6th Annual TAWC

Water College

January 23, 2020

Lubbock Civic Center

Lubbock, TX

TAWC

TEXAS ALLIANCE FOR WATER CONSERVATION

The TAWC project was made possible through a grant from the

Texas Water Development Board

6th Annual Water College

January 23, 2020
Lubbock Memorial Civic Center
Lubbock, TX

Morning Sessions:

8:30 am **Registration & Visit Booths**

8:50 am **Welcome & Introductions**

***Dr. Glen Ritchie**, Department Chair and Professor of Plant & Soil Science, Texas Tech University*
***Cameron Turner**, Manager, Agricultural Water Conservation Program, TWDB*

9:00 am **Future Trends in World Demographics and Ag: The Effect of Population Changes on the American Farmer**

***Kevin Brinkley**, President and CEO Plains Cotton Cooperative Association*

9:40 am **Using Cover Crops to Manage Soil and Weed Control While Being Economically Sustainable**

***Kris Verett**, Lubbock Texas Producer*

10:30 am **Break & Visit Booths**

10:50 am **Real Farm Data – Using Irrigation Management Technology to Conserve Water and Gain Profitability**

***Lloyd Arthur**, TAWC Producer*
***Jeff Miller**, Forefront Agronomy*

11:50 am **Update from the Texas Water Development Board**

***Brooke Paup**, Texas Water Development Board (TWDB)*

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Afternoon Sessions:

12:15 pm **Lunch & Visit Booths**

12:30 pm **Keynote Address**

Jodey Arrington, *U.S. Representative, District 19 Congressional District*

1:30 pm **Upcoming Weather Patterns – What is in store?**

Brian Bledsoe*, Chief Meteorologist/ Climatologist, Colorado Springs, CO*

2:00 pm **Hot Topics of Texas Water Law**

Tiffany Dowell Lashmet J.D.*, Extension Specialist Agricultural Law, Texas A&M AgriLife Extension*

2:40 pm **Break & Visit Booths**

3:10 pm **US Cotton Trust Protocol – What Farmers Need to Know**

Ken Burton, *Executive Director of U.S. Cotton Trust Protocol National Cotton Council*

3:40 pm **The Future of Cotton Genetics and Weed Control**

Dr. Luis Herrera-Estrella, *President's Distinguished Professor of Plant Genomics and Director of the Center for Functional Genomics of Abiotic Stress, Texas Tech University*

4:30 pm **Close**

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Thanks to Our Sponsors

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TEXAS TECH UNIVERSITY
College of Agricultural Sciences & Natural Resources

indigo

FiberMax cotton | BASF We create chemistry

Cotton Incorporated

PIONEER

(ALPHA) CAPITAL STRATEGIES

Diversity D
specializing in drip irrigation

WATER GROWS
A PROJECT BY TEXAS CORN PRODUCERS AND USDA NATURAL RESOURCES CONSERVATION SERVICE

TEXAS CORN PRODUCERS

AGWORKERS INSURANCE

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WATER DEPARTMENT

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FOREFRONT agronomy, llc

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High Plains Underground Water Conservation District

HFS HURST FARM SUPPLY, INC.

ZIMMATIC BY LINDSAY

MILLER

OgallalaWater.org
OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

PLAINS COTTON GROWERS

Plains LAND BANK

PRAIRIE VIEW A&M UNIVERSITY

Reinke
MORE RIGHT THAN RAIN

SOUTH PLAINS VALLEY IRRIGATION, INC.

Texas Agricultural Irrigation Association

T-L

City Bank

Texas Grain Sorghum Producers

AG TEXAS
FARM CREDIT SERVICES

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TEXAS TECH UNIVERSITY
College *of* Agricultural Sciences & Natural Resources

If questions/needs ask any of these TAWC Personnel:

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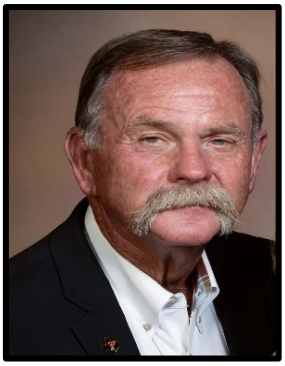
chuck.west@ttu.edu



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Websites: www.TAWC.US / www.tawcsolutions.org

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Welcome, Moderator and Presenters for 2020 TAWC Water College

Dr. Glen Ritchie is Chair of the Department of Plant and Soil Science at Texas Tech University (TTU). Dr. Ritchie received his B.S. degree from Utah State University in Crop Science in 2000, his M.S. degree from Utah State University in Crop Science in 2003, and his Ph.D. degree from the University of Georgia in Agronomy in 2007. He joined the Texas Tech Faculty in 2011 as an Associate Professor of Crop Physiology. His responsibilities at Texas Tech include teaching Crop Physiology and Plant Water Relations. Dr. Ritchie has completed approximately 20 Master of Science and PhD. students. Dr. Ritchie has an active research program examining plant water relations in cotton and sorghum.

Research interests include developing effective and economical water management strategies for crop production in the Southern High Plains. Current projects include research on cultivar selection, irrigation management, and the effects of persistent and episodic drought on crop growth, morphology, yield, and quality.

Cameron Turner is the Manager of the Agricultural Water Conservation Program at the Texas Water Development Board. His duties include managing grant projects, developing statewide irrigation estimates, and providing outreach and education to the public.

He was raised on a family farm with operations in parts of Deaf Smith, Parmer, Bailey, and Lamb counties. His rural upbringing fuels his passion for conservation as a means to preserve rural economies, livelihoods, and the prosperity of agriculture in rural Texas.

Cameron attended Texas A&M University where he received a degree in Agricultural Economics with a focus on Farm and Ranch Management. He now lives in Cedar Park with his wife and two children.

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Kevin Brinkley is the president and chief executive officer of Plains Cotton Cooperative Association headquartered in Lubbock, Texas. PCCA is a grower-owned marketing cooperative supplying cotton from Texas, Oklahoma and Kansas to textile mills around the world.

Originally from Burnet, Texas, Brinkley graduated from Texas Tech University with bachelor's and master's degrees in agricultural economics. Upon graduation, he joined the staff of the National Cotton Council until 2000, when he joined The Seam. Brinkley was named chairman and chief executive officer of The Seam in January 2015.

Brinkley has spent the last 30 years in the cotton industry, using his knowledge and experience to promote U.S. cotton and ensure the success of American cotton farmers around the globe. He serves as an advisor on trade policy to Secretary of Agriculture Sonny Perdue and United States Trade Representative Robert Lighthizer.

Kris Verett is a fourth-generation operator of Verett Farms in Ralls, TX, where cotton and multi-species covers comprise the majority of the operation.

Kris grew up working on the farm and grew to love all things farming. He continued his passion by completing a degree in agronomy and entomology at Texas A&M, followed by a masters in agronomy at Texas Tech. Upon completing school, Kris knew he wanted to return to the farm to employ his knowledge.

After attending R.N. and Ronnie Hopper's no-till meeting in 2013, Kris became interested in implementing the system into his operation. Today nearly every acre follows a rotation of cotton followed by multi-species covers. Kris looks forward to continuing to better utilize our resources and leave the farm better than he found it for his two boys, Charley and Luke.

Lloyd Arthur is a fifth-generation farmer living in Ralls, Texas with his wife Angela.

They have four children, and together the family has created a farming operation that has received awards and recognition such as Crosby County Agriculturist of the Year, Ralls Chamber of Commerce Mr. & Mrs. Cotton Boll and Texas Farm Bureau District II Outstanding Young Farmer and Rancher. Field to Market Farmer Spotlight, and Outstanding Friend of Extension Specialists Award. Lloyd has served in numerous leadership roles including the boards of Rio Blanco Soil

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and Water Conservation District, Cotton Incorporated, and Texas Farm Bureau (just to name a few).

Jeff Miller was born and raised in Plainview, TX and has been involved in agriculture his whole life. Jeff holds a BS in Integrated Pest Management from Texas Tech and an MS in Crop Physiology from Texas Tech. Jeff is married to Kate and has 4 beautiful children. Jeff worked for 10 years with Deltapine/Monsanto in product development and worked 8 years with Pioneer in drought research, sales, and agronomy.

He founded Forefront Agronomy in 2017 to provide leading edge individualized agronomy insight and support to the growers of West Texas. There are many challenges in agriculture and by utilizing our partnerships with DuPont Pioneer, CropMetrics, and 360 Yield Center we have the best support behind us to tackle these challenges and strive for profitability.

Brooke Paup was appointed to the Texas Water Development Board by Governor Greg Abbott on February 22, 2018 and reappointed to a new term on February 6, 2019.

Prior to her appointment to the Board, Paup served as the director of legislative affairs for the Texas Comptroller of Public Accounts for the previous three years. While there, she led a team of legislative professionals to address statutory tax reforms.

Paup is formerly the deputy division chief of intergovernmental relations and former special assistant for policy and research for the Office of the Attorney General, where she worked on legislative issues, special litigation, and public finance—notably House Bill 4 and Senate Joint Resolution 1 in the 83rd Legislative Session, which created the State Water Implementation Fund for Texas (SWIFT) and the State Water Implementation Revenue Fund for Texas (SWIRFT). Paup has 13 years of state government experience.

She is a member of the State Bar of Texas, Symphony League, Wine and Food Foundation of Texas Auction Committee, and Doss PTA. Paup earned a Bachelor of Arts from Texas A&M University and a juris doctor from Texas Tech School of Law.
She lives in Austin with her husband, Spivey, and their two children, Henry and Heidi.

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Keynote Address

Congressman Jodey Arrington was raised in Plainview, Texas, the son of a tractor salesman and a school teacher. Jodey graduated from Texas Tech and his passion of public service took him to Austin, Texas where he worked for Governor George W. Bush. He was then tapped by President Bush to join the White House as a senior advisor before being appointed as Chief of Staff to the Federal Deposit Insurance Corporation. In 2007, he returned to West Texas where he was Vice Chancellor of the Texas Tech University System before taking the helm as President of a healthcare innovation company in Lubbock.

In January of 2017, Jodey became only the fifth person to represent Texas' 19th Congressional District since its formation in 1935. In Congress, Jodey has been an outspoken advocate for reining in the federal government, promoting agriculture and energy, strengthening national security, and respecting the Constitution.

In his first term, Jodey served as a member of the Agriculture, Budget and Veterans' Affairs committees. He was also appointed by the Speaker as the only freshman member to serve on the Joint Select Committee on Budget and Appropriations Reform.

Upon entering the 116th Congress, Jodey was selected to serve on the Committee on Ways and Means. The oldest Congressional Committee, Ways and Means also has the broadest legislative jurisdiction including tax, trade, healthcare, social security, and welfare. As a new member on the Committee, prioritizing rural America's most critical issues – agriculture, energy, and healthcare, will remain his driving force.

He is grateful to serve and is especially thankful for the tremendous sacrifice and support of his wife, Anne, and their three children.

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Brian Bledsoe is the Chief Meteorologist/Climatologist for KKTV 11 News in Colorado Springs, Colorado.

Brian's goal is to help AG producers make their business more successful, by using accurate weather forecasts, both short term and long term. His strong background in agriculture is important, as he recognizes the need for good common-sense weather forecasting that can be readily used by farmers and ranchers. Brian has several private clients scattered around Colorado, and the whole United States. He frequently speaks all across the region about weather and the importance of using long range forecasting to help your business.

Tiffany Dowell Lashmet, J.D. is an Associate Professor and Extension Specialist in Agricultural Law with Texas A&M AgriLife Extension. Tiffany grew up on a family farm and ranch in Eastern New Mexico, received her Bachelor of Science in Agribusiness (Farm and Ranch Management) *summa cum laude* at Oklahoma State University, and her law degree *summa cum laude* at the University of New Mexico.

Prior to joining Texas A&M AgriLife Extension, Tiffany worked for 4 years at a law firm in Albuquerque practicing civil litigation. She is licensed to practice law in New Mexico and Texas. She lives in the Texas Panhandle with her husband, son, and daughter.

In 2016, Tiffany was named the State Specialist of the Year for Texas Agriculture by the Texas County Agricultural Agents Association. In 2019, she won the Excellence in Agricultural Law Award for Academia from the American Agricultural Law Association.

Ken Burton is the Executive Director of the U.S. Cotton Trust Protocol. Ken is responsible for the overall development and operation of the U.S. Cotton Trust Protocol. He works with producers and other cotton industry members to enroll participants in the Trust Protocol, as well as interact with textile brands/retailers and civil societies in the development, acceptance and use of the program.

A graduate of Auburn University, Ken has 28 years of experience in the cotton industry, most recently serving as Vice President of Loeb and Company, Inc. He has built strong relationships with industry participants throughout the

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supply chain from growers to textile manufacturers. Ken coordinated all aspects of Loeb and Company's participation in the Better Cotton Initiative.

Ken is happily married to his wife, Laura for 27 years. They have three children: Madeline (22), William (20), and Kristen (17).

Dr. Luis Rafael Herrera-Estrella's research focuses on the molecular mechanisms that allow plants to cope with a continuously changing environment. In particular, he has studied the two fundamental processes of molecular responses to light as a source of energy and a developmental signal, and nutrient availability.

Herrera-Estrella identified DNA regulatory elements that allow plants to activate genes in response to light stimuli and the protein sequence present in many corresponding gene products that ultimately allow participation in the photosynthesis process.
A holder of 15 patents, Herrera-Estrella has published more than 180 research papers and 47 book chapters and other reviews while having delivered more than 200 presentations on his work. He served as a senior international research scholar at the Howard Hughes Biomedical Institute from 2012 to 2017 and earned the Dr. Luis Federico Leloir Award in 2012 from the Argentinian Ministry of Science, Technology and Innovation.

A native of Mexico, Herrera-Estrella also has served as the president of the International Society of Plant Molecular Biology (*2001-2003*), and in 2000, earned the gold medal from the World Intellectual Property Organization as one of the most distinguished inventors in Mexico, one of only three Mexican citizens to receive this honor.

Herrera-Estrella earned his doctoral and postdoctoral degrees in genetics from the State University of Ghent, Belgium. He received his master's degree in genetics and molecular biology from the Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, and his bachelor's degree from Escuela Nacional de Ciencias Biológicas Instituto Politécnico Nacional.

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Future Trends in World Demographics and Agriculture

The Effect of Population Changes on the American Farmer

1

Current global political and economic conditions are the darkest in history.

True or False

2

What percent of the world lives in poverty?

A.) 61% B.) 54% C.) 35% D.) 28%

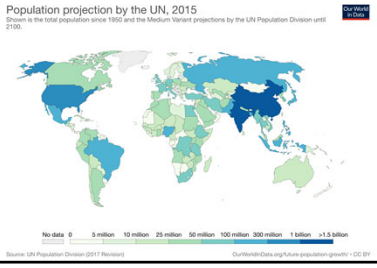
3

For most of the world's population, the human condition has improved.

What are the implications for the future of agriculture?

4

A Shifting Population



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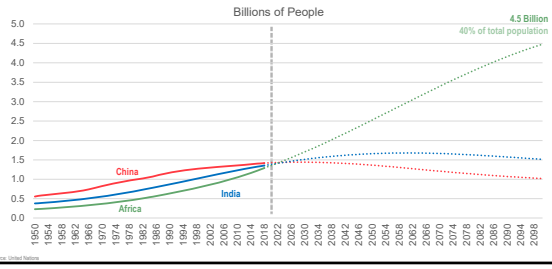
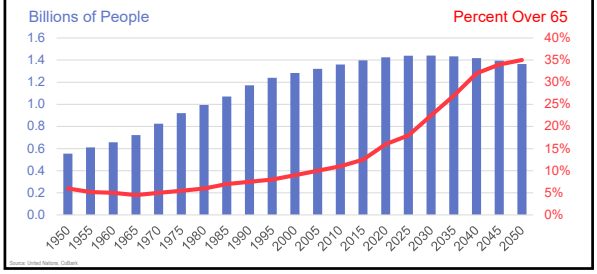
Population Growth



6

China's Aging Population



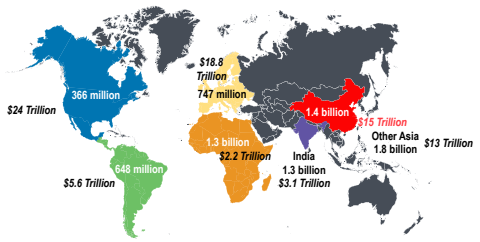
7

What does population growth mean to agriculture?

Gap=Production Minus Consumption

8

Population vs. GDP



9

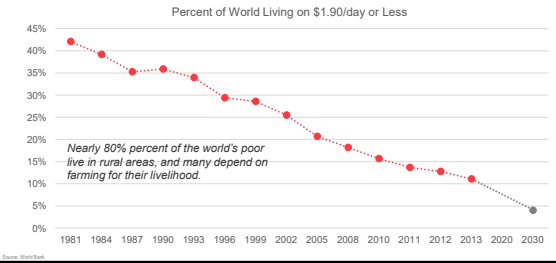
What percent of the world lives in poverty?

A.) ~~64~~% B.) ~~54~~% C.) ~~35~~% D.) ~~28~~%

10.6%

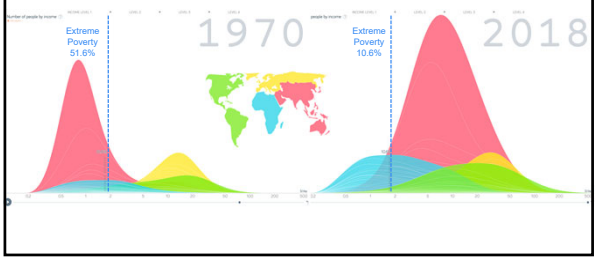
10

Poverty is rapidly declining



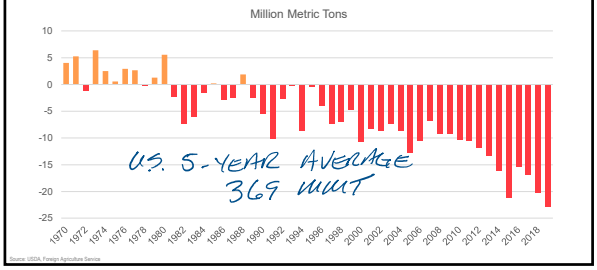
11

Global Income Distribution



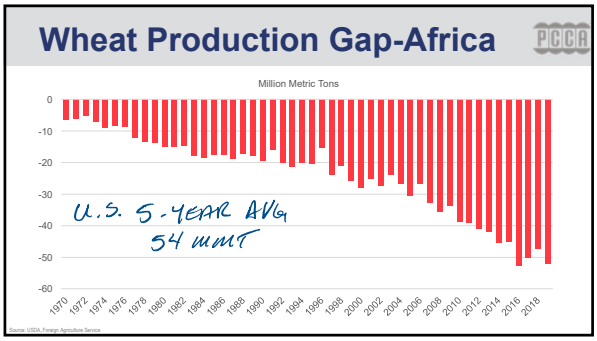
12

Corn Production Gap-Africa



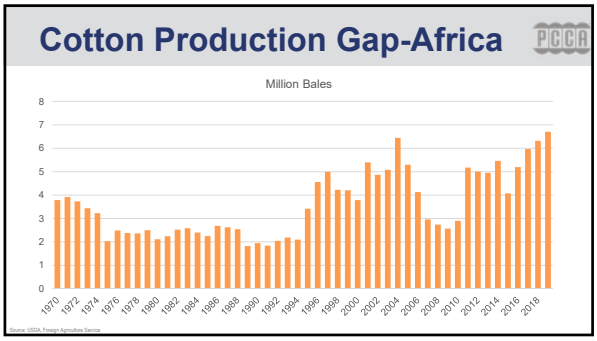
13

Wheat Production Gap-Africa



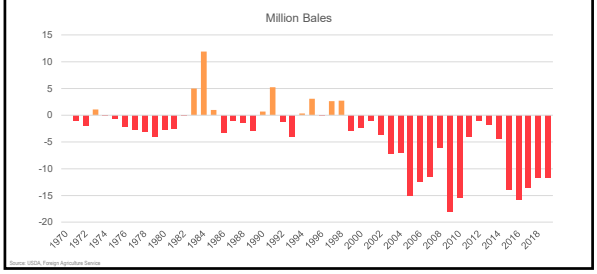
14

Cotton Production Gap-Africa



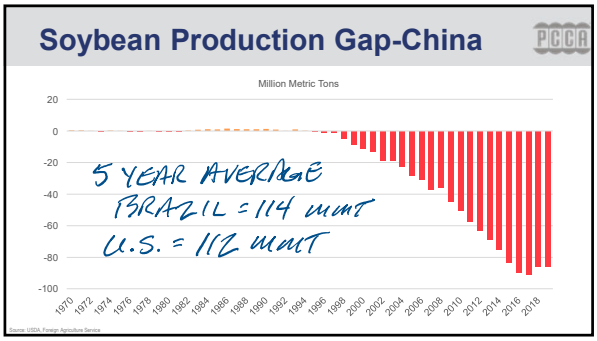
15

Cotton Production Gap-China



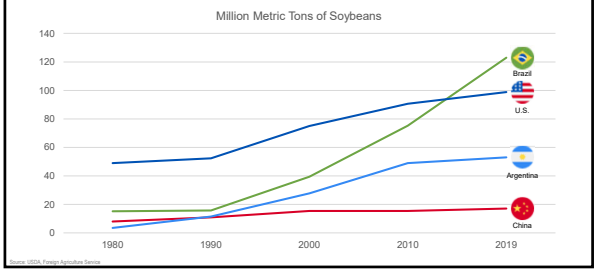
16

Soybean Production Gap-China



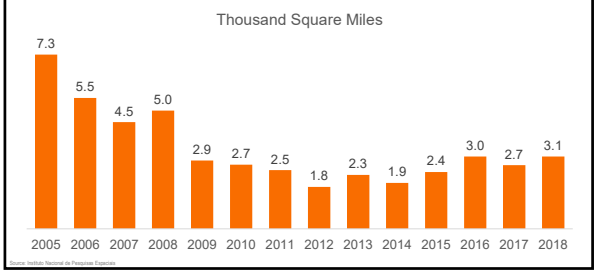
17

Who Benefitted from China's Demand?



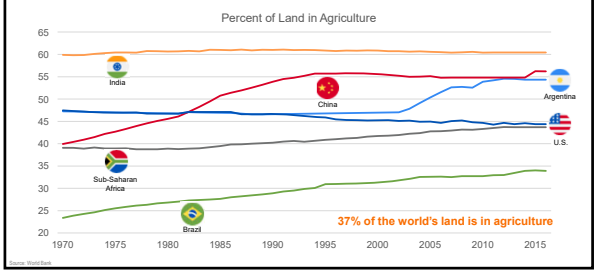
18

Brazil's Deforestation



19

Competitors of the Future?



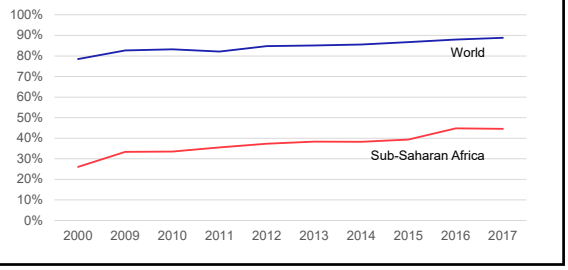
20

Lesser Developed Nations Needs

- Money
- Infrastructure
- Education
- Time
- Political Stability

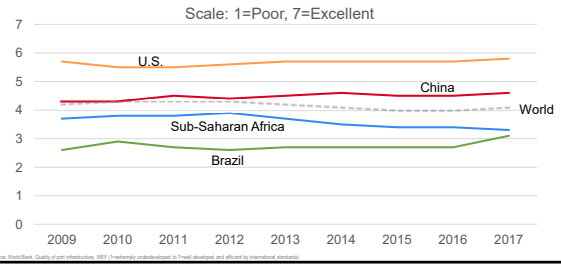
21

Access to Electricity



22

Quality of Port Infrastructure



23

Workforce Skills

Only 68% of Sub-Saharan Africa has completed a primary education

24

Current global political and economic conditions are the darkest in history.

True or False

25

What does all of this mean for our farmers?

26

Trade

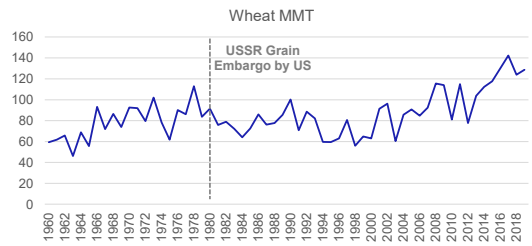
27

In 1980, President Jimmy Carter embargoed U.S. grain sales to the U.S.S.R.

Did it permanently impact our market?

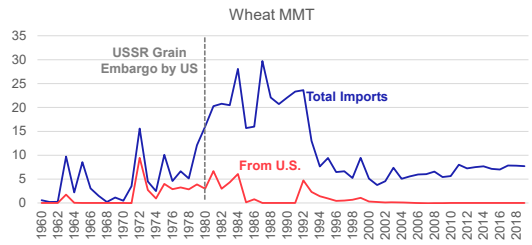
28

Former Soviet Bloc-12 Production



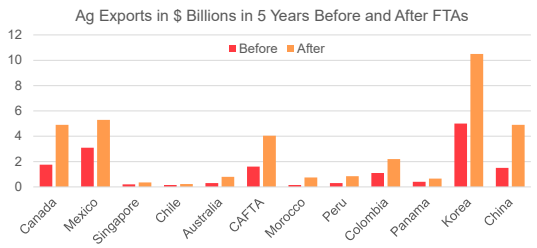
29

Former Soviet Bloc-12 Imports



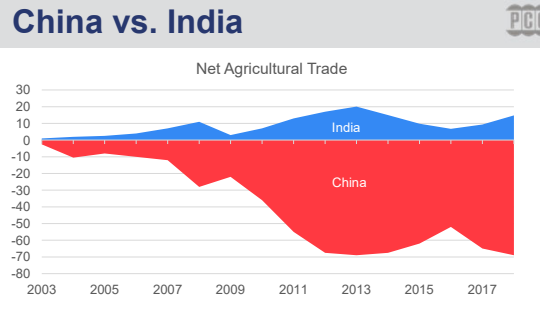
30

Free Trade Works for Ag



31

China vs. India



32

China Dominates World Market

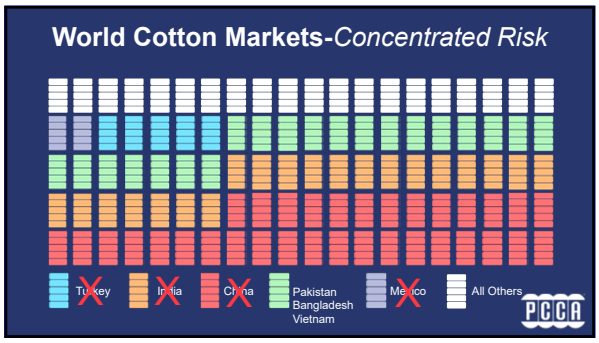
22% Production

33% Consumption

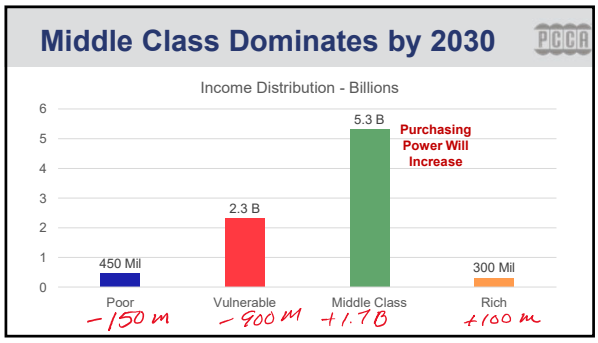
23% Imports

41% World Stocks

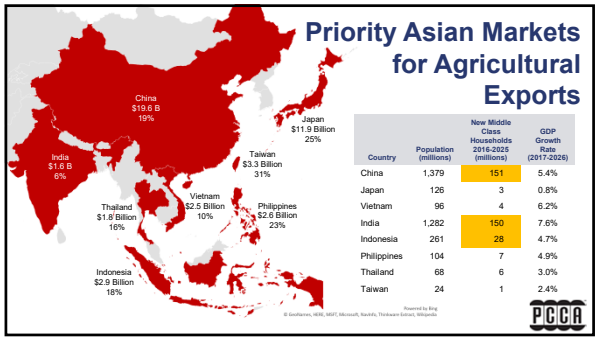
33


World Cotton Markets-Concentrated Risk
Turkey
India
China
Pakistan
Bangladesh
Vietnam
Mexico
All Others
PCCA

34

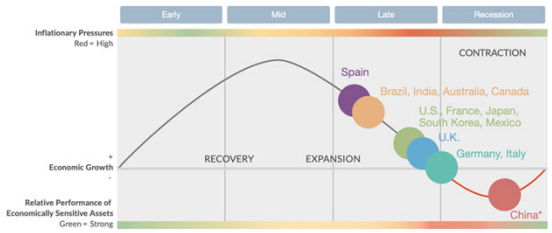

Middle Class Dominates by 2030
PCCA
Income Distribution - Billions
6
5
4
3
2
1
0
450 Mil
2.3 B
5.3 B
Purchasing Power Will Increase
300 Mil
Poor
Vulnerable
Middle Class
Rich
-150 M
-900 M
+1.7B
+100 M

35


Priority Asian Markets for Agricultural Exports
China $19.6 B 19%
Japan $11.9 Billion 25%
India $1.5 B 6%
Taiwan $3.3 Billion 31%
Vietnam $2.5 Billion 10%
Thailand $1.8 Billion 16%
Philippines $2.6 Billion 23%
Indonesia $2.9 Billion 18%
Country | Population (millions) | New Middle Class Households 2016-2025 (millions) | GDP Growth Rate (2017-2026)
China | 1,379 | 151 | 5.4%
Japan | 126 | 3 | 0.8%
Vietnam | 96 | 4 | 6.2%
India | 1,282 | 150 | 7.6%
Indonesia | 261 | 28 | 4.7%
Philippines | 104 | 7 | 4.9%
Thailand | 68 | 6 | 3.0%
Taiwan | 24 | 1 | 2.4%
PCCA

36

What About the Near Term?



37

Summary

Demand Drivers

- Global population growth
- Income Improvements
- Lack of production capacity in highly populated areas

Supplier Advantages

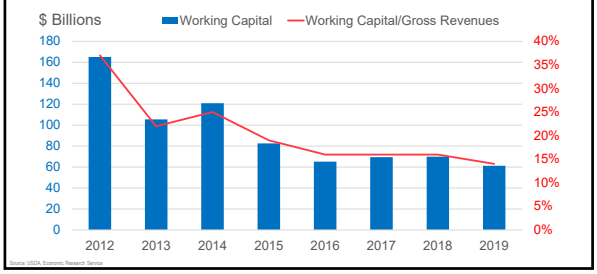
- Limited land means productivity is critical
- Infrastructure investments
- FTAs work for agriculture

38

What do we do until demand starts to improve?

39

U.S. Farm Working Capital



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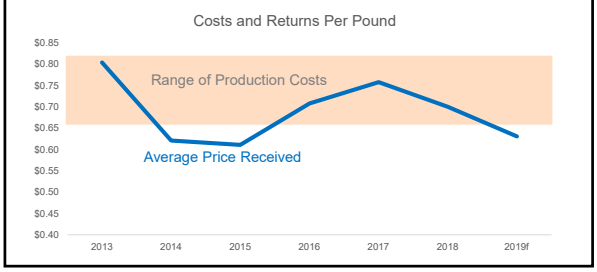
Opportunities for Change?



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Focus Areas for Growers

- Reduce costs per unit of production
- Add value through innovative marketing
- Advocate for appropriate federal support

42

Sources

- United Nations
- World Bank
- USDA
- CoBank
- Plains Cotton Cooperative Association

Plains Cotton Cooperative Association

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Using Cover Crops to Manage Soil and Weed Control While Being Economically Sustainable

Kris Verett

1

Overview

- Verett Farms background
- Why no-till & covers?
- Rotational sequence
- Cover progression
- Planting & setup
- Weed control strategies
- Budget comparison
- Questions

2

Verett Farms Background

- Location: Ralls, TX
- Acres: approximately 4,000
- Primary crops:
  - Cotton
  - Multi-species covers
  - Cows?

3


Why No-Till & Covers?
Less soil erosion
https://cimss.ssec.wisc.edu/satellite-blog/archives/32871

4


Why No-Till & Covers?
Less soil erosion
Cost savings
Fuel - using 60% less
Maintenance
Wear & tear

5


Why No-Till & Covers?
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Less employee burnout

6


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Better water infiltration

7


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Collecting unruly precipitation

8


Why No-Till & Covers?
Less soil erosion
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Better water infiltration
Collecting unruly precipitation
Less evaporation
Keeps ground cooler

9


Why No-Till & Covers?
Less soil erosion
Cost savings
Fuel - using 60% less
Maintenance
Wear & tear
Less employee burnout
Better water infiltration
Collecting unruly precipitation
Less evaporation
Keeps ground cooler
Soil health benefits
Less compaction
Firmer seed beds

10


Rotational Sequence

11


Drilling Rye
Timeliness
Planting rate
Rye
Radishes
Minimal soil disturbance

12

Seed	Rate (lb)
Daikon Radish	0.5
Dwarf Essex Rape	0.5
Purple Top Turnip	0.5
Proso Millet	2.0
Japanese Millet	2.0
Pearl Millet	2.0
Sorghum Sudan	4.0
Crimson Clover	1.0
Hairy Vetch	1.0
Sunn Hemp	2.0

Multi-Species Mix

13

Planting Multi-Species into Rye

14

Cover Progression – Wideman Pivot – April 25th

15

Cover Progression – Wideman Pivot – June 15th

16

Cover Progression – Wideman Pivot – June 24th

17

Cover Progression – Wideman Pivot – July 9th

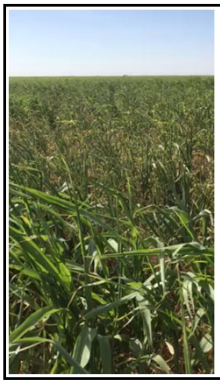
18


Cover Progression – Wideman Pivot – July 17th

19


Cover Progression – Wideman Pivot – August 3rd

20



Cover Progression – Wideman Pivot – August 17th

21

Cover Progression – Wideman Pivot – August 29th

22

Cover Progression – Wideman Pivot – September 23rd & 30th

23

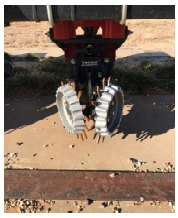
Cover Progression – Wideman Pivot – November 19th

24

Cotton Planting Setup

- Case IH Planter
- Yetter finger-style trash whippers, with depth band
- Martin spiked closing wheels



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Planting Cotton Behind Cover

26

Emergence Progression Pics

27

- Ideal to have both horizontal & vertical cover

Cover Degradation – Starting Point – September 10th

28

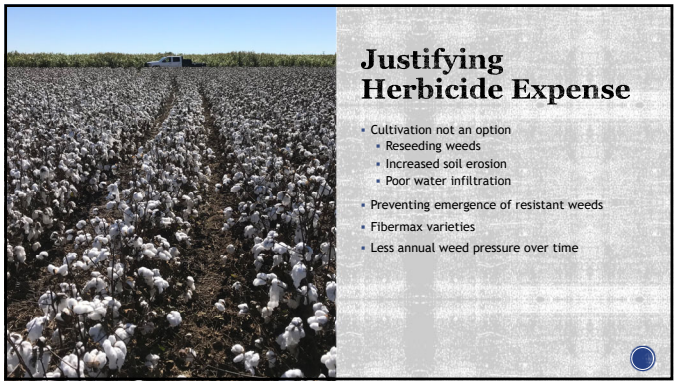
Cover Degradation – You Can't Have Enough!

29

Timing	Herbicide Mix
Late February	8 oz Weedmaster + 1 qt Roundup
April	24 oz Weedmaster + 1 qt Roundup
Behind planter	2 oz Staple + 1 lb Direx + 32 oz Gramoxone
Early-mid post	Dual or Warrant + 40 oz Liberty + 1 qt Roundup
Post-directed layby	1 lb Direx + 1 qt Roundup

Weed Control Strategies

30



Justifying Herbicide Expense

- Cultivation not an option
  - Reseeding weeds
  - Increased soil erosion
  - Poor water infiltration
- Preventing emergence of resistant weeds
- Fibermax varieties
- Less annual weed pressure over time

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Budget Comparison - Irrigated

120 Acres Irrigated Cotton 2 gpm/a 850# yield potential				
Revenue	Acres	Yield	Price	
	120	850	0.65	$66,300
Expenses		Acres	$/Acre	
Seed Cost 45K/A		120	$75	$9,000
Fertilizer		120	$50	$6,000
Herbicide		120	$60	$7,200
Land Prep and tillage		120	$60	$7,200
Total Expense				$29,400
Net for 120 Acres				**$36,900**

60 Acres Irrigated Cotton 4 gpm/a 1500# Yield potential				
Revenue	Acres	Yield	Price	
	60	1500	0.65	$58,500
Expenses		Acres	$/Acre	
Seed Cost 45K/A		60	$75	$4,500
Fertilizer		60	$70	$4,200
Herbicide		60	$75	$4,500
Herbicide		60	$10	$600
Cover Crop Seed		60	$45	$2,700
				$16,500
Net for 60 Acres				**$42,000**

https://southplainsprofit.tamu.edu

32

Budget Comparison - Dryland

120 Acres Dryland Cotton 400# yield potential				
Revenue	Acres	Yield	Price	
	120	400	0.65	$31,200
Expenses		Acres	$/Acre	
Seed Cost 25K/A		120	$40	$4,800
Fertilizer		120	$25	$3,000
Herbicide		120	$50	$6,000
Land Prep and tillage		120	$60	$7,200
Total Expense				$21,000
Net for 120 Acres				**$10,200**

60 Acres Dryland Cotton 650# Yield potential				
Revenue	Acres	Yield	Price	
	60	650	0.65	$25,350
Expenses		Acres	$/Acre	
Seed Cost 25K/A		60	$40	$2,400
Fertilizer		60	$35	$2,100
Herbicide/Cotton		60	$50	$3,000
Herbicide/Cover Crop		60	$25	$1,500
Cover Crop Seed/Planting		60	$45	$2,700
				$11,700
Net for 60 Acres				**$13,650**

https://southplainsprofit.tamu.edu

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Questions?

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Real Farm Data - Using Irrigation Management Technology to Conserve Water and Gain Profitability

Jeff Miller - ForeFront Agronomy
Lloyd Arthur - Crosby Co Farmer

1

Hindsight

- We have many technologies available to look back on past performance
  - Yield Monitor - yield Data
  - Soil Moisture
  - Historical Weather Data
  - Soil Information
  - EC Data

2

Insight

- Having the ability to look at what is happening now.
  - Soil Moisture Probes - plant water use, rooting depth, available moisture
  - Imagery
  - Tissue/Soil Testing
  - Crop Scouting

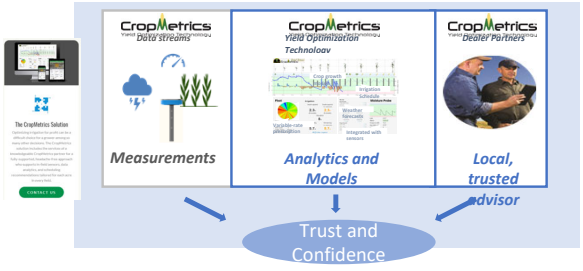
3

Foresight

- The ability to predict what may happen and give us the chance to make adjustments before it happens
  - Soil Moisture Crop Modeling
  - Fertility Modeling
  - Weather Forecasting
  - Sap Analysis
  - Biological Soil Testing

4

Confidence is found in systems



5

The opportunity is in the Variability

- Its Because of the variables that we need to plan
- If you fail to plan, you will plan to fail
  - Plan to fail - when and where to abandon or move water to best parts of the field
  - Identify the 50% best part of the farm we have to make money
- Manage the fixed variable that are known
- Unknown variables
  - Depleting wells, weather, commodity price

6

Variable Rate Irrigation Basics

7

Speed Control VRI

Application rate is varied by changing the speed of the pivot

Irrigation Management Zones are "pie Sliced' shaped

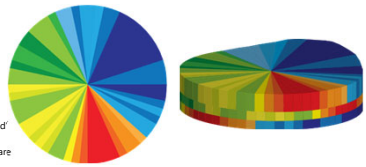
Relatively inexpensive - many pivot panels are capable without additional investment

No special hardware on sprinklers

If spacial variation lines up well with pie slices

Varying application based on topography (reduced application on low spots it it lines up with pie slices

Multiple crops or varieties under one pivot



Optimize Every Acre In Every Field Every Time!

8

Types of VRI Irrigation Prescriptions

Type	Description	Consideration	Example Uses
Static	Prescription stays the same or changes only a few times during the season	Relatively simple to apply. Does not account for changes in spatial variability over. season	Avoiding irrigation on uncrossed areas. Mining differences in soil available water capacity Windshield Wiper pivot with little spatial variability
Dynamic	Prescription changes frequently during the season, possibly for each irrigation event	May be complicated and increase management efforts May provide maximum gross benefit	Varying irrigation to each part of the field as needed and adjusting areas as needs change during the season

9

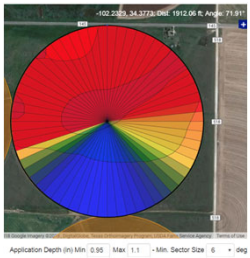
Possible VRI Uses - Thinking outside the box of Soil Variability

Uses	Prescription Type	Management Intensity
Avoid application in uncrossed areas	Static	Low
Overlapping Pivots or Windshield Wiper Pivots	Static	Low
Reduce application in wet areas to avoid water logging or leaching	Static & Dynamic	Low
Reduce application rate to reduce soil surface sealing in early season	Static	Low
Irrigate lighter soils when needed while crop uses water in the heavier soils	Static	Medium
Reduced application rate to avoid runoff in part of a field	Static	Medium
Apply extra water to sloping areas to compensate for runoff after a heavy rain	Static & Dynamic	Medium/High
Irrigate each part of the field as needed because variability caused by precipitation, runoff, evapotranspiration, wind, and/or drainage	Dynamic	High

10

Steps for Implementing a VRI Strategy

1. Measure field variability via a soil electrical conductivity survey (EC)
2. Build the VRI prescription layer
3. Schedule Irrigation
4. Monitor the field during the season



11

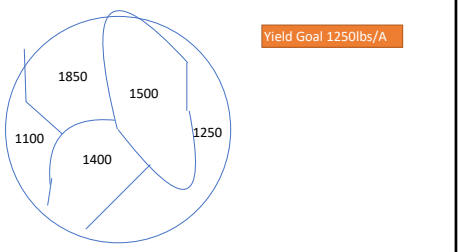
Keep Eyes Focused Forward to move the needle

- Performance is PAST
- Potential is FUTURE
  - Whats interesting is that 2.5 bales may be all that piece of ground is going to produce but with current inputs for 3 bales we are limiting the 3.5 and 4 bale regions (Who knows where the upper limit is)

12

Why Variable Rate Works

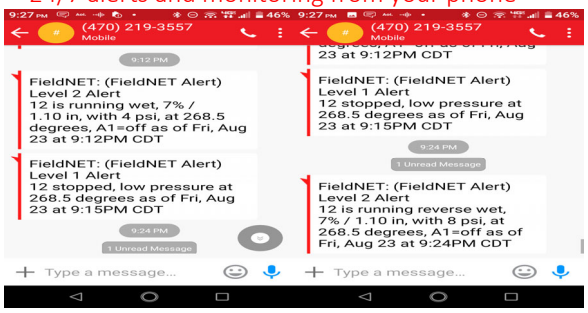
Precision Farming is MODERN DAY FARMING - letting the DATA lead us in that direction



CropMetrics

13

24/7 alerts and monitoring from your phone



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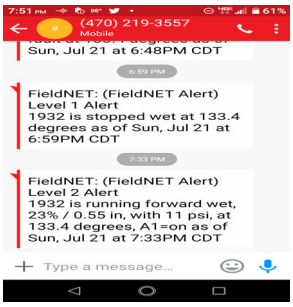
24/7 alerts and monitoring from your phone



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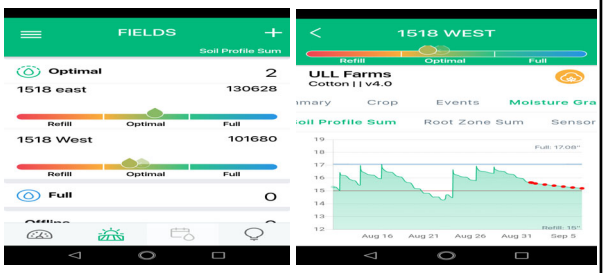
CropMetrics VO

Jell Miller ForeFront Agronomy

Soil Moisture Probes



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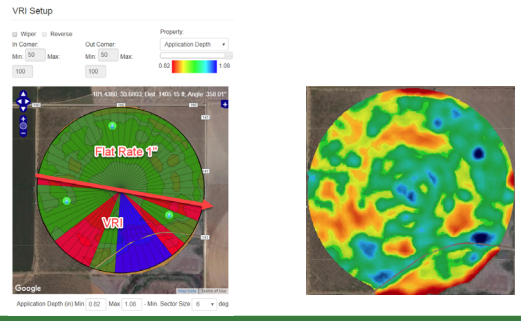
Lloyd Arthur - Ralls, TX



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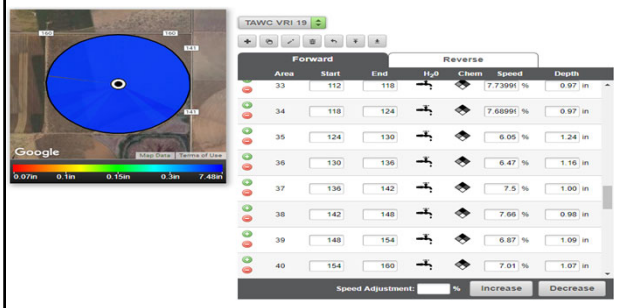
Irrigation Scheme	Avg Application/Pass	Total inches applied inseason
VRI	0.935	7.20
Flat Rate	1.000	7.60

18

VRI Farm 12



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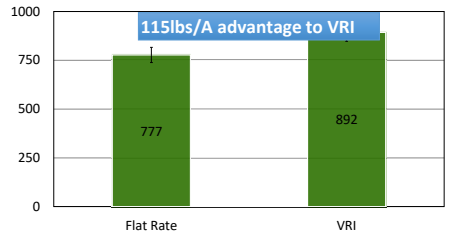
Flat Rate vs VRI Yield Comparison 3 yr – Arthur Farms



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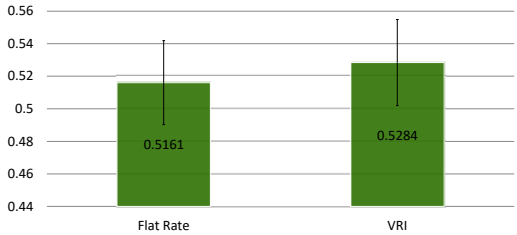
Flat Rate vs VRI Loan Rate Comparisons 3yr– Arthur Farms



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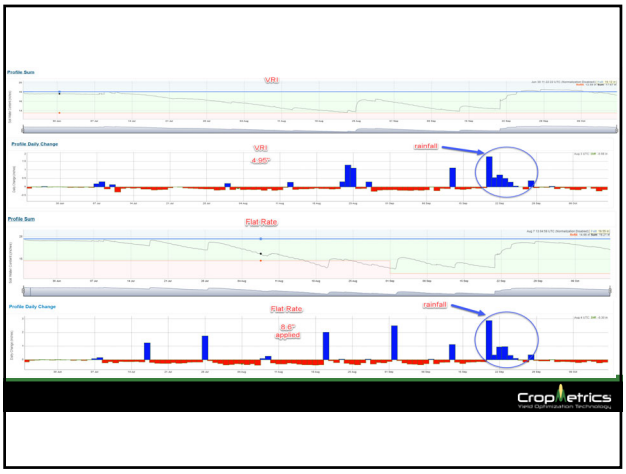
Sector	Yield	Lint	Total
Flat Rate	777.2	$0.5173	$402.04
VRI	892.2	$0.5284	$471.41
VRI Advantage	115.0	$0.0111	$69.37
Probe Cost			-$13.3/A
VRI Cost			-$5/A
Controller Cost			-$5.46/A
			$45.61
Water savings of 0.4" @$8/inch		$3.20	**$48.81**

22



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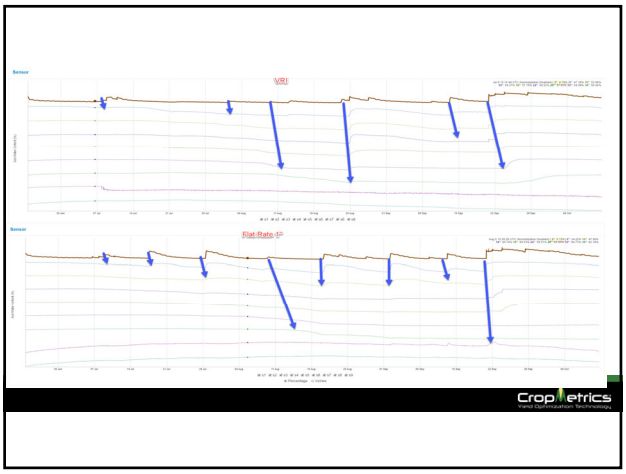

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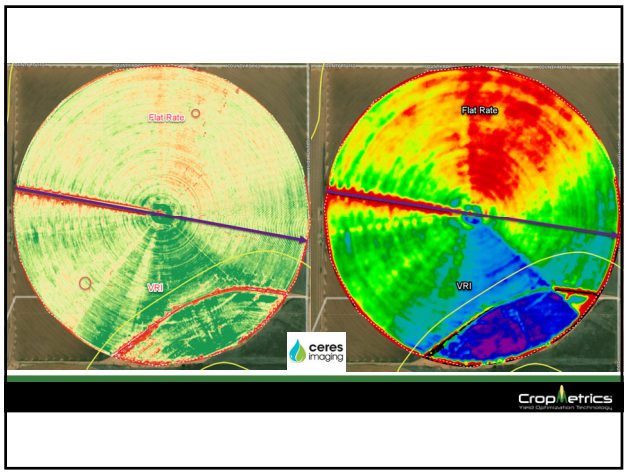
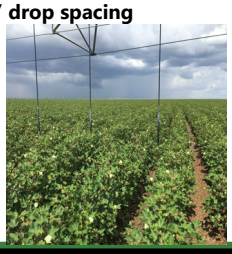


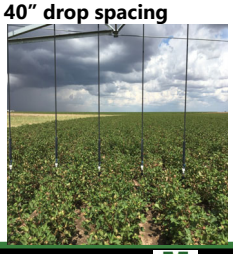
25

Nozzle Spacing Differences

80" drop spacing



40" drop spacing



FOREFRONT
CropMetrics

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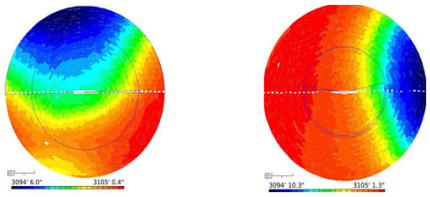
1518 W&E Elevation Change



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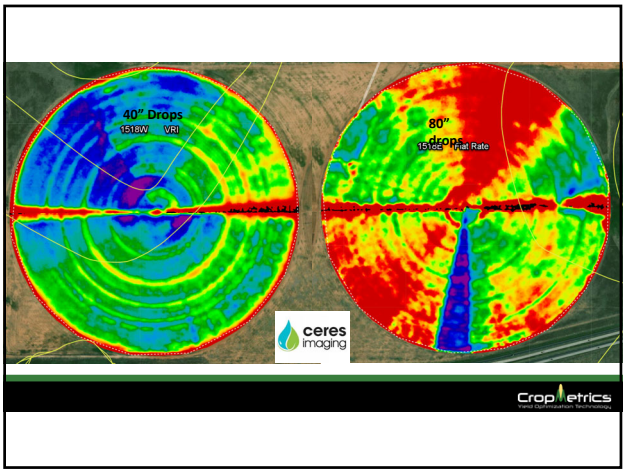

29

Nozzle Spacing Comparison

Irrigation Type	Yield	Loan	$/A
40" Drop Spacing	731.6	$0.5161	$377.55
80" Drop Spacing	563.1	$0.5048	$284.20

2 yr Avg - 10.4" of irrigation in season

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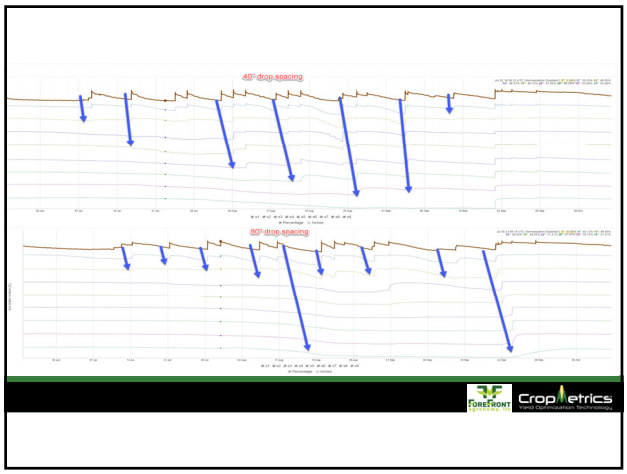

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Other Uses for VRI

32

Water on turn rows/how many gallons wasted?

33

1932 - 2018 Seed Germination

34

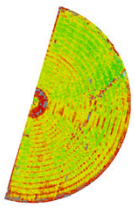
1518 West VRI/48 VRI-Fert

35

Variable Rate Irrigation to address Wiper or Split Pivots

For wiper pivots or pivots that reverse, VRI prescriptions can be smartly adjusted to speed into and out of e
These prescriptions help insure more uniformly managed application depths at the field edges while prever
irrigation and slower overall windshield wipes.

- Constant Speed at 1.5”
- 26 bu/Ac yield difference between N side and S side



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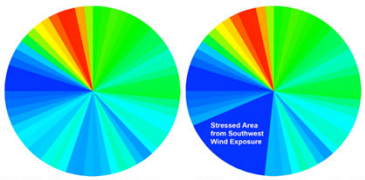
Variable Rate Irrigation

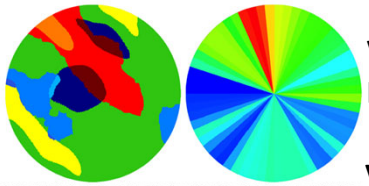
For wind stress, VRI prescriptions can be easily programmed to increase irrigation to any edge of the field that shows crop damage or potential yield loss as determined by visual observation.



Wind VRI Rx - Real-Time Spatial Irrigation Management that Targets Wind Stressed Areas of the Field

37

For optional Variable Rate Seeding prescriptions, VRI prescriptions can more precisely match irrigation to increased or decreased seed densities to further optimize yields.



Variable Rate Seeding VRI Rx - Matches Irrigations to Seed Populations from As-Applied VRS Maps

Variable Rate Irrigation

Variable Rate Seeding

38

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forefrontagronomy@gmail.com
https://forefrontagronomy.com

39

Don't Mess with Texas: Water Edition

Director Brooke T. Paup
Texas Water Development Board

TAWC Water College
January 23, 2020

1

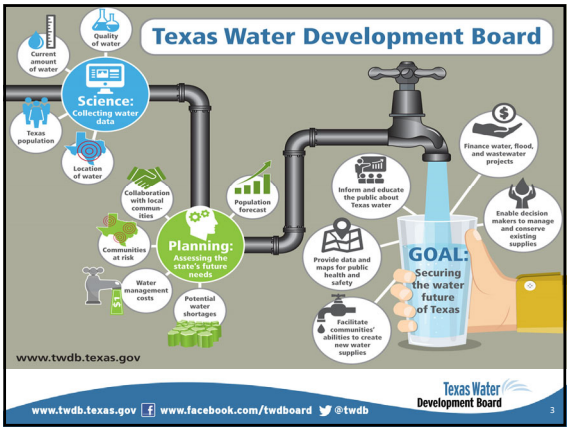
Mission

The mission of TWDB is to provide:

- Leadership
- Information
- Education
- Support for planning, financial assistance, and outreach

For the conservation and responsible development of water for Texas.

2



3

Legislative Update

4

Groundwater bills

- HB 720 (Larson) – Appropriations of water for aquifer storage & recovery projects (ASR)
- HB 721 (Larson) – TWDB studies on ASR projects
- SB 1041 (Taylor) – Extend HB 30 deadline to designate brackish groundwater production zones

5

Update Water Availability Models

- HB 723 by Larson (Perry)
- For the following rivers:
  - Brazos
  - Neches
  - Red
  - Rio Grande

6

Water Planning

- HB 807 by Larson (Buckingham)
  - Requires TWDB to create an inter-regional planning council
  - For the following purposes:
    - Improve coordination among regional planning groups
    - Improve coordination between each regional group and the TWDB
    - Facilitate dialogue on water management strategies that could affect multiple planning areas
  - Regional planning groups encouraged to make legislative recommendations

7

SB 7

Financing Flood Mitigation

8

Senate Bill 7

- Relating to:
  - Flood planning
  - Mitigation
  - Infrastructure projects
- Creates two funds
  - Flood Infrastructure Fund
  - Texas Infrastructure Resiliency Fund

9

Senate Bill 7

- Stated goal is to "encourage development of structural and non-structural flood mitigation"
  - Structural: physical barriers near rivers, coastline
  - Non-structural: policies or naturally-existing
- Recognizes financial need: preference for counties whose median income is lower than 85% of state median income

10

Flood Infrastructure Fund

- Use of the fund
  - Loans (potentially below market rates) for:
    - Construction of flood projects
    - Costs for planning, design, regulatory approval
  - Grants for:
    - Matching funds for federal flood programs
    - Political subdivisions who would have difficulty repaying a loan
    - Flood projects outside of metro areas

11

Flood Infrastructure Fund

- Additional requirements
  - Political subdivisions must "act cooperatively" with other nearby political subdivisions
  - All political subdivisions "substantially affected by a proposed flood project" must participate in planning process
  - Public meetings required
  - Must analyze whether a proposed flood mitigation project could capture floodwater for water supply purposes

12

Texas Infrastructure Resiliency Fund

Four accounts comprise the TIRF:

- Floodplain Management Account
- Hurricane Harvey Account
- Federal Matching Account
- Flood Plan Implementation Account

13

Floodplain Management Account

- Money in this account to be used for:
  - Collecting and analyzing flood-related data
  - Public outreach and education
  - Evaluating responses to flood events
- Funded by insurance taxes – about $3.05 million each fiscal year
- The existing money in Floodplain Management Account #330 will be transferred and re-allocated as one of the 4 TIRF accounts

14

Hurricane Harvey Account

- This account to provide money to TDEM to finance Harvey-related projects
  - Grants to provide matching funds for:
    - TDEM or FEMA hazard mitigation projects
    - TDEM or FEMA public assistance projects
  - Loans for planning/design, permitting, construction
- TWDB will develop a point system with TDEM to properly prioritize projects
- Highest priority to projects that:
  - Recommended by Director of TDEM
  - Meet emergency need in Governor-declared disaster area

15

Federal Matching Account

- TWDB can only use these funds to meet matching requirements for federal projects
  - This includes US Army Corps of Engineers projects
- TWDB may also make subsidized loans to political subdivisions to provide the local share of a federal ship channel improvement project

16

Flood Plan Implementation Account

- This account will take center stage once the first State Flood Plan is adopted in 2024
- TWDB may only use money in this account to fund projects in the State Flood Plan, much like current SWIFT structure
- Other three accounts will finance projects over the next 4-5 years
- Money may be awarded to several political subdivisions for a single flood project

17

TIRF Advisory Committee

- Composed much like the existing SWIFT Advisory Committee
- 3 House members: Phelan, Metcalf, Walle
- 3 Senate members: Perry, Hinojosa, Kolkhorst
- 1 Comptroller's Office / 1 TDEM
- Can hold hearings, work sessions, meetings
- Committee will review operation, function, and structure of the TIRF
- TWDB will provide annual reports to committee

18

SB 8

Statewide Planning for Flood Mitigation

19

Senate Bill 8

- Relating to state and regional flood planning
- TWDB shall prepare and adopt a comprehensive state flood plan
  - Composed of several regional plans
  - Guide to state and local flood control policy
  - Contribute to water supply where possible

20

Senate Bill 8

- What is included in the State Flood Plan?
  - Evaluation of existing flood infrastructure
  - Statewide ranked list of ongoing and proposed flood control projects
  - Analysis of completed, ongoing, proposed flood projects (starting with second plan in 2029)
  - Analysis of development in the 100-year floodplain
  - Legislative recommendations

21

Senate Bill 8

- Who will participate in the process?
- TWDB will adopt guidance principles with:
  - Texas Commission on Environmental Quality
  - Texas Department of Agriculture
  - General Land Office
  - Texas Parks and Wildlife Department
  - Texas Department of Emergency Management
  - State Soil and Water Conservation Board

22

Regional Flood Planning

- TWDB will first designate flood planning regions that correspond to river basins
  - Some river basins are so big that TWDB may subdivide those into multiple planning regions
- TWDB will provide financial and technical assistance to these regional planning groups
- Composed of the same interest groups that do regional planning for SWIFT

23

Regional Flood Planning

- Regional plans must:
  - Use information based on hard science and updated mapping
  - Describe existing flood infrastructure
  - Describe changes in land use and population increases that could have an effect on flooding
  - Indicate whether a proposed project:
    - Meets emergency need
    - Uses federal money as a funding source
    - Has water supply benefits

24

Regional Flood Planning

- Regions must hold open meetings that allow for substantive public comment
- Posting and notice requirements like most other political subdivisions
- TWDB then determines the following before the region adopts its plan:
  - Satisfies all statutory requirements
  - Whether proposed projects affect neighboring areas
  - If so, then TWDB would help coordinate a solution that accommodates all affected areas

25

Advisory Committee

- Composition of committee
  - Chair of Senate Water and Rural Affairs
  - Chair of House Natural Resources
  - Chair of Senate Finance
  - Chair of House Appropriations
  - Representative from TDEM
  - Representative from State Soil and Water Conservation Board
- Committee will oversee the implementation of the State Flood Plan

26

Agricultural Conservation Grants

27

Agricultural Conservation Grants

- Eligible applicants
  - Groundwater districts
  - University systems
  - Other political subdivisions
- Eligible participants
  - Ag producers
  - Crop consultants
  - Equipment dealers
  - Non-profit organizations

28

Agricultural Conservation Grants

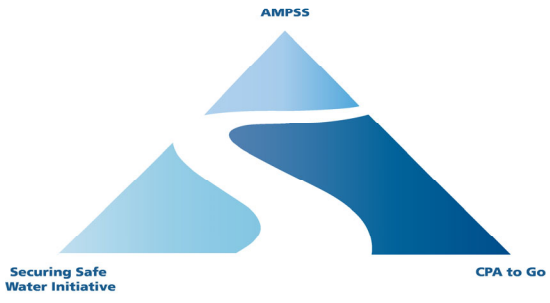
- $1.2 million available this year
  - Amount recently doubled by the Legislature
- Focus this year
  - Improving soil health
  - Promoting irrigation conservation
- Applications due: February 19th, 2020

29

New TWDB Initiatives

30

SRF Trifecta: Tri-ing Hard for Texas Water



31

Asset Management Program for Small Systems

- Assist smaller utilities in operating proactively
- Help utilities create a plan to keep them technologically and financially sustainable
- Utilizes management tools developed by TCEQ
- No local match requirement, just 80 staff hours of "sweat equity" to develop the plan
- Initial round SFY19: $450,000 / 6 small systems
- Any entity (not just small systems) now eligible to borrow up to $75,000 at 0% interest to prepare similar asset management/financial planning tools

32

CPA to Go Initiative

- Similar in concept to AMPSS
- CPAs provide technical assistance services
- Targets systems in need of special assistance to maintain adequate SRF compliance
- 2 broad categories
  - Regulatory and financial assistance covenant compliance procedures
  - Professional services

33

Securing Safe Water Initiative

- EPA Strategic Plan goal: significantly reduce the number of systems with health violations
- April 2019: 261 public water systems in Texas had unresolved health issues
- Special allocations: Very Small Systems, Urgent Need, Disadvantaged, Small/Rural
- Outreach and determining need
- Technical assistance
- Track outcomes

34

Program Updates

35

SWIFT Update

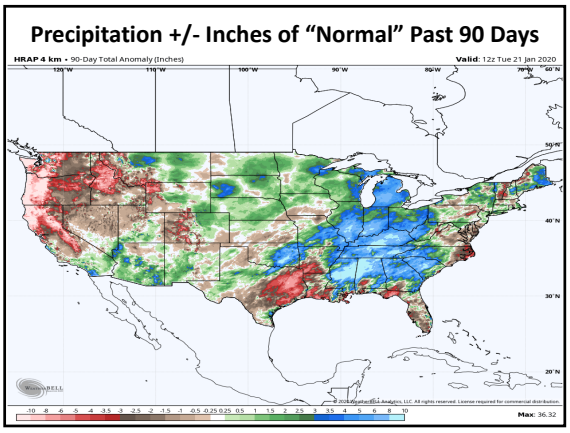
- September 24th, 2019 bond sale
- Will provide approximately $972 million for financing new state water plan projects
- Estimated savings of approximately **$170 million** for these ten SWIFT borrowers
- Brings total savings to **over $1 billion** since the first funding cycle in 2015
- SWIFT 2020 funding cycle is now open. Abridged SWIFT applications are due February 3rd

36

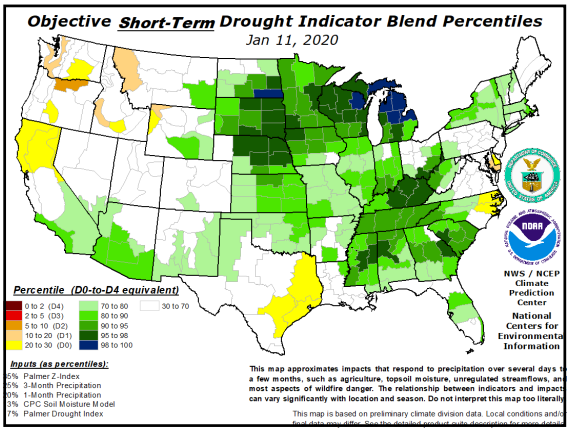
Flood Update

- SB 7: Flood Infrastructure Fund
  - Draft rule comment period: Closed January 13th
  - Special board meeting: January 30th
  - Adopt final rules: End of February
- SB 8: Guidance principles/Designate planning areas
  - Draft rule comment period: Closes February 3rd
  - Adopt final rules: End of March

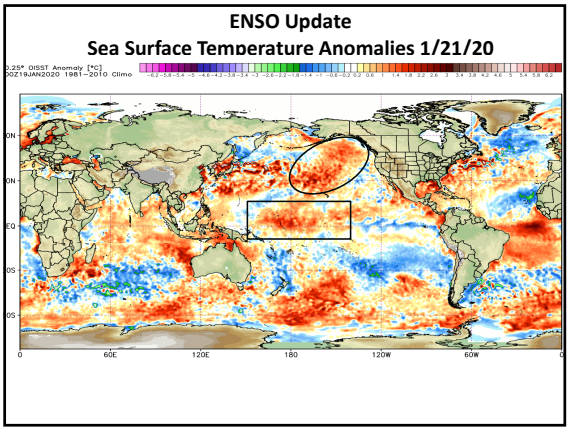
37


Precipitation +/- Inches of "Normal" Past 90 Days
HRAP 4 km • 90-Day Total Anomaly (Inches)
Valid: 12z Tue 21 Jan 2020
Max: 36.32

1

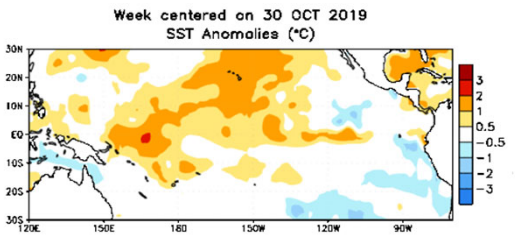

Objective Short-Term Drought Indicator Blend Percentiles
Jan 11, 2020
Percentile (D0-to-D4 equivalent)
0 to 2 (D4)
2 to 5 (D3)
5 to 10 (D2)
10 to 20 (D1)
20 to 30 (D0)
30 to 70
70 to 80
80 to 90
90 to 95
95 to 98
98 to 100
Inputs (as percentiles):
5% Palmer Z-Index
5% 3-Month Precipitation
0% 1-Month Precipitation
3% CPC Soil Moisture Model
7% Palmer Drought Index
NWS / NCEP
Climate
Prediction
Center
National
Centers for
Environmenta
Information
This map approximates impacts that respond to precipitation over several days t
a few months, such as agriculture, topsoil moisture, unregulated streamflows, an
most aspects of wildfire danger. The relationship between indicators and impact
can vary significantly with location and season. Do not interpret this map too literally
This map is based on preliminary climate division data. Local conditions and/c

2


ENSO Update
Sea Surface Temperature Anomalies 1/21/20
0.25° OISST Anomaly [°C]
20Z19JAN2020 1981-2010 Climo
0
60E
120E
180
120W
60W

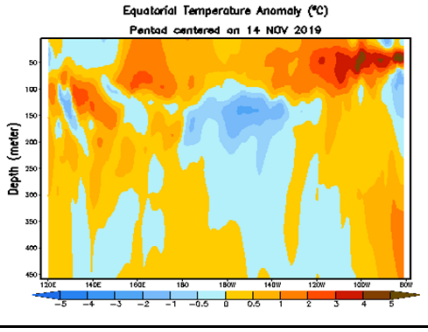
3

Neutral to weak Modoki El Niño…



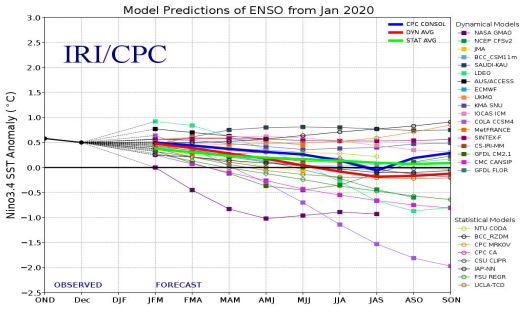
4

Possible Legit El Niño Brewing?



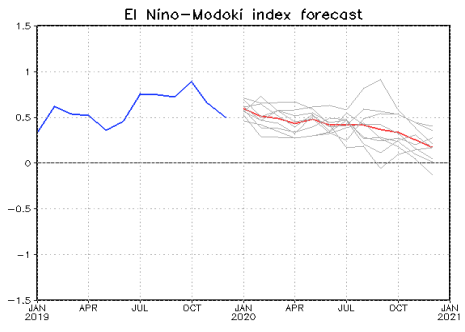
5

ENSO Plumes Ensemble Favors Neutral ENSO Conditions



6

JAMSTEC Modoki Index
Weak Modoki El Niño Likely Continues



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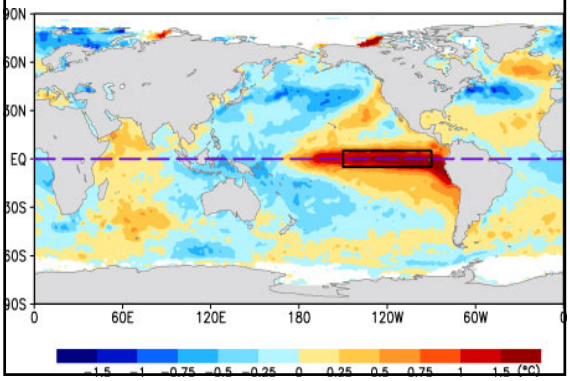
Traditional El Niño



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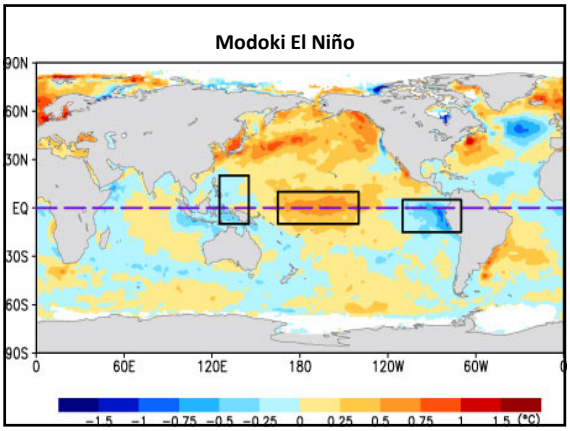
Modoki El Niño



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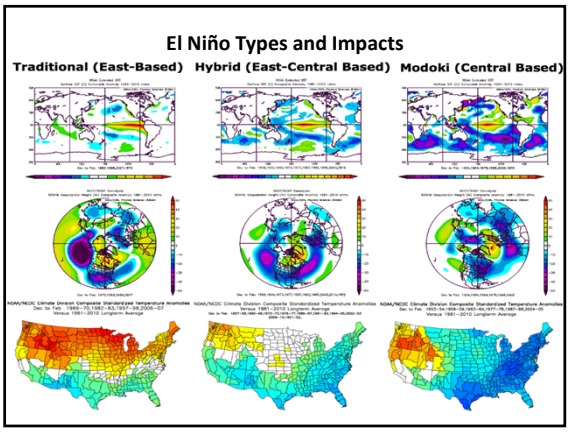
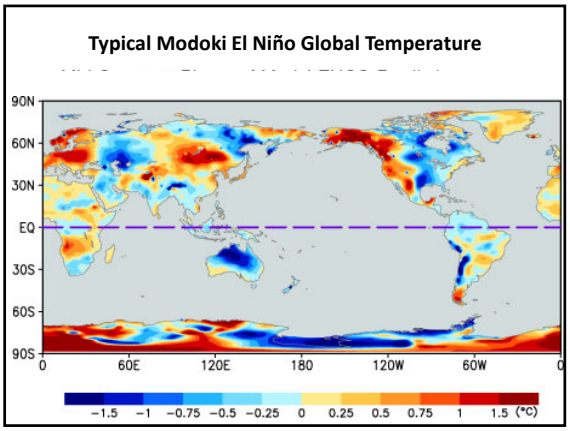
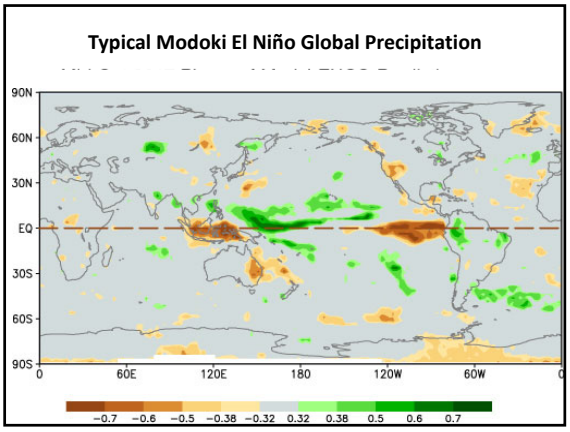

El Niño Types and Impacts
Traditional (East-Based)
Hybrid (East-Central Based)
Modoki (Central Based)

10


Typical Modoki El Niño Global Temperature
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
−1.5 −1 −0.75 −0.5 −0.25 0 0.25 0.5 0.75 1 1.5 (°C)

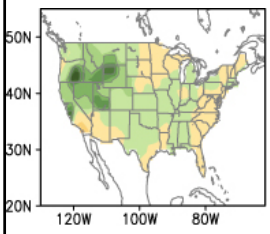
11


Typical Modoki El Niño Global Precipitation
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
−0.7 −0.6 −0.5 −0.38 −0.32 0.32 0.38 0.5 0.6 0.7

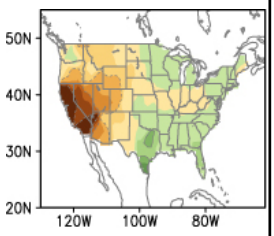
12

Precipitation Differences With Different El Niños

- Traditional El Niño

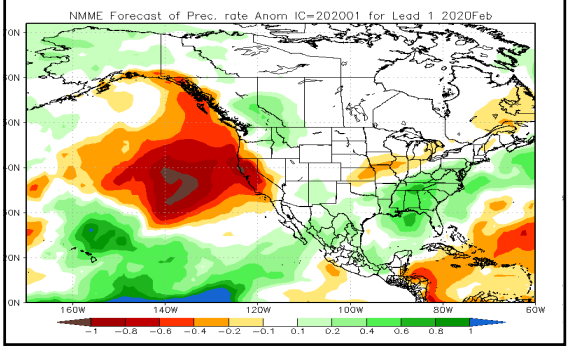


Modoki El Niño



13

NMME Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"



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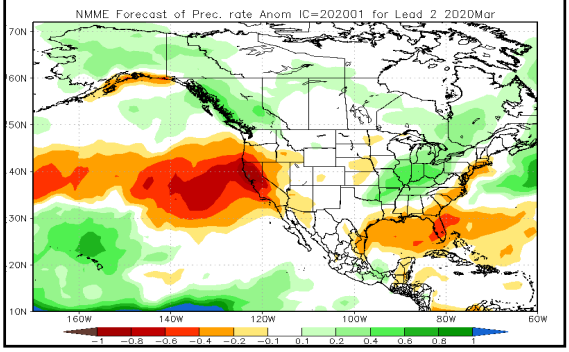
NMME Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"



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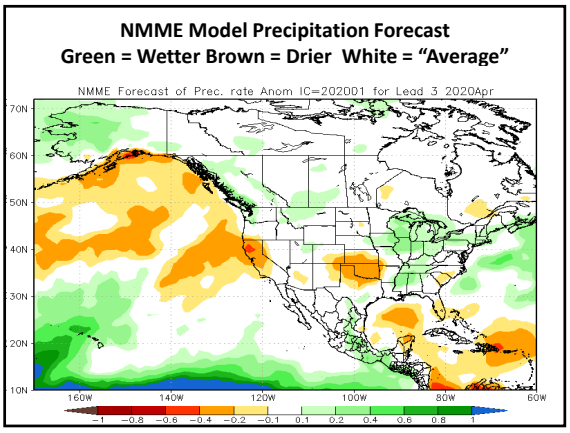
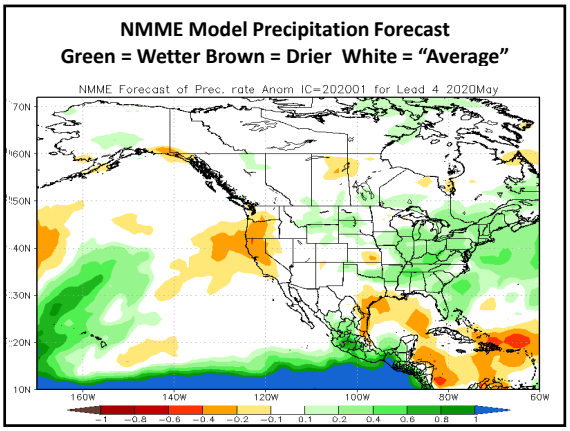

NMME Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"
NMME Forecast of Prec. rate Anom IC=202001 for Lead 3 2020Apr

16


NMME Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"
NMME Forecast of Prec. rate Anom IC=202001 for Lead 4 2020May

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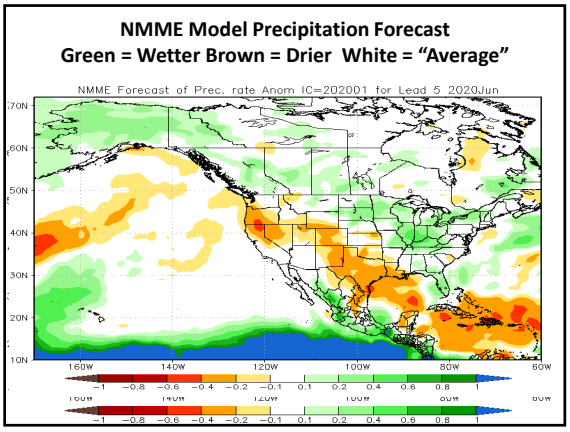
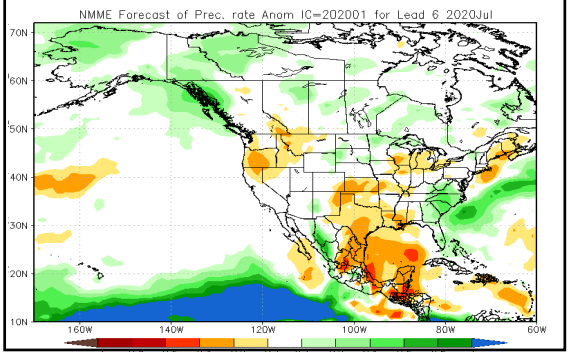

NMME Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"
NMME Forecast of Prec. rate Anom IC=202001 for Lead 5 2020Jun

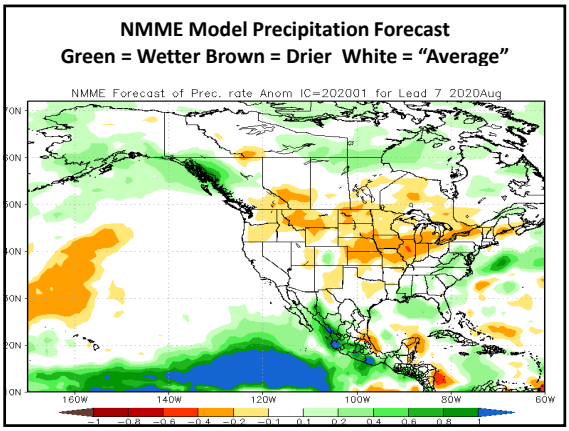
18

NMME Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"



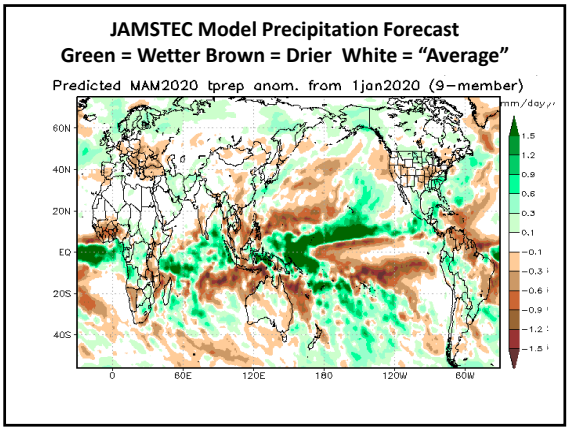
19

NMME Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"



20

JAMSTEC Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"



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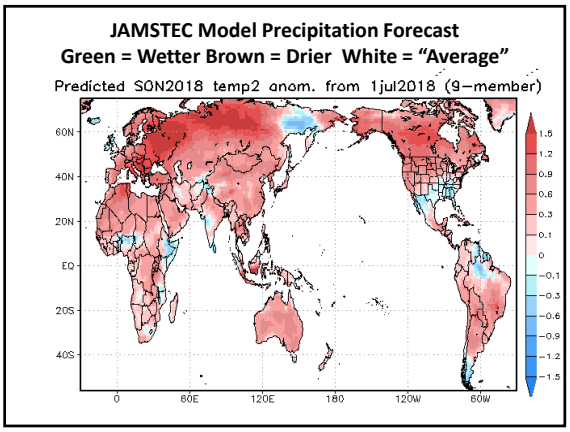
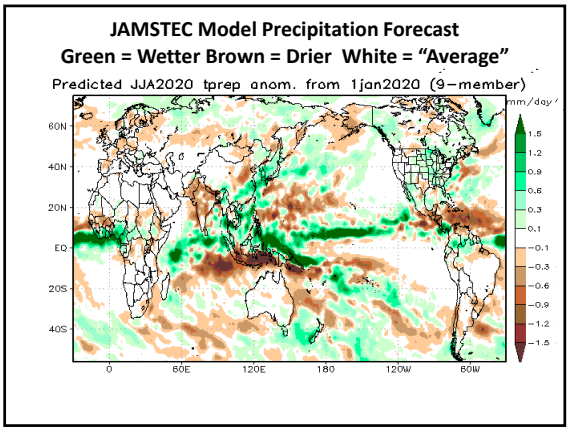
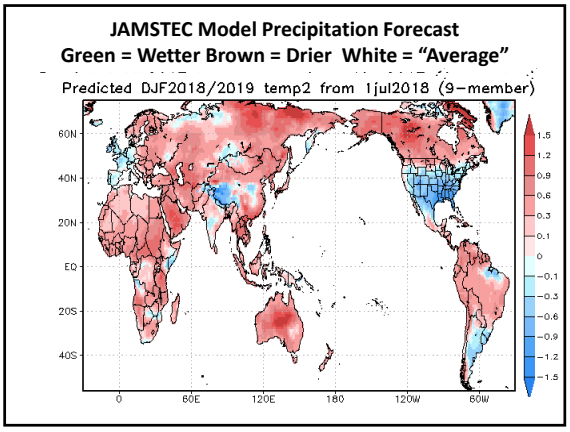

JAMSTEC Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"
Predicted SON2018 temp2 anom. from 1jul2018 (9-member)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
1.5
1.2
0.9
0.6
0.3
0.1
0
-0.1
-0.3
-0.6
-0.9
-1.2
-1.5

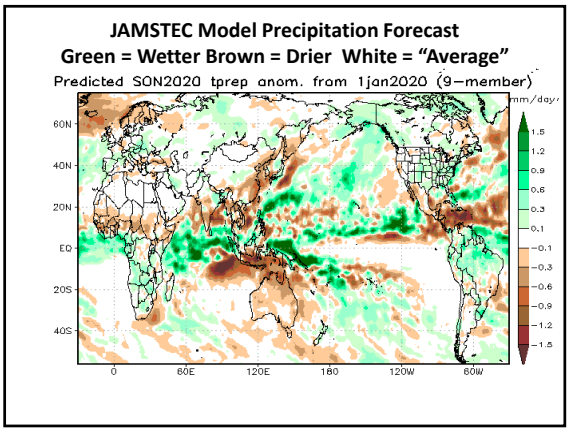
22


JAMSTEC Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"
Predicted JJA2020 tprep anom. from 1jan2020 (9-member)
mm/day
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
1.5
1.2
0.9
0.6
0.3
0.1
-0.1
-0.3
-0.6
-0.9
-1.2
-1.5

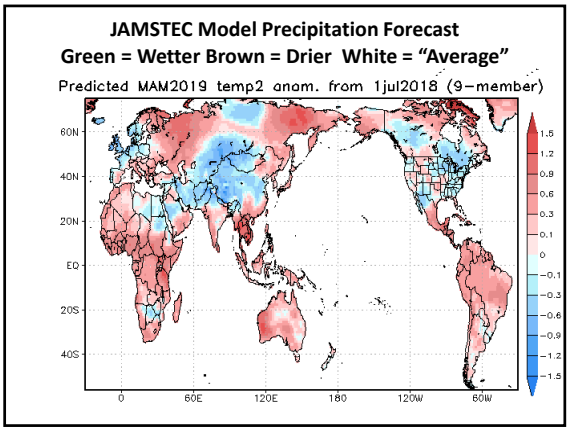
23


JAMSTEC Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"
Predicted DJF2018/2019 temp2 from 1jul2018 (9-member)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
1.5
1.2
0.9
0.6
0.3
0.1
0
-0.1
-0.3
-0.6
-0.9
-1.2
-1.5

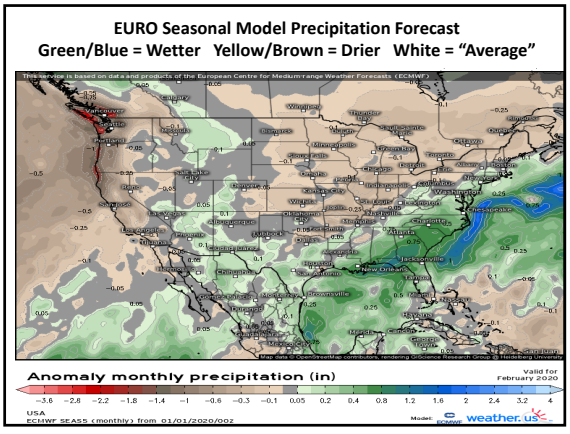
24


JAMSTEC Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"
Predicted SON2020 tprep anom. from 1jan2020 (9-member)
mm/day
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
1.5
1.2
0.9
0.6
0.3
0.1
-0.1
-0.3
-0.6
-0.9
-1.2
-1.5

25

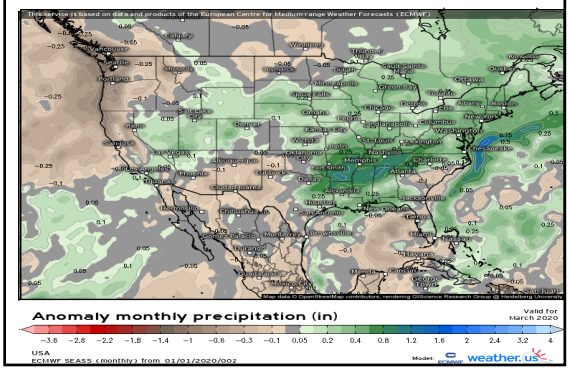

JAMSTEC Model Precipitation Forecast
Green = Wetter Brown = Drier White = "Average"
Predicted MAM2019 temp2 anom. from 1jul2018 (9-member)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
1.5
1.2
0.9
0.6
0.3
0.1
0
-0.1
-0.3
-0.6
-0.9
-1.2
-1.5

26


EURO Seasonal Model Precipitation Forecast
Green/Blue = Wetter Yellow/Brown = Drier White = "Average"
Anomaly monthly precipitation (in)
Valid for
February 2020
-3.6 -2.8 -2.2 -1.8 -1.4 -1 -0.6 -0.3 -0.1 0.05 0.2 0.4 0.8 1.2 1.6 2 2.4 3.2 4
USA
ECMWF SEAS5 (monthly) from 01/01/2020/00z
Model:
weather.us

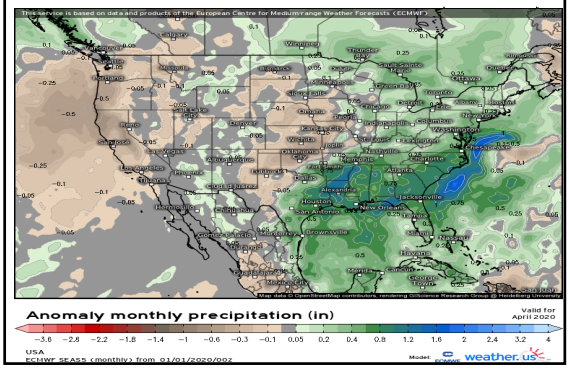
27

EURO Seasonal Model Precipitation Forecast
Green/Blue = Wetter Yellow/Brown = Drier White = "Average"



28

EURO Seasonal Model Precipitation Forecast
Green/Blue = Wetter Yellow/Brown = Drier White = "Average"



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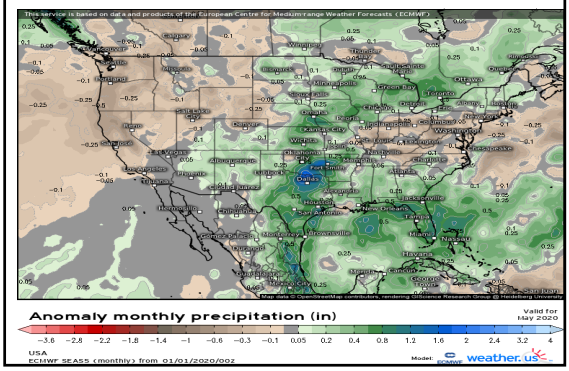
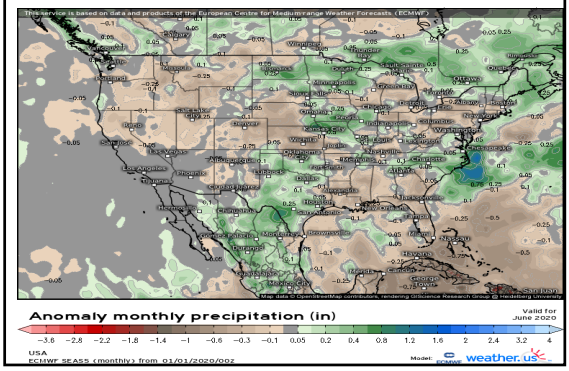
EURO Seasonal Model Precipitation Forecast
Green/Blue = Wetter Yellow/Brown = Drier White = "Average"



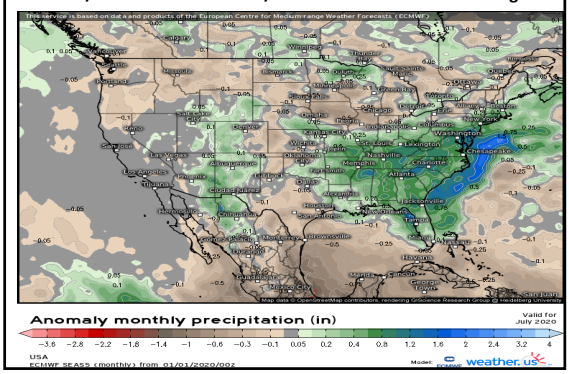
30

EURO Seasonal Model Precipitation Forecast
Green/Blue = Wetter Yellow/Brown = Drier White = "Average"



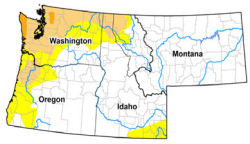
31

EURO Seasonal Model Precipitation Forecast
Green/Blue = Wetter Yellow/Brown = Drier White = "Average"



32

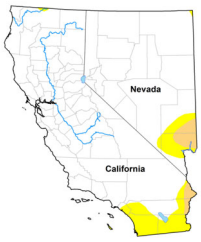
Pacific Northwest Regional Outlook



Drought currently an issue, especially northwest…and could worsen according to models and analogs. Dry signal isn't strong for a prolonged stretch, but worth protecting against.

33

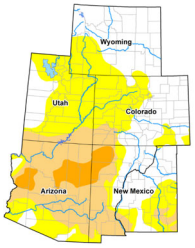
California/Nevada Outlook



Drought not an issue at this time. However, various models show the potential for the wetter than average at times, and much drier than average at times. The driest stretch could be Jan/Feb per models. Esp. if weak Modoki occurs…

34

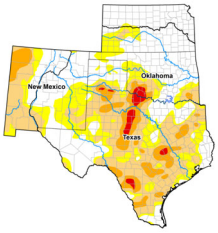
Four Corners Regional Outlook



Drought continues to expand due to monsoon season failure. May continue to worsen through the fall, before getting better through the winter and spring of 2020.

35

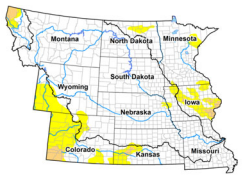
Southern Plains Regional Outlook



Drought has worsened in New Mexico and parts of Texas Panhandle. Drought has eased considerably farther east. Models optimistic for continued relief, especially east per Modoki. Less west…

36

Plains/Midwest Regional Outlook



Most areas not experiencing ANY drought. Models do not show stout dry signal for most areas. In fact, the winter/spring could be quite active for most of this region…esp. Northern Plains and Missouri Valley.

37

My Thoughts…

- ENSO neutral or weak Modoki El Niño continues...
- Drought not an issue for now…
- Models not exactly wet for spring, and it may take awhile to activate the pattern farther west. Cautious optimism for late spring moisture?
- Concerned about La Niña ***POTENTIAL*** late in 2020 into 2021…make sure you are prepared.

38

Weather 5280

- brianbledsoewx@gmail.com
- E-Mail Anytime
- Twitter @BrianBledsoe
- Need weather for your biz? Just ask for a quote…
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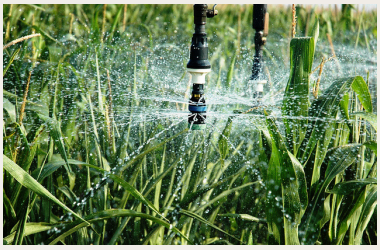
Texas Water Law Hot Topics



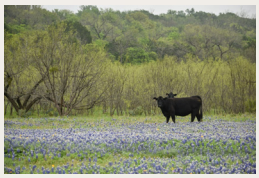
TAWC Water College ■ Lubbock, TX ■ Jan. 23, 2020

Tiffany Dowell Lashmet
Associate Professor & Extension Specialist – Ag Law
TAMU AgriLife Extension

1

Disclaimer

This presentation is for educational purposes only as well as to give general information and a general understanding of the law, not to provide specific legal advice. This presentation does not create an attorney/client relationship and should not be used as a substitute for the advice of a licensed attorney.



2

Road Map

- Quick overview of Texas water law
- State line water law clash
- *Stratta* case
- Groundwater as a conduit

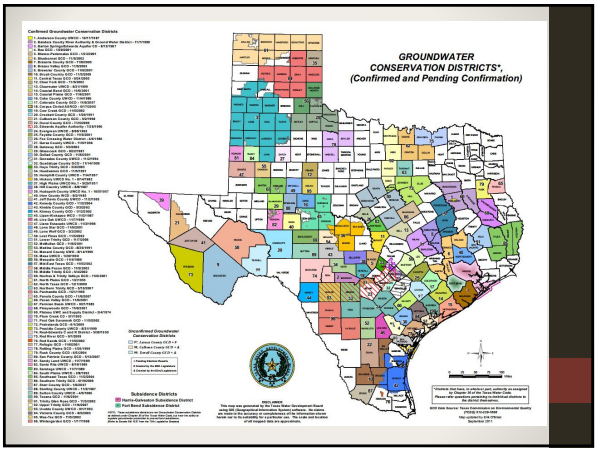
3

Texas Water Law

- Applicable law depends on the type of water
  - Groundwater: water percolating in an aquifer
  - Surface water: water in a defined watercourse
  - Diffused surface water: storm runoff not yet in a defined watercourse
- Who owns the groundwater?
  - Landowner owns the water beneath his land.
  - Rule of capture, subject to limitations (common law & GCDs)
  - Exceptions from GCD permitting for domestic and livestock uses.
  - *Bragg v. Edwards Aquifer Authority*

TEXAS A&M AGRILIFE EXTENSION

4



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Texas Water Law (cont.)

- Who owns the surface water?
  - State of Texas
  - Must obtain a permit for use from the TCEQ
  - Prior Appropriation
  - Exceptions to permit requirement: domestic and livestock uses
- Who owns the diffused surface water?
  - Landowner has right to use but cannot divert to damage neighbor.

TEXAS A&M AGRILIFE EXTENSION

6

"Navigable Streams"

- Classification matters for two reasons.
  - Exempt diversions allowed only on non-navigable streams.
  - Beds of navigable streams are owned by the state, meaning public can use the stream even if flowing across private land and the landowner may not fence or dam.
- Navigability tests
  - Navigable in fact: Can serve as "common highway for trade and travel."
  - Navigable in law: Does streambed maintain average width of 30 feet from the mouth up?

7

State Line Water Law Clash

- Southeastern NM is major oil and gas country.
- NM water law requires a permit for groundwater use.
- Oil and gas companies have been refused fracking permits.
- So….across the state line they go.
- In TX, the landowner owns the groundwater.
  - Loving County, no GCD.
- Companies purchase water in TX, essentially run a hose across the line, use it in New Mexico.
- Former NMLC says this is theft of NM groundwater.

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Prime Opportunity for This Issue…

11

The Law of the Ogallala

- SD: Prior appropriation
- NE: Reasonable use/correlative rights (in times of shortage)
- WY: Prior appropriation
- CO: Prior appropriation
- KS: Prior appropriation
- OK: Reasonable use/correlative rights (based on age)
- NM: Prior appropriation
- TX: Absolute dominion/rule of capture

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Stratta Case

- Brazos Valley GCD uses formula to determine the number of acres required in order to for a certain amount of water to be pumped.

$$\left(\frac{\text{Average Annual Production Rate in Gallons/Minute}}{43{,}560} \times \text{District Spacing Requirement Between Wells}\right)^2 \times \pi = \text{Total number of contiguous acres required to be assigned to the well site}$$

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Stratta Case (cont).

- City of Bryan owns 2.7 acres of land next to Fazzino.
  - Granted permit to drill well 3,000' from property line to pump 3,000 gpm and 4,838 AF/year.
  - Ignored formula, which would have allowed 192 gpm and 315 AF/year.
- Fazzino owns 26 acres of land.
  - He seeks permit to drill a well pumping 3,000 gpm.
  - Apply formula to determine he is limited to 192 gpm and 315 AF/year.
- Fazzino files suit claiming taking, violation of equal protection.

14

Clean Water Act: Groundwater as a Conduit

- Clean Water Act says a federal NPDES permit is needed if:
  - Point source discharge
  - Pollutant
  - WOTUS
- Question has arisen: does the discharge have to be direct, or can groundwater serve as a conduit?
- Cases around the country have reached different results.
- SCOTUS heard argument in November.

15

16

Groundwater as a Conduit (cont.)

- Summary so far:
  - CWA does apply: 4th(twice); 9th
  - CWA does not apply: 6th (twice); trial court in 7th
- Three case examples:
  - *County of Maui* (9th Cir.): Disposal well for sewage goes into groundwater, out into Pacific Ocean. CWA does apply– "fairly traceable from point source to a WOTUS."
  - *Upstate Forever* (4th Cir.): Pipeline ruptures, gasoline seeps into groundwater and then 1,000' into WOTUS. "Sufficiently connected to navigable water."
  - *Kentucky Waterways* (6th Cir.): Coal ash pond seeps into groundwater, ends up in lake. "Inconsistent with the text and structure of the CWA."

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Groundwater as a Conduit (cont.)

- Court seemed to struggle…
  - Concerned about "fairly traceable" test being far too broad.
  - Concerned about "directly into" test being far too narrow.
- Potential impacts for agriculture and for rural landowners.

18

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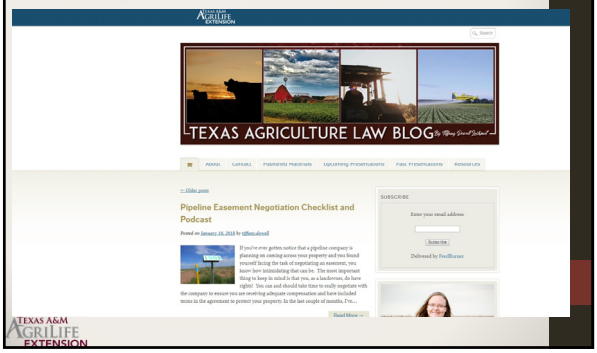

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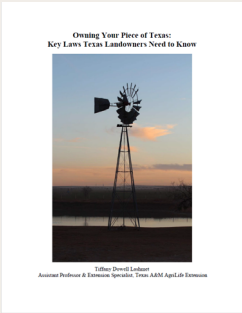
Additional Resource



20

Other Programs…

- 2020 Ranchers Leasing Workshops
  - Palestine: January 16
  - Abilene: March 31
  - LaVernia (San Antonio area): April 24
  - Brenham: August 17
  - Fredericksburg (Bennett Trust Program): September 14
- 2020 Owning Your Piece of Texas
  - Amarillo: February 12
  - Conroe: March 16
  - Seguin: June 4
  - Burnet: September 15

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22

Thank You!

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23

U.S. COTTON TRUST PROTOCOL SUSTAINABILITY

2020 TAWC Water College
Lubbock, TX
January 23, 2020

1

U.S. Cotton's Journey To Sustainability

1970's +

Cotton Producers

Increased Management and Environmental Practices

2

U.S. Cotton's Journey To Sustainability

1970's +

Cotton Producers

Increased Management and Environmental Practices

2006

Field to Market

Alliance for Sustainable Agriculture focuses on defining, measuring and advancing the sustainability of commodity crop production in the U.S.

3

Field to Market

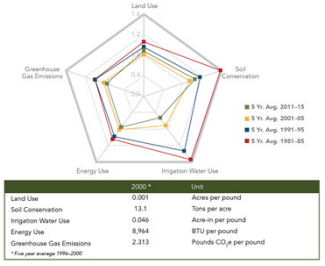
Field to Market: The Alliance for Sustainable Agriculture focuses on defining, measuring and advancing the sustainability of commodity crop production in the United States

4

Field to Market | Uniting the Supply Chain to Deliver Sustainable Outcomes for Agriculture

5

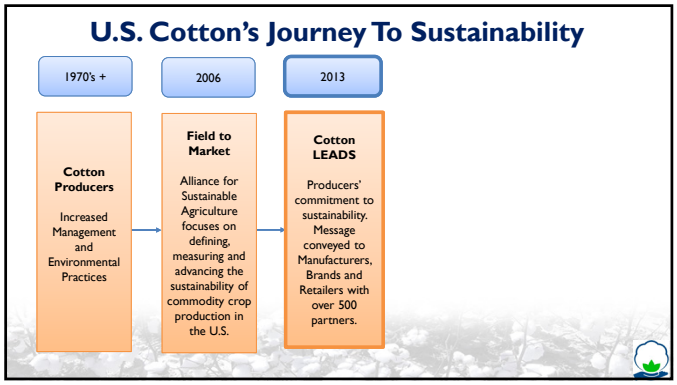
Resource Use Efficiency for Cotton



	2000 *	Unit
Land Use	0.001	Acres per pound
Soil Conservation	13.1	Tons per acre
Irrigation Water Use	0.046	Acre-in per pound
Energy Use	8,964	BTU per pound
Greenhouse Gas Emissions	2.313	Pounds CO_2e per pound

*Five year average 1996–2000

6



7

COTTON LEADS™

KEY POINTS ABOUT THE COTTON LEADS PROGRAM	
CREATION	
Created in 2013 as a means of promoting sustainability of US and AU cotton to retailers, brands and manufacturers	
DESIGN	
Founded on 5 principles	Strategically designed to address sustainability concepts, benevolence, and bale identification (traceability)
FUNCTION	
Joint promotion, with individual bragging rights	Cotton LEADS website features U.S. growers, researcher profiles, and videos. We control content of US postings and almost all the direct outreach to and meetings with Cotton LEADS partners.

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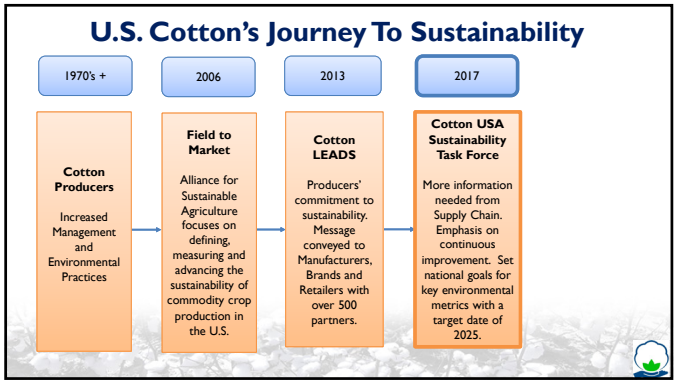


9

COTTON USA Sustainability Task Force

Producers
Aaron Barcellos
Matt Coley
Dahlen Hancock
John Hardwick
Mark Nichols
Ted Schneider
Gregory Wuertz

Cottonseed
Fred Serven

Merchants
Steve Dyer
Tim North

Cooperatives
Kevin Brinkley
Hank Reichle

Ginner
Curtis Stewart

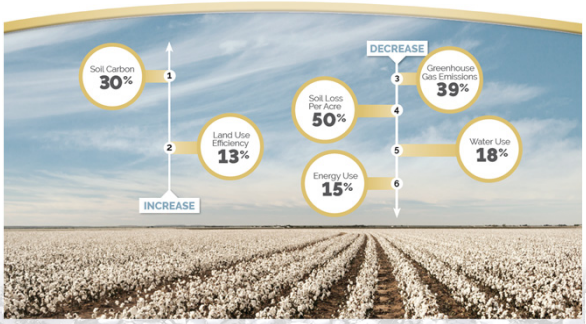
Warehouse
Coalter Paxton III

Manufacturers
Garry Bell
Charles Little
Jim Martin

Advisors
Jesse Daystar
Bill Gillon
Andy Jordan
Marty Matlock
Berrye Worsham

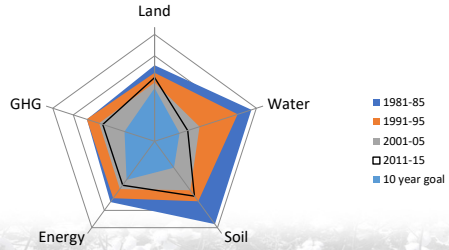
10

U.S. Cotton's Sustainability Goals for 2025



11

BY ACHIEVING GOALS, THE FOOTPRINT SHRINKS



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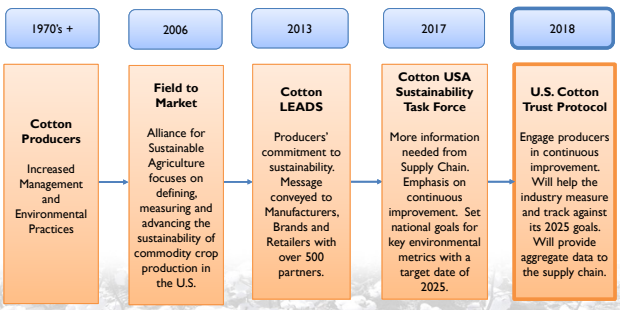
U.S. Cotton's Journey To Sustainability



13

U.S. COTTON TRUST PROTOCOL

- Two questions to answer
  - ✓ **What is the Trust Protocol?**
  - ✓ Why do we need it?

14

U.S. COTTON TRUST PROTOCOL

- Single-Member LLC within the National Cotton Council
- Governed by a Board comprised of growers, ginners, merchants, coops, spinning mills, civil societies, and Brands/Retailers. This includes people from the following organizations:
  - -World Wildlife Fund
  - -Environmental Defense Fund
  - -Tesco
  - -Levi Strauss & Co.
  - -Louis Dreyfus Company

15

U.S. COTTON TRUST PROTOCOL

- A voluntary farm-level program designed to engage growers in continuous improvement
- A program that can help the industry reach its 2025 goals
- A system that will provide aggregate data that can be passed through the textile supply chain which includes: producers, merchandisers, manufacturers, brands and retailers and others

16

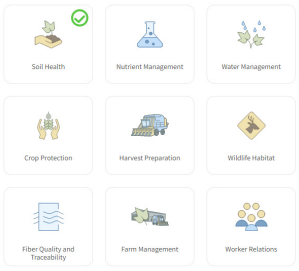
KEY REQUIREMENTS FOR THE PRODUCER

- Self-assessment against standards
- Use of a data tool for environmental metrics
- Verification by an independent party

17

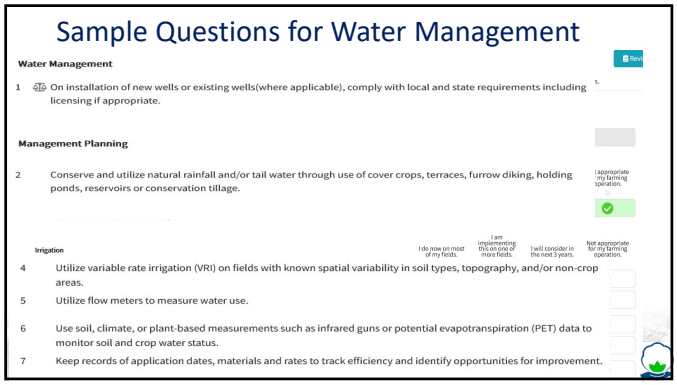
SELF-ASSESSMENT QUESTIONNAIRE

- 9 categories with approx. 100 questions
- Choices for answers
  - A. I do this now on my operation
  - B. I am implementing on 1 or more of my fields
  - C. I will consider in next 3 years
  - D. Not appropriate for my farming operation



18

Sample Questions for Water Management



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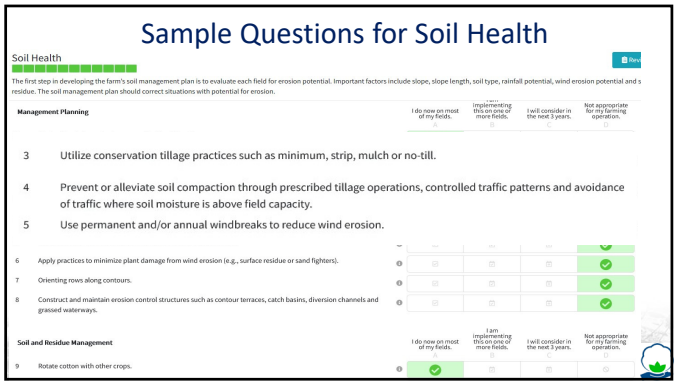
Sample Questions for Soil Health



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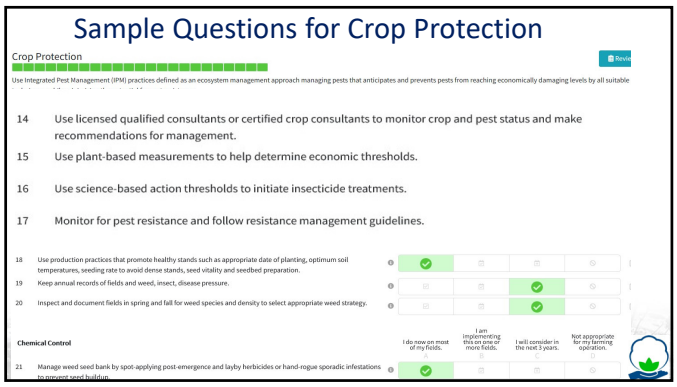
Sample Questions for Crop Protection



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SELF-ASSESSMENT QUESTIONNAIRE

Categories	Required Practices	Recommended Practices	Total
Soil Health	1	10	11
Nutrient Management	1	9	10
Water Management	1	11	12
Crop Protection	13	10	23
Harvest Preparation	2	7	9
Wildlife Habitat	0	5	5
Fiber Quality and Traceability	0	4	4
Farm Management	9	13	22
Worker Relations	11	5	16

22

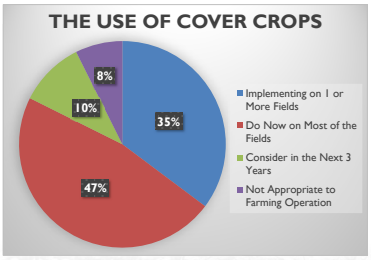
SELF-ASSESSMENT QUESTIONNAIRE

- 33% Required Management Practices
- 67% Recommended Management Practices with 4 Choices
- Provides Cumulative Data as Producers Answer Questionnaire

23

SELF-ASSESSMENT DATA RESULTS

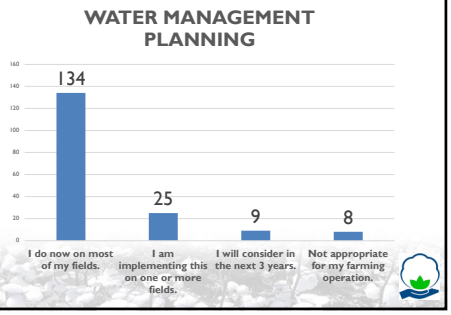
Plant cover crops with a goal to have living roots on as many months of the year as possible to protect soil and improve soil organic matter.



24

SELF-ASSESSMENT DATA RESULTS

Conserve and utilize natural rainfall and/or tail water through use of cover crops, terraces, furrow diking, holding ponds, reservoirs or conservation tillage



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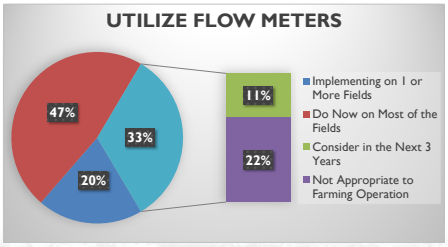
SELF-ASSESSMENT DATA RESULTS

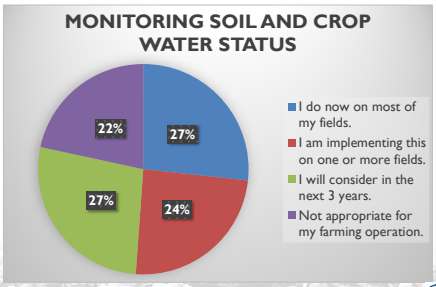
Utilize flow meters to measure water use



26

SELF-ASSESSMENT DATA RESULTS

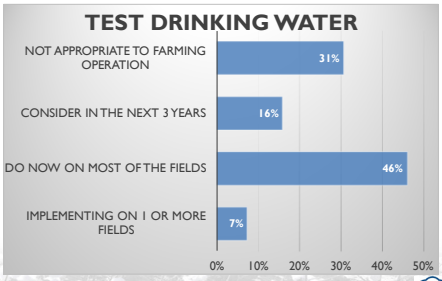
Use soil, climate, or plant-based measurements such as infrared guns or potential evapotranspiration (PET) data to monitor soil and crop water status



27

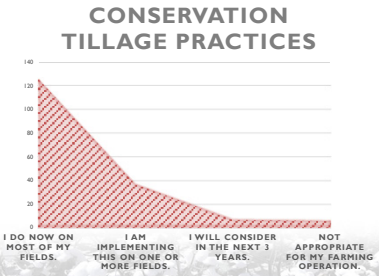
SELF-ASSESSMENT DATA RESULTS

Test drinking water used by family and farm workers periodically to assure bacteria, nitrate and other pollutants do not exceed safe levels



28

SELF-ASSESSMENT DATA RESULTS



Utilize conservation tillage practices such as minimum, strip, mulch or no-till

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DATA TOOLS

- Field to Market tool named the FieldPrint Platform
  - Record inputs into a system that measures the environmental impacts of crop production and identify opportunities for improvement
- Additional qualified data management Field to Market partners who can make these recordings for the producer

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Sensitivity Analysis Field 27

Before:

- Conventional tillage
- Includes erodible area
  - 150 acres cultivated
  - 50 acres poor productivity
- Average slope 1.5%
- Cultivated crop to bayou

After:

- No-till
- Excludes erodible area
  - 100 acres cultivated
  - 50 acres in native vegetation
- Cultivated slope 0.5%
- Riparian buffer

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Field 27

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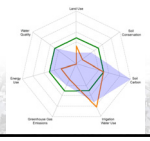
Impacts
Yield and Inputs-Constant (1000 lb/a)

	Before:	After:
Soil loss t/ac	9.4	1.1 T/ac
Soil Carbon Index	-1.0	+ 0.42
Green House Gas CO2e	2.3 lb.	1.9
Energy Btu	12,000	9,000
Water Quality Index	5.0	9.4



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VERIFICATION

- Validate accurate use of the on-line enrollment tool such as the self-assessment questionnaire and the data tool.
- A statistically valid random sample of the producers will be selected each year for an independent third-party verification of their questionnaire and data.

34

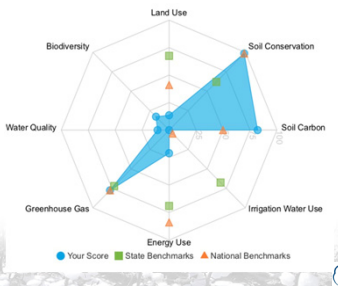
U.S. COTTON TRUST PROTOCOL

- Two questions to answer
  - ✓ What is the Trust Protocol?
  - ✓ **Why do we need it?**

35

Why? To Drive Continuous Improvement

- Annual quantitative measurements
- Feedback for the producer
- How do you compare?



36

Why? To Achieve Industry Goals

Best Management Practices		Industry's 10-Year Goals For Environmental Metrics					
		Reduce Land Use by 13%	Increase Irrigation Efficiency by 18%	Reduce GHG by 39%	Reduce Energy Use by 15%	Reduce Soil Loss by 50%	Increase Soil Carbon by 30%
Environmental	Soil Health	✓	✓	✓		✓	✓
	Nutrient Management	✓		✓	✓		
	Water Management	✓	✓	✓	✓		
	Crop Protection	✓		✓	✓		
	Harvest Preparation			✓	✓		
	Wildlife/Biodiversity			✓		✓	✓
Social	Worker Relations	Provide a safe work place for all employees, assure fair treatment and compensation.					
	Farm Management	Maintain household and farmstead operations which assure safety for family, workers, farm animals and the environment.					
	Fiber Quality/Traceability	Work to assure fiber quality is maximized by selecting appropriate varieties, managing for fiber quality consistent with yield goals and preserving quality during harvest and ginning.					

37

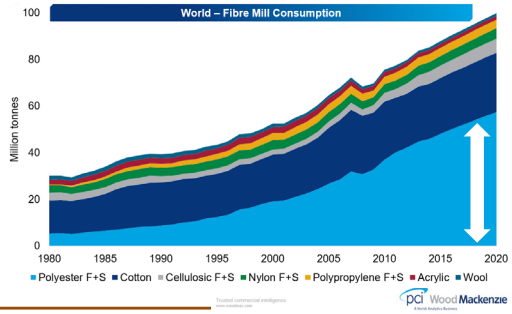
Why? To Meet the Needs of Our Customers

"It's the Wild West out there right now," says Paul Magel, president of the business applications and technology outsourcing division at CGS, a software company that works with retail clients.

- The needs of customers will vary
- Many brands/retailers accept U.S. cotton as sustainable or responsibly produced
- However, not all have done so. They point to the lack of a standard or independent verification
- We must be flexible in the ability to pass data to the textile supply chain

38

Why? To Reclaim Market Share



39

Why? To Be the Supplier of Choice

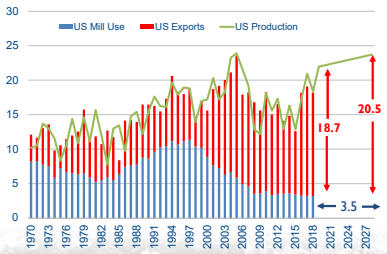
- The Protocol is NOT about
  - One grower or one bale being more sustainable than another, or
  - Guaranteeing a premium
- The Protocol IS about U.S. cotton
  - **Competing in every market and every supply chain**
- The United States cannot afford to lose market access because of a perceived lack of sustainability

40

U.S. Cotton is Poised to Compete

With 14 million acres and increasing yields, there is excellent potential for 20-25 million bales of production

But, we must have the demand base!



41

Compete in Every Market & Every Supply Chain

- To be the Supplier of Choice, We Must Meet the Customer's Needs for
  - Quality
  - Cleanliness
  - Timeliness
  - **Sustainability**

- **The Protocol allows U.S. cotton to tell an even stronger story to our customers and provide support for their various reports.**

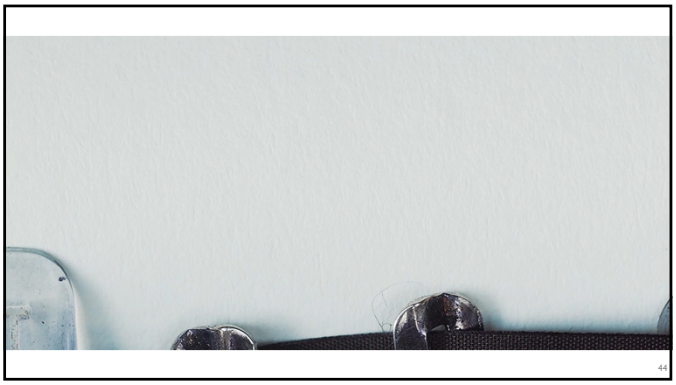
42

THE COTTON FUTURE PLEDGE

OUR PLEDGE:

We will enable brands to meet their sustainability goals

43

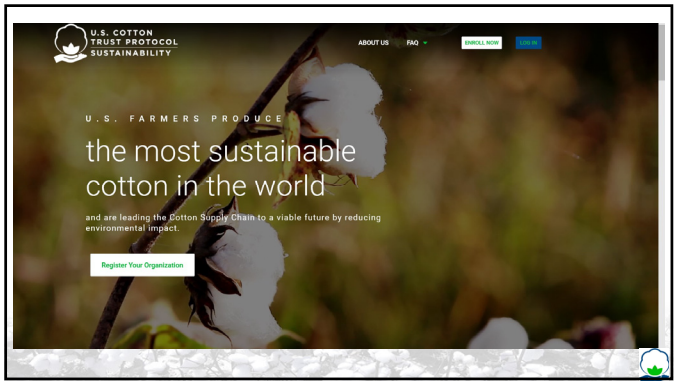


44

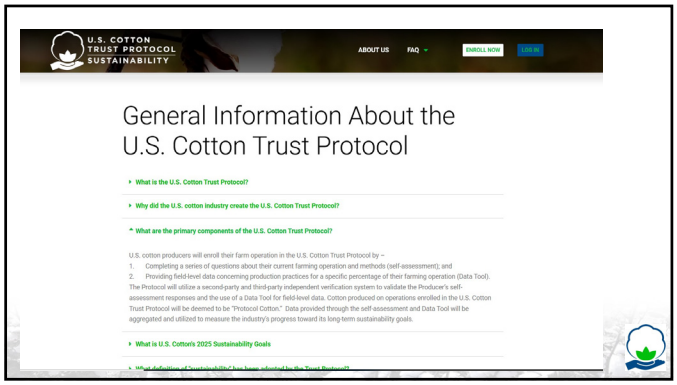
U.S. COTTON TRUST PROTOCOL SUSTAINABILITY

trustUScotton.org

45


U.S. COTTON TRUST PROTOCOL SUSTAINABILITY
ABOUT US
FAQ
ENROLL NOW
LOG IN
U.S. FARMERS PRODUCE
the most sustainable cotton in the world
and are leading the Cotton Supply Chain to a viable future by reducing environmental impact.
Register Your Organization

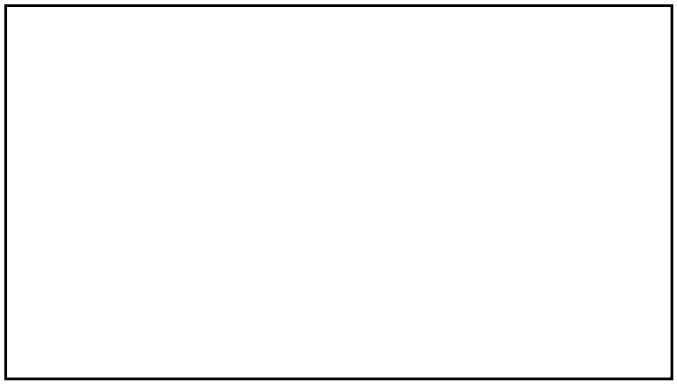
46


U.S. COTTON TRUST PROTOCOL SUSTAINABILITY
ABOUT US
FAQ
ENROLL NOW
LOG IN
General Information About the U.S. Cotton Trust Protocol
What is the U.S. Cotton Trust Protocol?
Why did the U.S. cotton industry create the U.S. Cotton Trust Protocol?
What are the primary components of the U.S. Cotton Trust Protocol?
U.S. cotton producers will enroll their farm operation in the U.S. Cotton Trust Protocol by –
1. Completing a series of questions about their current farming operation and methods (self-assessment); and
2. Providing field-level data concerning production practices for a specific percentage of their farming operation (Data Tool).
The Protocol will utilize a second-party and third-party independent verification system to validate the Producer's self-assessment responses and the use of a Data Tool for field-level data. Cotton produced on operations enrolled in the U.S. Cotton Trust Protocol will be deemed to be "Protocol Cotton." Data provided through the self-assessment and Data Tool will be aggregated and utilized to measure the industry's progress toward its long-term sustainability goals.
What is U.S. Cotton's 2025 Sustainability Goals

47


4 Pillar Approach
Enrollment Journey
Awareness & Education
Engagement
Registration
Completed Enrollment
What Growers Need To Know About The US COTTON TRUST PROTOCOL
WHY
I'M IN
THE TRUST
DON'T FORGET
YOUR ENROLLMENT IS ALMOST COMPLETE.
COMPLETE ENROLLMENT NOW

48



49

"The future of Cotton Genetics and Weed Control"

Texas Alliance for Water Conservation
(TAWC) Water College
Jan 2020

Laboratorio Nacional de Genómica para la Biodiversidad
LANGEBIO

1

Institute of Genomics for Crop Abiotic Stress Tolerance (IGCAST)

Vision
In the next 10 years IGCAST will be one of the top 10 institutes in plant genomics worldwide, with a large production of high impact publications and patents.

Mission
Develop relevant research and technology to contribute to a more sustainable agriculture.

Optimize the use of natural resources and decrease the use of agrochemicals to diminish the impact of agriculture on the environment and create a significant social and economical benefit to the farmer.

2

Current IGCAST Faculty Members

Damar López-Arredondo: Cotton and microalgae
Nutrient stress, lipid metabolism, novel herbicides

Jinping Jiao: Maize and sorghum
Comparative genomics, drought and salinity tolerance

Gunvant Patil: Soybean and cotton
Genome editing, plant transformation, drought and heat tolerance

Mylea Lovell- Greenhouse Manager

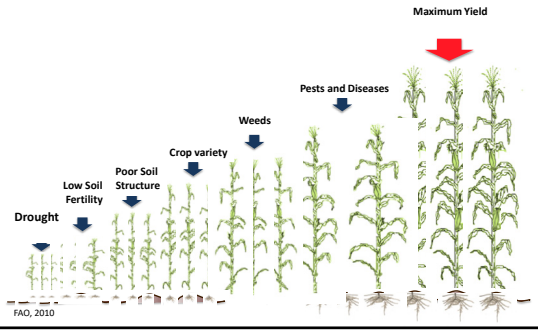
3

Potential Associated Faculty Members:

Dr. Eric Hequet, PSS, CASNR
Dr. Benildo de los Reyes, PSS, CASNR
Dr. Noureddine Abidi, PSS, CASNR
Dr. Wenxuan Guo, PSS, CASNR
Dr. Venugopal Mendu, PSS, CASNR
Dr. Lindsey Slaughter, PSS, CASNR
Dr. Jyotsna Sharma, PSS, CASNR
Dr. Rosalyn Shim, PSS, CASNR
Dr. Jaime Malaga, AAE, CASNR
Dr. Edurado Segarra, AAE, CASNR
Dr. Hong Zhang, DBS, CASNR
Dr. Chris Rock, DBS, CASNR
Dr. Amanda Brown, DBS, CASNR
Dr. Natasja van Gestel, DBS, CASNR
Dr. John D'Auria, DCB, CASNR
Dr. Huazhong Shi, DBS, CASNR
Dr. Naima Moustaid-Moussa, CHS

4

Many factors affect crop productivity



5

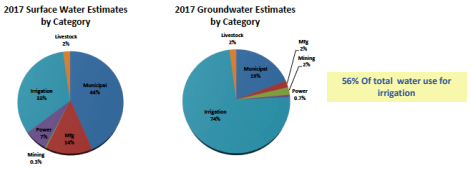
6

Water Use concerns

- In 2014, the USDA designated 240 Texas counties as primary natural disaster areas due to drought.
- Texas' agricultural industry suffered losses attributable to drought of $7.6 billion in losses in 2011 alone.
- If water supply needs are not met by 2060, the Texas WDB projects that the state will lose over 1 million jobs and as much as $115.7 billion per year.
- If extreme droughts persist by 2060, Texas businesses and income might suffer $12.8 billion in losses, leading to lost jobs and income that can result in a reduced population by 1.4 million people.

2017 Surface & Groundwater Use Estimates

Approximately 54% of the 2017 estimated water use in Texas was from groundwater sources, 43% from surface water sources and only 3% from reuse.



7

Desiccation tolerance is a marvelous trait that has evolved in many organisms (Cryptobiosis)

Artemia salina

A. salina eggs are viable for over 10 years in the desiccated state

Tardigrades
Water bears

Water bears survive 50 years in the desiccated state

8

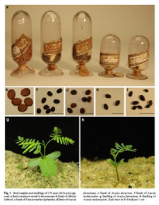
Desiccation tolerance in plants

9

Desiccated seeds maintain viable embryos for centuries

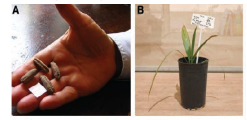
Germination of 151-year old *Acacia* spp. seeds

Matti W. Leino · Johan Edqvist

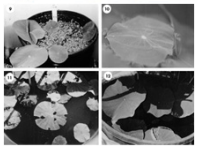


Germination, Genetics, and Growth of an Ancient Date Seed

Sarah Sallon,[1] Elaine Solowey,[2] Yuval Cohen,[3] Kaia Korchinsky,[3] Markus Egli,[4] Ivan Woodhatch,[5] Orit Simchoni,[3] Mordechai Kislev[6]



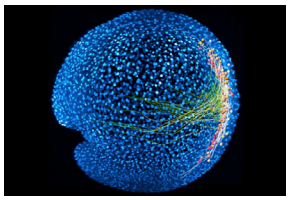
2,000 year old date seed

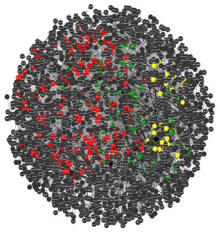


1,300 year old Lotus seed

10

Biological processes are controlled by genetic networks that function similar to brain circuits

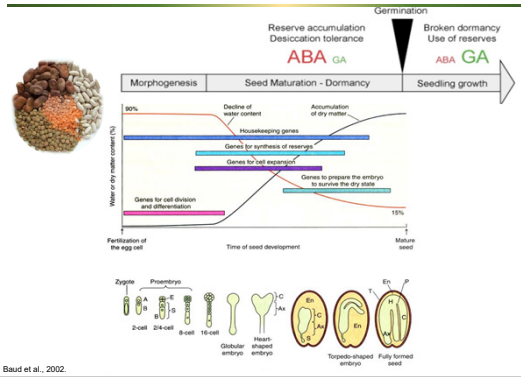




Plants have between 30,000 and 50,000 genes that can produce up to 500,000 different proteins, which functions are interconnected.

11

Acquisition of seed desiccation tolerance in plant seeds



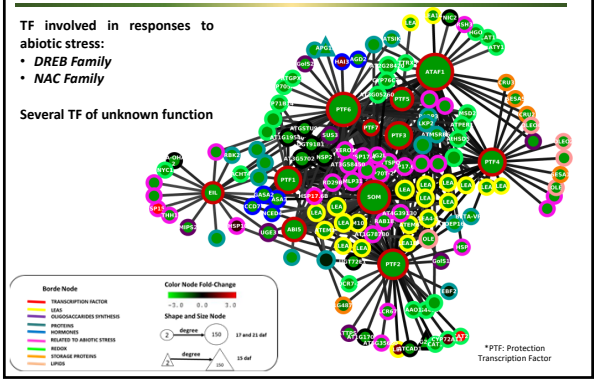
Baud et al., 2002.

12

Sub-network 2: cell protection mechanism in seed desiccation

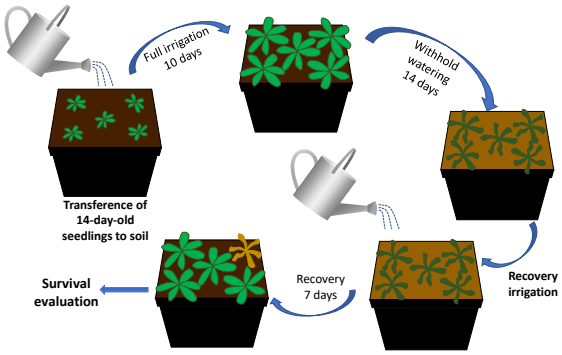
TF involved in responses to abiotic stress:
- *DREB Family*
- *NAC Family*

Several TF of unknown function



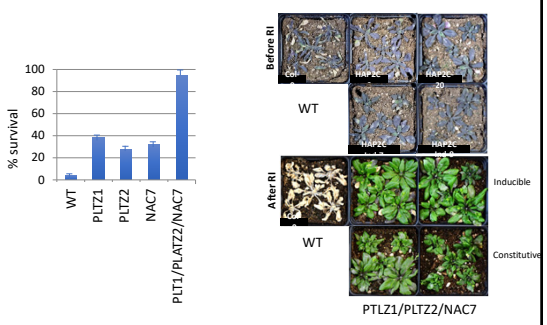
13

Low water availability test



14

Activation of seed desiccation tolerance master genes in the leaves of a plant



Rico-Cambrón unpublished data.

15

16

Weeds are a major problem for crop production

To control weedy plants the farmer needs to apply herbicides.

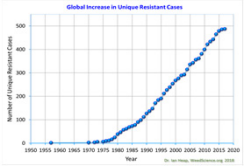
17

Herbicide resistant weeds are making herbicides obsolete

New York Times (March 2011)

Scientific American (May 2011)

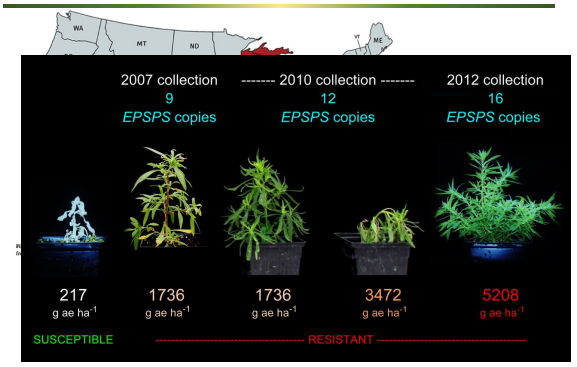
The dramatic increase in herbicide-resistant weed biotypes; a major concern worldwide



Science (May 2018)

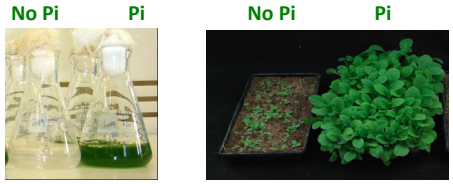
18

Dynamic dispersion of increasingly herbicide resistant weeds



19

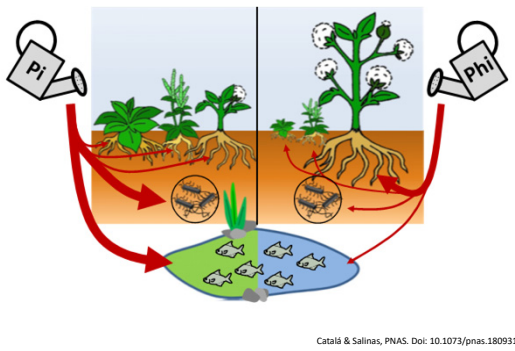
All organisms require phosphorus for their growth and reproduction



Phosphorus can only be assimilated by the vast majority of organisms in the form of phosphate (PO_4).

20

An alternative system: crop selective nutrition



Catalá & Salinas, PNAS. Doi: 10.1073/pnas.1809311115

21

Phosphites (Phi): a more efficient source of Phosphorus

Phosphite was proposed after Second World War as a superior alternative source of phosphorus-fertilizers over phosphate because of its physicochemical properties:

-**Phosphite** solubility is less dependent on pH than **phosphate**.

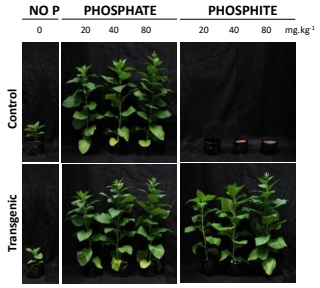
-**Phosphite** is less reactive than **phosphate** with soil components.

-**Phosphite** is already widely used in agriculture as an effective treatment against Oomycetes (i.e. Phytophthora, etc.).

-No toxicity reported for humans and animals (FDA).

22

Plants capable of using phosphite as a nutrient source



Transgenics are able to use phosphite as sole phosphorus source with a phenotype and yield comparable to non transformed control plants grown in phosphate.

López-Arredondo and Herrera-Estrella, Nat Biotechnol 2012.

23

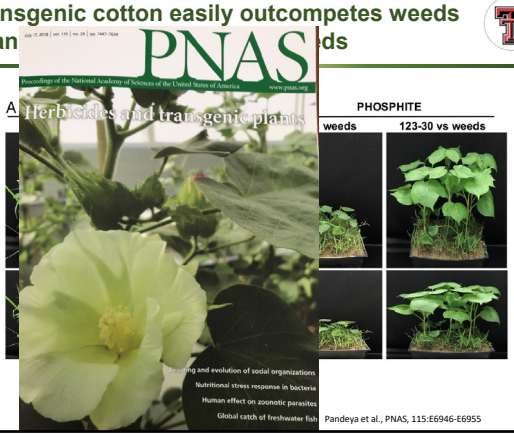
Phosphite is not a herbicide, however, it cannot be used as a source of Phosphorus by conventional plants and inhibits their growth because it competes with phosphate for the entry into the plant via a common set of transporters.

Can phosphite be used to selectively fertilize crops and reduce weed growth?

Can we replace phosphate fertilizer and herbicides with phosphite?

24

Transgenic cotton easily outcompetes weeds in an ds



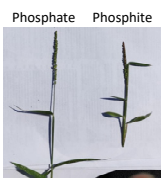
Pandeya et al., PNAS, 115:E6946-E6955

25

Weed suppression in the field

26

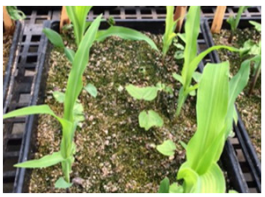
Field trails with transgenic cotton in San Angelo, Texas



Collaboration with Cotton Incorporated. San Angelo, Texas, 2019.

27

Control of one of the most important weeds for maize production in Mexico



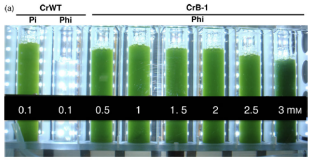
Pi

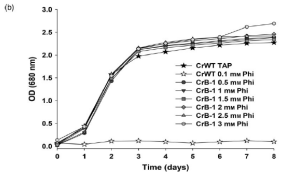
Phi

- ***Ipomea purpurea***

28

Chlamydomonas reinhardtii expressing *ptxD* are able to grow using Phi as a sole P source



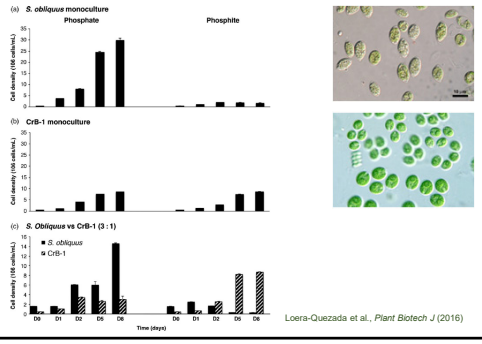


- **Kinetics of growth in Pi and Phi are quite similar.**

Loera-Quezada et al., *Plant Biotech J* (2016)

29

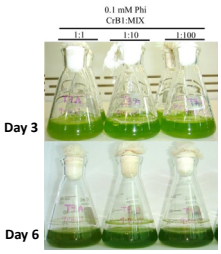
Engineered *C. reinhardtii* outcompetes the faster growing *Scenedesmus obliquus* in media containing Phi as a sole P source



Loera-Quezada et al., *Plant Biotech J* (2016)

30

Transgenic *C. reinhardtii* grown in media containing Phi can outcompetes a natural mix of bacteria-microlagae-cyanobacteria



31

The Phi systems allows a robust control of biological contaminants in open air reactors

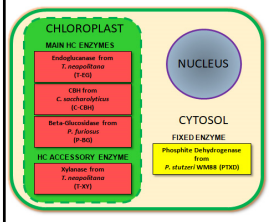
Chlamydomonas reinhardtii expressing ptxD

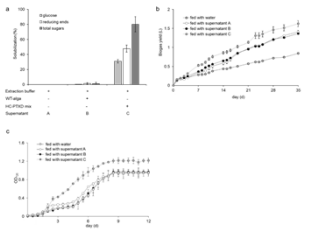
October 26 (4 days culture) **October 29 (7 days culture)**

- **Media and reactors were NOT sterilized.**

32

Development of industrial applications: hydrolytic enzymes for the degradation of lignocellulosic residues

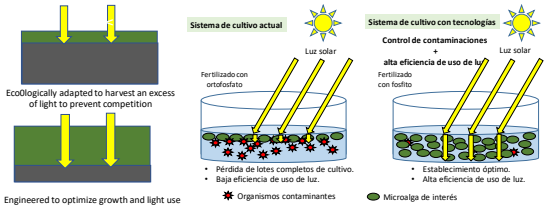




33

Technology to optimize light harvesting

The system is based on mutants that have altered light harvesting complexes to prevent an excess of harvested light that is eliminated as heat by the microlagae



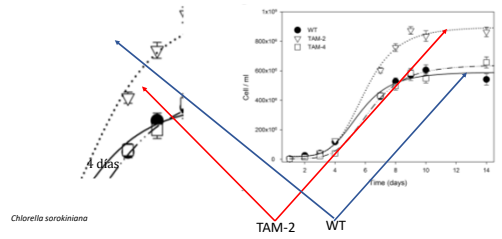
Developed by Dr. Roberto Bassi, Verona University, exclusive rights StelaGenomics en 2017.

34

Technology to optimize light harvesting

Developed by Dr. Roberto Bassi, Verona University, exclusive rights StelaGenomics en 2017.

Concentración celular respecto al tiempo de cultivo



35

Applications and benefits

Applications
Biomass production
Production of enzymes
Production of vaccines
Production of pigments

Benefits
Facilitates the use of open air raceway systems
Reduces production costs
Eliminates de use of antibiotics and herbicides
Increases biomass production

36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Cotton
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Kan Wang-Iowa State U
Keerthi Rathore- Texas A&M
Kazimierz Wrobel and Kasha
Wrobel- U Guanajuato
Stefan de Folter and Ricardo Eric
Lyons-U. Arizona
Victor Albert-SUNY-Buffalo

37

General Notes

The TAWC project was made possible through a grant from the
Texas Water Development Board

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The TAWC project was made possible through a grant from the
Texas Water Development Board

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Texas Water Development Board

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Ogallala CAP Project*
Plains Cotton Growers
Plains Land Bank
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South Plains Valley Irrigation*
Texas Ag Irrigation Association*
T-L Irrigation*

The TAWC project was made possible through a grant from the
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Special Thanks to:

HPWD (Provided Doughnuts and Coffee)
AgTexas (provided water)
Indigo Ag, Inc. (Provided lunch)
CASNR (Live Radio Coverage Sponsor)
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***Please see Display Booth in Exhibit Hall.**

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