Economic Team Update

Bridget Guerrero

Bill Golden

Donna McCallister

Andrew Wright

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Economic Budgets

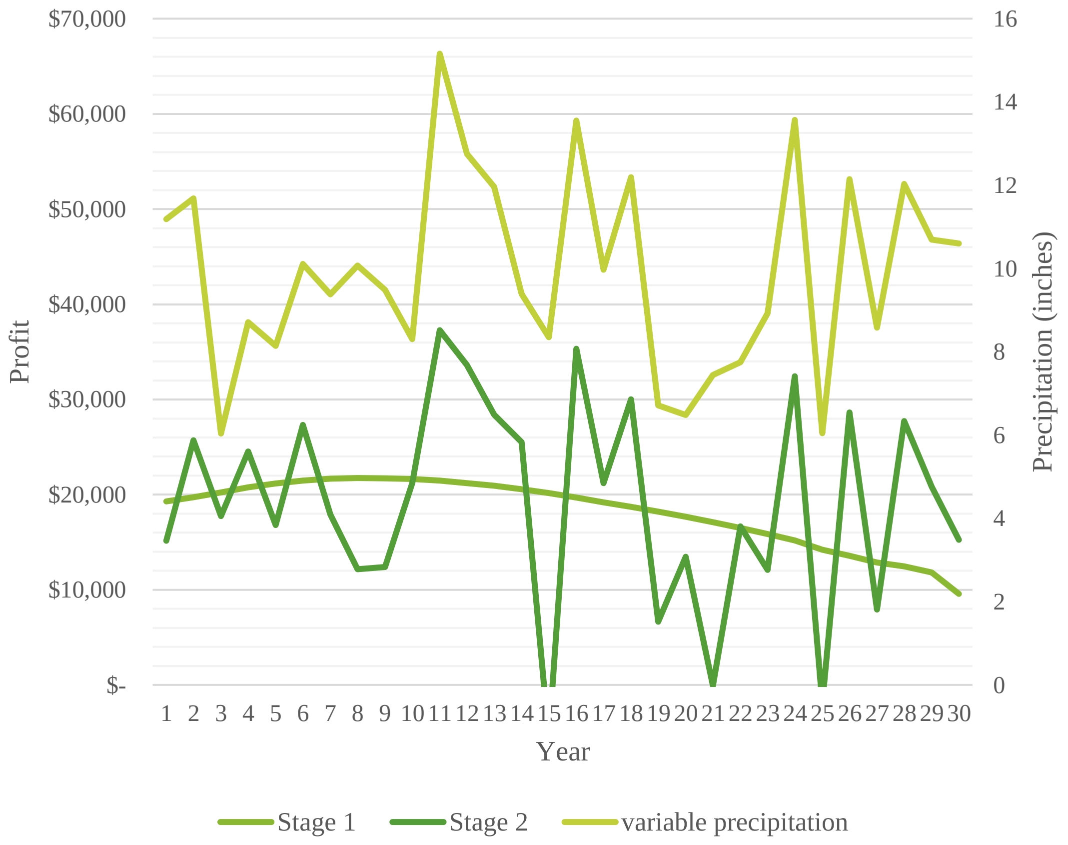
- Economic Budgets are used to provide baseline profitability
  - Historical costs and returns for irrigated cotton and irrigated corn were compiled from KSU Research and Extension crop budgets and Texas A&M AgriLife Extension budgets for Kansas and Texas
  - Data from agronomic field trials have been collected for previous years (2021-2023) from Objective 2 leaders and will be incorporated into economic budgets for comparison with extension reports and for developing production functions with DSSAT
  - **Make sure to send 2023 data**

Kansas Cotton Budget

Southwest Kansas Cotton Production Budget			
	5 Year Average (2019 - 2023)		
	Price	Quantity	Total
Income			
Cotton Lint	$0.75	1500	$1,125.00
Cotton Seed	$0.04	2025	$81.00
Total Income			$1,206.00
Direct Expenses			
Additional labor			$3.85
Crop consulting			$10.41
Crop insurance			$44.89
Custom Operation			$213.76
Diesel			$17.96
Fertilizers			$82.47
Herbicides			$49.90
Insecticides			$3.17
Irrigation energy (NG			$33.38
Irrigation labor			$4.83
Miscellaneous			$63.78
Operator labor			$8.90
Repair & Maintenance			$32.82
Seeds			$108.72
Interest on operating capital			$21.90
Total Direct Expenses			$700.74
Gross Profit			$505.26

Optimization Modeling

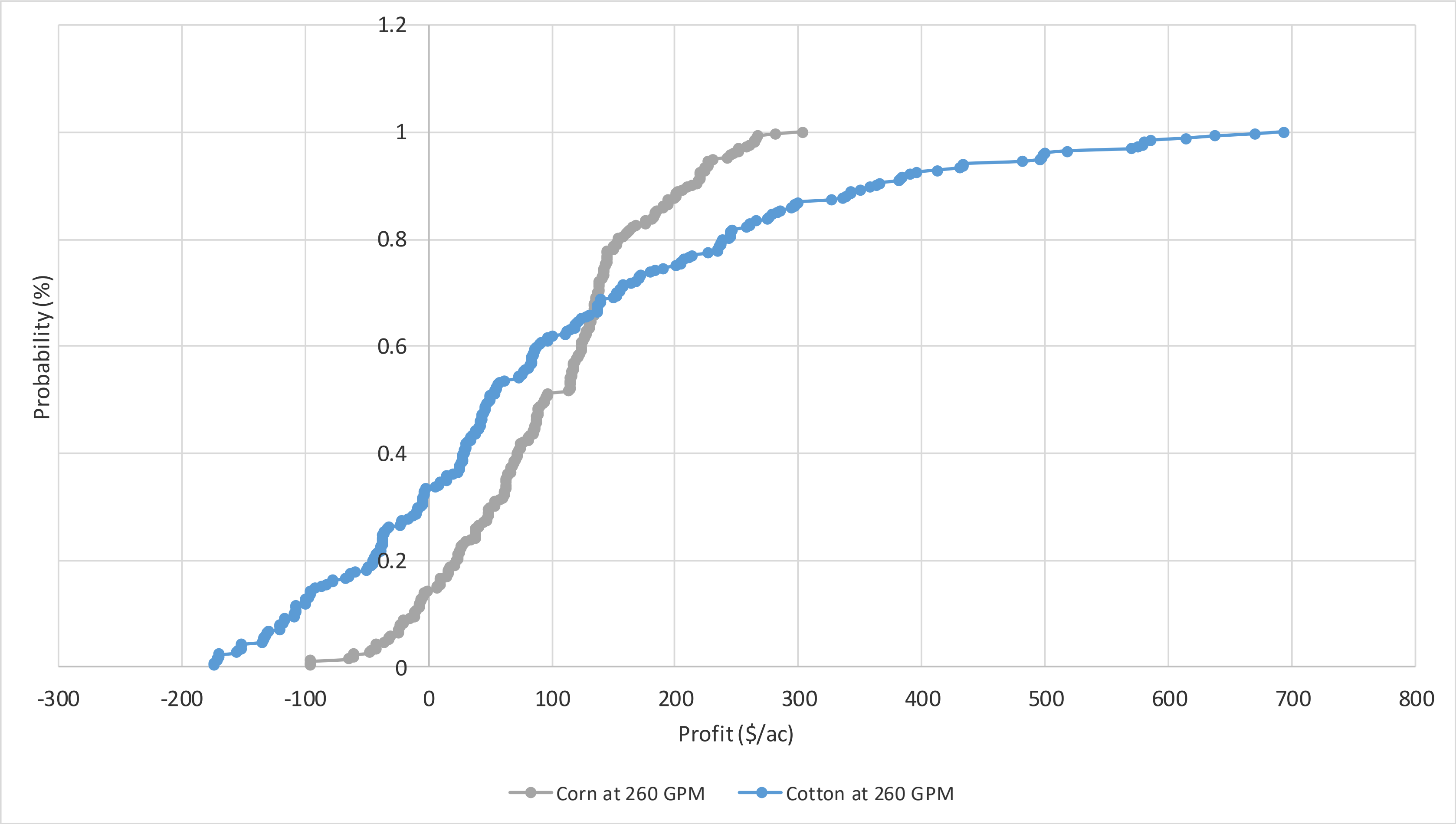
- Initial Results:
  - Two-stage integrated optimization model used to evaluate changes in crop mix, water availability, and profits for producers within Hartley County, Texas.
  - The integrated model incorporated changing agronomic, hydrogeological, and economic components.
  - In this model, optimization occurs in two stages. The stage one decision variable is the amount of acreage to plant to each crop to maximize profit based on average historical annual precipitation expected water availability. In stage two, the decision variable is the amount of irrigation water to apply based on the variable precipitation that may occur during the growing season. The model was developed using a general non-linear optimization package called 'Rsolnp' in RStudio (RStudio, 2020).



Risk Simulation

- A risk simulation model was created to compare cotton and corn production under three different well capacities (260, 470, and 780 GPM).
- DSSAT was used for the yield-water relationships and KSU Research and Extension crop budgets were used for costs and returns. Monte Carlo yield simulations were generated.
- Cumulative distribution functions (CDFs) are often used to evaluate risk. A CDF describes the probability that a random variable (profit for example) will be found at a value equal to or less than a given amount.

Cotton and Corn CDF at 260 GPM



Highlights

- This research suggests that:
  - With low capacity wells (260 GPM range), cotton generates 2.1% more profit than corn and uses 43.3% less groundwater than corn
  - With medium capacity wells (470 GPM range), cotton generates 18.0% more profit and uses 43.2% less groundwater than corn
  - With higher capacity wells (780 GPM range), cotton generates 51.6% more profit and uses 28.0% less groundwater than corn

- Assuming an equal distribution of these well capacities, this research suggests that:
  - Producers could shift from corn to cotton production and generate 30.8% more profit and use 26.6% less groundwater.
  - While cotton tends to be more profitable, it also tends to have more risk. This may be due to low yielding years that suffered from cool weather and had a reduction accumulated heat units.
  - The actual increase in profit and reduction in groundwater is dependent upon many factors including the rate of crop conversion by producers.

Optimization Modeling

- Production Functions
  - Develop a single equation cotton yield response function
  - Data (1961-2000) for the Kansas production functions was provided by Dr. Baumhardt using GOSSYM (Baumhardt et al. 2021). The functional form used is:

$$Yield_{Cotton} = \beta_0 + \beta_1 * TW + \beta_2 * TW^2 + \beta_3 * HU + \beta_4 * IRRIGATION\ CAPACITY$$

where $Yield_{cotton}$ is lint yield in kilograms per hectare, *TW* is total water (seasonal precipitation plus applied irrigation) in millimeters, *HU* is heat units in growing degree days Celsius degrees, and *IRRIGATION CAPACITY* is irrigation capacity in millimeters per day.

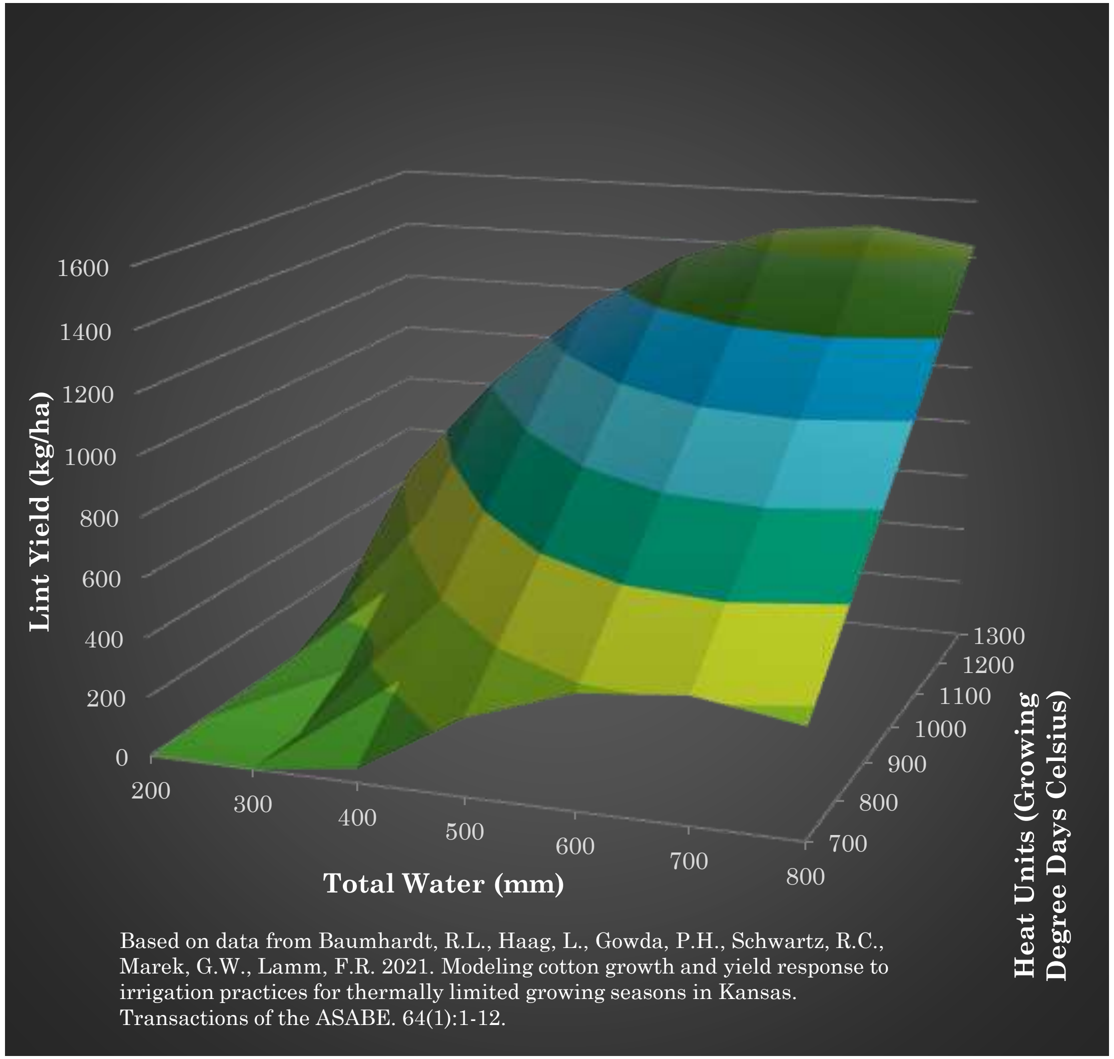
Regression Results

- The regression results generated an $R^2 = 0.643$, and the parameter estimates are reported in Figure 1.

Variable	Parameter Estimate	Pr > F
Intercept	-3039.48261	<.0001
TW	6.082	<.0001
TW^2	-0.00441	<.0001
HU	1.79829	<.0001
Irrigation Capacity	33.36007	0.172

- Note: The parameter estimate on irrigation capacity is not statistically different from zero. This should not be interpreted as meaning that irrigation capacity is not a determinant of crop yield, only that the effects of irrigation capacity is already incorporated into the model once seasonally applied irrigation is included in the *TW* variable. Baumhardt et al. (2021) also noted that irrigation capacity was not highly correlated with crop yield. Previous modeling with DSSAT data also supports this finding.

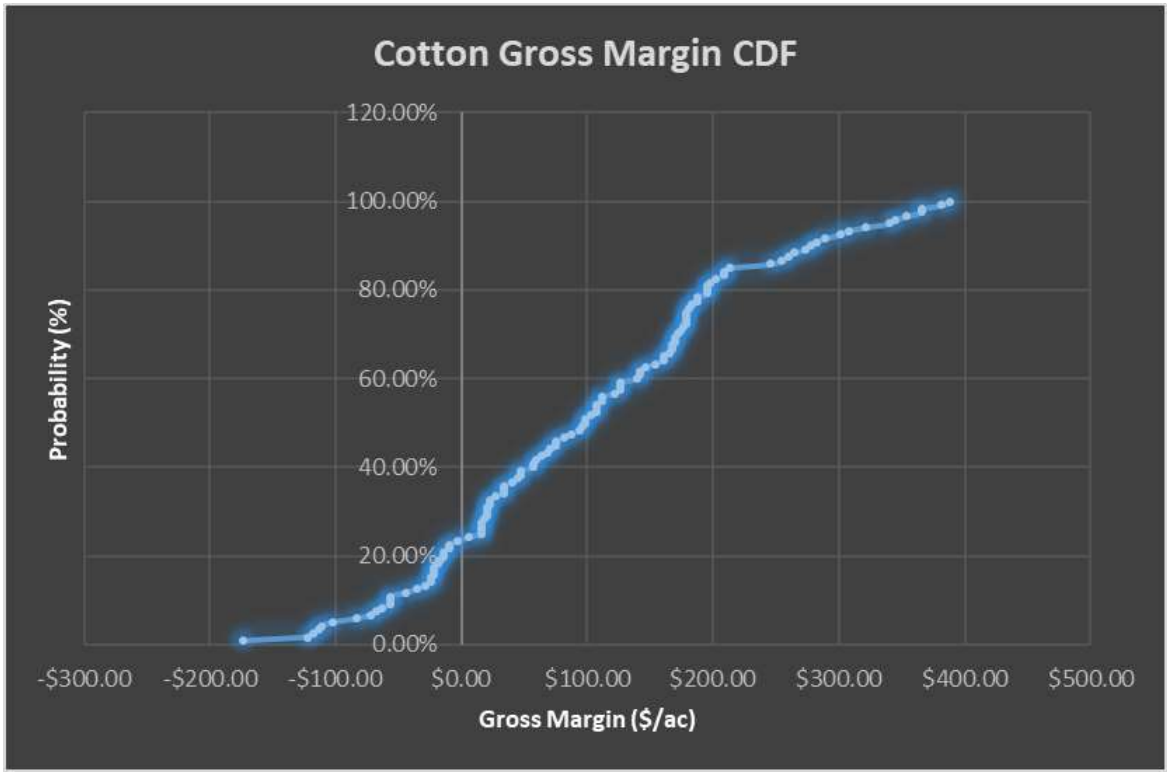
Cotton Production Function

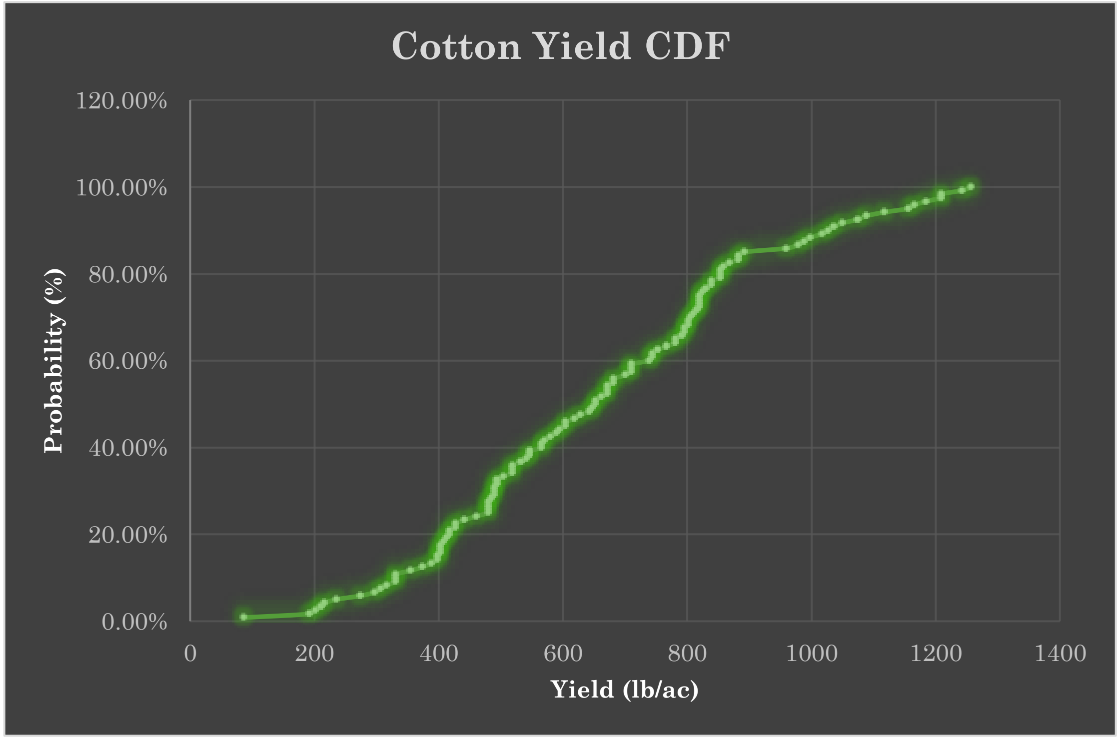


Validate Production Functions

- Incorporate field trial data from this project (2021-2023+)
- Duplicate the above analysis with DSSAT data which was previously obtained and discussed
- With assistance from Dr. Baumhardt, we will scale this production function to field trial data (to correct for variety improvements and fertilizer application)
- Ensure the impact of heat units coincides with USDA cotton variety data trials across the US, identifying regional trends.
- This same analysis will be done for Texas using Bushland data.
- Convert to English units.

Kansas Cumulative Distribution Functions (CDF)





Impact of Growing Degree Days on Cotton Yield Across the US

- A mixed-level econometric analysis was performed on USDA variety trial data from across the cotton belt to analyze the impact of GGD on yield in 15 states from 1980-2020.
- Initial results indicate year, day length, rainfall, short wave radiation, max temp, water vapor pressure are statistically significant.
- Progress being made, analysis not completed.

Insurance Simulation

- Completed work:
  - RMA Summary of Business files obtained for both coverage and type, practice and unit.
  - Building a model in Simetar with both yield and revenue options.
  - Ready to run as soon as historical yields are incorporated.

Regional Economics

- Examine the rural economic impact of cotton production
- IMPLAN:
  - Subscription has been purchased and data obtained for Texas
  - Kansas data will be obtained by September 2024
- GeoDa to analyze spatial dependence of cotton production on locational factors, such as availability of inputs and ginning. County Business Patterns data.

Future Direction

- Refine/modify/expand the GOSSYM data.
- Duplicate production function analysis with DSSAT data.
- Continue work to incorporate crop insurance indemnity payments into the model.
- Incorporate the above data into an economic dynamic intertemporal allocation model.
  - Kansas Geological Survey is currently developing a revised MODFLOW model which should be available in 2024. The intention is to incorporate our economic data into their hydrologic results in a fashion similar to Golden and Guerrero (2017).
- Evaluate Regional Economics of increased cotton production in Texas and Kansas.

Thank you!