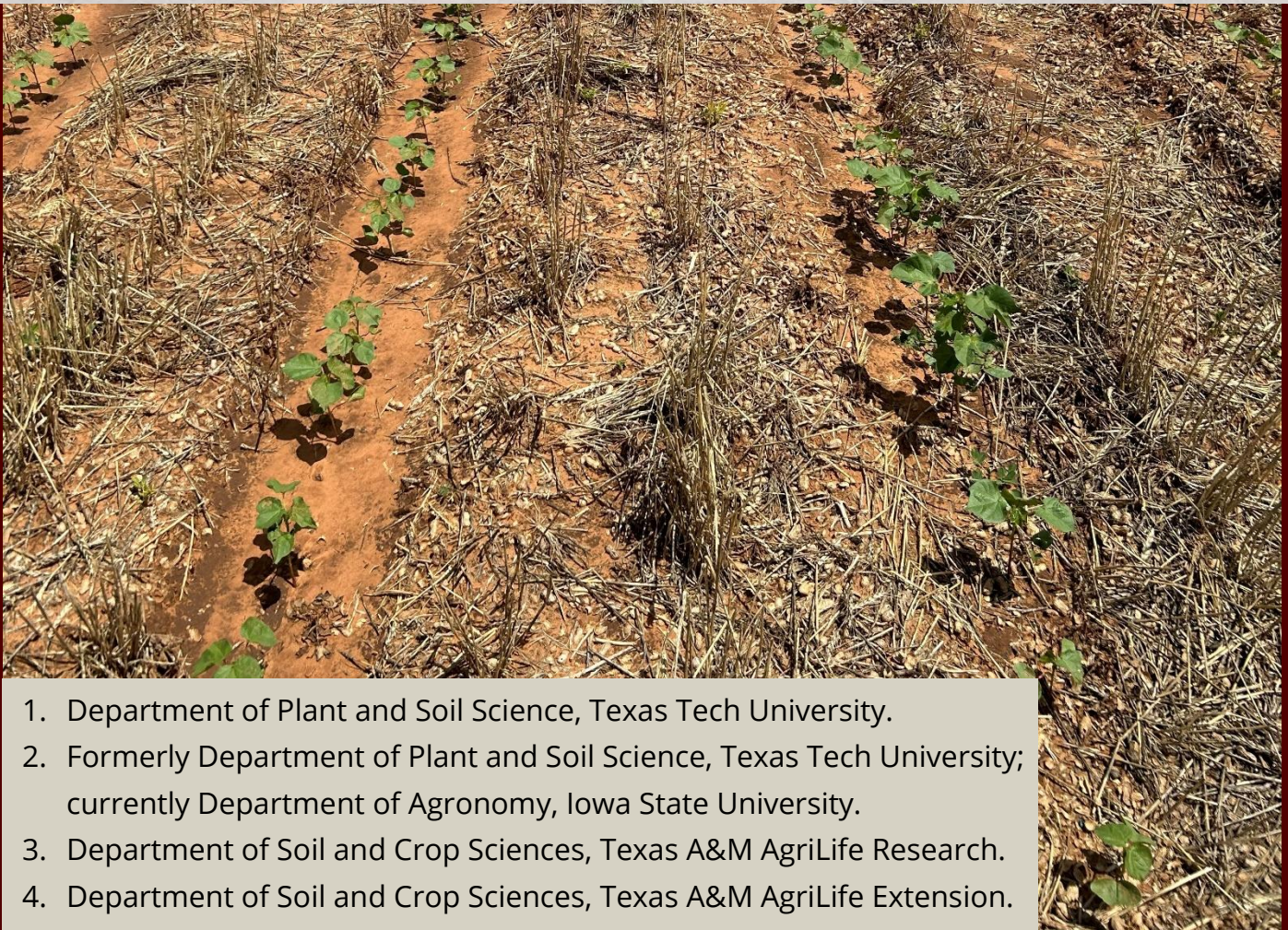




Improving Cotton Yield and Water Productivity through Cropping Systems

Why cropping systems matter in the High Plains?

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Cotton production in the Texas High Plains relies heavily on irrigation from the Ogallala Aquifer, which continues to decline. As pumping capacity decreases and drought risk increases, how efficiently cotton uses water becomes just as important as yield itself. Selecting an appropriate cropping system is one of the most practical and viable tools producers can use to improve water productivity while maintaining profitable yields. This study evaluated continuous cotton, cotton-sorghum, and cotton-wheat cropping systems using producer field data and the DSSAT cropping system model in six High Plains counties. It was based on evidence from 23 years (2000–2022) across 48 producer fields in the Texas High Plains, spanning three cotton-based cropping systems.

Figure 1. Continuous cotton cropping system. P-E: planting and emergence. S: squaring. F-BD: flowering and boll development. BO-H: boll opening and harvesting.

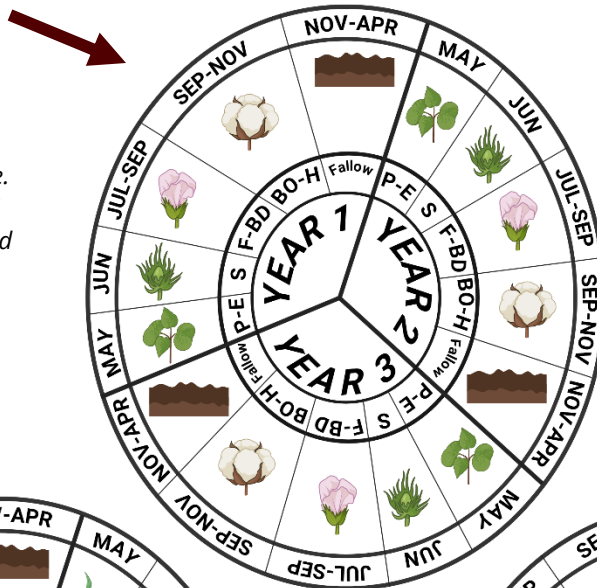


Figure 2. Cotton-sorghum cropping system. P-E: planting and emergence. S: squaring. F-BD: flowering and boll development. BO-H: boll opening and harvesting. HI-L: head initiation and flag leaf development. HI-FL: head initiation and flag leaf development, B-F-SD: booting, flowering, and soft dough stage. PM-H: physiological maturity and harvesting.

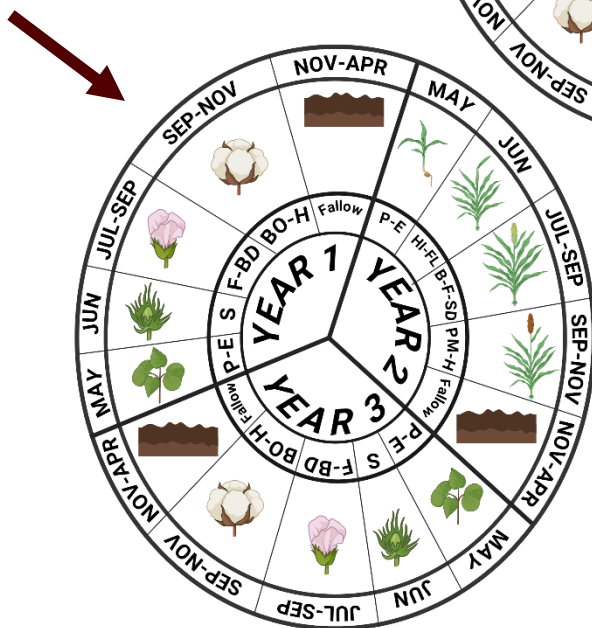
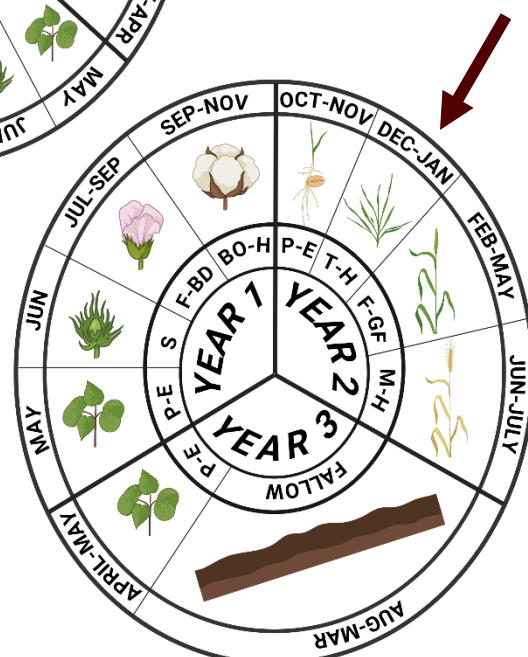


Figure 3. Cotton-wheat cropping system. P-E: planting and emergence. S: squaring. F-BD: flowering and boll development. BO-H: boll opening and harvesting. T-H: tillering and heading. F-GF: flowering and grain production. M-H: maturity and harvest.



Findings of study:

1. Cotton-sorghum rotation produced the most cotton per unit of water received via precipitation and irrigation:

Cotton grown after sorghum consistently showed the highest water productivity, meaning more cotton was produced for each inch of water used. Even when yields are similar, rotations make better use of limited irrigation water, which becomes increasingly important as pumping capacity declines.

Cotton-Grain Sorghum	Cotton-Wheat	Continuous Cotton
143 lbs Ac ⁻¹ in. ⁻¹	125 lbs Ac ⁻¹ in. ⁻¹	113 lbs Ac ⁻¹ in. ⁻¹

2. Cotton yields tended to be higher in rotations:

Average seedcotton yield (lint + seed) across years and fields followed the trend but yield differences were not always statistically significant, but the trend was consistent over time. Rotational crops help break pest cycles, improve residue cover, and enhance soil moisture conditions going into the cotton season.

Cotton-Grain Sorghum	Cotton-Wheat	Continuous Cotton
3010 lbs Ac ⁻¹	2921 lbs Ac ⁻¹	2761 lbs Ac ⁻¹

3. Continuous cotton required the most irrigation:

Average irrigation applied to cotton differed by system. Rotations helped reduce irrigation demand without limiting the yield, improving overall system efficiency.

Cotton-Grain Sorghum	Cotton-Wheat (cotton phase)	Continuous Cotton (cotton phase)
13.4 in.	11.9 in.	11.8 in.

Why do rotations improve cotton performance?

- ✓ Residue and soil benefits: Sorghum and wheat leave more surface residue than cotton. Residue reduces soil evaporation, maintains temperature, and controls runoff and erosion, which reduces windblown sand damage and eliminates the need for sand fighting operations.
- ✓ Soil water dynamics: Better residue cover improves rainfall capture; improved infiltration helps store off-season moisture and more stable soil moisture early in the cotton season.
- ✓ Nutrient cycling: Sorghum and wheat residues decompose at a moderate rate, supporting nutrient availability, and rotations reduce long-term nutrient depletion seen in continuous cotton.
- ✓ Soil and climate considerations: Yield stability was strongest on clay loam soils. Sandy and loamy sand soils showed more yield variability due to lower water-holding capacity. Extreme drought years (e.g., 2011) led to sharp yield reductions across all systems. Rotations still helped moderate water stress, but cannot fully offset severe drought.

What does this mean for producer decision-making?

- ✓ Cotton-sorghum rotations offer the best balance of yield stability and water productivity.
- ✓ Cotton-wheat rotations also improve efficiency compared to continuous cotton.
- ✓ Continuous cotton increases irrigation demand and long-term soil stress
- ✓ Rotations are a practical, low-cost strategy for adapting to declining irrigation capacity.

Although not a part of this study, rotations to either sorghum or wheat are generally superior to using small grains as cover crops in an otherwise continuous cotton system. While small grain cover crop residues offer potential moisture retention benefits during the cotton season in irrigated fields, those small grains residues can deplete surface moisture needed for cotton emergence, especially under dryland conditions. Residue from sorghum and wheat tend to store more cotton-available moisture compared to simply having a small grain cover crop.

Citations:

Burke, J.A., Lewis, K.L., DeLaune, P.B., Cobos, C.J. & Keeling, J.W. (2022). Soil water dynamics and cotton production following cover crop use in a semi-arid ecoregion. *Agronomy*, 12, 1306.

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