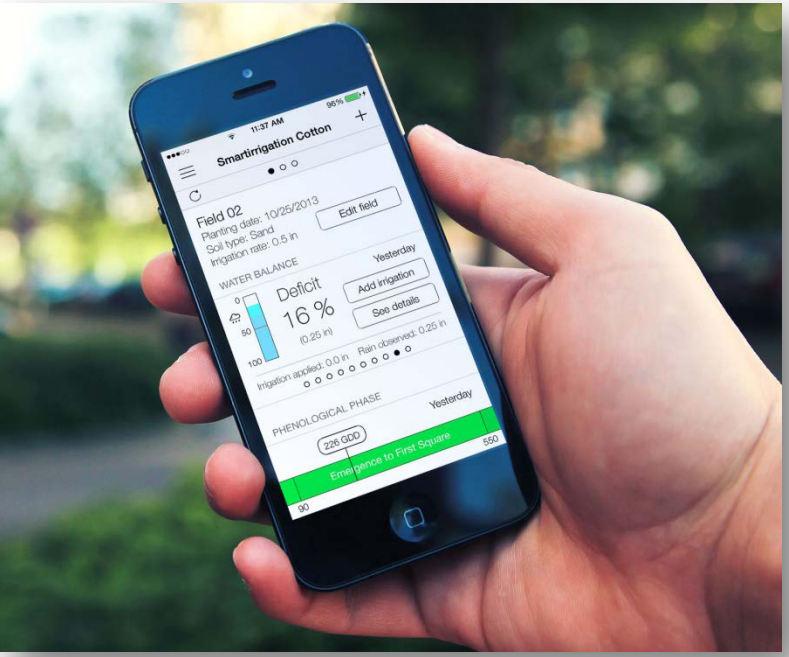


A Smartphone App for Scheduling Irrigation on Cotton

George Vellidis

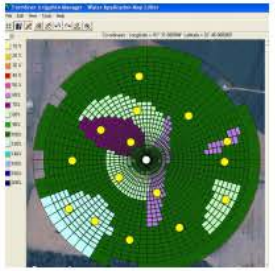
Vellidis Research Group at The University of Georgia

www.vellidis.org

Vellidis Research Group

Our research group is a dynamic blend of engineers and scientists working on the sustainability of agricultural production systems. We are located at the University of Georgia's Tifton Campus but our projects are distributed across Georgia's Coastal Plain. Most of our research projects are conducted on working farms to ensure that we provide practical solutions to problems facing Georgia's farmers.

Smart Irrigation



We have several ongoing projects whose objectives are to develop a wide variety of tools which will enable farmers to better utilize their water resources.
The projects range from developing smartphone apps for scheduling irrigation to developing smart wireless soil moisture sensing systems.

Read More

Precision Agriculture

Precision agriculture has the potential to greatly improve the efficiency of agricultural production efficiency by optimizing the use of inputs. We have been involved in precision agriculture projects for more than 15 years.
Our latest work is on variable rate application of nitrogen on cotton and on using RTK-based GPS guidance for planting and inverting peanuts.

Read More

Water & Climate

Our program on water and climate has ranged from understanding the dynamics of dissolved oxygen in blackwater streams and rivers of the southeastern Coastal Plain to understanding how climate variability and climate change will affect the production of bioenergy feedstocks in the Southeast.
We are members of the Southeast Climate Consortium (SECC) and work closely with SECC members at other institutions.

Read More

TAPAC

TAPAC - The TransAtlantic Precision Agriculture Consortium - consists of agricultural scientists and engineers at three southeastern land grant universities and three European Union (EU) universities dedicated to fostering the global awareness and competence of their students, faculty and staff. Dr. George Vellidis leads the consortium.
As the name implies, TAPAC operates under the umbrella of precision agriculture – a common teaching, research, and outreach endeavor of all six universities.

Partners

Project Team

- University of Florida
  - Kati Migliaccio, Kelly Morgan, Clyde Fraisse, Diane Rowland, Jose Andreis
- University of Georgia
  - Guy Collins, Calvin Perry, John Snider
- Clemson University
  - Jose Payero

Funding

- USDA NIFA NIWQ (2 grants)
- USDA NRCS CIG
- Cotton Inc.
- Georgia Cotton Commission

smartirrigation apps.org

Smartphone Technology For Managing Urban And Agricultural Irrigation

This project focuses on the development of Smartphone apps for citrus, cotton, strawberry, and urban lawn to provide real-time and forecasting information that can then be used for more efficient irrigation and water conservation.

See How It Works

Citrus App

The citrus app will provide users with an irrigation schedule based on a water balance and real-time weather and forecasted data intended to conserve water while also minimizing nutrient leaching from the root zone.

Read More

Urban Lawn App

The urban lawn app will provide users with an estimate of irrigation run times needed (minutes) to meet current lawn turf water demand using a simplified approach for automated irrigation systems.

Read More

Strawberry App

The strawberry app will provide users with an irrigation schedule based on a water balance and real-time weather and forecasted data intended to conserve water while also minimizing nutrient leaching from the root zone.

Read More

Cotton App

The innovative cotton model and Smartphone app will provide users with a mobile interface for determining cotton irrigation needs and estimate potential savings with app use.

Read More

Our Goals

- Provide the most accurate, site-specific, real-time and forecast information
- Notify user as needed – no requirements of user to consistently check
- Minimum user input
- Ready-to-use output
- Engaging – not static

Three Phases

- Phase I: Develop citrus, cotton, strawberry, urban turf irrigation apps
- Phase II: Evaluate and demonstrate apps with plots
  - Assess different rainfall sources to site measured data
  - Add drought strategy component
  - Add measured rainfall to irrigation schedule (citrus, strawberry, turf)
- Phase III: Evaluate apps with replicated field trials
  - Add peanut app

Operating Principle of All Apps

Crop coefficient approach for estimated ET

$$ETc = ETo \times Kc$$

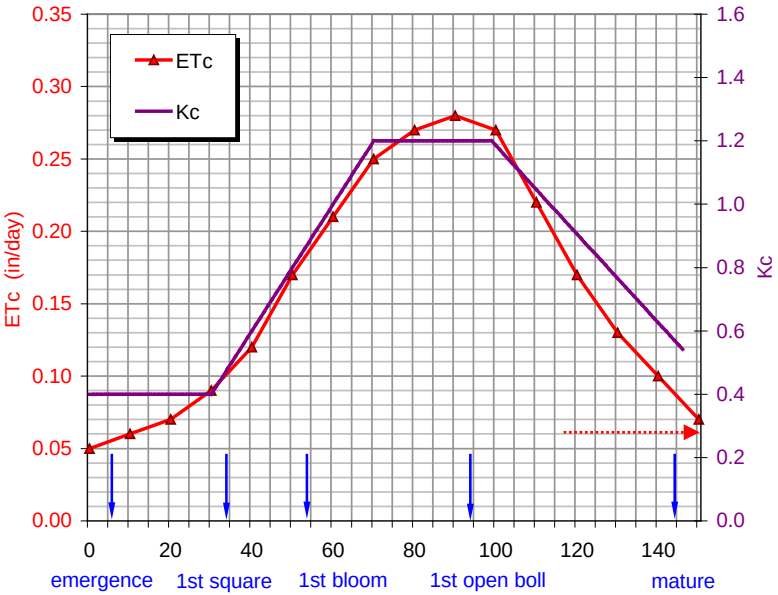
where

ETc = estimated crop ET

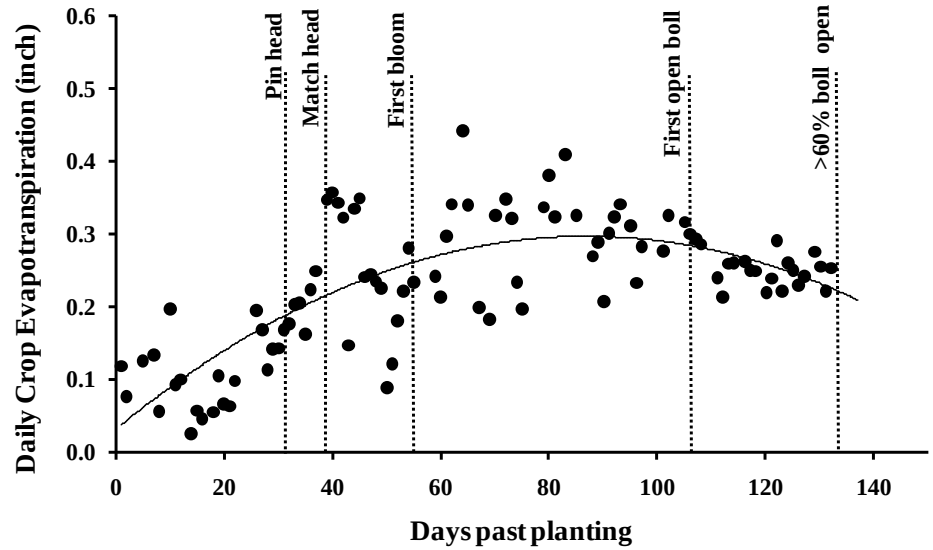
Kc = crop coefficient

ETo = Penman-Monteith reference ET (FAO-56)

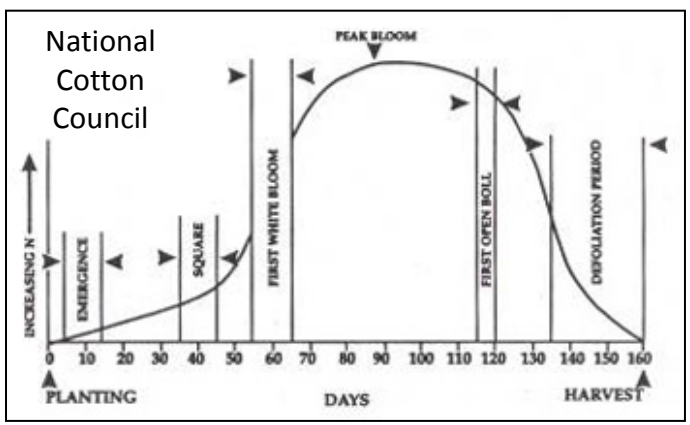
Determining the Kc Curve

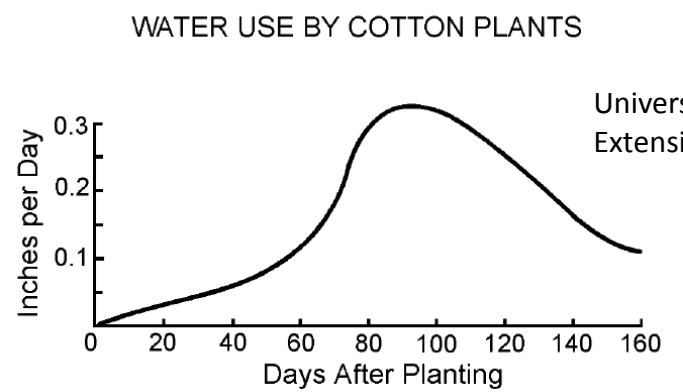


Water use and crop coefficient function for cotton in Stoneville, Mississippi.

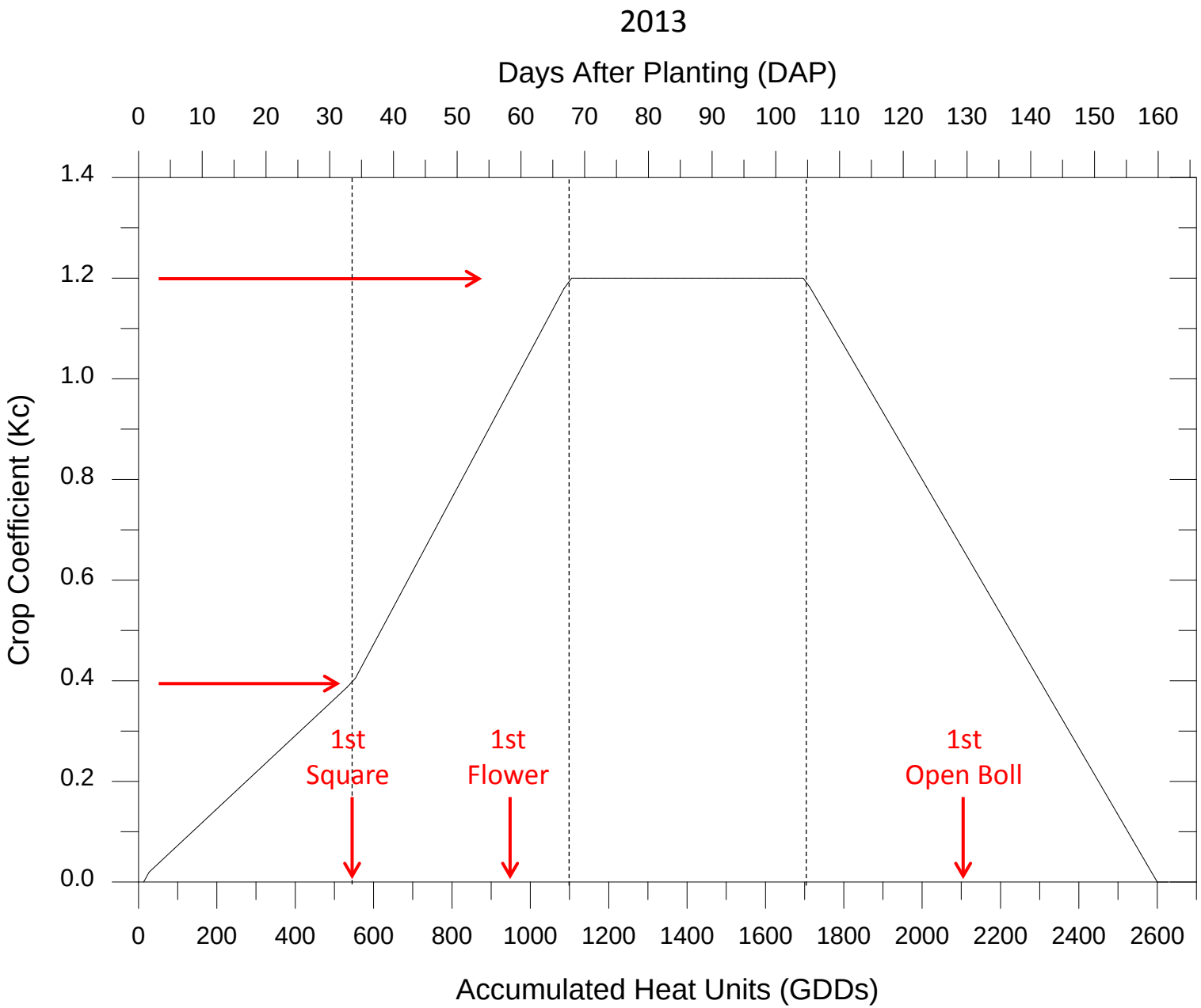


Measured crop water use from a cotton field in Louisiana over the growing season.





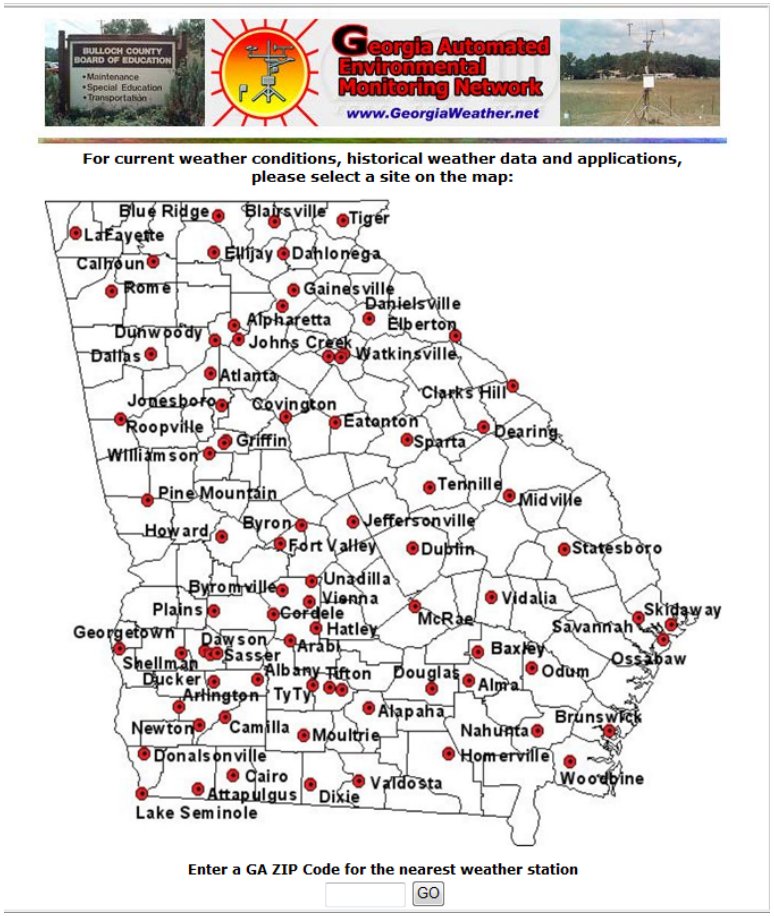
University of Georgia Extension publication.


2013
Days After Planting (DAP)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
Crop Coefficient (Kc)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1st Square
1st Flower
1st Open Boll
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600
Accumulated Heat Units (GDDs)

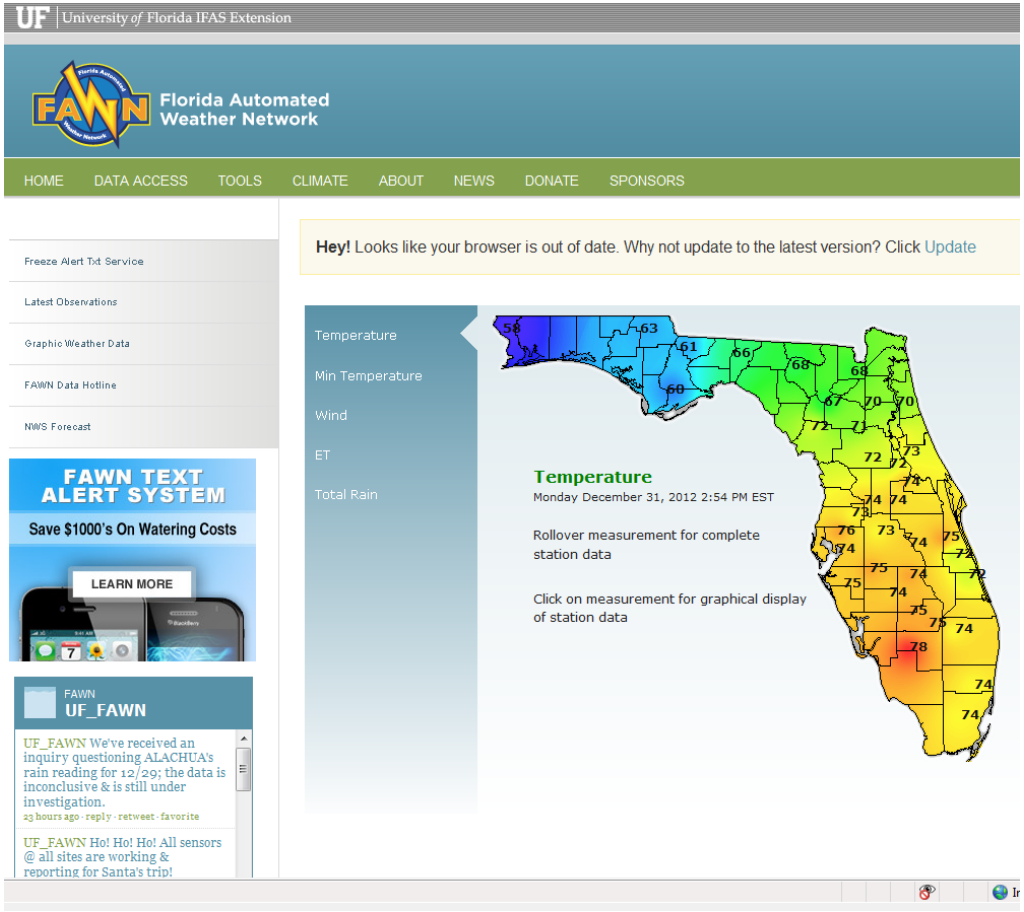
Operating Principle of Cotton App

- Simplified water balance approach
  - Soil water holding capacity
  - Estimated rooting depth
  - Measured precipitation and irrigation
  - Estimated evapotranspiration (ETc)
  - Minimum allowable soil water depletion (50%)
  - Irrigation system characteristics (where applicable)

GAEMN - Georgia Automated Environmental Monitoring Network



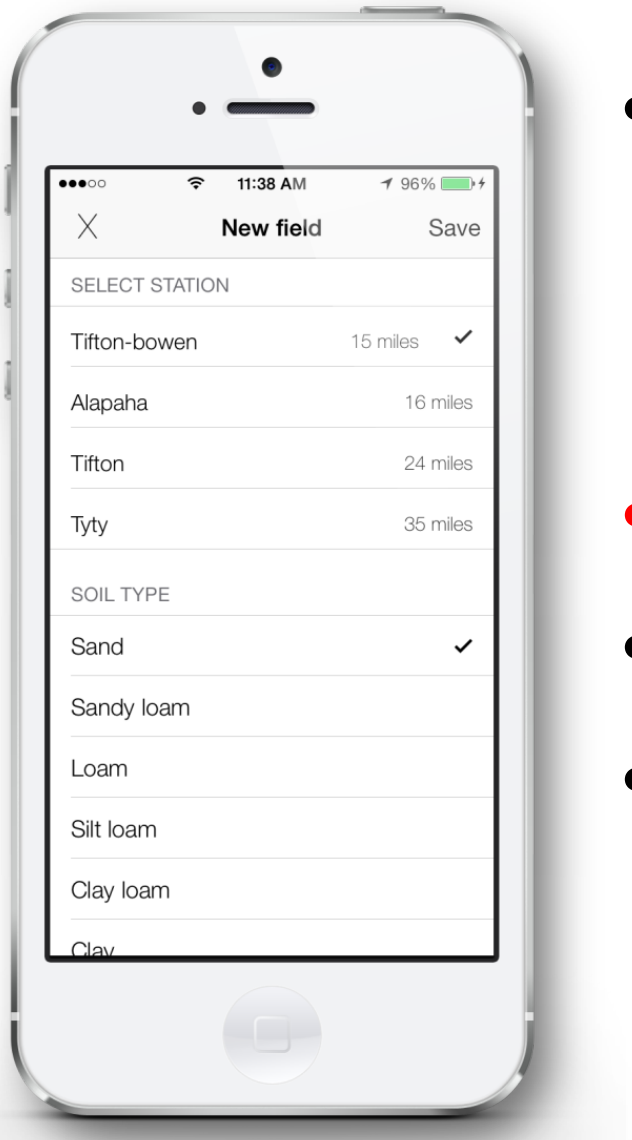
FAWN - Florida Automated Weather Network



Cotton App

- Plant phenology and crop coefficient (Kc) change with accumulated heat units (GDDs)
  - User can override GDD-driven phenology
- Does not recommend irrigation amounts
  - Advises user of Root Zone Water Deficit in terms of inches and % total
  - Maximum Recommended Deficit is 50%
  - Provides weekly (Monday – Sunday) estimated ETc

Model Variables



- Meteorological Data from weather stations
  - Temperature, Precipitation used to calculate Penman ET
- Soil type (sand, sandy loam, etc.)
- Soil Water Holding Capacity (in/in)
- Initial Soil Condition (in of available soil water)

Model Variables

- Rooting Depth
  - Minimum = 6 in; Maximum = 24 in; Increase = 0.3 in/day
- Irrigation System Type
  - Irrigation Effectiveness – % of applied water which enters soil (85% for pivots)
- Default Irrigation Depth (in)

App Calculations

Crop Coefficient based on GDD (Kc)	ETo (from GAEMN) (in/day)	Eto 5-Day Moving Avg (in/day)	ETc (Kc*ETo avg) (in/day)	Rooting Depth (in)	Available Soil Water (in)	Irrigation Applied (in)	Effective Irrigation (in)	Rain (in)	Irrigation + Rain (in)	Root Zone Water Defecit (in)	Root Zone Water Defecit (%) (Keep Under 50% to Avoid Stress)
0.32	0.21	0.16	0.05	13.80	1.52	-	-	-	-	0.00	0%
0.34	0.23	0.17	0.06	14.10	1.55	-	-	-	-	0.05	3%
0.36	0.24	0.18	0.06	14.40	1.58	-	-	-	-	0.11	7%
0.37	0.21	0.20	0.08	14.70	1.62	-	-	-	-	0.17	11%
0.39	0.24	0.23	0.09	15.00	1.65	-	-	-	-	0.25	15%
0.41	0.22	0.23	0.09	15.30	1.68	-	-	-	-	0.34	20%
0.45	0.22	0.23	0.10	15.60	1.72	-	-	-	-	0.43	25%
0.49	0.22	0.22	0.11	15.90	1.75	-	-	-	-	0.53	30%
0.53	0.17	0.22	0.11	16.20	1.78	-	-	-	-	0.64	36%
0.56	0.19	0.21	0.12	16.50	1.82	-	-	-	-	0.76	42%
0.60	0.24	0.21	0.13	16.80	1.85	-	-	-	-	0.87	47%
0.64	0.18	0.20	0.13	17.10	1.88	-	-	-	-	1.00	53%
0.67	0.15	0.18	0.12	17.40	1.91	-	-	0.31	0.31	1.13	59%
0.70	0.14	0.18	0.12	17.70	1.95	-	-	0.04	0.04	0.94	49%
0.74	0.23	0.19	0.14	18.00	1.98	-	-	0.00	0.00	1.03	52%
0.78	0.24	0.19	0.15	18.30	2.01	-	-	-	-	1.16	58%
0.82	0.14	0.18	0.15	18.60	2.05	-	-	0.20	0.20	1.31	64%
0.85	0.10	0.17	0.14	18.90	2.08	-	-	1.37	1.37	1.25	60%
0.88	0.14	0.17	0.15	19.20	2.11	-	-	0.12	0.12	0.03	1%
0.91	0.09	0.14	0.13	19.50	2.15	-	-	1.76	1.76	0.06	3%
0.94	0.15	0.12	0.12	19.80	2.18	-	-	0.76	0.76	0.00	0%

2013 Plot Studies

Method	Conservation Tillage		Conventional Tillage	
	Lint Yield (lb/ac)	Water Use (in)	Lint Yield (lb/ac)	Water Use (in)
Checkbook	1350	12.7	1150	12.2
Cotton App	1485	3.0	1259	3.0
CWSI	1430	5.0	1305	2.3
Irrigator Pro	1455	2.8	1200	4.3
Rainfed	1450	1.5	-	-

Variety = DP 1252 B2RF

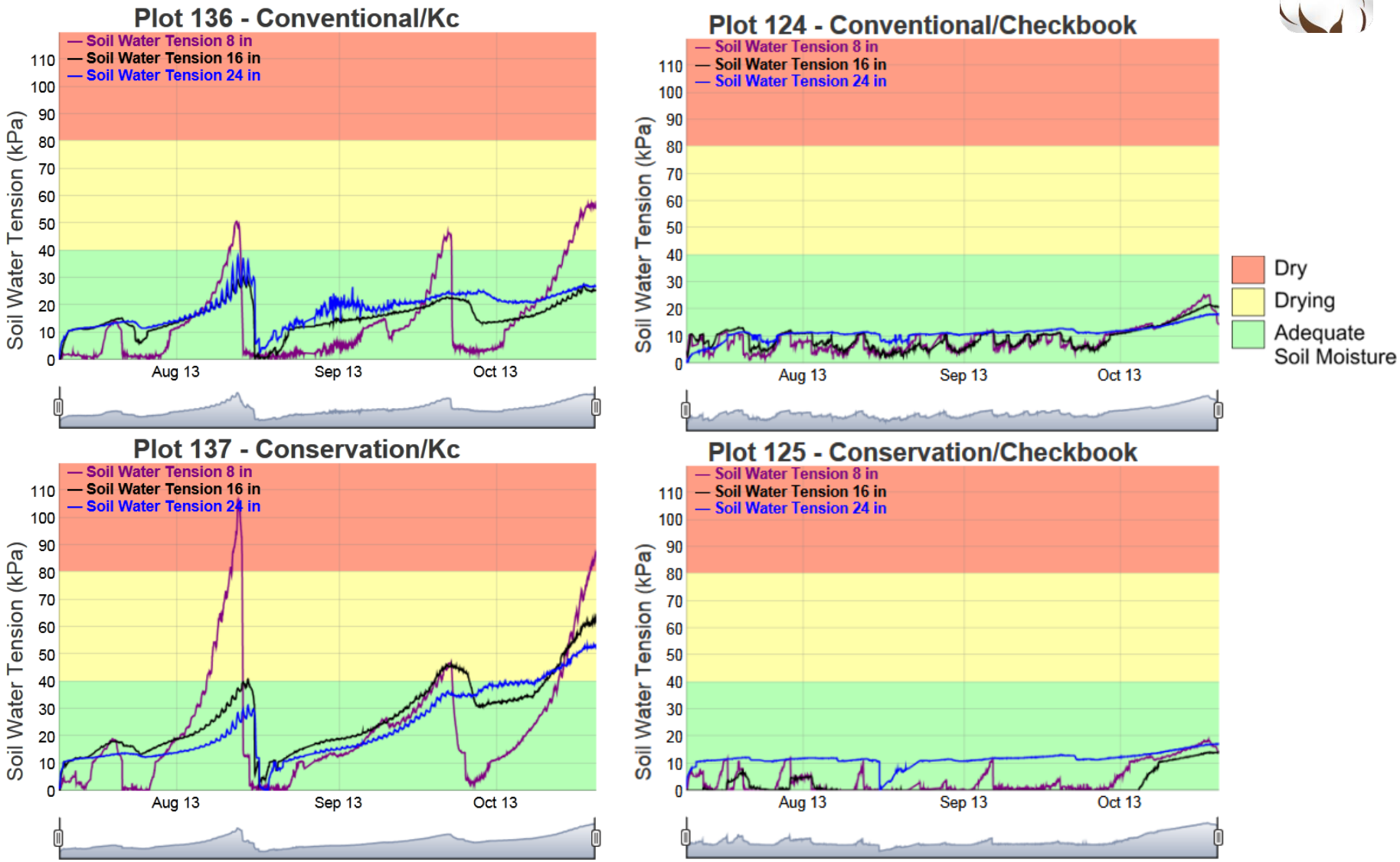
Planting Date = 16 May 2013

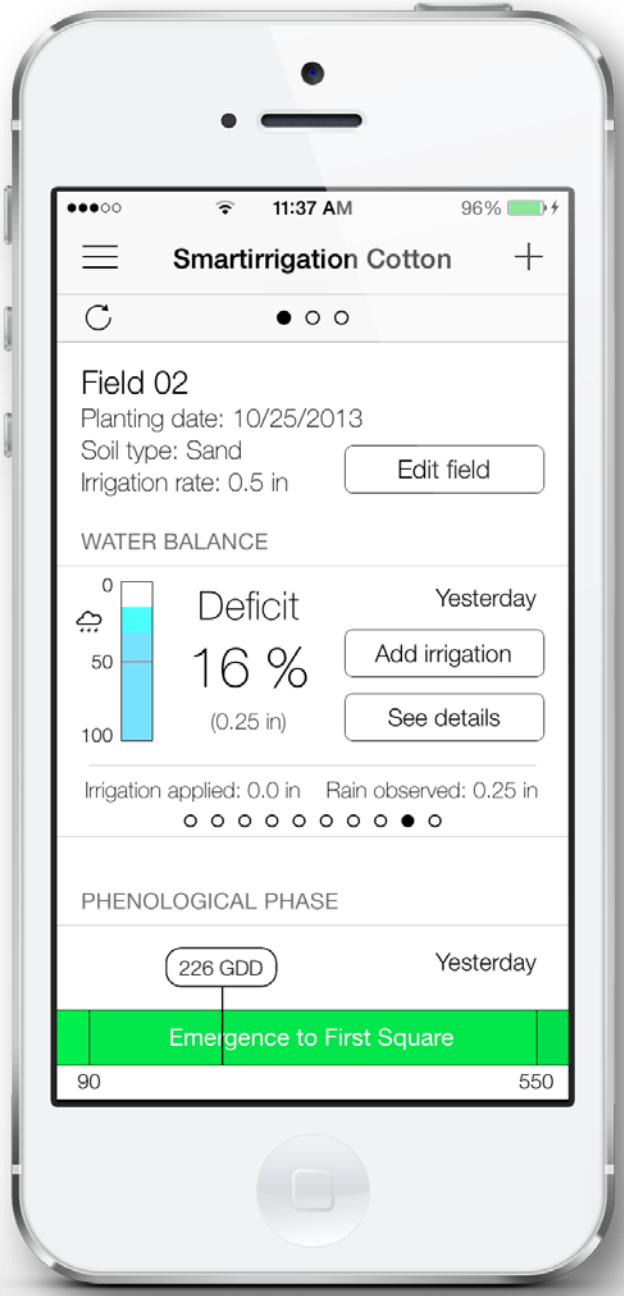
Harvest Date = 15 Nov 2013

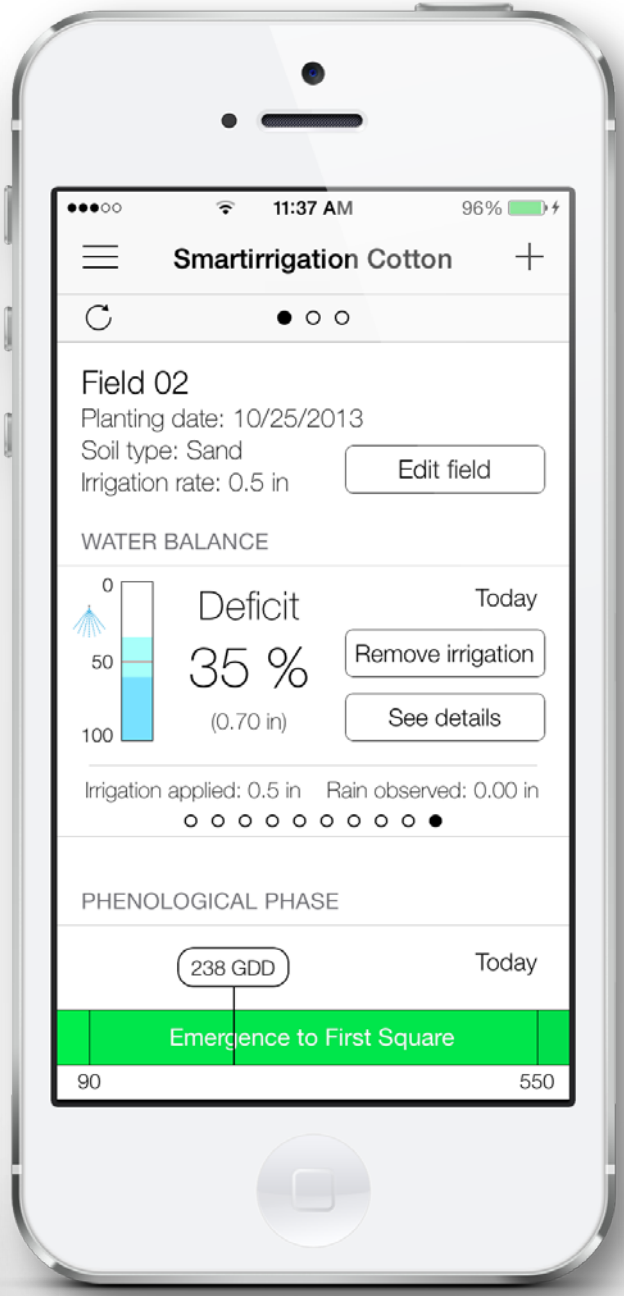
Rainfall = 27.4 inch

C.M. Stripling IRRIGATION RESEARCH PARK

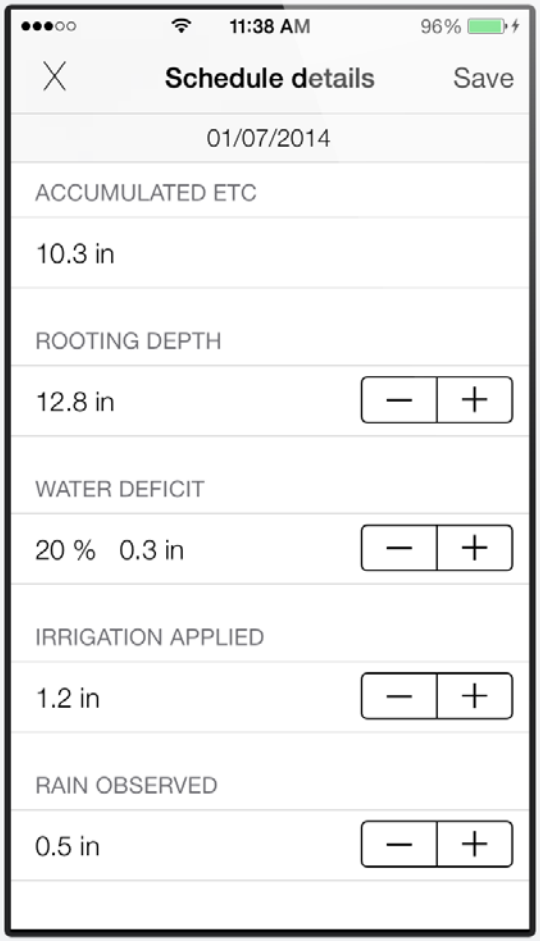
THE UNIVERSITY OF GEORGIA

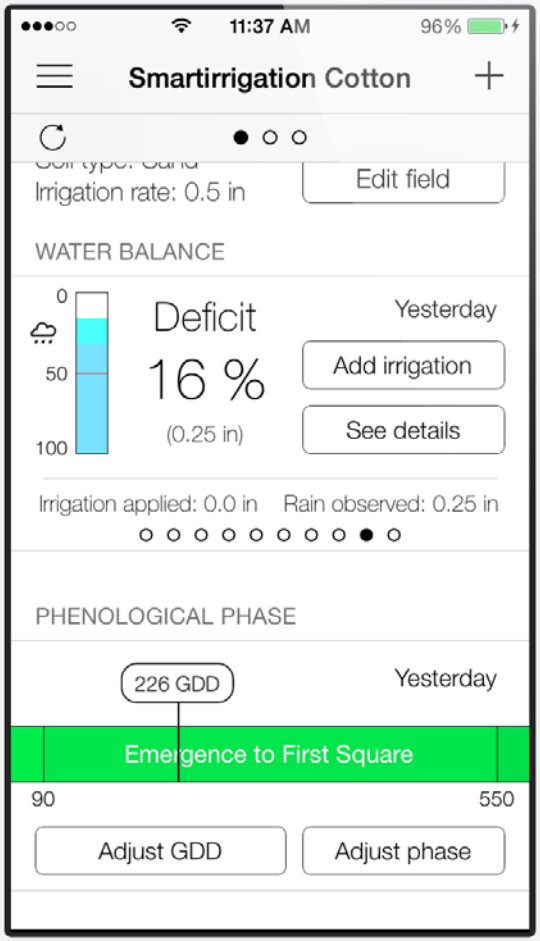

Plot 136 - Conventional/Kc
Plot 124 - Conventional/Checkbook
Plot 137 - Conservation/Kc
Plot 125 - Conservation/Checkbook
Soil Water Tension 8 in
Soil Water Tension 16 in
Soil Water Tension 24 in
Soil Water Tension (kPa)
0
10
20
30
40
50
60
70
80
90
100
110
Aug 13
Sep 13
Oct 13
Dry
Drying
Adequate Soil Moisture


11:37 AM
96%
Smartirrigation Cotton
Field 02
Planting date: 10/25/2013
Soil type: Sand
Irrigation rate: 0.5 in
Edit field
WATER BALANCE
0
50
100
Deficit
16 %
(0.25 in)
Yesterday
Add irrigation
See details
Irrigation applied: 0.0 in
Rain observed: 0.25 in
PHENOLOGICAL PHASE
226 GDD
Yesterday
Emergence to First Square
90
550


11:37 AM
96%
Smartirrigation Cotton
Field 02
Planting date: 10/25/2013
Soil type: Sand
Irrigation rate: 0.5 in
Edit field
WATER BALANCE
0
50
100
Deficit
35 %
(0.70 in)
Today
Remove irrigation
See details
Irrigation applied: 0.5 in
Rain observed: 0.00 in
PHENOLOGICAL PHASE
238 GDD
Today
Emergence to First Square
90
550


92%
11:10
Tuesday, January 7
SI Cotton
The water deficit at Field 1 is 65%.
Irrigation is recommended.
slide to unlock


11:38 AM
96%
Schedule details
Save
01/07/2014
ACCUMULATED ETC
10.3 in
ROOTING DEPTH
12.8 in
WATER DEFICIT
20 % 0.3 in
IRRIGATION APPLIED
1.2 in
RAIN OBSERVED
0.5 in


11:37 AM
96%
Smartirrigation Cotton
Irrigation rate: 0.5 in
Edit field
WATER BALANCE
0
50
100
Deficit
16 %
(0.25 in)
Yesterday
Add irrigation
See details
Irrigation applied: 0.0 in
Rain observed: 0.25 in
PHENOLOGICAL PHASE
226 GDD
Yesterday
Emergence to First Square
90
550
Adjust GDD
Adjust phase


97%
12:53
Tuesday, January 7
SI Cotton
Field 1 is approaching the First Open Boll phase.
slide to unlock

Next Steps

- App available March 2014
- Beta-testing with users in southern Georgia
- Continued testing with plots
- Regionalize app
  - Alabama, Florida, Georgia, South Carolina
- Add drought strategy component
- Evaluate apps with replicated field trials
  - Add peanut app

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