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Research and Extension

PROJECT UPDATE REPORT: Water Conservation through Irrigated Cotton Production

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Executive Summary
The Ogallala Aquifer continuously show declining water levels across Western Kansas. Cotton was identified as one of the crops that show promising net returns to producers under constrained water resource. In response, cotton research was initiated in Garden City, the northern border of the typical cotton production area. Initial results show that with specific seed varieties and strategic irrigation management, cotton could be grown and get decent yield in this region. There are still some research needs particularly with regards germination and seeding rates, and the corresponding economic returns from these variable inputs.

Introduction
Irrigated cotton production has been predominantly centered in the Texas Panhandle. In the past several years, the production area has been moving north and into the Southwest corner of Kansas. New improved varieties and the drought-tolerant characteristics of the cotton are two major reasons for this expansion in acreage. In particular, short/early season varieties and tolerance to herbicide drift (e.g. 2,4-D choline, glyphosate and glufosinate herbicides). The objective of this study was to test if irrigated cotton would thrive North and outside of the typically cotton production area and if it did, test its response to different planting dates and irrigation treatments.

Experimental Procedures
An experiment conducted at the Kansas State University Southwest Research-Extension Center's Finnup Farm (38º01'20.87"N, 100º49'26.95"W, elevation of 2,910 feet above mean sea level) near Garden City, KS. The soil at the study site is a deep, well-drained Ulysses silt loam with water holding capacity of 2 in./ft. Two planting dates were evaluated each with at least 10 days apart and centered around May 15th whenever the soil temperature is above 65F. Phytogen 210 cotton variety was planted for both years. Previous crops for the plots were either corn, grain sorghum or wheat stubble. The plot treatments were five irrigated (full, 60% ET, 30% ET, 1 inch at match head square (MHS), and 1 inch at MHS and another inch at boll formation) and one dryland in a randomized complete block replicated at least 3 times. Irrigation was applied using a linear move sprinkler system (Model: Valley 8000 series, Valmont Industries, Inc., Valley, Nebraska) with four spans and each span serving as a replicate. Each irrigation event

applied 1 in. for all treatments irrigated on a given day, and irrigation treatments were based on frequency and soil water monitoring. Harvest was done using a 4-row mechanical cotton stripper and the samples were sent to Fiber and Biopolymer Research Institute in Texas for fiber analysis.

Using data from Prof. Dan O'Brien, agricultural market analyst and from other publications, cotton and corn production and cash flow functions were generated and compared.

Results and Discussion

In 2019, only the later planted plot (May 30th) was continued since the earlier planted plot (May 15th) had a very low germination rate (<10%) and was abandoned. One of the most likely reason for the low germination rate is the weather condition after planting, where the temperature dipped below 50^{o}F for several days. The germination rate at the later planted plot was 43%. In 2020, the conditions were flipped, this time the germination rate of the earlier planted plot was better (53%) than the later planted plot (39%).

Results show that there are no significant differences in the lint value, lint yield and other yield parameter across the different irrigation treatments, including dryland (Tables 1 and 2). However, there are notable numerical differences in some treatments. Fully irrigated cotton does show a diminished yield compared with other treatments. On the other hand, the strategic irrigation of one inch at match head square does show a consistently higher yield and lint value against other treatments.

Total soil water measurements show that there was an aggressive use of water for the whole profile (Figure 1). By harvest time, there was any noticeable differences in available soil water across treatments. There is a strong correlation between water productivity and lint yield as show in Figure 2c. A much stronger correlation exists between water use efficiency and lint yield (Figure 2d). In both cases, the higher the productivity and efficiency, the higher lint yield.

From the production and cash flow functions, there is evident advantage in growing cotton compared to corn under limited irrigation scenario. At the least, this will be a good option for crop rotation in some fields.

Thus, going back to the objectives, it could be concluded that irrigated cotton can be grown in this region. Since the planting window for cotton is very narrow in this region, planting issues, such as the optimum condition and emergence rate needs to be fine-tuned. Based on this initial research, the emergence rate is very which is less than 50% (36% if we include the failed plots).

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Acknowledgments

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Results

Table 1. Irrigation treatment averages on irrigation amount, loan average, lint yield, Micronaire, and lint value cotton lint yield in 2019.

Treatments	Total Irrign. (in)	Loan Avg. ($'s/lb)	Lint Yield (lb/ac)	Average of MIC	Lint Value ($/ac)
Fully Irrigated (100% ET)	5	0.36	658	2.61	238
Partially Irrigated (66% ET)	4	0.41	845	2.87	344
Limited Irrigated (33% ET)	1	0.48	1,061	3.46	507
Dryland	0	0.48	787	3.67	379
One Irrigation (1.00 in.) at Match Head Square Only	1	0.45	902	3.28	408
One irrigation (1.00 in.) at Match Head Square and at Boll Formation	2	0.41	820	2.89	334
Average		0.43	845	3.13	368

Table 2. Water treatment effect on cotton lint yield, water productivity, irrigation water use efficiency (IWUE), Micronaire, loan value, and lint value in 2020.

Factors	Micronaire	Lint yield	Productivity	IWUE	Loan Value	Lint Value
Water Treatments	Mass/ Length	lb/ac	lb/ac-in		$/lb	$/ac
1. 100% ET	2.2	638.7	62.3	851.5	0.3	195.0
2. One irrigation M & B	2.2	735.4	71.8	980.5	0.3	220.9
3. 66% ET	**2.1**	**387.7**	**39.2**	**516.9**	**0.3**	**115.7**
4. One Irrigation M Only	2.4	766.6	82.1	1022.2	0.4	292.4
5. 33% ET	**2.2**	**434.3**	**46.9**	**579.0**	**0.3**	**130.2**
6. Dryland	2.4	683.9	81.5	-	0.4	290.6
HSD[1]	NS	NS	NS	NS	NS	NS
Type 3 test						
Pr > F	0.3912	0.5886	0.5759	0.2623	0.4511	0.5326

[1]HSD is minimum difference between two treatments used to declare they are significantly different using Tukey’s Honest Significant Difference Test at $p<0.05$.

Bold treatments and numbers shows results that are relatively low, even though the statistical test show no significant difference.

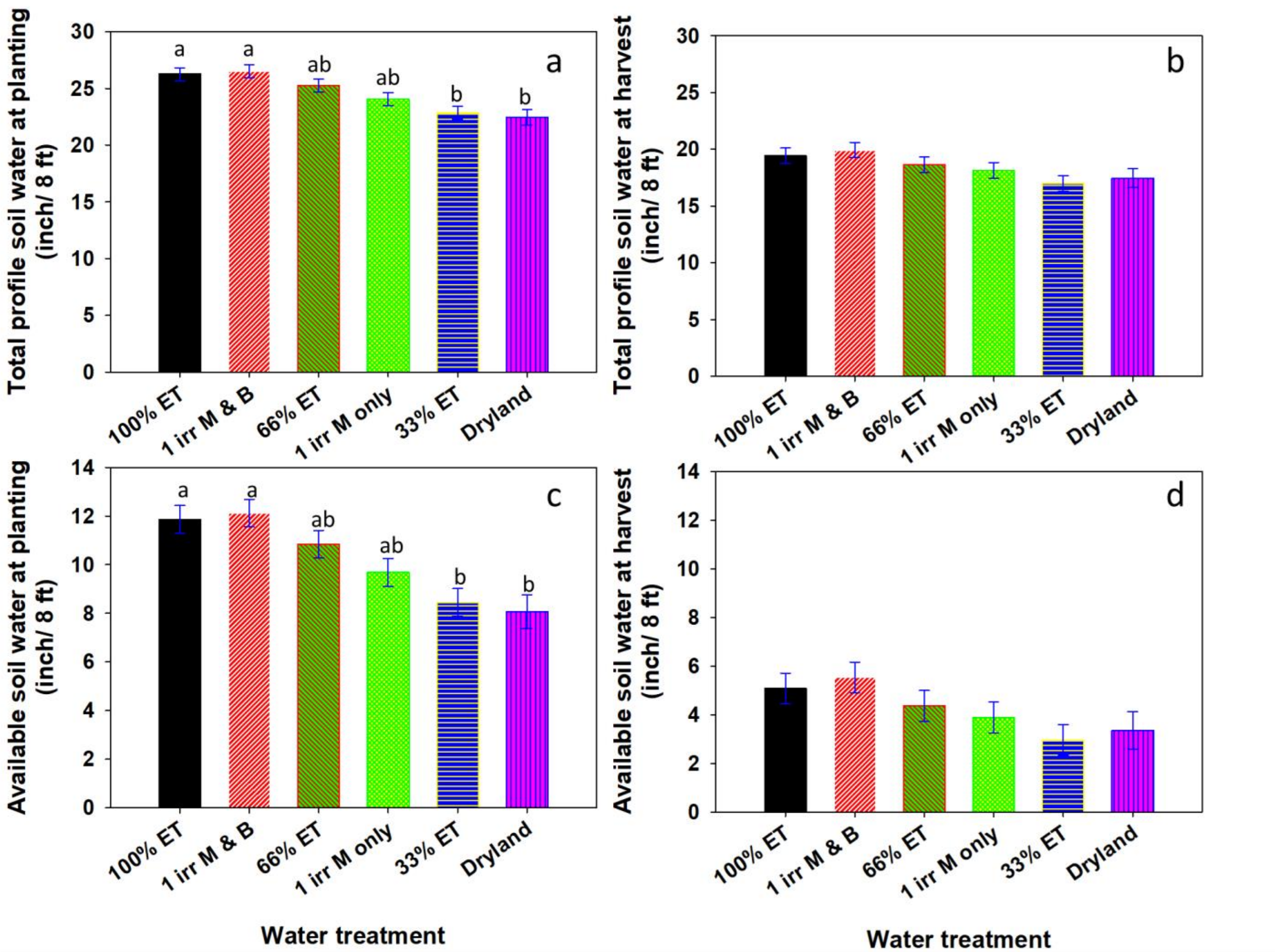

Figure 1. Total soil water (a) at planting and (b) at harvest; and available soil water (c) at planting and (d) at harvest of cotton across water treatments. Error bars are standard errors and bars with the same letter or no letter are not significantly different (P<0.05).

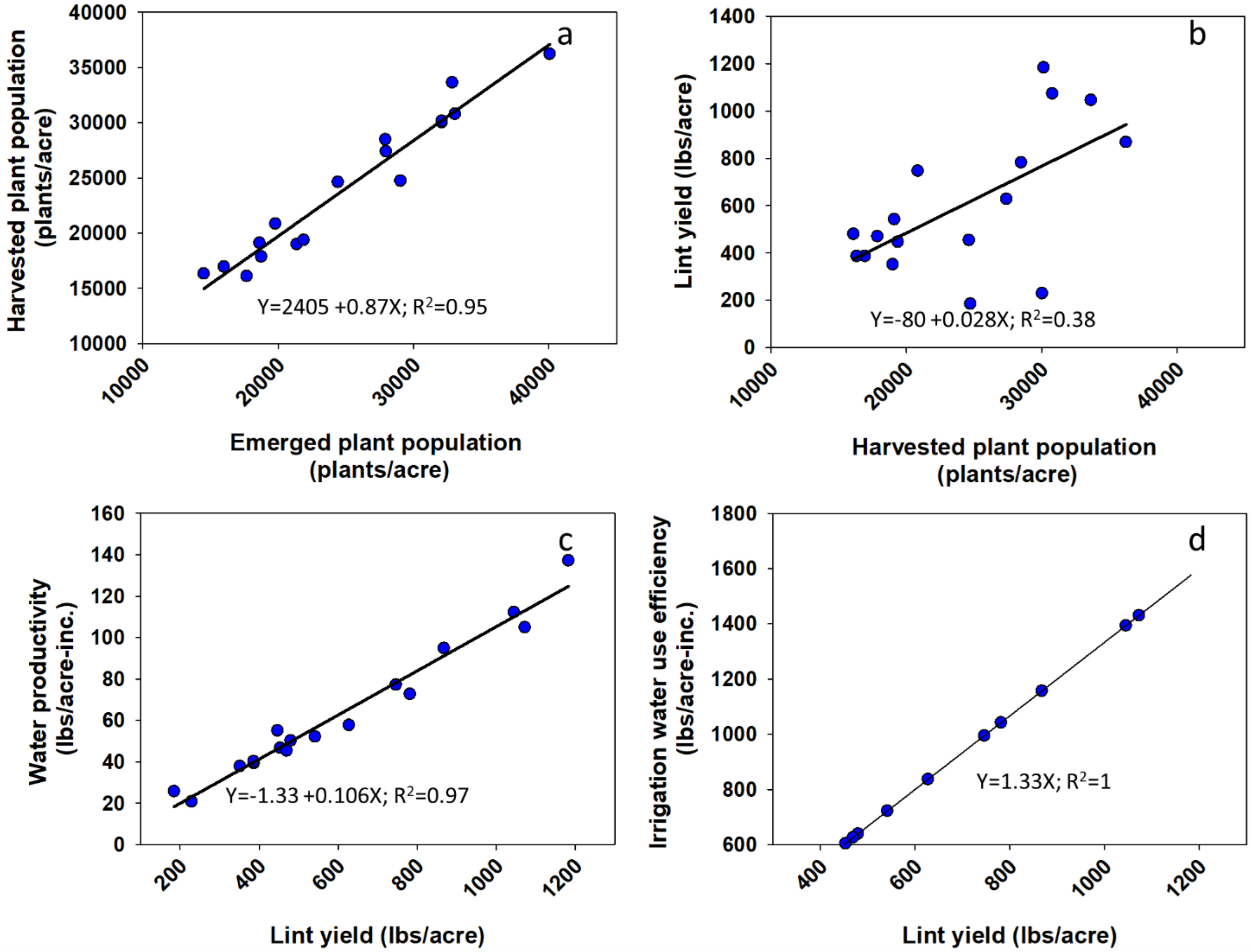

Figure 2. Simple linear relationships between (a) emerged plant population and harvested plant population, (b) harvested plant population and lint yield, (c) lint yield and productivity, and (d) lint yield and irrigation water use efficiency.

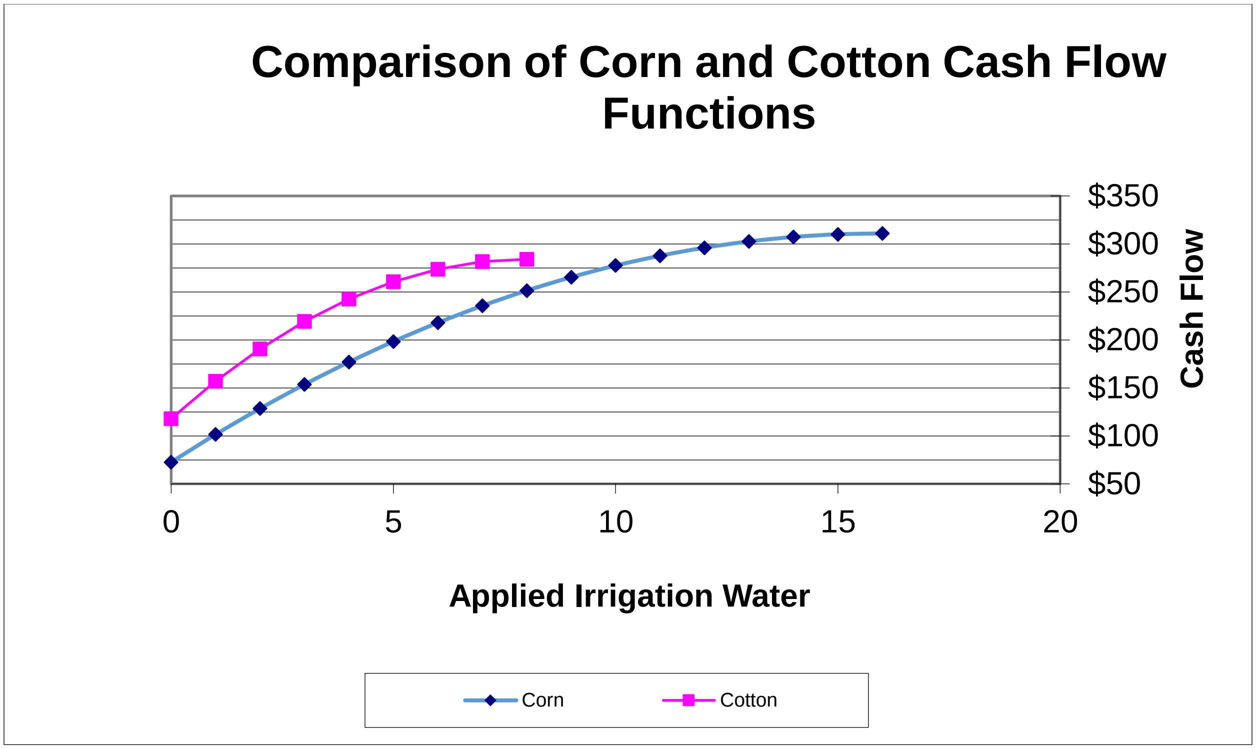

Figure 3. Initial cash flow function for cotton compared to corn in relation to applied irrigation water.