Irrigation Research and Extension at Edisto REC

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Pee Dee River Basin Council Meeting
Florence, SC
March 28, 2022

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Outline

1. Center Pivot Mapping Software
2. Drip Fertigation Calculator
3. Center Pivot Fertigation Calculator
4. Watermark Soil Moisture Calculator
5. Center Pivot Irrigation Testing Extension Program
6. Other Edisto REC Water/Irrigation Work

Outline

1. **Center Pivot Mapping Software**
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Center Pivot Mapper – Overview

https://www.clemson.edu/extension/agronomy/PrecisionAgriculture/Software/center_pivot_mapper.html

- Windows desktop software
- GIS mapping tool for center pivot irrigation systems

C.P.M.
Center Pivot Mapper

- Layout, planning, management
- Exports: ESRI shapefile, Google Earth KML, and PDF
- Published February 2021

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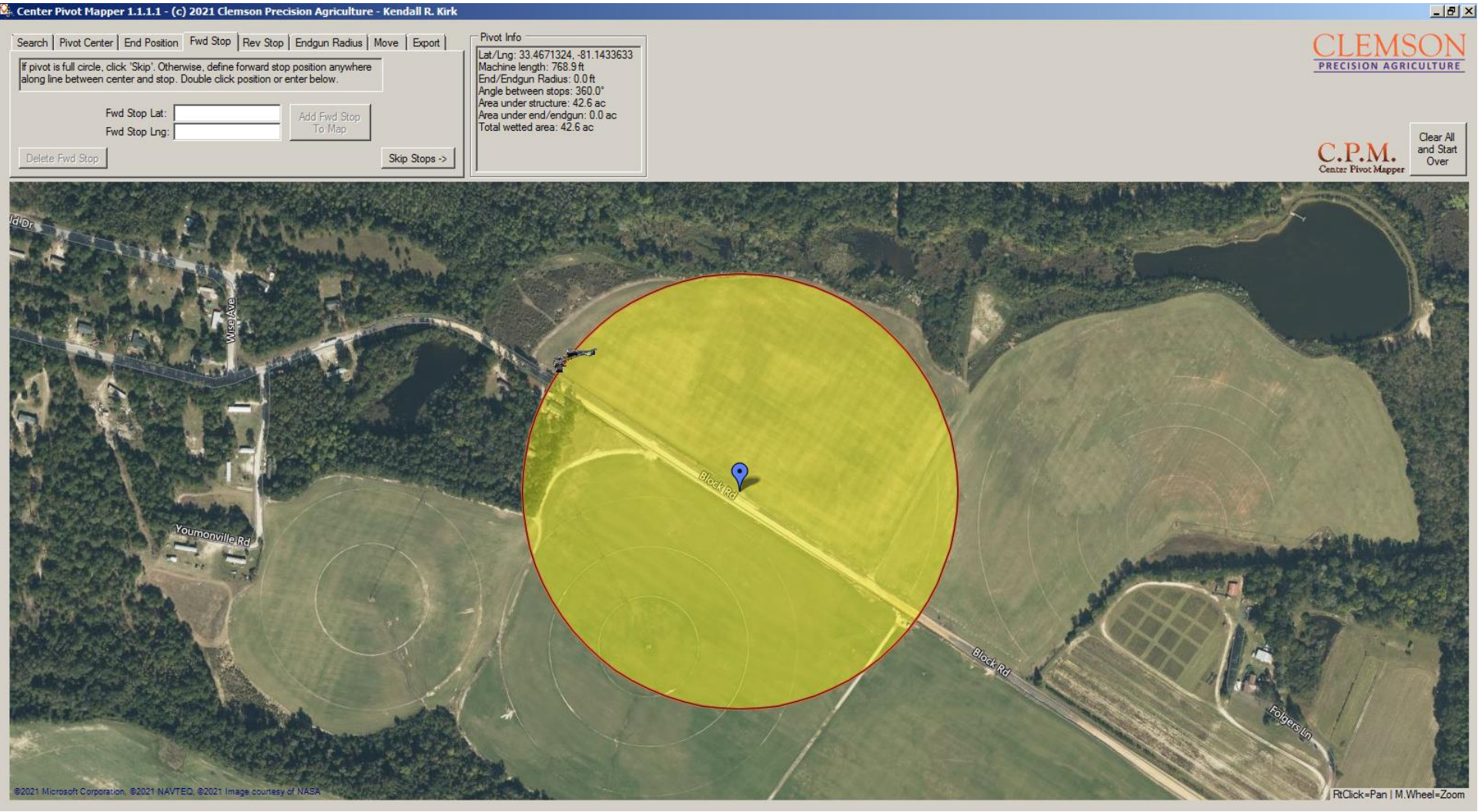
Center Pivot Mapper – Mark Center and End



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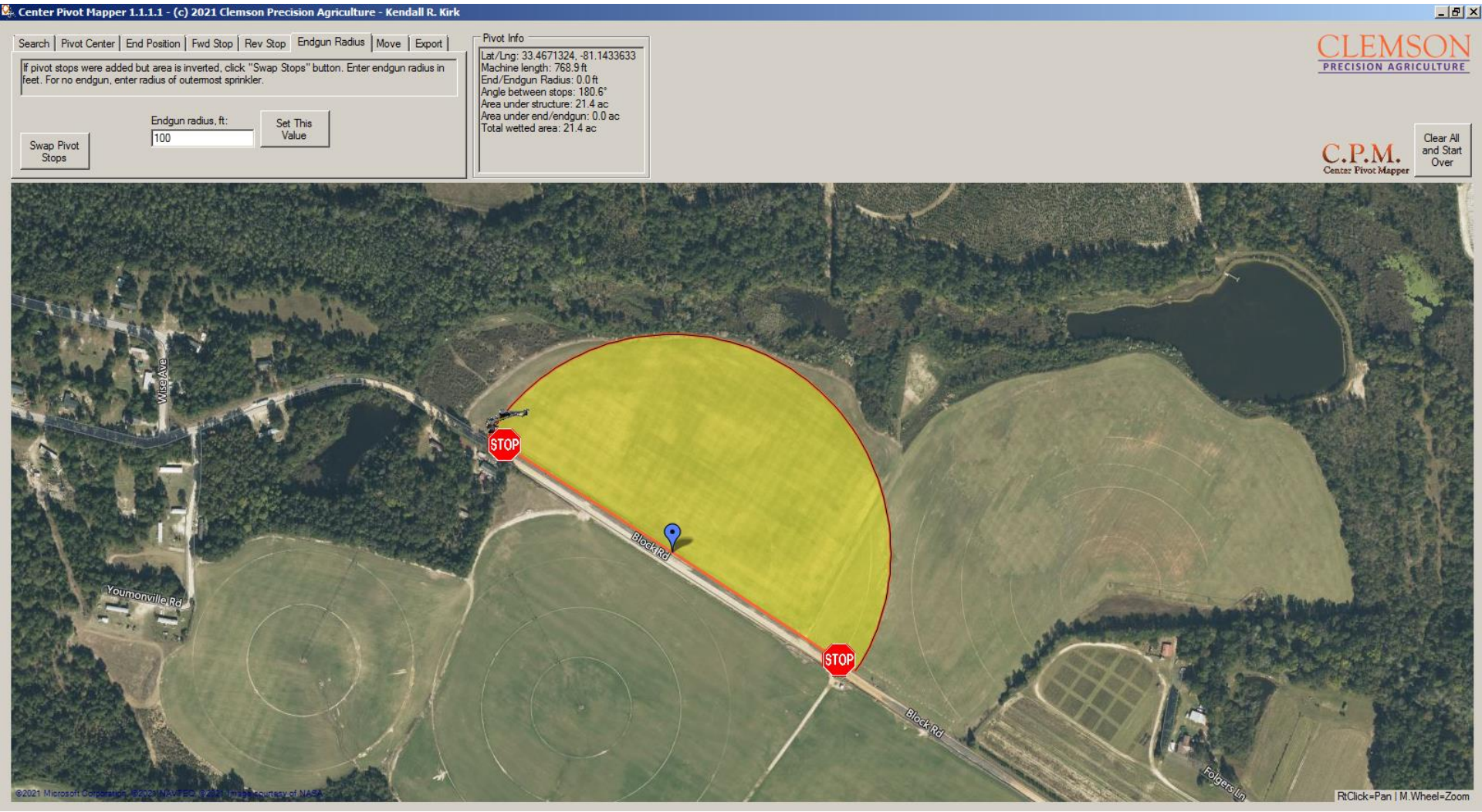
Center Pivot Mapper – Mark Center and End



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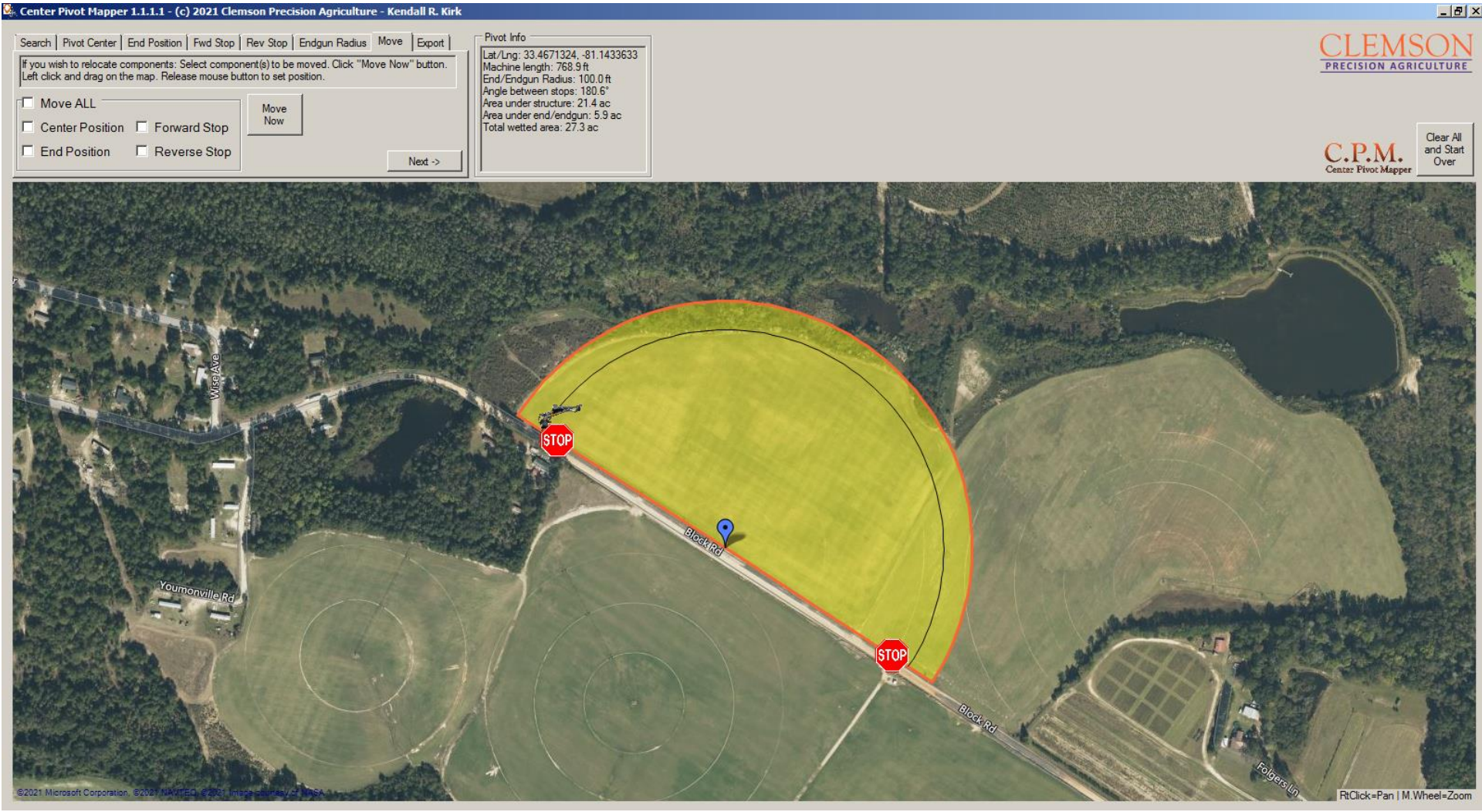
Center Pivot Mapper – Add Endgun Radius



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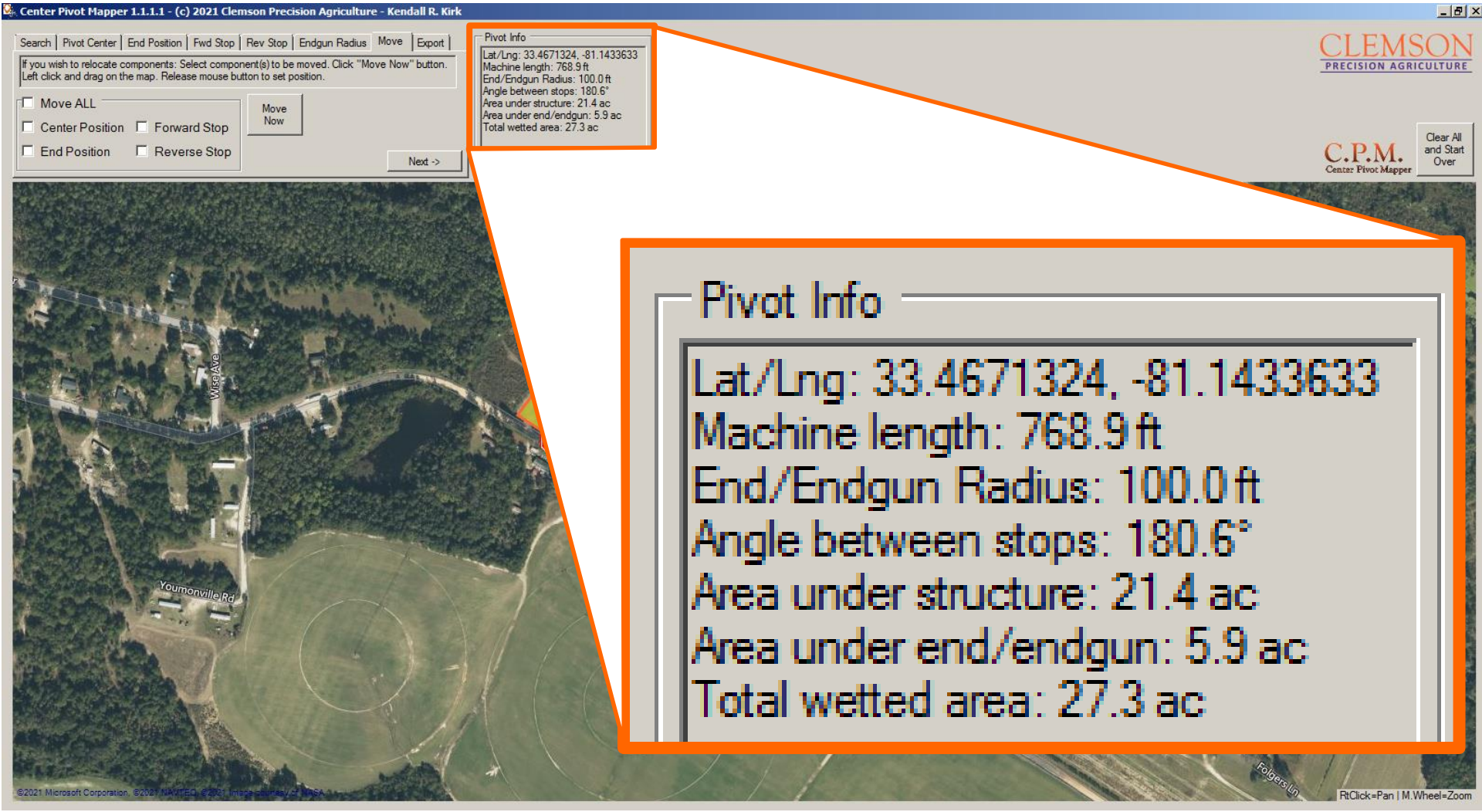
Center Pivot Mapper – Pivot Info



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Center Pivot Mapper – PDF Export

Pivot Layout: ERBC Sample

Report generated using Center Pivot Mapper Software (v.1.1.1.1)

User Inputs

Pivot center position: 33.4671324086174°, -81.1433632671833°
End/Endgun position: 33.4682880722117°, -81.1454728245735°
Forward stop position: 33.4660835718331°, -81.1414340883493°
Reverse stop position: 33.4681650109938°, -81.1453058570623°
Endgun or last sprinkler radius: 100.0 ft

Calculated Outputs

Machine length: 768.9 ft
Wetted radius: 868.9 ft
Angle between stops: 180.6°
Machine travel between stops (at end): 2423.6 ft
Area inside end/endgun position: 21.39 ac
Area outside end/endgun position: 5.93 ac
Total wetted area: 27.32 ac
24/7 flow required for 1 in. per week: 74 gpm
24/7 flow required for 2 in. per week: 147 gpm
Date of report generation: May 25, 2021

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Center Pivot Mapper – SHP/KML Export

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Center Pivot Mapper – Future Work

- Manage/view multiple pivots
- Record keeping
  - Application depths
  - Sprinkler charts
  - Service history
- Endgun shutoff recommendations
- Output irrigation management plans
  - Irrigation scheduling by crop/soil/region
  - Depth per application recommendations

C.P.M.
Center Pivot Mapper

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Drip Fertigation Calculator - Overview

https://precisionag.sites.clemson.edu/Calculators/Fertigation/Drip/

- App for calculating proper drip fertigation rates
- Inputs
  - Fertilizer Product
  - N Rate or Crop/Growth Stage
  - Area fertigated
- Outputs
  - Gallons per acre per day and per week
- Benefits
  - Encourages use of fertigation
  - Eliminates “guess-timates”
  - Cited recommendations
  - Encourages leaf tissue sampling

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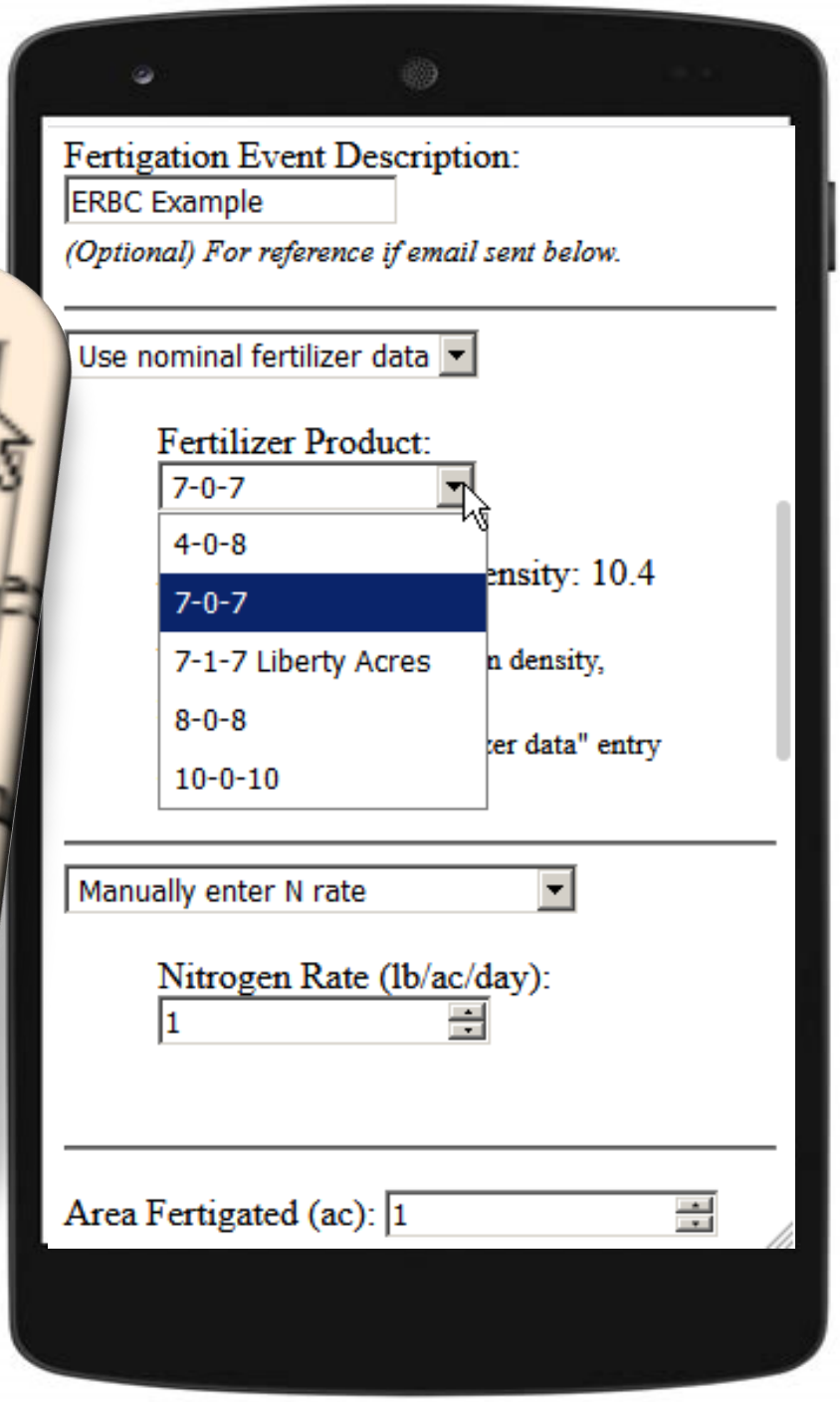
Drip Fertigation Calculator

Select Nominal Fertilizer



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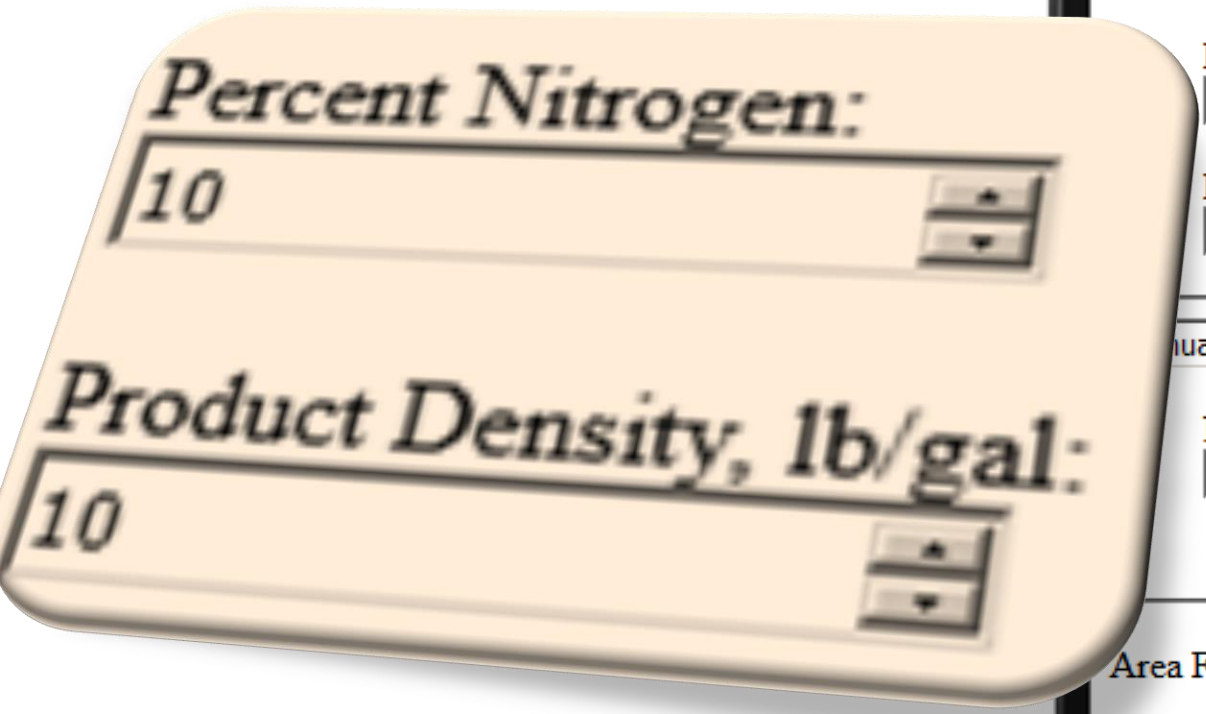
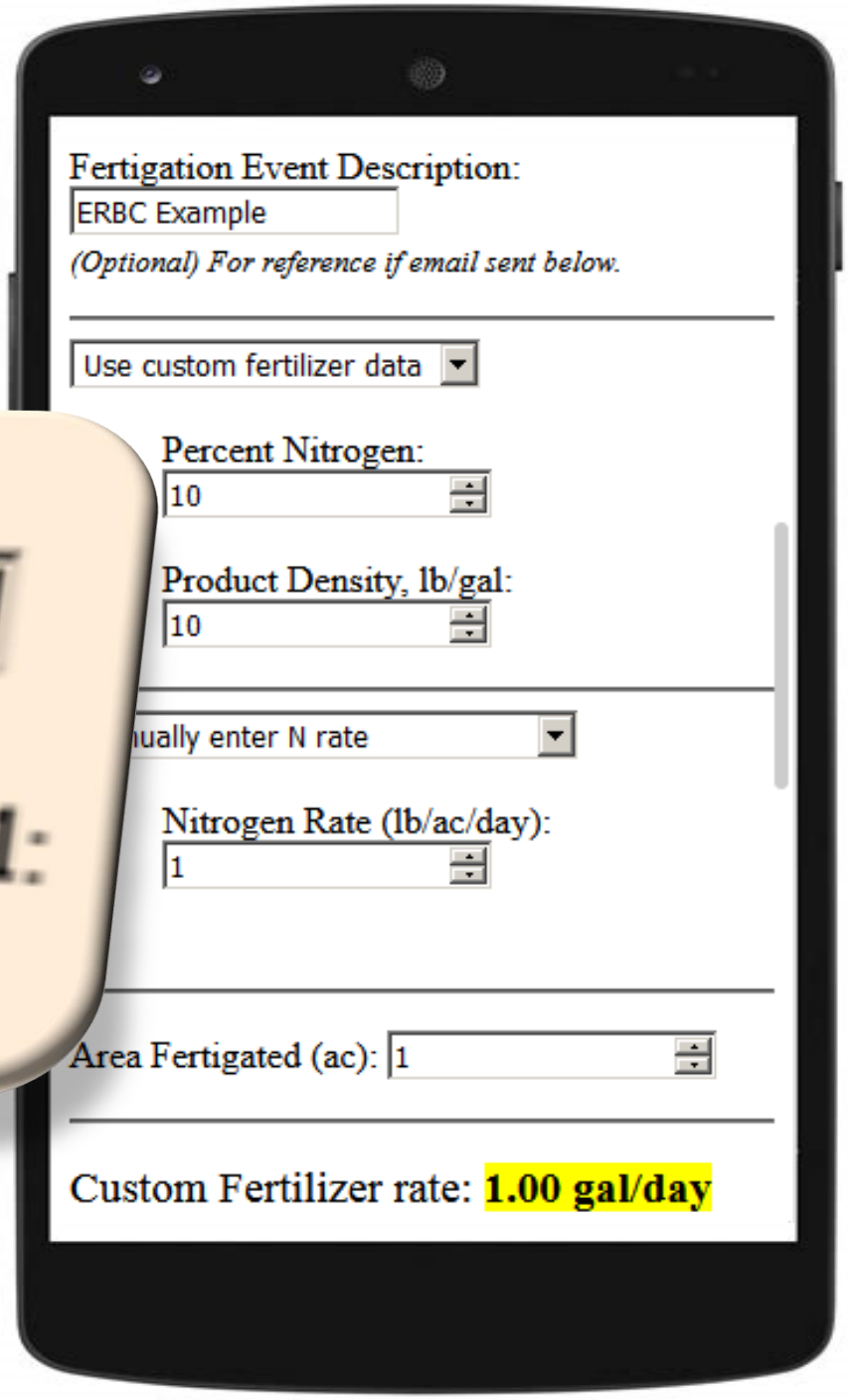
Drip Fertigation Calculator

Input Custom Fertilizer





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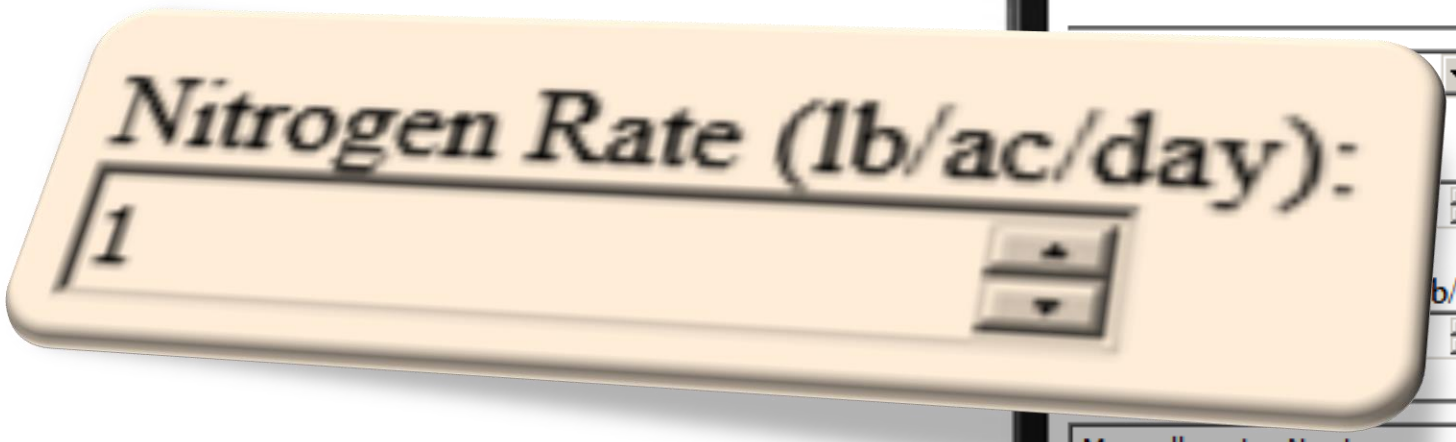
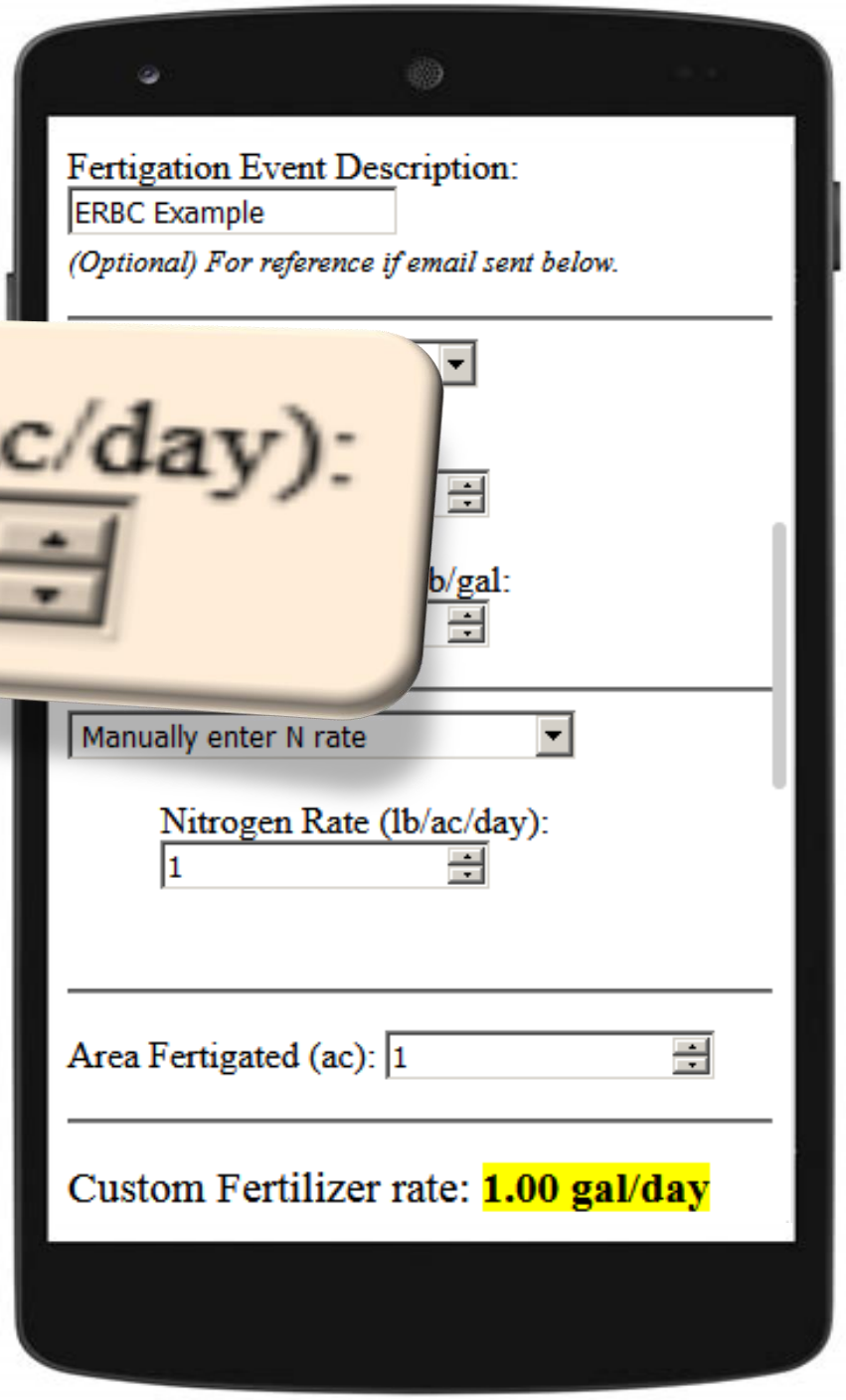
Drip Fertigation Calculator

Input Manual N-Rate





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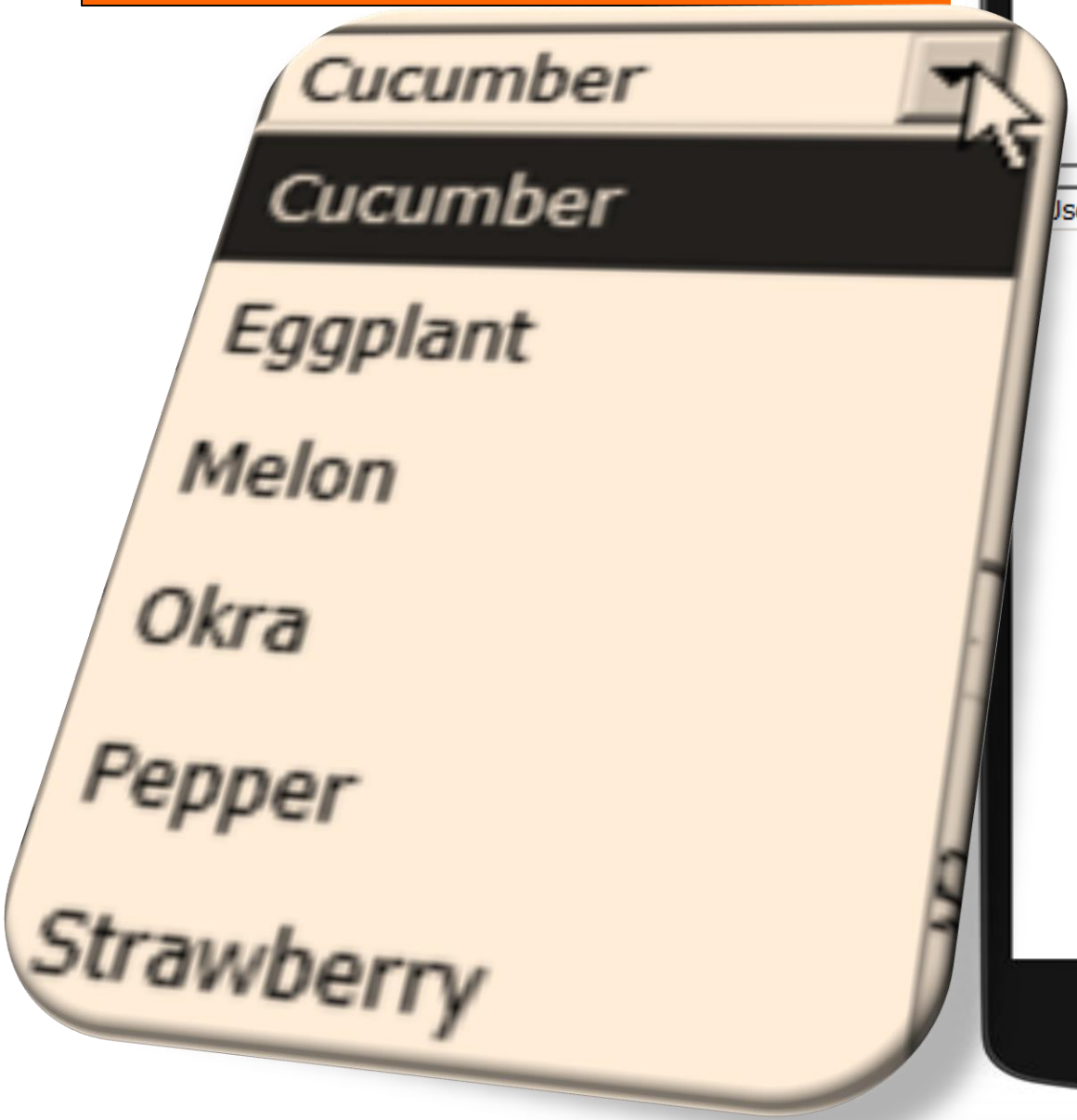
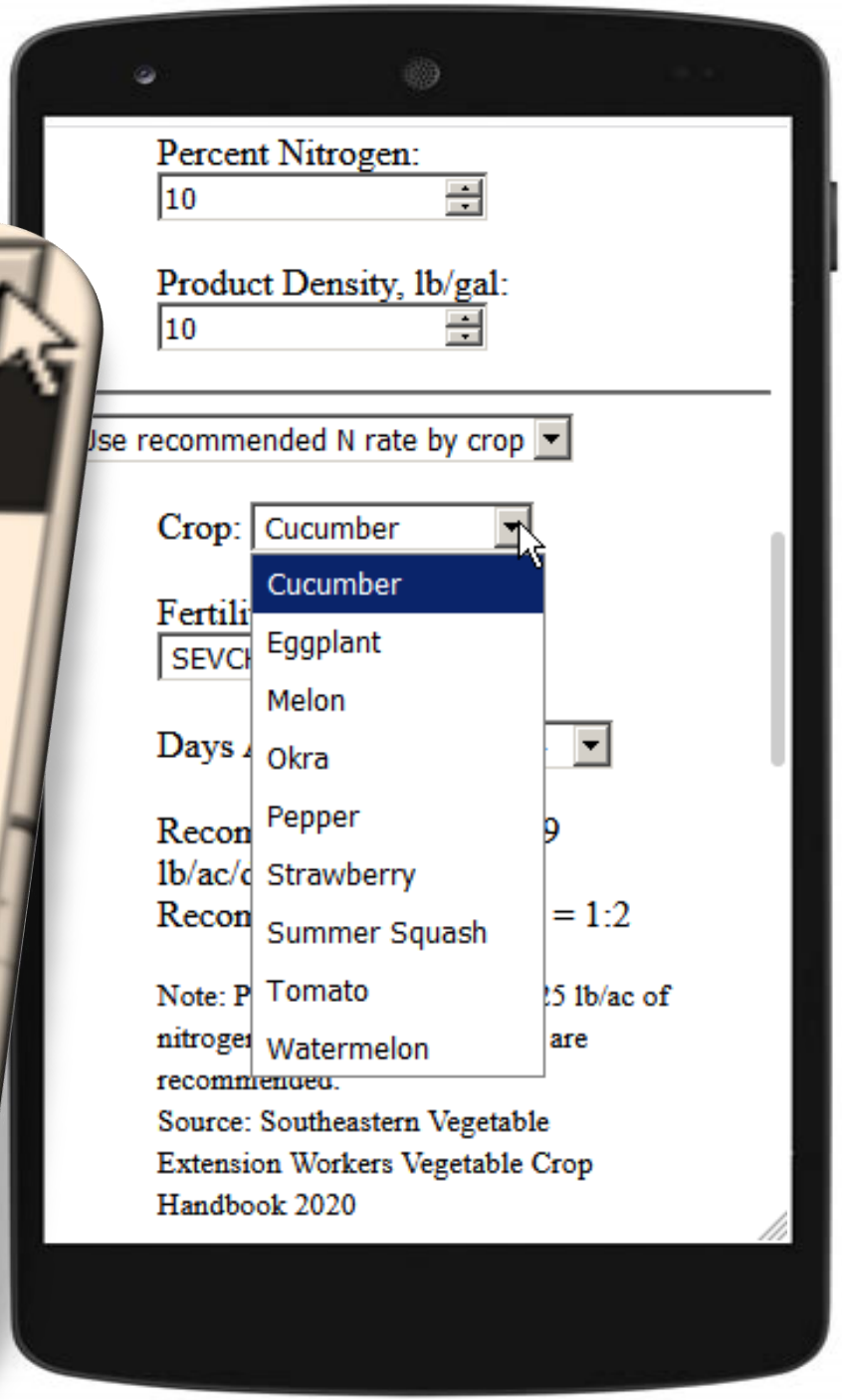
Drip Fertigation Calculator

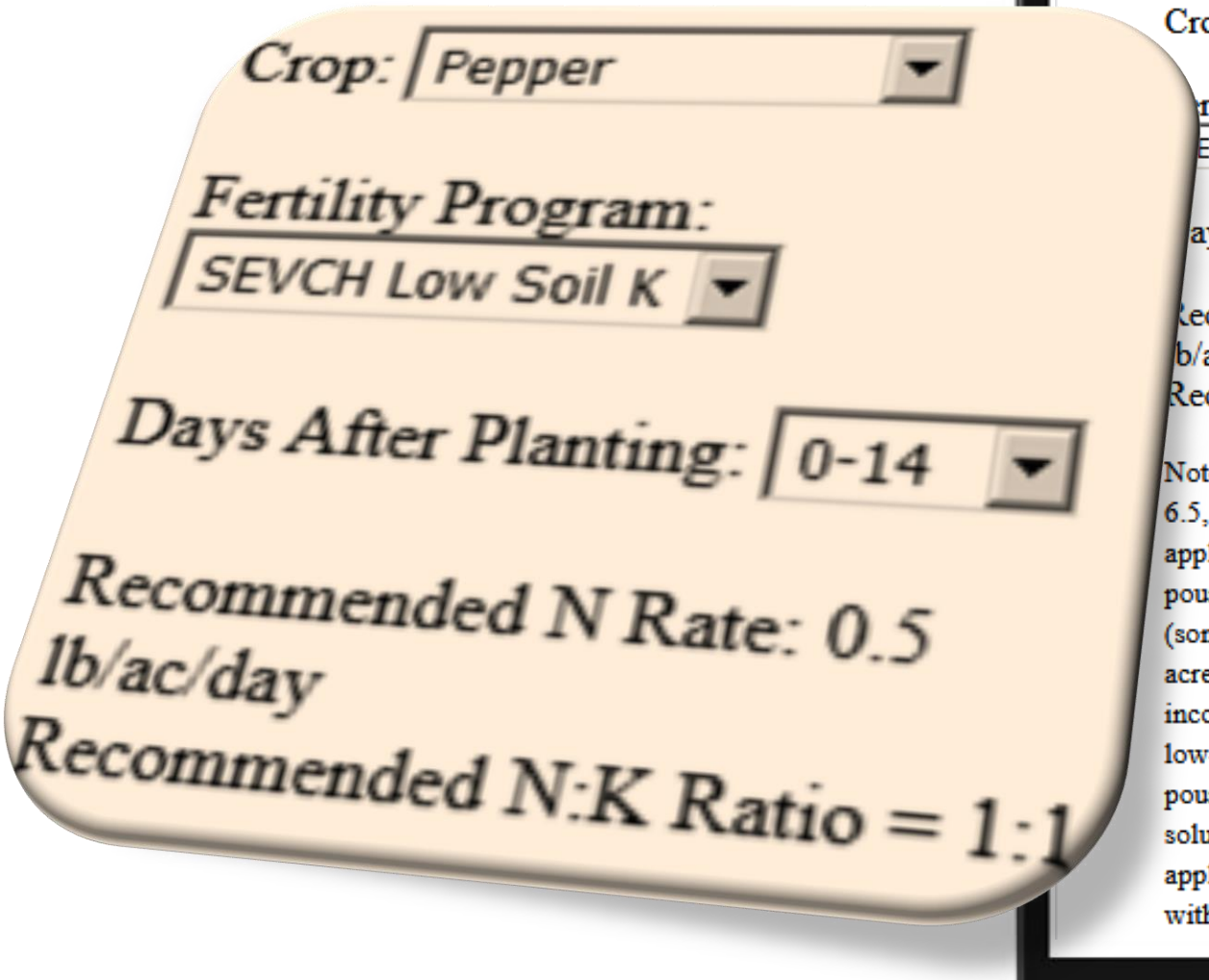
Get N-Rec by Crop/Stage

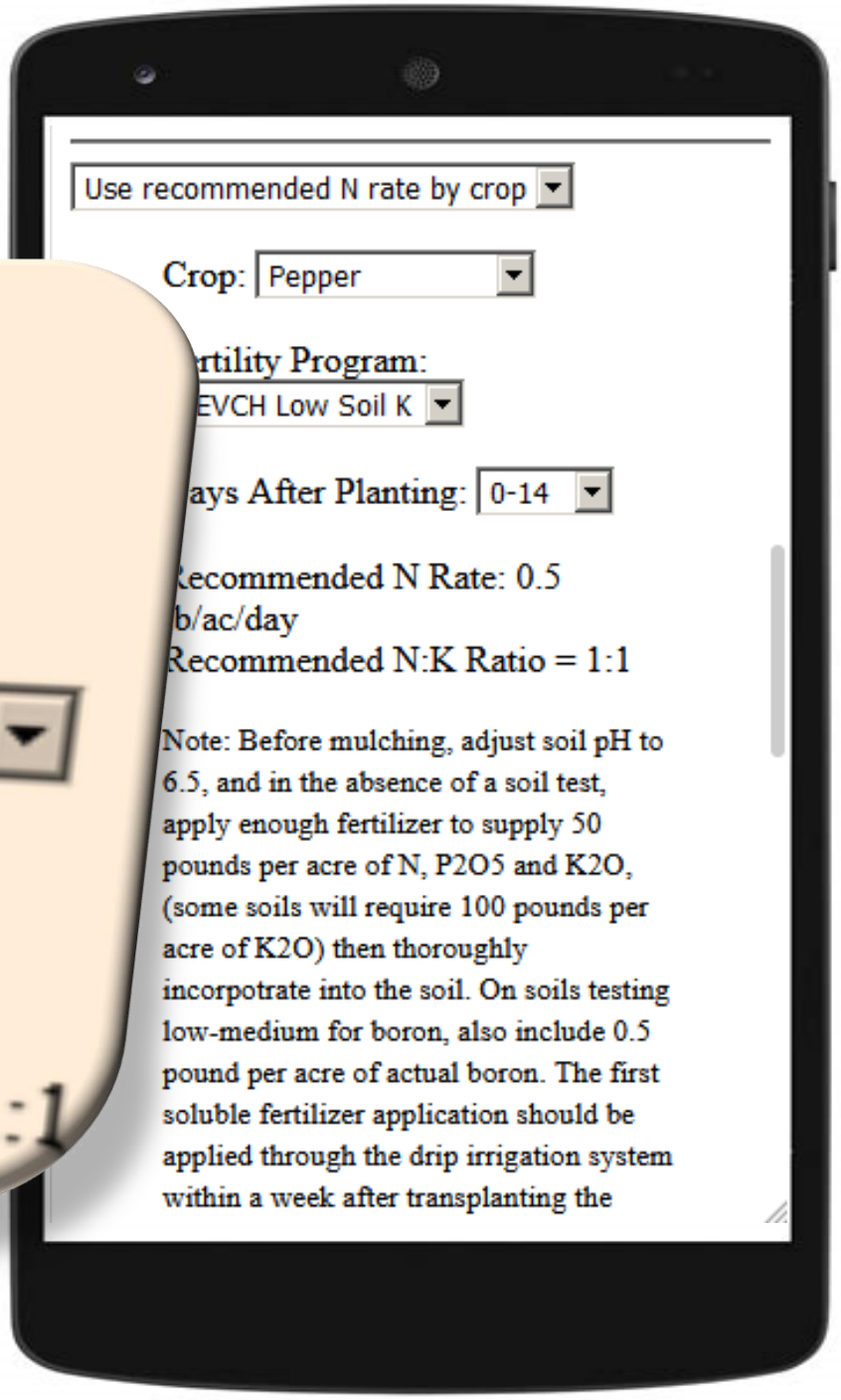




Drip Fertigation Calculator

Get N-Rec by Crop/Stage





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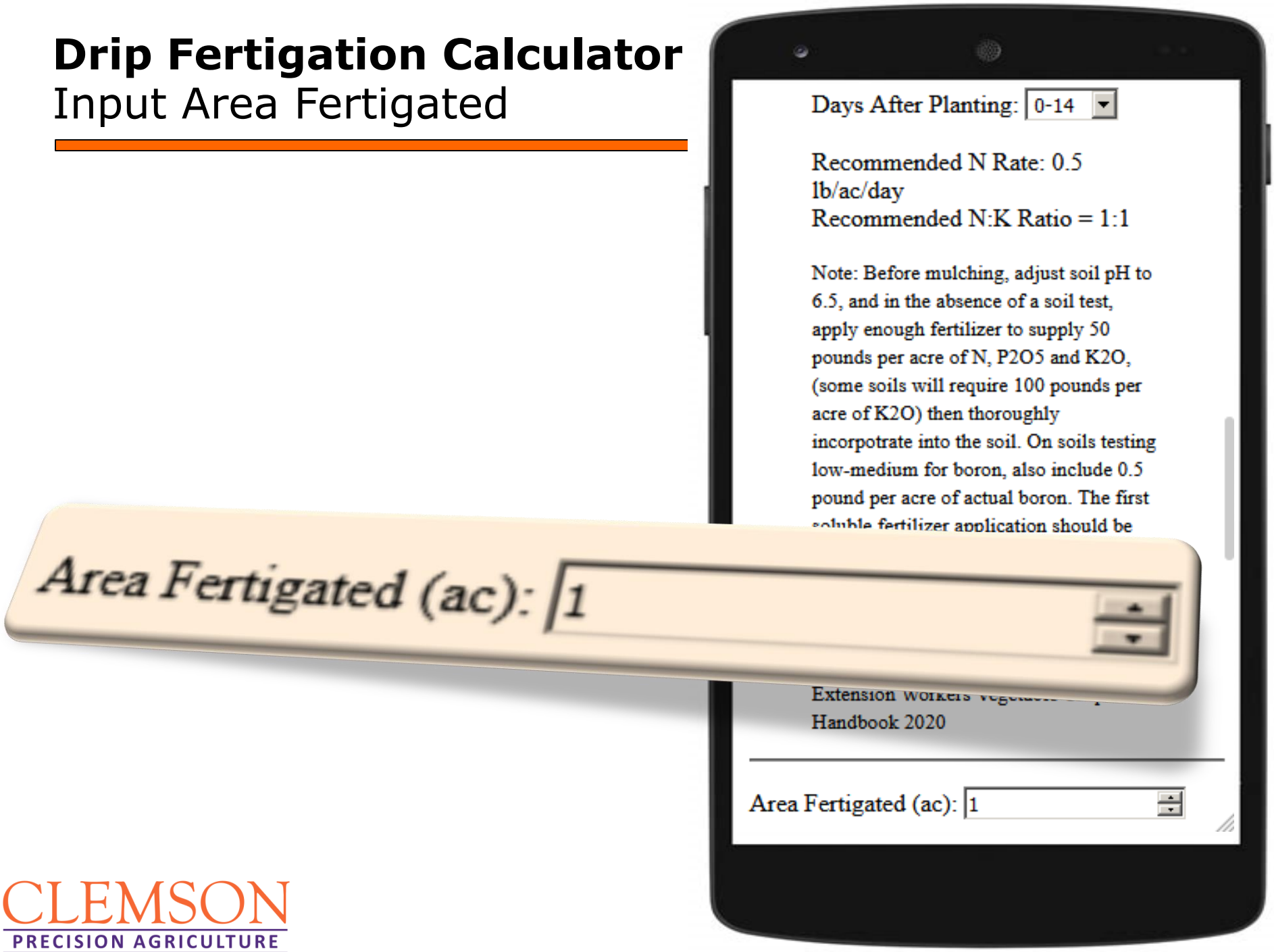
Drip Fertigation Calculator
Input Area Fertigated



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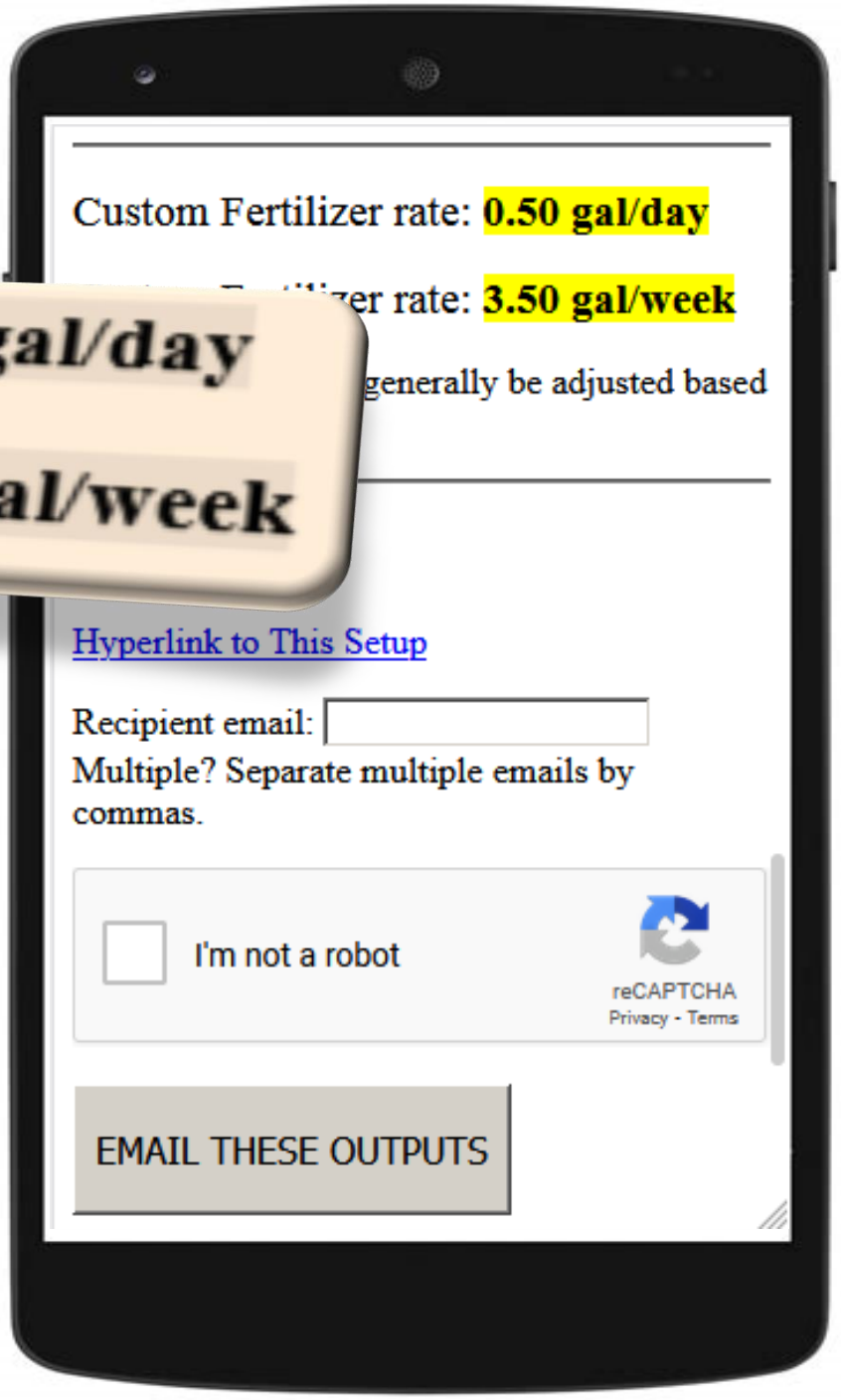
Drip Fertigation Calculator

Output: Fertilizer Rate

Custom Fertilizer rate: **0.50 gal/day**

Custom Fertilizer rate: **3.50 gal/week**



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Outline

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6. Other Edisto REC Water/Irrigation Work

Pivot Fertigation Calculator - Overview

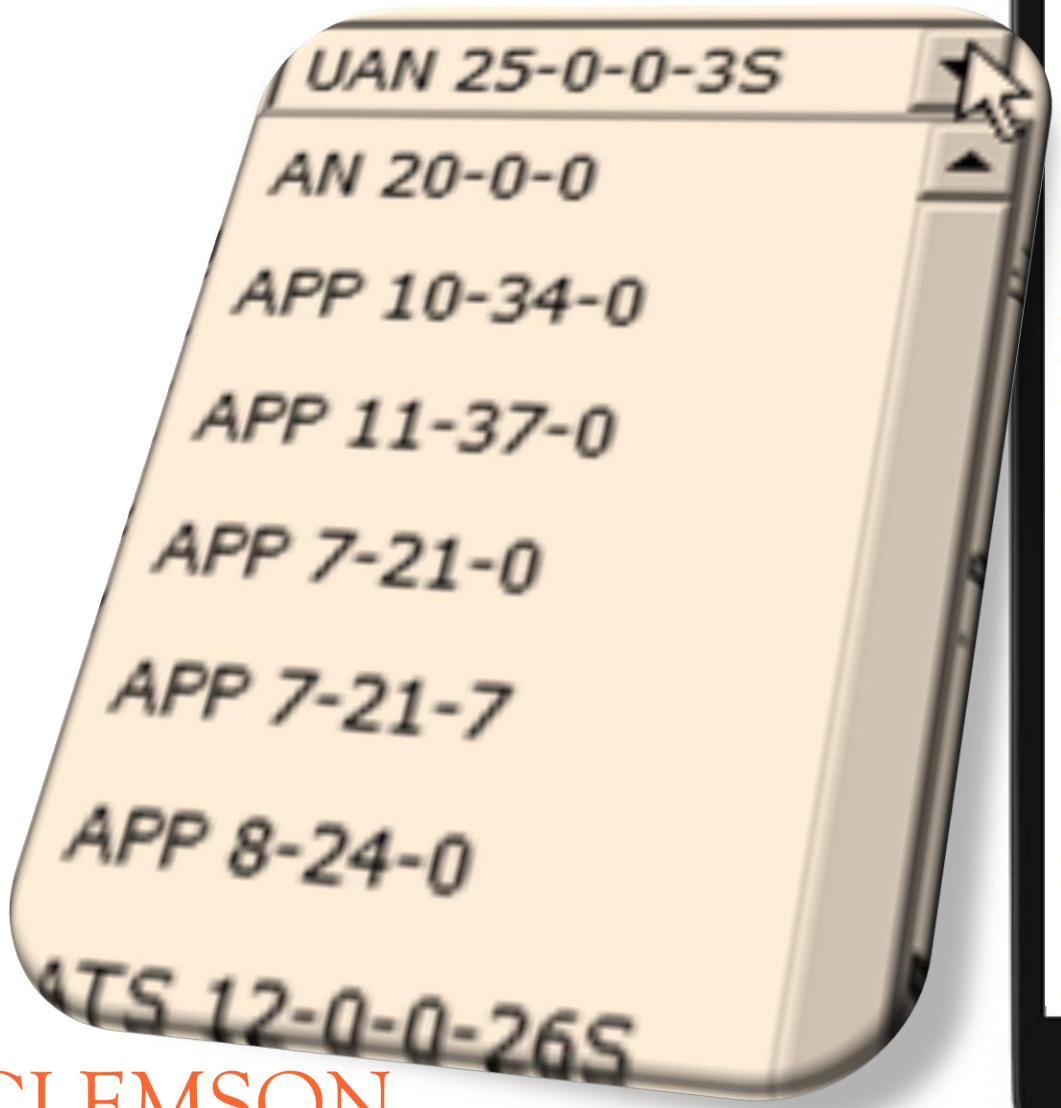
https://precisionag.sites.clemson.edu/Calculators/Fertigation/Pivot/

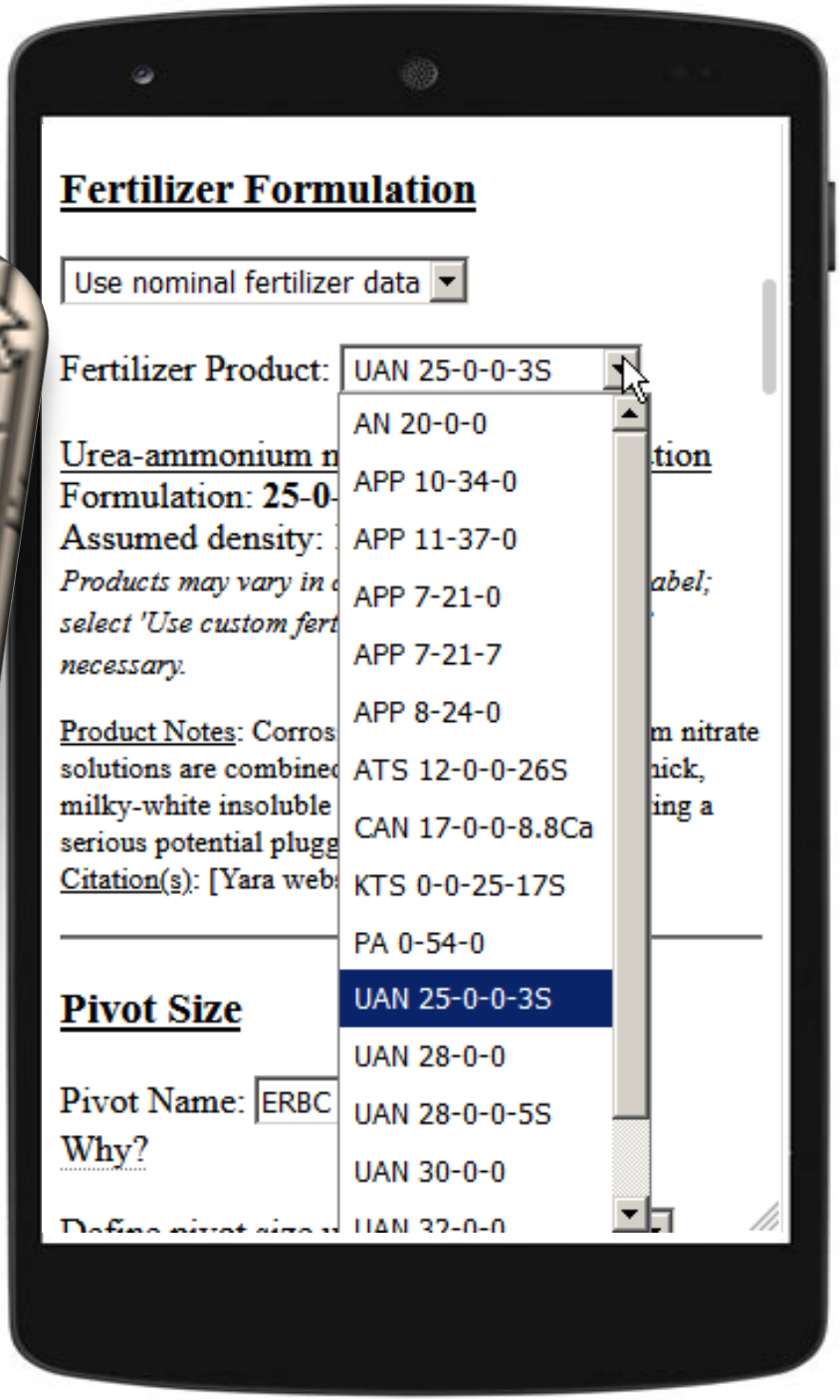
- App for calculating proper center pivot fertigation rates

- Inputs
  - Fertilizer Product
  - Pivot Size/Travel Time
  - Nutrient Rate (lb/ac)
  - Injection Pump Model
- Outputs
  - Product Rate (lb/ac, gpm)
  - Injection Pump Setting
  - Fertigation Schedule
- Benefits
  - Encourages use of fertigation
  - Eliminates “guess-timates”
  - Reduces over-fertilization

Pivot Fertigation Calculator

Select Nominal Fertilizer





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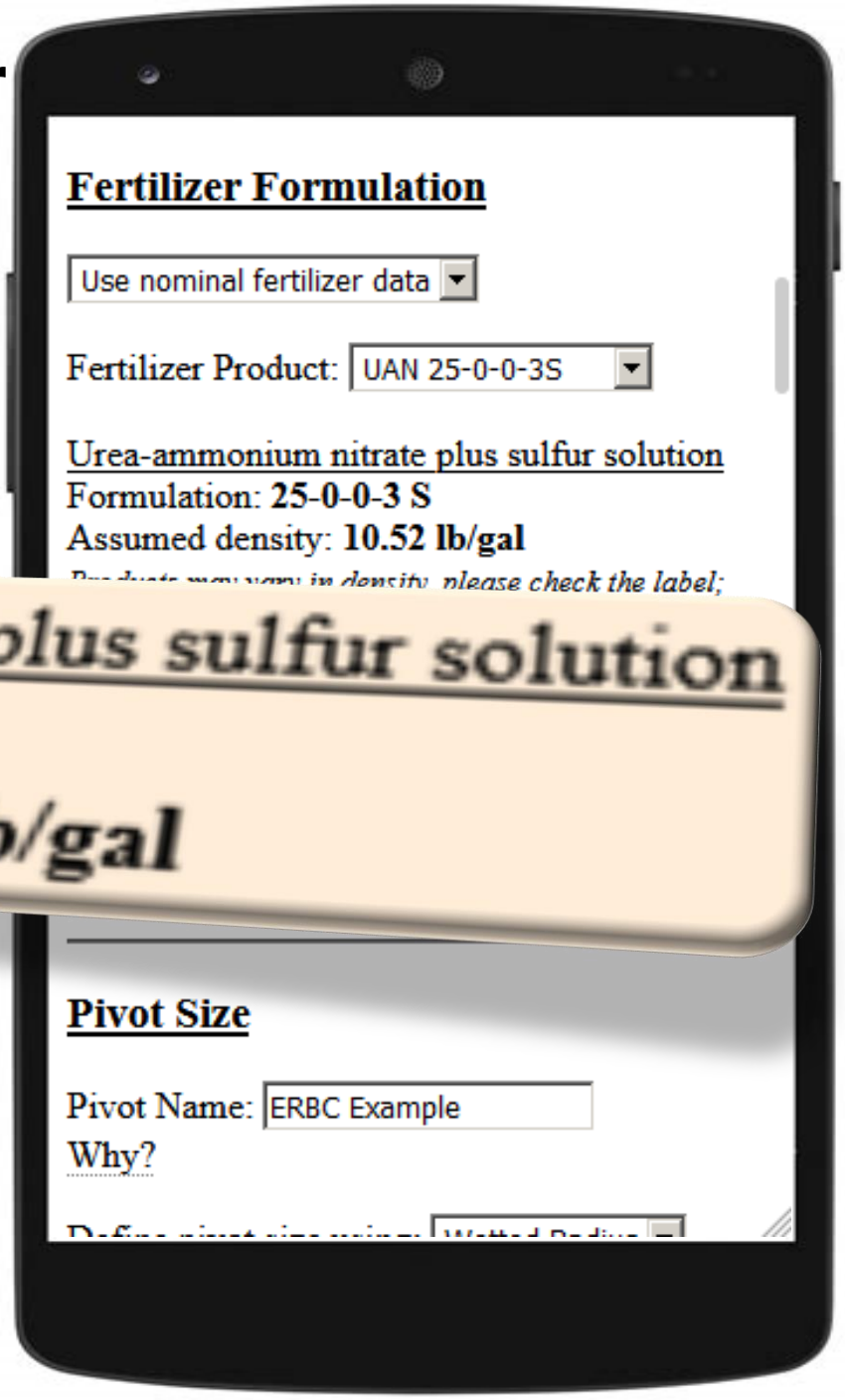
Pivot Fertigation Calculator

Nominal Fertilizer Info



Urea-ammonium nitrate plus sulfur solution
Formulation: 25-0-0-3 S
Assumed density: 10.52 lb/gal

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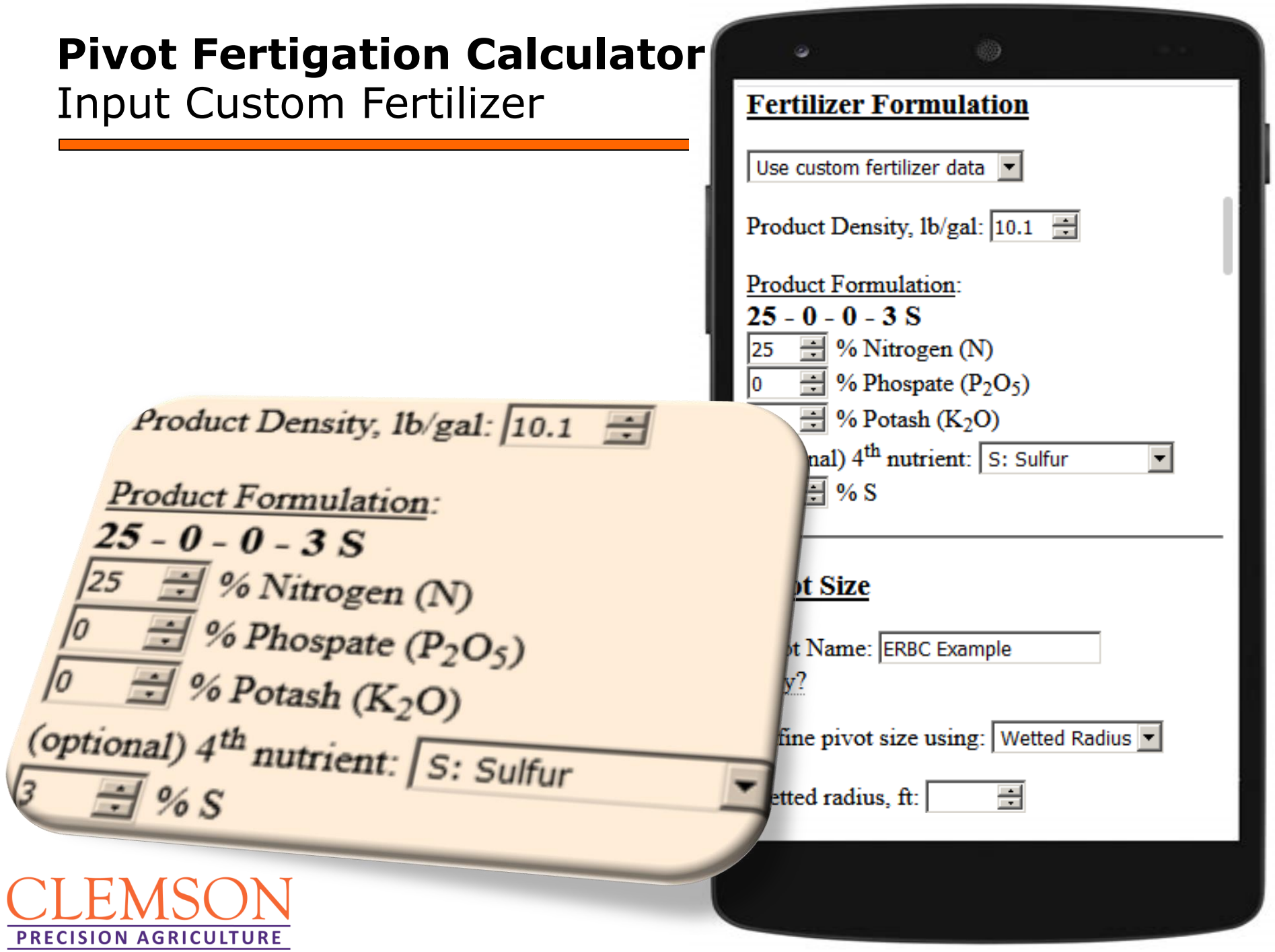
Pivot Fertigation Calculator

Input Custom Fertilizer



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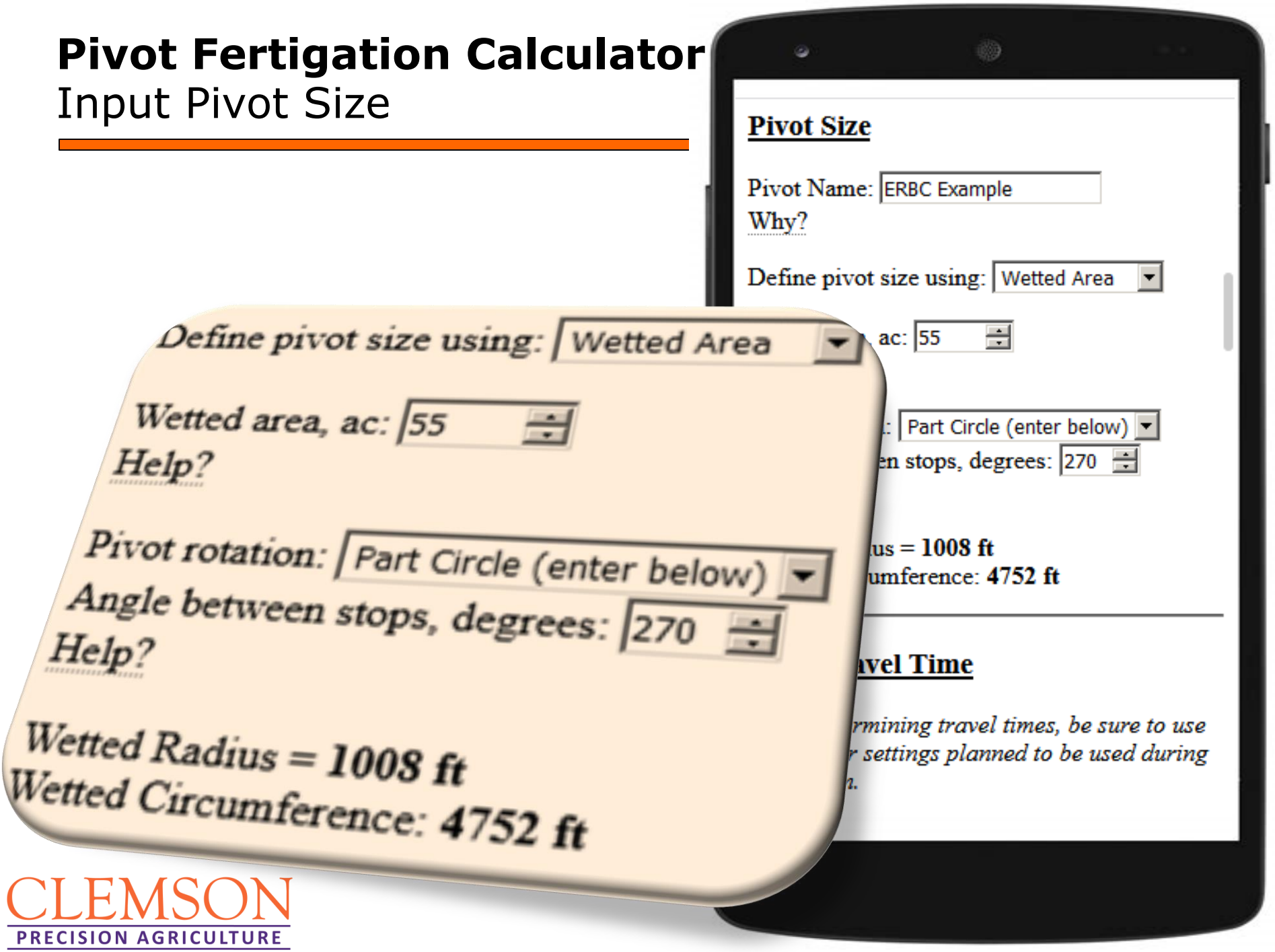
Pivot Fertigation Calculator

Input Pivot Size



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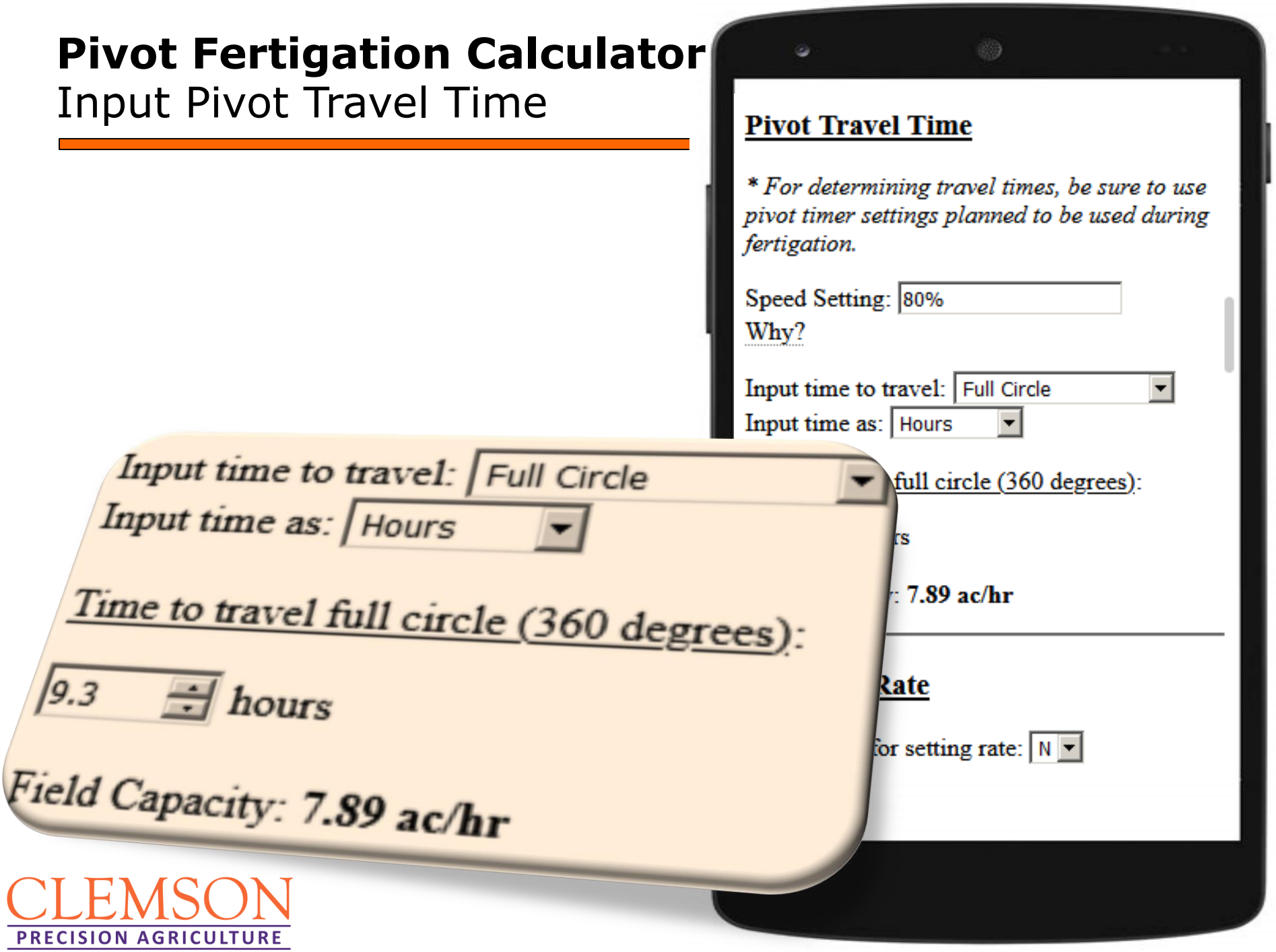
Pivot Fertigation Calculator

Input Pivot Travel Time



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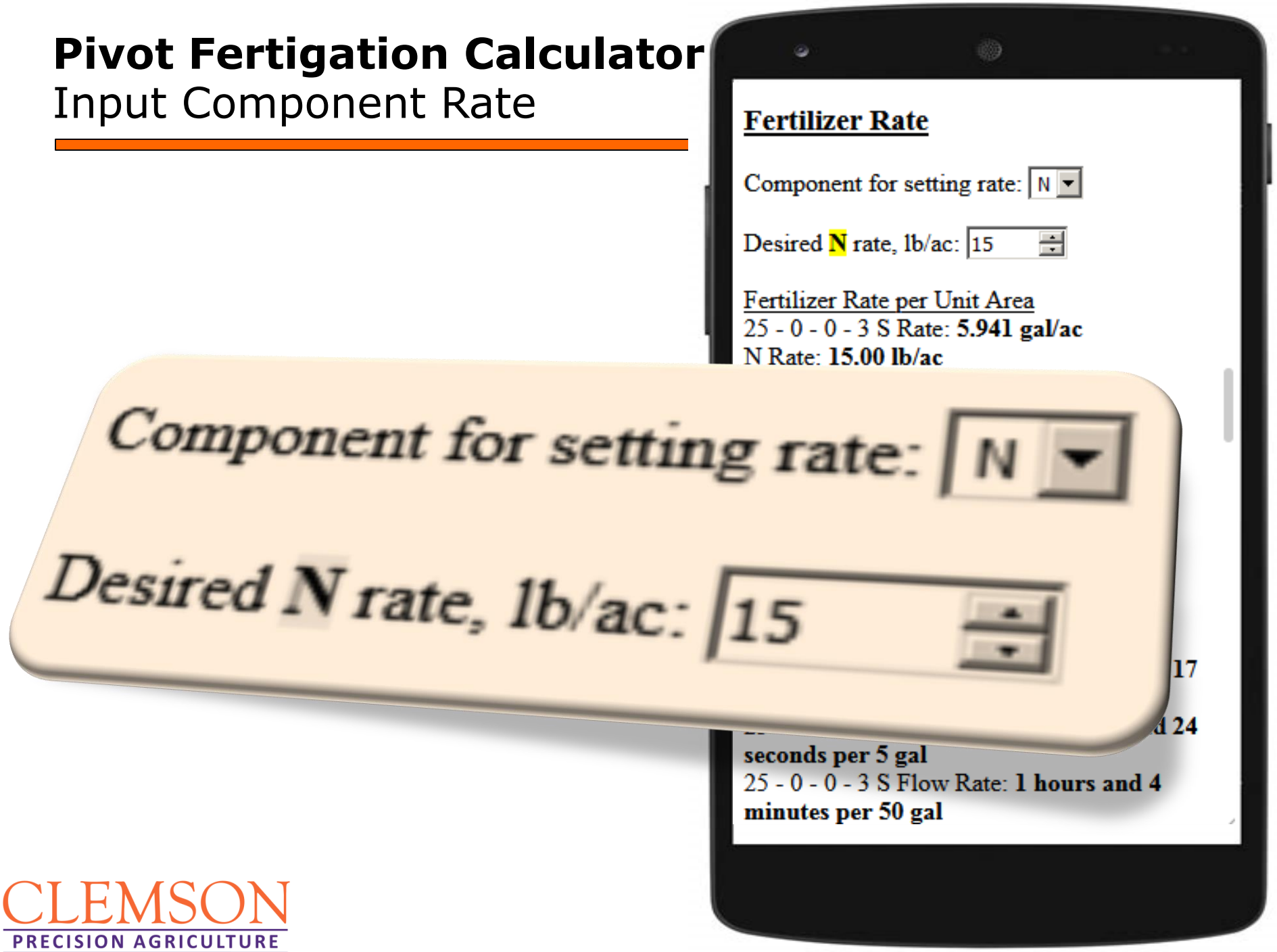
Pivot Fertigation Calculator
Input Component Rate



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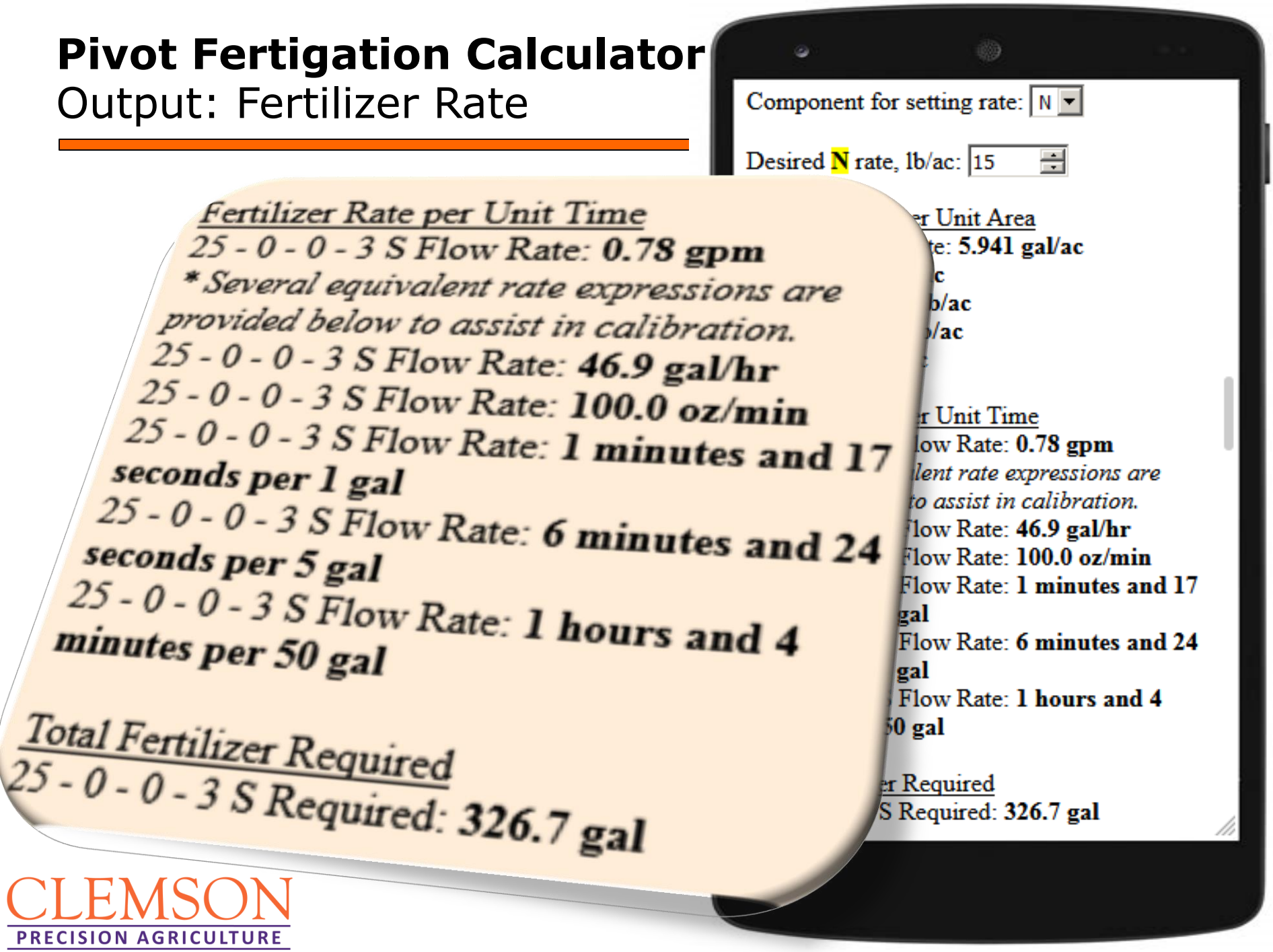
Pivot Fertigation Calculator

Output: Fertilizer Rate



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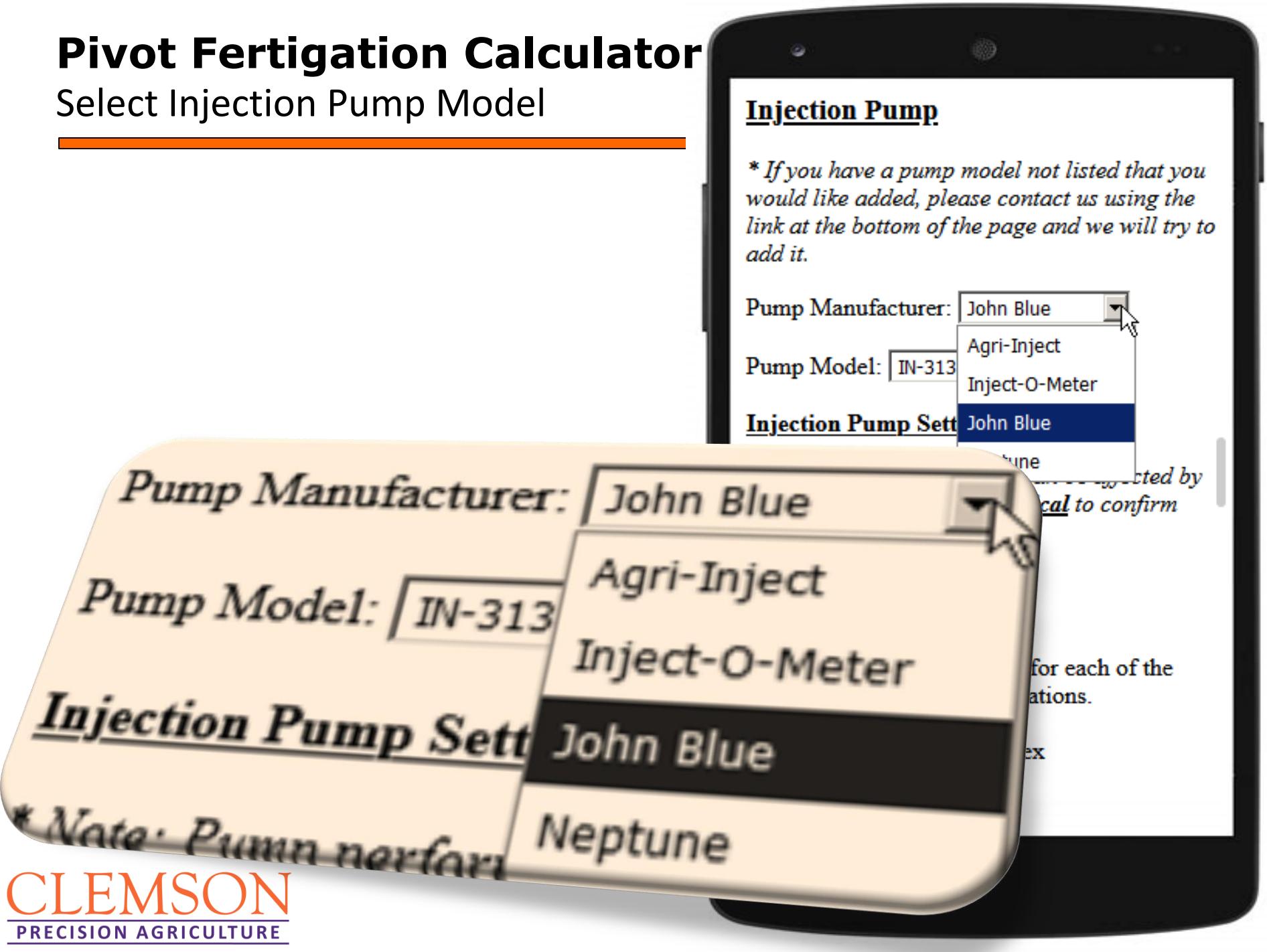
Pivot Fertigation Calculator

Select Injection Pump Model



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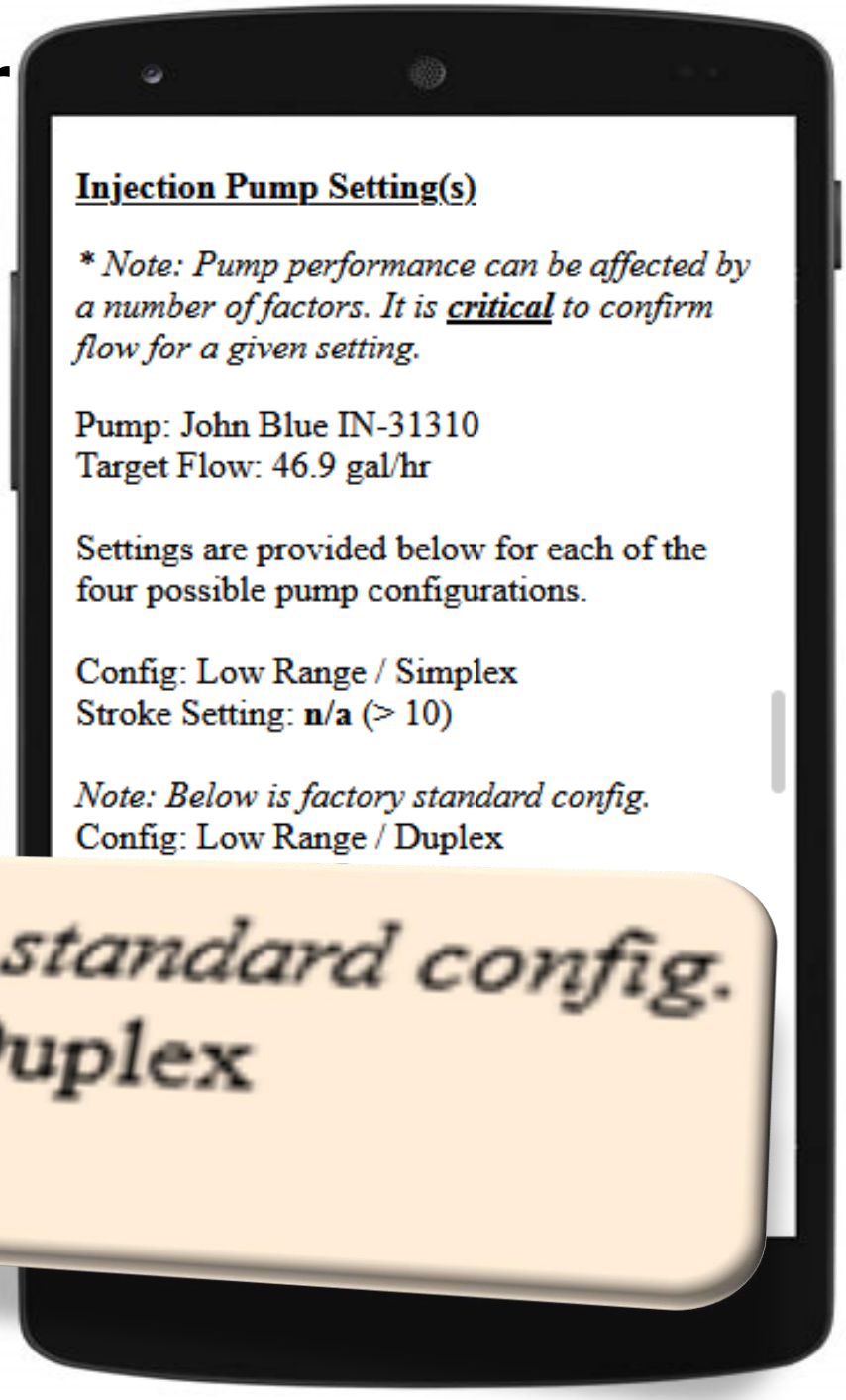
Pivot Fertigation Calculator

Output: Injection Pump Setting



Note: Below is factory standard config.
Config: Low Range / Duplex
Stroke Setting: 5.5

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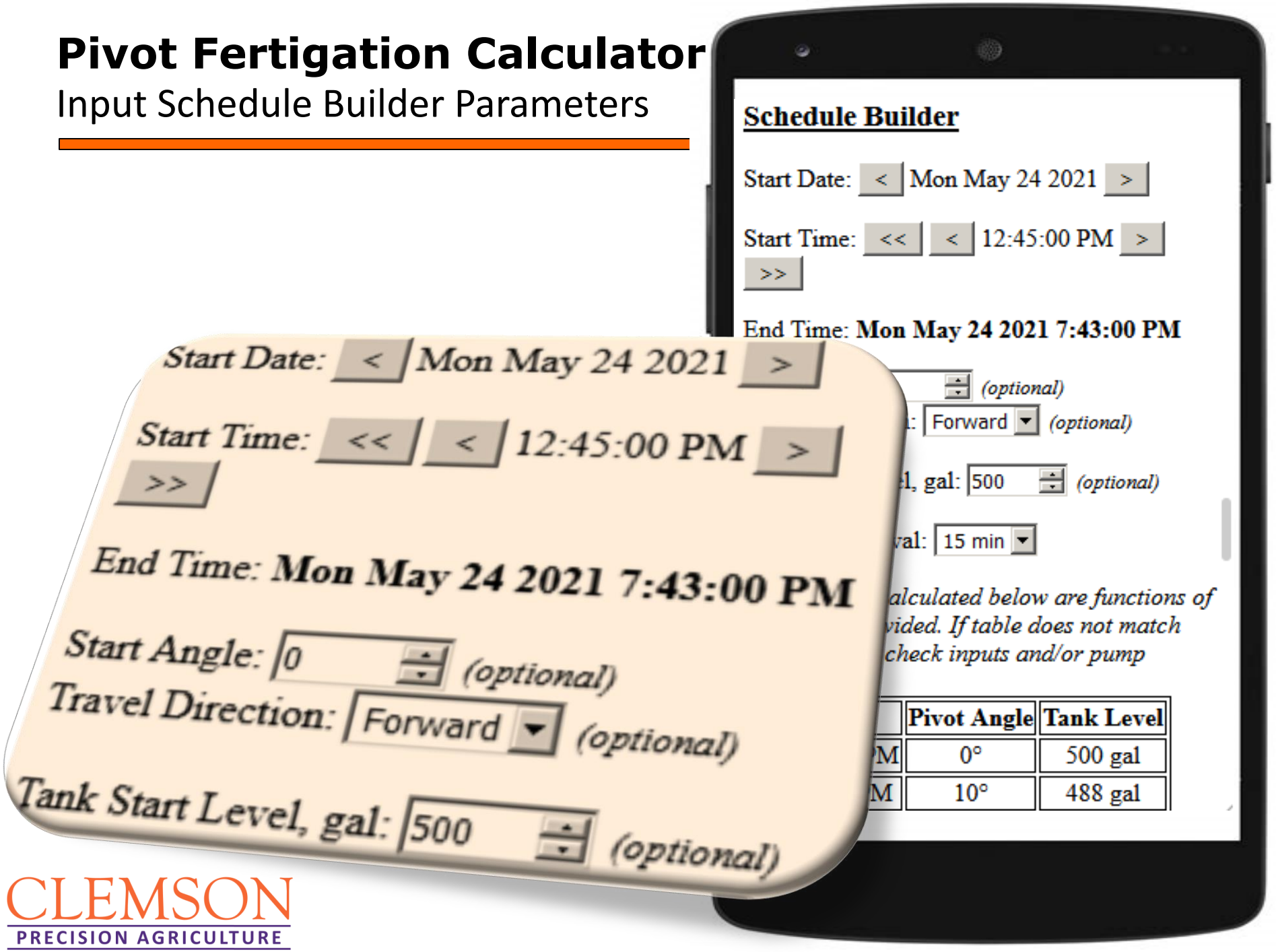
Pivot Fertigation Calculator

Input Schedule Builder Parameters



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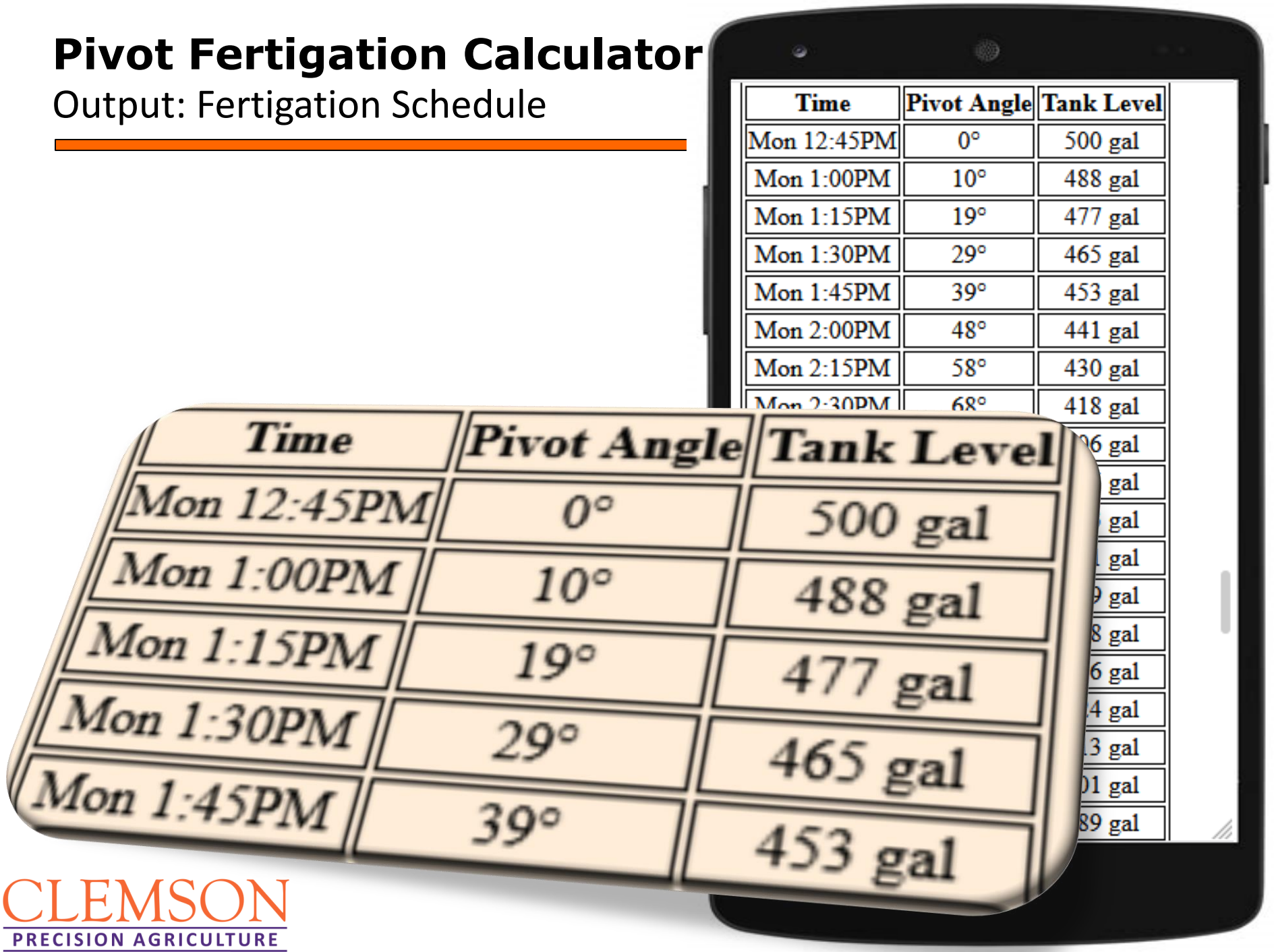
Pivot Fertigation Calculator

Output: Fertigation Schedule



Time	Pivot Angle	Tank Level
Mon 12:45PM	0°	500 gal
Mon 1:00PM	10°	488 gal
Mon 1:15PM	19°	477 gal
Mon 1:30PM	29°	465 gal
Mon 1:45PM	39°	453 gal
Mon 2:00PM	48°	441 gal
Mon 2:15PM	58°	430 gal
Mon 2:30PM	68°	418 gal

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Watermark Soil Moisture Calculator - Overview

https://precisionag.sites.clemson.edu/Calculators/Irrigation/WatermarkCalculator/

- App for recommending when to irrigate based on Watermark sensor readings
- Inputs
  - Soil tension at multiple depths
  - Irrigation threshold
- Outputs
  - Weighted soil tension
  - Irrigation recommendation

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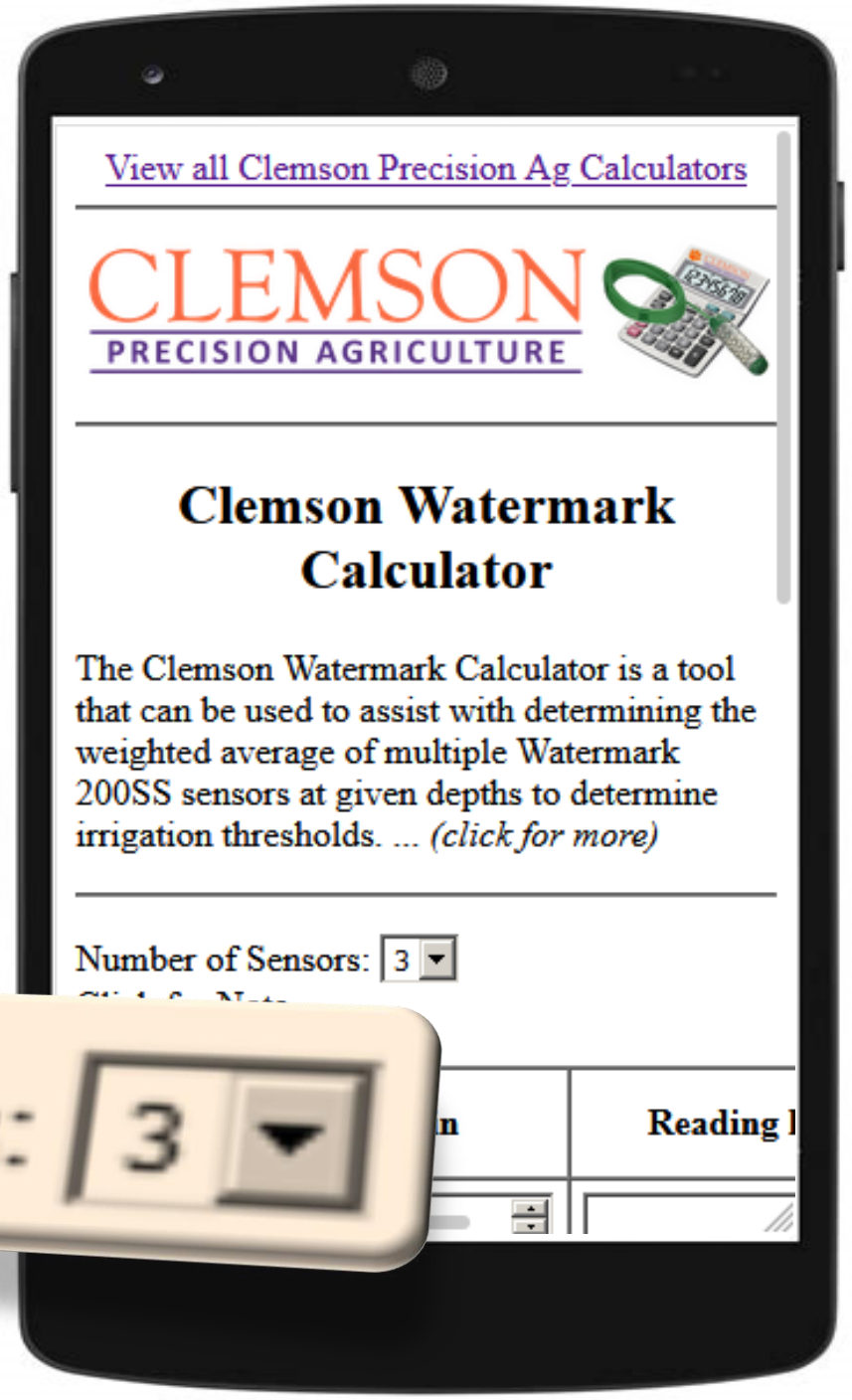
Watermark Calculator

Select Number of Sensors



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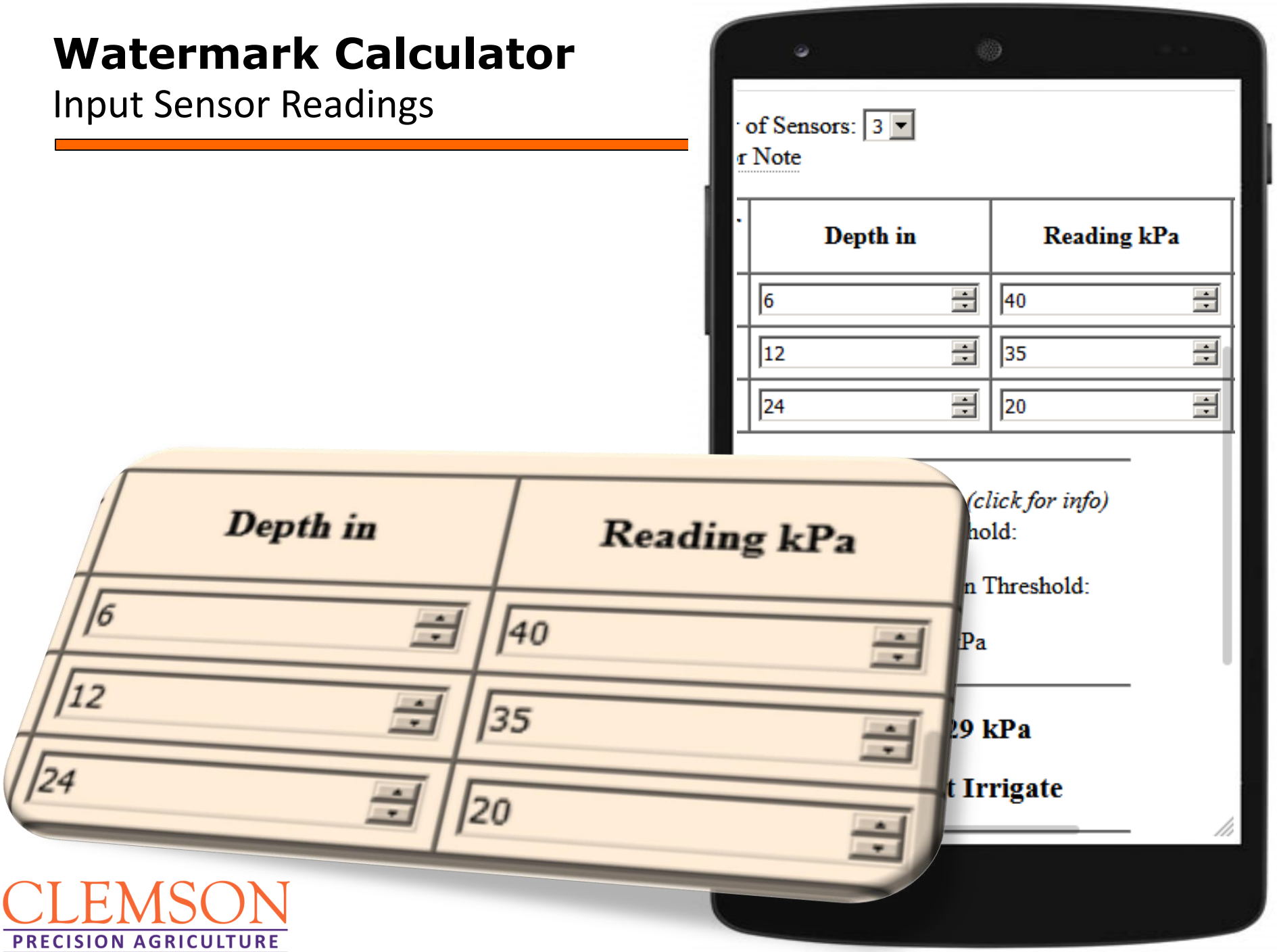
Watermark Calculator

Input Sensor Readings



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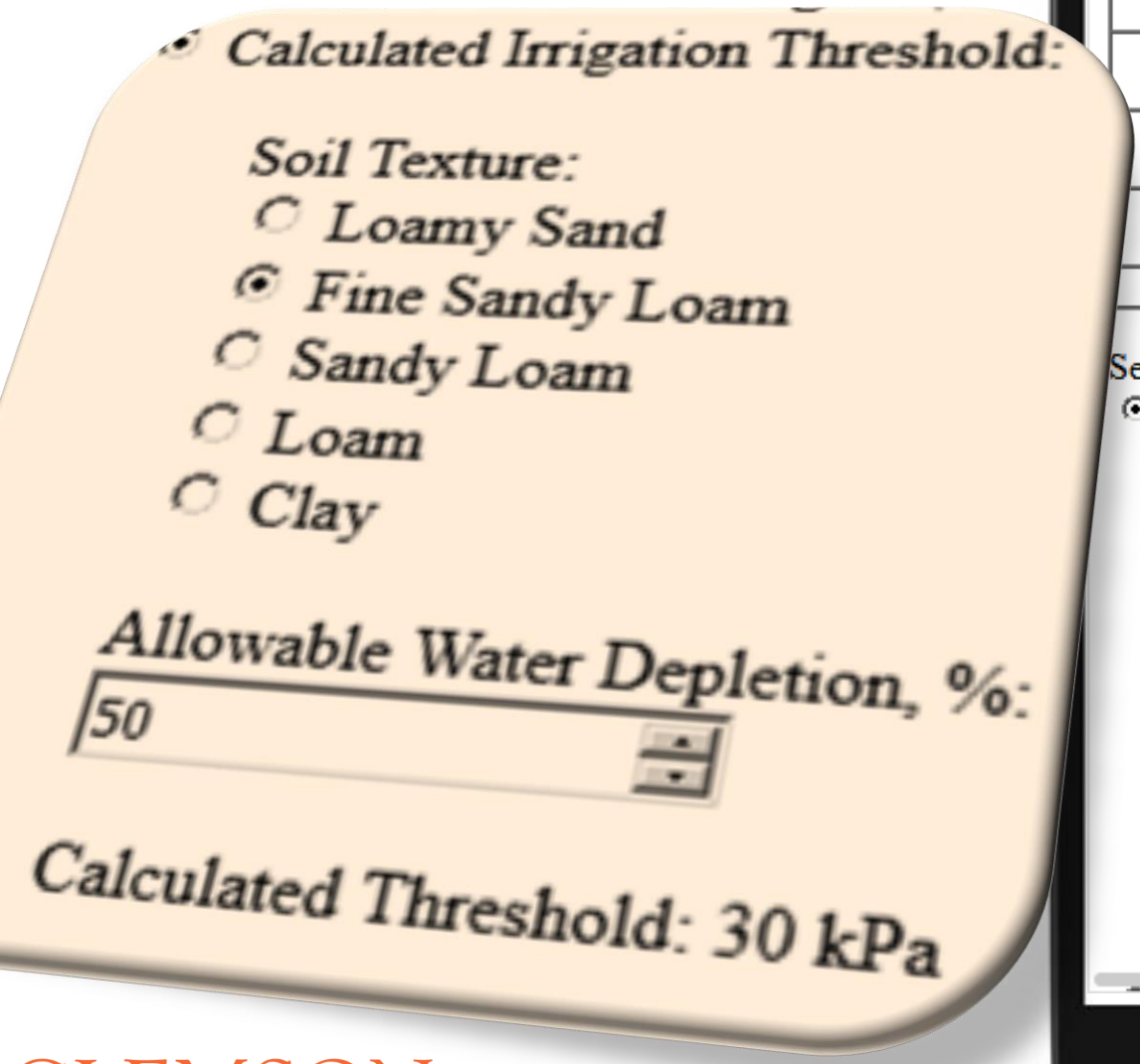
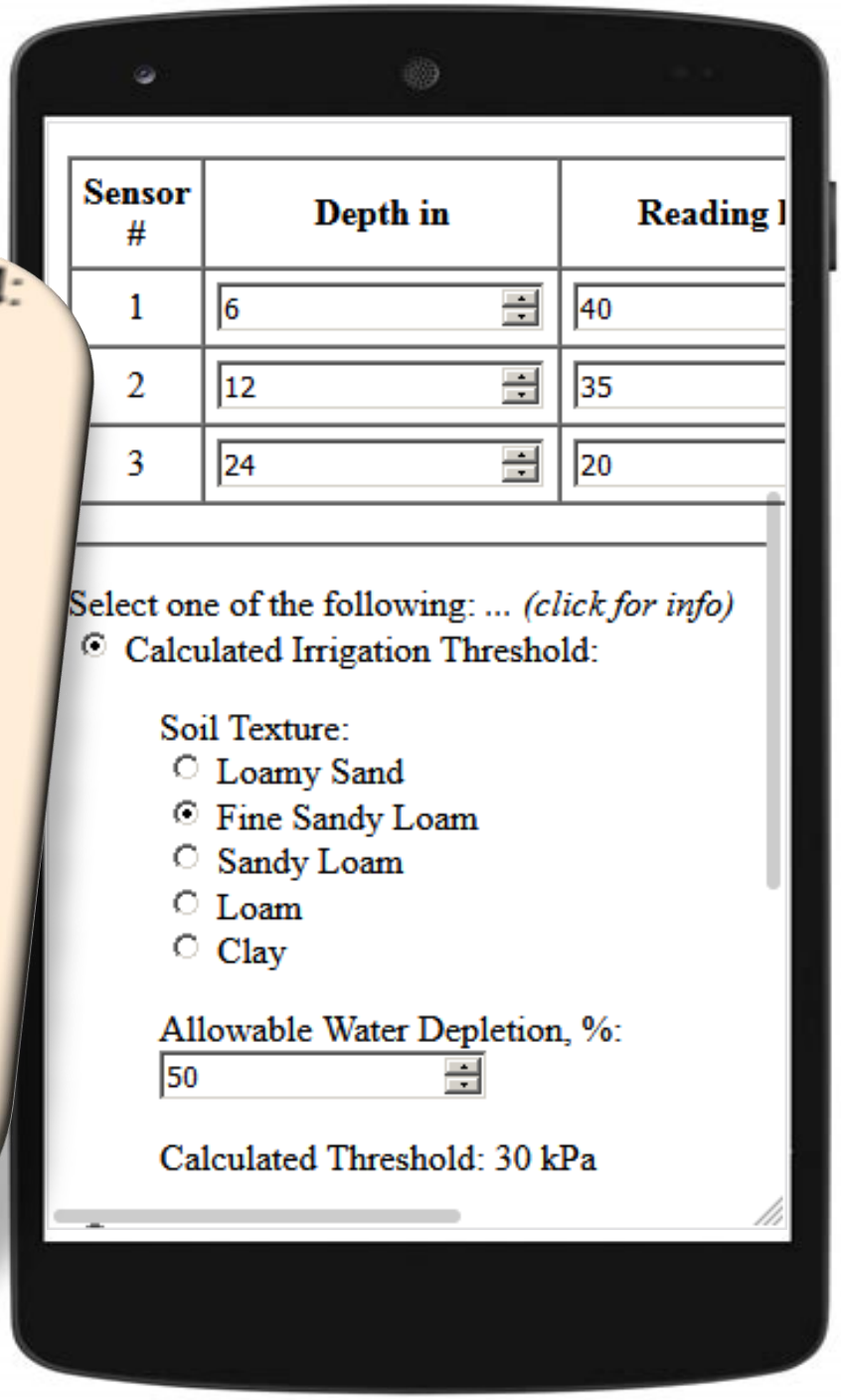
Watermark Calculator

Calculated Irrigation Threshold





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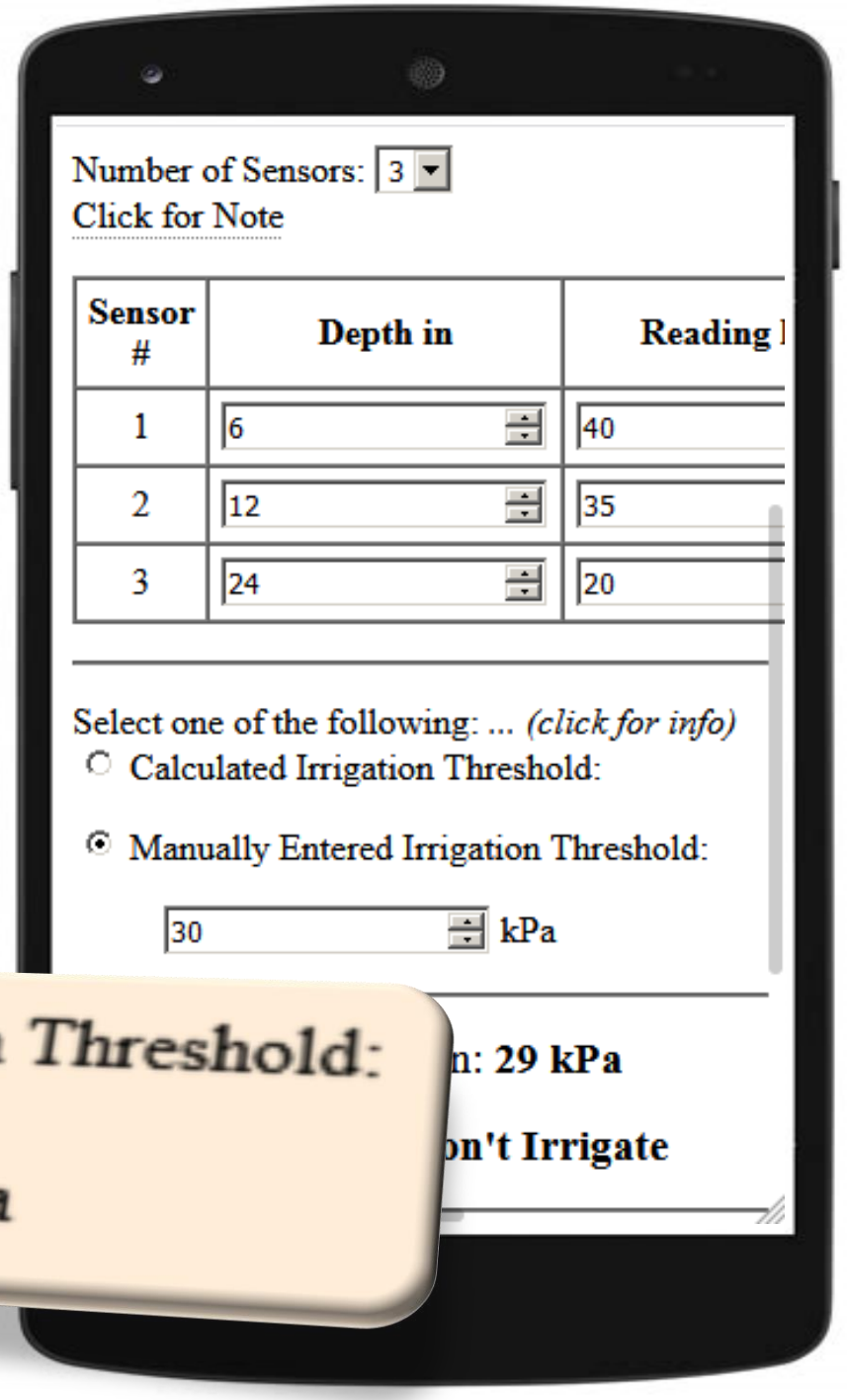
Watermark Calculator

Manual Irrigation Threshold



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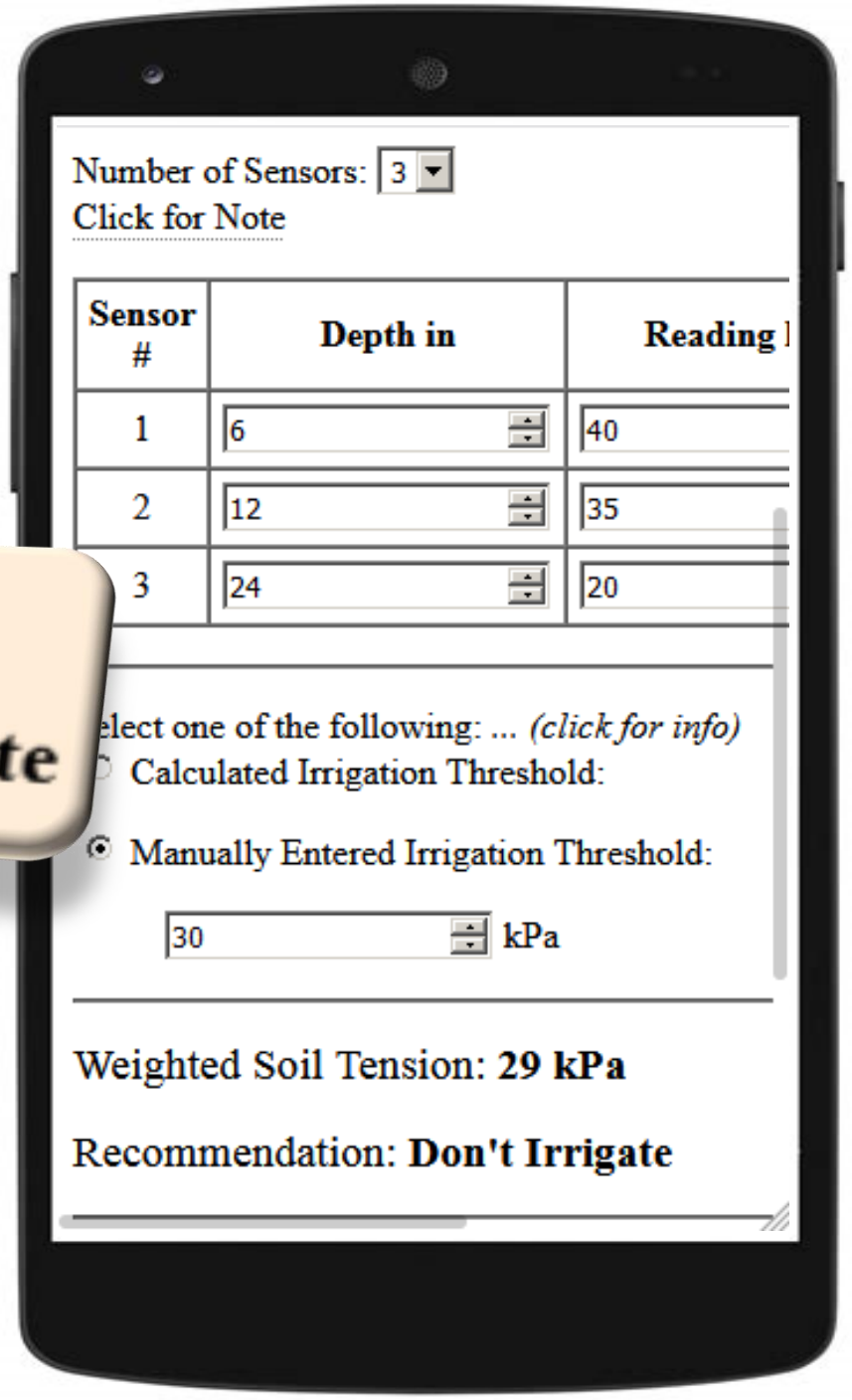
Watermark Calculator

Output: Irrigation Recommendation



Weighted Soil Tension: ***29 kPa***

Recommendation: ***Don't Irrigate***

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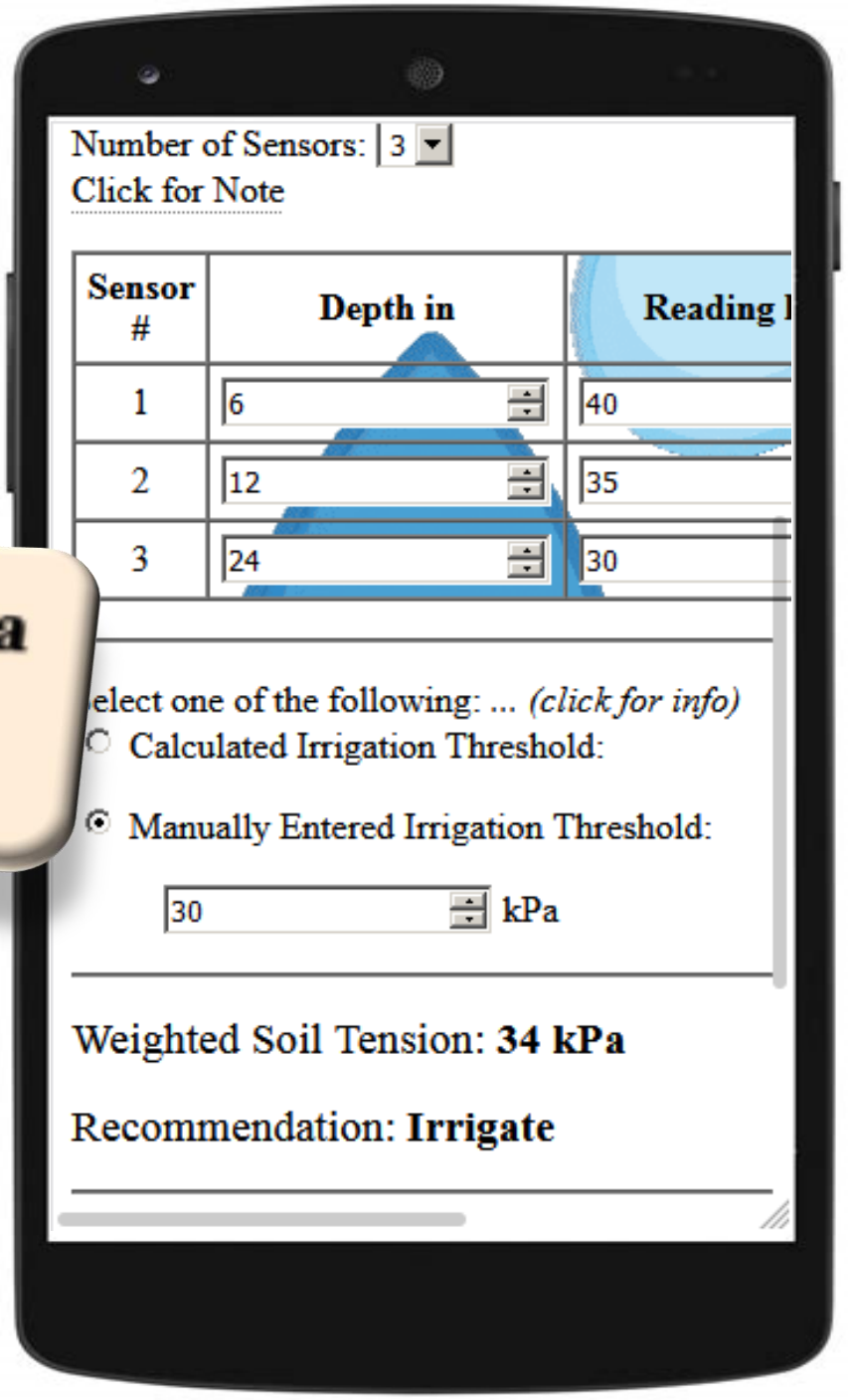
Watermark Calculator

Output: Irrigation Recommendation



Weighted Soil Tension: ***34 kPa***

Recommendation: ***Irrigate***

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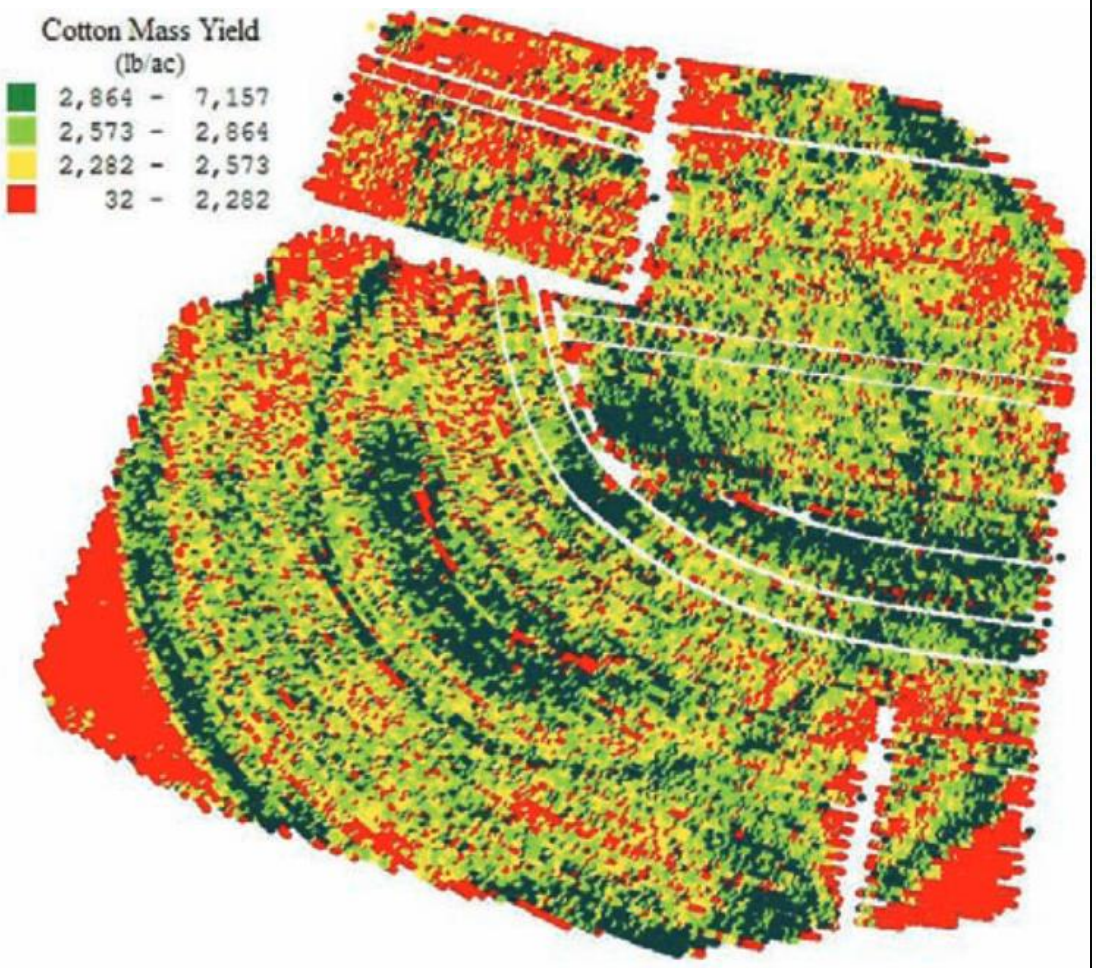
Irrigation System Assessment – Why???

- Components wear and malfunction with time
- Demonstrate cost-benefit of repairs
- Improve irrigation water use efficiency by 17% (SWFWMD)



Cotton Yield Maps:
Tools for Increasing Efficiency and Profitability
Cotton Inc.: Vellidis, Barnes, and Brannen, 2012

Center Pivot Irrigation Testing (CPIT) Program

- What is it?
  - Service for center pivot efficiency assessments
  - Similar programs in Florida, Georgia, others
- Short-Term: MIL Pilot Program funded by NRCS
  - ***Aiken SWCD***, NRCS, SCDNR, SCFB, Clemson University, and Ag South
  - Pre- and post-retrofit audits on 24 pivots in S.C.
  - Retrofits to quantify water savings potential
- Long-Term: Extension Service to S.C. growers
  - Clemson Extension: Water Resources and Agronomic Crops Teams
  - Software development by Clemson Precision Ag

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Center Pivot Irrigation Testing Pilot Program

- Provides S.C. growers with a “health checkup” on their center pivots (~2/3 of ag irrigation in S.C.)
- Information for better water management
  - Calibrated application depths
  - Endgun shutoff recommendations
  - Soil moisture sensor placement
  - Cost of irrigating a particular depth
  - Cost of under- and over-irrigation
- Information to drive improvements
  - Increased profitability
  - Increased irrigation water use efficiency
  - Support for cost-share programs

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Clemson Center Pivot Irrigation Test (CPIT) program

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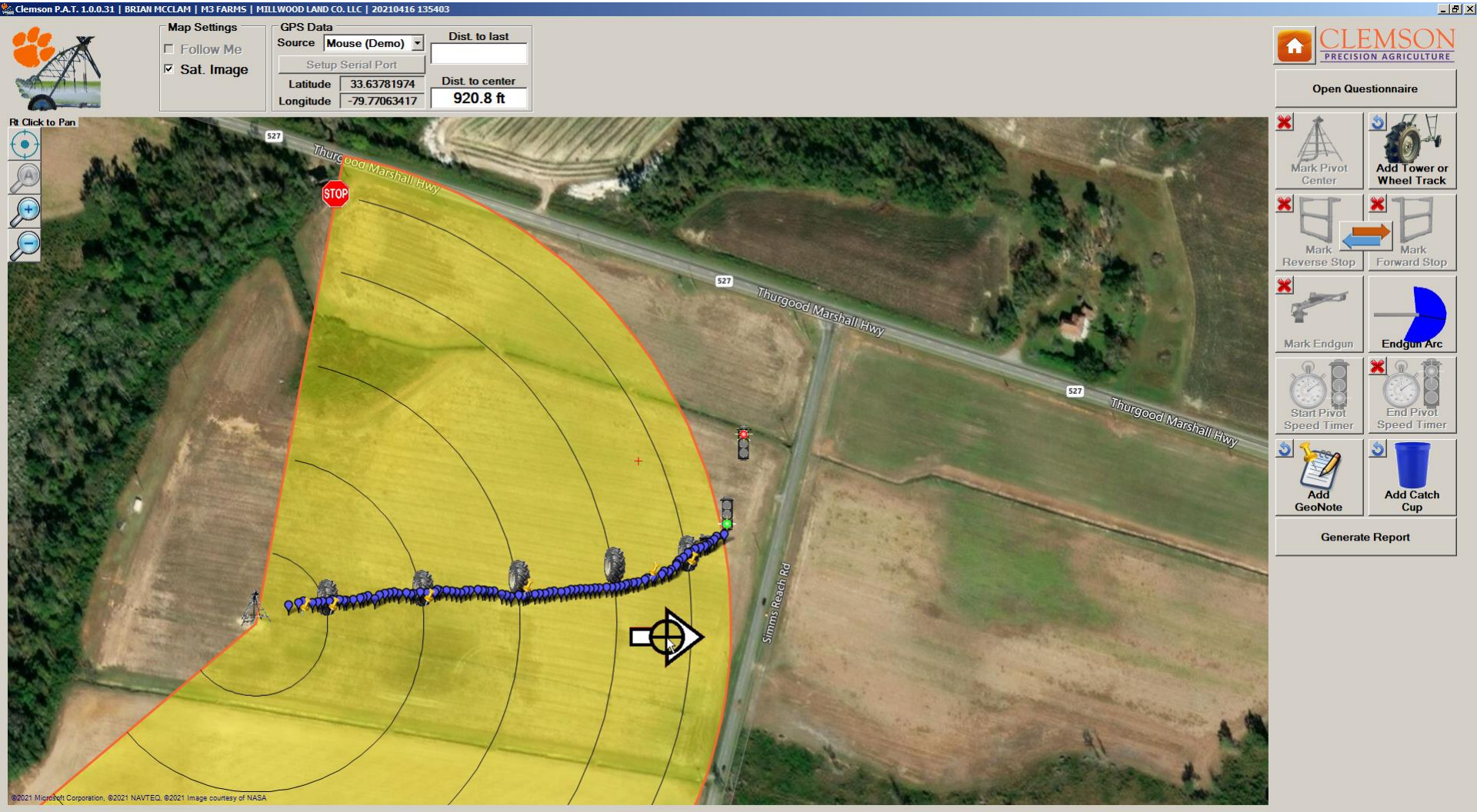
CPIT Screenshot: Data Collection Screen



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CPIT Report

General System Information

WATEREE PRISON FARM | DURAI | DURAI 1 | 3/30/2021

Pivot Description

Pivot Make: VALLEY
Controller Make: VALLEY
Sprinkler Make: NELSON
Sprinkler Model: ROTATOR
Pivot Age: 8 yr
Sprinkler Age: 8 yr
Number of Spans: 4
Sprinkler Height: 6 ft

Pivot Options

Chemigation/Fertigation: No
Endgun: Yes
Regulators: Yes, bottom of drops
Swing Arm: No
Variable Frequency Drive: No

Pump Description

Water Source: Groundwater/Well
Booster Pump: Yes
Phase Converter: No
Variable Frequency Drive: No

Energy Consumption

Energy Source: Electricity - Three Phase
Assumed Energy Cost: $0.057/kWh
Metered Rate: 22.0 kWh/hr
Irrigation Cost: $1.954/acre-inch
Irrigation Cost: $85.28/inch @ 44 ac

CPIT Report

General System Information

WATEREE PRISON FARM | DURAI | DURAI 1 | 3/30/2021

System Dimensions

Wetted Area: 43.6 ac
Machine Area: 36.6 ac
Machine Travel: 360 deg
Endgun Area: 7 ac @100%
Machine Length: 711.9 ft
Endgun Throw: 66.0 ft
Wetted Radius: 777.9 ft
Endgun Centerline: 0 deg
Endgun Sweep: 180 deg

Flow Rate

Design Flow: 400 gpm
Meter Flow: N/A
Caught Flow: 290.4 gpm
App. Rate: 6.65 gpm/ac
App. Rate: 0.35 in./day
App. Rate: 2.5 in./wk
App. Depth: 0.060 in.@100%

Pressure

Design: 65 psi @ pivot
Observed: 40 psi @ pivot
Observed: N/A @ end

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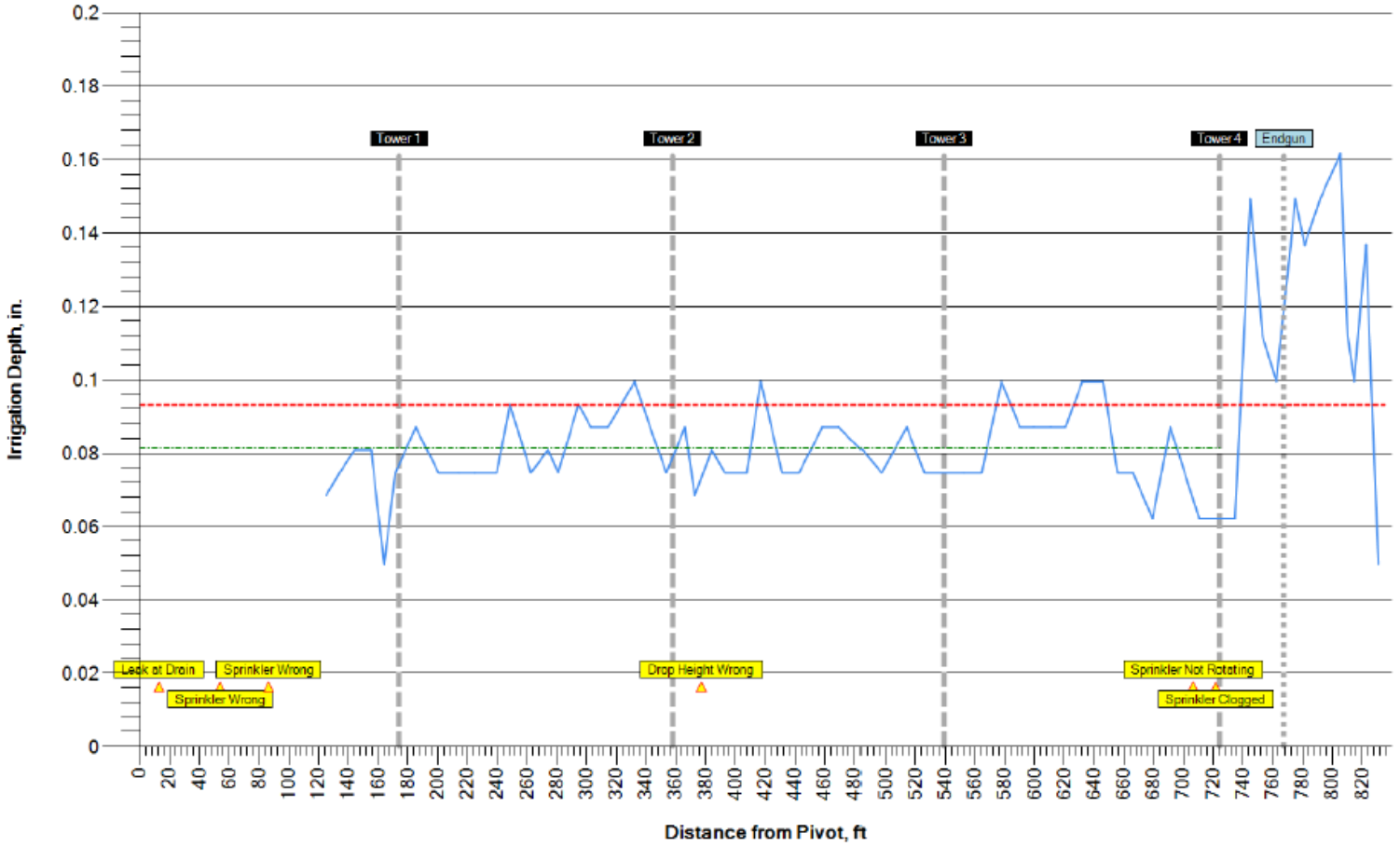
Irrigation Uniformity

WATEREE PRISON FARM | DURAI | DURAI 2 | 3/30/2021

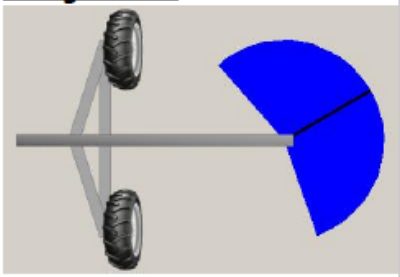


Catch Cups

Overall Avg. (0.093 in.)

Avg. Inside Last Tower (0.081 in.)

Endgun Arc



Irrigation Uniformity

CU_HH to Last Tower: 0.89
CU_HH Total System: 0.77
LQDU to Last Tower: 0.86
LQDU Total System: 0.77

CU_HH Interpretation

Good. Sprinkler package changes not likely to be profitable.

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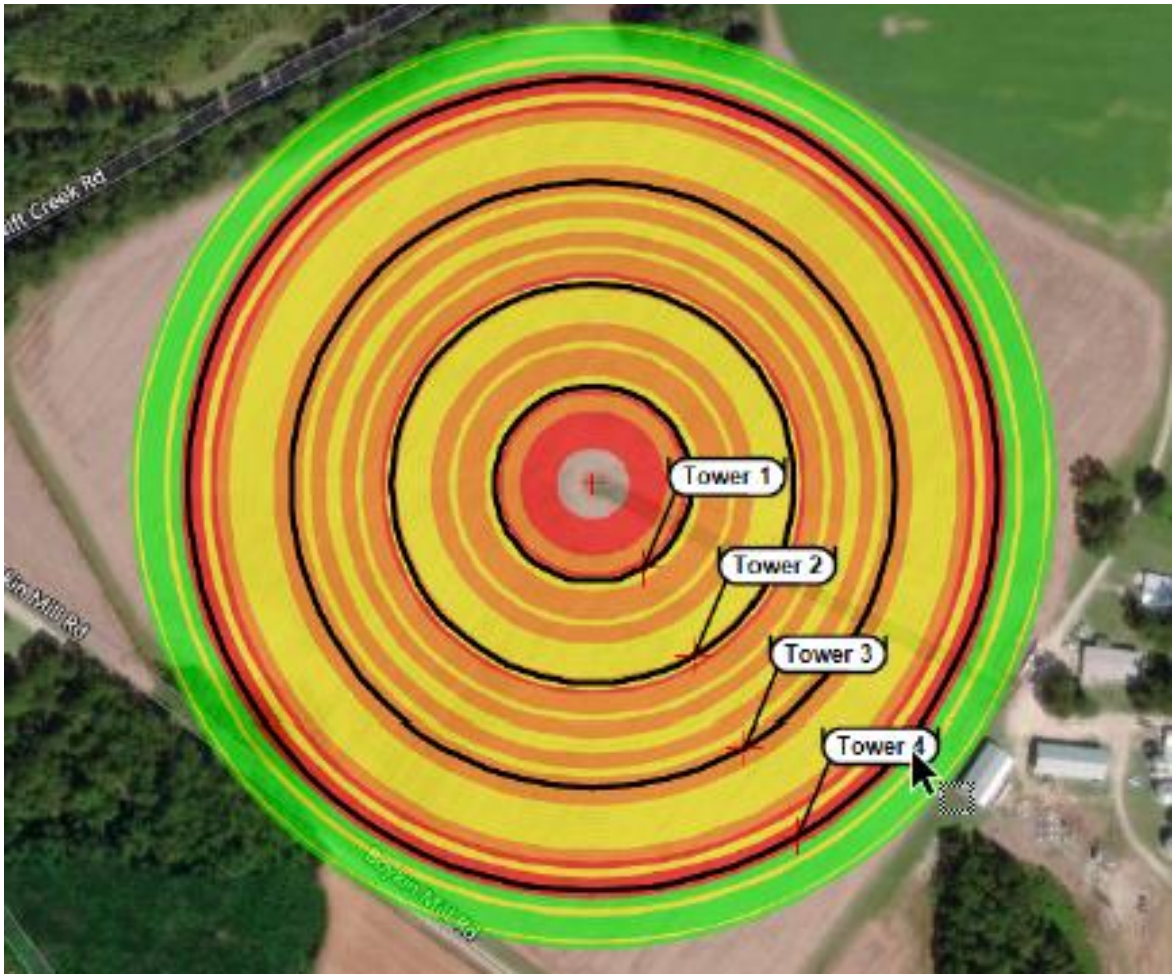
Application Depth Map

WATEREE PRISON FARM | DURAI | DURAI 2 | 3/30/2021



Depth Compared to Average

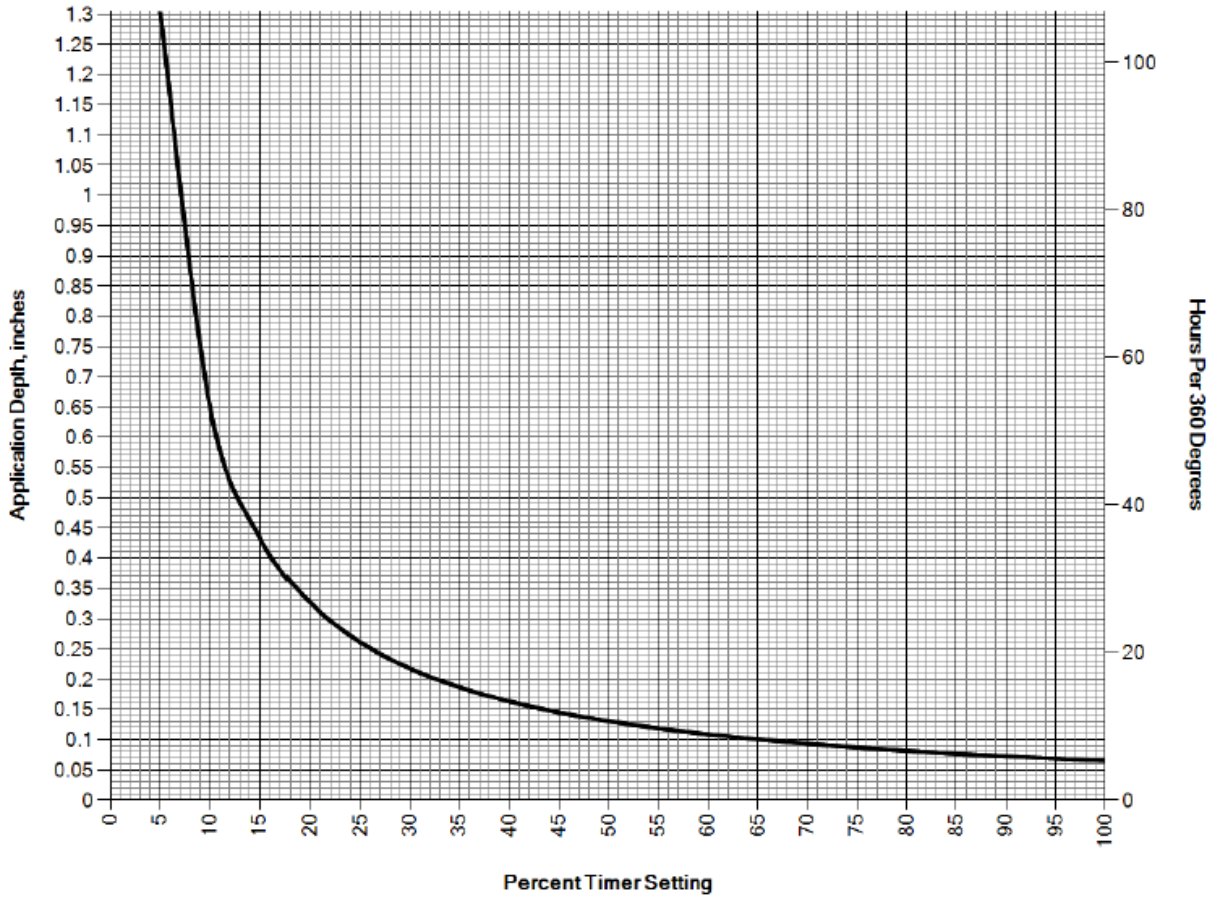
- > 120%
- 110% - 120%
- 90% - 110%
- 80% - 90%
- < 80%

CPIT Report

Calibrated Timer Chart

WATEREE PRISON FARM | DURAI | DURAI 2 | 3/30/2021

Timer Setting %	Inches App.	Hrs Per 360 Deg	Acres Per Min
100	0.07	5.3	0.157
95	0.07	5.6	0.149
90	0.07	5.9	0.141
85	0.08	6.3	0.133
80	0.08	6.7	0.126
75	0.09	7.1	0.118
70	0.09	7.6	0.110
65	0.10	8.2	0.102
60	0.11	8.9	0.094
55	0.12	9.7	0.086
50	0.13	10.7	0.078
45	0.14	11.9	0.071
40	0.16	13.4	0.063
35	0.19	15.3	0.055
30	0.22	17.8	0.047
25	0.26	21.4	0.039
20	0.33	26.7	0.031
15	0.43	35.6	0.024
10	0.65	53.4	0.016
5	1.30	106.8	0.008



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Irrigation Economics

WATEREE PRISON FARM | DURAI | DURAI 2 | 3/30/2021

Estimated Cost of Suboptimal Irrigation

Estimates below are as compared to a system with CU_HH = 93%. Estimates do not consider uniformity beyond the last tower. Assumed irrigation cost: $7.00 / ac-in. Estimated cost to retrofit sprinkler package for this pivot at $5/ft is $3,622. Costs to retrofit are dependent on a number of factors...consult your supplier. Estimated payoff period for retrofitting: 13.0 years.

Crop Name	Assumed Yield Benefit from Irrigation	Assumed Crop Value	Assumed Annual Irrigation, Inches	Annual Cost of Under-Irrigation	Annual Cost of Over-Irrigation	Total Sub-Optimal Irrigation Cost	Total Sub-Optimal Irrigation Cost
Corn for grain	67.7 bu/ac	$3.98 / bu	7.6	$236	$42	**$278**	**$6.54 / ac**
Full Crop Rotation			7.6	$236	$42	**$278**	**$6.54 / ac**

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Endgun Shutoff Recommendation

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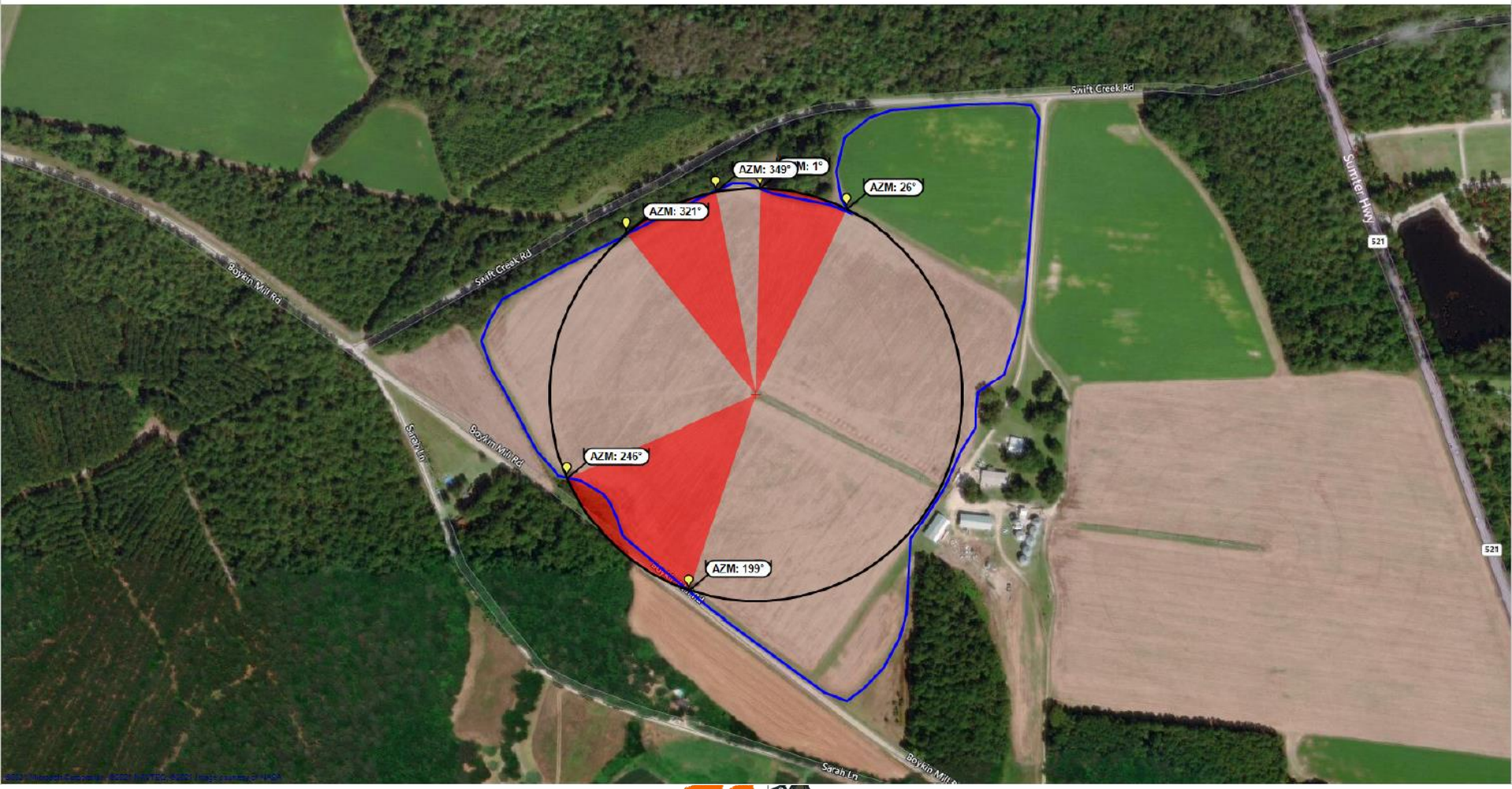

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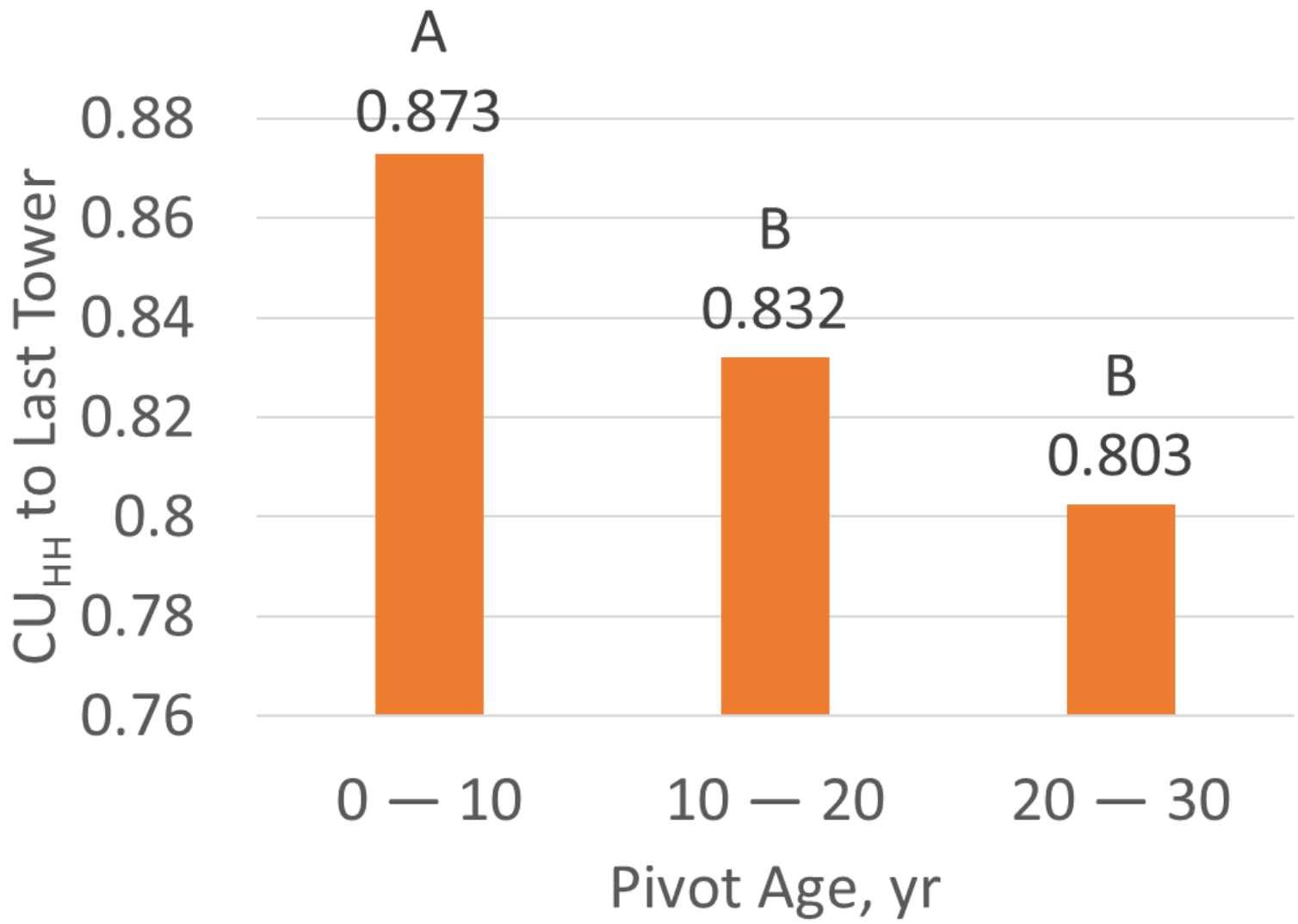
CPIT Program Update

- Launched in February 2022
- Water Resources and Agronomic Crops agents trained in every (relevant) S.C. county
- Test kits distributed throughout the state
- >140 center pivots tested to-date
- NRCS-EQIP cost share for sprinkler package retrofits
- P.A.T. software may be made publicly available
- Anonymized, aggregated database from test results

Aggregated CPIT Data: Uniformity vs. Age



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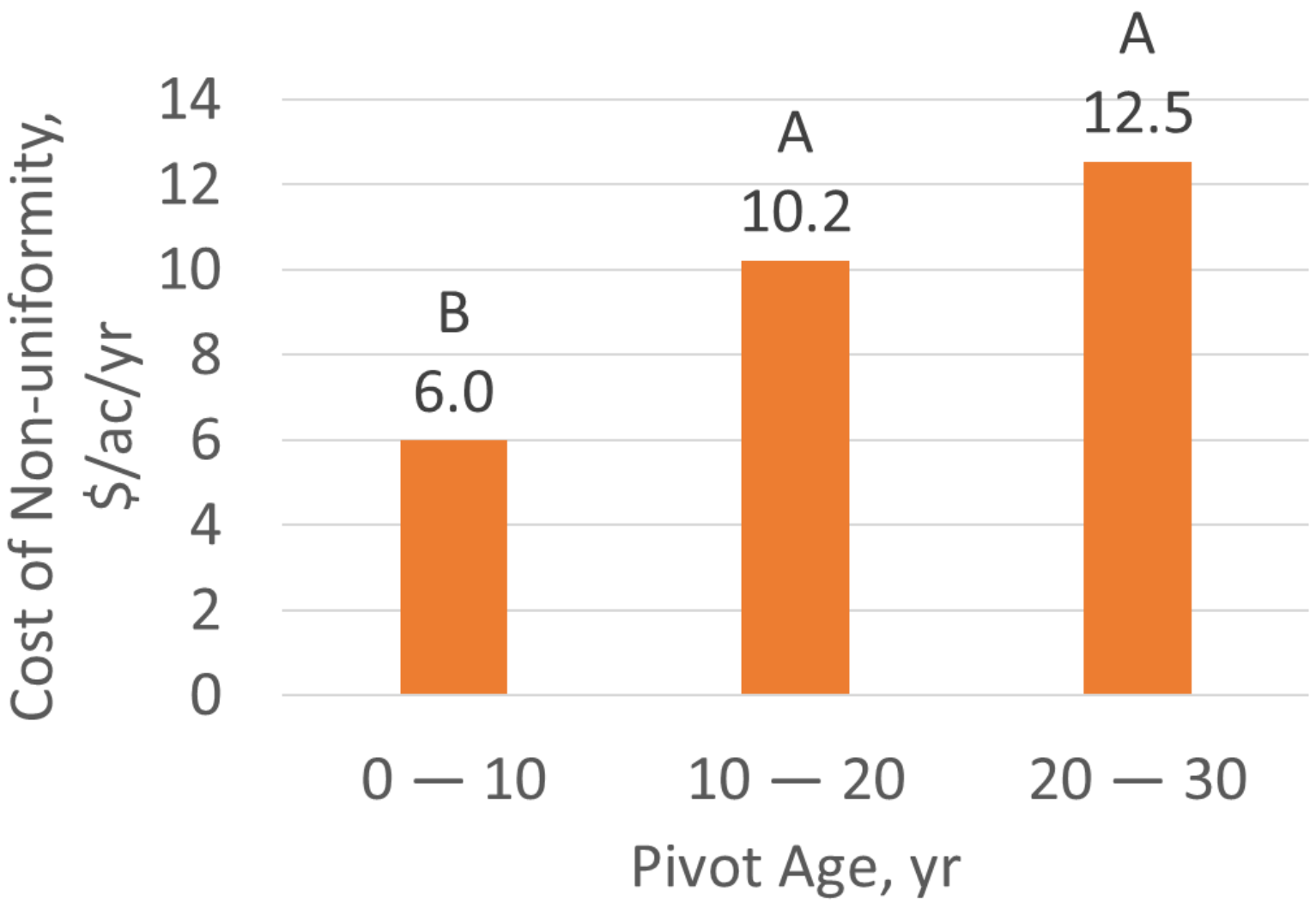
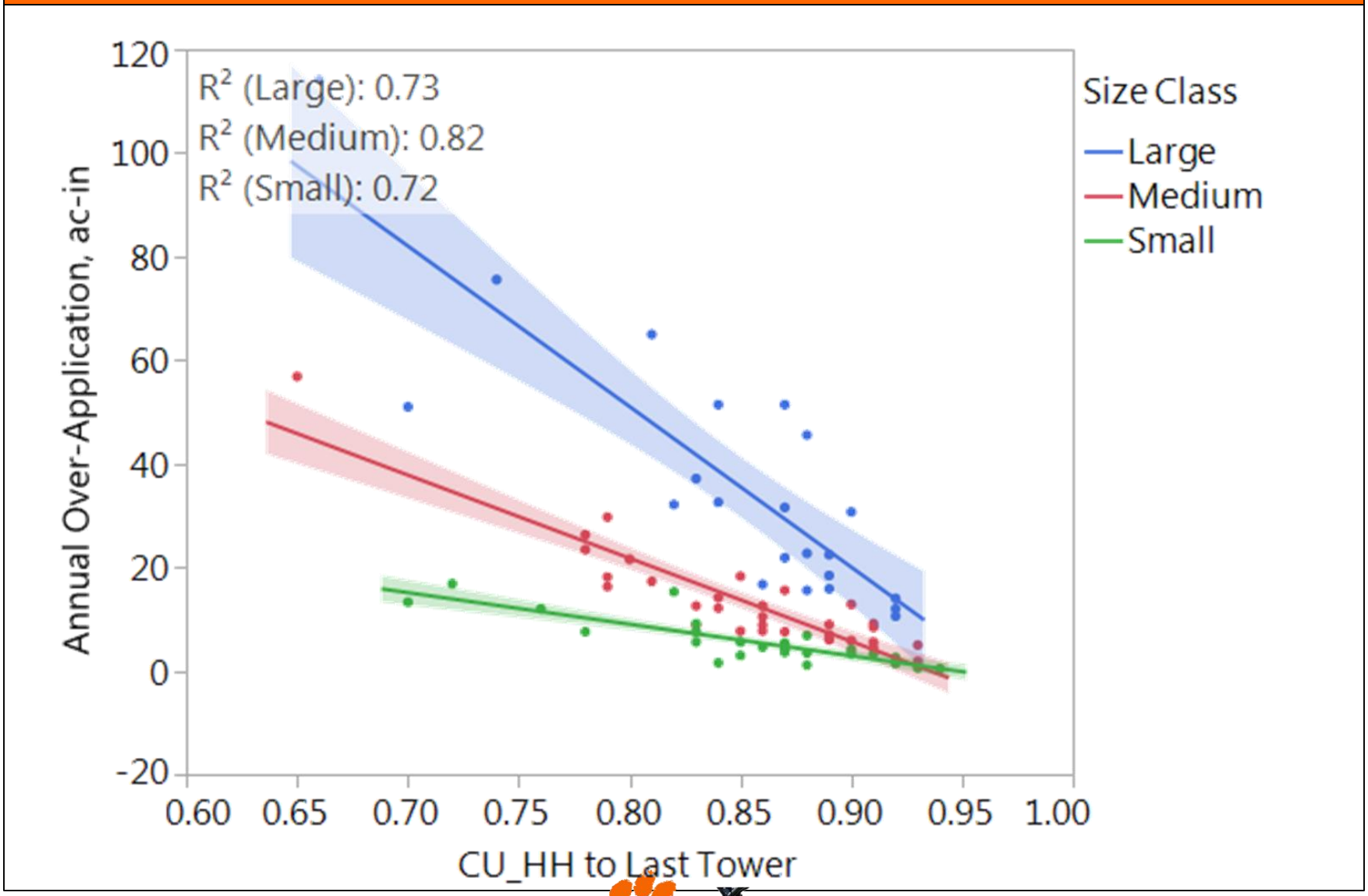
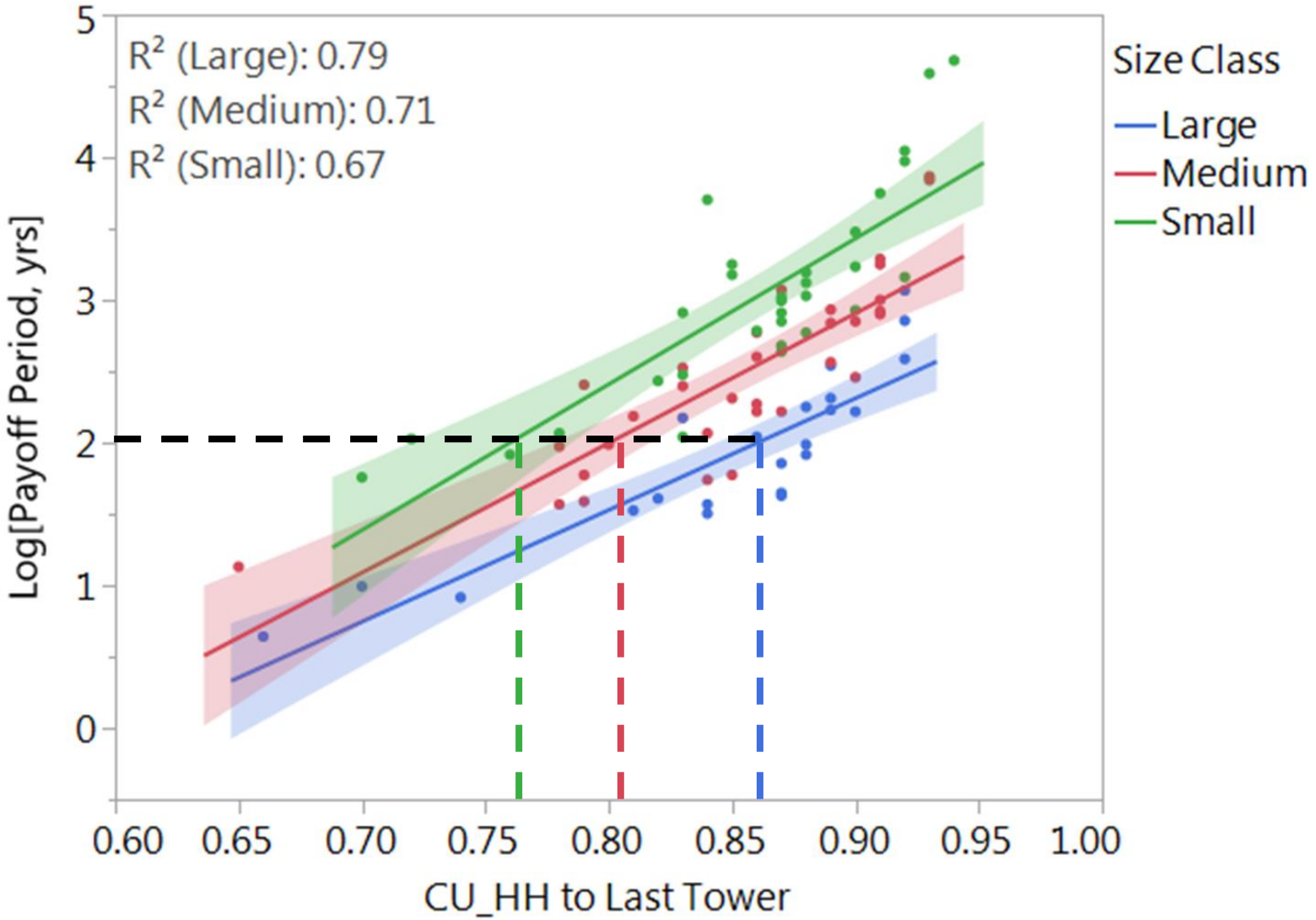
Aggregated Data: Nonuniformity Cost vs. Age



Aggregated Data: Over-application vs. CU_{HH}



Aggregated Data: Threshold CU_{HH} & Pivot Size



Outline

1. Center Pivot Mapping Software
2. Drip Fertigation Calculator
3. Center Pivot Fertigation Calculator
4. Center Pivot Irrigation Testing Extension Program
5. Watermark Soil Moisture Calculator
6. **Other Edisto REC Water/Irrigation Work**

Edisto REC Irrigation Research

- Jose Payero, Irrigation Specialist
  - Sensor/weather telemetry
  - Irrigation scheduling
  - Evapotranspiration
  - Drip Irrigation
  - Variable Rate Irrigation
- Michael Plumblee, Corn & Soybean Specialist
  - Soil moisture sensor thresholds for irrigation scheduling
- Gilbert Miller
  - Drip irrigation and fertigation
  - Soil moisture sensing
- Multiple Researchers
  - Cover crop research

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Questions?

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