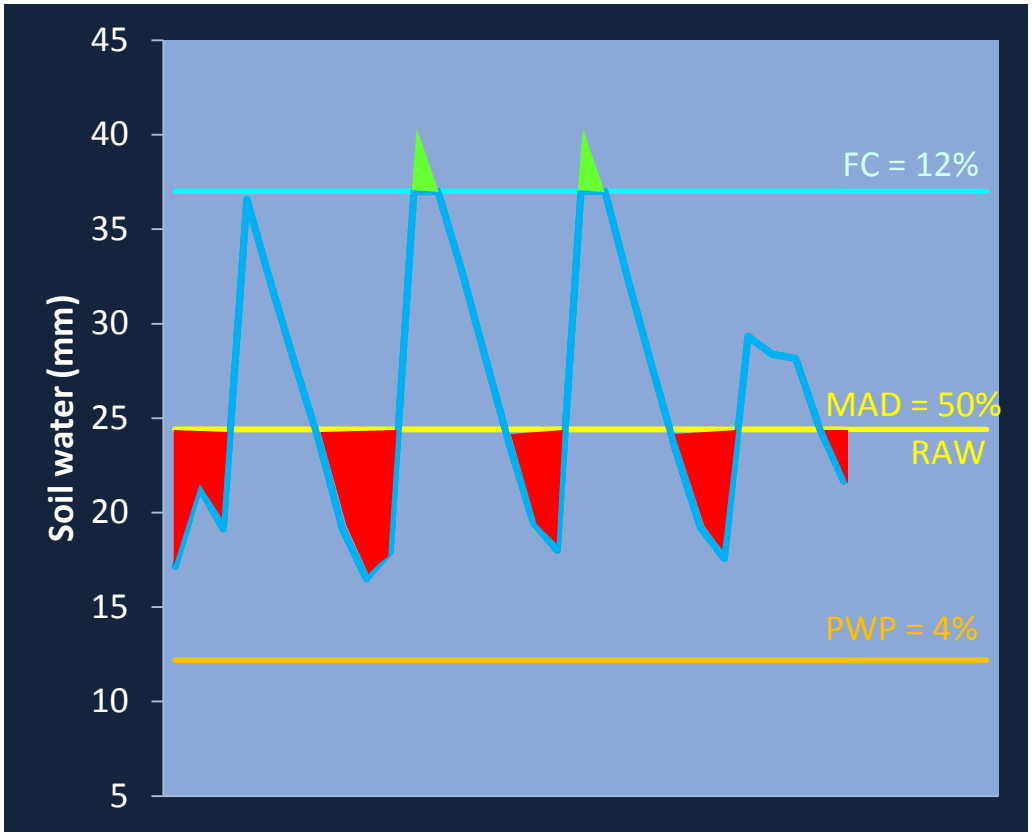
EPA WaterSense Protocol Evaluation

EPA WaterSense Protocol Evaluation



Assessing Smart Controllers

- Surplus: Irrigation exceeding water holding capacity
- Deficit: Lack of irrigation to meet plant needs



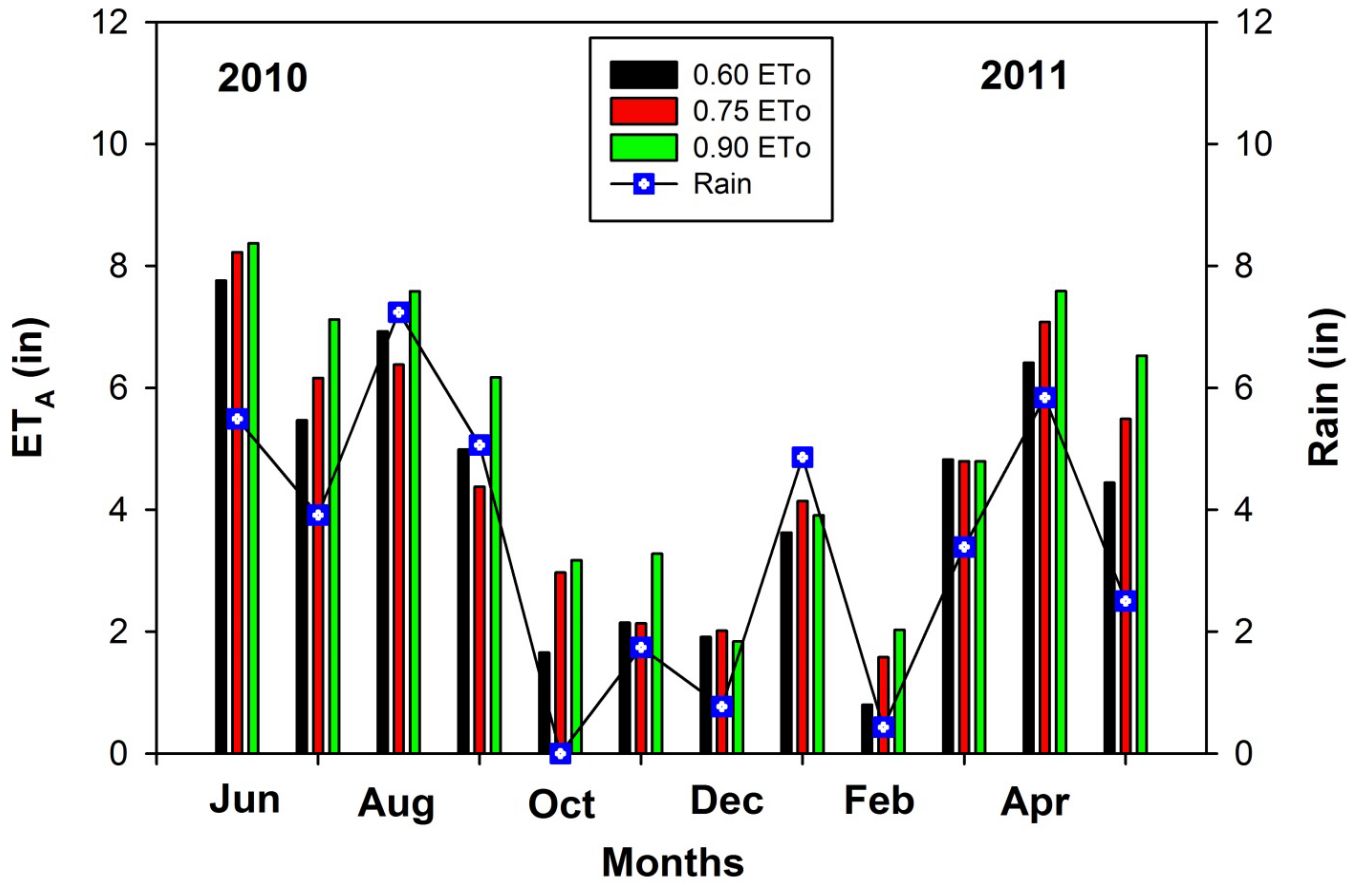
Turfgrass Water Requirements

- P424, Investigation of methods for permitting
- B284, Maximum turfgrass deficit
- B777, Turfgrass establishment

P424, Investigation of Methods for Permitting

- Determine turfgrasses well-watered ET
- Determine ET on representative ornamental species
- Determine mixed landscapes irrigation requirements/balancing quality

Mixed Landscapes ET



P424 Key Outcomes

- Irrigation with 75% ETo balanced quality with the least irrigation
- 75% ETo used 14% less irrigation than 90% ETo
- Can be used to update permitting methodology, likely reducing permitted irrigation

B284, Maximum Turfgrass Deficit

- Three cultivars
  - Floratam St. Augustine
  - Empire Zoysia
  - Captiva St. Augustine
- 10 irrigation levels
  - 2 d/wk w/o RS
  - ET
  - Reduced time
  - % wilt
  - No irrigation


04/12/20

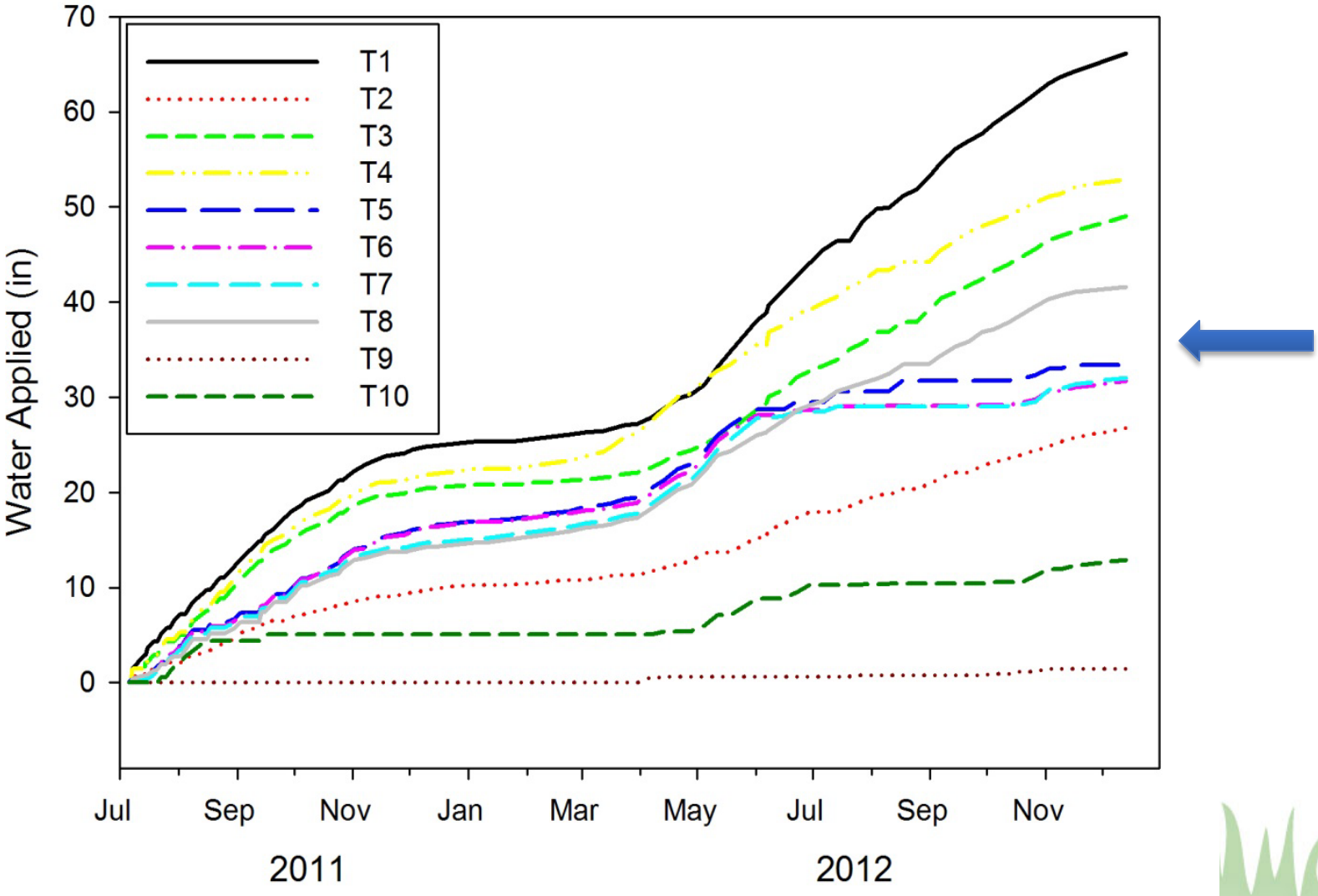

04/12/2011

Plot Layout

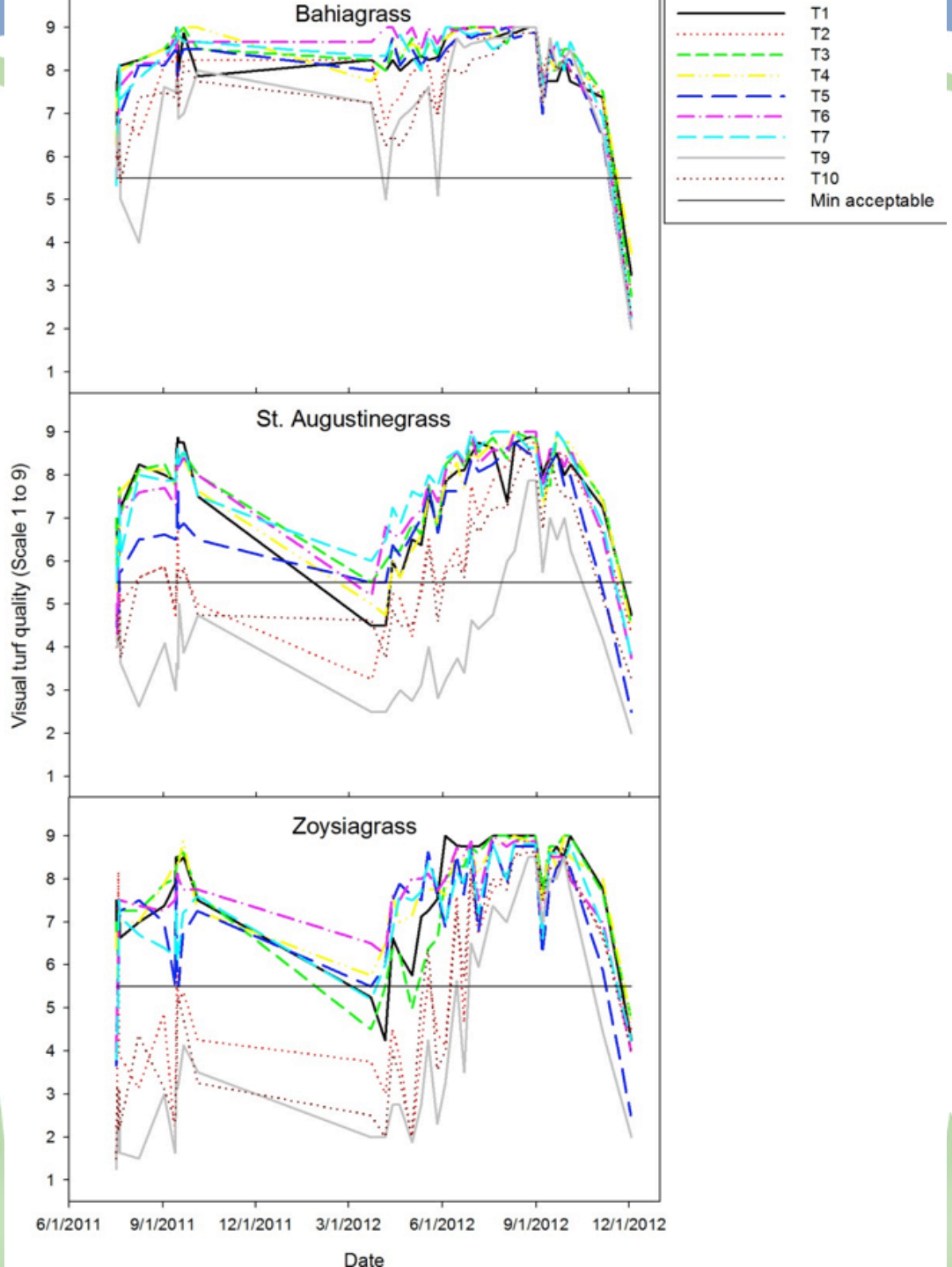
Laying Sod

Treatment	Description	Days wk^{-1}	Application (inches wk^{-1})[a]
T1	IFAS recommended amount, WOS[b]	2	1.4
T2	One half of IFAS recommended amount, WRS[c]	1	up to 0.7
T3	IFAS recommend amount, WRS	2	up to 1.4
T4	Calculated amount relative to maximum daily average ET in June	2	1.0
T5	Turf canopy more 60 to 80% of plot wilted (NTR = 0.1)[d]	any	as needed
T6	Turf canopy 30 to 50% wilted (NTR = 0.5)	any	as needed
T7	Turf canopy up to 30% wilted; first sign of wilt (NTR = 0.3)		
T8	Turf canopy fully-wilted (1 to 3 days after NTR = 0.1)	any	as needed
T9	Non-irrigated after establishment	none	none
T10	Re-establishment irrigation applied only when stand death was deemed imminent	none	as needed

Cumulative Irrigation



Turf Quality



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B777, Turfgrass Establishment

- Four cultivars
  - Floratam St. Augustine
  - Empire Zoysia
  - Captiva St. Augustine
  - Argentine Bahia
- Three establishment irrigation schedules
  - Immediate 2 or 1 d/wk
  - 15-15
  - 30-30
- Three plantings
  - Jan
  - Jul
  - Sept

Visual Quality Assessment

Empire Zoysiagrass

Quality Rating 3 | Quality Rating 5 | Quality Rating 7

Captiva St. Augustinegrass

Quality Rating 3 | Quality Rating 5 | Quality Rating 6.5

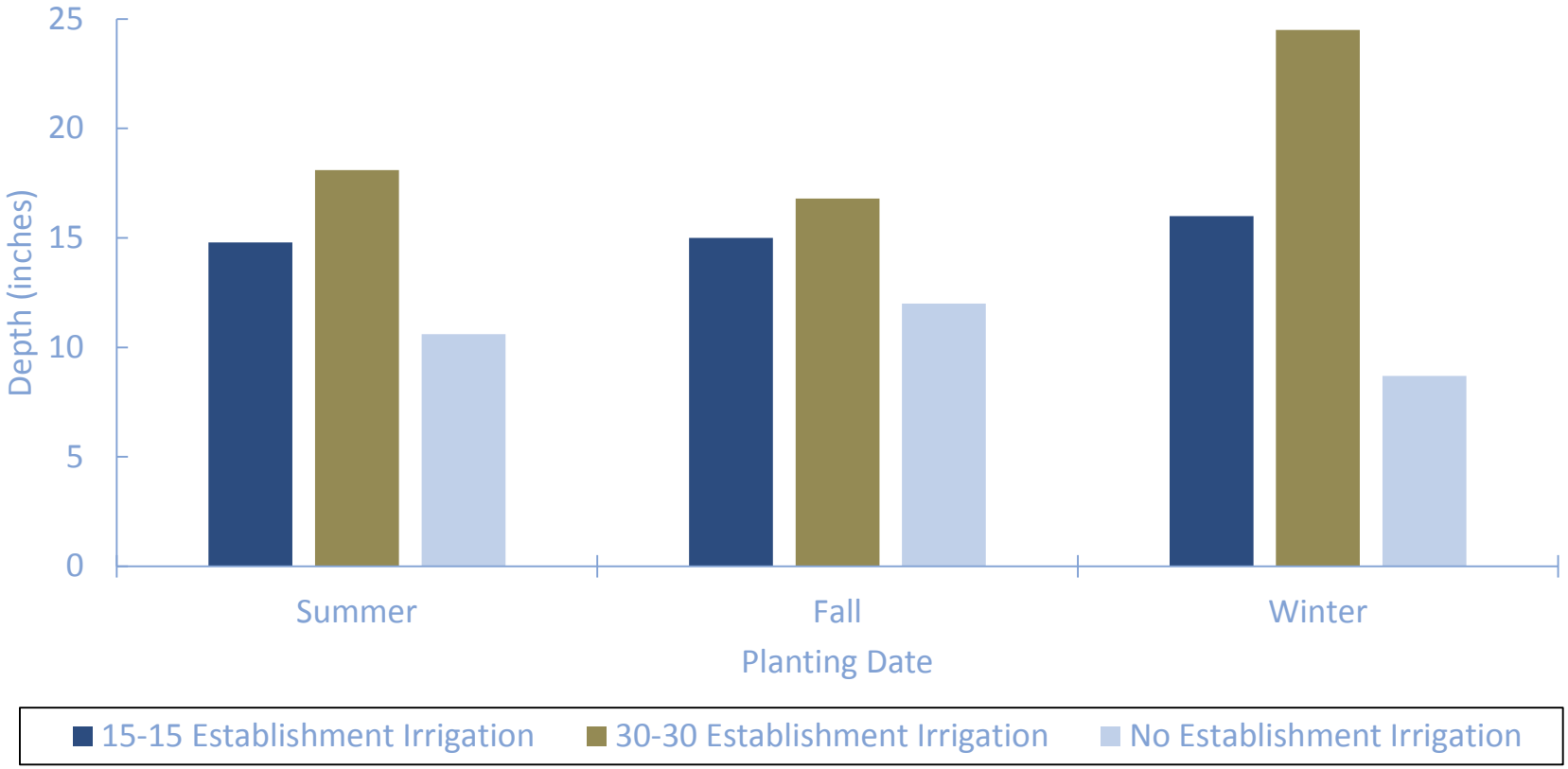
Floratam St. Augustinegrass

Quality Rating 3 | Quality Rating 5 | Quality Rating 6.5

Argentine Bahiagrass

Quality Rating 3 | Quality Rating 5 | Quality Rating 6.5

Year One Irrigation (0-60 d)



Sod Establishment Conclusions

- Bahiagrass – Increasing establishment irrigation did not increase long-term quality
- Captiva St. Augustinegrass – Higher quality on 30-30 or 15-15 in summer
- Floratam St. Augustinegrass – Higher quality on 30-30 or 15-15 in summer
- Empire Zoysiagrass – Highest quality 30-30 first summer
- 15-15 reduced irrigation vs. 30-30 → 26%Summer, 15%Fall, 36%Winter

Orange County Utilities SMS/ET demo

- Will smart controllers reduce irrigation on moderate to high use single family homes?
- What is effectiveness of ET vs. SMS controllers?
- Impact on landscape quality?
- Customers feelings about technology?

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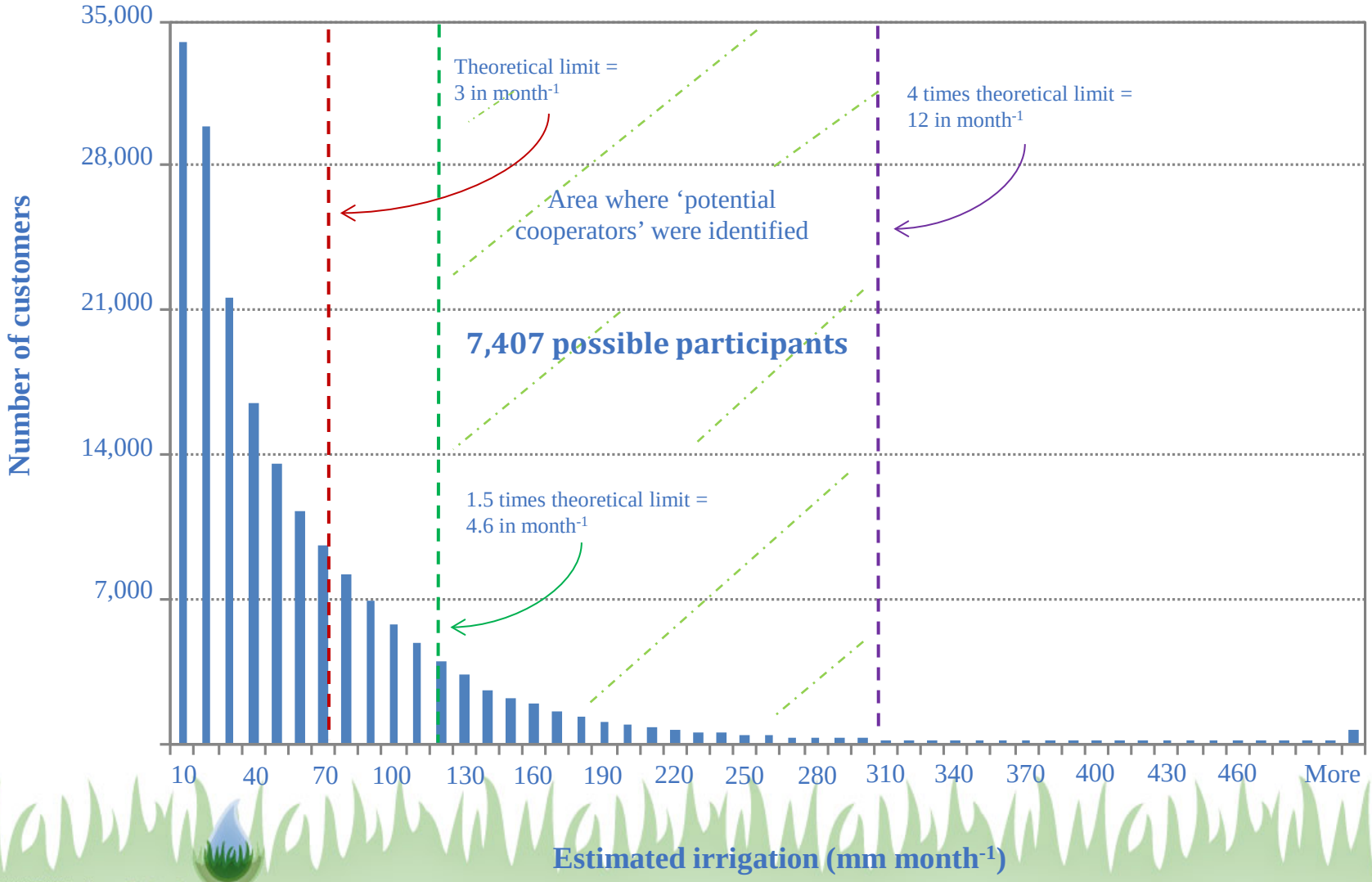
Selection of Excess Irrigators



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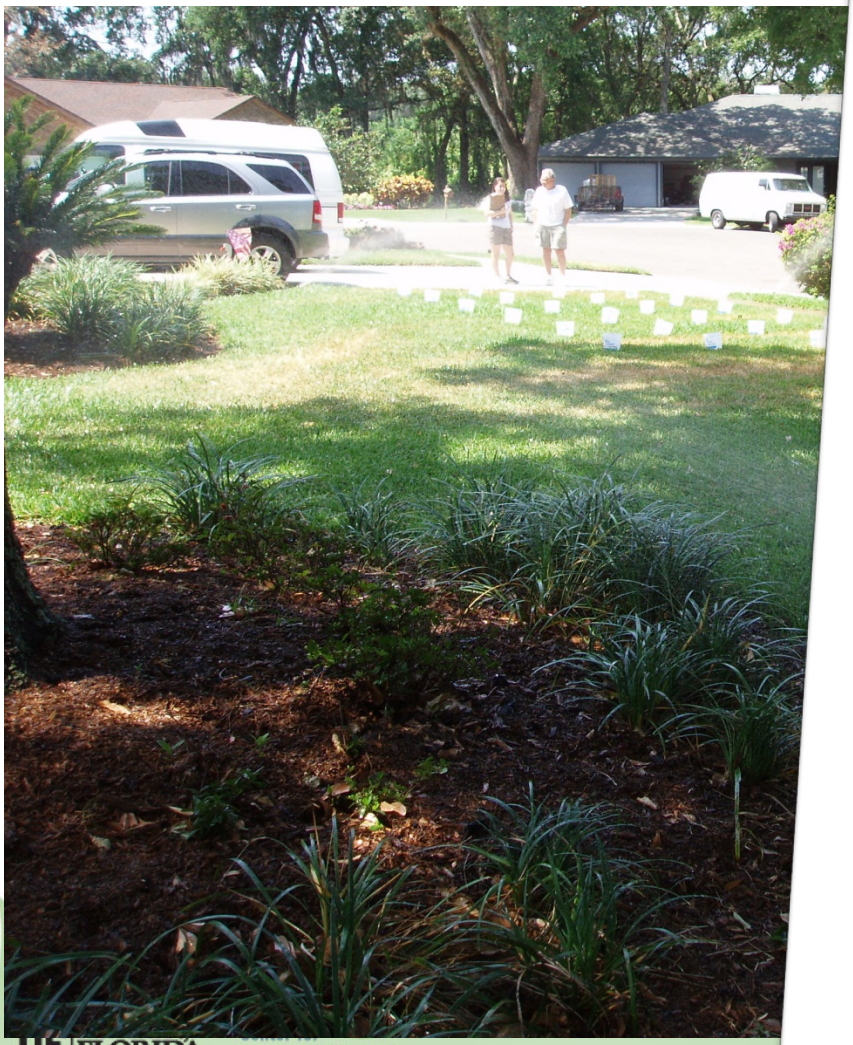
Site Evaluation



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IRRIGATION SYSTEM EVALUATION

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- **Address:** _____ Date: _____
- **Timer location:** Garage ☐ Outside wall ☐ Other: _____
- **Original schedule:**
  - A) Start time(s): Mon _____ Tue _____ Wed _____ Thu _____ Fri _____ Sat _____ Sun _____
  - A) Run time/zone (min): 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____
  - B) Start time(s): Mon _____ Tue _____ Wed _____ Thu _____ Fri _____ Sat _____ Sun _____
  - B) Run time/zone (min): 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____
- **Rain sensor:** Location: Roofline Not connected ☐ Obstructed ☐ Misplaced ☐ Absent ☐

Irrigation Zones (stations)		1	2	3	4	5	6	7	8
1. Zone location from the house	a. Front	☐	☐	☐	☐	☐	☐	☐	☐
	b. Left	☐	☐	☐	☐	☐	☐	☐	☐
	c. Center	☐	☐	☐	☐	☐	☐	☐	☐
	d. Right	☐	☐	☐	☐	☐	☐	☐	☐
	e. Back	☐	☐	☐	☐	☐	☐	☐	☐
2. Sun reaching the zone	a. Full sun	☐	☐	☐	☐	☐	☐	☐	☐
	b. Mostly sunny	☐	☐	☐	☐	☐	☐	☐	☐
	c. Mostly shady	☐	☐	☐	☐	☐	☐	☐	☐
	d. Full shade	☐	☐	☐	☐	☐	☐	☐	☐
3. Plant type	a. Turf	☐	☐	☐	☐	☐	☐	☐	☐
	b. Ornamentals	☐	☐	☐	☐	☐	☐	☐	☐
	c. Mixed (%)	Turf							
		Orn.							
4. Turf Quality (1=Dead, 9=Top Qual.)									
5. Num. of irrigation heads	a. Sprinklers								
	b. Rotors								
	c. Microirrigation	☐	☐	☐	☐	☐	☐	☐	☐

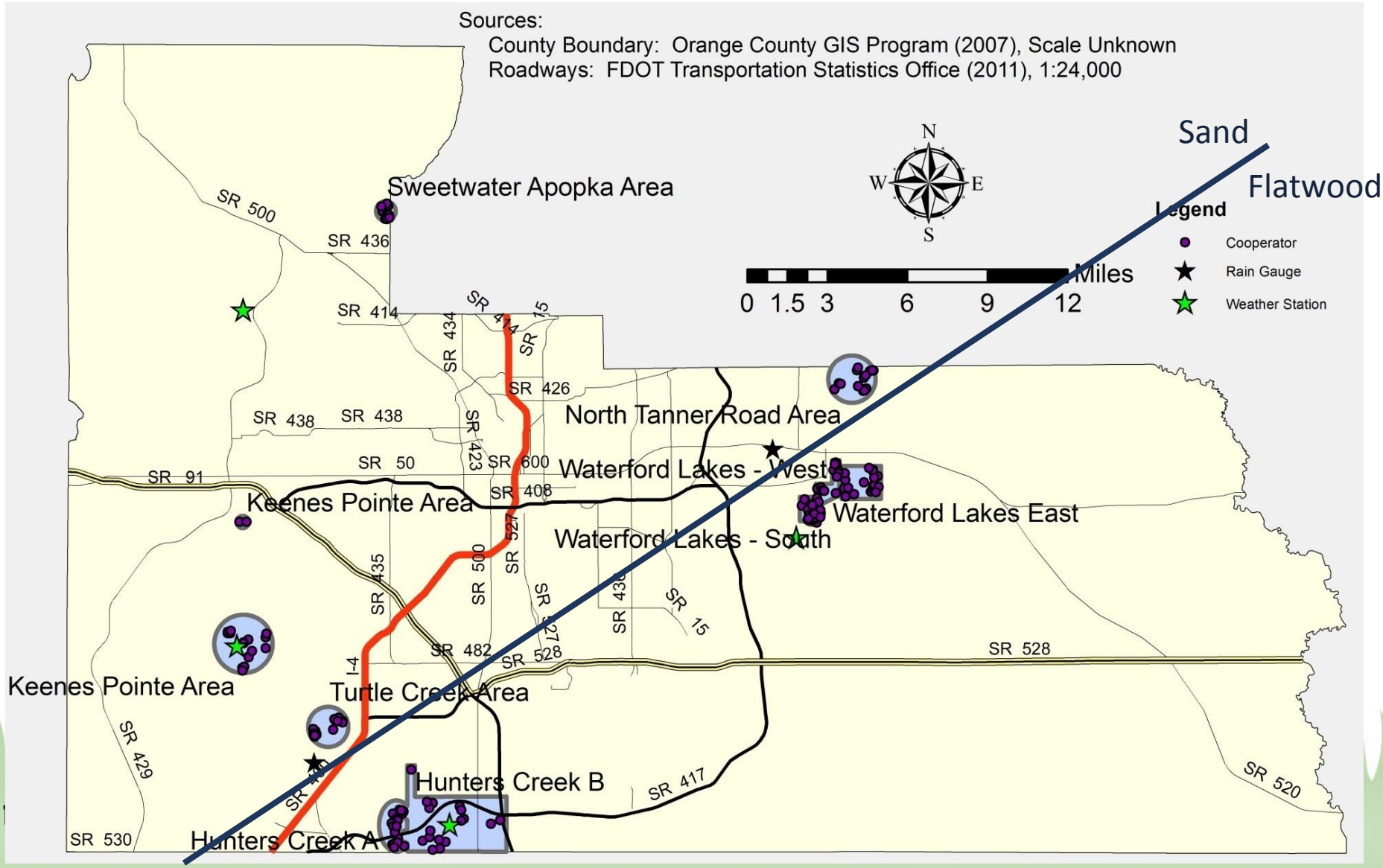
Irrigated Area: Calculated (Aerial photo) _____ ft² Corrected (In situ) _____ ft²

Flow Test: Run time per zone _____ minutes Meter reading before _____ Meter reading after _____

Comments:

FOR UF USE ONLY Evaluator

Summary of Participants



OCU Technologies & Expt. Design

Treatment	ET	ET+Edu	SMS	SMS+Edu	Comparison
Technology	Rain Bird ESP-SMT 	Rain Bird ESP-SMT	Baseline WaterTec S100 	Baseline WaterTec S100	--
Locations Installed	7	9	7	9	9
Number Installed	28	38	28	38	35

Monitored: 1 Dec 2011 through 30 Nov 2012 (12 months)

Contractor Group

- ET
  - Contractor programmed with default landscape settings
  - Daily water windows
  - Limited interaction with homeowner

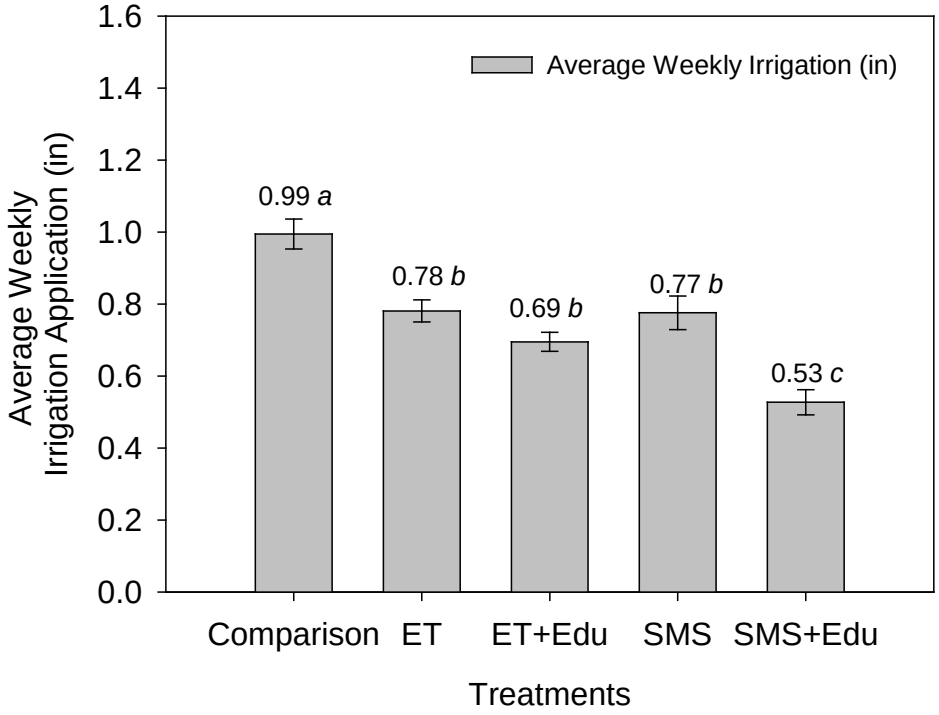
- SMS
  - Buried at 6 inches in minimally compacted soil
  - Re-programmed time clock schedules for daily irrigation:
    - 20 minutes spray
    - 45 minutes rotor
  - Limited interaction with the homeowner

Controllers with IFAS Recommendations

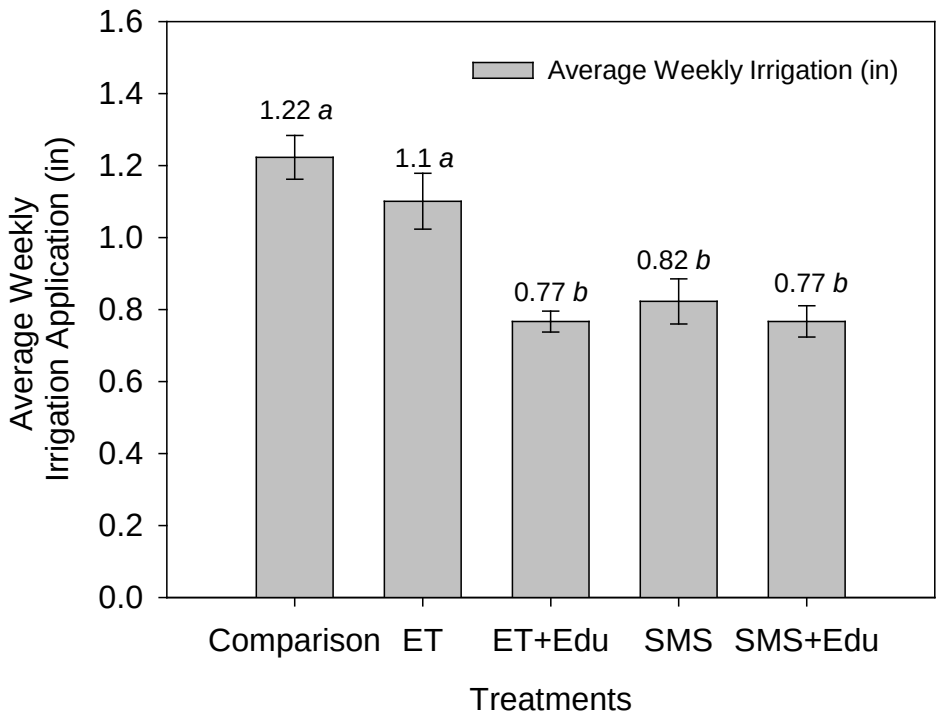
- ET+Edu treatment
  - Reprogrammed for site specifics
  - 5 minute tutorial
  - Total Count = 38
  - Total Locations = 9
- SMS+Edu treatment
  - Inserted into soil column at 3 inch depth
  - Reprogrammed for 0.25” per event, 2 events per day, 3 d/wk
  - 5 minute tutorial
  - Total count = 38
  - Total locations = 9

Residential Avg. Irrigation

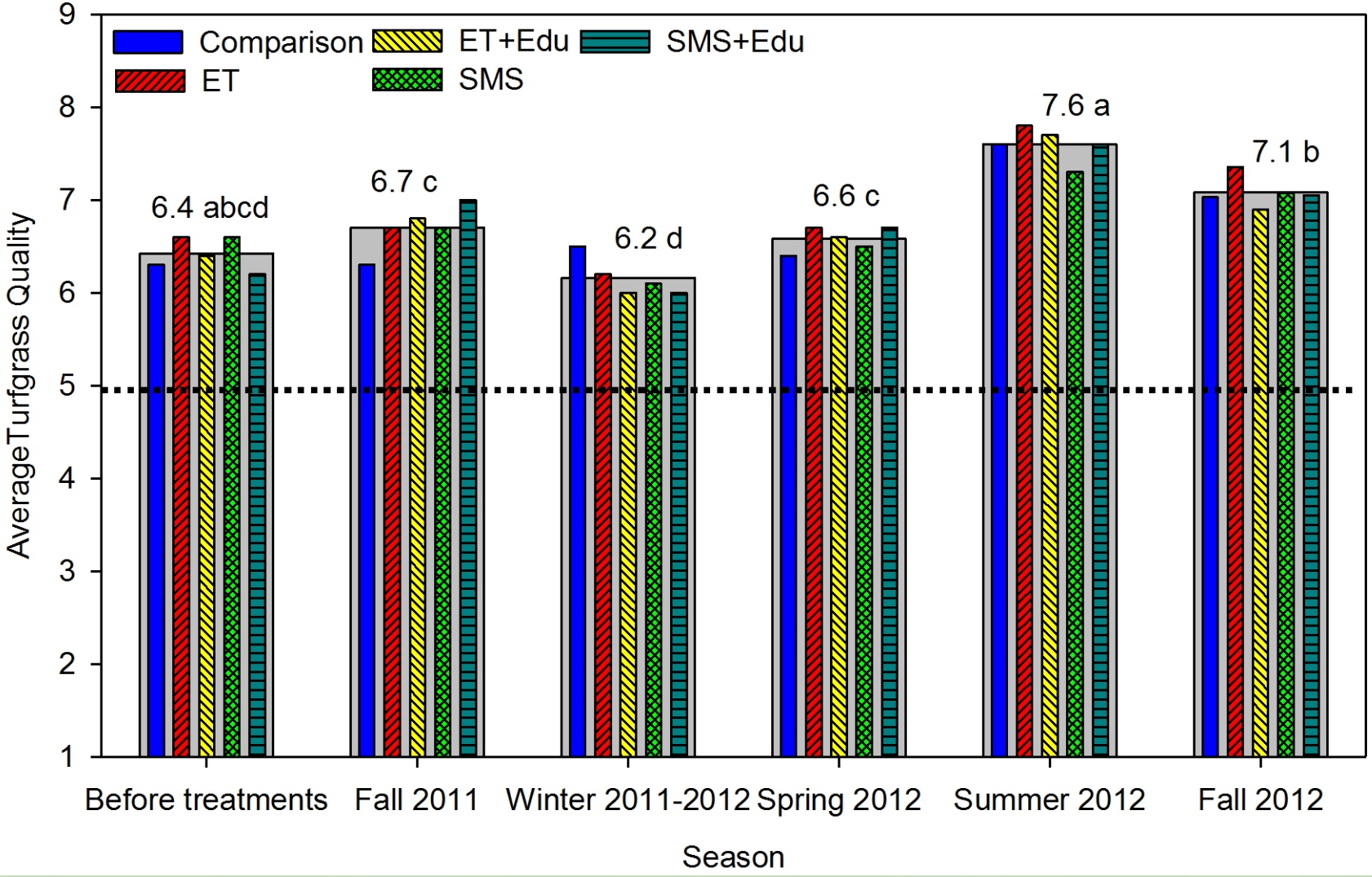
Flatwoods



Sand



Turfgrass Quality



Customer Driven Issues

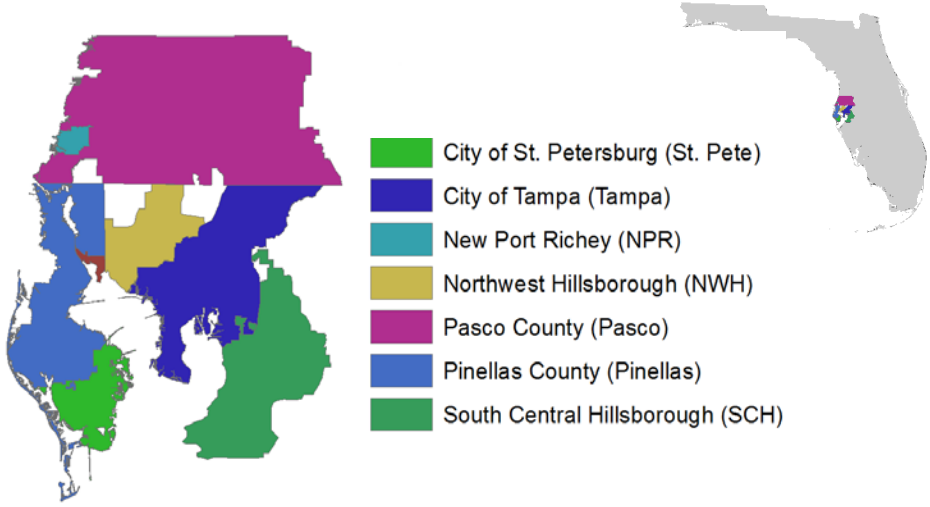
Complaint Description	Count of Complaints from Cooperators
High water bill	14
Too much water	10
Too little water	15
Sensor not working	5
Sensor not allowing irrigation	1
Sensor not preventing irrigation	3
Watering too soon after rain	12
ET controller not working	2
Grand Total	62

B283, Landscape Irrigation Use SW FL

- Characterize irrigation use throughout SWFWMD
- Assess 300 gpad benchmark
- Utility data from TBW
  - Pasco Co.
  - New Port Richey
  - Pinellas Co.
  - St. Petersburg
  - NW Hillsborough
  - SC Hillsborough
  - Tampa

Estimating SFH Irrigation

- Tampa Bay Water (TBW)
- Potable monthly water billing records for single-family residential for ~12 years
- Parcel records including greenspace
- Soil data (sandy, urban)
- Daily rainfall and ET data

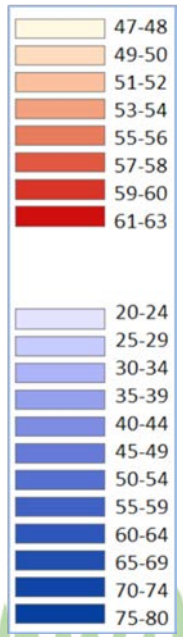


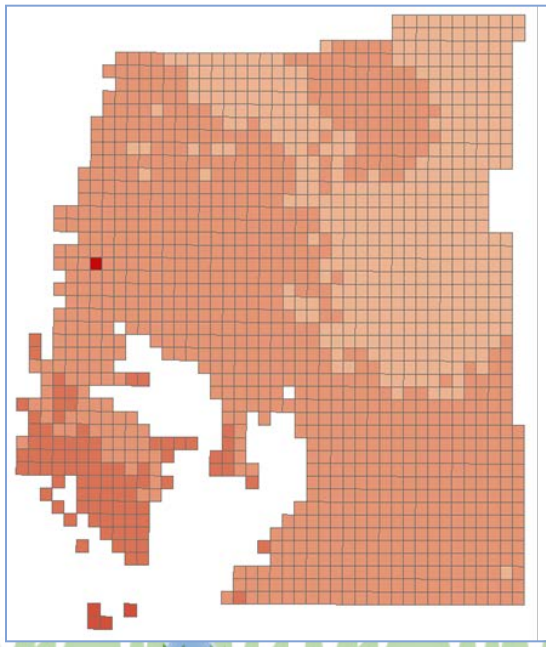
Characteristic	Observations	Variables
Customers	~650,000	-
Monthly water billing	~44,000,000	25
Parcels	~432,000	24
Soils	~40,000	40
Daily weather	~5,782,000	12

Individual SFH Irrigation Estimate

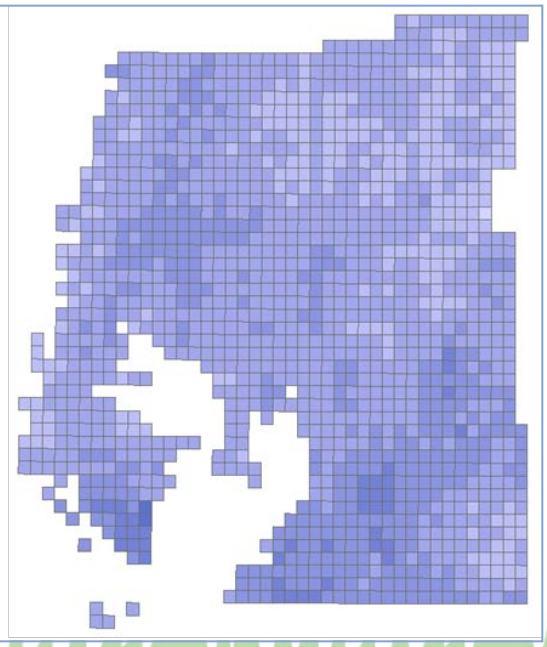
- Irrigation required based on daily soil-water balance
- 1,440 separate calculations for 4,380 days, summed monthly

Annual ET_o (2000)

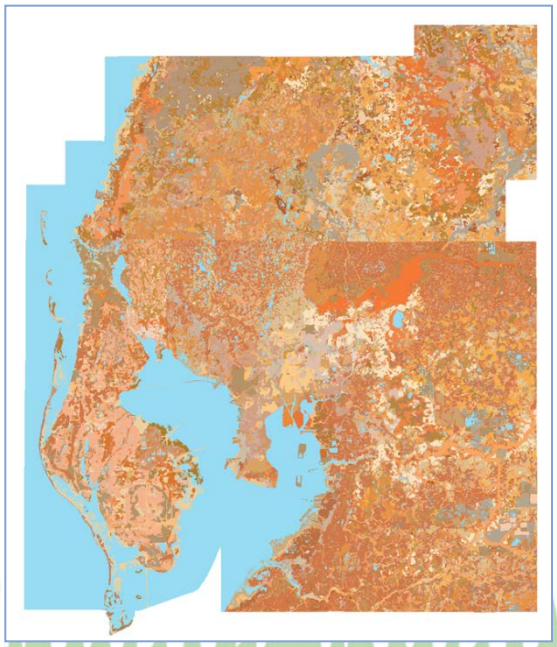




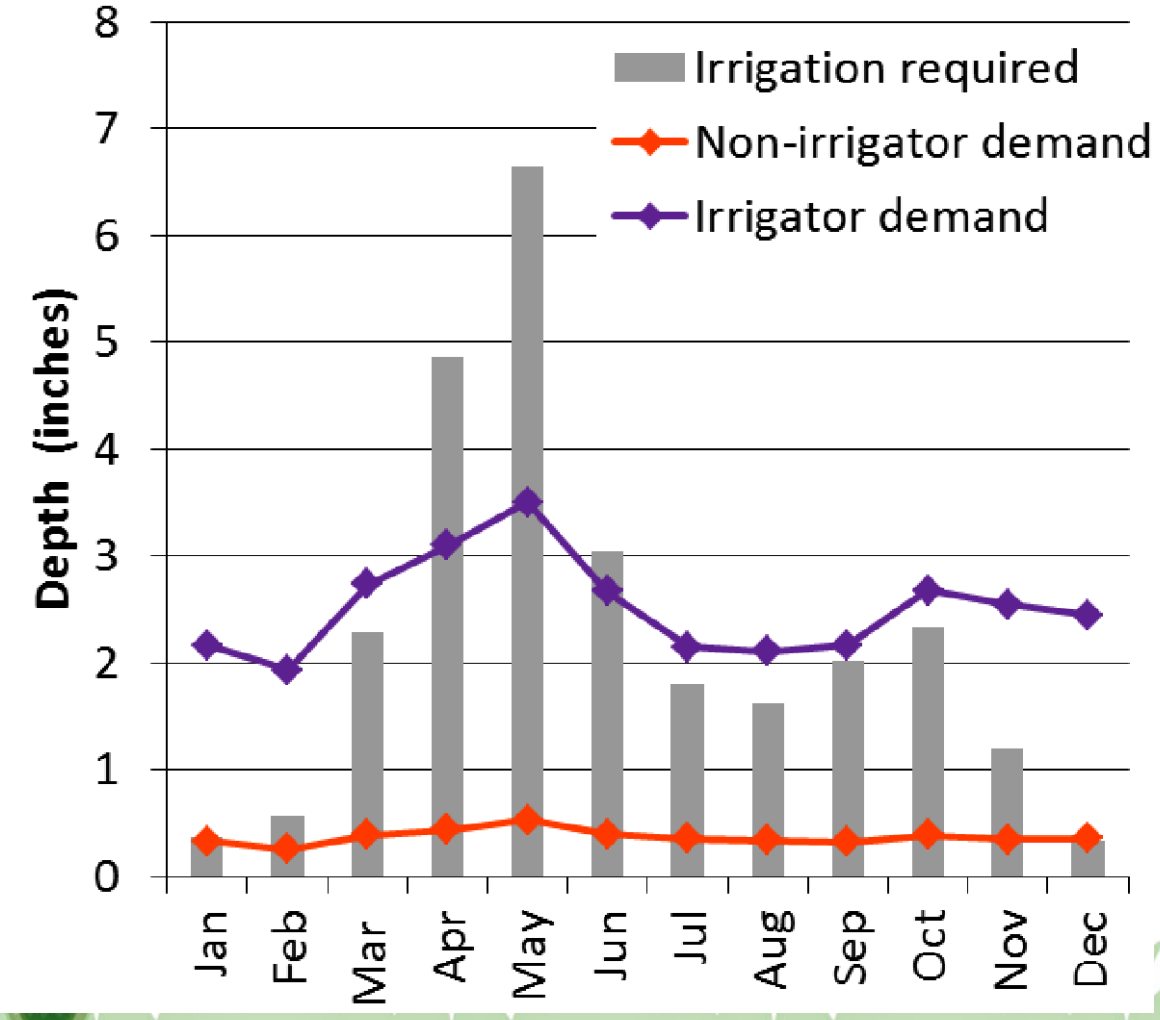
Annual Precipitation (2000)



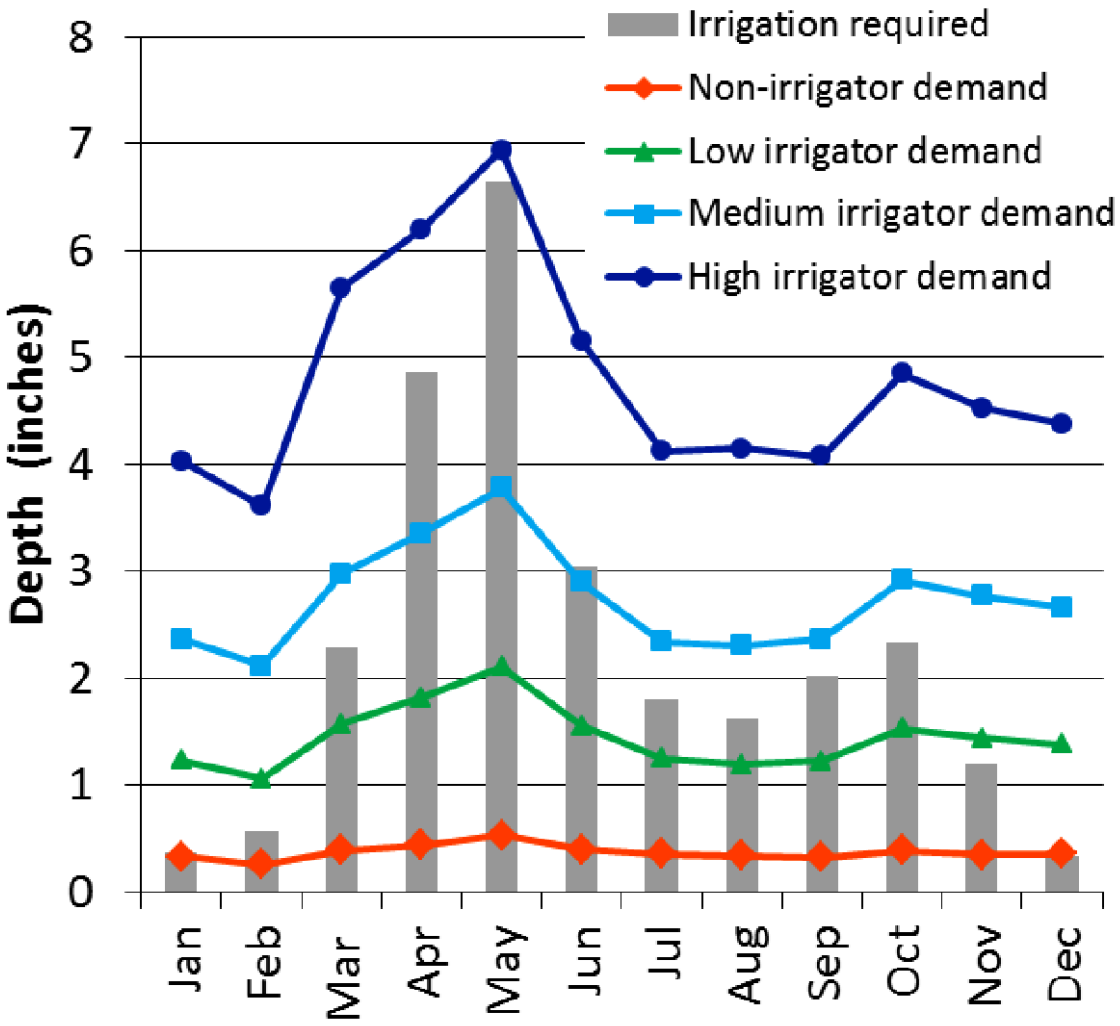
Soil types



Tampa Bay Region Irrigation



Irrigation Stratification



Per capita Across District

Service area	Average daily irrigation volume for all customers (gpad)	Average daily irrigation volume for "irrigating" customers (gpad)
Pasco	109	208
NPR	77	159
Pinellas	138	345
St. Pete	114	226
NWH	120	253
Tampa	114	226
SCH	113	231
All TBW	**111**	**256**

- Planning estimate is 300 gpad

Scope Revision

- Assess FFL irrigation savings
- Determine source of savings

Summary

- Rain sensors not effective at saving water “in the wild”
- SMS & ET controllers effective (>25% savings) in OCU when set up properly
- Higher savings possible (up to 70%) given plot research results

Future Needs

- Long term monitoring of SMS and ET performance
  - B252 reclaimed project monitoring can be extended
  - Continue OCU monitoring
- Pilot scale project implementation
  - Education of contractors (via Extension)
  - Ongoing monitoring/verification of impact

Questions?

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