Web-Based Tool for Irrigation Scheduling

Shar Siddiqui, Eduardo Carrascal, Rachel Lo, Bryan Gutierrez
UF Department of Agricultural and Biological Engineering

Design Goal

Quantitatively analyze the water supply requirements of a small-scale organic farm in North Florida to:

- Calculate sufficient water supply for expected consumption needs
- Optimize irrigation effectiveness to ensure all plants receive sufficient water

Figure 1: Location of project site, Easeland Organic Farm in Live Oak, FL.

Motivation

- Optimize water resources to improve sustainability and efficiency of farm
- Dually provide real-world engineering training to graduating senior engineers and consultancy services to farm

Project Objectives

1. Calculate irrigation needs for each crop on farm
2. Create custom calculator tool that provides weekly irrigation schedule for farm
3. Recommend upgrades to current irrigation infrastructure

Project Site

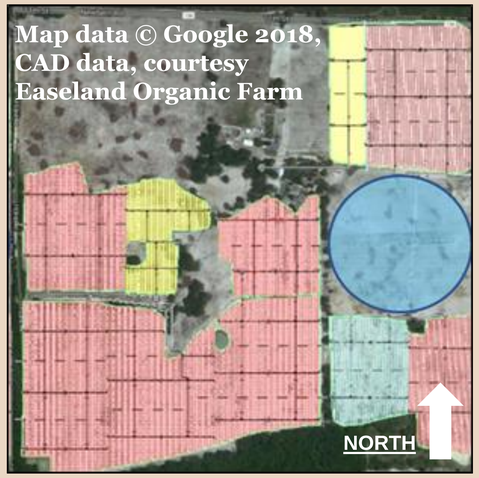

Figure 2: The 520-acre farm's current irrigation infrastructure includes a pivot (shown in blue), two wells and micro-sprinklers (shown in red and yellow) supplied by two wells.

Design Details

Water balance equation → water supply requirements

$$I = K_c ET_O - P_e$$

Where I is irrigation required for a crop, K_c is the crop coefficient, ET_0 is the historical monthly average for the FL wet or dry season, and P_e is the effective precipitation

Using the water balance equation, and weather data taken from the Florida Automated Weather Network (FAWN) (Figure 2), the irrigation needs for crops on the farm were determined for a month in the FL wet season (June - Oct) and dry season (Nov - May) (Figure 3).

Average 1998-2017 FAWN data (mm/mo)	
Wet season P_e	70
Wet season ET_o	108
Dry season P_e	44
Dry season ET_o	69

Figure 3

Crop	Crop coefficient	Wet season I (mm/mo)	Dry season I (mm/mo)
Persimmon	0.9	27	18
Pecan	1.95	140	90
Oranges	0.87	24	16
Kale	1.1	43	28
Ginger	1	38	25
Jujube	0.74	10	7

Figure 4

Proposed Design

- Script-enhanced Google Sheet reports irrigation event frequencies and timings specific to each zone at this farm
- Incorporates 7-day predicted ET data, pump and infrastructure variables, crop coefficients and growth stages
- Values programmed weekly to farm's irrigation system

	A	B	C	D	E	F
1	Easeland Organic Farm - Evapotranspiration-Guided Irrigation Calculator					
2	Well 1 - "Mary"					
3	Zone:	Frequency [Events/Week] :	Cycles:	Speed (% of max):	Update FRET	
4	Pivot - "Kale & Ginger"	1	1	100		
5	Zone:	Frequency [Events/Week] :	Duration [min]:			
6	M1 - "U-Pick"	2	10		FRET Data [Hover & Click]	
7	M2 - "Citrus"	2	12		https://digital.weather.gov/rr.con	
8	M3 - "Persimmon"	4	20			
9	M4 - "Persimmon 2"	4	22		This calculator will determine on a weekly basis the duration to program for each zone on wells "Bob" and "Mary" for each of their zones on the Rainbird controllers.	
10	Well 2 - "Bob"					
11	Zone:	Frequency:	Duration:		To use the calculator, please update the Future Reference Evapotranspiration Value (FRET) using the button and link above, and if needed, crop and crop stage coefficients and zone constituencies in the backend. The values should auto calculate to new values to program the zone for the next 7 days. Note that pivot instructions refer to cycle's and approximate speed.	
12	B1 - "Pecan 1"	4	22			
13	B2 - "Pecan 2"	4	27			
14	B3 - "Pecan 3"	4	26			
15	B4 - "Satsuma Oranges"	2	10			
16	B5 - "Jujube 1"	2	9			
17	B6 - "Jujube 2"	2	15			
18	B7 - "Pecan 4"	4	28			
19	B8 - "Expansion TBD"	TBD	TBD			
20					Please note the following restrictions:	
21					1. Without rainshutoff functionality, and/or some method of soil moisture determination thereafter, without intervention, you will be irrigating during and immediately after a rain event.	
22						
23					2. The predictive ET data from the NWS is assumed to be functional, accurate, and	

Main Page | Map of Zones | Backend

Project Timeline

Task	1/15/18	1/22/18	1/29/18	2/5/18	2/12/18	2/19/18	2/26/18	3/5/18	3/12/18	3/19/18	3/26/18	4/2/18	4/9/18
Review proposed design project with faculty mentor								Spring Break					
Site Visit 1: Assess General and Specific Design Needs													
Gather farm specifications													
Finalize semester timelines													
Gather online data (soil, maps)													
Literature Review (water balance)													
Start GIS work - farm zoning													
Preliminary water balance table													
Standards lit review													
Finalize water balance map													
Site visit 2: get info on 8-in well center pivot													
Start friction loss calculations													
PowerPoint presentation and review													
Start pivot upgrade recommendations													
Site Visit 3: Final stakeholder design presentation													
Develop 8-inch center pivot irrigation schedule													
Results and statistics													
Gather stakeholder feedback													
Capstone Design Poster Showcase													
Video Abstract Submission													
Finalize report													

Acknowledgements

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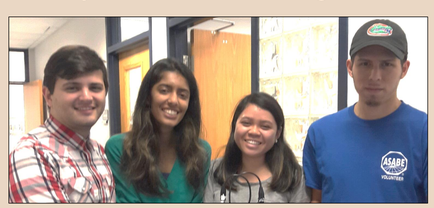

L to R: Bryan Gutierrez, Shar Siddiqui, Rachel Lo, Eduardo Carrascal