Meeting Notes from the: Cotton Water Summit: Developing Strategies to Thrive in Arid Conditions

Held June 27, 2024 at the:

USDA-ARS Conservation & Production Research Lab
2300 Experiment Station Rd
Bushland, TX 79012

Meeting Goal and Overview: The meeting was held to discuss water strategies that can help southwestern cotton producers adapt to declining water resources and transition to dryland production systems when necessary. An overview of existing research in the region was given to identify any research gaps and coordinate efforts across institutions and initiatives. More than half of the meeting was spent in facilitated discussions to determine if there are additional strategies to address water shortages that require research support and to identify funding opportunities.

This document contains notes from the meeting of 35 research scientists and other representatives from west Texas, Kansas and Oklahoma. A list of participants is included at the end of the document.

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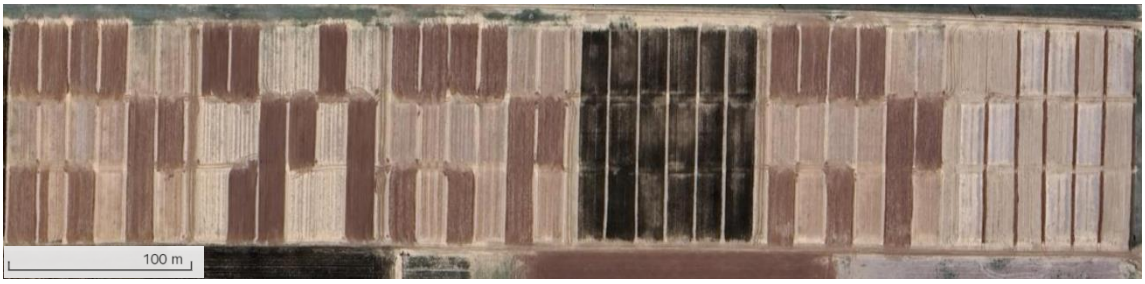
Tour of Two Bushland ARS Research Plots

The summit began with a brief visit to two of the cotton experiments in progress at the Bushland research facility.

Variable rate irrigation and mobile drip irrigation (MDI)

Dr. Susan O'Shaughnessy showed their irrigation system equipped with mobile drip irrigation (MDI, Dragonline) and infrared sensors for real-time variable rate irrigation control. The MDI was comparable to low elevation spray application (LESA) and could have an advantage over LESA in low infiltration situations. Initial results from this study are available in O'Shaughnessy, S.A., Colaizzi, P.D. 2023. Improving water productivity in cotton using mobile drip irrigation technology. Proceedings of the U.S. Committee on Irrigation and Drainage Conference, October 17-20, 2023, Ft. Collins, Colorado.

Cotton, wheat, fallow rotation



Louis Baumhardt showed us a long-term rotation study has that included cotton, wheat, corn and sorghum. The study is picture above using an image from Google Earth where the dark area is

wheat. Different cover crops and tillage systems are included in the study. Publications resulting from this study include:

- Baumhardt, R.L., R.C. Schwartz, T.A. Howell, S.R. Evett and P.D. Colaizzi. (2013). Residue management effects on water use and yield of deficit irrigated corn. Agron. J. 105(4):1035-1044. https://doi.org/10.2134/agronj2012.0362
- Baumhardt, R.L., R.C. Schwartz, T.A. Howell, S.R. Evett and P.D. Colaizzi. (2013). Residue management effects on water use and yield of deficit irrigated cotton. Agron. J. 105(4):1026-1034. https://doi.org/10.2134/agronj2012.0361
- Baumhardt, R.L., R.C. Schwartz, S.R. Evett, P.D. Colaizzi, and T.A. Howell. (2015). Crop rotation and residue management effects on deficit irrigated cotton and corn. Paper Number: 152143137. ASABE Publication No. 701P0415. 2015 ASABE/IA Irrigation Symposium: Emerging Technologies for Sustainable Irrigation. Proceedings of the 10-12 November 2015 Symposium, Long Beach, Calif., 2015. American Society of Agricultural and Biological Engineers, 2950 Niles Road, St. Joseph MI 49085-9659 USA. https://doi.org/10.13031/irrig.20152143137

Introductory Presentations

Overview and history of the USDA-ARS Bushland Facility – *Steve Evett, USDA-ARS*

Slide deck of the presentation:

Evett-Conservation and Production Research Laboratory-Overview.pdf

Selected milestones at the facility include (more included in the slides):

- The lab was established in1938 to address wind erosion and study stubble mulch tillage systems.
- Irrigation research began in 1948
- Well at the site has fallen from 170 ft in 1952 to 255 ft in 1997
- 1958 a focus was added on dryland cropping systems.
- 1959 – Study indicated that underground water recharge from playa lakes was not feasible (this point was debated in a later discussion)
- 1976 – wind energy
- 1986 - evapotranspiration
- 1996 – Animal nutrition
- **2003 – Ogallala aquifer initiative (program)**
- 2005 – Variable rate irrigation
- 2019 – mobile drip irrigation
- 2021 greenhouse gas

Ogallala Aquifer Big Cotton Program Update – *Jourdan Bell Texas A&M – presented by Steve Evett*

Slide deck of the presentation:

Jourdan Big Cotton Project Update 2025-06-27.pdf

- Focused on profitably producing cotton in thermo-limited regions, including Panhandle of TX and OK and Kansas, with collaboration with TAMU, West TX A&M, OSU, and KSU
- Funding at $2.34 million to date and runs through 2026
- Primary objectives: heat units, water use, risks, economics, and outreach
- Enlist cotton varieties due to perpetual 2,4-D damage
- Multiple planting dates are being evaluated to determine the most stable yields, especially since replanting is not a great option in this area. General observations are that the earliest planting date generally looks bad, but has been the most consistent yielder.
- Overapplication of irrigation resulted in high micronaire.
- Cotton growth curve in this region is considerably different than other growth curves in the Cotton Belt
- Suggested output: develop a "rule of thumb" extension publication on when to keep the stand and when to replant.
- The project website is: https://ogallala.tamu.edu/ and includes all publications that have been generated by the project.

Texas Alliance for Water Conservation Update – *Samantha Borgstedt, Texas Tech TAWC Project Director*

Slide deck of the presentation:

Borgstedt-TAWC-Overview.pdf

- On farm observations from S. HP to Panhandle for the past 19 years
- TAWC's mission is: "To conserve water for future generations by collaborating to identify and implement sustainable agricultural practices to conserve water, protect soil health, and boost economic opportunities."
- Working with various private companies as growers explore water sensors, autonomous pivots, Some companies mentioned were Goanna Ag, AquaSpy, Arable, Autonomous Pivot and others
- Climate smart cotton/sorghum rotation with cover crop grant that is funding on-going observations. 26 field sites outfitted with weather stations and soil analysis.
- Dryland is being transformed to pasture and cattle
- Lindsey Slaughter – taking GHG measurement with collars in four fields
- More interest in water savings and alternative crops, including forages, than 5-10 years ago.
- For outreach, better utilization of crop consultants maybe be helpful in adoption of water saving techniques.

- Questions resulting: 1. Where or how can someone obtain the historical and current data being collected? 2. With all this observational data, can AI be used to summarize and process the data for more useful management decisions?

Oklahoma Water Issues – *Summon Datta, Oklahoma State University, and Tom Buchanan, District Manager, Lugert-Altus Irrigation District*.

Sumon Datta provided the following summary of his comments:

- We have collected multi-depth soil moisture and canopy temperature data along with weather variables and irrigation-precipitation data from 49 irrigated fields (most of them are under cotton production) between 2017 and 2023, encompassing about 17 million data points. Due to challenges in sensor technologies in estimating soil moisture and canopy temperature and the fact that we do have a considerably large dataset on these variables collected from actual producer fields throughout Oklahoma (Southern Great Plains), there is a unique opportunity to use state-of-the-art machine learning (ML) techniques to model these variables while reducing the requirements for labor and monetary resources. We will be evaluating different ML approaches to estimate soil moisture and canopy temperature to develop and improve irrigation scheduling approaches for cotton.
- We are looking at coupling physics-based and crop models together to conduct "what-if" scenarios to develop deficit irrigation strategies for cotton. The scenarios may include, but not be limited to, reduced pumping rates, seeding rates, plant populations, etc.
- We are exploring the application of OpenET to optimize irrigation scheduling for cotton. We have a recently funded USGS grant to see how crop ET from OpenET can be used to develop/update crop coefficients for Lugert-Altus Irrigation District in Oklahoma. More efforts are going into validating ET from OpenET with ET from soil moisture sensors.
- We continue to provide energy efficiency and irrigation water distribution uniformity audit services for cotton producers in Oklahoma having center-pivot irrigation systems at free of cost. These audits help producers find the area being over- or under-irrigated and provide possible solutions along with potential monetary savings.
- We are in the process of building an advanced irrigation scheduling tool based on dual crop coefficient approach that can automatically update irrigation recommendations based on user inputs during the growing season. The tool will run with automated inputs from USDA SSURGO soil data and real-time weather data from Oklahoma Mesonet. The development is going on right now and tool is supposed to be released in the late October.

Kansas Water Issues - Jonathan Aguilar, Kansas State University

Slide deck of the presentation:

Aguilar-2024_OAP_Kansas_Cotton.pdf

- Lots of good graphics in slides on water use, well levels, etc.
- Cotton acreage is increasing and moving further north
- Goal of state is to stabilize well water levels

- Local Enhanced Management Area approach is showing some success in slowing aquafer decline.
- Cotton crop coefficients are different for KS
- On-station research challenges: 1. Good stand establishment; 2. harvesting equipment

Cropping systems and soil health practices to facilitate cope with climate change, including declining water – *Katie Lewis, Texas A&M*

Slide deck of the presentation:

Lewis_Bushland Cotton Water Summit_06272024.pdf

- USDA, Sustainable Agricultural Systems project, including HP, RP, and OK for research and outreach
- Main focus:
    - Developing a Master Soil Stewardship kits, a real-time, learning experience to compare systems
    - Developing classroom curriculum
    - Provided their definition of Regenerative Agriculture for West Texas which includes a major emphasis on wind erosion.
- Field research includes:
    - Rotations, systems, and cover crops
    - Water storage benefits with strong soil moisture data from different cropping systems
    - Net balance CO2
    - Showing yield benefits in cotton wheat fallow rotation

Lewis Lab Webpage: https://www.txsoillab.com/

Facilitate Discussion Notes

The following are notes taken during facilitated discussions of the listed topics. The discussion of grower comments were partly addressed in these discussions and additional notes on the grower comments is included after the topic notes.

Important plant traits to improve/maintain productivity as irrigation declines

- We must consider at the growth pattern and maturity of the crop. Growing season length.
- Roots – we know very little about phenotypic and genotypic characteristics. Roots key to drought tolerance.
- From soil moisture data can see the roots are going deeper.
- Drought tolerant lines appear to be growthier genotypes but boll load is not good. Could we use those plants to get drought tolerance?
- Water x variety trials – looking for genotypes suited to dryland/low water.

- Need to also consider fiber quality – can we improve SW cotton quality? Some genotypes reacted to ginning based on water stress.
- Cold tolerance needed to allow early planting – and would be good for late season. Oil type and membrane integrity may be factors impacting cold tolerance. - Rosalyn Shim working in this area with Dick Aulds mutant lines.
- Lower plant populations will be needed and early planting dates, so need very high quality seed.
- Need to germinate under low moisture and/or marginal moisture conditions. Permeability and other characteristics of seed moisture uptake.
- Virtual cultivars – heat tolerance (increase optimal temperature), increase leaf size, boll retention
- Increased salt tolerance needed as water quality will likely decrease with depleting irrigation water. Also, some common characteristics in drought and salt tolerance.
- Challenge to balance getting a determinate plant that will only produce a limited of bolls despite conditions – sacrifice high yields in good conditions. Challenge is going from 8-in to 32-in of water across years, across HP geography, and across irrigation capacities
- Going to see a decrease in yield and total production as we transition to non-irrigated systems. Do we need to recognize we are limited in yield and work toward replacing it with better quality? Could it be marketed as "low water footprint" cotton? Could it be blended with irrigated cottons when higher quality fiber is needed?
- In early planting, face extreme weather events in May/early June.
- Root architecture could impact more carbon into soil.

Rainfall storage and capture [Playa lakes, county road ditches….]

- Playa lake recharge – Steve's comments – Robert- hydrologist working in Halfway regarding recharge – not much recharge at all from playa lakes. Tom Marek, disagrees, due to macropore flow and microfractures that can occur
- UT did research in 2008, and the Ogallala hasn't recharged since the 1940s. Research discussed today does not support playa lake recharge as being a viable option.
- Playa recharge – vertical movement due to the lateral movement caused by clay layers – Victor Houser – 1960s; Playa lake comparison on TAMU land and random clay layers
- Could playa lake surface water be used for irrigation? Likely not an option due to other "competing uses", mainly wildlife concerns. Additionally, the inconsistency of the availability doesn't justify infrastructure investments.
- Currently a Playa Lake Restoration in South Plains project is ongoing through NRCS to pay landowners to preserve playa lakes for wildlife.
- Louis commented on some value of watershed terracing in dryland production
- Is there a transition area based on precipitation for on-farm water storage? No clear substance discussion was had on this topic.
- OK has a recharge plan underway – if successful, who the question becomes, who owns the water?
- Any water capture in the SW will only allow for only very supplemental water

- In Altus, surface water is being used for sub-surface drip, but only after additional filtering occurs.
- Diverting water from bar ditches to course deposits
- Water rights – capture water overland flow on private property; state law
- Any type of rainfall capture on a field level; can be problematic if rainfall capture is too effective as downstream people to downstream people – Jonathan comments

Soil health for the southwest & Crop rotations

- Quantification of reduced runoff in cover crops? Infiltrometers measurements can be misleading as they do not represent the most common rainfall events.
- 800 lbs of biomass in cover crop can reduce / eliminate wind erosion of soil, which is the most common soil loss in West Texas. Could be more important in this area than increased rainfall infiltration
- Cover crop every other year to get wind erosion benefits without drawing down water resources
- 300 days after cover crop termination (of a headed wheat or rye) about 40% of residue still present (Lamesa).
- 3.5 Mg per ha biomass is required to count as conservation tillage according to NRCS
- Any form of standing stubble increased wind protection, but standing, stripper harvested cotton stalks do not provide much protection.
- Termination timing – can see reduced runoff in Vernon. Have to let residue mature to heading in wheat cover crop get 18 months of residue persistence. Terminate prior to stem elongation, residue gone in 3 months. Need to balance terminating later and still having adequate planting moisture.
- Wheat versus rye and seeding rate not as big a difference as termination timing.
- Soil health is related to carbon capture (feed microbes & chemical / physical aspects of the soil). Also reducing soil erosion is an important component. Carbon levels in the soil tracked plant productivity, but were not always reflected in higher lint yields.
- What is the increase in water holding capacity from soil health? It is increased, but without adequate precipitation and proper timing, the increased water holding capacity may not impact much in any given field or year.
- Residue more valuable at planting time as reduce soil evaporation and wind damage to cotton seedlings.
- Need to be careful to not overestimate the value of soil water storage. Lamesa, 0.2% to 0.4% soil carbon
- How much soil moisture is lost in sand fighting?
- Meaning of “soil health” is site specific. It was highly emphasized that the most important soil health factor is to reduce wind erosion with crop or cover crop residue.
- Nitrogen dynamics need to also be considered. Immobilization of N can be a challenge from cover crop in West Texas. So, need to move N application early in season.
- What is the best way to make use of water available – crop type, livestock, fallow?

- New grain sorghum that could allow grazing after harvesting due to no prussic acid under stress conditions.
- Will crop rotations impact variety selection? Will shorter season varieties be needed? Can we adjust when peak water use occurs, so it does not match other crops on the farm?
- In wheat, cotton, fallow hard to maintain cover crop in fallow period.
- Insect pressure (e.g., thrips & wire worms) can be associated with cover crops in some years.
- Cotton-wheat (CW) – what do we do during the fallow period. Add cover or pulse crop and graze? Livestock is a risk management tool in Rolling Plains where they are leasing out wheat pasture to those who own the cattle.
- Need to try fit into current infrastructure.
- Corn will have an earlier peak irrigation period than cotton.
- Herbicide rotation is an added benefit of crop rotation. Also, nematode pressure is reduced in some rotations.
- Market price and access are key drivers in rotation. Trucking costs 20% of wheat return by transporting from Lamesa to Lubbock.
- Rotation can be a challenge when negotiating lease agreements.
- High yield locked in cotton is hard to pass on for some landowners.
- Need absentee landowner education. The survey of absentee landowners shows it is younger generation who may be more open to new concepts and technology.
- Forage rotations (both annual and perennial).

Plant spacing / geometry

- Lege' and Burke have on-going trials – not so much water use efficiency, can only get ½ acreage, but premiums are half. Boost APH in the long-term. Root exploration and root volume. Joined with very low seeding rates (~13,000 per land acre).
- Crop insurance will now allow cotton planting on up to 80" centers.
- 1 year of data wide-row research from Craig, yields were the same, little difference in quality and maturity
- Is this variety specific?
- 2:1 was once very popular in S.HP
- Root system does not have to meet in the middle, but water is going to be pulled from middles
- Joseph – 40 & 80 inch row spacings in 2023 season. The project will continue into 2024 and include water use and water movement.
- Katie will send Jim Bordovski's publications
- James – maybe at some point we just say "it really doesn't matter" regarding row spacing.
- Lascano – plant dimension and plant population has been published 50 years ago.
- Wide-rows should be paired with soil health practices and will have additional weed management

Irrigation management with minimal and/or poor-quality water

- Seed germination critical in all locations, but especially with salty water
- Priority should be for crop emergence
- Why not use non-traited (inexpensive) seed in dryland/low input situation?
- Is organic going to be an option? Probably not, as it will flood market fast and premium lost.
- Irrigation timing (Bordosvsky reference), remember soil type and put into context. Is it transferable? Started with full soil profile.
- Salinity build-up can be a big problem in sub-surface drip
- Surface salinity causing problems at emergence from splashing. 2003 where surface salinity moved into the root zone following a high rainfall event late season and caused issues.
- Genetically, quite a bit of diversity in salt tolerance – Jane did work and likely in thesis and dissertations – likely multiple genes
- Some soil moisture probes do not work with salty soils
- Joseph- recycling of oilfield frac water 5 barrels of water for 1 barrel of oil, desalination to extract Lithium, then can be land applied
- Waste water use and accumulation of PFAS
- Is cotton a good crop for utilization of municipal waste water
- Modelling crop water salinity production functions

Additional strategies to transition to non-irrigated production systems

- Dairy concentrations in area, where is the fit for cotton? Cotton and forage crop rotations to fill the need.
- Vivian – forage grazing and cotton rotations. Showed positive economic impact, but economics was based on selling grass seed at high price
- Cotton: forage sorghum rotations at Helms Farm
- Brent: growing millet, and sorghum in dryland, cotton could be worked in the rotation?
- Risk, mitigation and profitability – modeling based on local research data
- Crop Insurance, what is the path for getting things changed? Get information together and present to RMA.
- Need data compilation that can help provide complex modeling and answers
- Need for social sciences for making changes and adoption
- Everything talked about results in less production

Discussion of Southwestern Cotton Grower Comments

Comments were made by Cotton Board and Cotton Incorporated Board of Directors in West Texas, Kansas, and Oklahoma in both a zoom meeting on March 14 and an in-person meeting on June 10. The grower comments are included in the following section with comments by attendees at the Water Summit shown in blue font.

Grower Meeting Attendees

Zoom – March 14: Walt Hagood, Kent Goyen, Kent Dunn, David Light, Harvey Schroeder, Kathy Fowler, Carson/Sam Vinyard, Martin Stoerner, Joe Baumgardner, Sigifredo Valverde, Julie Holladay, Lacy Vardeman, Matt Farmer, Brent Nelson, North plains water district, Ed Barnes, Gaylon Morgan, Ryan Kurtz, Sally Taylor, Shelley Heinrich

June 10 Attendees in Dallas: Steven Clay, Sam Vinyard, Kent Dunn, Kent Goyen, Joe Baumgardner, Lloyd Arthur, Brent Nelson, Mike Patschke, Martin Stoerner, Lacy Vardeman, Ed Barnes, and Ryan Kurtz.

Discussion Summary

The objective of both meetings was to 1) review Cotton Incorporated's water strategy specific to the conditions in the southwestern United States; 2) get farmer input on any areas where an increased research focus may be needed; 3) to hear about on-farm strategies being used to address declining water tables and increased drought frequency in many parts of the region.

The following were the main points discussed by the group:

1) Invasive species such as Salt and Red Cedars are consuming a tremendous about of water that would otherwise fill reservoirs and help replenish aquifers. Removal of those species across a watershed could reduce stress on existing water resources.
    a. Not sure if invasive species taking up more water than any vegetation present.
    b. There was success with Canadian river in replacing vegetation with no vegetation
    c. Arizona department of resources report?
2) Furrow diking was discussed to improve effective rainfall and irrigation infiltration but is limited to conventional tillage systems. Additionally, the different spacings between tractors and new sprayers (3 row sprayer versus 2 row tractor), also makes furrow diking difficult.

    Alternatives to furrow diking for improving irrigation infiltration were discussed at the June board meeting, including decreasing the nozzle spacing from 80-inches to 40-inches. The use of the "Dragon-line" (https://www.dragonline.net/) was also discussed and no one had personal experience with the system. It was noted that there were reports if reversing direction, the lines can become tangled in the plant and until the plants were a certain size, the lines did not always accurately follow the furrow. The importance of following the contour with rows to prevent runoff was also discussed for sloping land. Also, the use of spinners to more widely distribute water at the end of large pivots was mentioned. The use of autonomous control to speed up and slow down the pivot based on land slope and soil type was also noted as another option.

    Seeing more water infiltration with Dragonline than LISA
    TAWC – also saw improved infiltration but more management with dragonline
    SDI can be more efficient, but do have more potential for salt accumulation in SDI.
    Salt challenges vary by region – less of a challenge as rainfall increases.
    Circular planting does reduce runoff.
    Dragonline requires good water quality and some filtering and higher costs

SDI also has cost and water quality challenges plus cannot irrigated up crop in sandy soils
Furrow dikes have to be plowed out in wheel tracks

When using a "windshield wiper" pattern, an option to increase infiltration is to irrigate different rows on the return trip.

3) As the water table drops in some aquifers, mineral levels in the water are increasing and are beginning to create soil salinity issues. More research is needed on how to manage salinity in low water resource conditions.

   Addressed in discussion of "*Irrigation management with minimal and/or poor-quality water"*

4) There is both potential and challenges for a wheat, cotton type rotation. Challenges include managing herbicide resistant weeds in the wheat fallow, and there are landlord concerns about loss income in the fallow year. And research is needed to establish if there is a net economic return to the practice (e.g., does income from increased cotton yield offset the loss of income in the fallow year). One potential benefit from integrating crop rotations, fallow periods, reduced tillage, cover crops, and rotations is improved cotton yield stability which will help maintain the farm's Actual Production History (APH) for the federal crop insurance program. It was also suggested that long-range weather forecast may help make decisions about when it is going to be advisable to plant a wheat cover crop. An alternative to using cover crops to increase surface residue was a cotton / sorghum rotation. The price of sorghum is a current challenge, but could yield increases in cotton offset the loss in sorghum years? Hemp is another crop being tested to serve as a cash and "cover" crop.

   Another option discussed was more frequent rotation between CRP and cropped acres.

   Several noted that cover crops were necessary to prevent wind damage as they did not have the capacity to run sand fighters on all their acres.

   - Lack of infrastructure is a challenge to rotations. Need elevators for wheat and sorghum plus do not have combine or access to custom harvester.
   - Need to consider impact on labor and efficiency when considering rotations like with cotton harvester.
   - Sizing harvesters with rotation can help with economics.
   - Do need to look at profit margin increase and can it pay for distance to elevator and other constraints.
   - In declining water – if can increase cotton yield by 50% can reduce water and help justify combine cost. Tax costs are there every year.

   Additional discussion related to these points were addressed in the "*Soil health for the southwest & Crop rotations"* discussion.

5) There is interest in investigating methods to increase water infiltration for ground water recharge. Three ideas were discussed:
    a. The creation of artificial recharge basins.
    b. Restoration of playa lakes to increase infiltration there. However, some concerns about how playa lake restoration could restrict growers' ability to apply some pesticides, due to ESA needs to be part of the discussion.
    c. Looking at how roadways and terracing are impacting water flows and seeing if that water can be better captured. Some research on that topic is occurring in Oklahoma. Concerns were expressed about the capacity of county road managers to supply additional services when road maintenance is already minimal. Additionally, concerns about where the water is delivered need to be who addressed (who gets access to that water).
    d. It was also noted that pumping surface water for use in drip or pivot systems will require filtration but would not be an issue for furrow applications.

    Addressed in the discussion of *Rainfall storage and capture [Playa lakes, county road ditches….]*

6) Wide row spacing also appears to be another option to maintain yield under drought conditions. A challenge to wide row spacing is how it is currently treated by the USDA Risk Management Agency (RMA). For the issue of increased wide row spacing, skip-row configurations, and other novel approaches, it was suggested that a crop model could help generate the data RMA would need to consider the practice in its program. Outputs from the economic models could also be used to educate landlords about the economic and communal value of these non-traditional agronomic practices. The need to have better insurance coverage under alternative row patterns was reinforced in June. Perhaps data showing that wide row spacings can yield higher per acre than narrow spacings could justify full coverage.

    Addressed in discussion of "*Plant spacing / geometry*".

7) There was a question about the status of cloud seeding efforts and the impact of wind turbines on weather patterns in the southwest.
    - San Antonio use to seed clouds, but then seeded the wrong storm and resulted in considerable damage.
    - Western KS focused on hail suppression and reducing size of hail
    - Solar panel also a challenge due to dust and hail damage.
    - No significant research to support impact on productivity.
    - Agrovoltaics – Israeli company adding solar panels between crop rows and capturing rainfall from panels for later use in irrigation. Could be net benefit to per acre productivity plus add energy generation income. Would those panels also provide some crop production (lower temperature and wind) and reduced wind erosion.
8) We need to find more information on the NRCS program to support transition from irrigated to non-irrigated acres

In KS, they want to transition to pasture – has to be all or nothing regarding irrigation. Cannot use for crop establishment. NRCS has details on their website. Code 134. More on the NRCS program is describe in the document at https://efotg.sc.egov.usda.gov/references/Agency/PA/Archived_134-TransitionfromIrrigatedtoDrylandFarmingandRanching_101105.pdf

9) Some producers are considering non-cotton options when wells run dry, such as transition to a pasture / cattle production system. Could this lead to an alternative rotation between forage and cotton?

   Partly addressed in discussion of *Soil health for the southwest & Crop rotations*

Wrap up and action items

- RMA to get modification on sound agronomic practices
- Social scientists should be engaged.
- More outreach is needed to transfer information.
- NIFA topics
  - consistent stands in dryland crop systems, specifically seed quality
  - Please contact Ryan, Gaylon or Ed with any ideas for future NIFA funding topics.

Next steps will include a follow up meeting with the grower representatives and a research meeting will be held at the 2025 Beltwide Cotton Conferences.

Literature and References Shared After the Meeting

- ARS white paper on water allocation to irrigate with limited water capacity. See: Limited irrigation _cotton_corn.pdf
- Note that all Ogallala Aquifer Program papers and reports are listed at https://ogallala.tamu.edu/publications/
- Google scholar link: Ogallala aquifer recharge - Internet Archive Scholar
- References supplied by Wenxuan Guo:
  - Spatial and Temporal Trends of Irrigated Cotton Yield in the Southern High Plains - https://www.mdpi.com/2073-4395/8/12/298
  - Agronomic Basis and Strategies for Precision Water Management: A Review - https://www.mdpi.com/2073-4395/9/2/87
  - Effects of irrigation rates on cotton yield as affected by soil physical properties and topography in the southern high plains - https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0258496
  - Field-scale spatial variability of soil calcium in a semi-arid region: Implications for soil erosion and site-specific management - https://www.sciencedirect.com/science/article/abs/pii/S100201602160019X
  - Spatial patterns of soil microbial communities and implications for precision soil management at the field scale - https://link.springer.com/article/10.1007/s11119-021-09872-1
  - Spatial and temporal patterns of cotton profitability in management zones based on soil properties and topography - https://link.springer.com/article/10.1007/s11119-024-10158-5
- Note that there also papers listed with the attendees list.

Meeting Attendees

Name, institution and any projects or publications listed for those who registered for the meeting is provided in the following pages.

Last Name	First Name	Organization	Research projects, publications noted, and related background
Aguilar	Jonathan	Kansas State University	https://scholar.google.com/citations?view_op=view_citation&hl=en&user=AANPjNEAAAAJ&sortby=pubdate&citation_for_view=AANPjNEAAAAJ:zA6iFVUQeVQC https://scholar.google.com/citations?view_op=view_citation&hl=en&user=AANPjNEAAAAJ&sortby=pubdate&citation_for_view=AANPjNEAAAAJ:hMod-77fHWUC
Ale	Srinivasulu	Texas A&M AgriLife	Research project 1: Evaluation of efficient crop-growth-stage-based deficit irrigation strategies for cotton production in the Texas High Plains. Related paper: Himanshu, S.K., S. Ale, J.M. Bell, Y. Fan, S. Samanta, J.P. Bordovsky, D.C. Gitz III, R.J. Lascano, and D.K. Brauer. 2023. Simulating efficient crop-growth-stage-based variable deficit irrigation strategies for sustaining cotton production in the Texas High Plains. Agricultural Water Management. Volume 280, 30 April 2023, 108222. https://doi.org/10.1016/j.agwat.2023.108222 Research project 2: Determining optimum irrigation termination periods for cotton production in the Texas High Plains Related papers:Himanshu, S.K., S. Ale, J.P. Bordovsky, J. Kim, S. Samanta, N. Omani, and E.M. Barnes. 2021. Assessing the impacts of irrigation termination periods on cotton productivity under strategic deficit irrigation regimes. Nature-Scientific Reports. 11, 20102 (2021), https://doi.org/10.1038/s41598-021-99472-w Ale, S., N. Omani, S.K. Himanshu, J.P. Bordovsky, K.R. Thorp, and E.M. Barnes. 2020. Determining optimum irrigation termination periods for cotton production in the Texas High Plains. Transactions of the ASABE Special collection on Global Water Security. 63(1): 105-115. https://doi.org/10.13031/trans.13483
Barnes	Ed	Cotton Incorporated	Director of agricultural engineering related research. Review paper on cotton irrigation management at: https://cottoncultivated.cottoninc.com/wp-content/uploads/2020/12/Fourty-years-Cotton-Water-Online26Aug2020.pdf
Baughman	Todd	Texas A&M	Resident Director for Lubbock Research and Extension Center; Training in Weed Science and the majority of his career has been as an Extension Weed Specialist in TX and OK.
Baumhardt	Louis	USDA-ARS Bushland	Research Soil Scientist, and on Dryland and Irrigated Crop Management Under Limited Water Availability and Drought project team. https://www.ars.usda.gov/people-locations/person/?person-id=337
Bean	Brent	United Sorghum Checkoff Program	Director of Agronomy for United Sorghum Checkoff Program and based out of Amarillo. Training in Agronomy and Weed Science and was an Extension Agronomist for Texas A&M for about 20 years prior to his current position.
Bednarz	Craig	West Texas A&M University	Rain fed cropping systems, OAP big cotton
Borgstedt	Samantha	Texas Tech University - TAWC	TAWC Communications Director

Buchanan	Tom	Lugert-Altus Irrigation District	Oklahoma farmer and rancher and General Manager of the Lugert-Altus Irrigation District.
Burke	Joseph	Texas A&M AgriLife	Conducts a research and extension program to enhance agricultural resiliency in semi-arid regions through sustainable soil, water, and weed management.
Colaizzi	Paul	USDA-ARS Bushland	(1) Site Specific Variable Rate Irrigation and Fertigation Management of Cotton for Sustainable Intensification (CRADA with Sentinel Fertigation); (2) Cotton ET under LESA and SDI as determined by large weighing lysimeters; (3) Cotton ET calculation by the Bushland two-source energy balance model.
Datta	Sumon	Oklahoma State University	1. Irrigation scheduling based on data-driven approaches for estimating soil moisture and canopy temperature for cotton production. 2. Evaluation of deficit irrigation strategies (schedules) on cotton production in Oklahoma.
DeLaune	Paul	Texas A&M AgriLife	Synergies between conservation tillage, cover cropping, crop rotation, and irrigation management systems on cotton agronomic production, water use efficiencies, and economic viability. These regenerative agricultural practices are also being evaluated under dryland cropping systems. On a larger scale, integrated crop-livestock systems are being studied in cotton-wheat-fallow systems to diversify continuous cotton cropping systems with the integration of high residue crops and cover crops with grazing of cover crops during fallow periods. DOI: 10.1002/agg2.20027; doi.org/10.1016/j.agwat.2020.106038; DOI: 10.1002/agj2.20135
Evett	Steven	USDA-ARS Bushland	Influence of irrigation application method on cotton crop coefficients - SDI vs. sprinkler. Influence of irrigation application method on cotton yield and fiber quality
Fischel	Lee	Texas Tech University - TAWC	TAWC master's student conducting data collection, quantitative sample analysis, and general field maintenance and operations.
Goebel	Tim	USDA-ARS Lubbock	Plant Physiologist. https://www.academia.edu/93103935/Seasonal_changes_of_groundwater_quality_in_the_Ogallala_Aquifer
Guo	Wenxuan	Texas Tech University	1. on-farm precision irrigation management; 2. cotton water stress assessment using remote sensing;
Heinrich	Shelly	Cotton Board	Southern Plains Regional Communications Manager. Also part of a farming operation in southern Lubbock and Lynn counties near Slaton, Texas.
Kelly	Carol	Texas A&M AgriLife	Cotton breeding for improved yield and quality.
Kurtz	Ryan	Cotton Incorporated	VP of Agricultural and Environmental Division
Lascano	Robert	USDA, ARS Plains Area	Dryland cotton production & cropping systems models. https://www.scirp.org/journal/paperinformation?paperid=115167

Lege'	Ken	Texas A&M	1. Southern high plains RACE trials (span dryland to high irrigation capacity; weather stations at each location to track rainfall and ET) 2. HVI, AFIS and yarn quality from representative RACE trials that span the water spectrum. 3. Proposal under review for plant spacing, gap analyses, and effect of varying plant age within the same stand under two irrigation regimes. If funded, project will begin 2025.
Lewis	Katie	Texas A&M AgriLife	1) Regenerative practice impacts on water availability and cycling 2) Impacts of water availability on nutrient uptake and plant production 3) Irrigation management strategies on nutrient uptake
Mahan	James	Irrigation Consultant	Plant physiologist has spent his career in water management. He and Paxton Payton have a good focus on cotton presentation at https://www.planthealthexchange.org/cotton/Pages/GROW-COT-02-20-212.aspx titled “Rainfed cotton production on the Texas High Plains: Opportunities for Sustainable Production”
Marek	Thomas	Texas A&M	Cotton Production in a Thermally Limited Environment.
Morgan	Gaylon	Cotton Incorporated	Facilitate research in the areas of agronomy, weeds, soil health, and planting seed quality.
Nakabuye	Hope	Texas A&M AgriLife Plain View	Before coming to Texas, Hope earned her PhD at the University Nebraska with a thesis on “Canopy Temperature Based Irrigation Management of Maize and Soybeans in Semi-Arid Climates.”
O`Shaughnessy	Susan	USDA-ARS Bushland	a. Comparison of irrigation water use efficiency between mobile drip technology and LESA. b. Assessing crop water productivity of cotton using an integrated CWSI for automated irrigation scheduling. c. Combining precision irrigation and precision fertigation to improve crop water productivity of cotton.
Porter	Dana	Texas A&M	USDA ARS Ogallala Aquifer Program "Big Cotton" project: "Collaborative Research on Cotton Production in Thermo-limited Regions of the High Plains"
Ritchie	Glen	Texas Tech University	We are currently working on a Cotton Inc. Texas State Support project titled "Plant phenotype and partitioning to maximize cotton productivity under water-deficit stress." Recent accomplishments from this and our related projects include a paper titled "Boll distribution of cotton effected by varying potassium rates within different irrigation levels" published in 2024 and led by Dr. Amee Bumguardner.
Schwartz	Robert	USDA-ARS Bushland	Recent publication *Irrigation Response, Water Use, and Lint Yield of Upland Cotton Cultivars* open access at https://elibrary.asabe.org/abstract.asp?AID=54664