

66th Annual West Texas Agricultural Chemicals Institute
Conference

Irrigation Management with Limited Water

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Lubbock / Halfway, Texas

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USDA NIFA Ogallala Water CAP

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USDA-NRCS CIG



Limited Irrigation Capacity and Below Average Rainfall

1. Crop establishment

- Benefits of cover crops
- Irrigation system options

2. Seasonal irrigations

- reduce water value (irrigation & rainfall) by spreading water too thin

3. Irrigation timing

- early season irrigation
- irrigation termination



**2018 Dryland Cotton
Near Halfway, TX
9/6/2018**



**2018 - Low Irrigation Capacity
Near Halfway, TX
9/6/2018**



**2018 - Low Irrigation Capacity
Near Halfway, TX
9/6/2018**



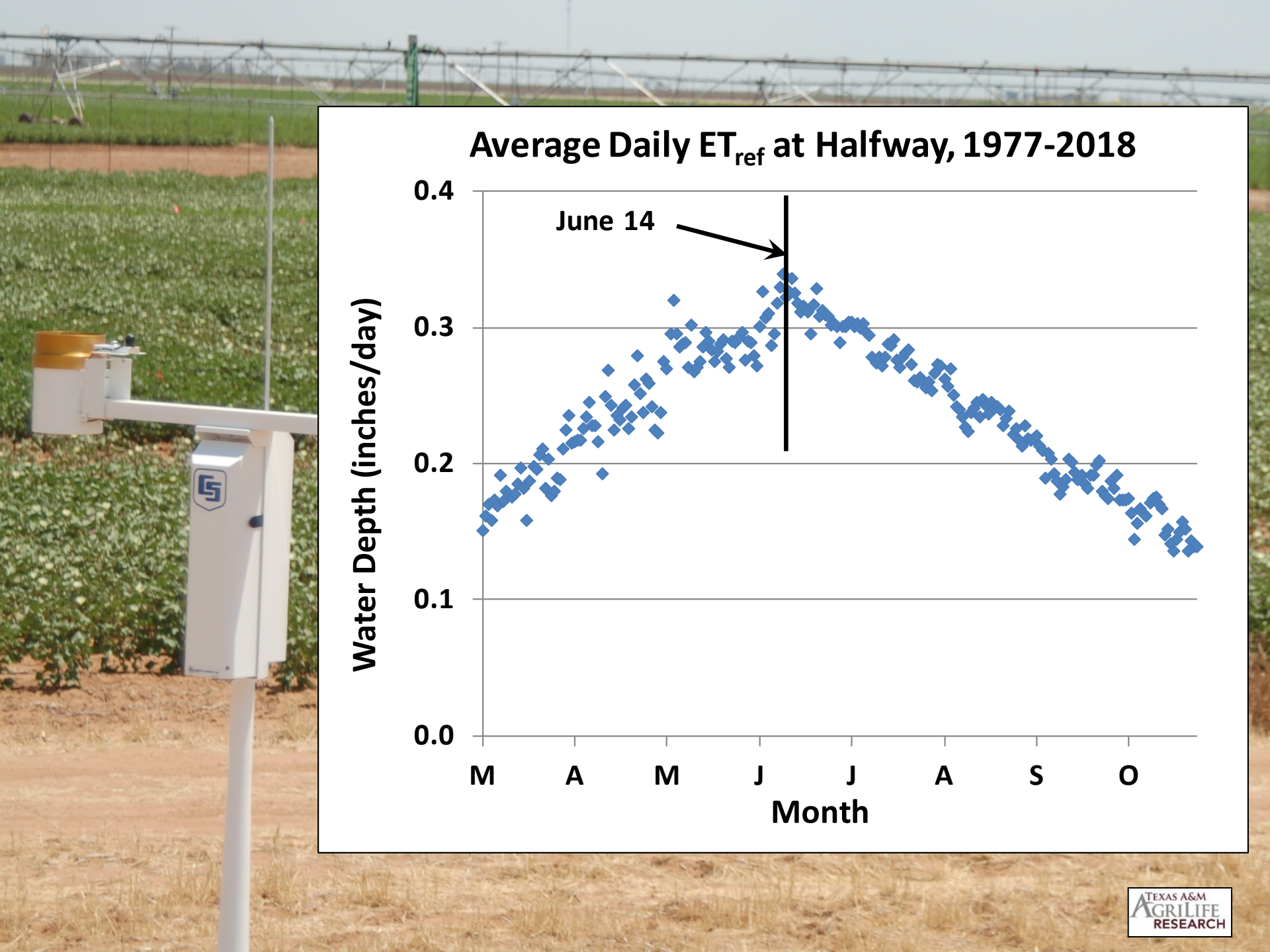
**2018 SDI Field - Cotton Seed
Germination Failure
Near Halfway, TX
9/6/2018**



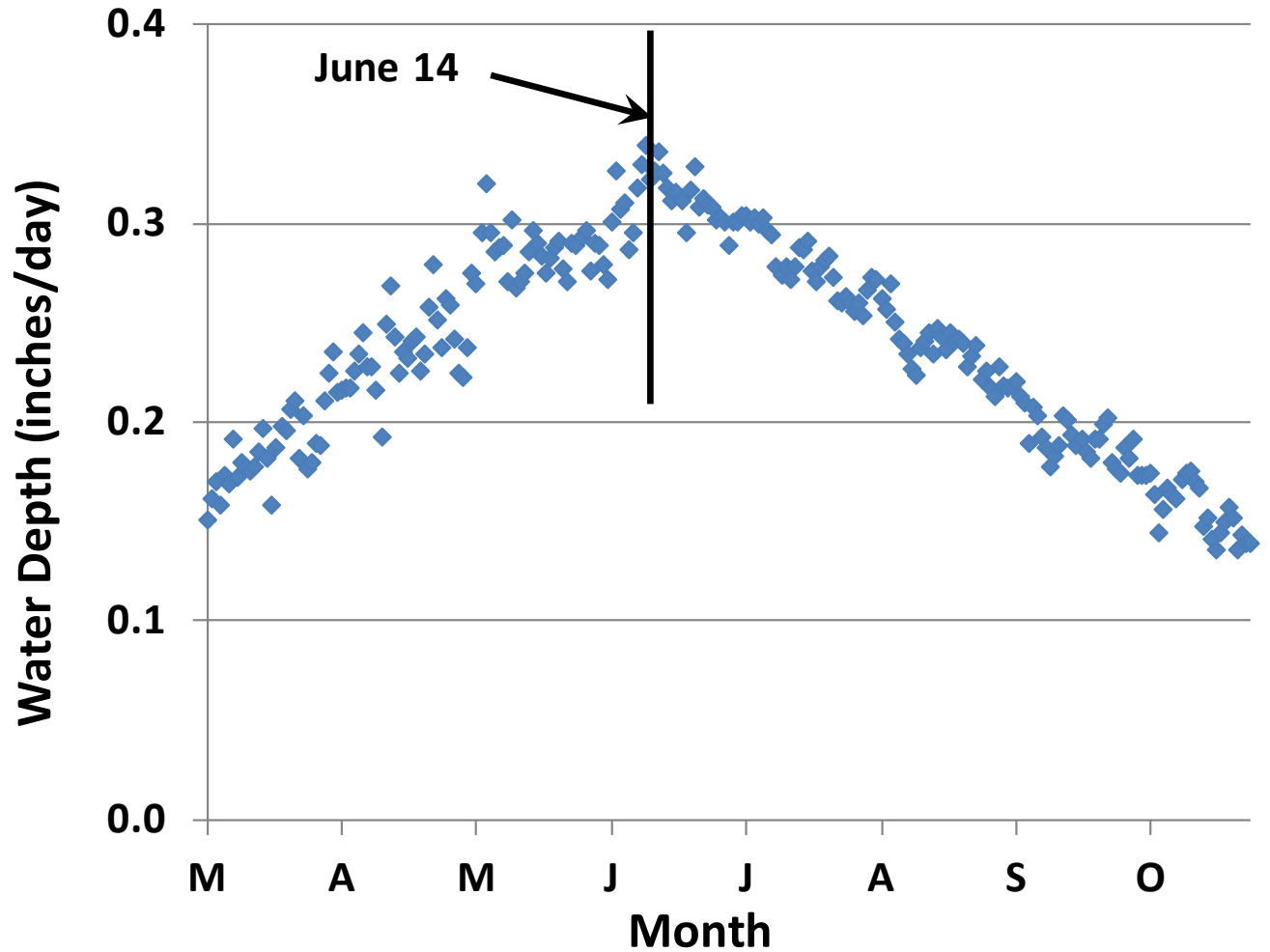
Difficult to place and store water in the soil profile with pivot applications (April – June)

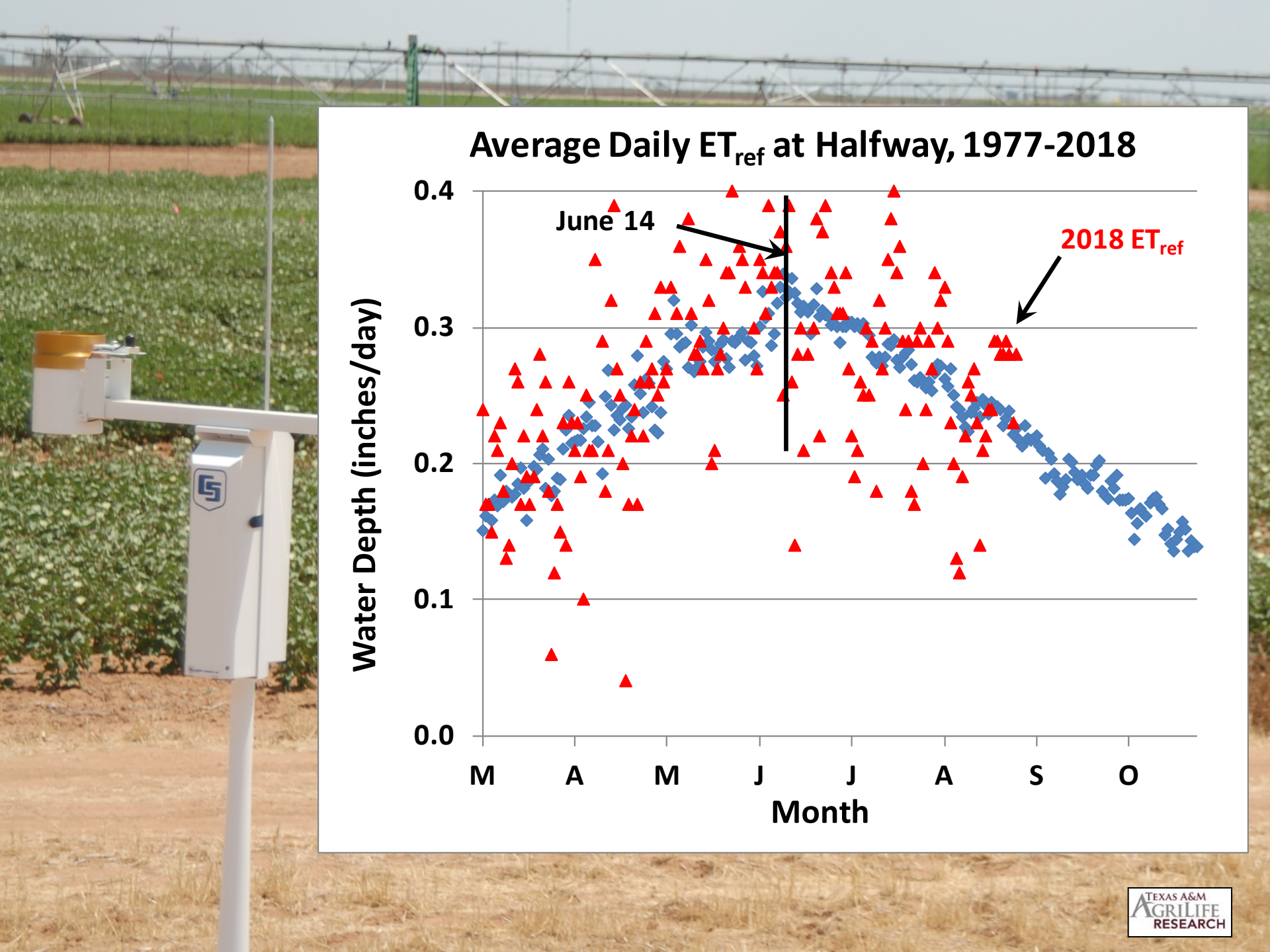
- *High E_t*
- *Low Irrigation Capacities*



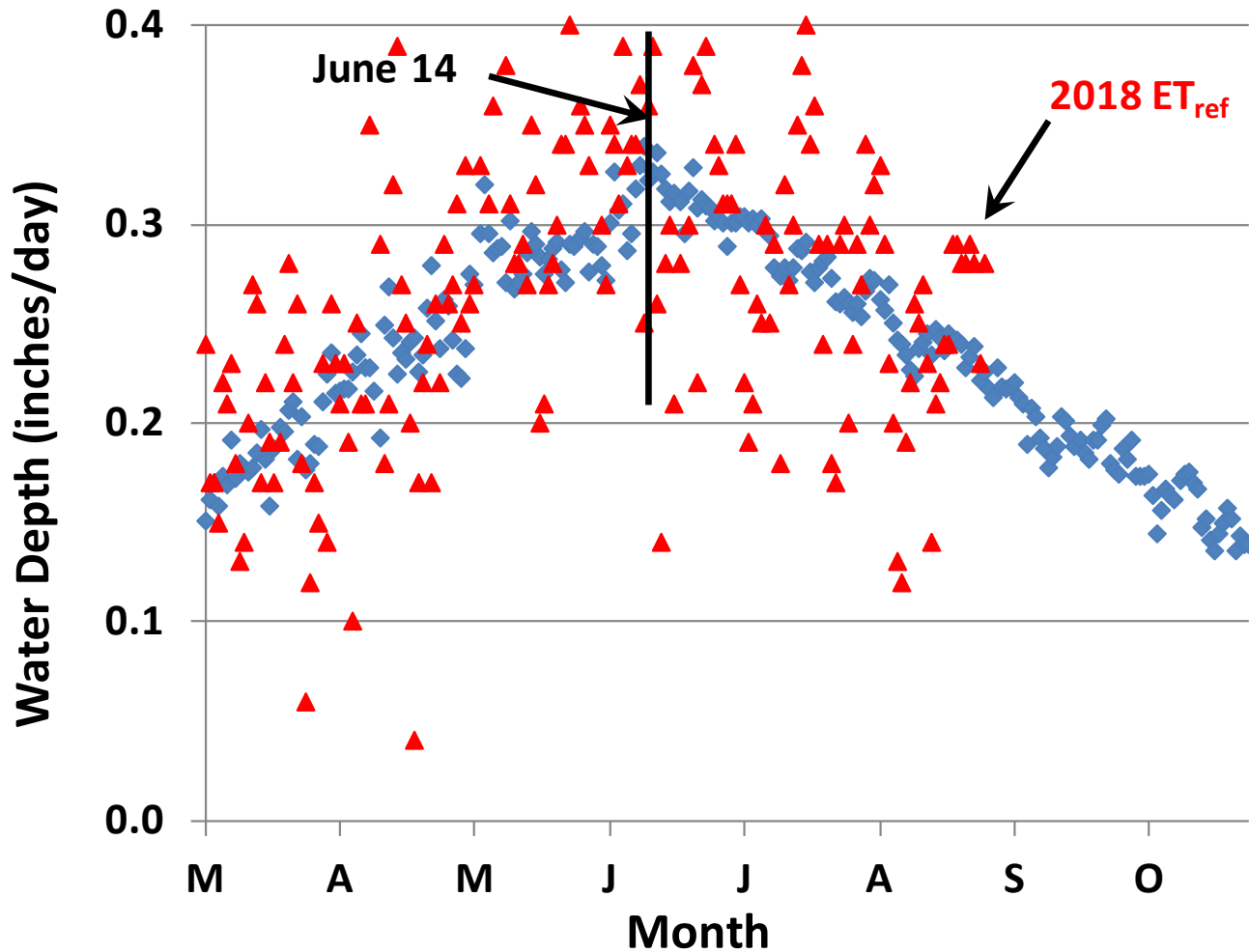


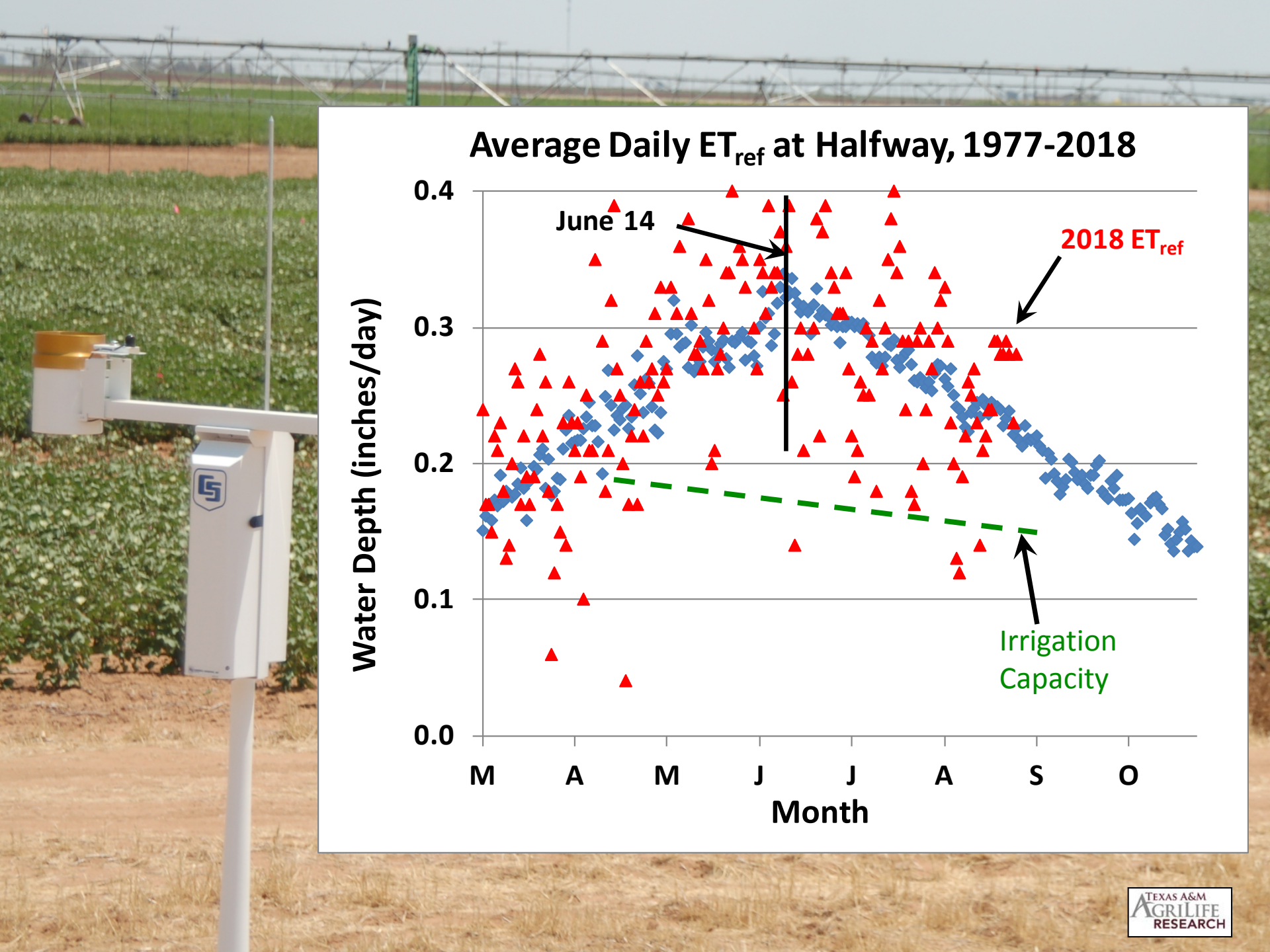
Average Daily ET_{ref} at Halfway, 1977-2018



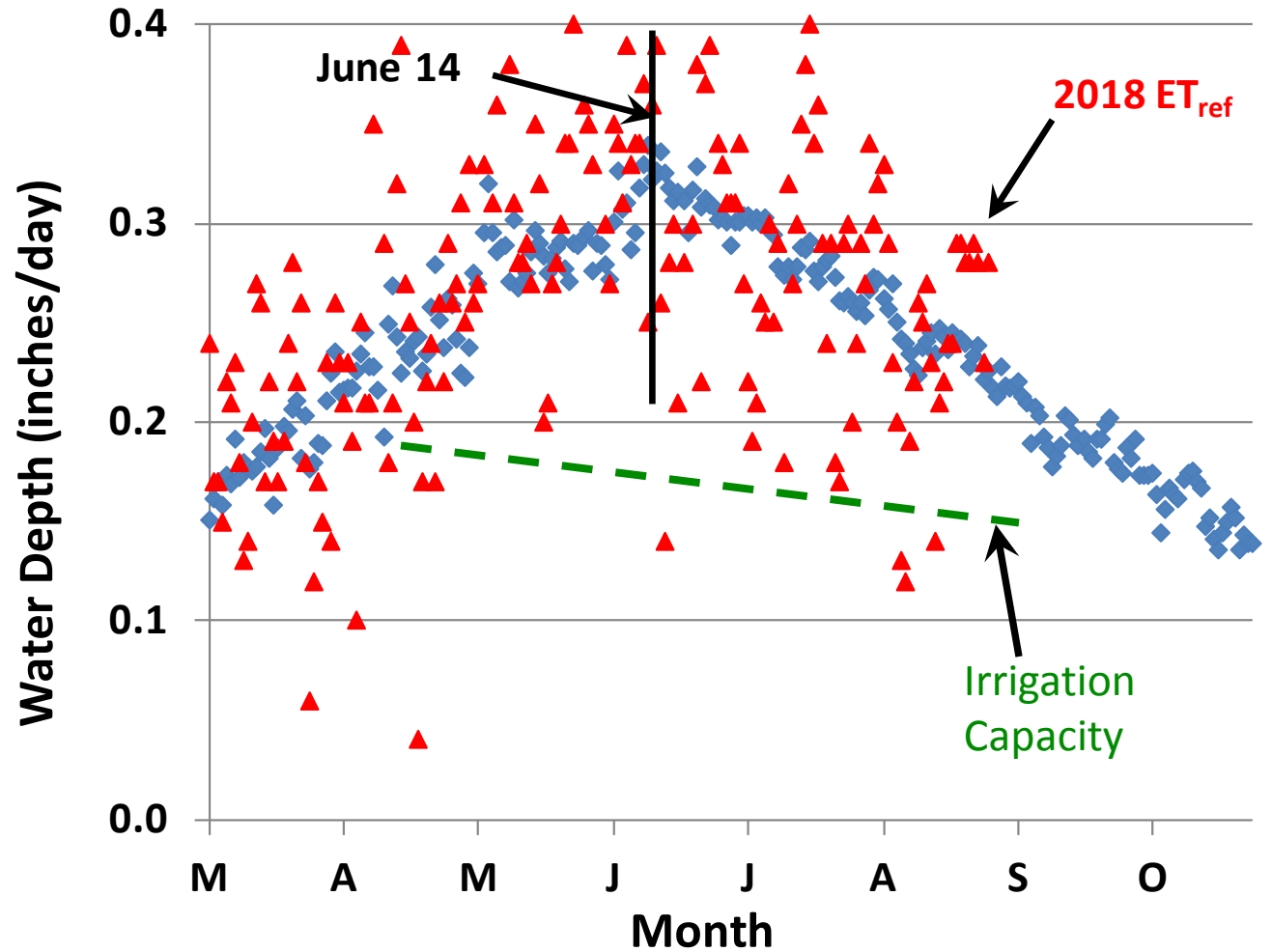


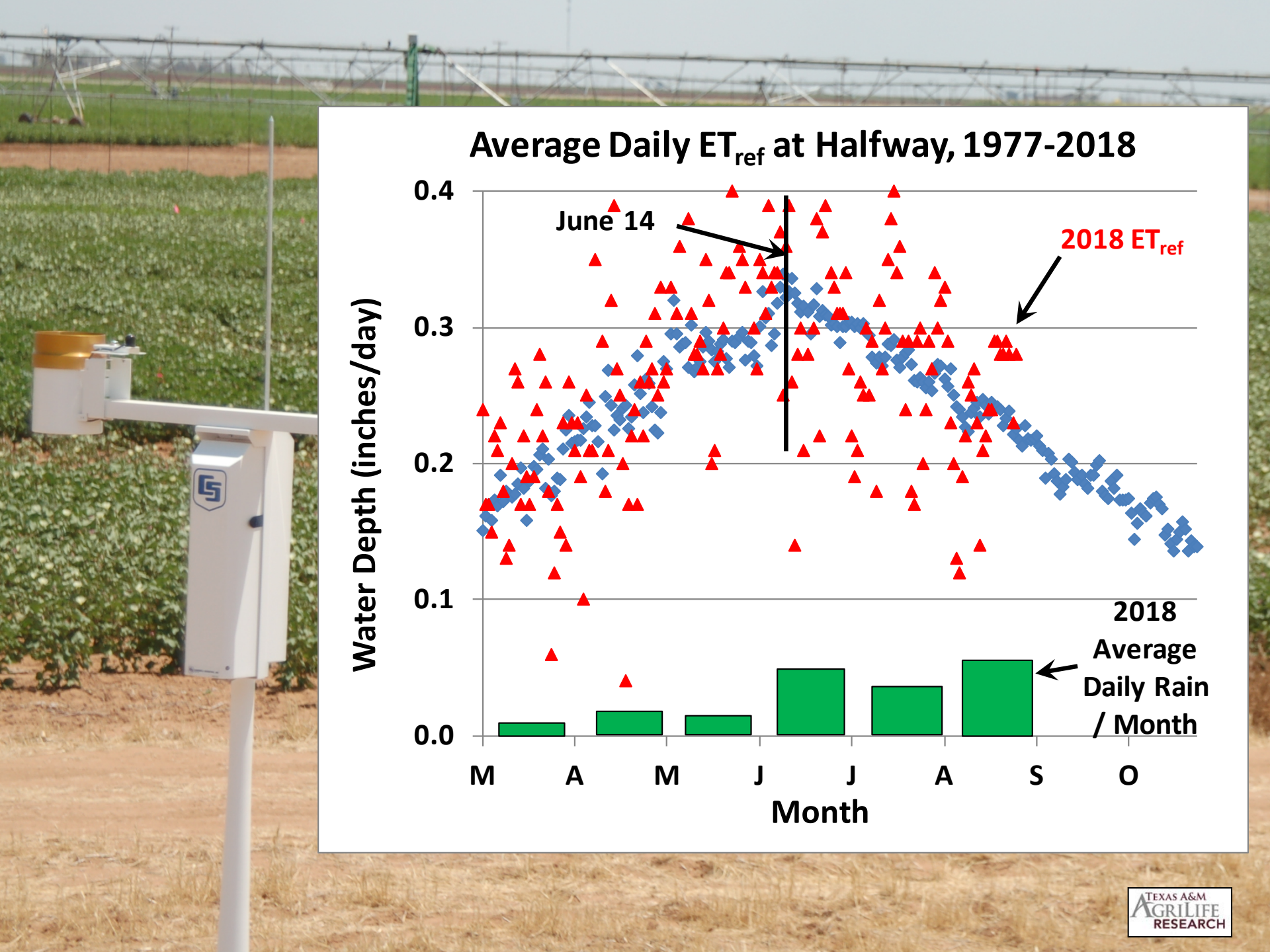
Average Daily ET_{ref} at Halfway, 1977-2018



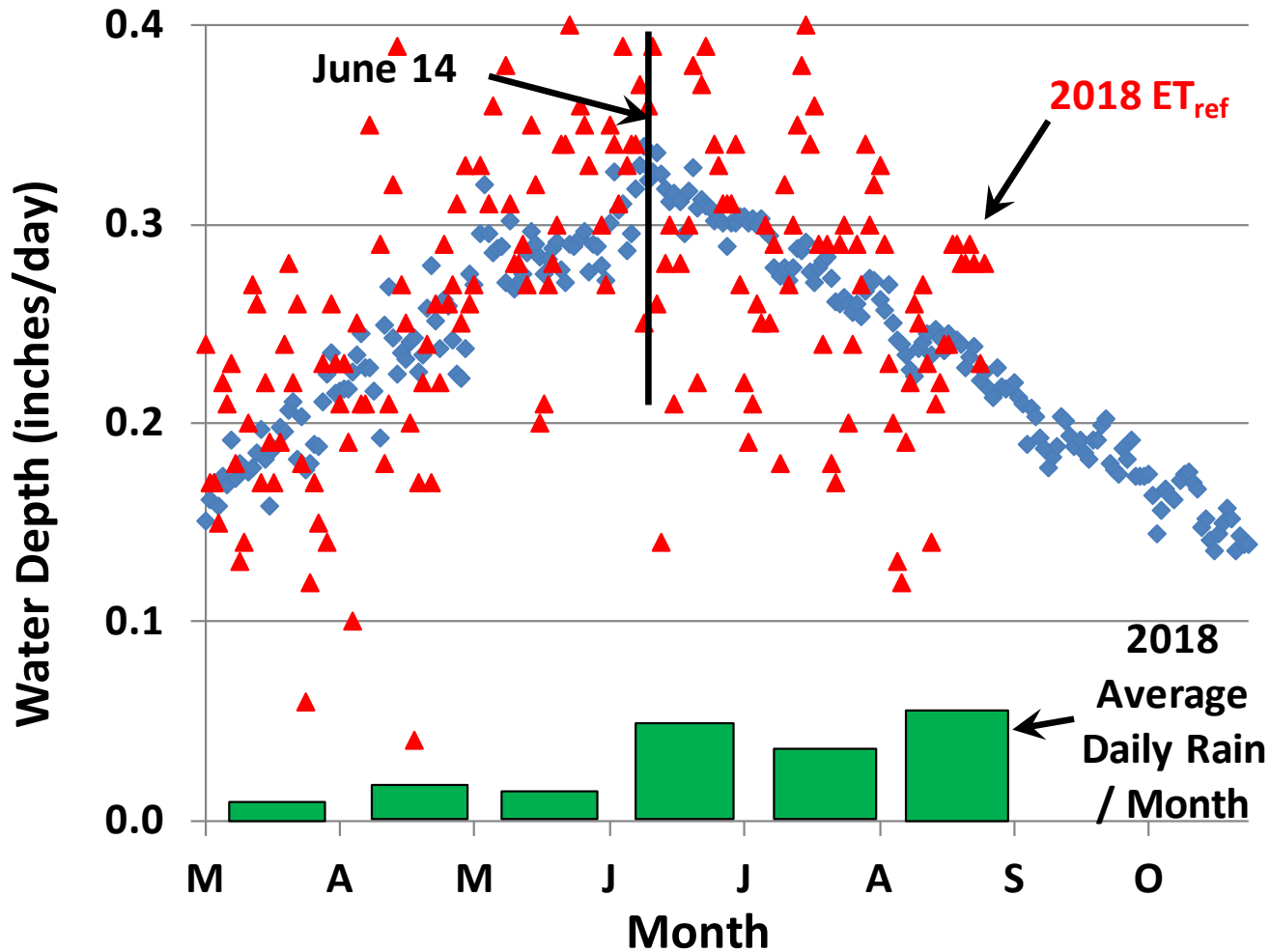


Average Daily ET_{ref} at Halfway, 1977-2018





Average Daily ET_{ref} at Halfway, 1977-2018



No-till & Terminated Cover Crops Can Reduce Evaporation and Improve Germination



Compare No-till to Conventional Till

Helms Farm - Ongoing



May 2016 – Planting Cotton

Cotton 2016, Cotton 2015



May 2016 – Planting Cotton

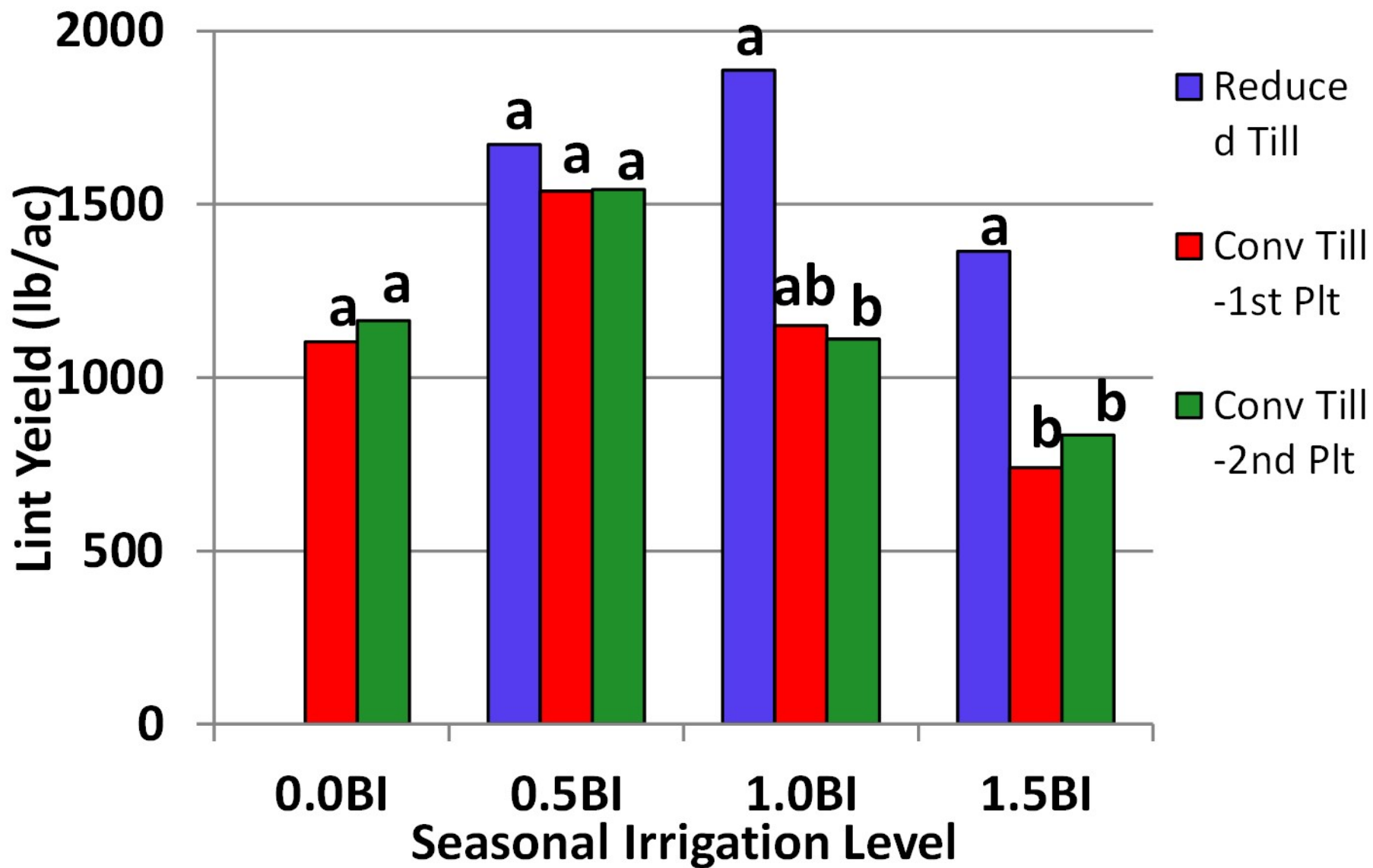
Cotton 2016, Wheat 2015



May 2016 – Planting Cotton Cotton 2016, Wheat 2015



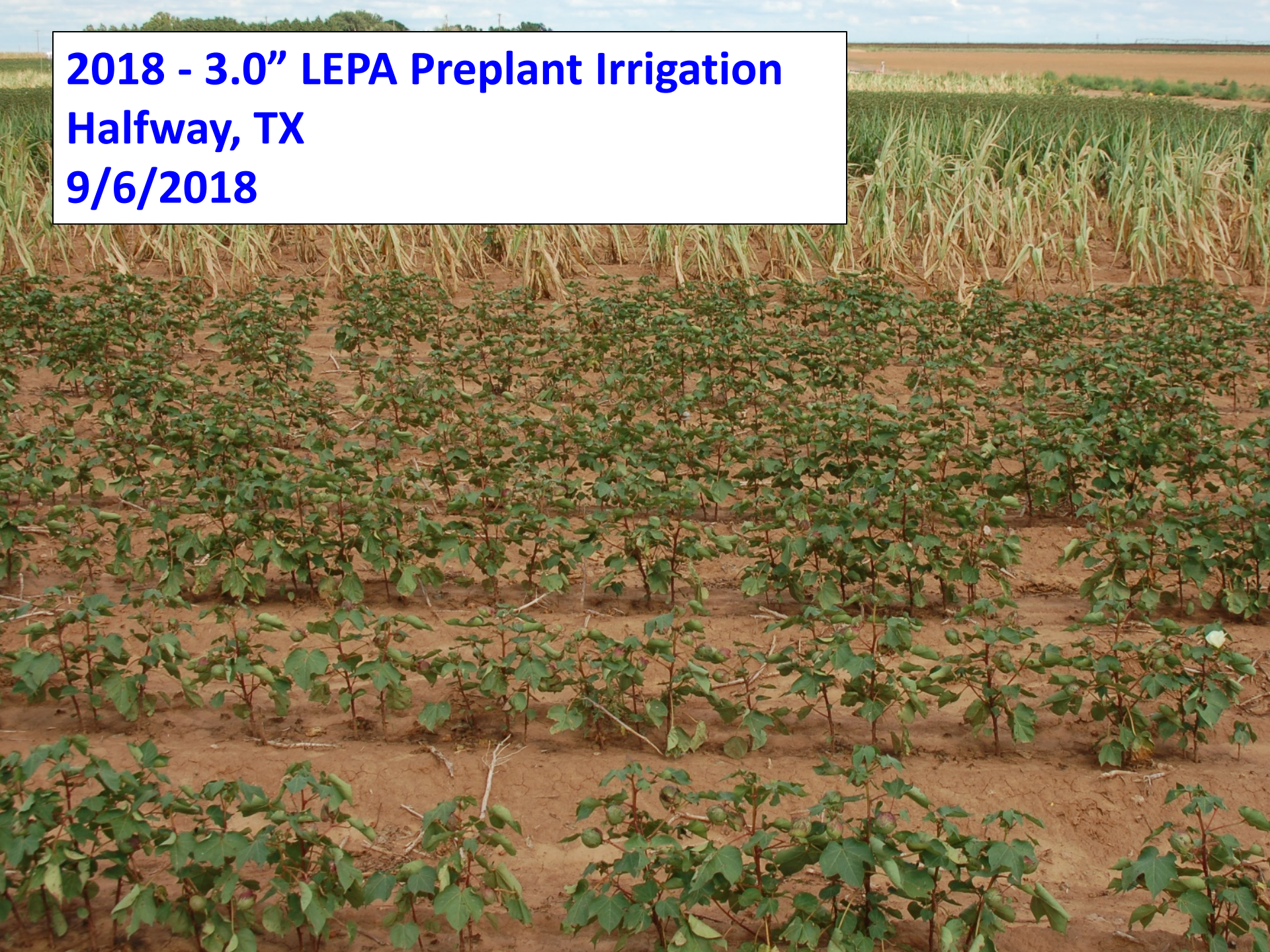
2016 Cotton Wheat Rotation



Irrigation Methods to Reduce Evaporation



**2018 - 3.0" LEPA Preplant Irrigation
Halfway, TX
9/6/2018**



Irrigation Methods to Reduce Evaporation



SDI does not guarantee germination



2013-2018 Germination Treatments

Lateral – Row Position

- T1 – traditional
- T2 – 30”- 50”
- T3 – skip row
- T4 – wet row – dry row
- T5 – every row

Planting Dates

- Early
- Late



T1 Traditional
July 20, 2013

SDI Laterals



**T2 30"-50"
July 20, 2013**

SDI Laterals



T3 Skip Row
July 20, 2013

SDI Laterals



T4 Wet Row – Dry Row
July 20, 2013

SDI Laterals



T5 Every Row
July 20, 2013

SDI Laterals

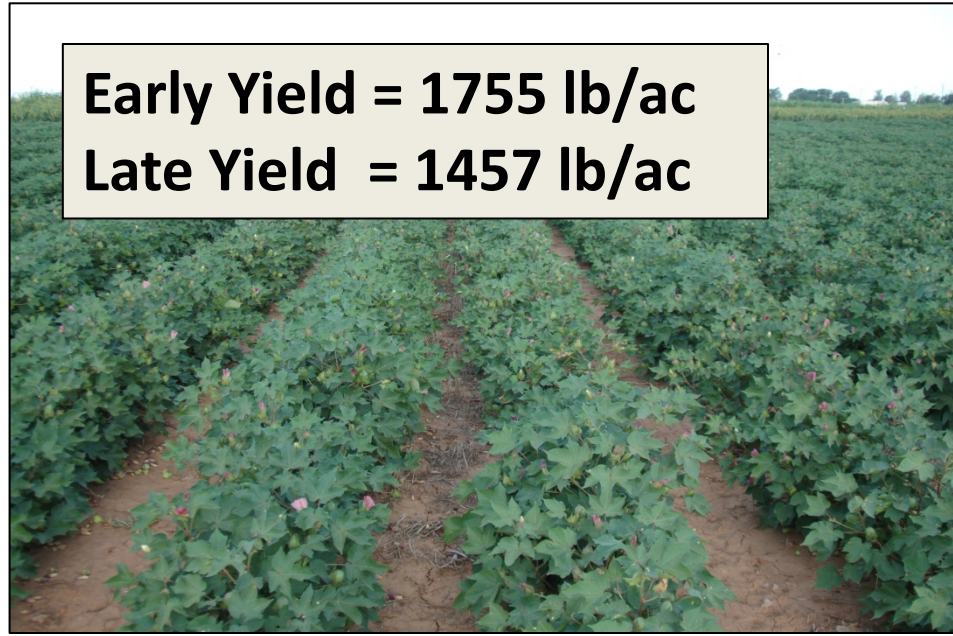


Traditional

2013 -2017

Early Yield = 1755 lb/ac

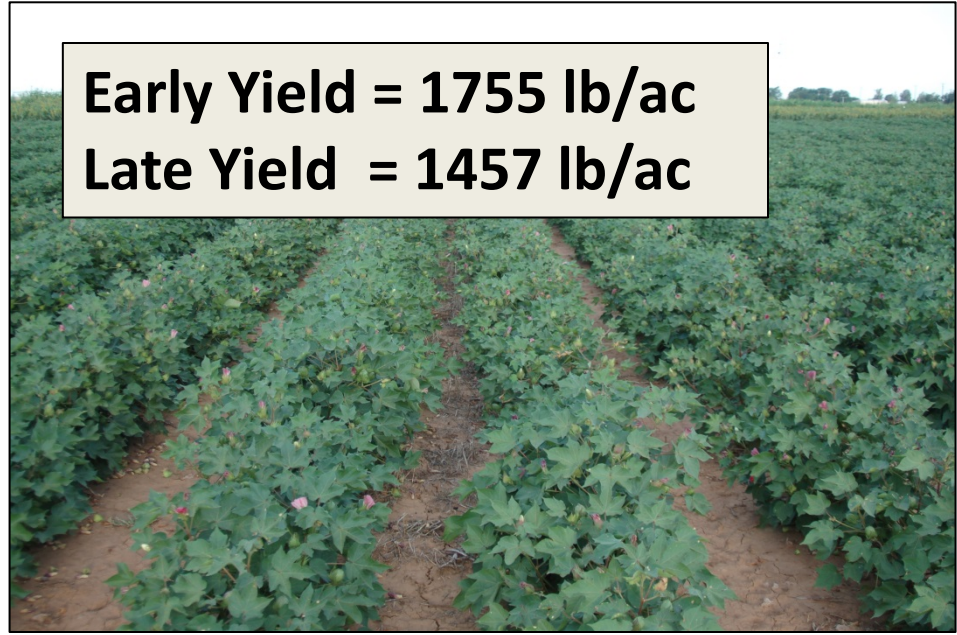
Late Yield = 1457 lb/ac




Traditional

2013 -2017

30-50 Planting

A photograph of a traditional planting field with wide rows of green plants. A text box is overlaid on the top left of the image.

Early Yield = 1755 lb/ac
Late Yield = 1457 lb/ac


A photograph of a 30-50 planting field with narrow rows of green plants. A text box is overlaid on the top left of the image.

Early Yield = 1709 lb/ac
Late Yield = 1416 lb/ac


Traditional

2013 -2017

30-50 Planting

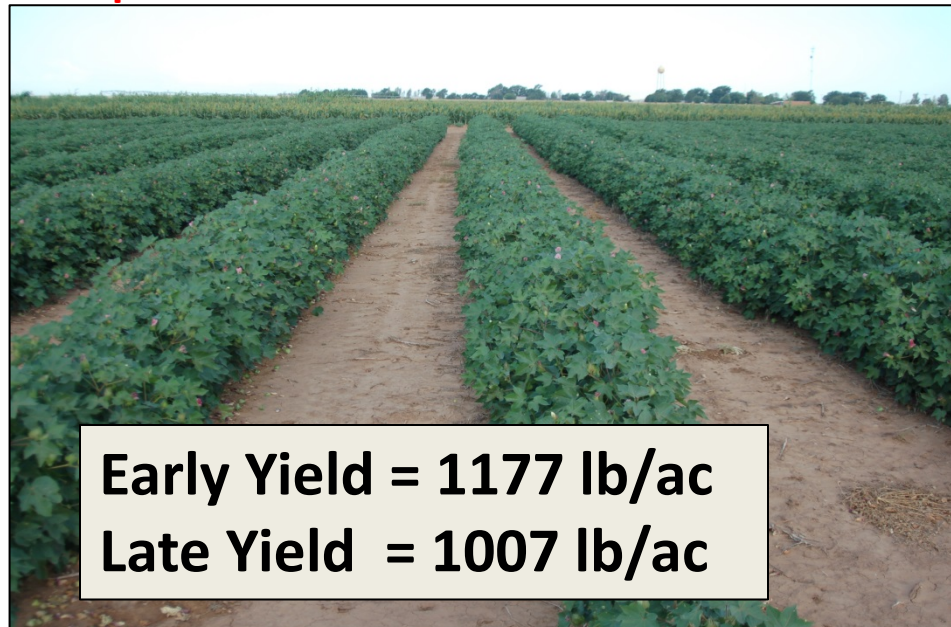
A photograph of a traditional soybean field with rows of plants. A text box is overlaid on the left side.

Early Yield = 1755 lb/ac
Late Yield = 1457 lb/ac

A photograph of a 30-50 planting soybean field with rows of plants. A text box is overlaid on the left side.

Early Yield = 1709 lb/ac
Late Yield = 1416 lb/ac

Skip Row

A photograph of a skip row soybean field with rows of plants. A text box is overlaid on the bottom left side.

Early Yield = 1177 lb/ac
Late Yield = 1007 lb/ac

Traditional

2013 -2017

30-50 Planting

**Early Yield = 1755 lb/ac
Late Yield = 1457 lb/ac**

**Early Yield = 1709 lb/ac
Late Yield = 1416 lb/ac**

Skip Row

Skip Row - Plus

**Early Yield = 1177 lb/ac
Late Yield = 1007 lb/ac**

**Early Yield = 1388 lb/ac
Late Yield = 1157 lb/ac**

Traditional

2013 -2017

30-50 Planting

Early Yield = 1755 lb/ac
Late Yield = 1457 lb/ac

Early Yield = 1709 lb/ac
Late Yield = 1416 lb/ac

SDI Under All Rows

Early Yield = 1767 lb/ac
Late Yield = 1462 lb/ac

Skip Row

Skip Row - Plus

Early Yield = 1177 lb/ac
Late Yield = 1007 lb/ac

Early Yield = 1388 lb/ac
Late Yield = 1157 lb/ac

Traditional

2013 -2017

30-50 Planting

Early Yield = 1755 lb/ac
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Traditional

2013 -2017

30-50 Planting

Early Yield = 1755 lb/ac
Late Yield = 1457 lb/ac

Early Yield = 1709 lb/ac
Late Yield = 1416 lb/ac

SDI Under All Rows

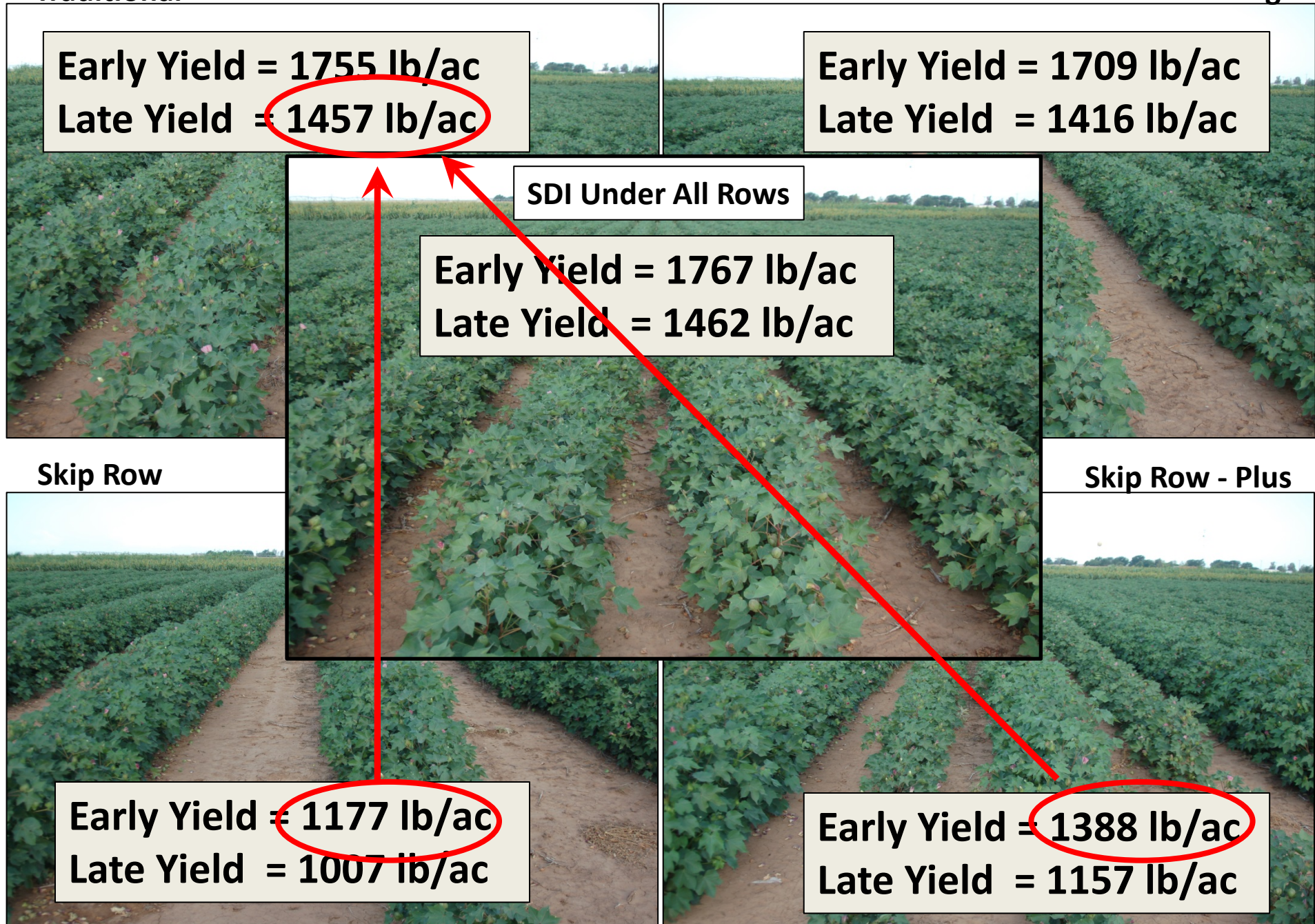
Early Yield = 1767 lb/ac
Late Yield = 1462 lb/ac

Skip Row

Skip Row - Plus

Early Yield = 1177 lb/ac
Late Yield = 1007 lb/ac

Early Yield = 1388 lb/ac
Late Yield = 1157 lb/ac



Current Conclusion

- **Wait for water to plant.**
- **As a last resort, plant in skip-row pattern late in planting window.**

Water Value is Reduced by Spreading Irrigation Too Thin.



General Goal –

Develop crop response data where rainfall is leveraged with low levels of irrigation in crop rotations with cotton (data to be available for crop and economic decision models)

General Goal –

Develop crop response data where rainfall is leveraged with low levels

**of irrig
cotton
econo**

Irrigation Treatments

- 3” preplant + 0” in-season**
- 3” preplant + 3” in-season**
- 3” preplant + 6” in-season**

General Goal –

Develop crop response data where rainfall is leveraged with low levels

of irrigation
cotton
econo

Irrigation Treatments

- 3” preplant + 0” in-season
- 3” preplant + 3” in-season
- 3”

Crop Sequence

- 2 years cotton
- 1 year of an alternative crop

General Goal –

Develop crop response data where rainfall is leveraged with low levels

of irrigation
cotton
econo

Irrigation Treatments

- 3” preplant + 0” in-season
- 3” preplant + 3” in-season

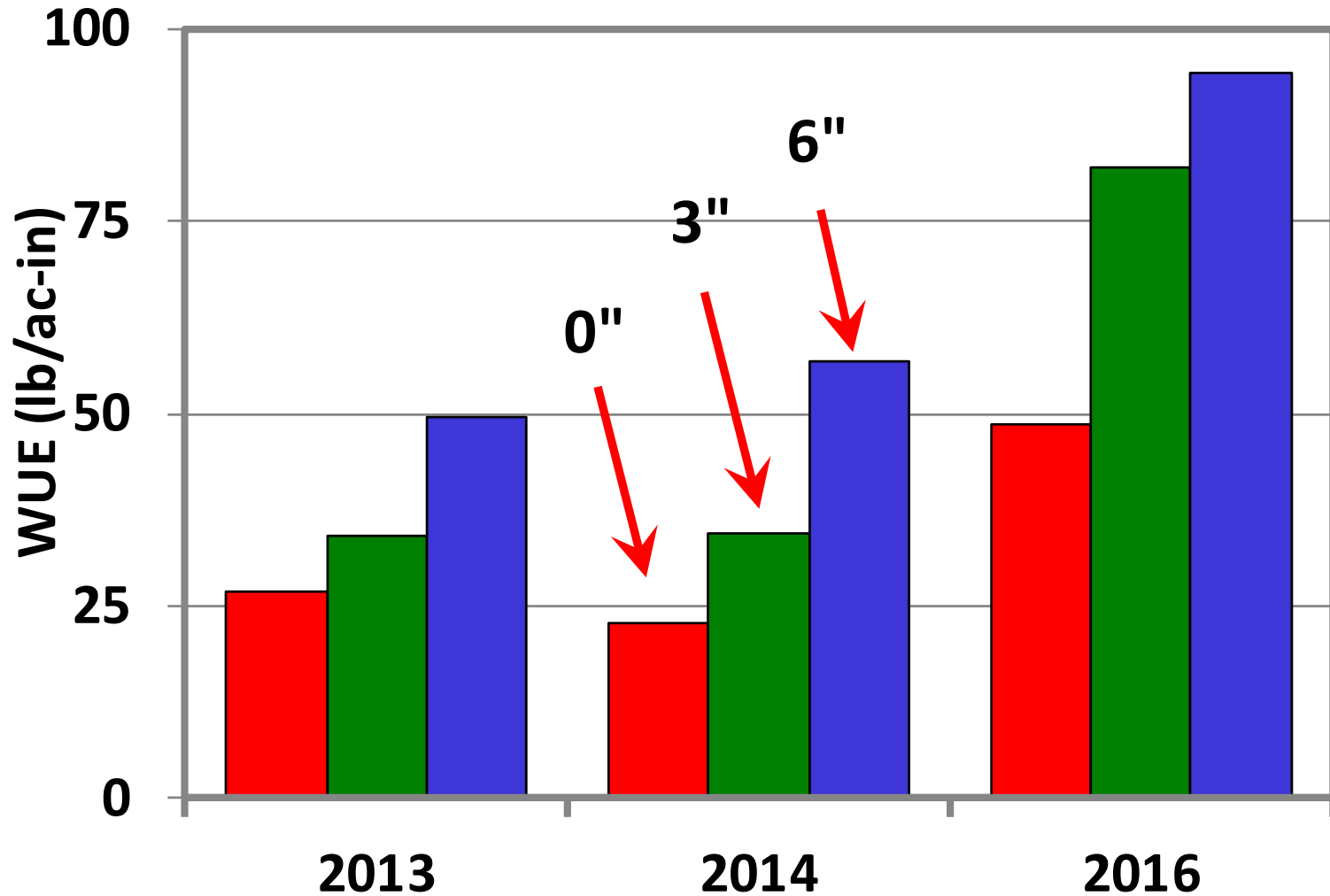
– 3” Crop Sequence

2017 - 18 Alternative Crops

- Corn 12k ppa
- 20k ppa
- Grain Sorghum 22k ppa
- 40k ppa


Water Productivity

Continuous Cotton



Irrigation Timing





**When do you use
available water?**



LMM

Oct 21, 2013

6.97" S. Irr.

1155 lb/ac

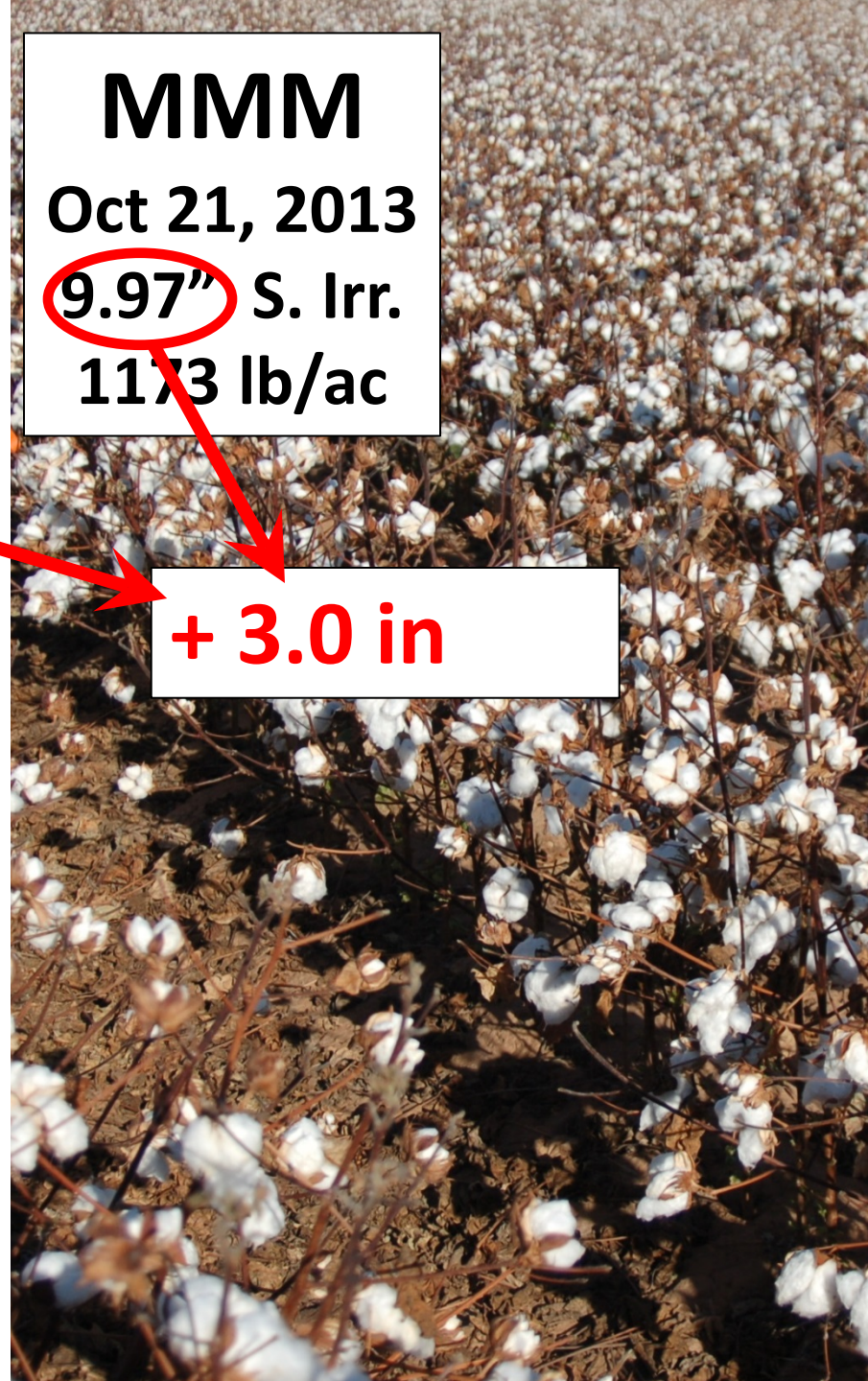
MMM

Oct 21, 2013

9.97" S. Irr.

1173 lb/ac

+ 3.0 in



LMM

Oct 21, 2013

6.97" S. Irr.

1155 lb/ac

MMM

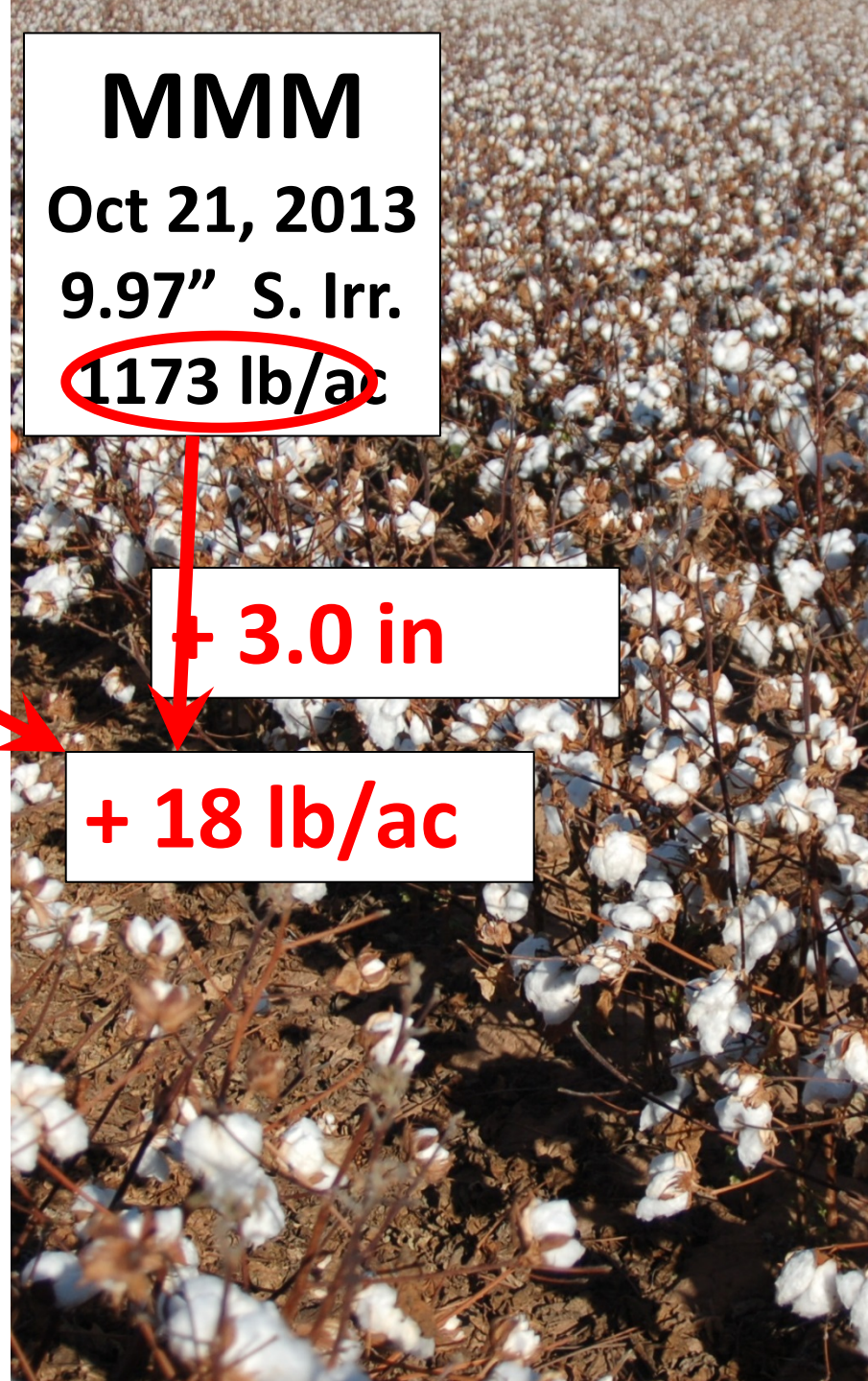
Oct 21, 2013

9.97" S. Irr.

1173 lb/ac

+ 3.0 in

+ 18 lb/ac



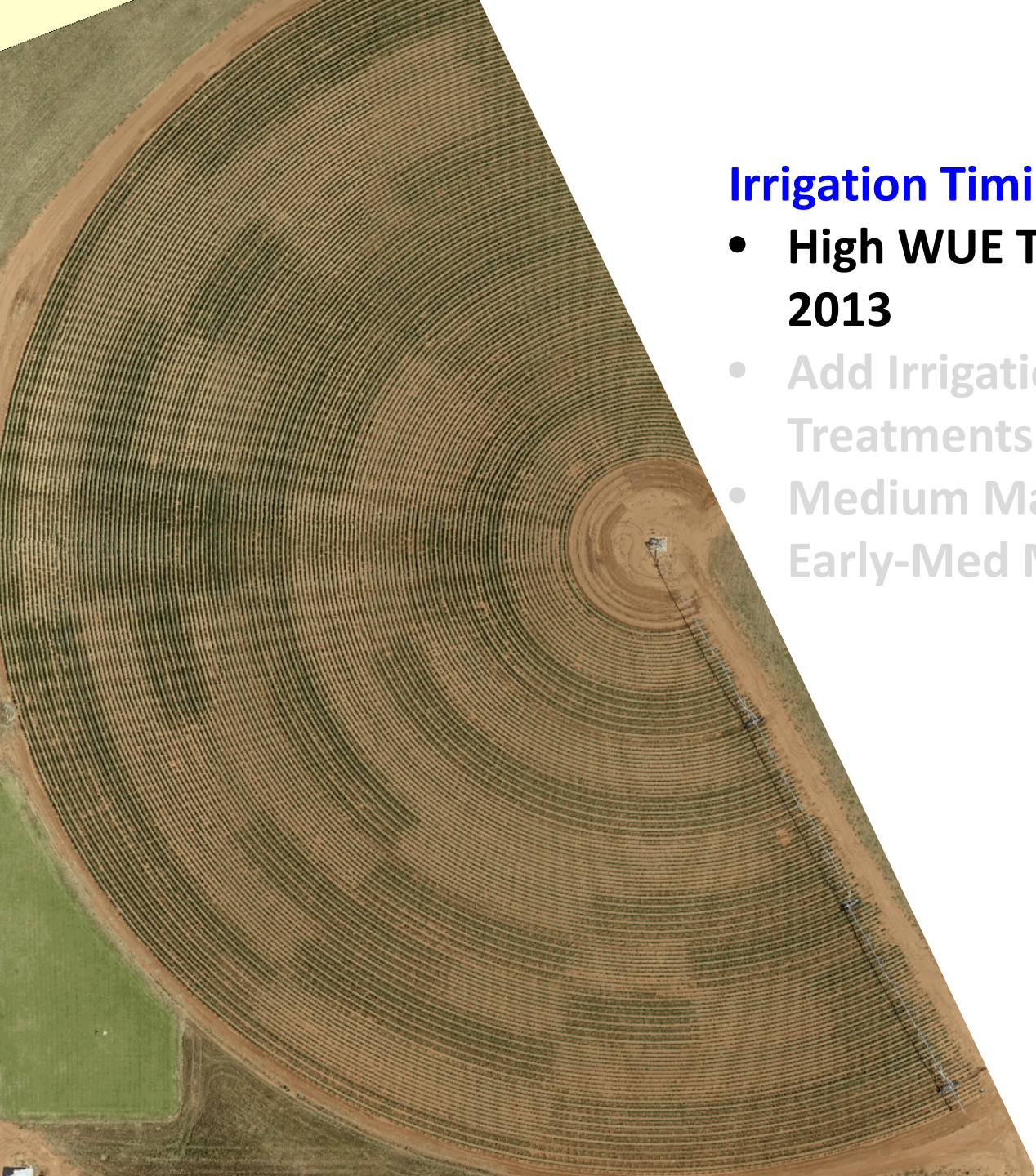


One Conclusion

- Attempting to build “profile water” early in growing season (with pivot irrigation) reduces irrigation water value.

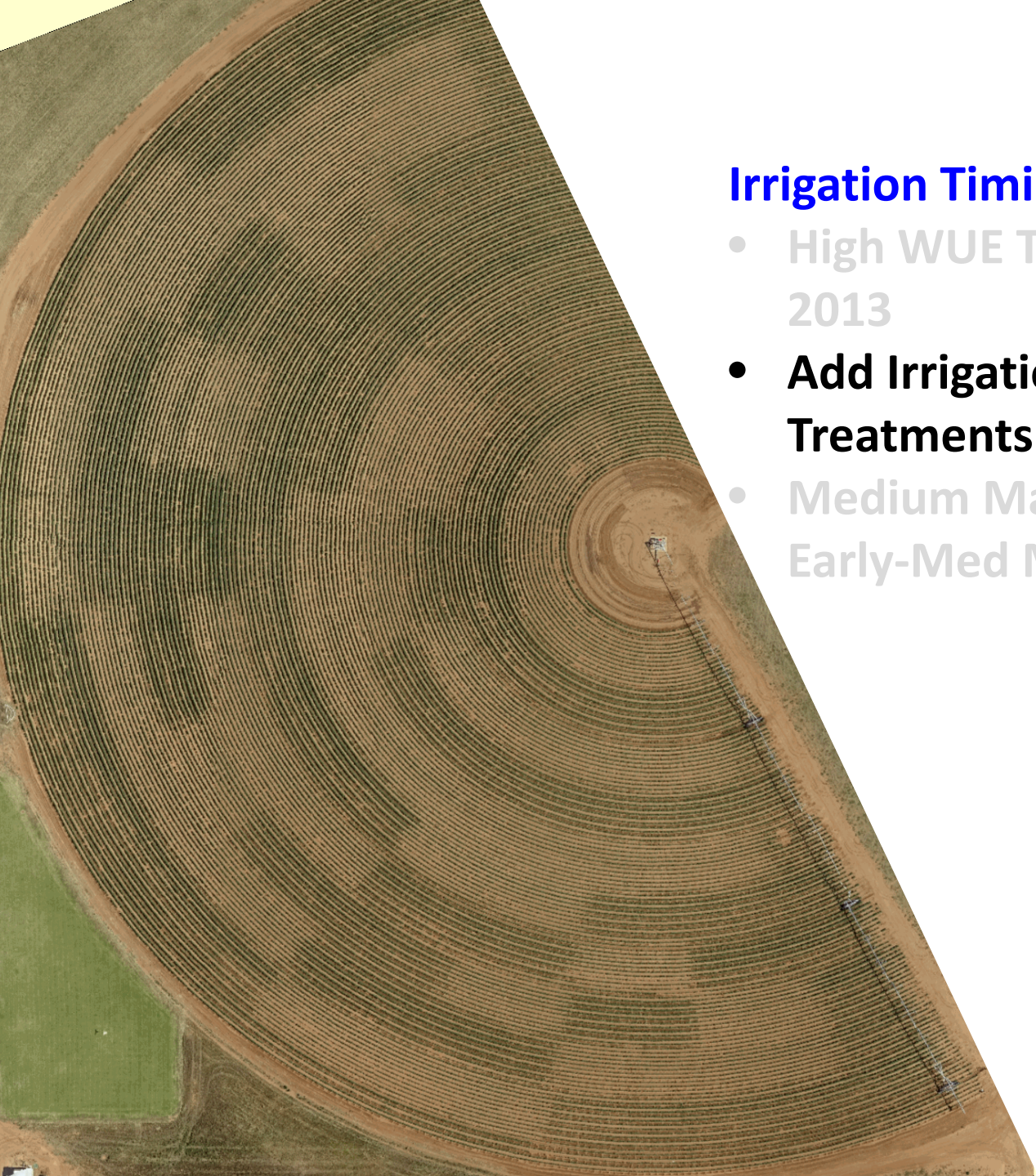
**2016-2018
Variable Rate Pivot**





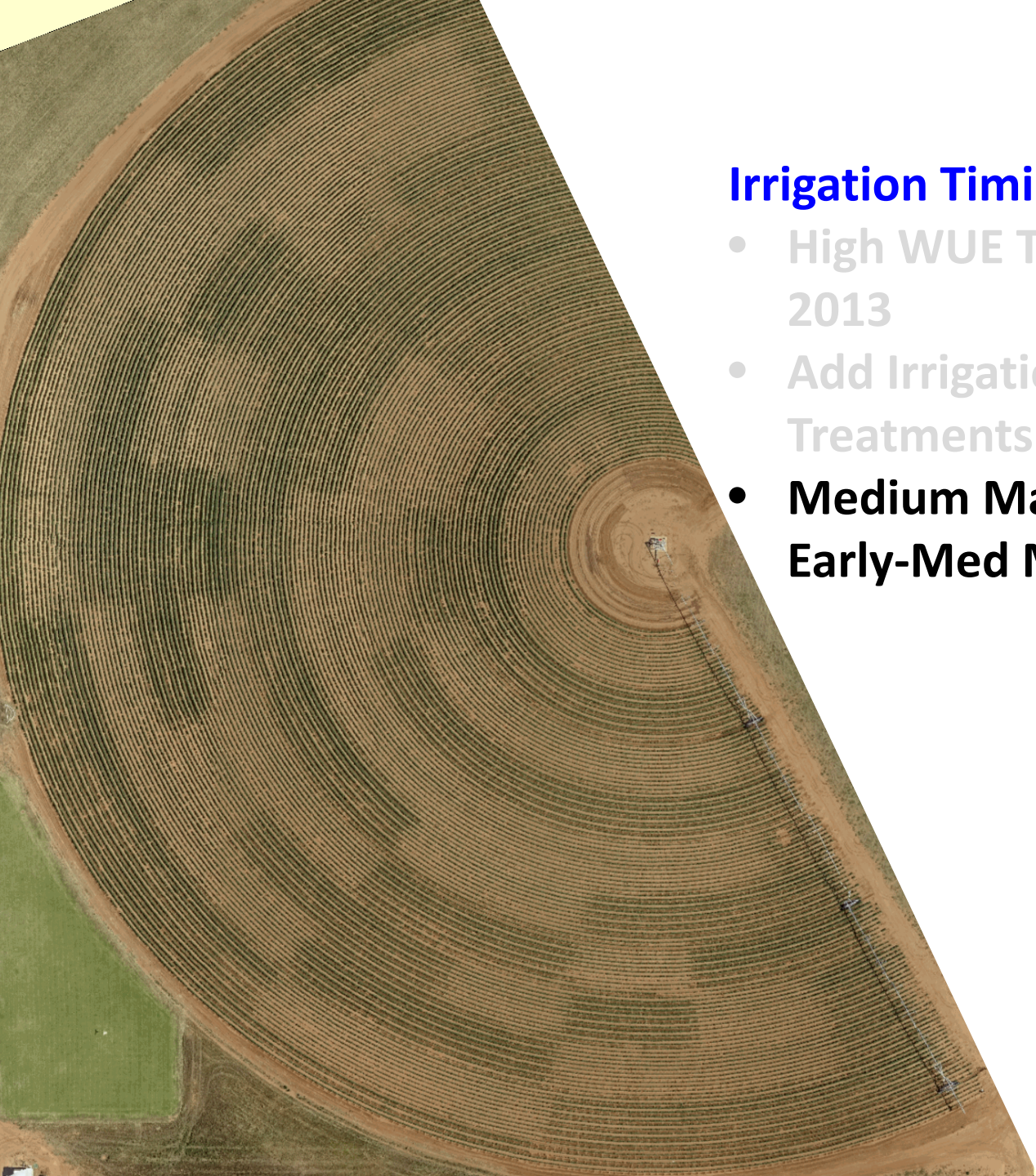
Irrigation Timing Treatment Factors

- **High WUE Treatments from 2010-2013**
- Add Irrigation Termination Treatments
- Medium Maturity (FM 2484 B2F) + Early-Med Maturity (FM 2011 GT)



Irrigation Timing Treatment Factors

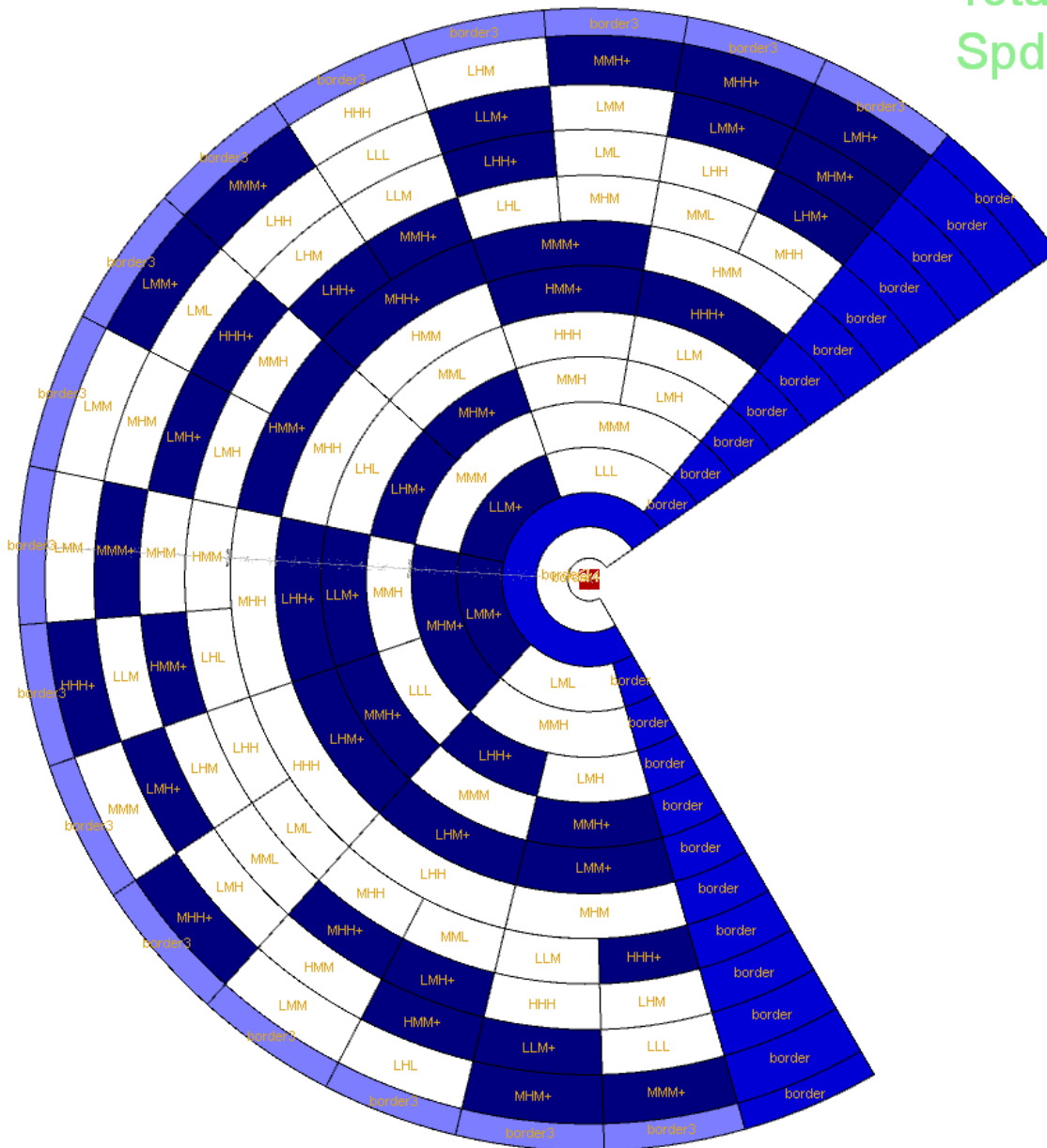
- High WUE Treatments from 2010-2013
- **Add Irrigation Termination Treatments**
- Medium Maturity (FM 2484 B2F) + Early-Med Maturity (FM 2011 GT)



Irrigation Timing Treatment Factors

- High WUE Treatments from 2010-2013
- Add Irrigation Termination Treatments
- **Medium Maturity (FM 2484 B2F) + Early-Med Maturity (FM 2011 GT)**

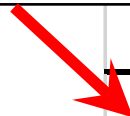
Total Flow: 55.9gpm
Spd: A 0.0% B 2.5%





2016 -2018 Irrigation Timing Treatments

Med. Maturity



FM 2484

and

FM 2011



**Early -Med.
Maturity**

	Aug 31 Irrigation Termination	Sept 18 Irrigation Termination
FM 2484	LLL	
and	LLM	LLM+
FM 2011	LML	
	LMM	LMM+
	LHL	
	LMH	LMH+
	MML	
	LHM	LHM+
	HMM	HMM+
	LHH	LHH+
	MMM	MMM+
	MMH	MMH+
	HHH	HHH+
	MHH	MHH+
	MHM	MHM+

2016 -2018 Irrigation Timing Treatments

**Repeat Irr.
Treatments**

**New Irr.
Treatments**

**+0.00”
in 2016**

**Aug 31 Irrigation
Termination**


**Sept 18 Irrigation
Termination**

FM 2484	LLL	
and	LLM	LLM+
FM 2011	LML	
	LMM	LMM+
	LHL	
	LMH	LMH+
	MML	
	LHM	LHM+
	HMM	HMM+
	LHH	LHH+
	MMM	MMM+
	MMH	MMH+
	HHH	HHH+
	MHH	MHH+
	MHM	MHM+

2016 -2018 Irrigation Timing Treatments

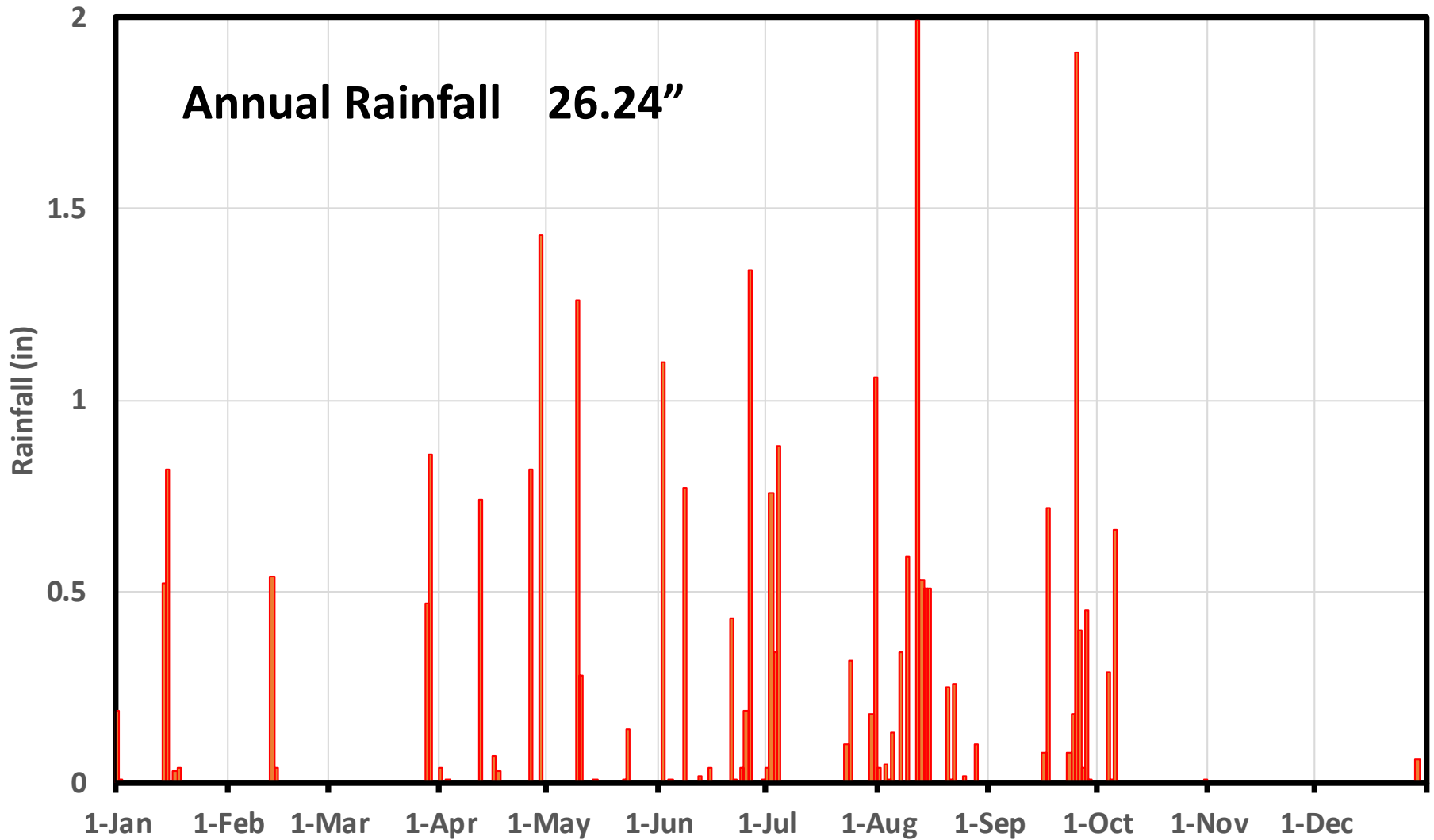
	Aug 31 Irrigation Termination	Sept 18 Irrigation Termination
FM 2484	LLL	
and	LLM	LLM+
FM 2011	LML	
	LMM	LMM+
	LHL	
	LMH	LMH+
	MML	
	LHM	LHM+
	HMM	HMM+
	LHH	LHH+
	MMM	MMM+
	MMH	MMH+
	HHH	HHH+
	MHH	MHH+
	MHM	MHM+

**+1.25”
in 2017**

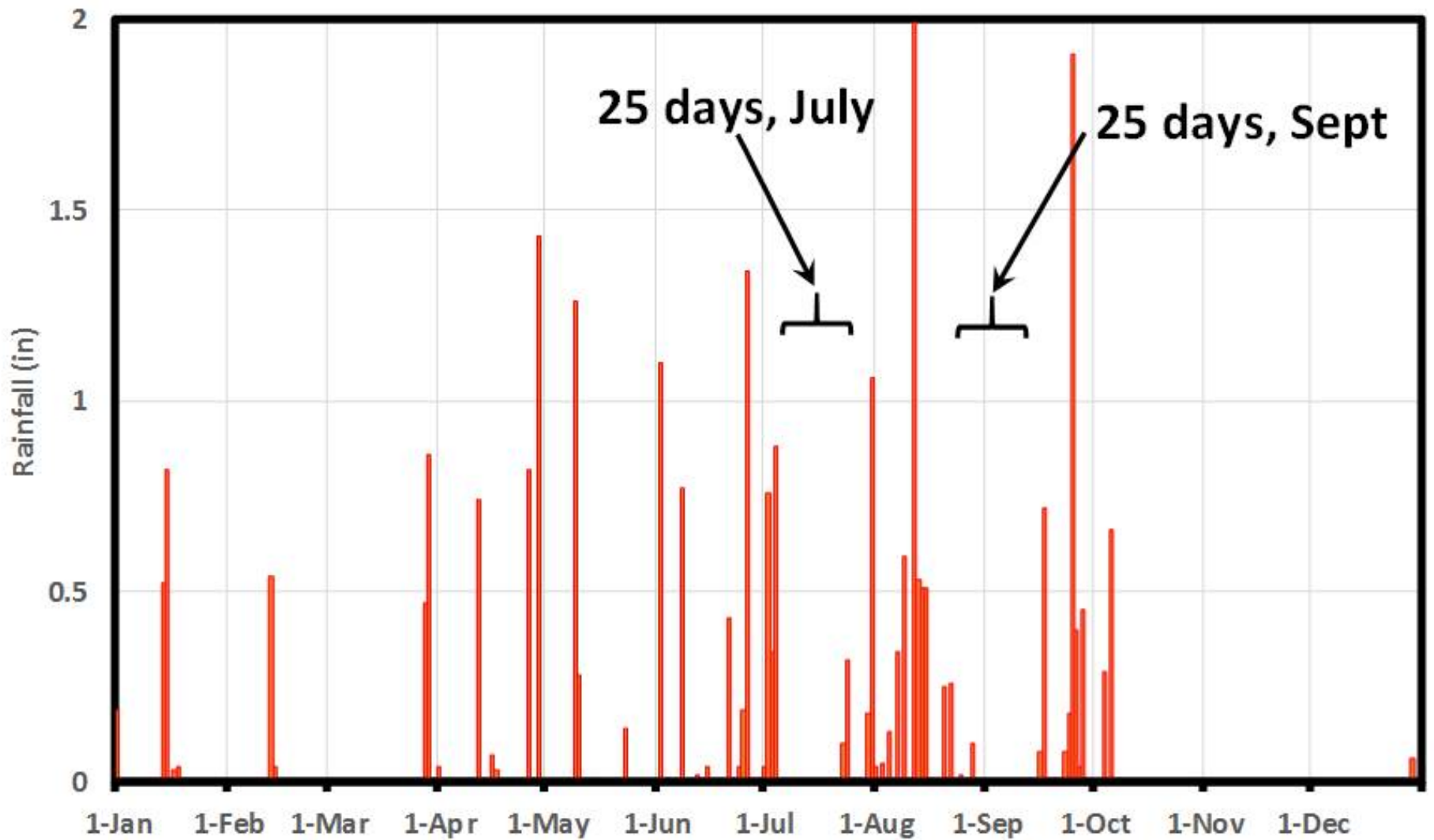


2017 Halfway CS Rain (in)

Annual Rainfall 26.24"



2017 Halfway CS Rain (in)



July 4, 2017

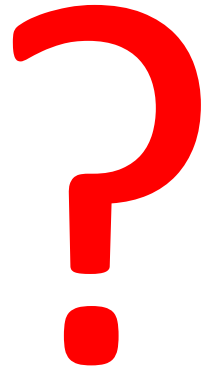




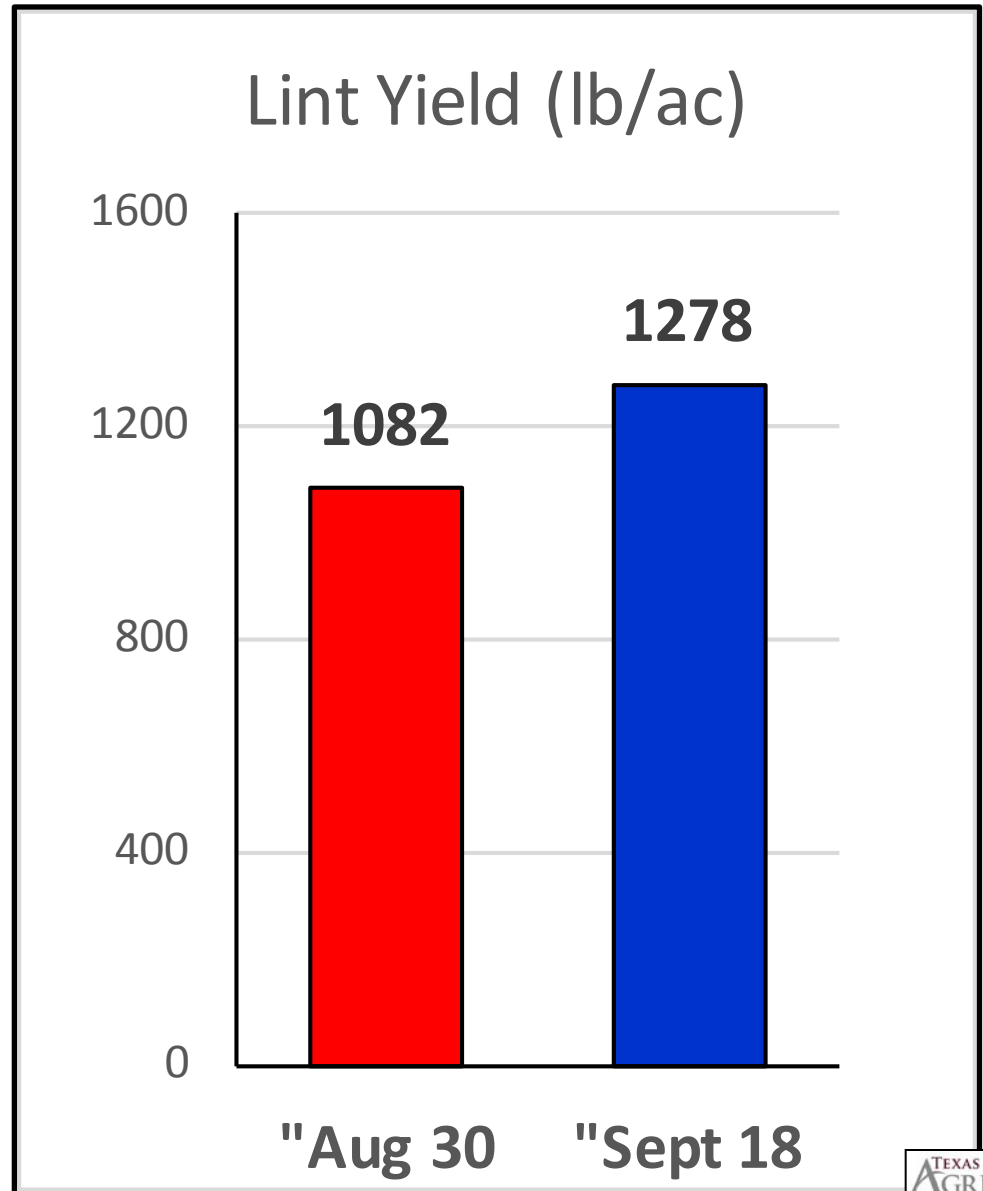
Nov. 17, 2017



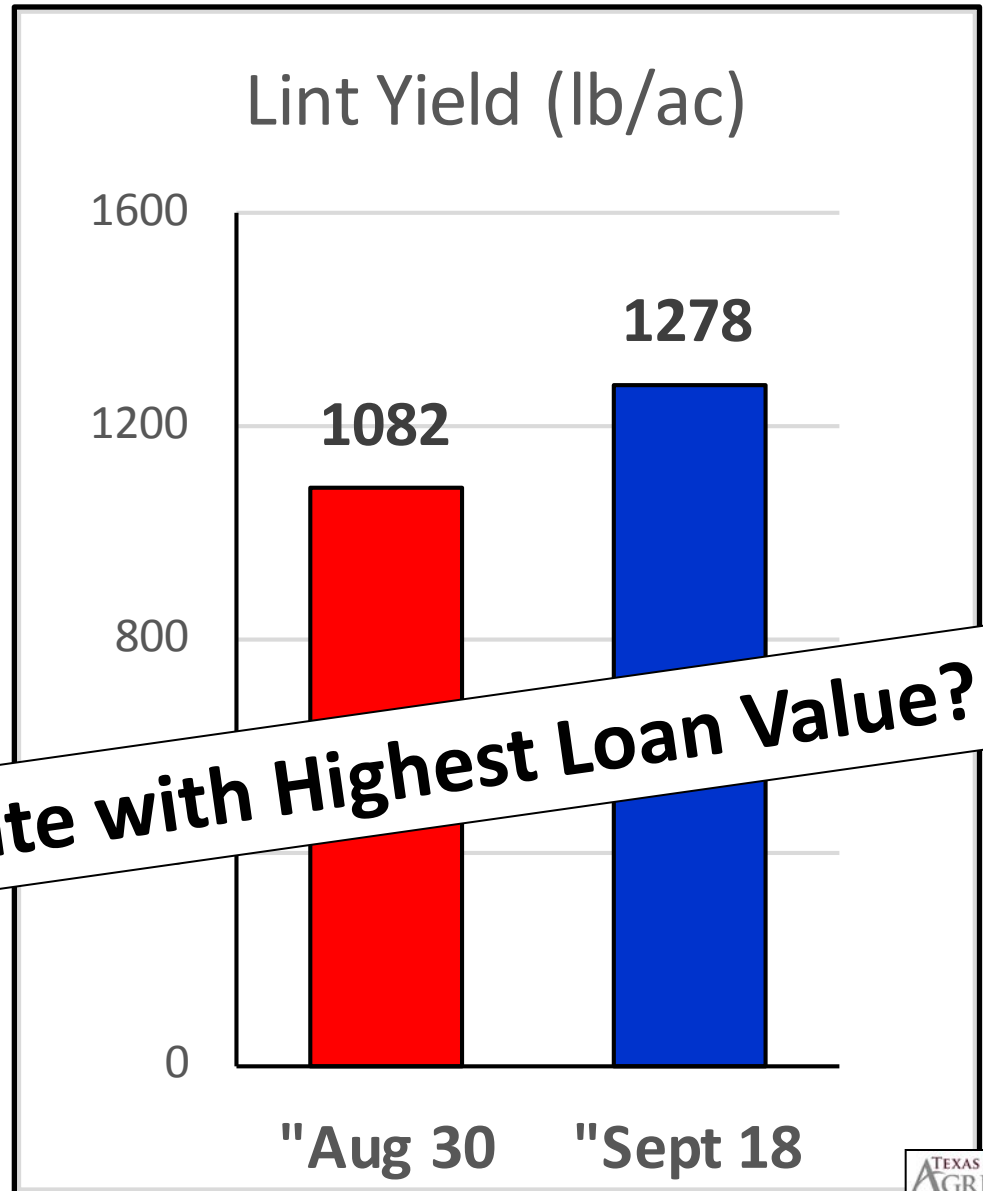
2017 Yield Diff. Due Irr. Termination



2017 Yield Diff. Due Irr. Termination

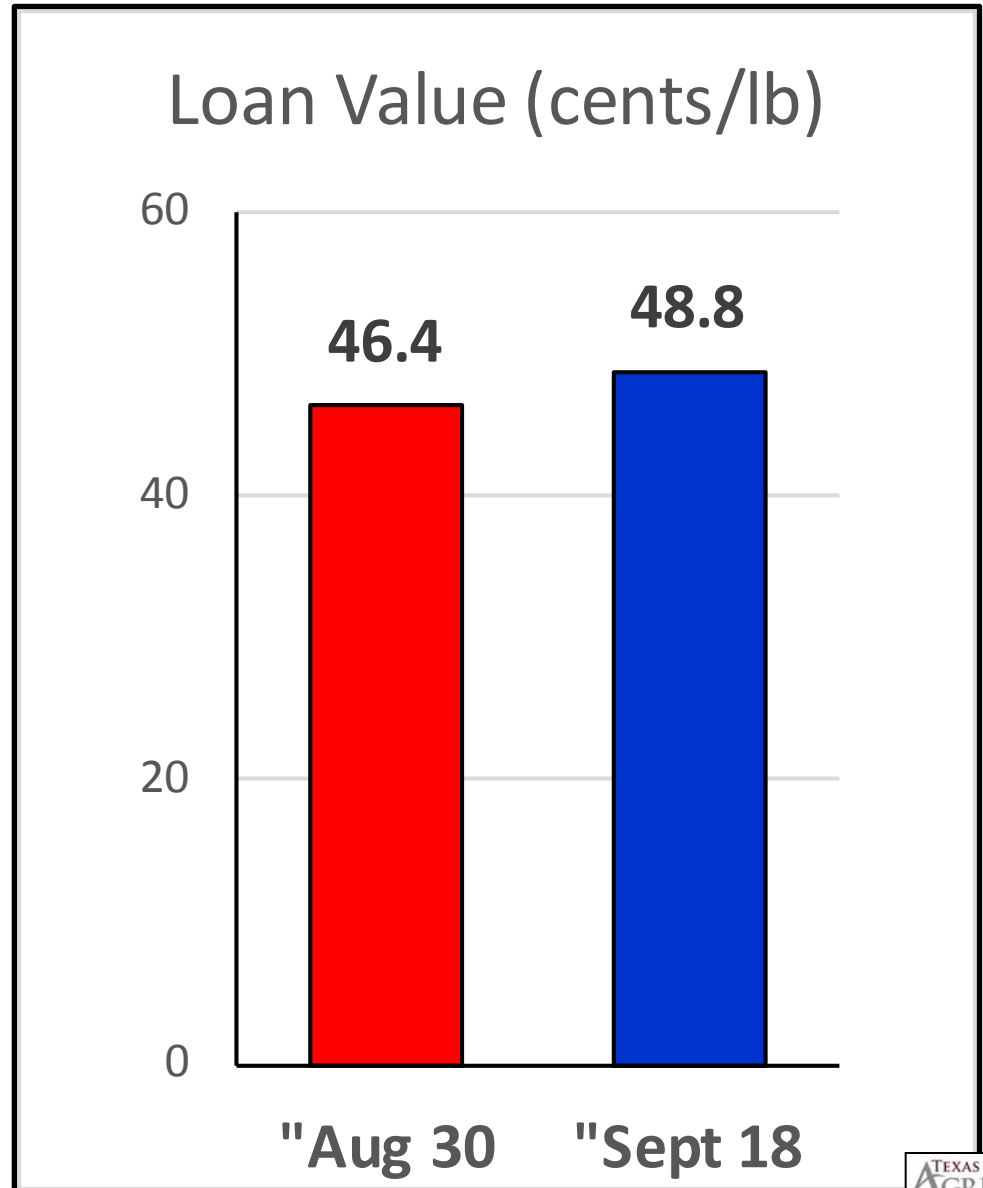


2017 Yield Diff. Due Irr. Termination

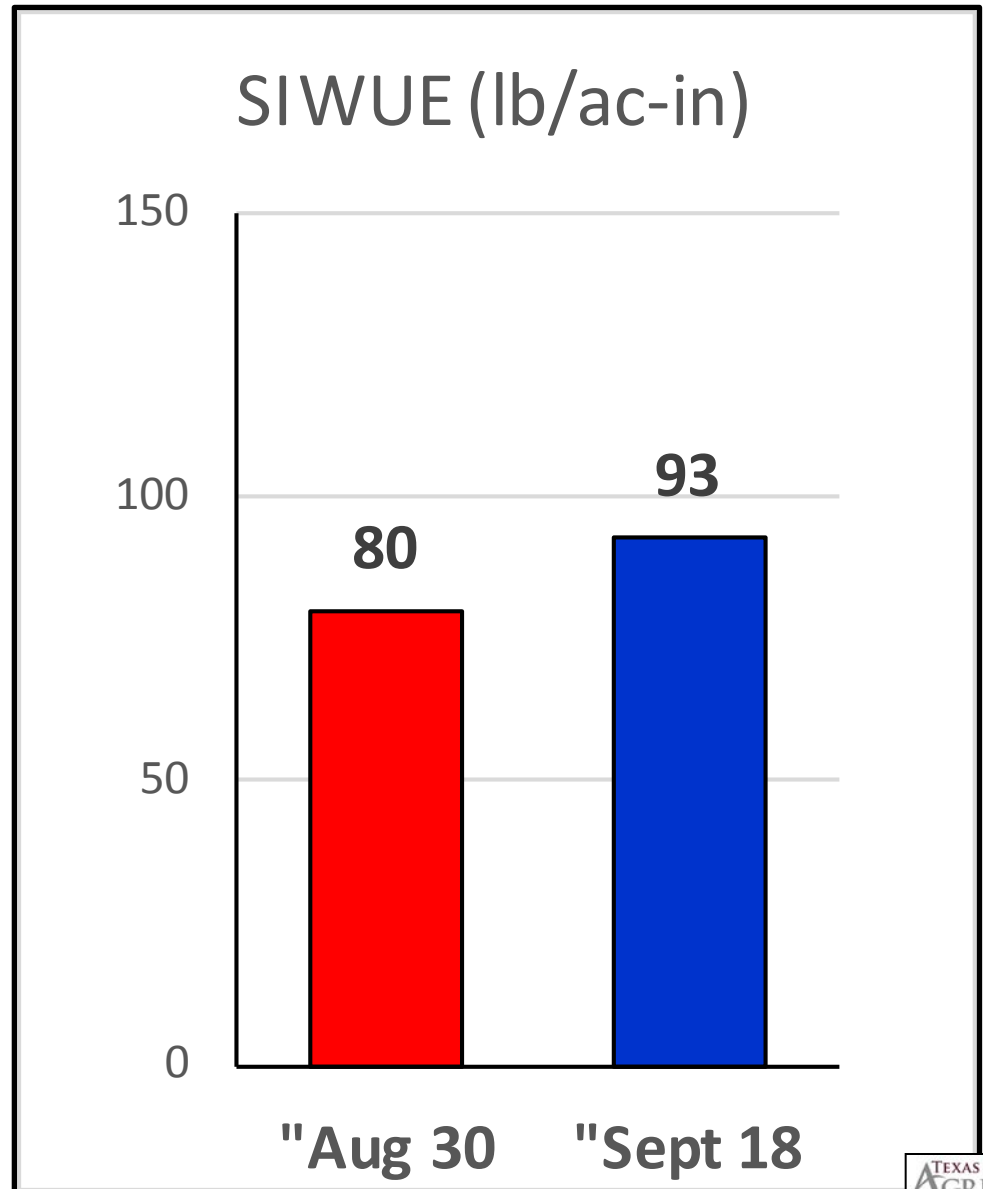


Termination Date with Highest Loan Value?

2017 Loan Diff. Due Irr. Termination



2017 SIWUE Diff. Due Irr. Termination



2017 Yield

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL	3.90		
LMH	4.10		
MML	4.50		
LMM+	4.95		
LHM	5.30		
LMH+	5.35		
HMM	5.50		
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
LHM+	6.55		
MHH	6.60		
MHH+	6.75		
HMM+	6.75		
LHH+	6.95		
MHM	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHM+	8.25		

2017 Yield

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL			
LMH			
MML			
LMM+			
LHM			
LMH+			
HMM			
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
LHM+	6.55		
MHH	6.60		
MHH+	6.75		
HMM+	6.75		
LHH+	6.95		
MHM	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHM+	8.25		

**Ranked from Low (0.00')
to High Irrigation (8.25")**

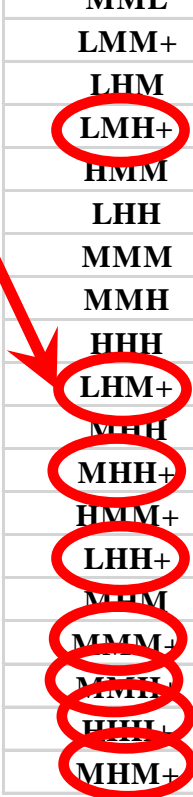
2017 Yield Above 1300 lb/ac

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL	3.90		
LMH	4.10		
MML	4.50		
LMM+	4.95		
LHM	5.30		
LMH+	5.35		
HMM	5.50		
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
LHM+	6.55		
MHH	6.60		
MHH+	6.75		
HMM+	6.75		
LHH+	6.95		
MHM	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHM+	8.25		

2017 Yield Above 1300 lb/ac

**Sept 18
Termination**

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL	3.90		
LMH	4.10		
MML	4.50		
LMM+	4.95		
LHM	5.30		
LMH+	5.35		
HMM	5.50		
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
LHM+	6.55		
MHH	6.60		
MHH+	6.75		
HMM+	6.75		
LHH+	6.95		
MMM	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHM+	8.25		



2017 Loan Values (cents/lb)

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL	3.90		
LMH	4.10		
MML	4.50		
LMM+	4.95		
LHM	5.30		
LMH+	5.35		
HMM	5.50		
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
LHM+	6.55		
MHH	6.60		
MHH+	6.75		
HMM+	6.75		
LHH+	6.95		
MHM	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHM+	8.25		

2017 Highest Loan Values

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL	3.90		
LMH	4.10		
MML	4.50		
LMM+	4.95		
LHM	5.30		
LMH+	5.35		
HMM	5.50		
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
LHM+	6.55		
MHH	6.60		
M+	6.75		
M	6.95		
M	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHH+	7.85		
MHM+	8.25		

Lowest Irr.

Low Early Irr.

2017 Seasonal Irrigation WUE (lb/ac-in)

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL	3.90		
LMH	4.10		
MML	4.50		
LMM+	4.95		
LHM	5.30		
LMH+	5.35		
HMM	5.50		
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
LHM+	6.55		
MHH	6.60		
MHH+	6.75		
HMM+	6.75		
LHH+	6.95		
MHM	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHM+	8.25		

2017 Highest SIWUE (lb/ac-in)

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL	3.90		
LMH	4.10		
MML	4.50		
LMM+	4.95		
LHM	5.30		
LMH+	5.35		
HMM	5.50		
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
MM+	6.55		
HHH	6.60		
MHH+	6.75		
HMM+	6.75		
LHH+	6.95		
MHM	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHM+	8.25		

128 lb/ac-in

134 lb/ac-in

2017 Highest SIWUE (lb/ac-in)

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL	3.90		
LMH	4.10		
MML	4.50		
LMM+	4.95		
LHM	5.30		
LMH+	5.35		
HMM	5.50		
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
LM+	6.55		
HH	6.60		
MHH+	6.75		
HMM+	6.75		
LHH+	6.95		
MHM	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHM+	8.25		

LMH+

128 lb/ac-in

134 lb/ac-in

2017 Highest SIWUE (lb/ac-in)

Treat Name	Irrigation (in)	FM 2484	FM2011
LLL	0.00		
LLM	1.40		
LML	2.30		
LLM+	2.65		
LMM	3.70		
LHL	3.90		
LMH	4.10		
MML	4.50		
LMM+	4.95		
LHM	5.30		
LMH+	5.35		
HMM	5.50		
LHH	5.70		
MMM	5.90		
MMH	6.30		
HHH	6.30		
LM+	6.55		
HHH	6.60		
MHH+	6.75		
HMM+	6.75		
LHH+	6.95		
MHM	7.00		
MMM+	7.15		
MMH+	7.55		
HHH+	7.55		
MHM+	8.25		

LMH+

128 lb/ac-in

134 lb/ac-in

**Yield = 1400 lb/ac
@ 5.35" Irr**

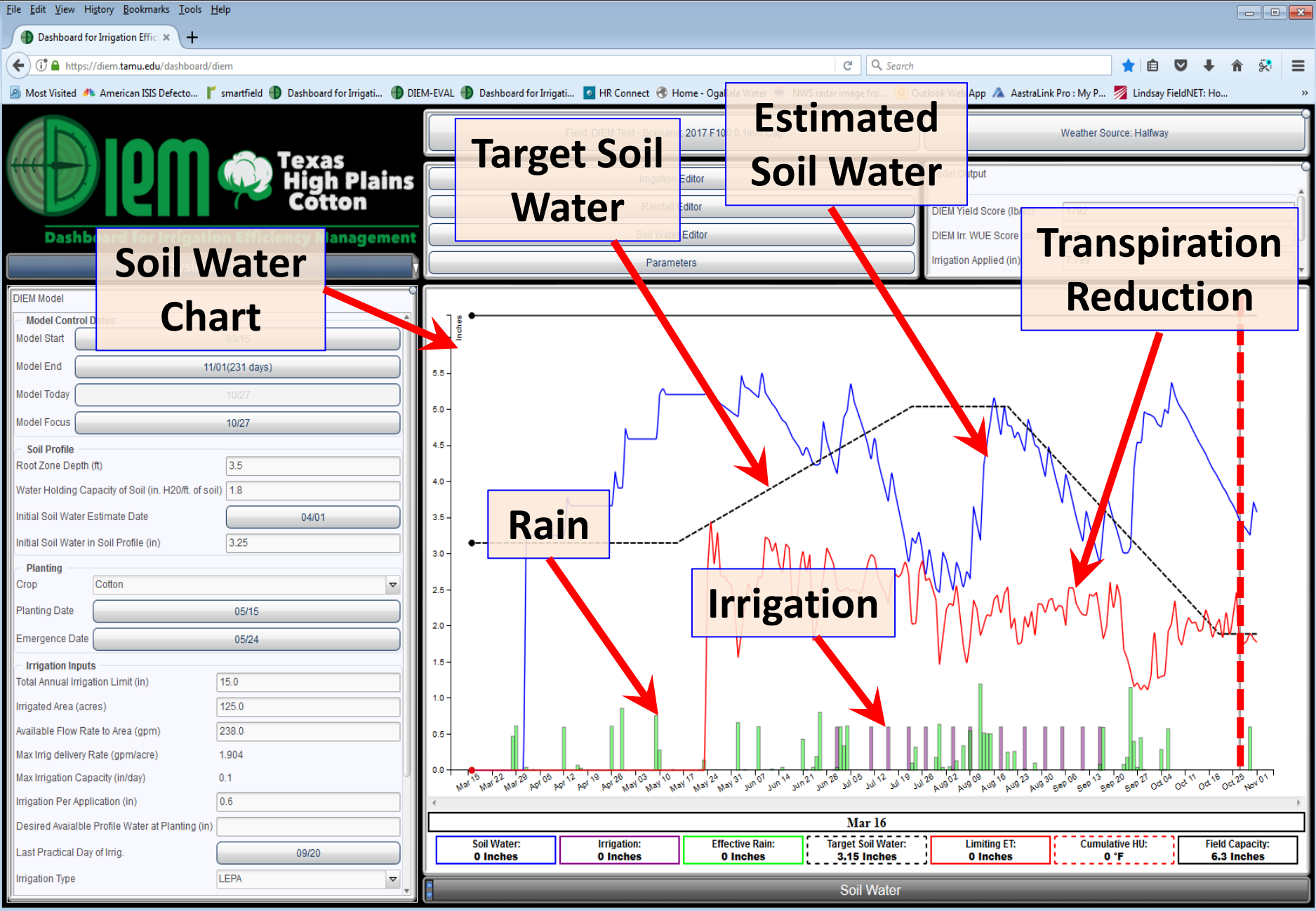


**Dashboard for Irrigation
Efficiency Management**



DIEM --- Focus is South Plains Cotton

- **Water availability**
 - Irrigation capacity**
 - Irrigation policy (pumping limits)**
- **Environment (ET_o , Rain, etc.)**
- **Soil profile characteristics**
- **Irrigation system characteristics**
- **Crop growth characteristics**
- **Relevant field research**





**Dashboard for Irrigation
Efficiency Management**

Currently : Beta-testing

<https://diem.tamu.edu>

**Contact: Dr. Dana Porter
or Jim Bordovsky**

A large center pivot irrigation system is shown over a field of green crops. The system consists of a long metal structure supported by multiple towers, with long arms extending across the field. The crops are densely packed and appear to be in the early stages of growth. The sky is clear and blue with a few wispy clouds. In the background, there are some buildings and trees.

Thank You....