Sensor Strategies in Cotton

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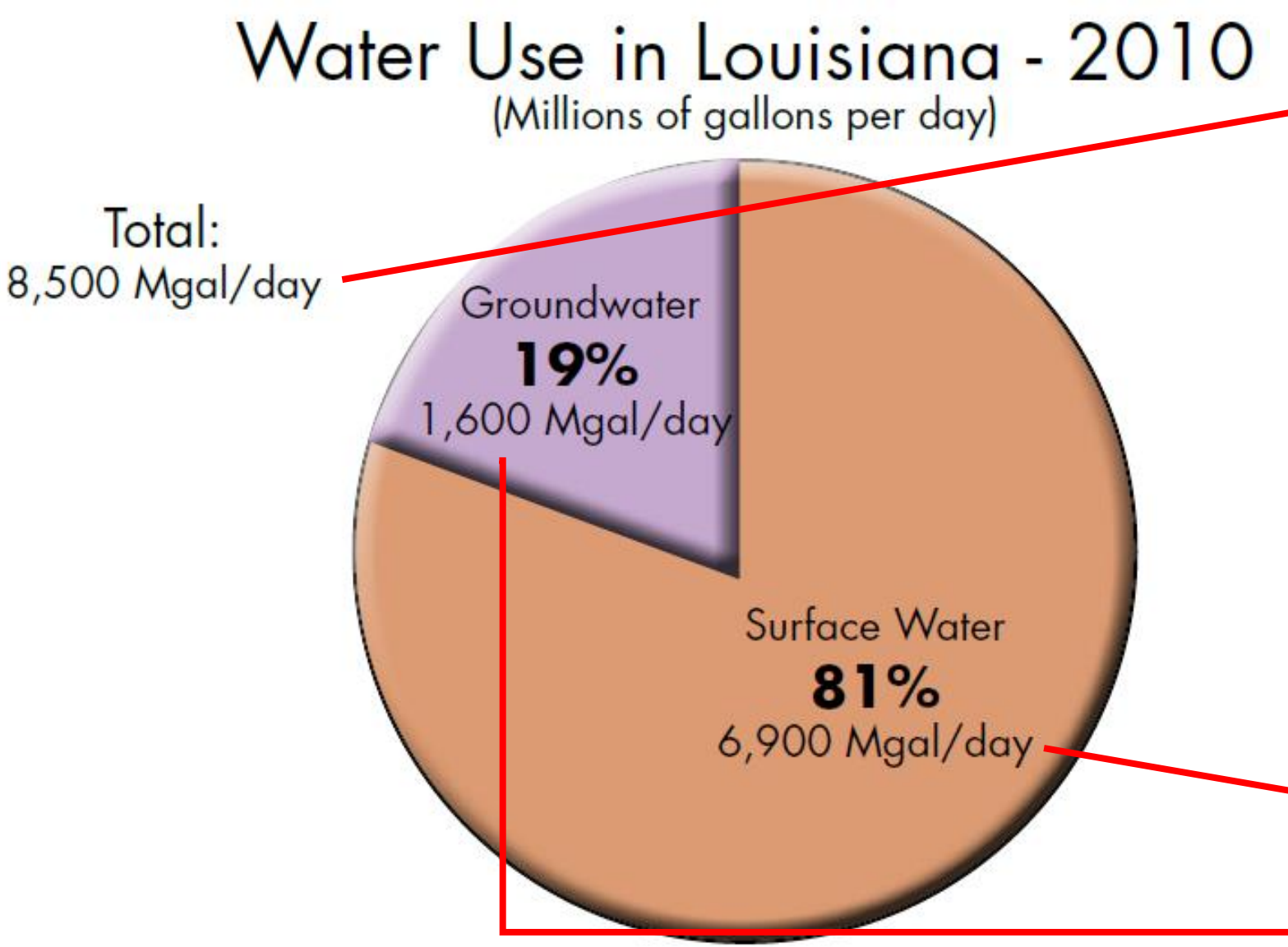
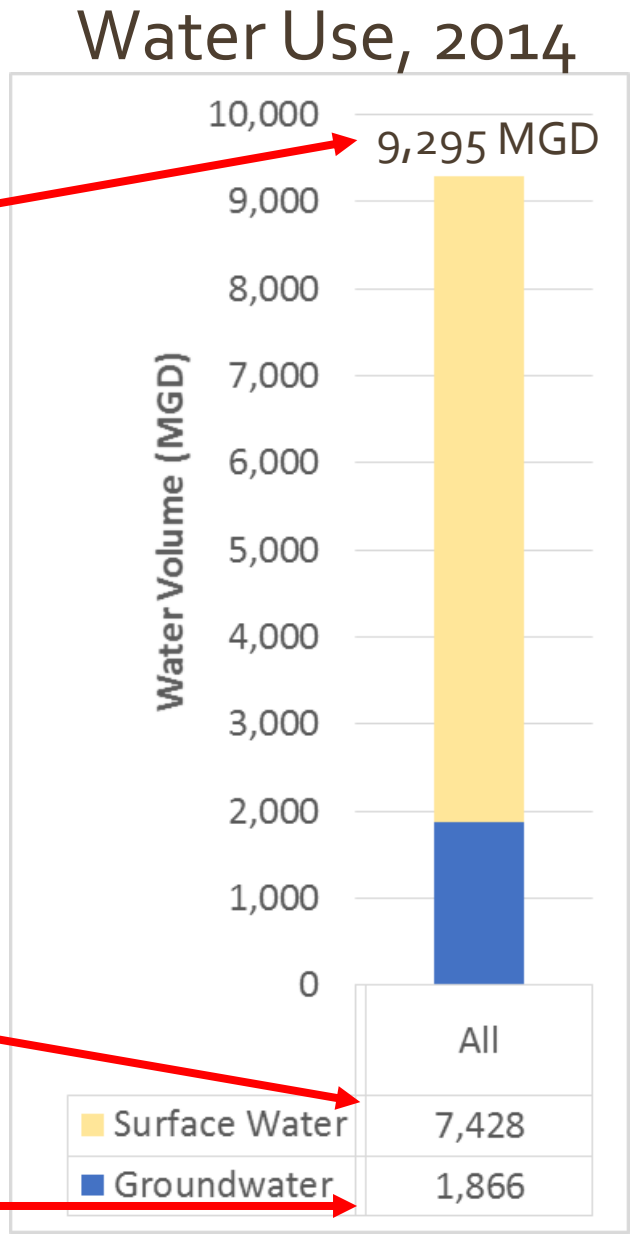
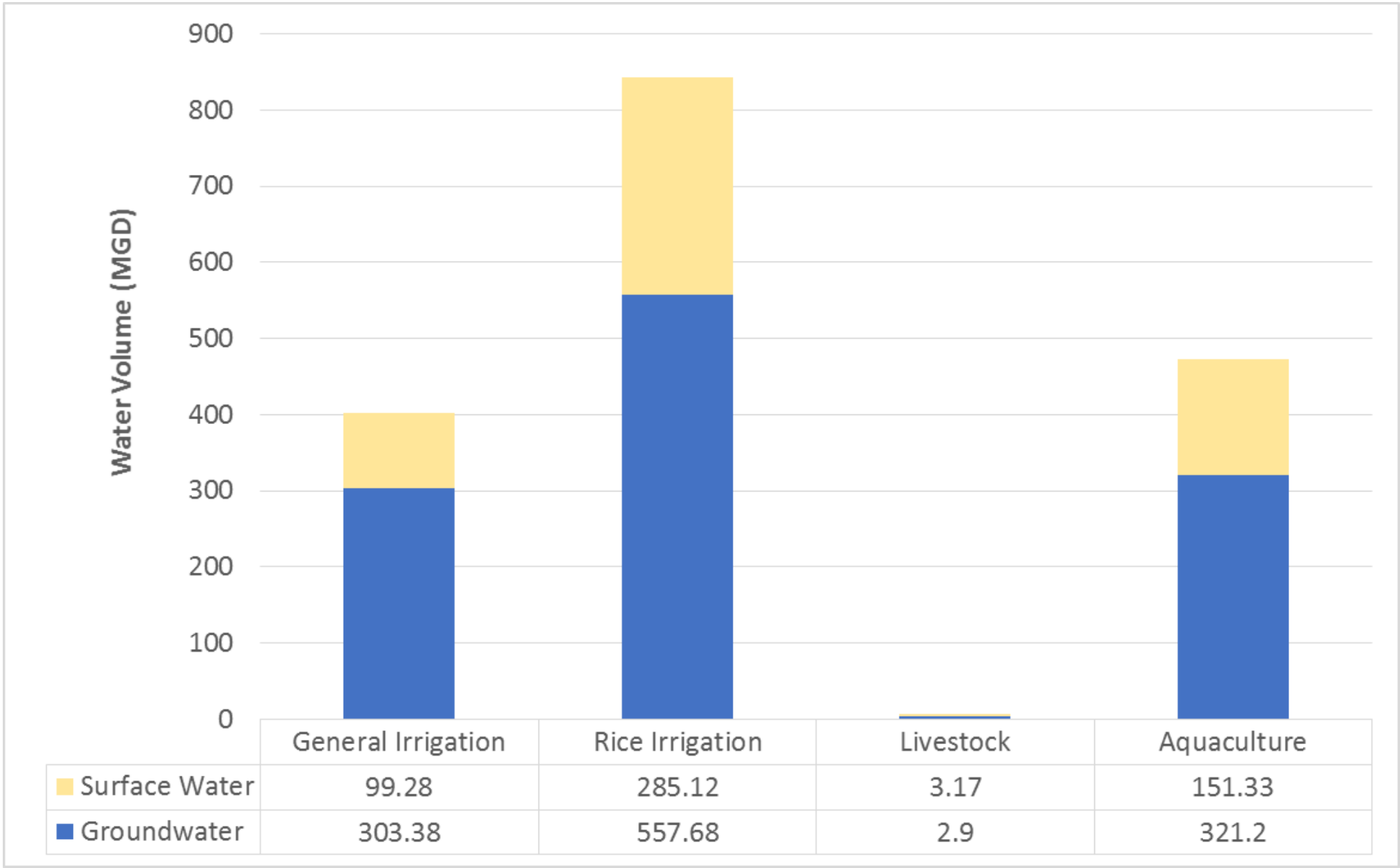
Introduction

- Comparing 2010 to 2014 totals…





Introduction

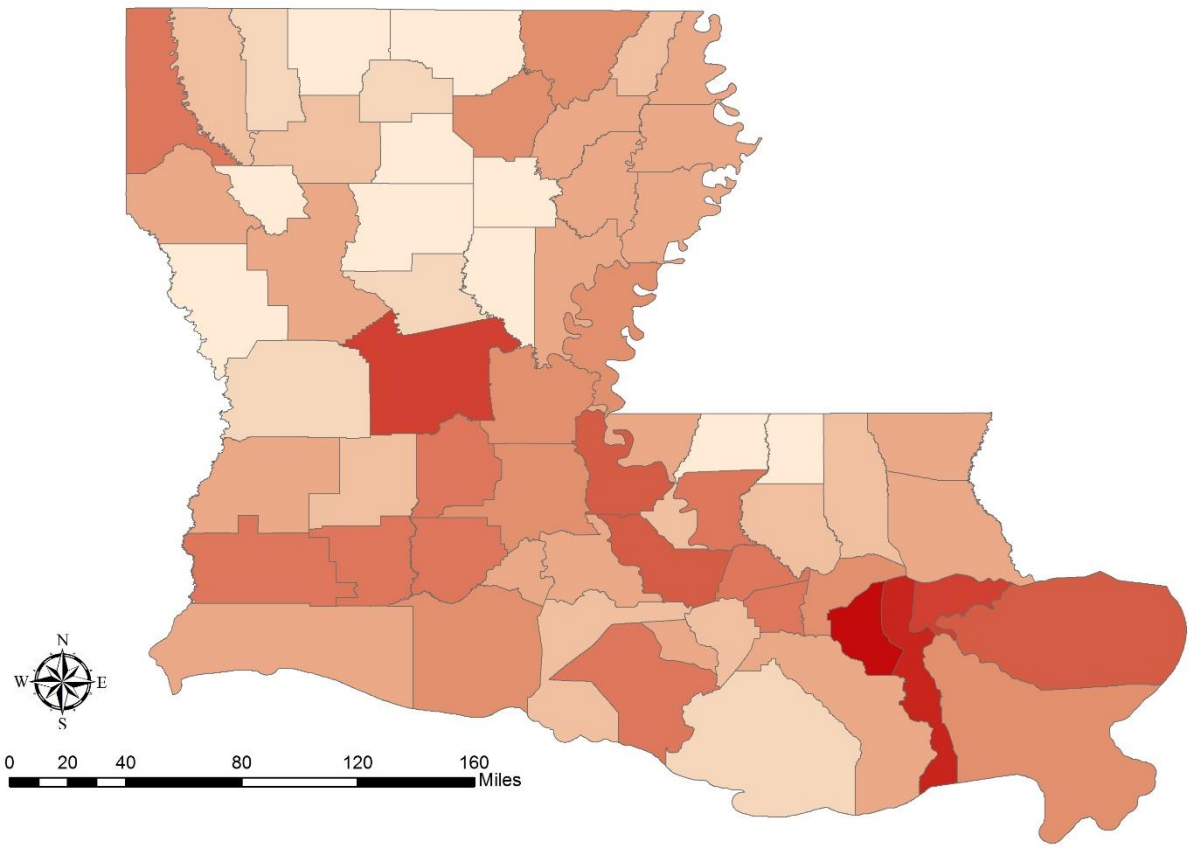


	General Irrigation	Rice Irrigation	Livestock	Aquaculture
Surface Water	99.28	285.12	3.17	151.33
Groundwater	303.38	557.68	2.9	321.2

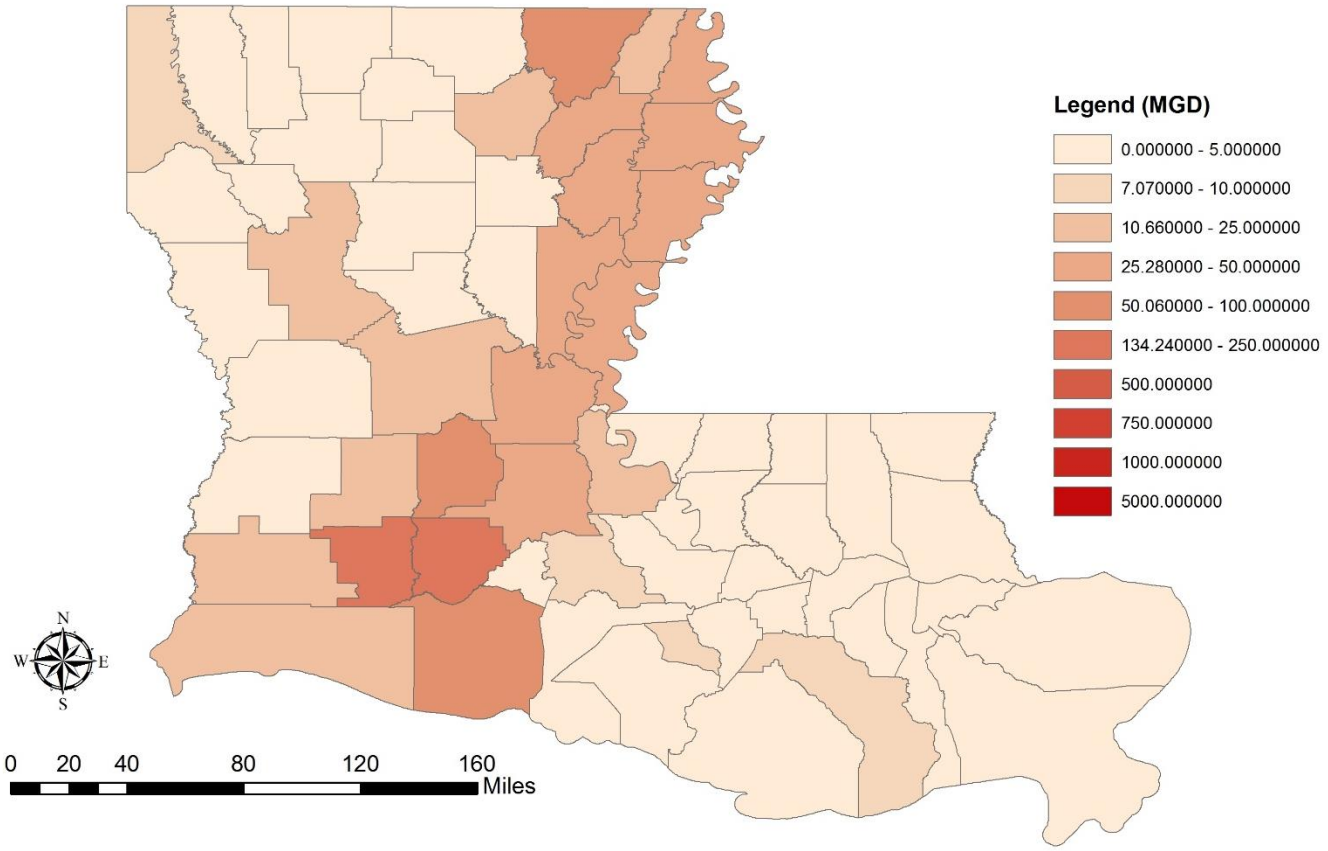
Introduction

- Same colors indicate significant irrigation use

Total (2010)



Total Irrigation (2010)



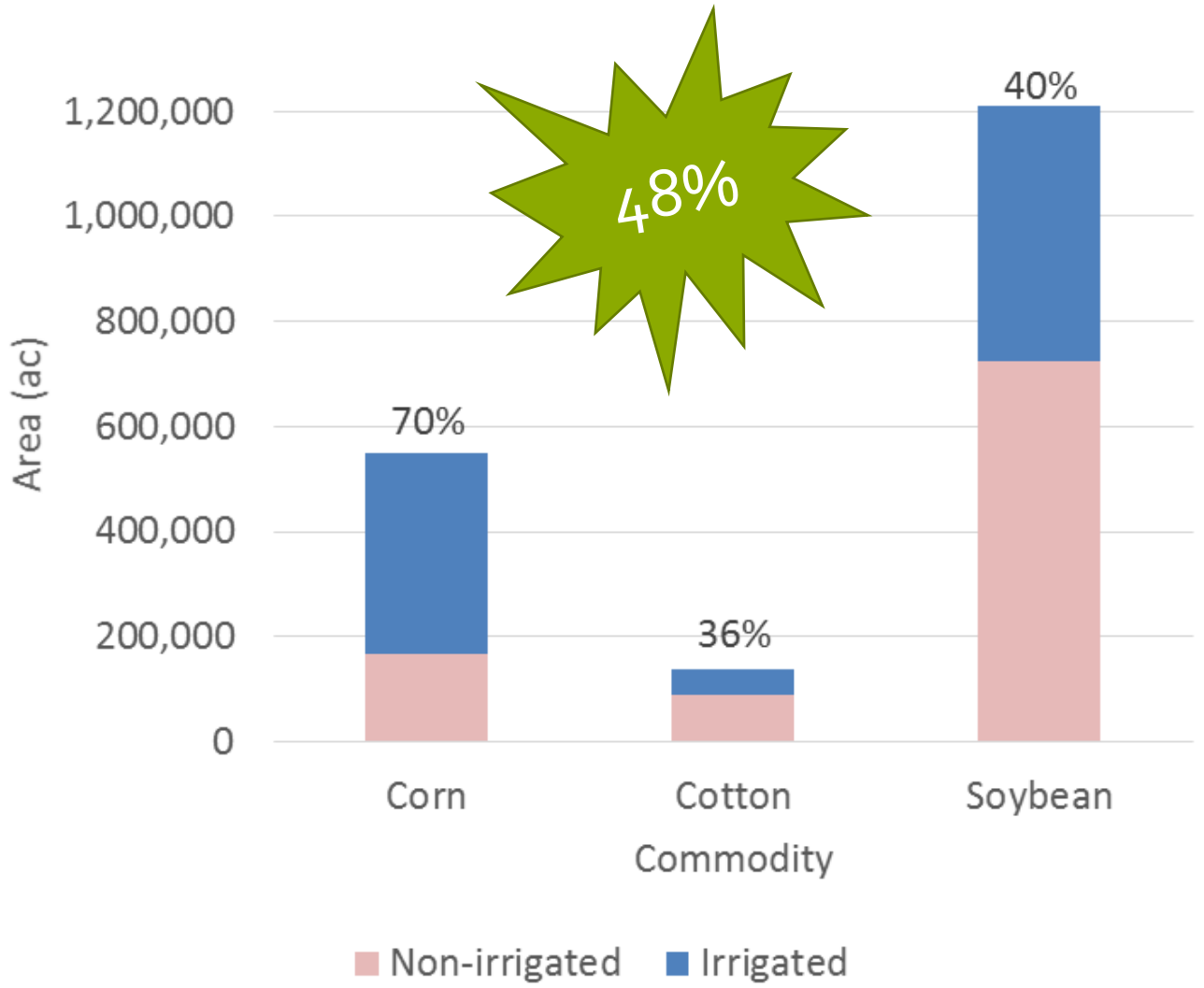
Introduction

- 43% of row crops are irrigated (based on available data in 2014)
  - 80% of irrigation systems are furrow

  - 20% of irrigation systems are center pivot

Introduction

- Louisiana irrigation on the rise
  - 2016 totals – 36 inches of rain, March - September



Soil Water Relationships

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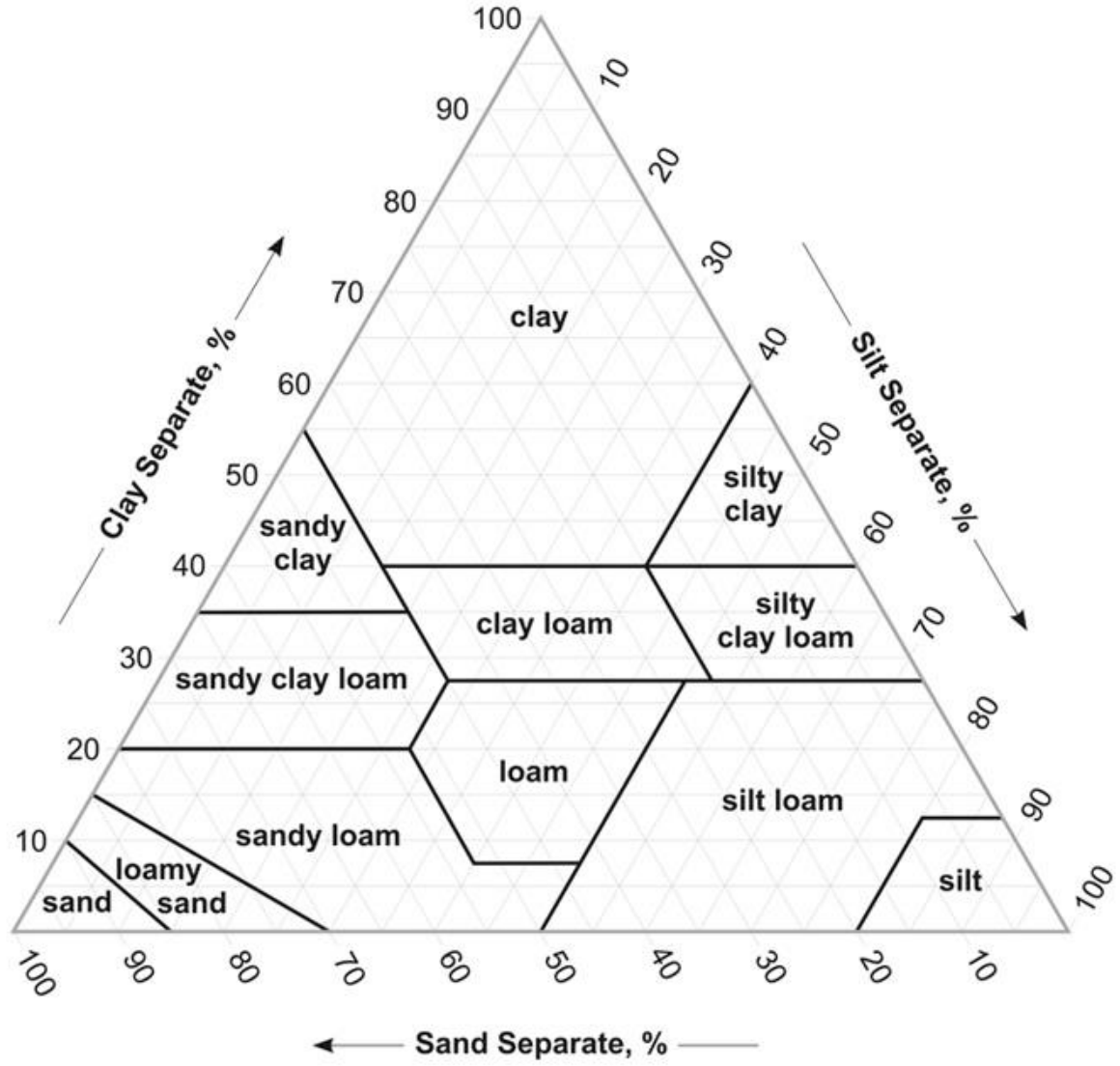
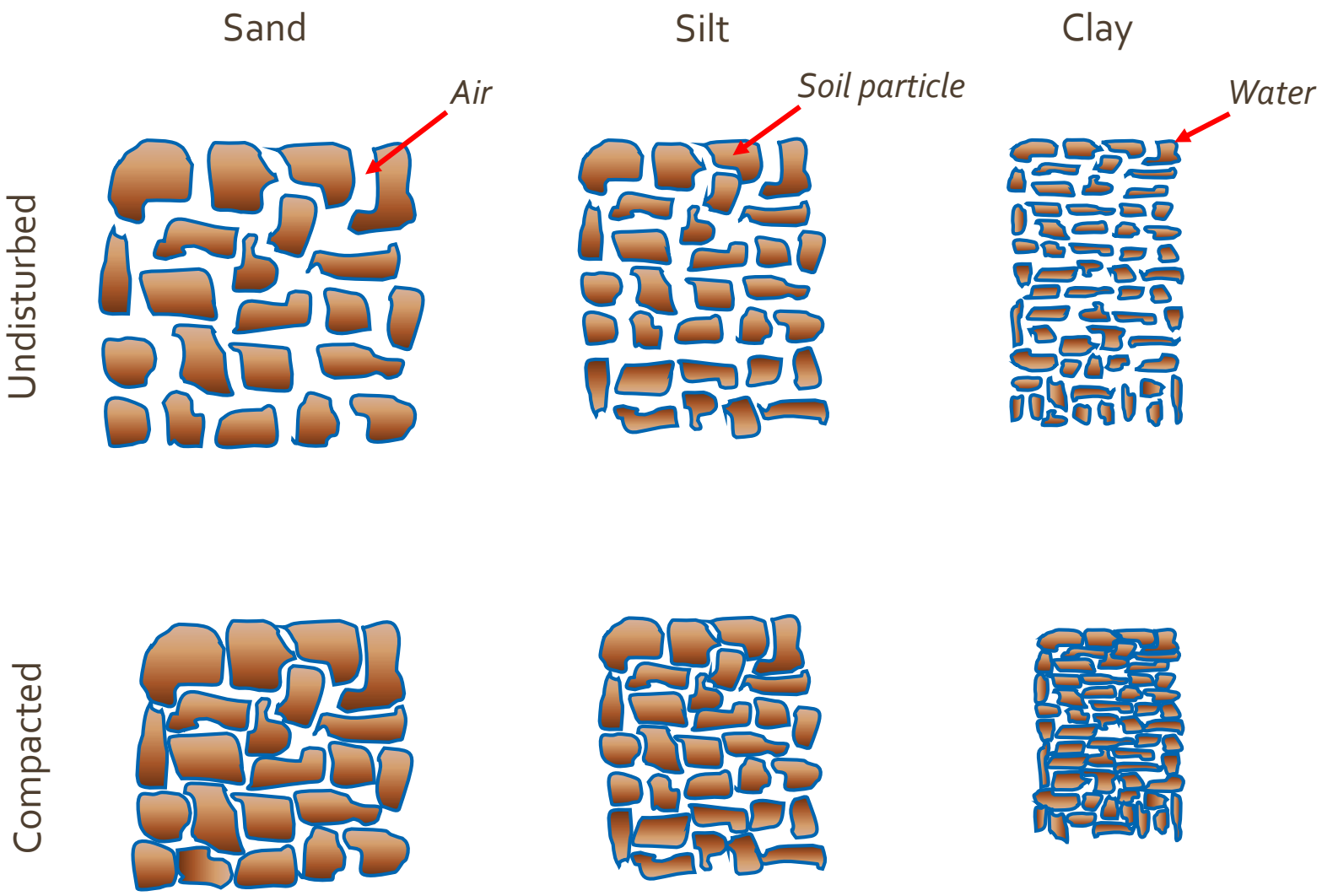
Soil Water Relationships

- Factors affecting soil water movement
  - Soil type
    - Structure
    - Texture
  - Land management
    - Tillage
    - Residue management
    - Soil amendments
  - Climatic factors



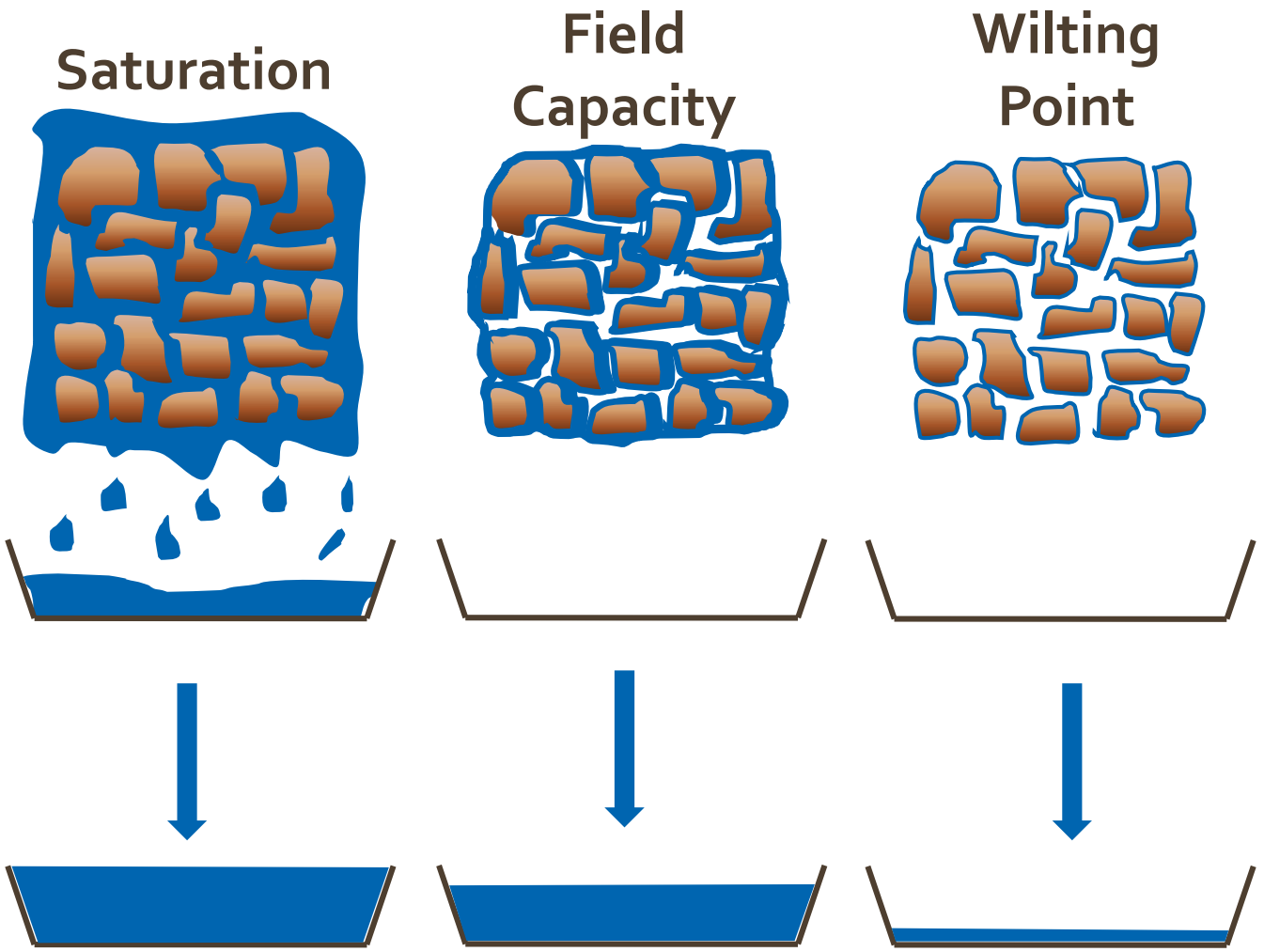
Source: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054311

Soil Water Relationships



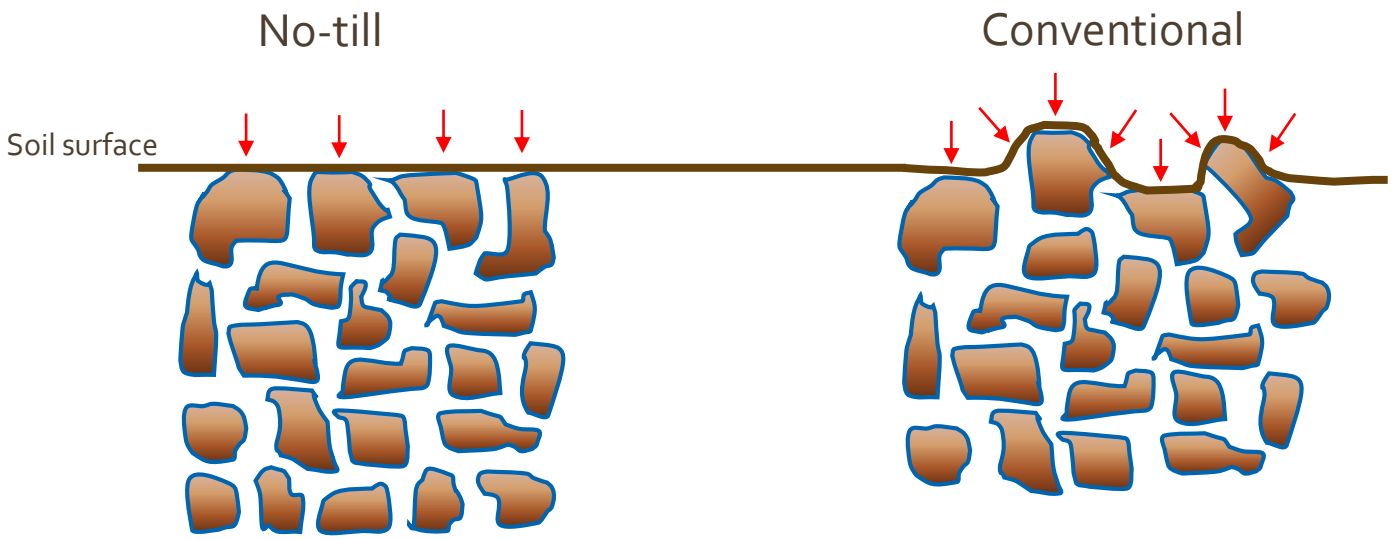
Soil Water Relationships

- Available water holding capacity
  - Difference between field capacity and permanent wilting point



Soil Water Relationships

- Land Management
  - Benefits of no-till over conventional tillage
    - Improves irrigation water use efficiency by improving soil structure
    - Higher organic matter
    - Less evaporation losses

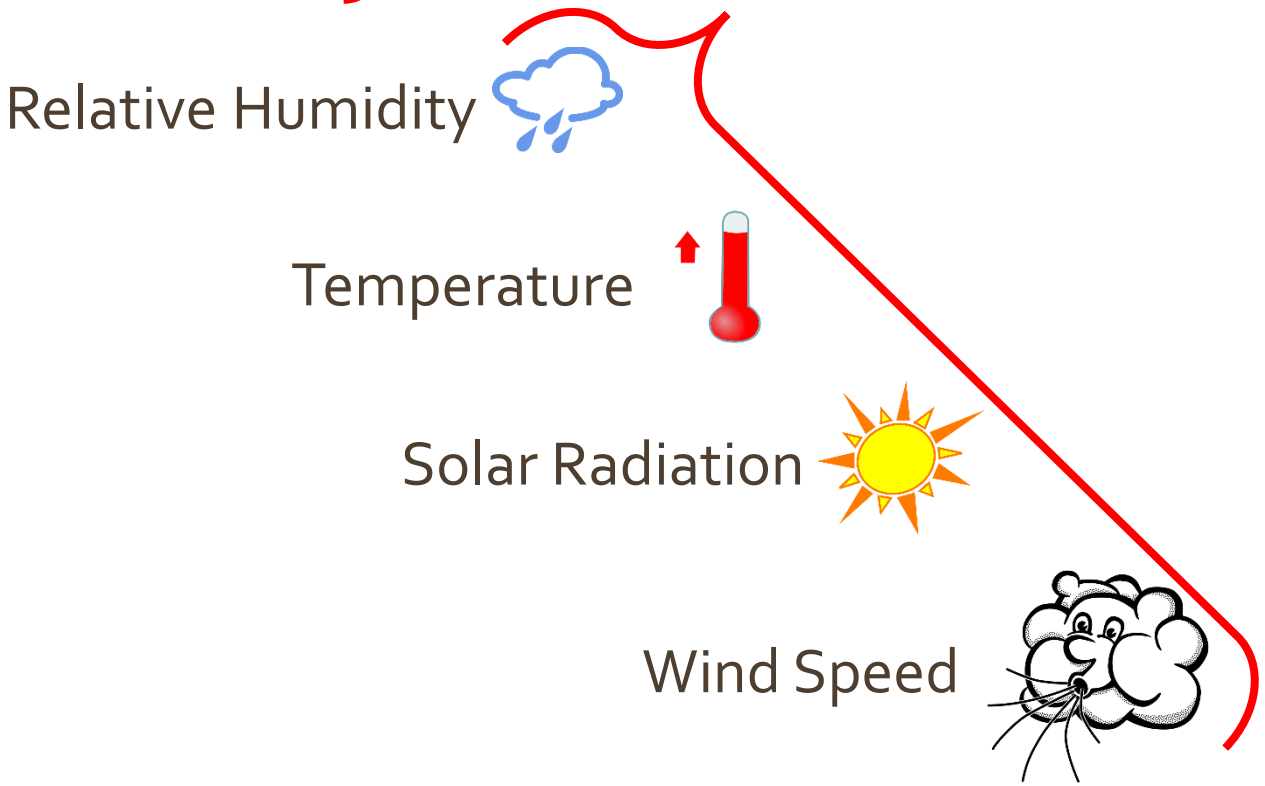


  - Are no-till practices a viable option for furrow irrigation practices?

Soil Water Relationships

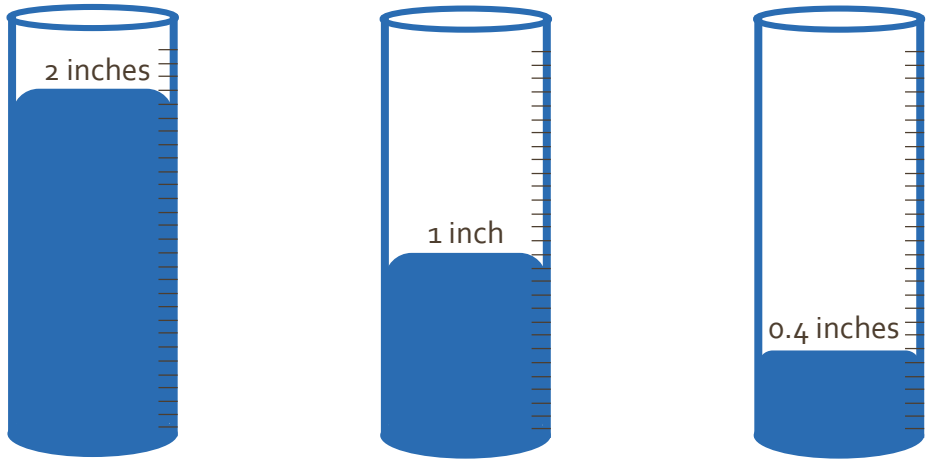
- Water movement is driven by:
  - Rainfall
  - Irrigation
  - Evaporation
  - Transpiration

Evapotranspiration (ET)



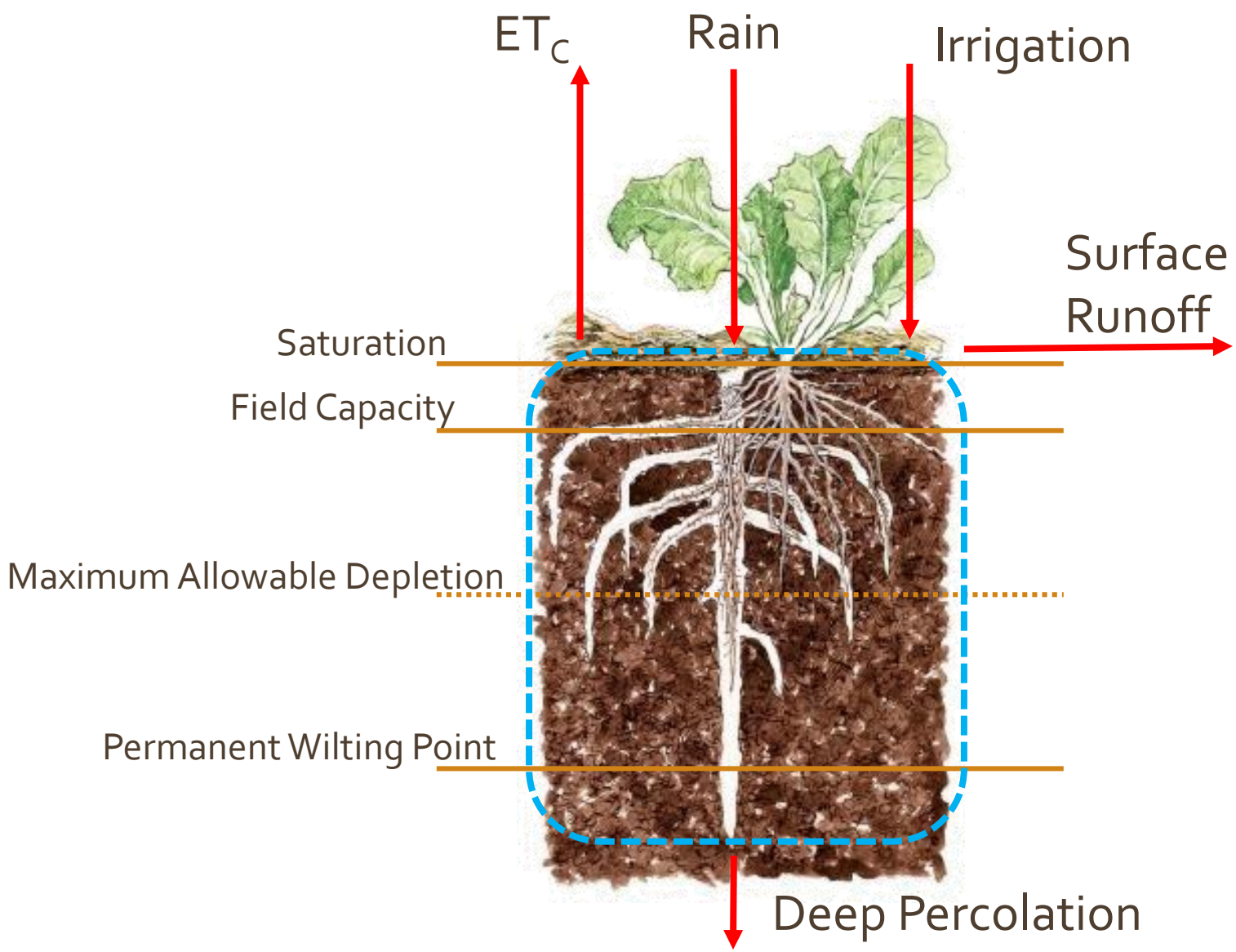
Soil Water Relationships

- How do you estimate:
  - ET
  - Effective rainfall?
    - How much can the soil hold in the root zone?
    - Is the soil prepared for infiltration or will it run off?
      - If your root zone can store 0.75 inches of water, how much rainfall was effective for each event?



  - Effective irrigation

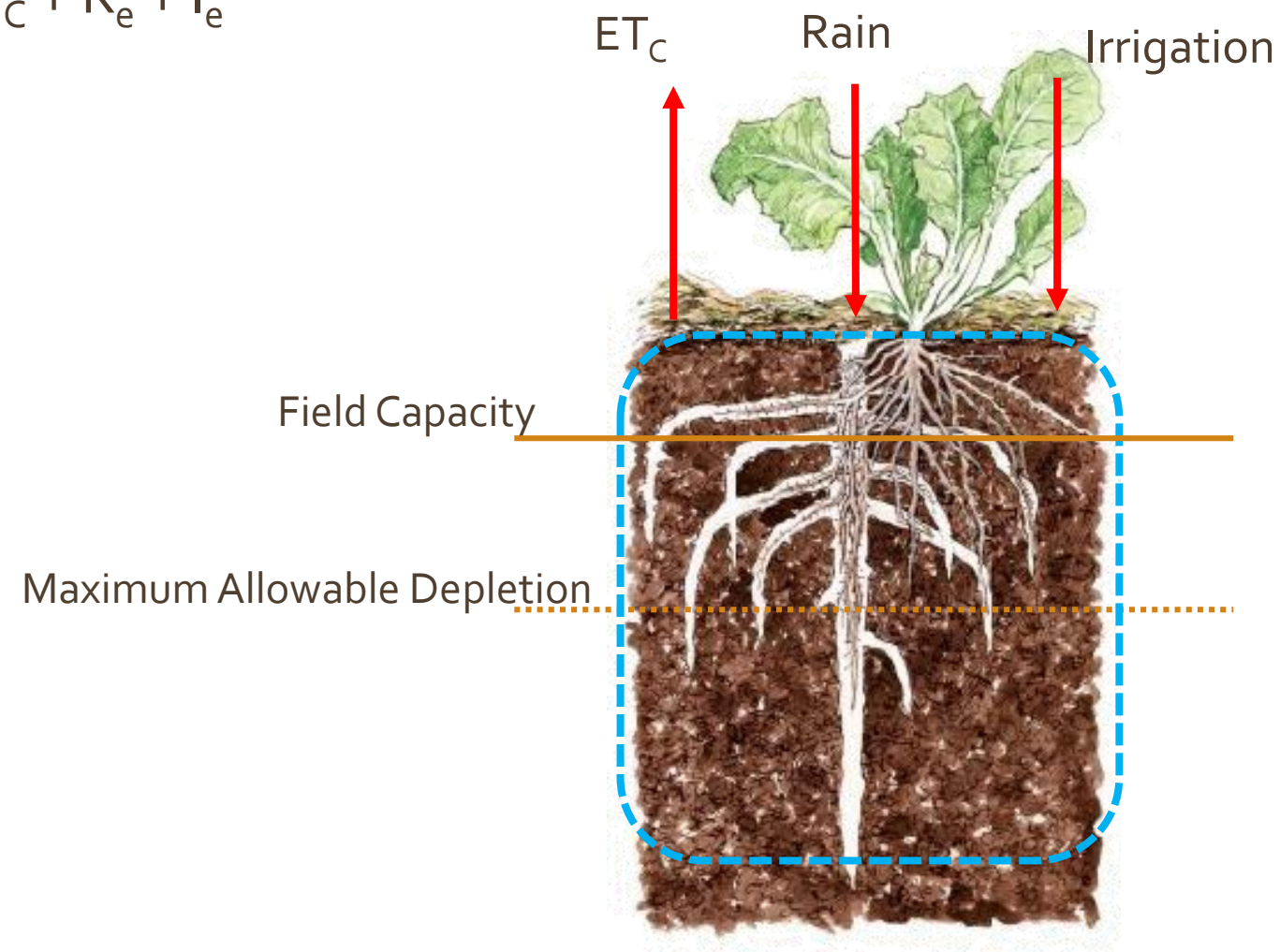
Soil Water Relationships



Soil Water Relationships

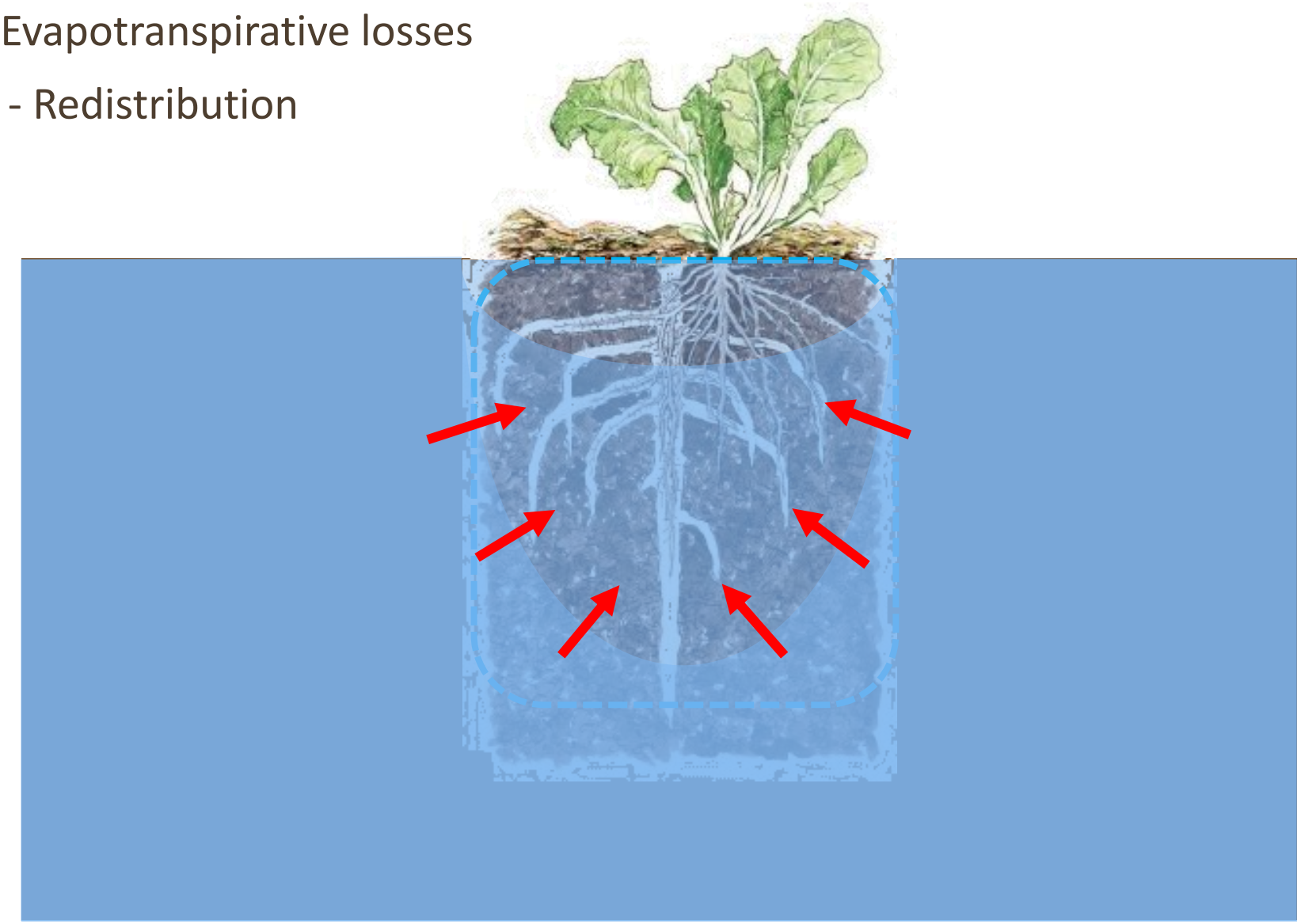
$$SWL_i = SWL_{i-1} - ET_C + R + I - P_d - RO$$

$$SWL_i = SWL_{i-1} - ET_C + R_e + I_e$$

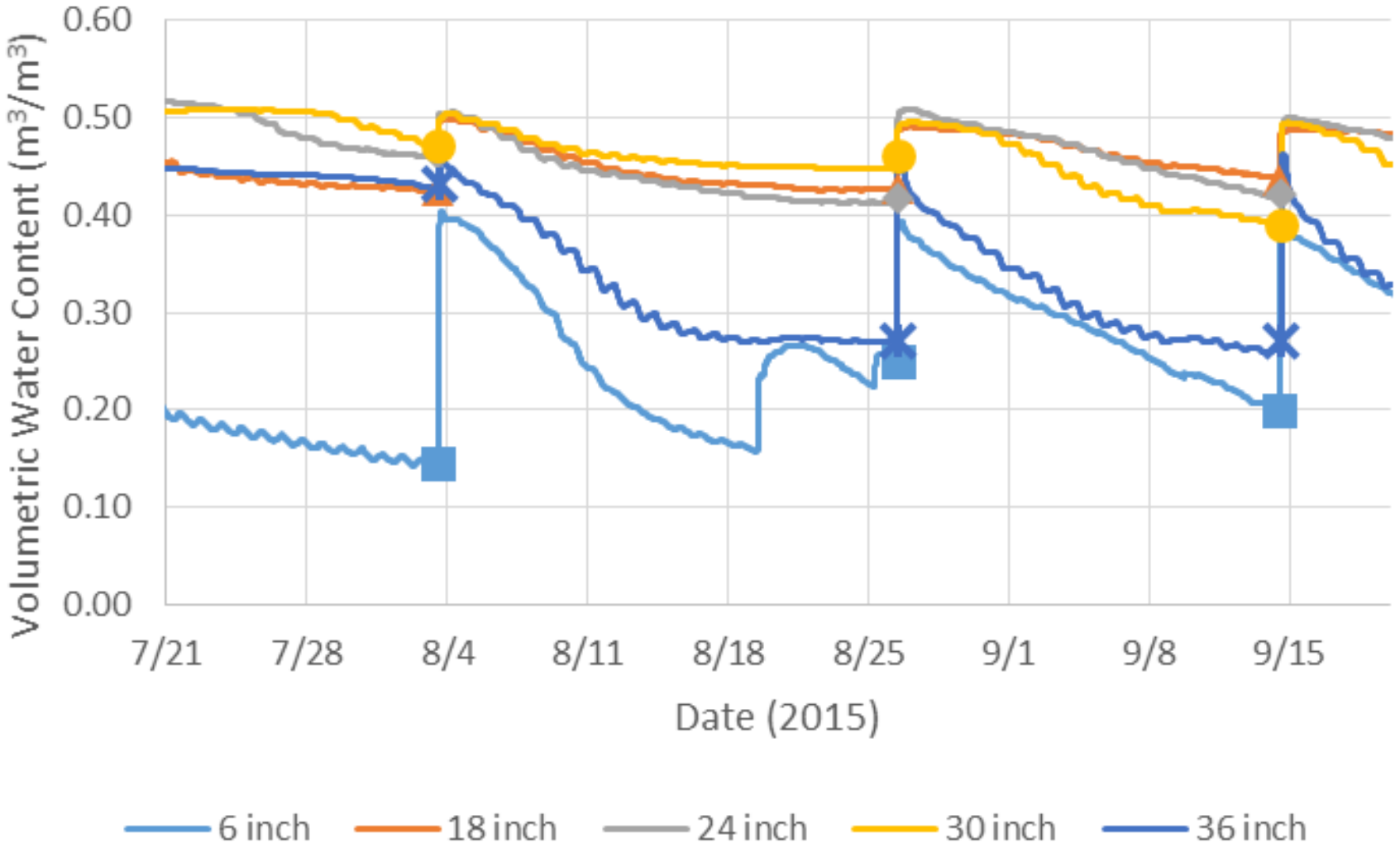


Soil and Water Relationships

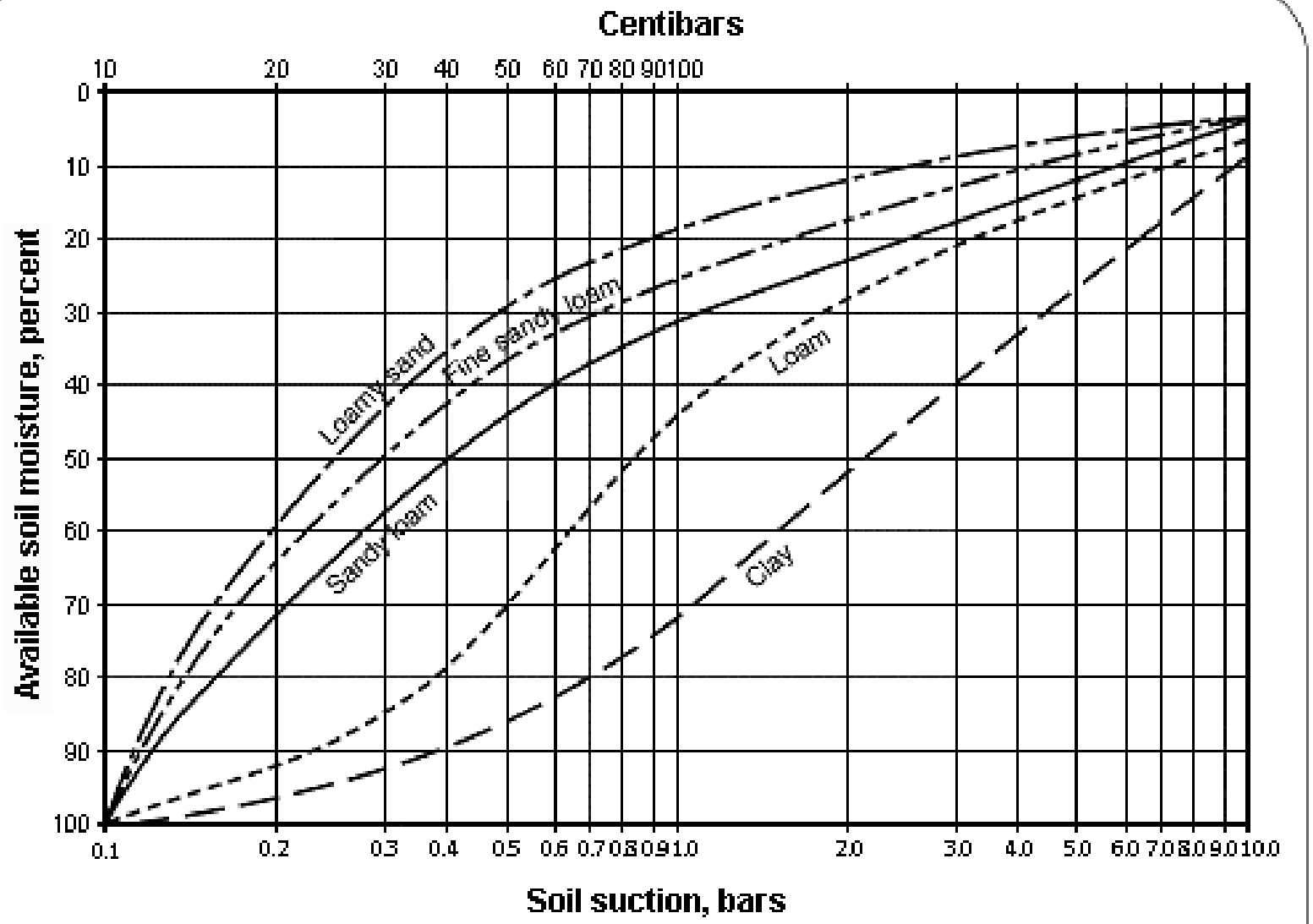
- Daytime – Evapotranspirative losses
- Night time - Redistribution



Soil Water Relationships



Soil Water Relationships



Adapted (with permission) from the *BC Trickle Irrigation Manual*, BC Ministry of Agriculture and Food, Irrigation Industry Association of British Columbia (T.W. Van der Gulik)
Note: 1 kpa = 1 centibar; 100 centibars = 1 bar

Objective:

Determine the viability of using soil moisture sensors for improving furrow irrigation efficiency in agronomic crops

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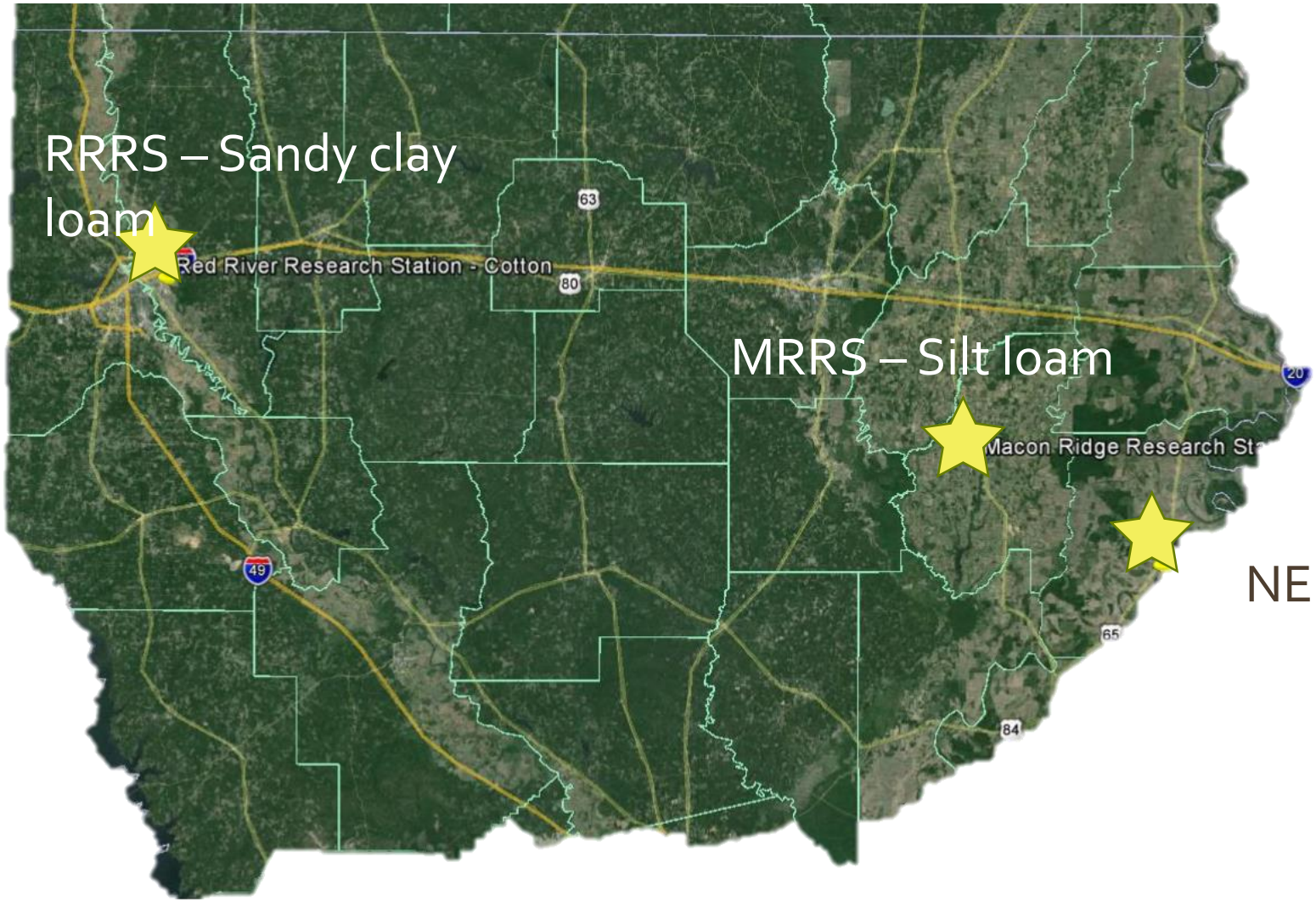
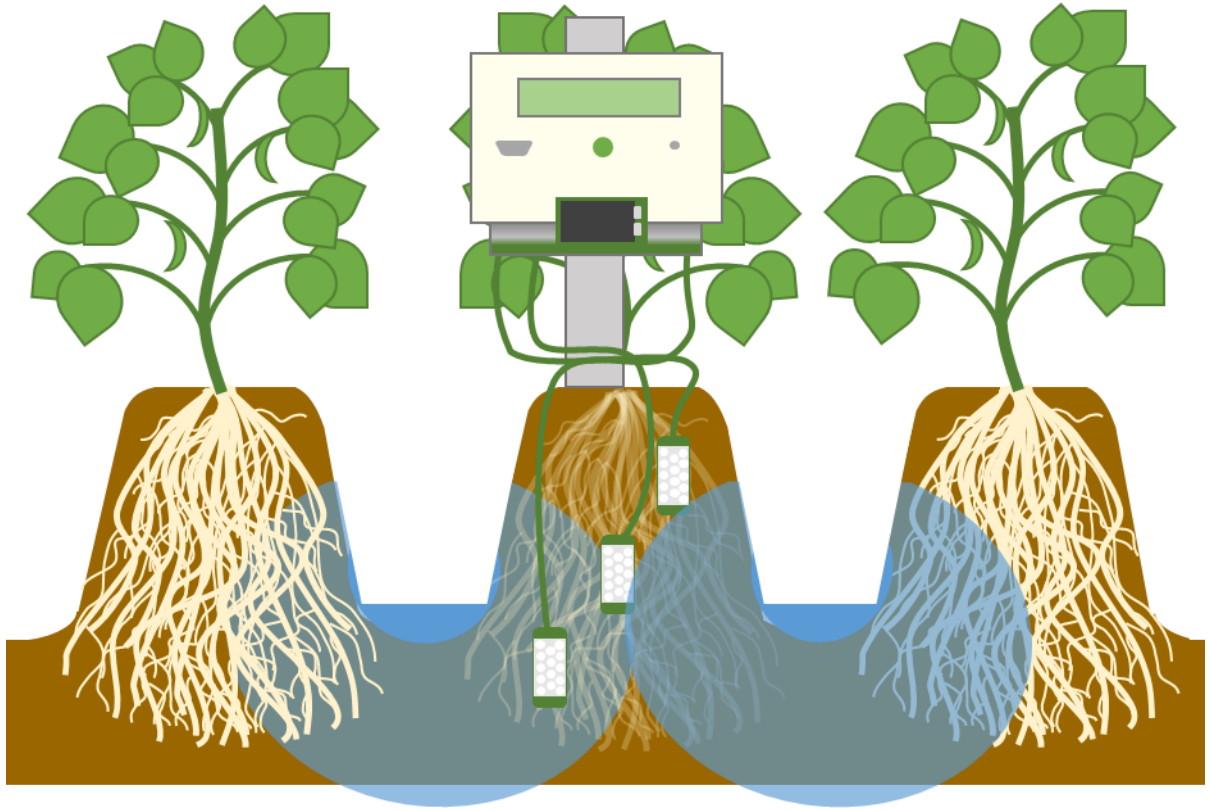
Materials and Methods

- Research locations



Materials and Methods

- Treatments
  - Calendar Method
  - Watermark Sensor
  - Decagon GS-1 Sensor

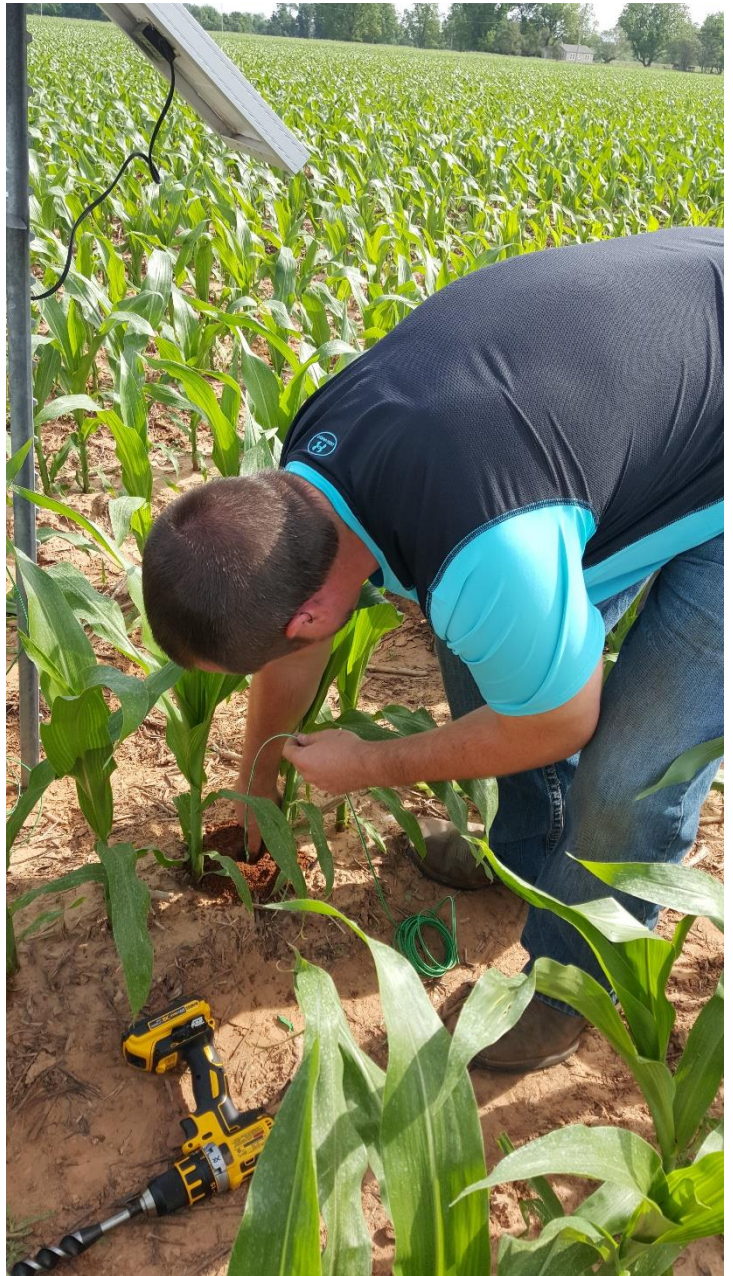


Materials and Methods

- Sensor installations – Watermark
  - Wetting/drying before burial
  - Soil slurry

Materials and Methods

- Sensor installations - Watermark



Materials and Methods

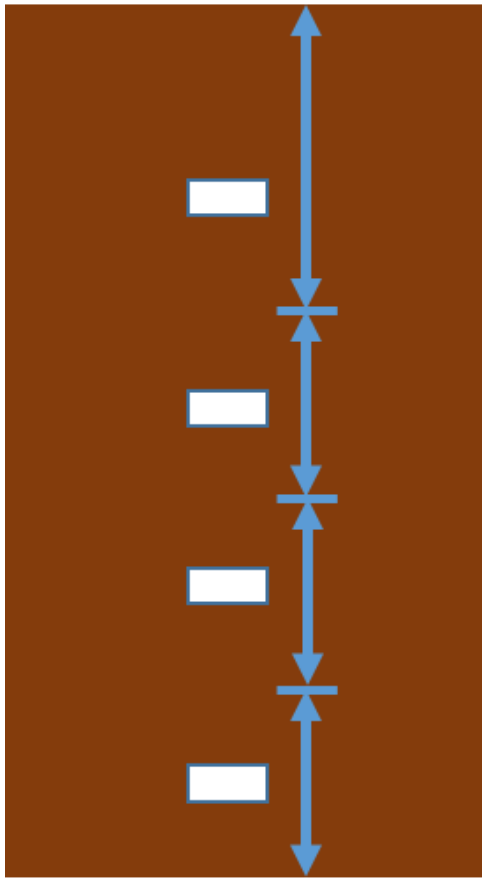
- Sensor installations – GS1

Materials and Methods

- Furrow-irrigated fields

Materials and Methods

- Calculating crop coefficients – cotton only
  - ET_O was estimated using the ASCE-EWRI standardized ET_O equation using a local weather station



Day 1		Day 2		Change		Root Depth		ET_C
0.33	-	0.31	=	0.02	*	12	=	0.24
0.34	-	0.33	=	0.01	*	9	=	0.09
0.38	-	0.38	=	0	*	9	=	0
0.40	-	0.40	=	0	*	9	=	0

$ET_C = 0.33$

$$K_c = \frac{ET_C}{ET_O}$$

$$K_c = \frac{0.33}{0.25}$$

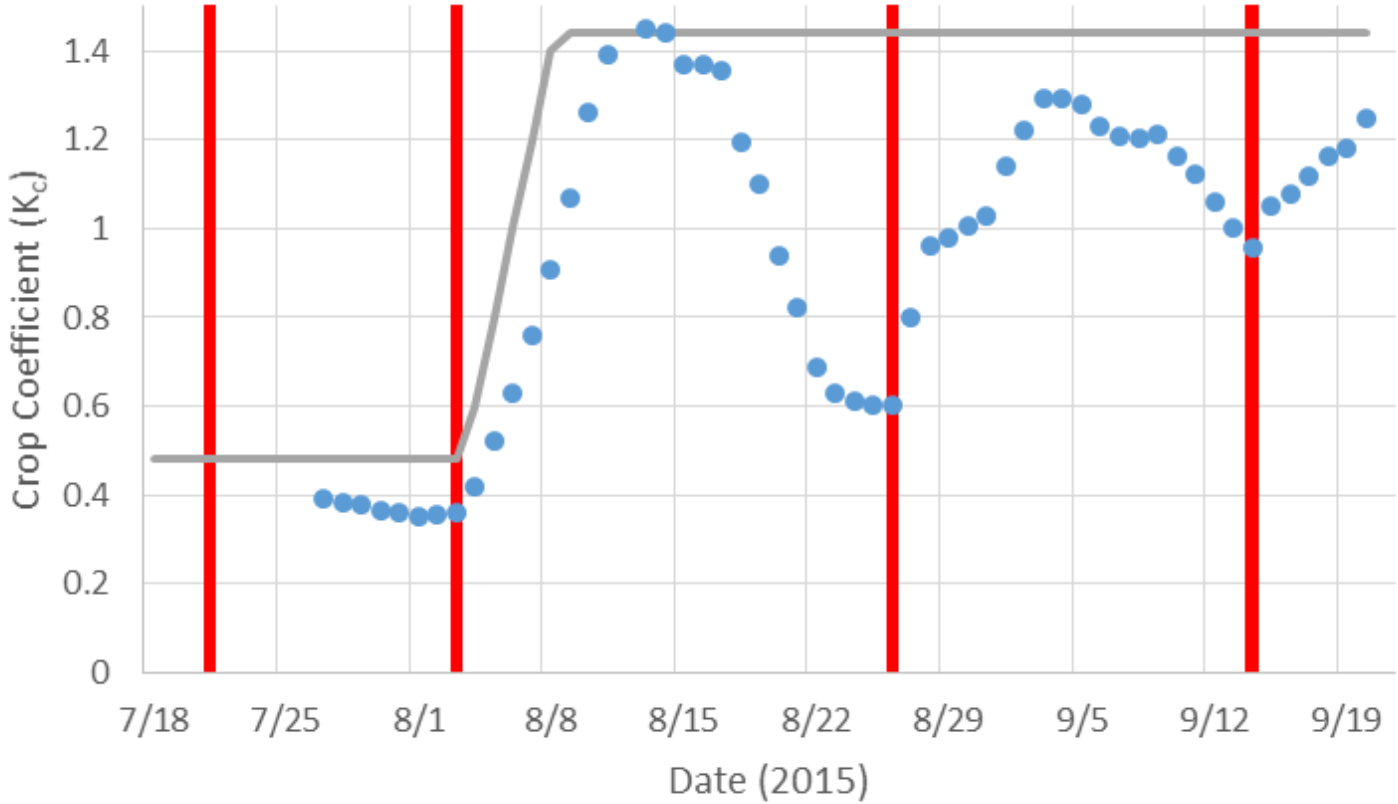
$$K_c = 1.32$$

Results

- Preliminary analysis only
- Need a better method for estimating irrigation requirement

2015 Results

- Cotton – sandy clay loam



Treatment	Number of Irrigation Events	Cumulative Irrigation (in)	Cumulative Rainfall (in)	Yield Weight (lb/ac)
Watermark	4	9.4	2.8	1,047 a
Decagon	4	9.4	2.8	1,177 a
Weekly	5	11.0	2.8	1,077 a

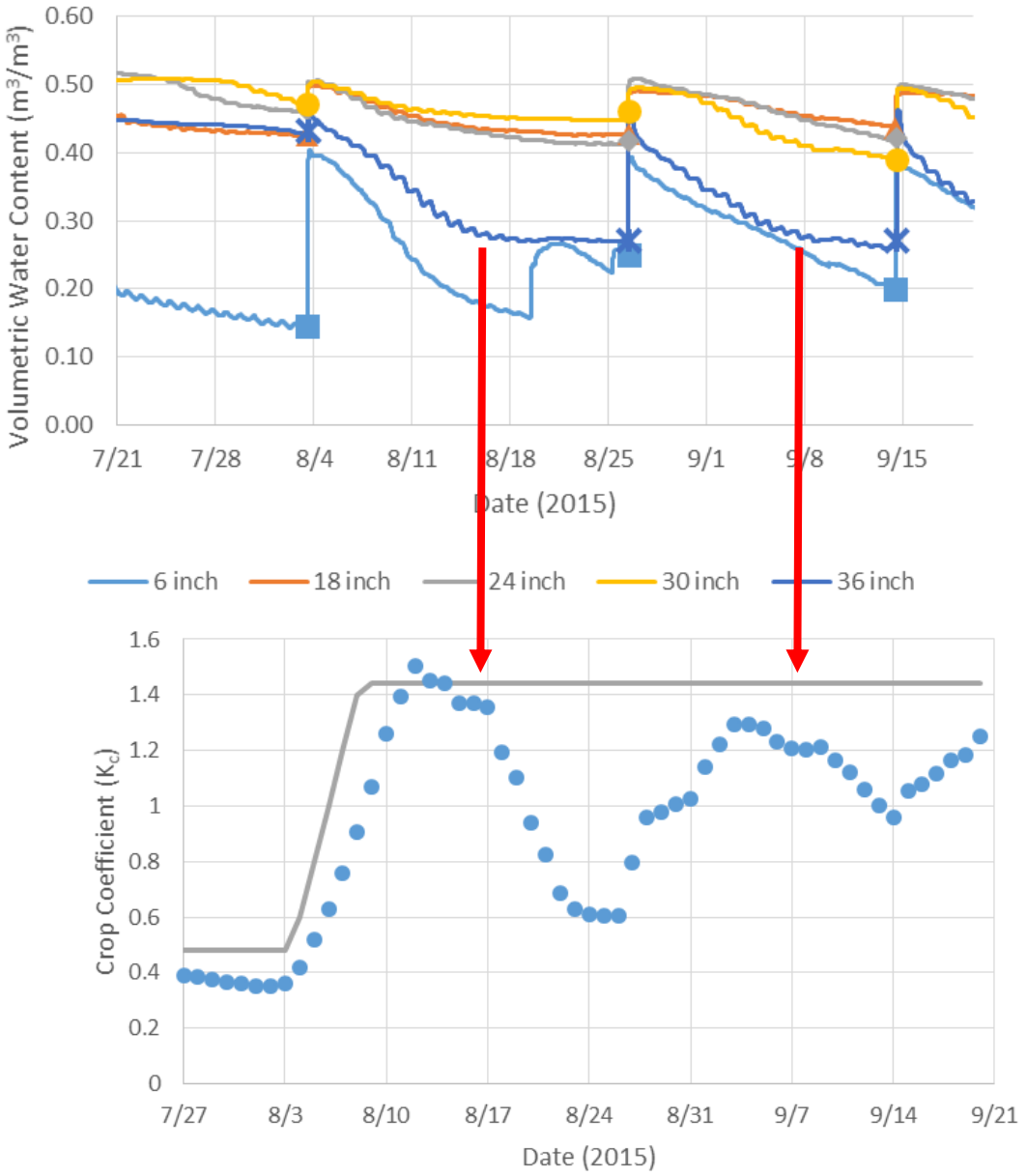
Pre-planting rainfall was 17.5 inches.

2015 Results

- Cotton on Sandy Loam

Stress occurred throughout the season.

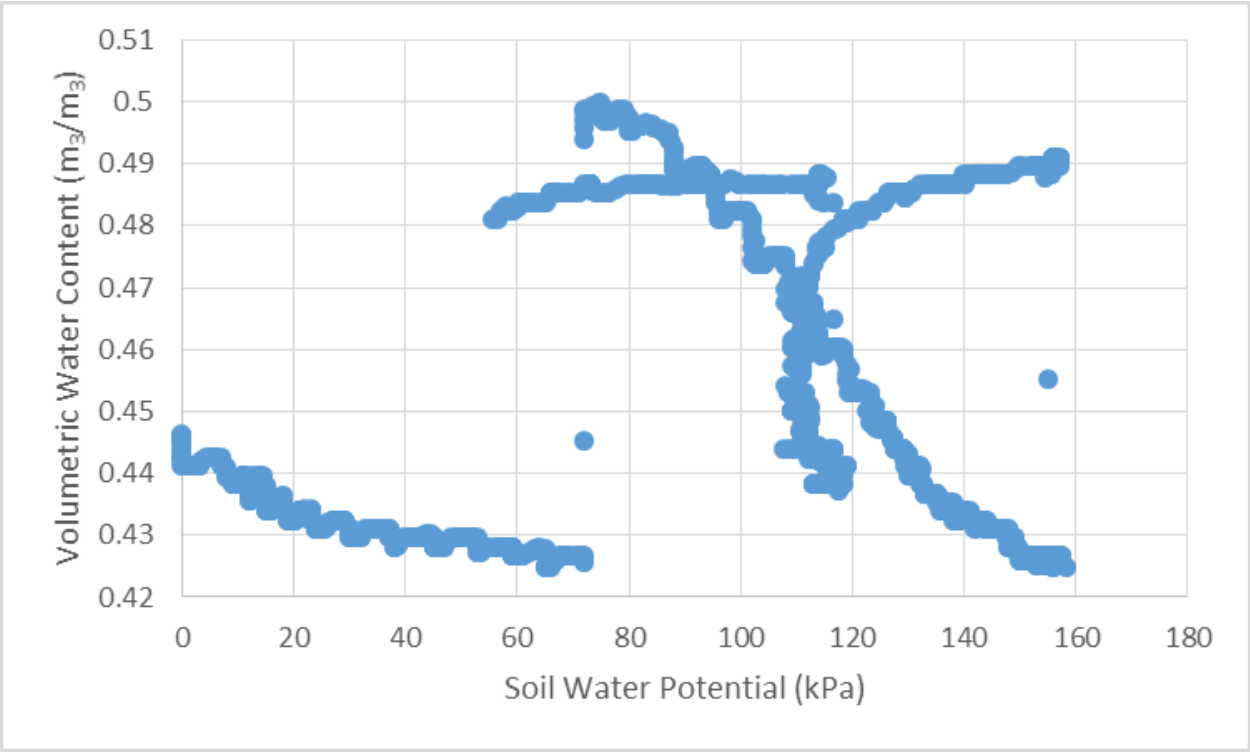
Additional irrigation events were necessary.



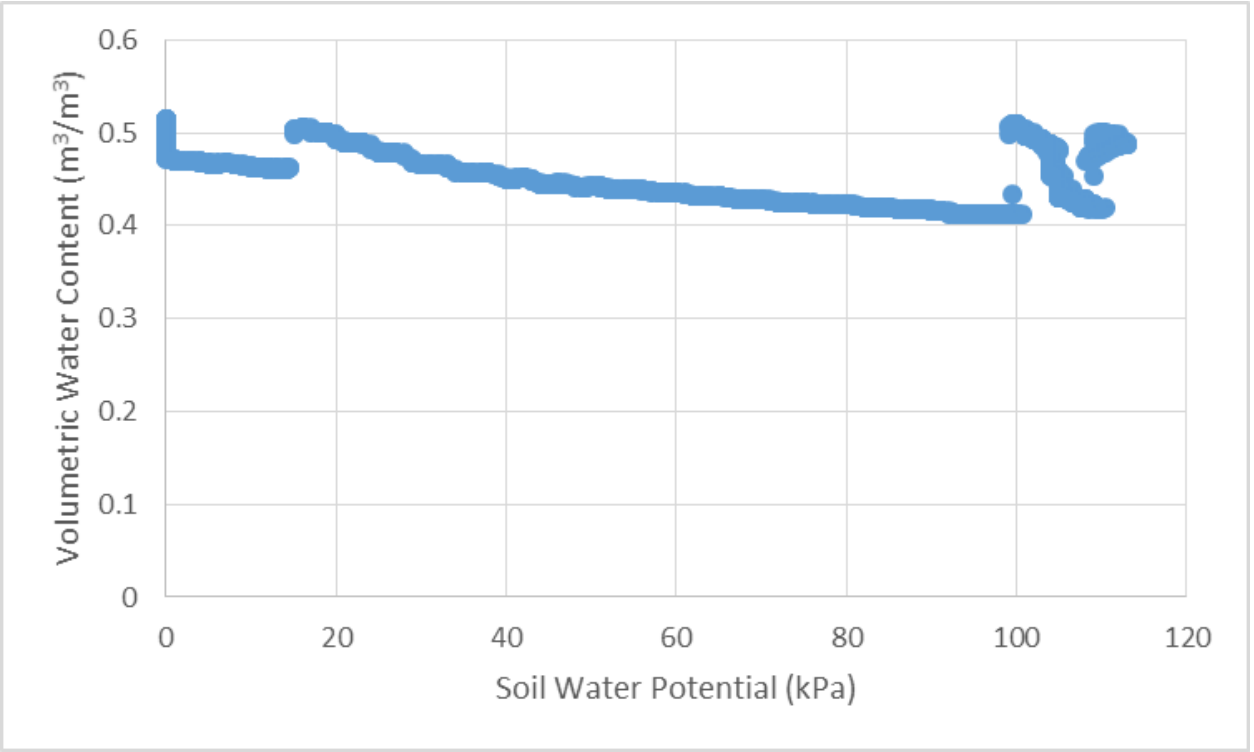
2015 Results

- Cotton on sandy clay loam

18 inch depth

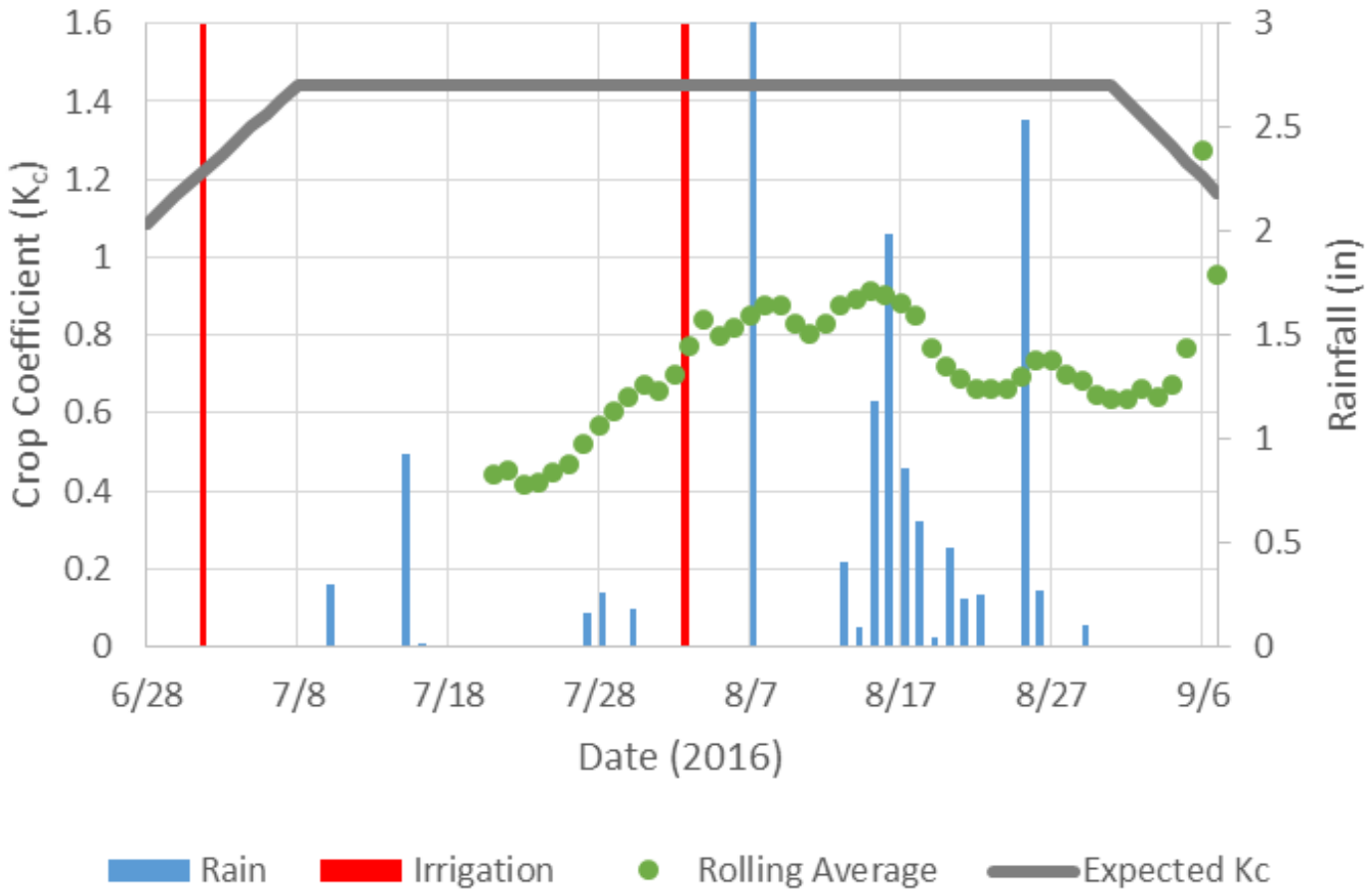


24 inch depth



2016 Results

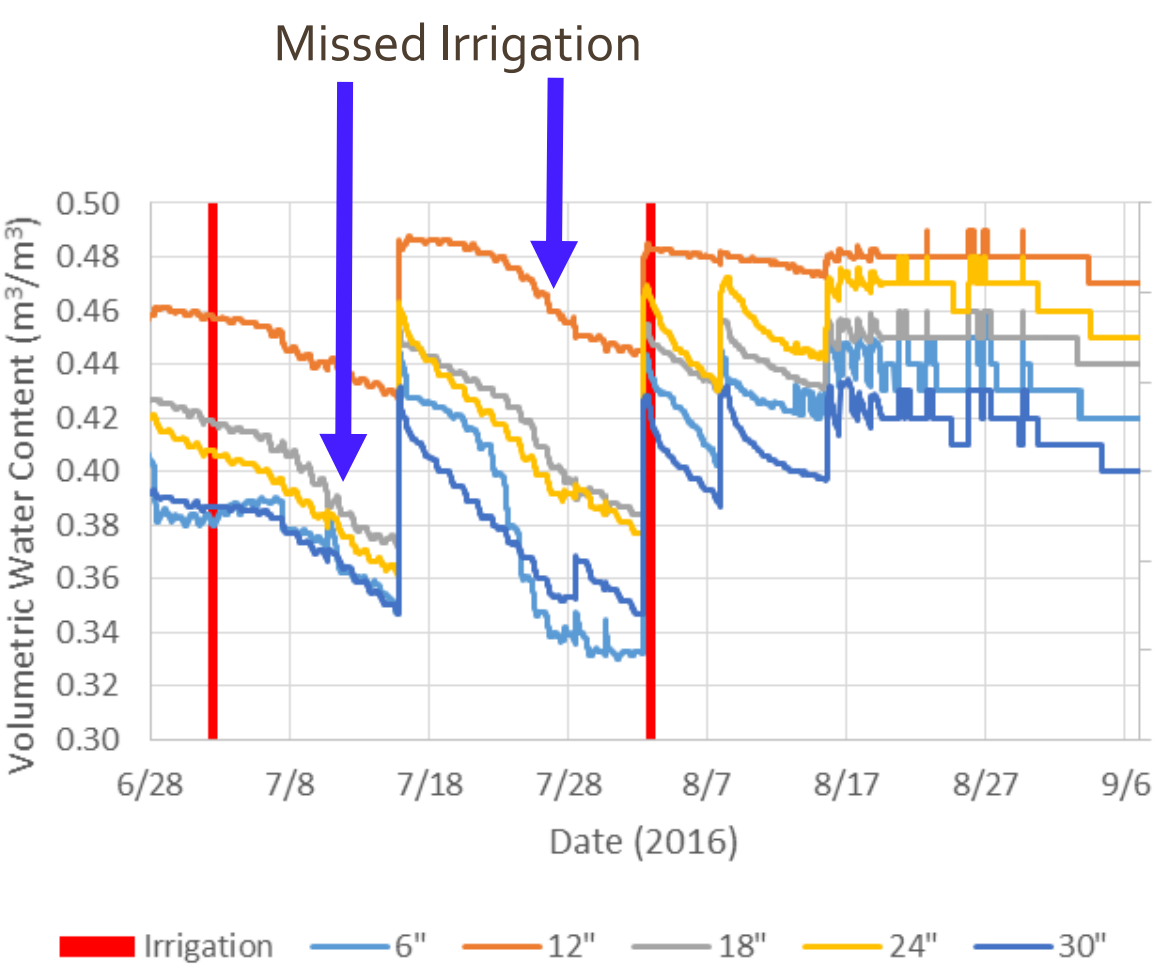
- Cotton on sandy clay loam

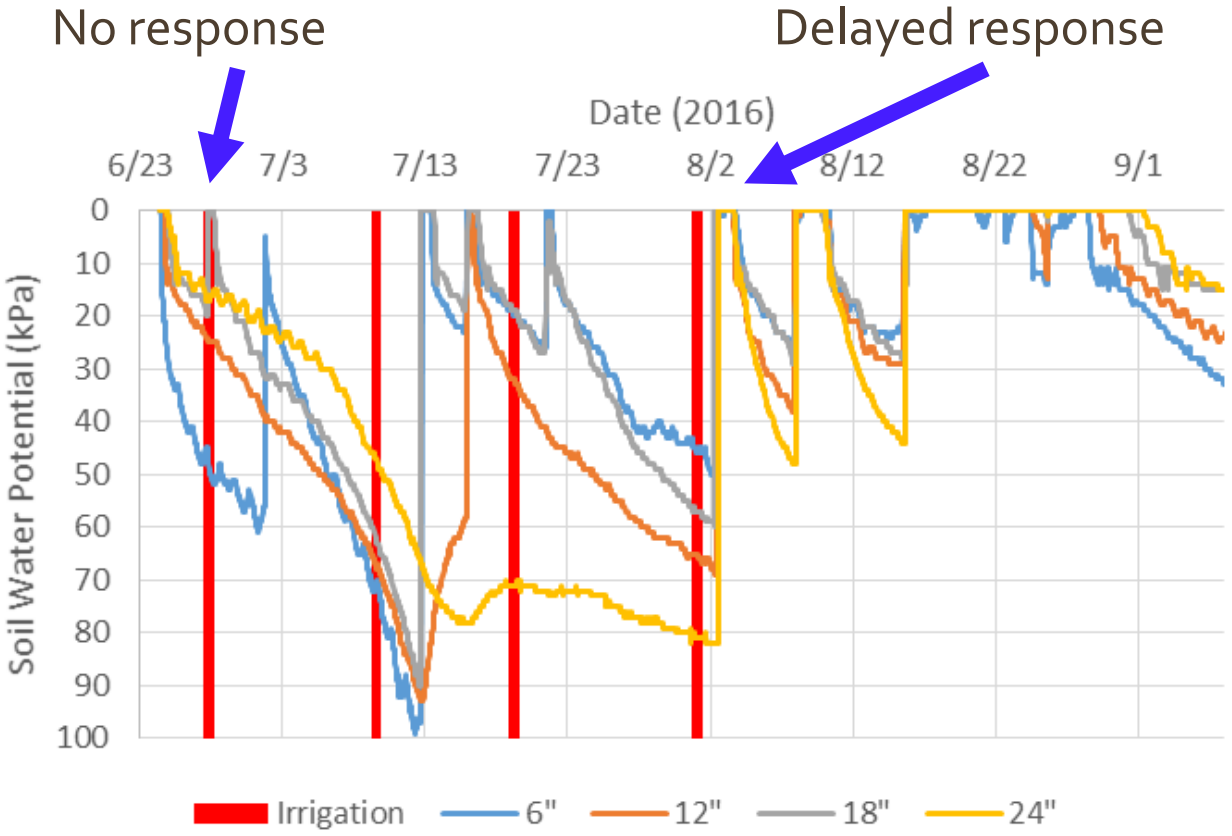


Treatment	Number of Irrigation Events	Cumulative Irrigation (in)	Cumulative Rainfall (in)	Yield Weight (lb/ac)
Watermark	4	8.5	18.5	1,247 a
Decagon	2	5.0	18.5	1,285 a
Weekly	4	8.5	18.5	1,157 a

2016 Results

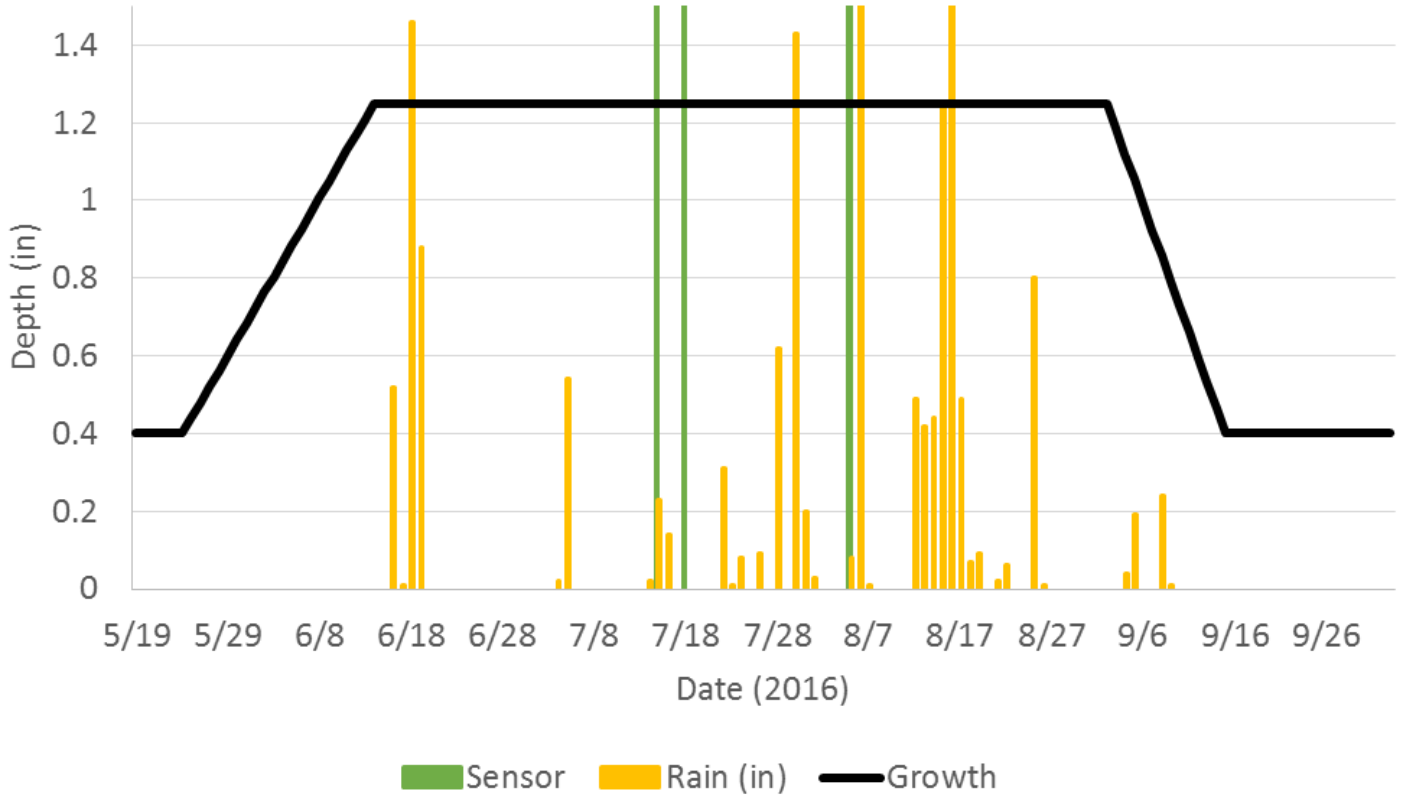
- Soil moisture data





2016 Results

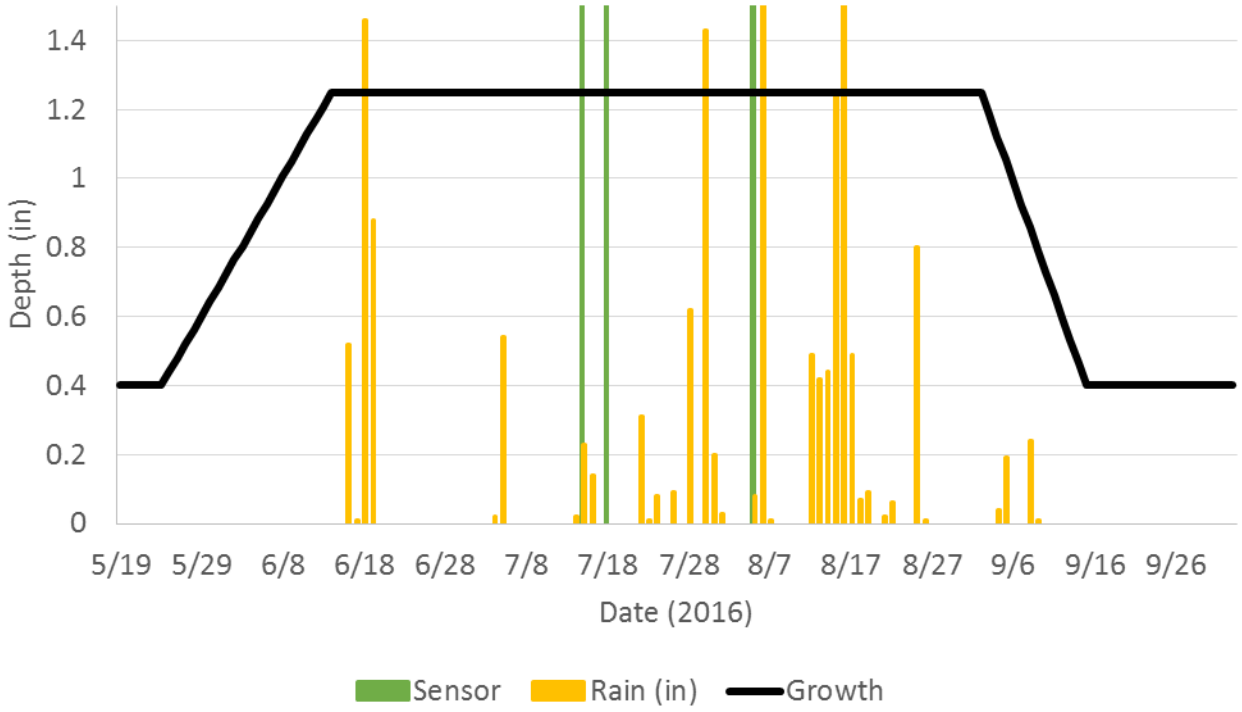
- Soybean on silt loam

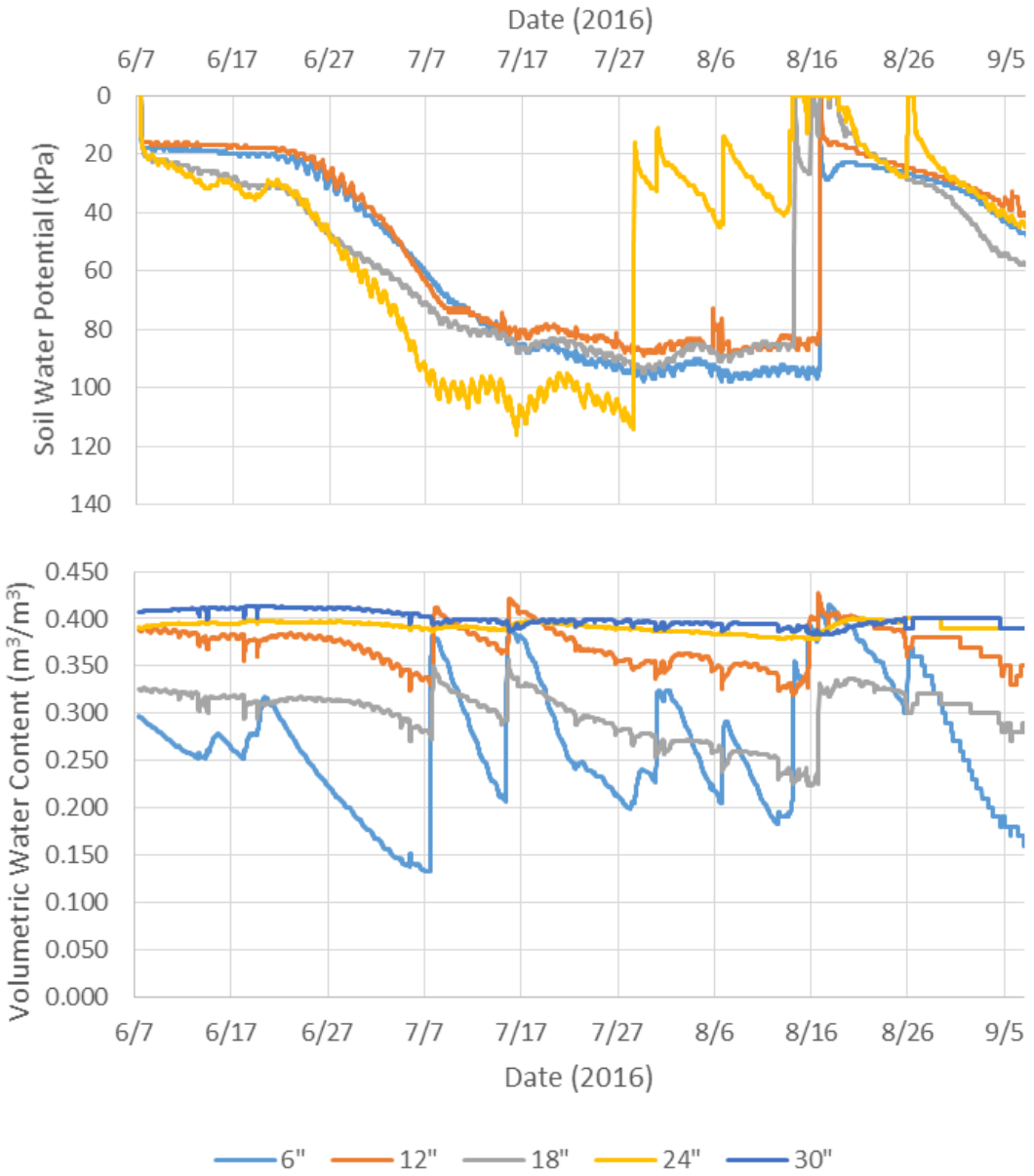


Treatment	Number of Irrigation Events	Cumulative Irrigation (in)	Cumulative Rainfall (in)	Yield Weight (bu/ac)*
Watermark	3	9.0	15.2	46.0
Decagon	3	9.0	15.2	43.8
Weekly	3	9.0	15.2	--
Unirrigated	0	0	15.2	43.7

2016 Results

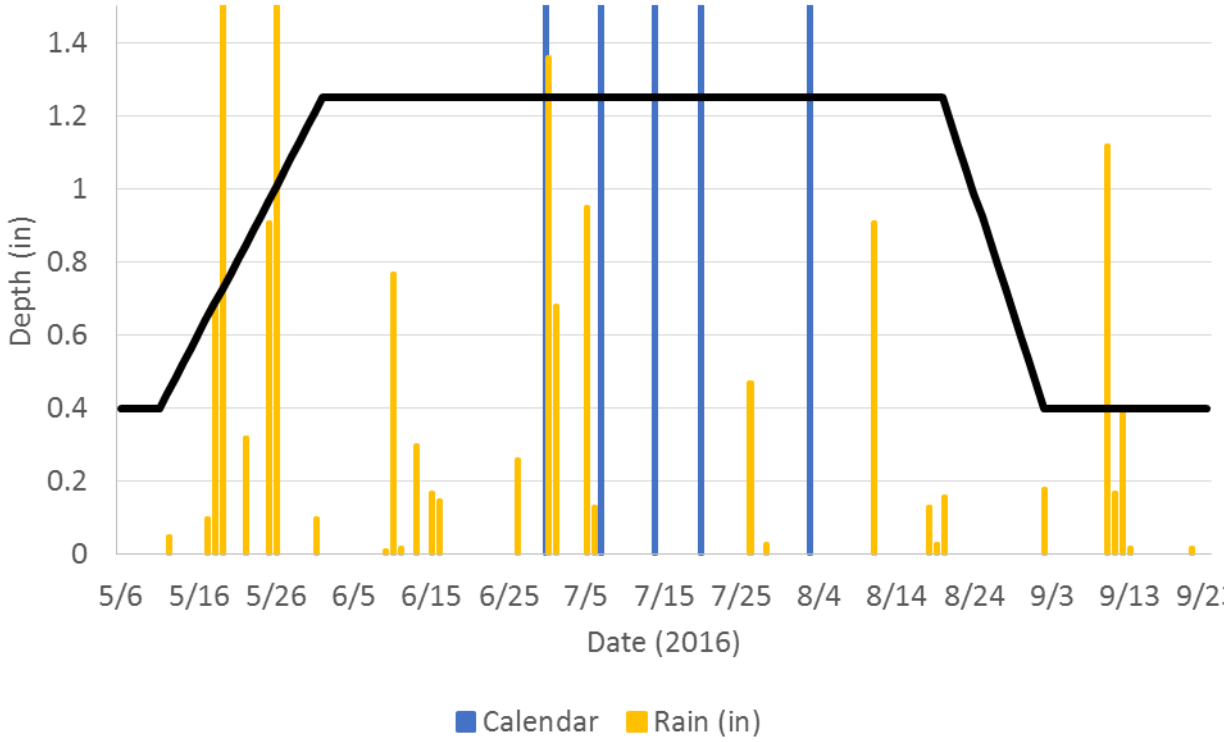
- Soybean on silt loam

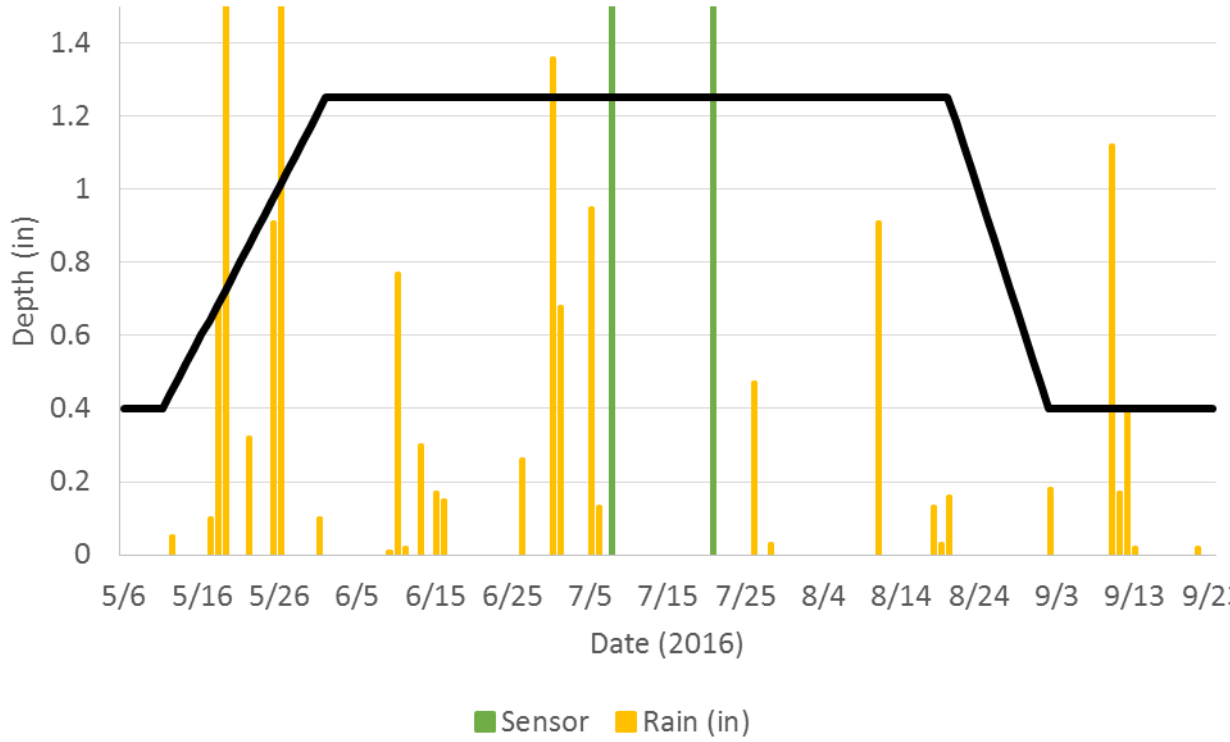




2016 Results

- Soybean on cracking clay

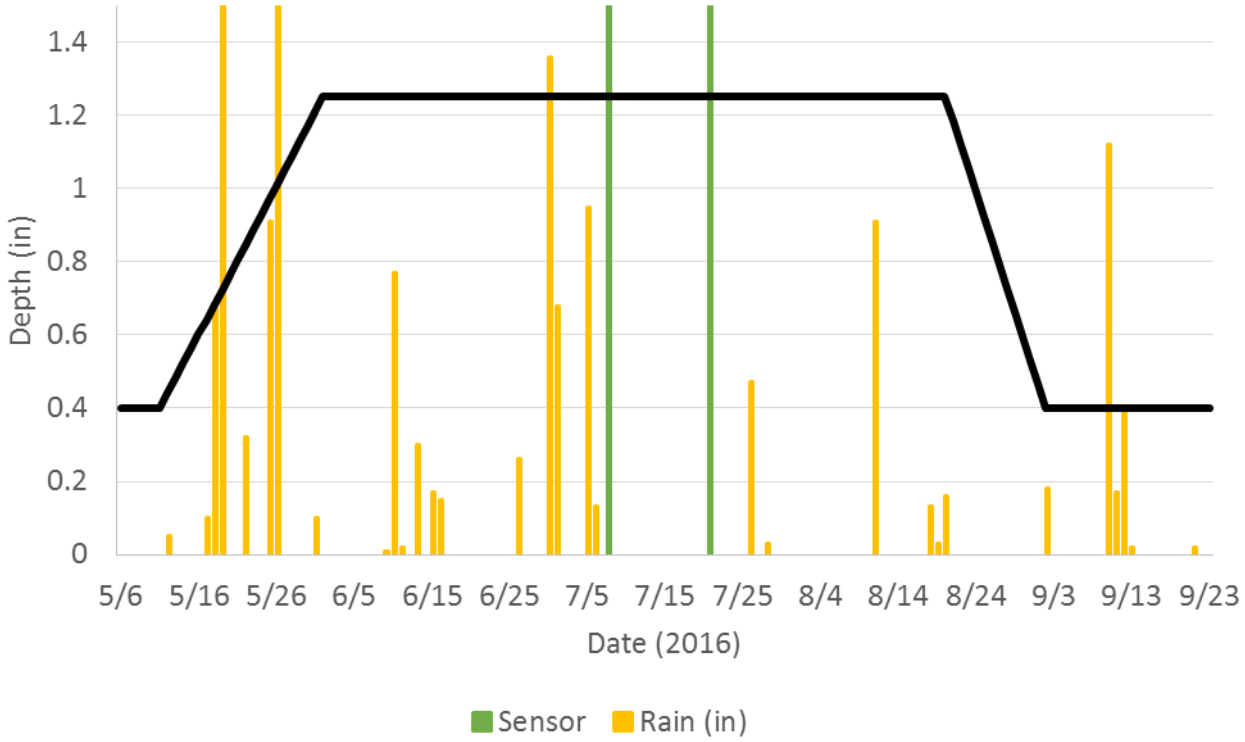


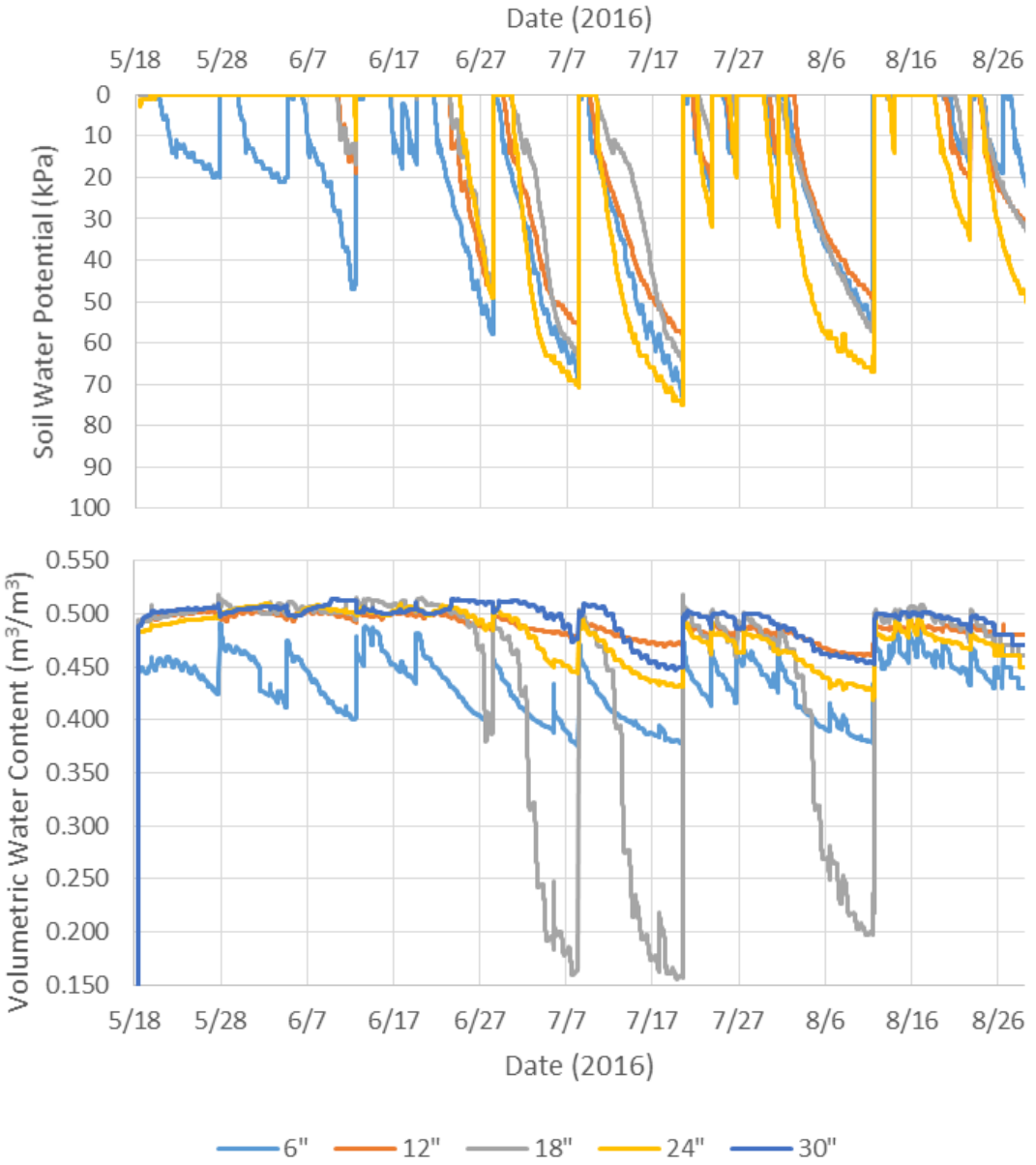


Treatment	Number of Irrigation Events	Cumulative Irrigation (in)	Cumulative Rainfall (in)	Yield Weight (bu/ac)
Watermark	2	8.8	19.7	63.2 a
Decagon	2	8.8	19.7	64.8 a
Weekly	5	29.8	19.7	68.2 a
Unirrigated	0	0	19.7	40.8 b

2016 Results

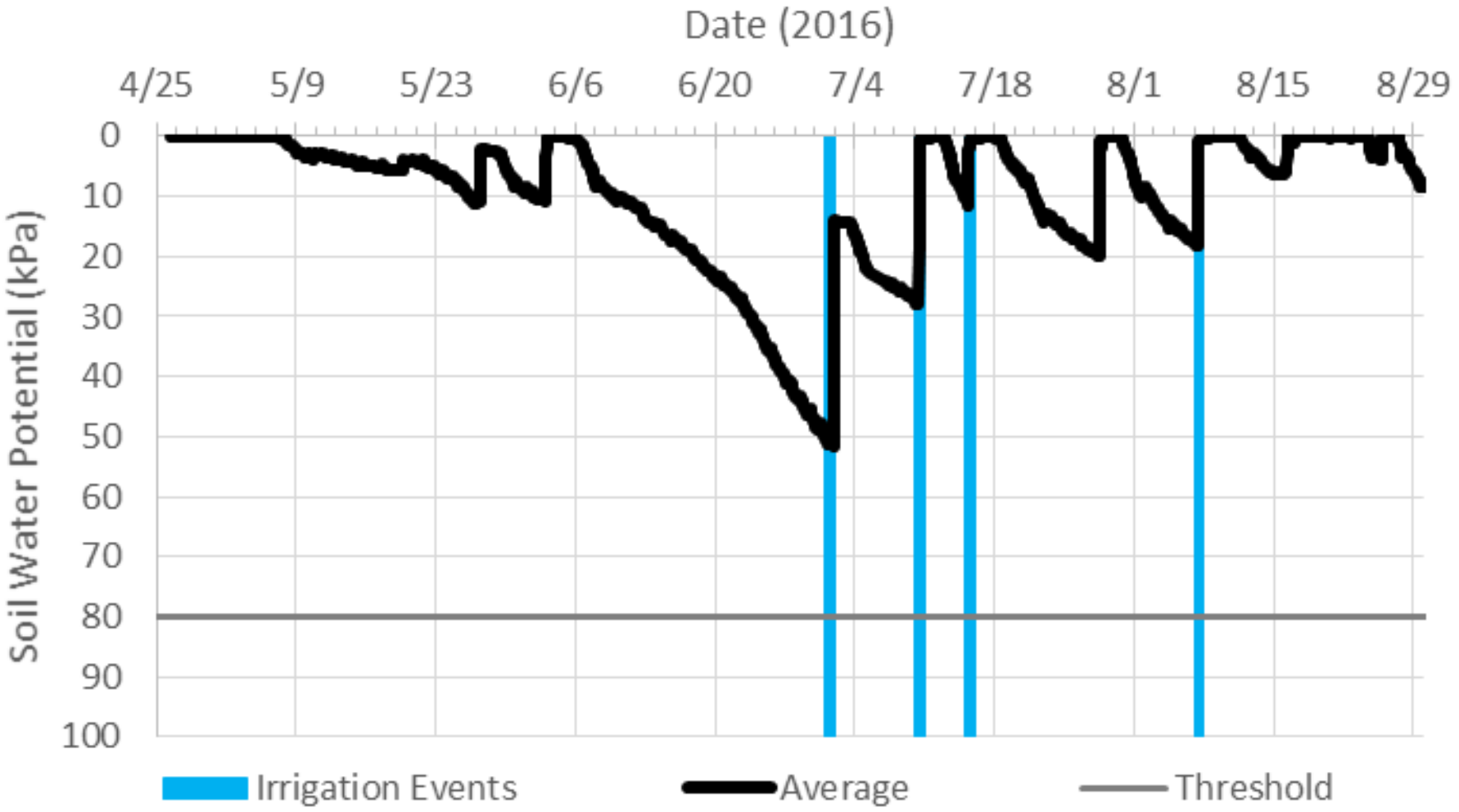
- Soybean on cracking clay





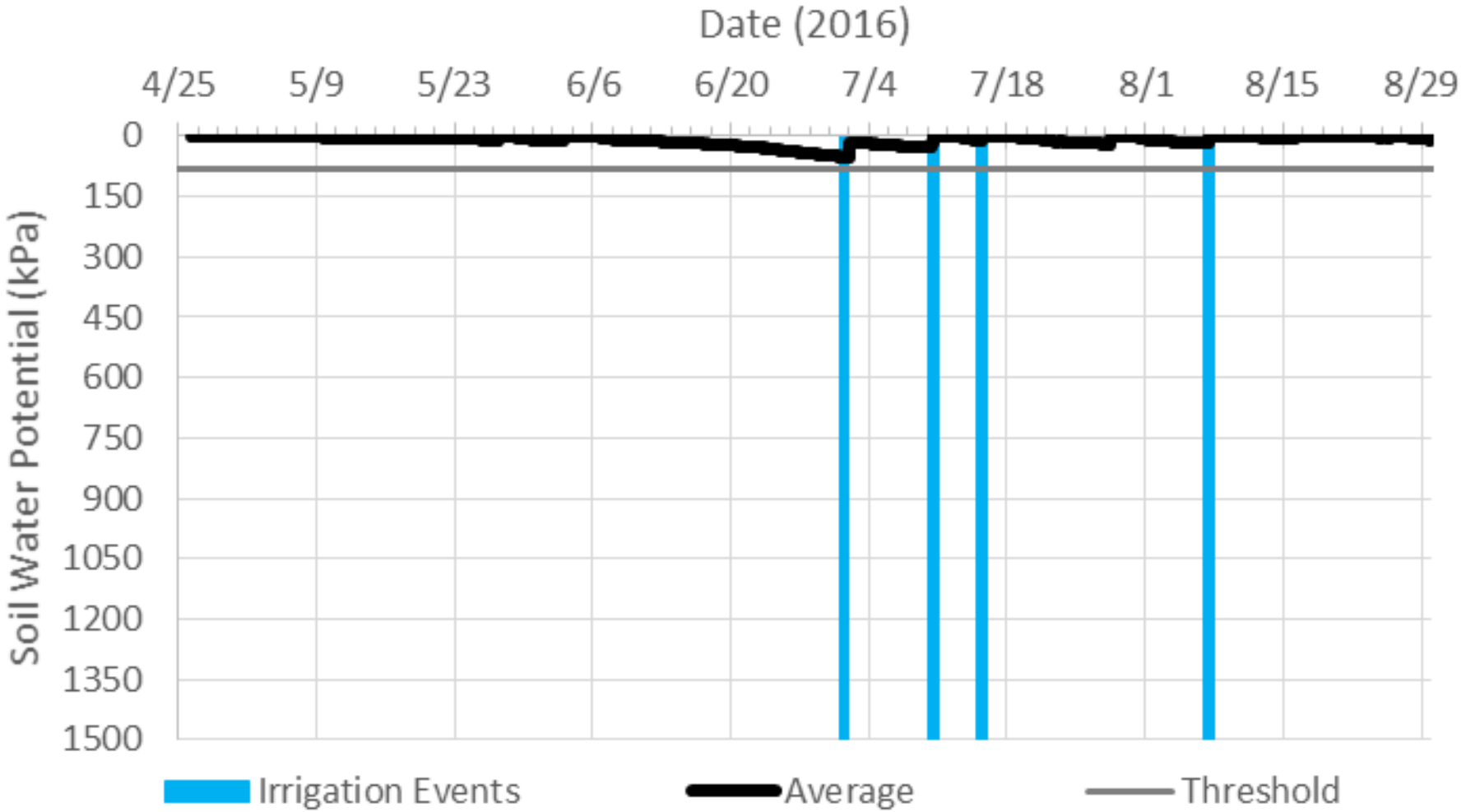
2016 On-farm Demonstrations

- Triggered irrigation too early?



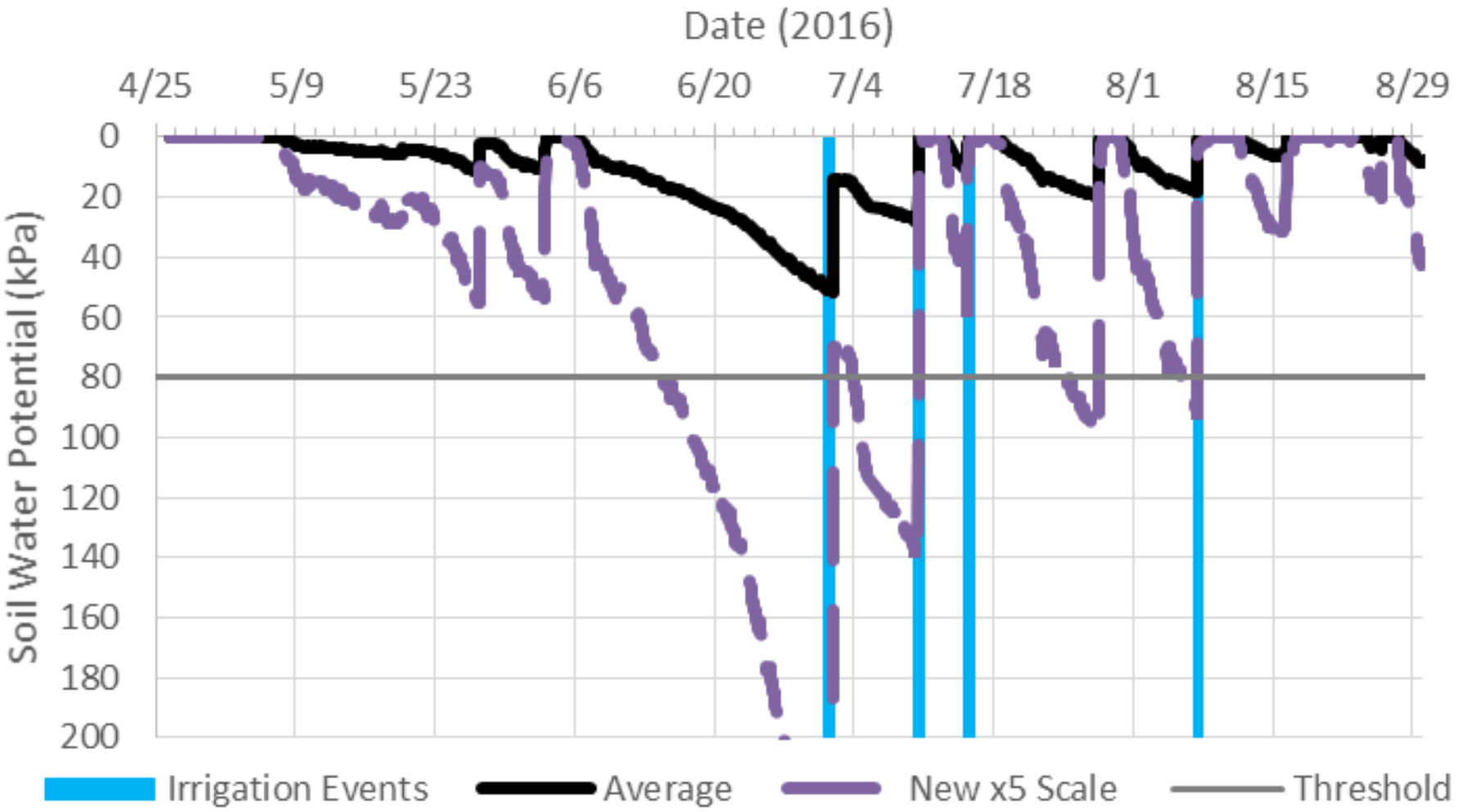
2016 On-farm Demonstrations

- Full soil moisture scale



2016 On-farm Demonstrations

- Scaled by 5 of actual reading



Conclusion?

- Soil moisture sensors are a good tool for estimating irrigation needs, but
- Soil moisture sensors are NOT a magical solution

- Next year's goals
  - Developing soil moisture release curves for these soil types
  - Looking at compaction issues
  - Actually quantifying irrigation volumes

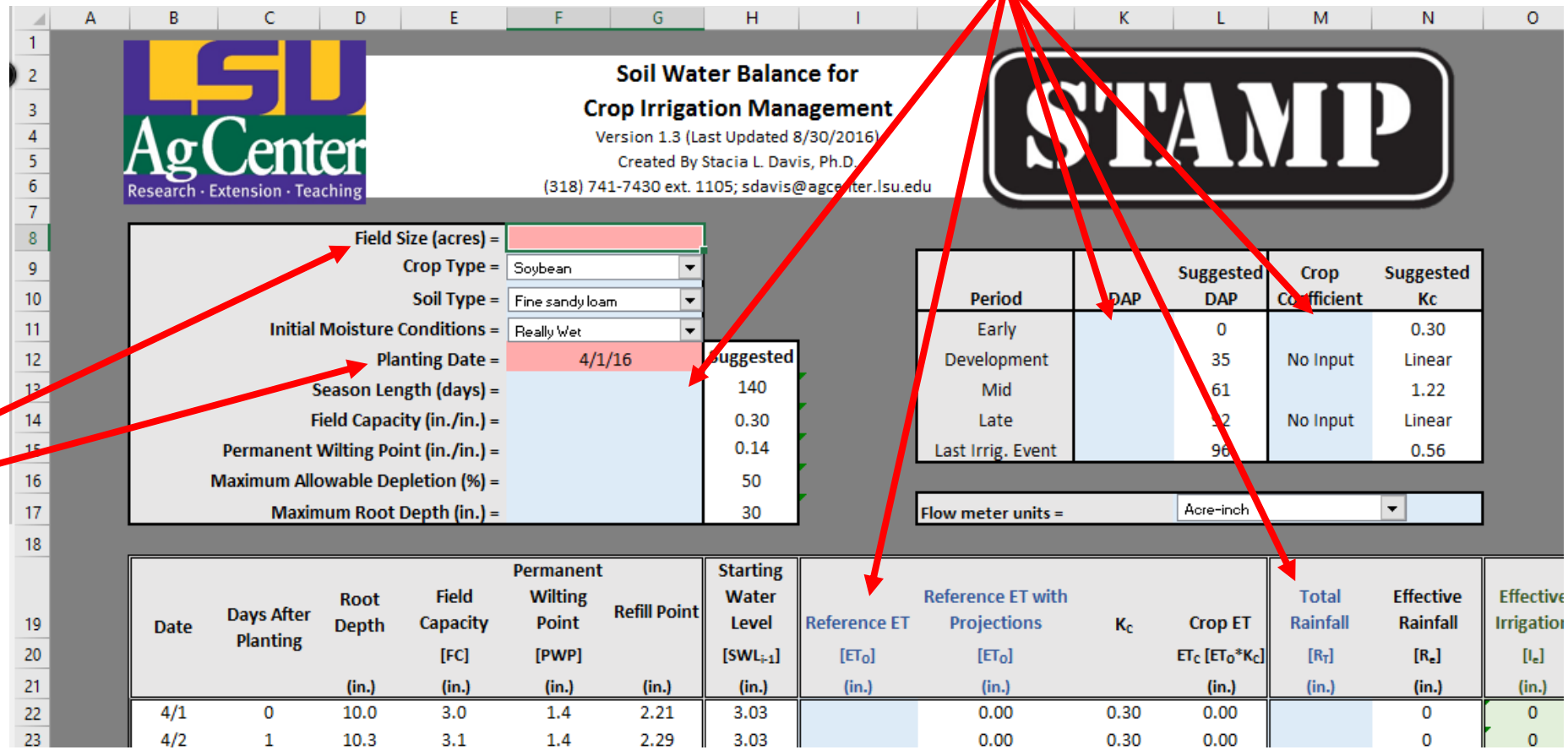
Treatment	Irrigation Per Event (in)	Irrigation Trigger Point
Watermark	3	75 cb
Decagon	3	40% Field Capacity
Weekly	3	Weekly
ET_C	0.20 – 0.40	Daily

Available Tools

- Soil water balance
  - Arkansas Irrigation Scheduler
  - MIST
  - STAMP Irrigation Tool

Blue: User inputs

Red: Mandatory information



Thank you!

Any Questions?

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