High Plains Cotton Research: Nutrient Management and Cropping Systems

Katie Lewis, Joseph Burke, Christopher Cobos, Paul DeLaune, Wayne Keeling, Will Keeling, and Ray White

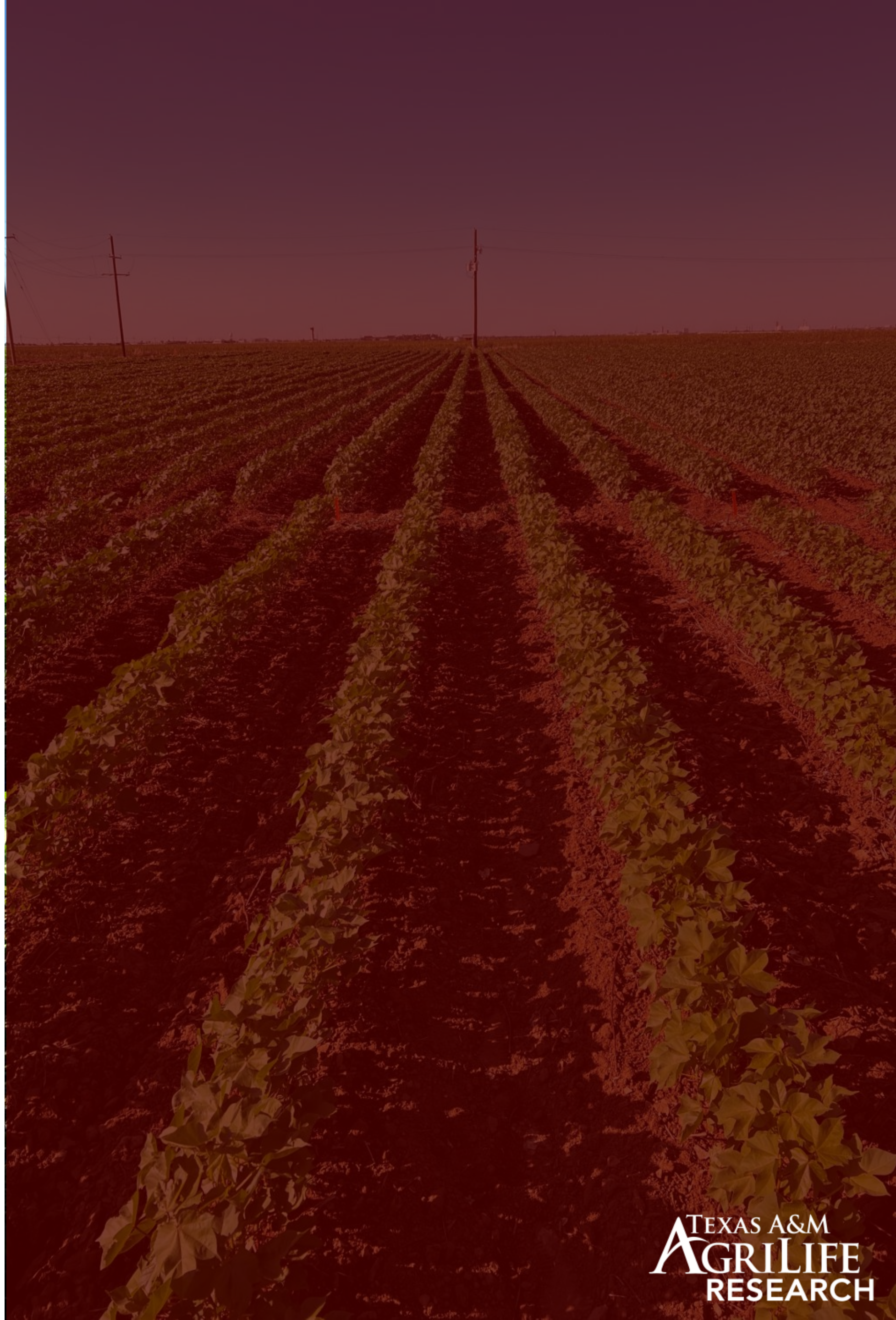
Cotton Physiology Conference
College Station, TX
Jan 31 – Feb 1, 2023

Texas A&M AgriLife Research

Texas Tech University
Davis College
Plant and Soil Science

What are the questions…

- What is the best approach to fertigation using subsurface drip irrigation?
- How to best utilize water resources?
- What is the best method to manage N following cover crops?
- How to build soil C and the health of soil in sandy, semi-arid environments?

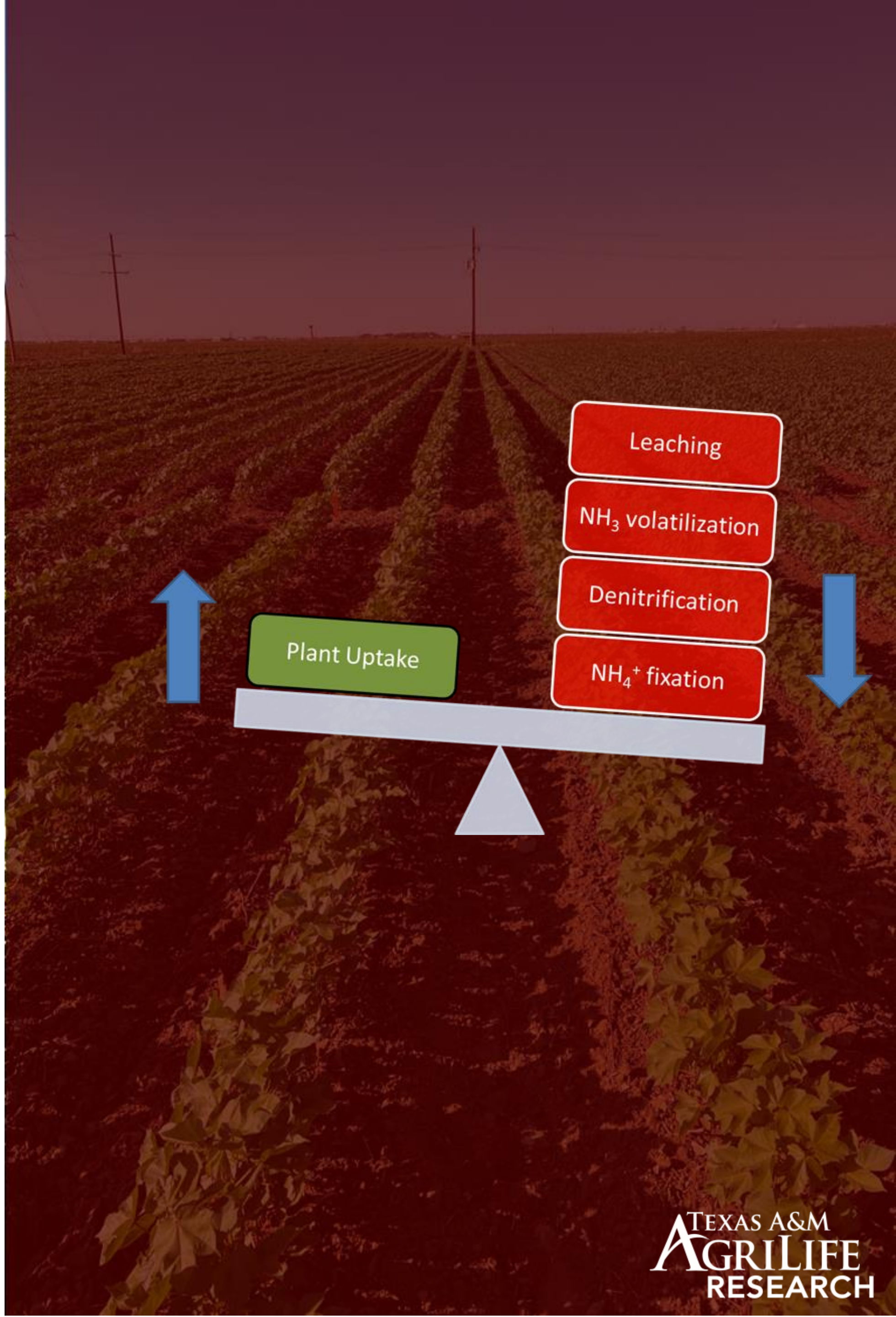


Fertigation and SDI

- SDI can be used to efficiently apply liquid fertilizers
  - Greater plant uptake
  - Less potential negative environmental impacts due to nutrient losses

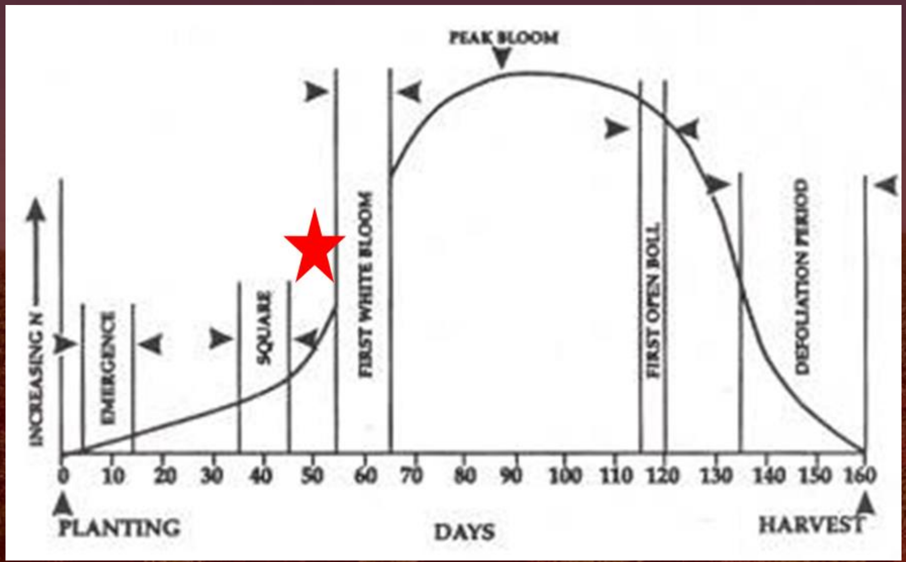
- SDI allows for more frequent applications
  - “Spoon-feeding”

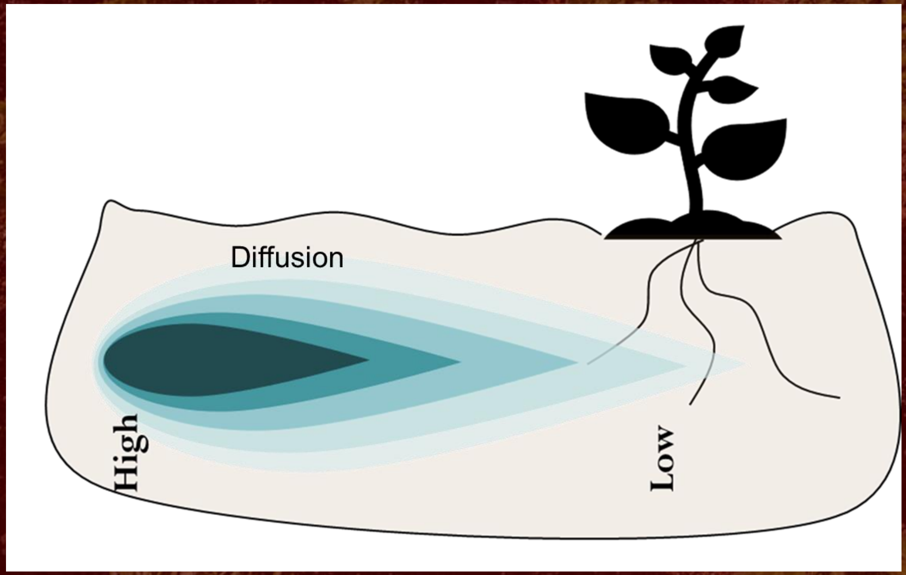
- Is this the best approach with all nutrients?



Fertigation and SDI

- Spoon-feeding method may result in less chance of missing peak demand because fertilizer is constantly being applied
  - May be a better approach for N fertigation
- May lead to excessive growth due to prolonged N applications later into the season
- May result in reduced P uptake
- Research is aimed at answering the spoon-feeding questions



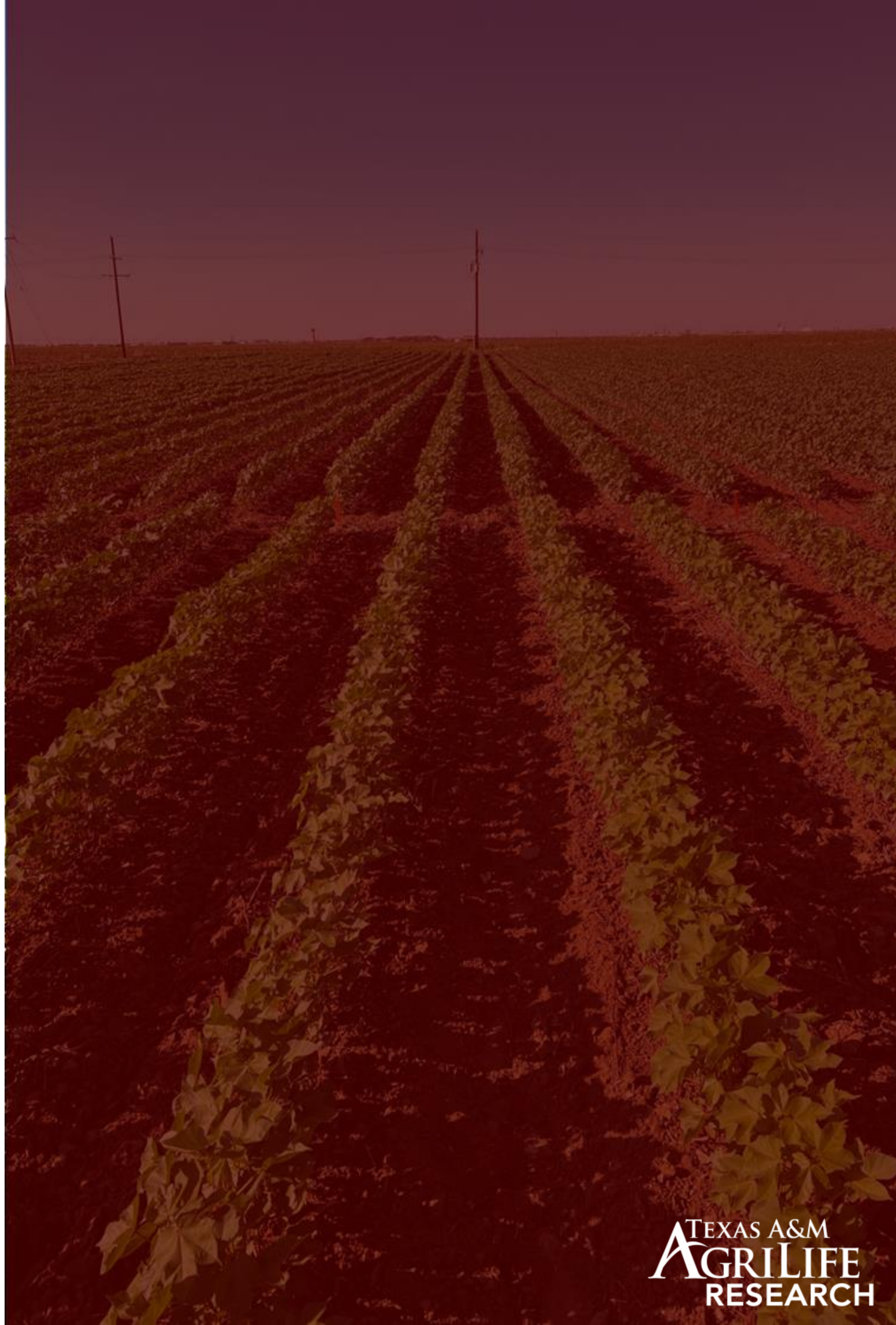


TEXAS A&M AGRILIFE RESEARCH

Fertigation: Objective

- Develop N and P fertigation strategies using SDI that optimizes cotton lint yield and fertilizer return on investment.

- More specifically, we will determine the number of fertilizer applications that results in the greatest nutrient uptake and yield when using SDI.



The experimental design

LOCATION: Lubbock, Lubbock County, TX

VARIETIES: DP 2143NR B3XF and DP 2020 B3XF

PLANTING DATE: 5/13/2021, replanted on 6/7/2021
5/27/2022

TREATMENTS (4 replications):

N	P
frequency	
3	0
3	1
3	3
3	9
9	0
9	1
9	3
9	9

N applied at 150 lb/a as UAN-32
P applied at 45 lb/a as 0-54-0

Applied using chemigation pump

3x applied every 20 d
9x applied every 10 d

The experimental design

Texas A&M AgriLife Research

APPLICATION DATES 2021:

Applic Freq: 1		Applic Freq: 3		Applic Freq: 9	
2021	2022	2021	2022	2021	2022
9-May	7-Jun	9-May	7-Jun	9-May	7-Jun
				28-May	17-Jun
			24-Jun	18-Jun	24-Jun
				8-July	1-July
		20-July	8-July	20-July	8-July
				2-Aug	18-July
		11-Aug		11-Aug	29-July
				20-Aug	12-Aug
				30-Aug	26-Aug

The variables

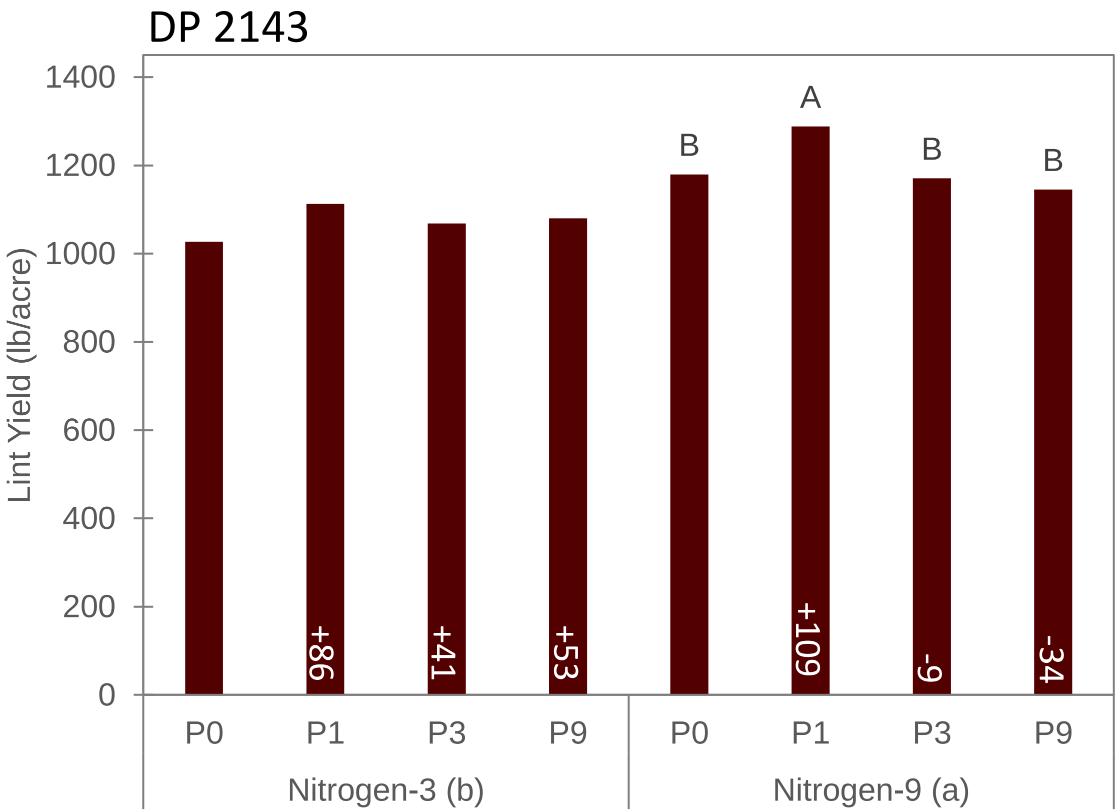
- Soil characterization
  - Samples collected at depth (0-6", 6-12", 12-24", and 24-36") prior to planting and fertilizer application
  - Elemental concentrations determined

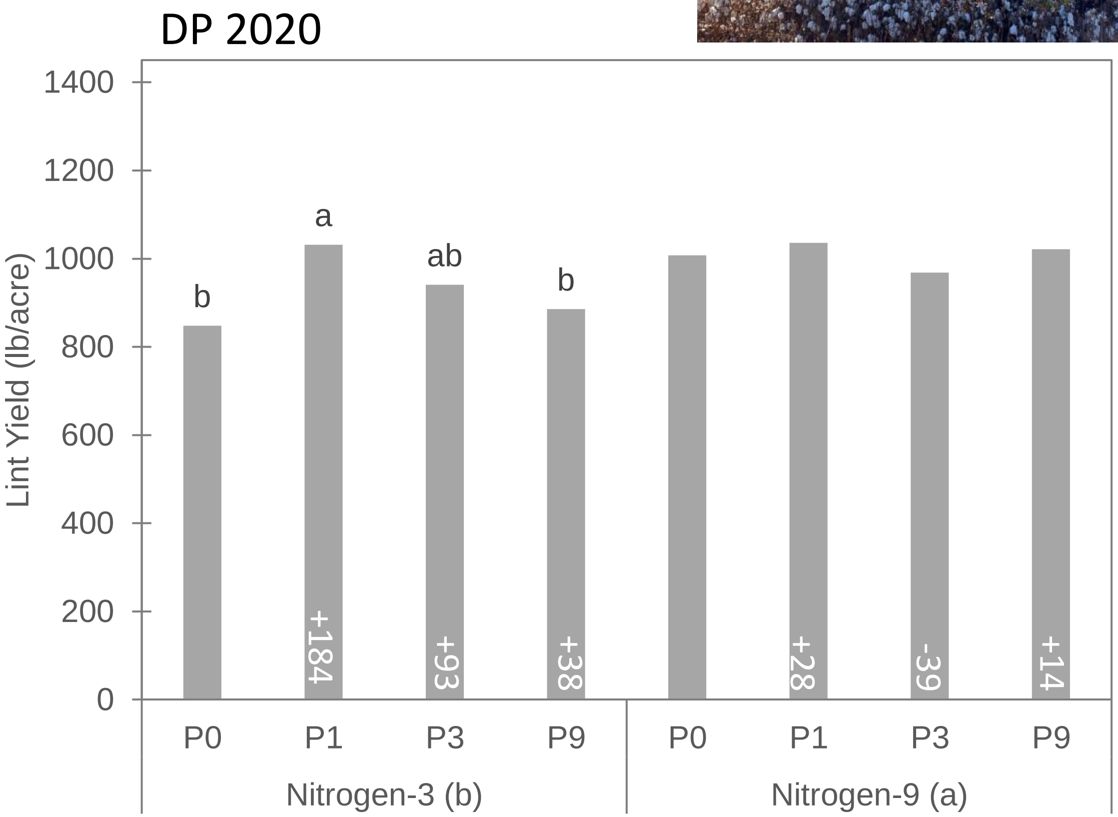
- Plant growth and health
  - Stand establishment
  - Morphological measurements
  - NDVI

- Plant nutrient uptake
  - Plants collected at first open boll and separated into plant parts, dried, and weighed
  - Elemental concentrations determined and uptake calculated

- Lint yield and fiber quality

Cotton lint yield (2021)





TEXAS A&M AGRILIFE RESEARCH

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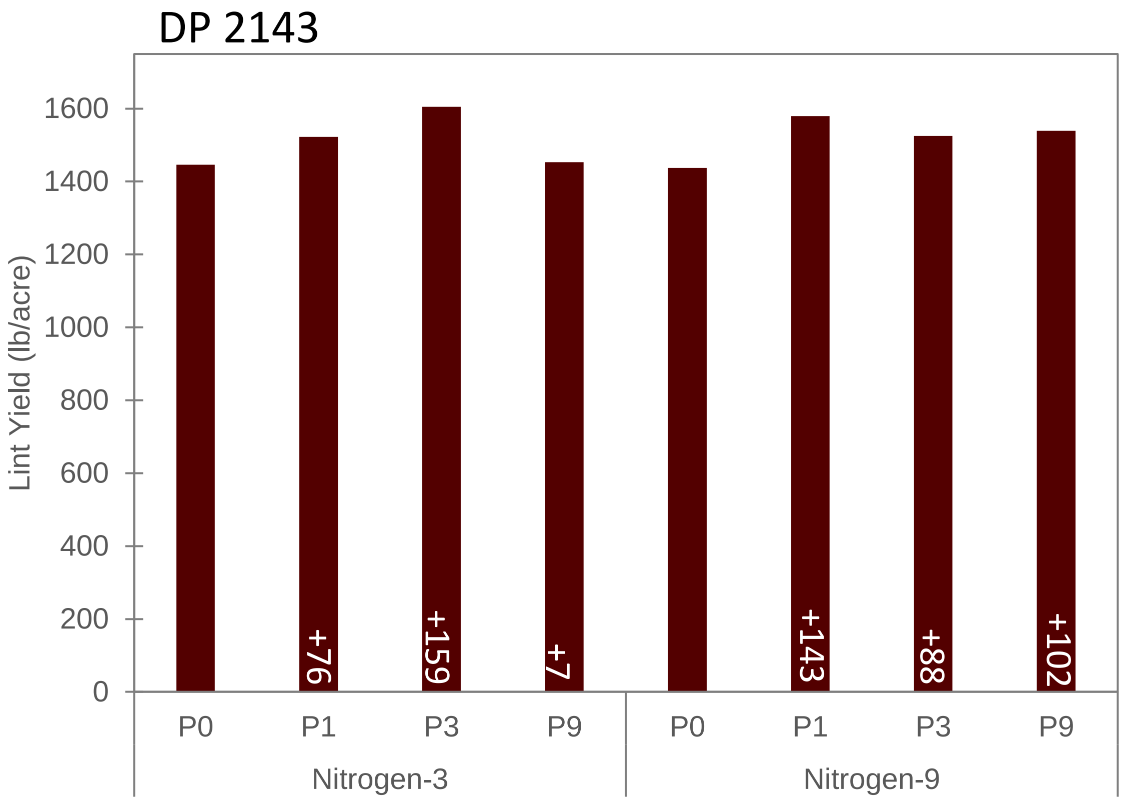
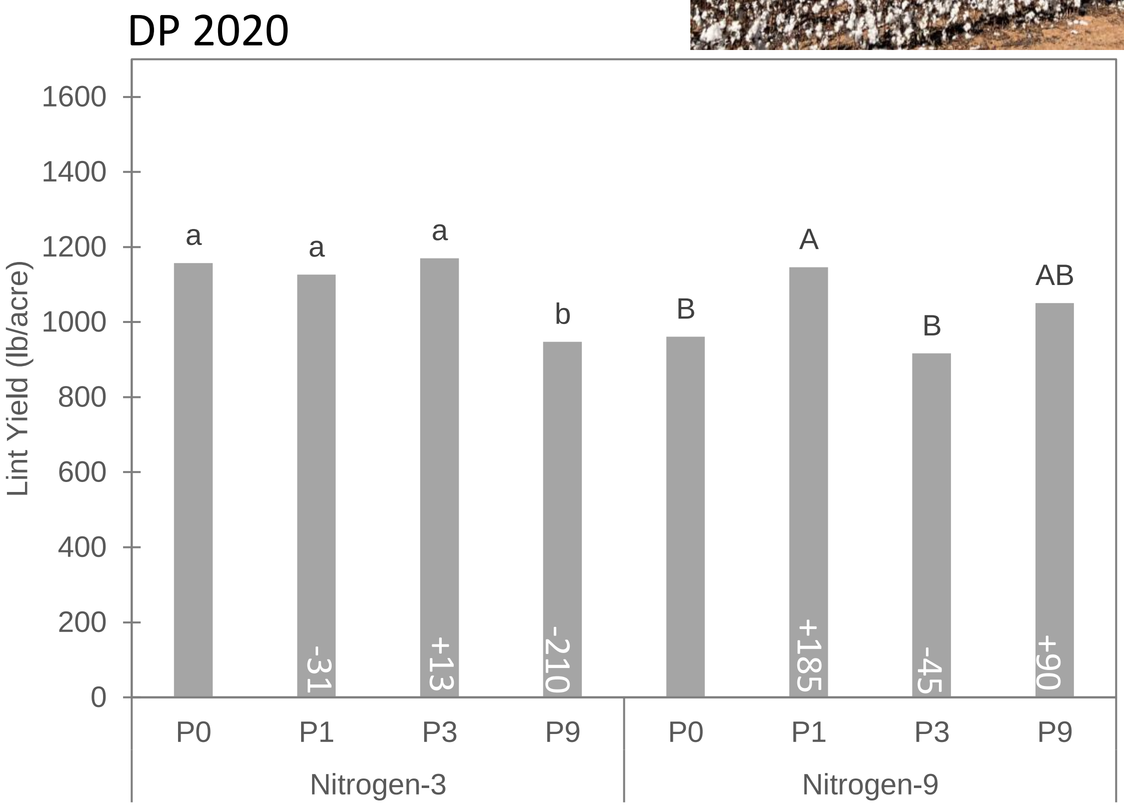




TEXAS A&M AGRILIFE RESEARCH

Agronomic Use Efficiency (2021)

AUE = (LY$_F$ *– LY*$_0$*)/45 lb P*

		AUE-P (lb lint/lb P)	
N	P	DP 2143	DP 2020
3	1	1.90	4.08
	3	0.92	2.06
	9	1.18	0.83
9	1	2.41	0.63
	3	-0.20	-0.87
	9	-0.76	0.32

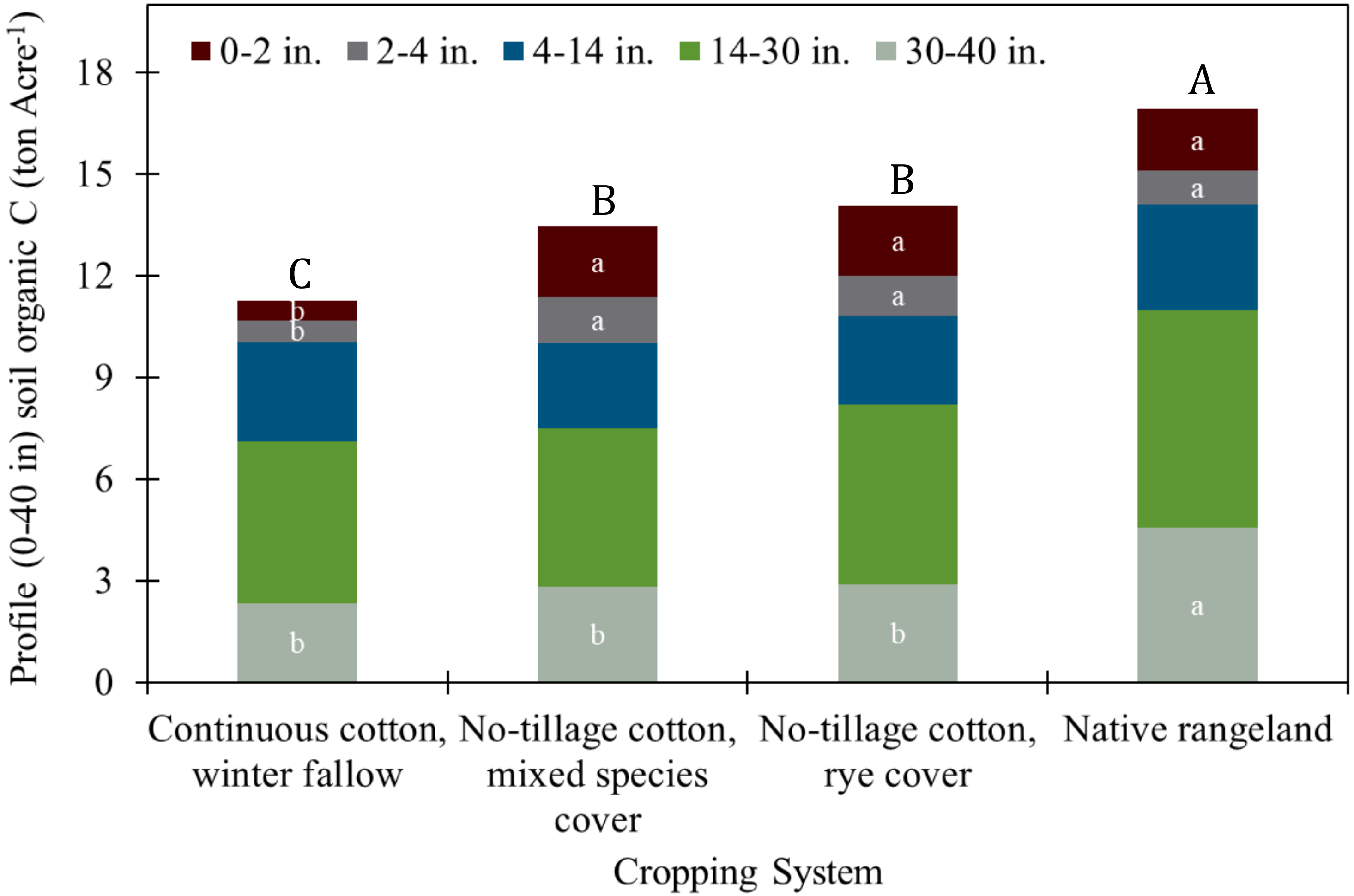
Fertigation Summary

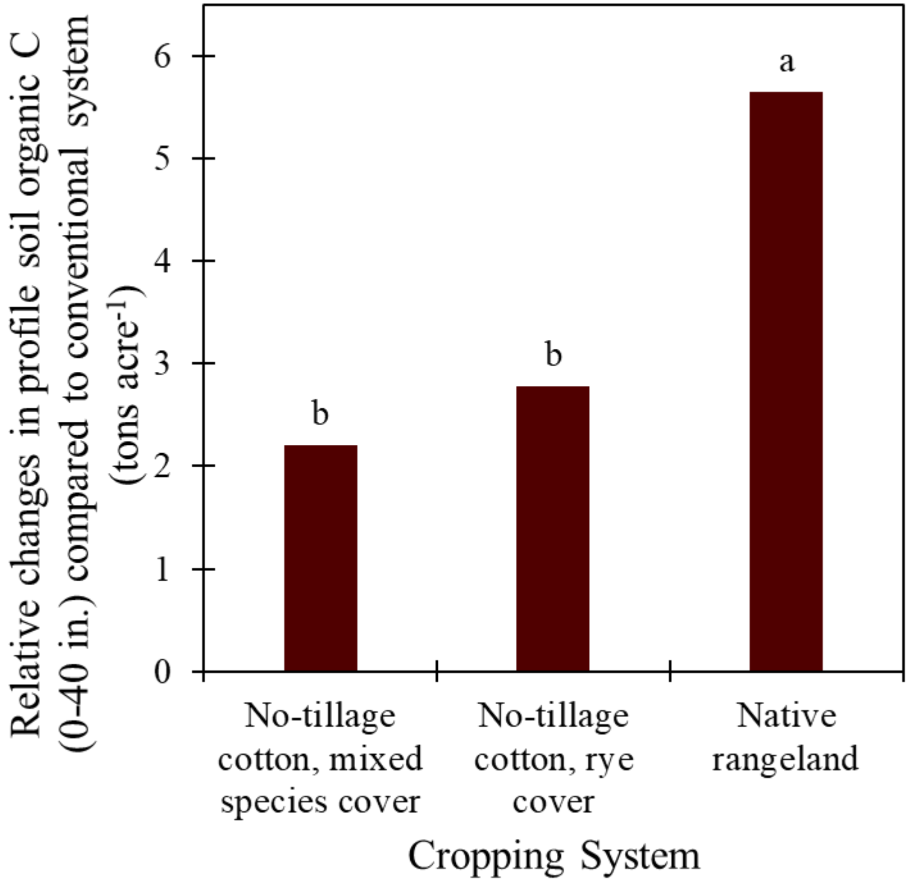
- Preliminary data suggest different management approaches needed for N and P when fertigating using SDI
- N resulted in generally greater yield response with greater frequency applications (2021)
  - Greater uptake corresponded to greater lint yield
- Greater yield response with fewer P applications
  - Uptake and recovery efficiency increased with greater frequency
  - Possibly an antagonistic effect between P and Zn uptake

Carbon, yield, and water in conservation systems

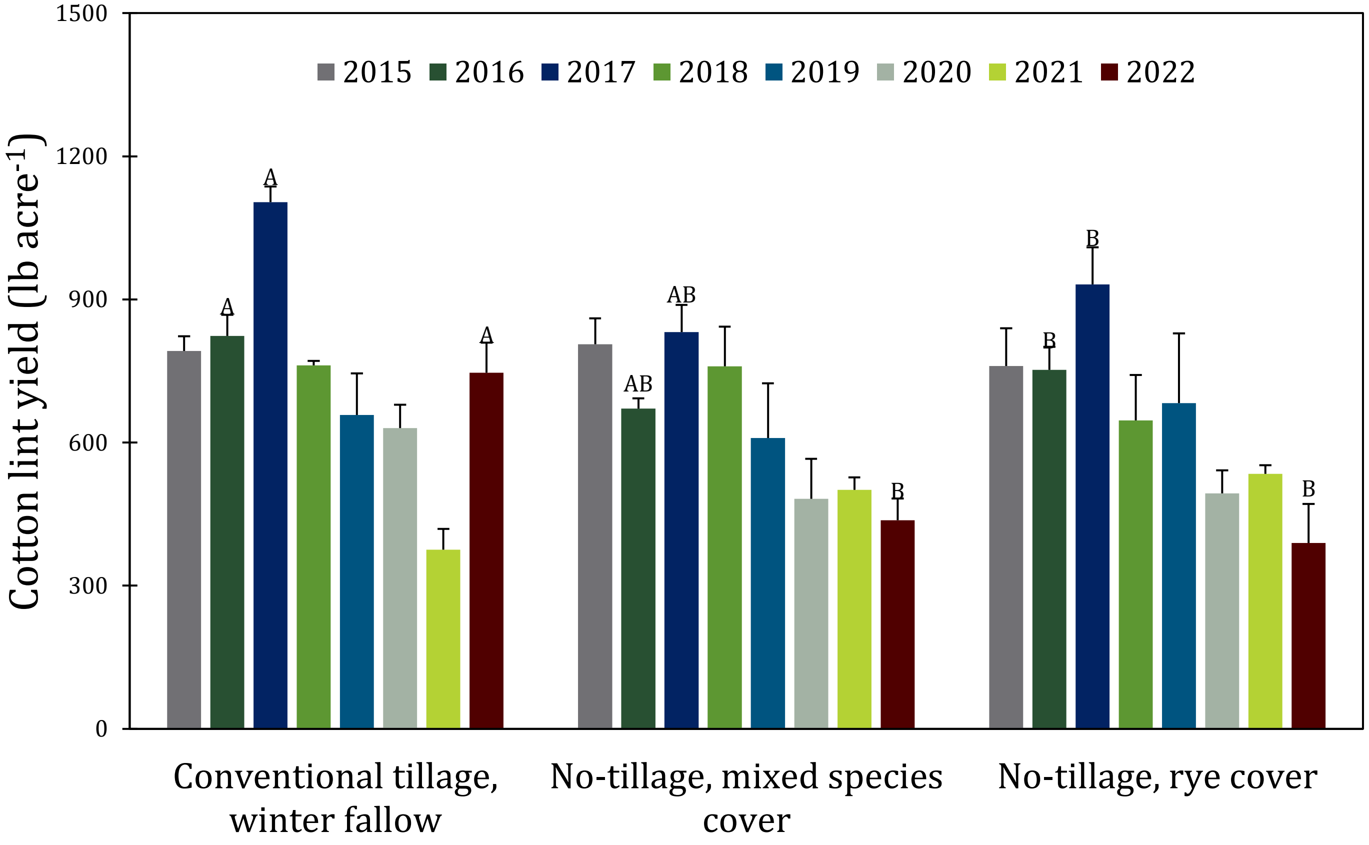
Soil organic carbon

*Samples collected in year 20 of the study





Cotton lint yield

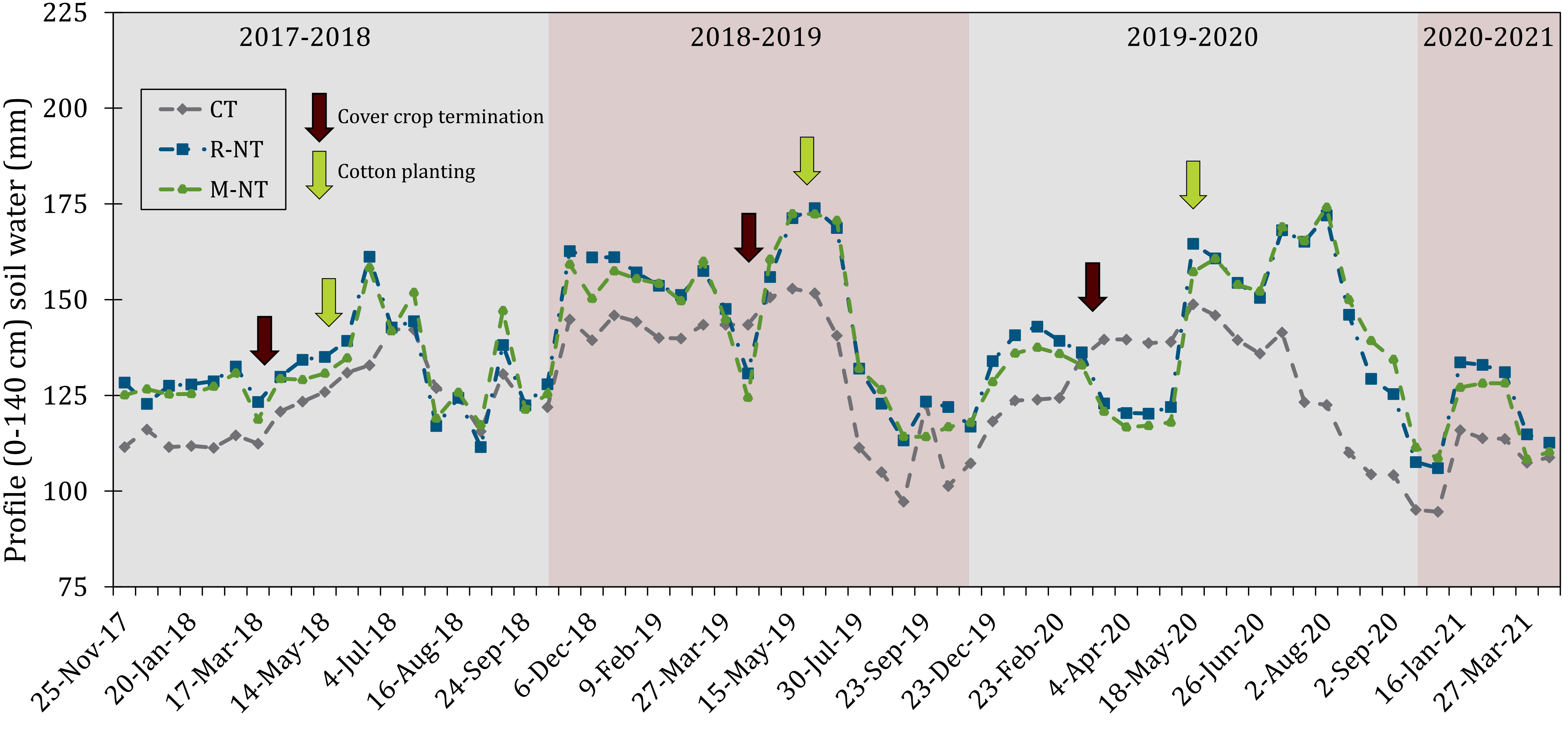


Conservation management has a variable effect on yield

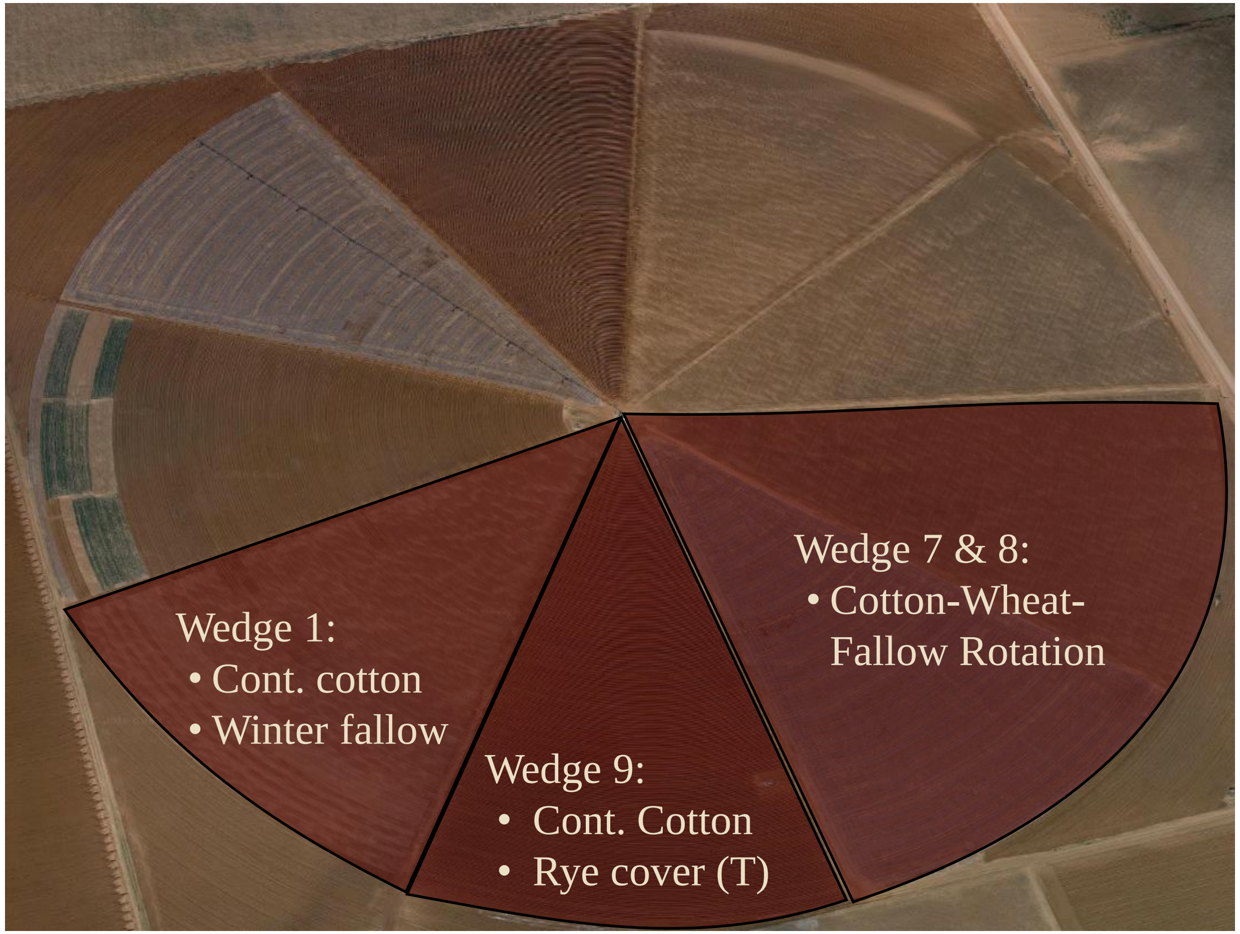
What is causing the yield drag in some years?

- Cover crop water usage?
- Nutrient immobilization?

Soil water


Profile (0-140 cm) soil water (mm)
225
200
175
150
125
100
75
2017-2018
2018-2019
2019-2020
2020-2021
CT
R-NT
M-NT
Cover crop termination
Cotton planting
25-Nov-17
20-Jan-18
17-Mar-18
14-May-18
4-Jul-18
16-Aug-18
24-Sep-18
6-Dec-18
9-Feb-19
27-Mar-19
15-May-19
30-Jul-19
23-Sep-19
23-Dec-19
23-Feb-20
4-Apr-20
18-May-20
26-Jun-20
2-Aug-20
2-Sep-20
16-Jan-21
27-Mar-21

The experimental design



Nitrogen study plot design at Ag-CARES in Lamesa, TX

Treatments

- Cropping systems –
  - Conventional tillage, winter fallow (CC)
  - Continuous cotton with rye cover (CCRC)
  - Cotton-wheat-fallow rotation (CWR)
- Nitrogen applications –
  - Farmer's practice (120 lb N A^{-1}, FP)
  - FP + 30 lb N A^{-1} preplant (PPN)
  - FP + 30 lb N A^{-1} 2-3 weeks post emergence (POS)
  - FP + 30 lb N A^{-1} pinhead square + 2 weeks (PIN)

Cotton production

Cropping System	Nitrogen fertilization strategies				
	FP	PPN	PEN	PHSN	
	Lint yield (lint acre^{-1})				AVG
CC	723	787 (8.9%)	715 (-1.1%)	683 (-5.5%)	**727**
CCRC	806	938 (16.4%)	965 (19.6%)	857 (6.2%)	**891** (23.3%)
CWR	1,134	1,032 (-9.0%)	1,117 (-1.5%)	1,064 (-6.2%)	**1,087** (50.4%)
AVG	**888**	**919** (3.5%)	**932** (5.0%)	**868** (-2.2%)	

2018-2020 averages

Fertilization strategies:

- FP = farmers practices (120 lb N A^{-1})
- PPN = FP + 20 lb N A^{-1} at preplant
- PEN = FP + 20 lb N A^{-1} at post emerg. + 2 wks
- PHSN = FP + 20 lb N A^{-1} at pinhead square + 2 wks

Cropping systems:

- CC = Continuous cotton, conventional tillage (>25 yrs)
- CCRC = Continuous cotton-Rye cover
- CWR = Cotton-Wheat rotation

Gross margins

Cropping System	Nitrogen fertilization strategies				
	FP	PPN	PEN	PHSN	
	Gross Margin($ acre^{-1})				AVG
CC	434	489 (12.7%)	441 (1.6%)	420 (-3.3%)	**336**
CCRC	489	591 (20.7%)	608 (24.3%)	536 (9.5%)	**556** (65.5%)
CWR	609	575 (-5.6%)	610 (0.3%)	587 (-3.6%)	**595** (77.1%)
AVG	**511**	**552** (8.0%)	**553** (8.2%)	**514** (0.6%)	

2018-2020 averages

Fertilization strategies:

- FP = farmers practices (120 lb N A^{-1})
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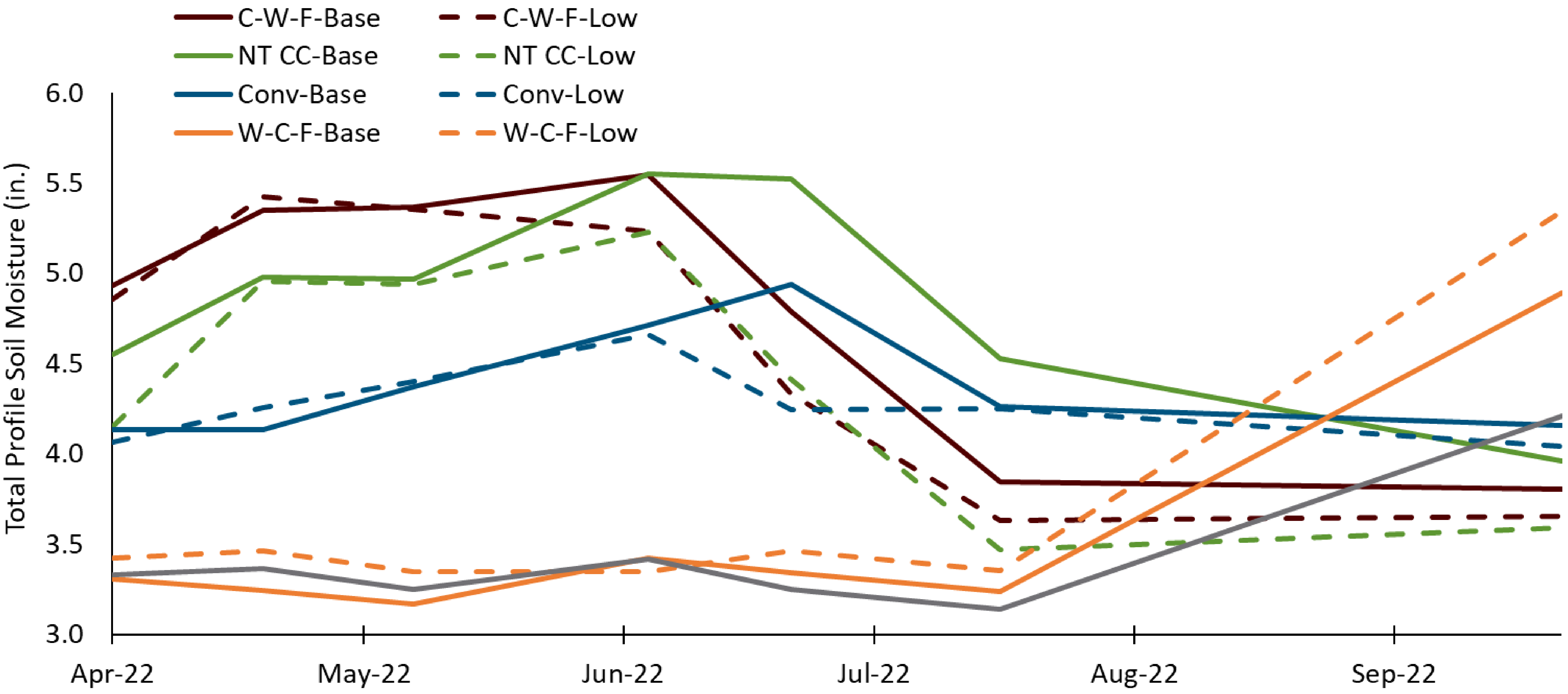
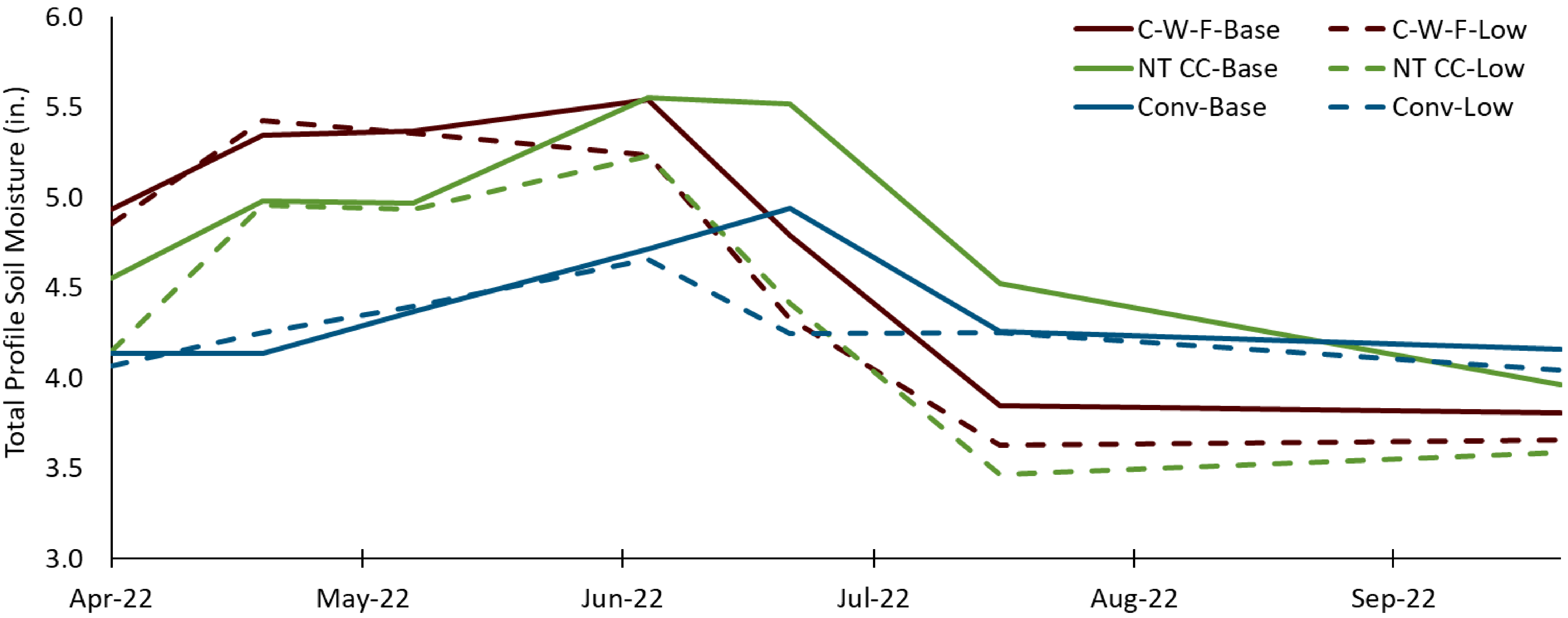
Soil water results

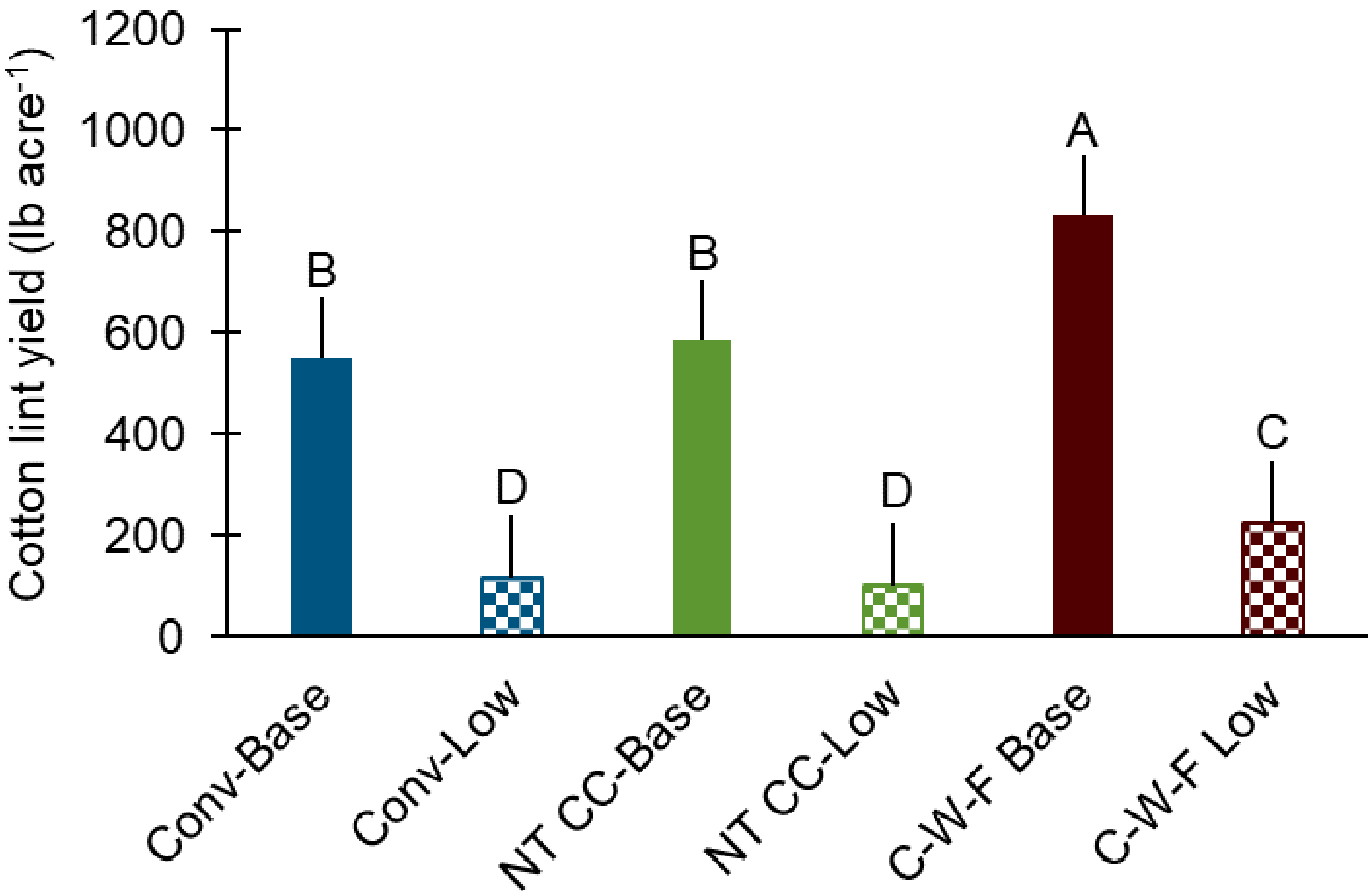


Soil water results



* = significant differences

Cotton lint yield



Summary & recommendations

Cotton following a cover crop benefits from additional N fertilization and added N fertilizer earlier in the growing season is most beneficial.

Cotton following wheat did not benefit from additional N fertilization to stimulate mineralization but did yield the greatest lint.

Partial budgets indicate no-tillage with cover crops or crop rotations are economical alternative to continuous cotton production on the High Plains.

Complete economic budgets are needed to understand the system. Current fertilizer prices may change the benefit of these production systems.

2023 and Beyond

Regenerative agriculture (#RegenAg)

Sustainable agricultural intensification and enhancement using regenerative agricultural practices

USDA Award Number: 2021-68012-35897

Our project goal is to intensify agricultural production in an environmentally sustainable manner that enhances the agronomic, economic, and community resiliency in the Southern Great Plains.

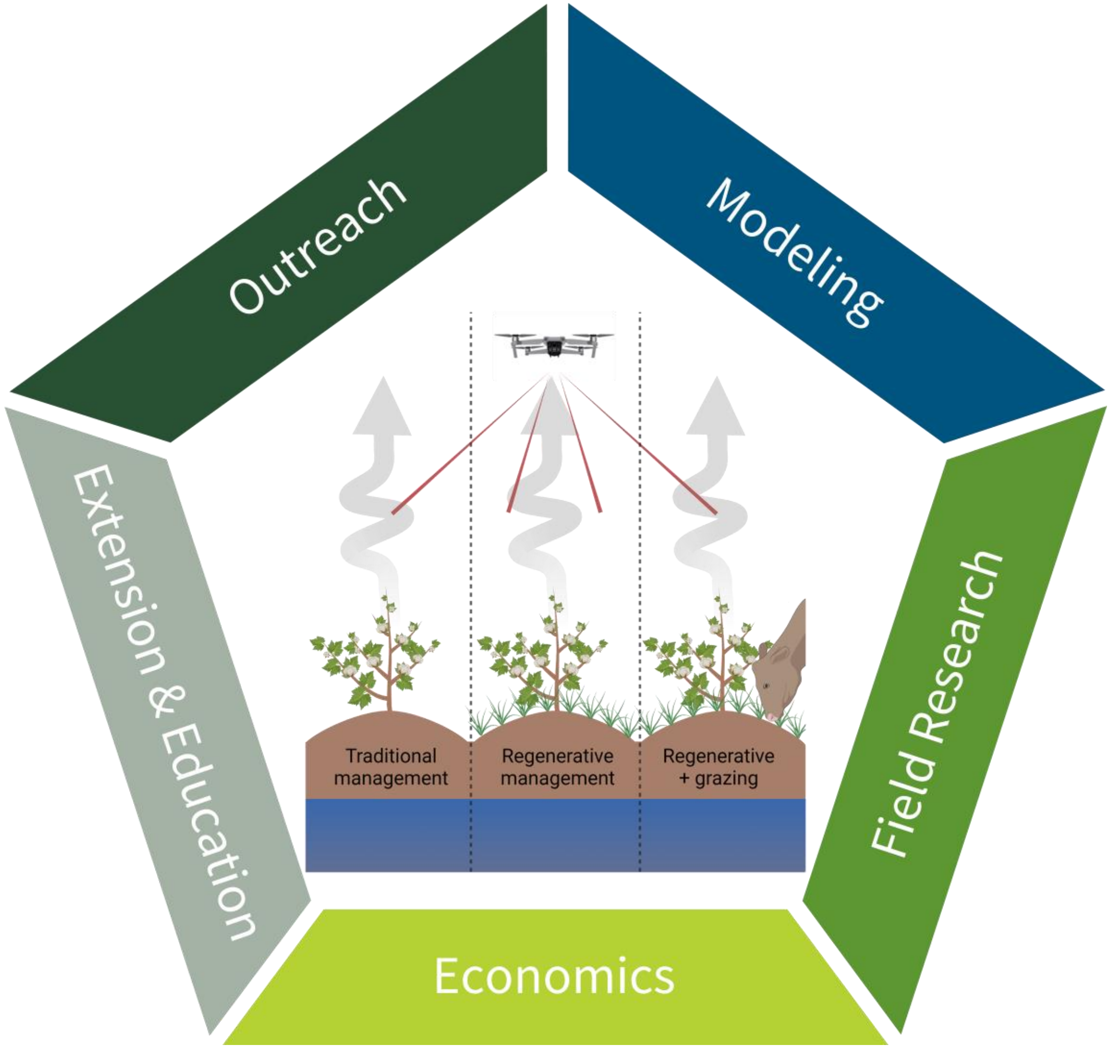
Collaborators -

Texas Water Resources Institute *make every drop count* · Texas A&M AgriLife Research · Texas A&M AgriLife Extension · Soil Health Institute · Kansas State University

Regenerative agriculture (#RegenAg)

Select objectives -

- Develop and deliver *Master Soil Steward Program*
- Utilize models to assess soil and water quality impacts of regenerative practices
- Evaluate regenerative agricultural practices
- Develop and deliver transdisciplinary graduate and undergraduate curriculum
- Create farm budgets and determine potential impacts on rural communities



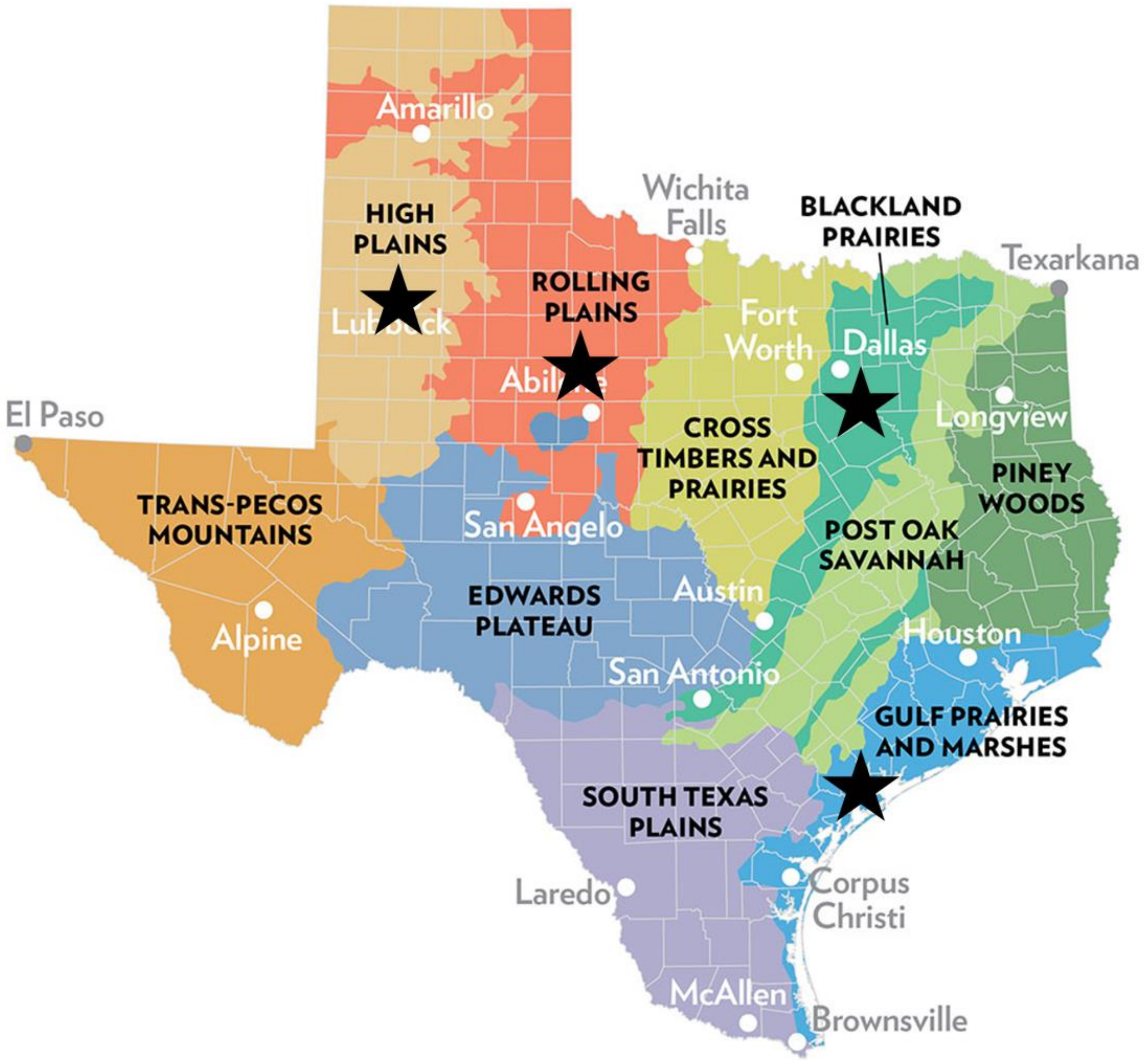
Regenerative agriculture (#RegenAg)

We are currently seeking producers in The Texas High and Rolling Plains and Southwestern Oklahoma

Management practices we are looking for integrated livestock grazing systems

- Cover crops in cotton monocultures
- Cotton-wheat rotations

Participating farmers will receive a detailed report of their soil and biomass results



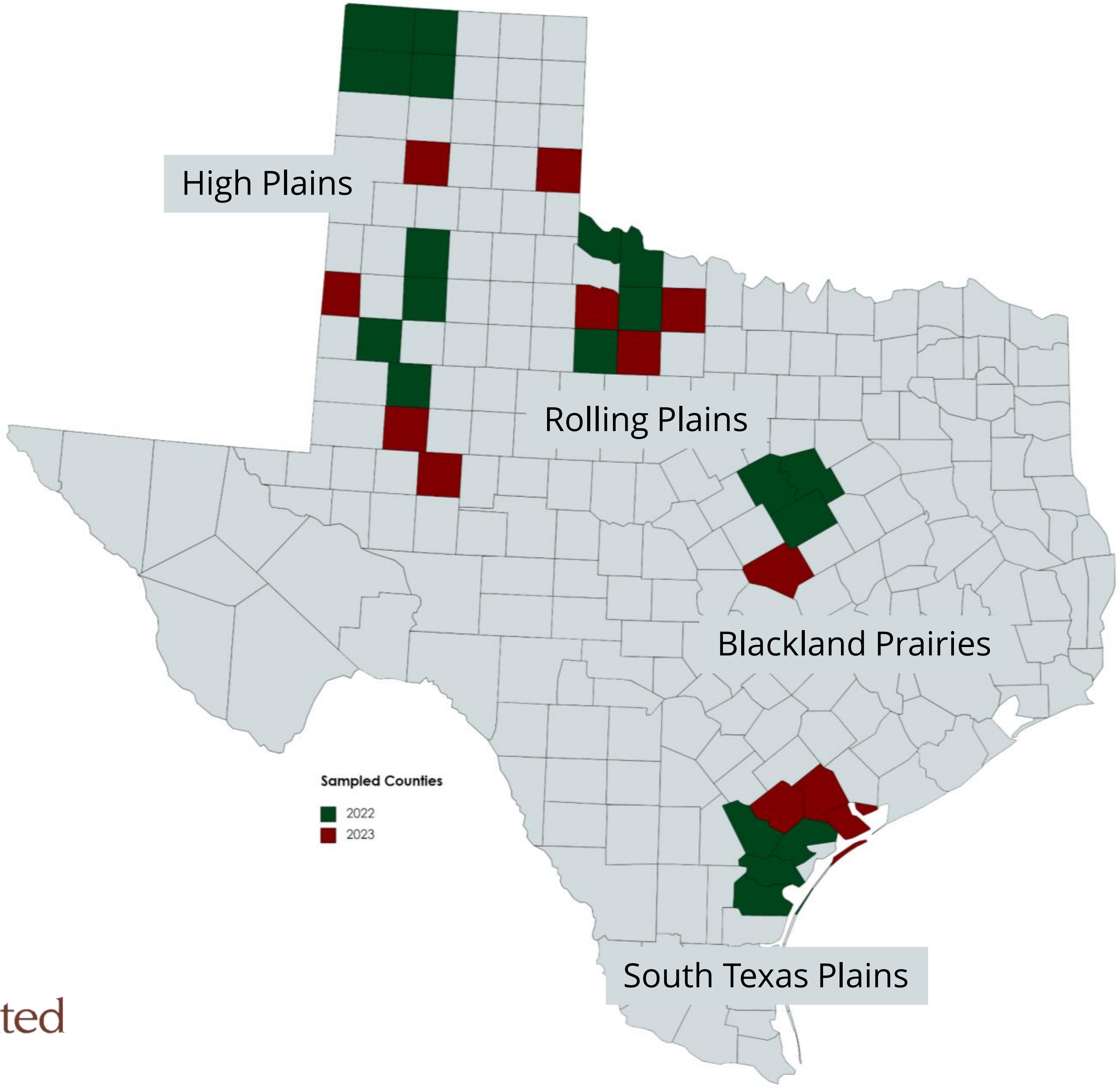
Carbon assessment in Texas cropping systems

Project specifics:

- Establish soil organic carbon baseline levels across Texas corn, cotton, and sorghum cropping systems
- Included conservation systems:
  - No-tillage, strip-tillage, conservation tillage, conservation irrigation, cover crops, crop rotations, integrated livestock grazing
- Soil sampling depths:
  - 0-6, 6-12, 12-18, 18-24, 24-30, 30-36 inches

Collaborators:

- Paul DeLaune
- Jamie Foster
- Jourdan Bell



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SORGHUM CHECKOFF
Cotton Incorporated

Carbon assessment in Texas cropping systems

Region	Soil Series	Acres Represented
Northern High Plains	Conlen loam	501,717
	Dallam fine sandy loam	851,576
	Sherm silty clay loam	1,432,333
	Sunray loam	500,625
Southern High Plains	Amarillo fine sandy loam	3,054,075
	Olton clay loam	1,800,547
	Pullman clay loam	3,091,530
Gulf Coast	Edroy clay	73,281
	Orelia sandy clay loam	228,130
	Raymondville clay loam	235,577
	Victoria clay	784,257
Rolling Plains	Abilene clay loam	340,476
	Miles fine sandy loam	1,439,014
	Grandfield fine sandy loam	801,794
	Rowena clay loam	492,390
Blackland Prairies	Austin silty clay	351,412
	Branyon clay	436,764
	Frio silty clay	520,407
	Houston Black clay	1,415,510
Total acres represented by our sampling efforts		***18,412,723***

Region	Soil Series	Cropping System	pH ----	Conductivity mmhos/cm	Organic matter %
Blackland Prairies	Austin	Wheat22/Corn21	8.1	0.39	4.1
	Branyon	Sorghum22 (no-tillage)	8.2	0.16	3.3
		Wheat22 (no-tillage)	8.2	0.15	3.5
	Frio	Sorghum22 (mixed species cove	8.2	0.16	3.0
		Wheat22 (mixed species cover)	8.2	0.13	2.9
	Houston	Continous Corn	8.2	0.25	4.5
		Cotton22/Corn21	8.2	0.31	3.4
South Texas	Edroy	Corn22	6.0	0.20	1.6
	Orelia	Cotton22	6.9	0.27	1.4
	Parrita	Introduced pasture	7.0	0.37	3.4
	Raymondville	Corn22	8.2	0.36	2.1
		Cotton22/Corn21	8.2	0.28	2.2
	Victoria	Cotton22	8.1	0.40	1.8
		Cotton22 (MinTillage)	8.2	0.28	2.0
		Cotton22/Sorghum21	8.1	0.36	2.4
		Fallow22	8.2	0.46	2.1

Climate-smart agriculture in Texas

ECOM

Climate-smart cotton - $35 million

Climate-smart cotton through a sustainable and innovative supply chain approach

Collaborators: Emi Kimura, Will Keeling, Josh McGinty, and the University of Arkansas Department of Agriculture

NATIONAL SORGHUM PRODUCERS
the voice of the sorghum industry

Climate-smart sorghum - $65 million

Conservation of natural and sustainable environmental resources with verified engagement (CONSERVE)

Collaborators: Jourdan Bell, Paul DeLaune, Kansas State University, and Oklahoma State University

2023 Texas State Support Committee Projects

Nitrogen management in conservation systems

Impact of cotton cropping systems and management strategies on the productive capacity of soil in the Texas Southern High Plains

Collaborators: Wayne Keeling and Paul DeLaune

Nutrient requirements of modern cotton varieties

Nutrient accumulation and requirements of modern cotton cultivars in the Southern High Plains and Rolling Plains of Texas

Collaborators: Reagan Noland

Subsurface drip irrigation fertigation strategies

Developing a fertigation strategy for subsurface drip irrigation on Texas' Southern High Plains

Collaborations with industry

ANUVIA PLANET INSPIRED PRODUCTS

WILBUR-ELLIS

HELENA

heliae

CORTEVA agriscience

TESSENDERLO Kerley CROP VITALITY EST. 1919

YARA

ICL

CHS

Mosaic

BAYER

WEST CENTRAL

Barker Research Farm
2023 Plans

The Barker Farm

Barker Research Farm

An Experiment in Regenerative Agriculture

Texas A&M AgriLife Research | Extension

In Collaboration with:

WSW

Grey Hare Analytics

High Plains Underground Water Conservation District No. 1 HPWD www.hpwd.org

West Texas A&M University

Semi-Arid Agricultural Systems Institute

Capital Farm Credit

MTS

Texas Tech University

horizon builders

lubbockhorizonbuilders.com FB @HorizonWestTexas

Frontier Valley, Inc Valley Morton, Tx

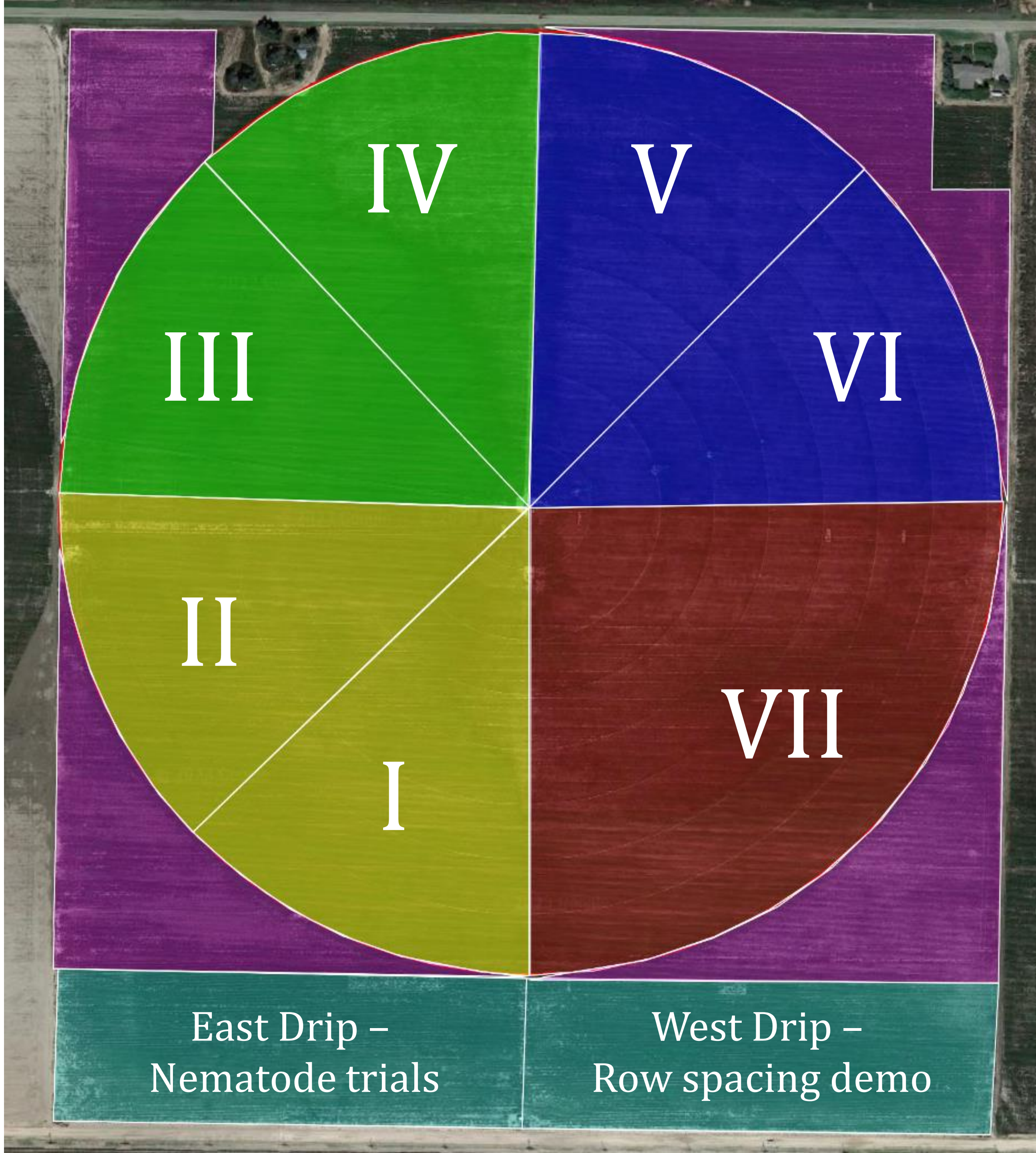
Plains Cotton Growers

Legislation. Research. Promotion. Service.

Cochran County

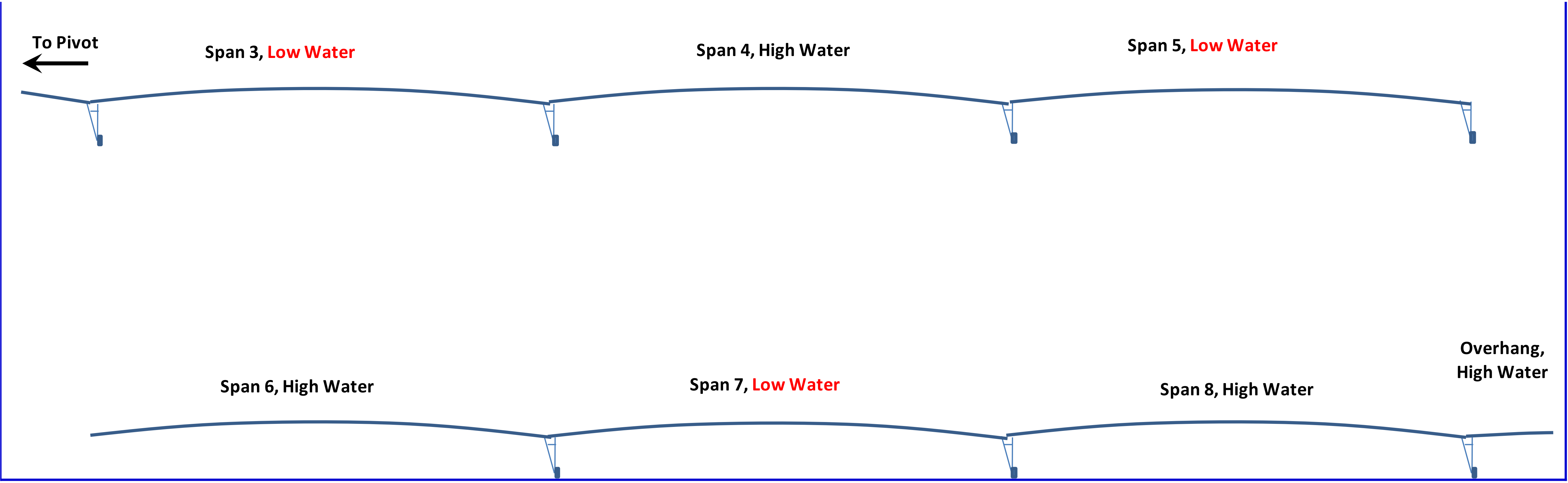
Cropping systems

I. Continuous cotton – winter fallow, conventional tillage
II. Continuous cotton – winter cover, no-tillage
III. Cotton ('23)-Sorghum ('24) Rotation, no-tillage
IV. Sorghum ('23)-Cotton ('24) Rotation, no-tillage
V. Wheat ('23)-Fallow-Cotton ('24) Rotation, no-tillage
VI. Cotton ('23)-Wheat ('24)-Fallow Rotation, no-tillage
VII. Continuous cotton – winter fallow, conventional tillage



Irrigation management

Evapotranspiration replacement will be determined in Q2 2023 based on irrigation supply.



2023 research trials

Detailed Soil and Site Characterization Prior to System Implementation

Cotton Variety Evaluation

Water x Variety Cotton Evaluation

Soil Water Dynamics within Cropping System

Row Spacing Evaluation

Pathogenic Nematode Evaluation

Cropping System Impact on Wind Erosion

Fluid Fertilizer Foundation

Cotton

Texas A&M AgriLife Research

Texas State Support Committee
Cotton Research and Promotion Program

THANK YOU

Katie Lewis
Associate Professor
katie.lewis@ag.tamu.edu

Joseph Burke
Postdoctoral Research Associate
Joseph.burke@ag.tamu.edu