

ECONOMIC EVALUATION OF LIMITED IRRIGATION PRODUCTION STRATEGIES ON THE SOUTHERN HIGH PLAINS OF TEXAS

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Abstract

Crop production on the Southern High Plains of Texas relies on groundwater drawn from the Ogallala Aquifer at rates greater than recharge. Agricultural water rules related to pumpage restrictions in addition to improving water use efficiency have been enacted on the Southern High Plains of Texas in order to manage groundwater resources. The reality of decreased water availability, whether by aquifer depletion or water district regulations, makes the assessment of economic viability regarding production practices imperative for irrigated crop producers as they weigh options to sustain their operations for the future. Dryland production of cotton on the Southern High Plains of Texas encompasses approximately 1.8 million acres (Texas Agricultural Statistics Service, 2005). On the more productive 2.4 million irrigated acres, the ability to maintain the greater production relies heavily on available groundwater. Irrigated crop rotations have shown potential economic advantages over continuous cotton production in previous studies (Segarra et al., 1991; Blackshear and Johnson, 2003).

This study conducted an economic analysis comparing continuous cotton production and cotton-grain sorghum rotation with emphasis on irrigation capacity and crop rotation (continuous cotton and cotton-sorghum rotations). Field experiments were conducted at the Texas AgriLife Research facility at Halfway, Texas from 2001-2008. Both production systems were irrigated according to three irrigation strategies. Many producers may soon face new management decisions to meet water district regulations and can be assisted by decision tools developed from this study. This study concluded that under current commodity prices and water cost, continuous cotton production was the economically preferred crop production system compared with a cotton-sorghum rotation.

Introduction

Crop production on the Southern High Plains of Texas relies on groundwater drawn from the Ogallala Aquifer at rates greater than recharge. Agricultural water rules related to pumpage restrictions in addition to improving water use efficiency have been enacted on the Southern High Plains of Texas in order to manage groundwater resources. The reality of decreased water availability, whether by aquifer depletion or water district regulations, makes the assessment of economic viability regarding production practices imperative for irrigated crop producers as they weigh options to sustain their operations for the future. Rotations have provided biodiversity (Francis and Clegg, 1990) and sustainability (Parr et. al., 1990) particularly in semi-arid regions (Howell et al., 2004). This study sought to determine whether rotations could provide an economic advantage in tandem with an established biological advantage.

Cotton-grain sorghum rotations are not uncommon on the Southern High Plains of Texas. However, continuous cotton production is the prevalent cropping system. Sorghum production in this region tends to be considered a “catch crop”, meaning it is typically planted when the primary crop, cotton, fails to mature usually due to adverse weather. This is also generally contingent on the producer anticipating that sorghum production would be financially advantageous, such as when sorghum prices are expected to be high. This study verifies this shift and analyzes when the shift occurs under different irrigation and price scenarios.

Materials & Methods

Data were collected at the Texas AgriLife Research facility at Halfway, Texas from 2001-2008. Irrigation was supplied using a center-pivot and Low Energy Precision Application (LEPA) techniques. The two cropping systems produced were continuous cotton and a 2:1 cotton-grain sorghum rotation. The rotation system was two years of cotton production followed by one year of grain sorghum production in a three year cycle. Each harvest cycle was

assigned one of the following identifiers: CCC (continuous cotton production), CCS (cotton production following a year of grain sorghum production), CSC (cotton production following a year of cotton production and a year prior of grain sorghum production), and SCC (grain sorghum production following two consecutive years of cotton production).

Both production systems were irrigated according to one of the three following irrigation strategies: 0 gpm/ac, 1.25 gpm/ac, and 2.5 gpm/ac. These strategies simulated dryland, reduced irrigation capacity, and normal irrigation capacity, respectively. The average irrigation water applied in season was 0 acre inches for the 0 gpm/ac irrigation treatment, 5.69 acre inches for the 1.25 gpm/ac irrigation treatment, and 10.35 acre inches for the 2.5 gpm/ac irrigation treatment. Pertinent data collected annually from the aforementioned treatments included the following: harvest year, block number, average yield within a block, loan value, 2008 loan value, and irrigation applied in season (from May 31st to August 27th).

Price and cost information from 2008 was used to determine cotton price, grain sorghum price, and irrigation cost. The assumed cotton price \$0.6305 per pound, which was \$0.10 above the average loan value of \$0.5305 per pound. The assumed grain sorghum price was \$6.75 per hundred-weight and irrigation cost was assumed to be \$8.86 per acre-inch. Yield information per acre was multiplied by the respective crop price to determine the crop value per acre. Irrigation applied in season was multiplied by the irrigation cost to determine seasonal irrigation cost per acre. The crop value per acre was then subtracted by the irrigation cost per acre and direct expenses for each respective production cycle to determine returns above direct expenses. Direct expenses were found using 2008 Texas Crop Budgets for Texas Extension District 2 (Texas AgriLife Extension Service, 2008).

Returns above direct expenses for CCS, CSC, and SCC were combined annually to create a Rotation production system. These annual returns were then averaged for CCC and Rotation production systems to create 2001-2008 system values. By calculating these system values, returns above direct expenses for CCC were then compared to the returns above direct expenses for "Rotation". Results for calculations of returns above direct expenses are provided in the results section of this paper.

Sensitivity analyses regarding price fluctuation established the point at which the rotation production system was economically preferred over continuous cotton production. Three scenarios were examined regarding price movement. First, the scenario of reduced cotton prices was examined and the results are provided in Table 2. Second, the scenario of increased grain sorghum prices was examined and the results are provided in Table 3. Third, the scenario of simultaneously reduced cotton prices and increased grain sorghum prices was examined and the results are provided in Table 4.

Results & Discussion

Table 1 contains the returns calculated under the assumed prices, irrigation costs, and direct expenses associated with each production system. This table shows that continuous cotton production was the economically preferred production system for each of the irrigation treatments. The table also provides the difference in returns between the continuous cotton production and a cotton-grain sorghum rotation. The difference in returns under the 1.25 gpm/ac irrigation treatment, \$28.10, is the smallest of the three irrigation treatments because the marginal physical product is increasing at an increasing rate between the two treatments. This also indicated that the 1.25 gpm/ac treatment would be the first to switch preference when analyzing price variations, which are shown in Table 2, Table 3, and Table 4.

Table 1. Economically preferred production system under assumed prices and costs.

Irrigation treatment	Average irrigation water applied (acre inch)	Production System	Average returns above direct expenses (\$/acre)	Difference from the CCC system
0 gpm/ac	0.00	CCC	62.27	
	0.00	Rotation	29.42	-32.85
1.25 gpm/ac	5.65	CCC	162.21	
	5.72	Rotation	134.11	-28.10
2.50 gpm/ac	10.33	CCC	342.77	
	10.37	Rotation	255.44	-87.33

Table 2 shows the point to which cotton prices would have to be reduced for the cotton-grain sorghum production system to be economically preferred over continuous cotton production. It should be noted that all prices provided to obtain a switch in preference are below the average cotton loan price of \$0.5305/lb. The 1.25 gpm/ac irrigation treatment was the first to switch preference to the cotton-grain sorghum production system at a cotton price of \$0.4795/lb, approximately a 24% decrease from the assumed average cotton price of \$0.6305/lb. The 2.5 gpm/ac irrigation treatment was the second to switch preference to the cotton-grain sorghum production system at a cotton price of \$0.3725/lb, approximately a 41% decrease from the assumed average cotton price of \$0.6305/lb. The 0 gpm/ac irrigation treatment was the last to switch preference to the cotton-grain sorghum production system at a cotton price of \$0.3550/lb, approximately a 44% decrease from the assumed average cotton price of \$0.6305/lb.

Table 2. Economically preferred production system under reduced cotton prices.

Irrigation treatment	Production System	Average returns above direct expenses (\$/acre)	Cotton price \$0.4795/lb (down 24%)	Cotton price \$0.3725/lb (down 41%)	Cotton price \$0.3550/lb (down 44%)
1.25 gpm/ac	CCC	162.21	40.20	- 46.26	- 60.40
	Rotation	134.11	40.29	- 26.20	- 37.07
2.50 gpm/ac	CCC	342.77	165.04	39.10	18.51
	Rotation	255.44	129.00	39.40	24.75
0 gpm/ac	CCC	62.27	5.80	- 34.22	- 40.77
	Rotation	29.42	- 9.04	- 36.29	- 40.75

Table 3 shows the point to which grain sorghum prices would have to increase for the cotton-grain sorghum production system to be economically preferred over continuous cotton production. The 1.25 gpm/ac irrigation treatment was the first to switch preference to the cotton-grain sorghum production system at a grain sorghum price of \$9.65/cwt, approximately a 43% increase from the assumed grain sorghum price of \$6.75/cwt. The 2.5 gpm/ac irrigation treatment was the second to switch preference to the cotton-grain sorghum production system at a grain sorghum price of \$11.95/cwt, approximately a 77% increase from the assumed grain sorghum price of \$6.75/cwt. The 0 gpm/ac irrigation treatment was the last to switch preference to the cotton-grain sorghum production system at a grain sorghum price of \$17.20, approximately a 155% increase from the assumed grain sorghum price of \$6.75. The change in grain sorghum price (Table 3) was proportionately larger than the change in cotton price (Table 2) because of the inherent ratio of the cotton-grain sorghum production system, which was a 2:1 ratio. Thus, changes in cotton price have a larger impact than changes in grain sorghum price.

Table 3. Economically preferred production system under increased grain sorghum prices.

Irrigation treatment	Production System	Average returns above direct expenses (\$/acre)	Grain sorghum price \$9.65/cwt (up 43%)	Grain sorghum price \$11.95/cwt (up 77%)	Grain sorghum price \$17.20/cwt (up 155%)
1.25 gpm/ac	CCC	162.21	162.21	162.21	162.21
	Rotation	134.11	162.23	184.53	235.44
2.50 gpm/ac	CCC	342.77	342.77	342.77	342.77
	Rotation	255.44	304.21	342.90	431.20
0 gpm/ac	CCC	62.27	62.27	62.27	62.27
	Rotation	29.42	38.54	45.78	62.30

Table 4 shows the point to which cotton prices would have to decrease and grain sorghum prices would have to increase for the cotton-grain sorghum production system to be economically preferred over continuous cotton production. The percentage change in both prices was shifted in equal proportion. The 1.25 gpm/ac irrigation treatment was the first to switch preference to the cotton-grain sorghum production system at a cotton price of \$0.5335/lb and a grain sorghum price of \$7.79/cwt, approximately a 15% decrease from the assumed cotton price of \$0.6305/lb and a 15% increase from the assumed grain sorghum price of \$6.75/cwt. The 2.5 gpm/ac irrigation treatment was the second to switch preference to the cotton-grain sorghum production system at a cotton price of \$0.4622/lb and a grain sorghum price of \$8.55/cwt, approximately a 27% change from assumed prices. The 0 gpm/ac irrigation treatment was the last to switch preference to the cotton-grain sorghum production system at a cotton price of \$0.4149/lb and a grain sorghum price of \$9.05/cwt, approximately a 34% change from assumed prices.

Table 4. Economically preferred production system under reduced cotton prices and increased grain sorghum prices.

Irrigation treatment	Production System	Average returns above direct expenses (\$/acre)	Cotton price \$0.5335/lb Grain sorghum price \$7.79/cwt (15% change)	Cotton price \$0.4622/lb Grain sorghum price \$8.55/cwt (27% change)	Cotton price \$0.4149/lb Grain sorghum price \$9.05/cwt (34% change)
1.25 gpm/ac	CCC	162.21	83.83	26.22	- 11.99
	Rotation	134.11	83.92	46.99	22.45
2.50 gpm/ac	CCC	342.77	228.60	144.68	89.01
	Rotation	255.44	191.71	144.79	113.59
0 gpm/ac	CCC	62.27	25.99	- 0.67	- 18.36
	Rotation	29.42	7.99	- 7.78	- 18.25

Figures 1 and 2 represent cotton and grain sorghum marketing year average (MYA) prices for 1965 – 2008 (National Agricultural Statistics Service, 2008) and the trigger prices for the 1.25 gpm/ac irrigation treatment under a cotton price of \$0.5335/lb (Figure 1) and a grain sorghum price of \$7.79/cwt (Figure 2). Figure 1 shows that the cotton price at \$0.5335/lb occurred often between the years 1975 and 2008. Figure 2 shows that the grain sorghum price of \$7.79/cwt did not occur between the years 1965 and 2008.

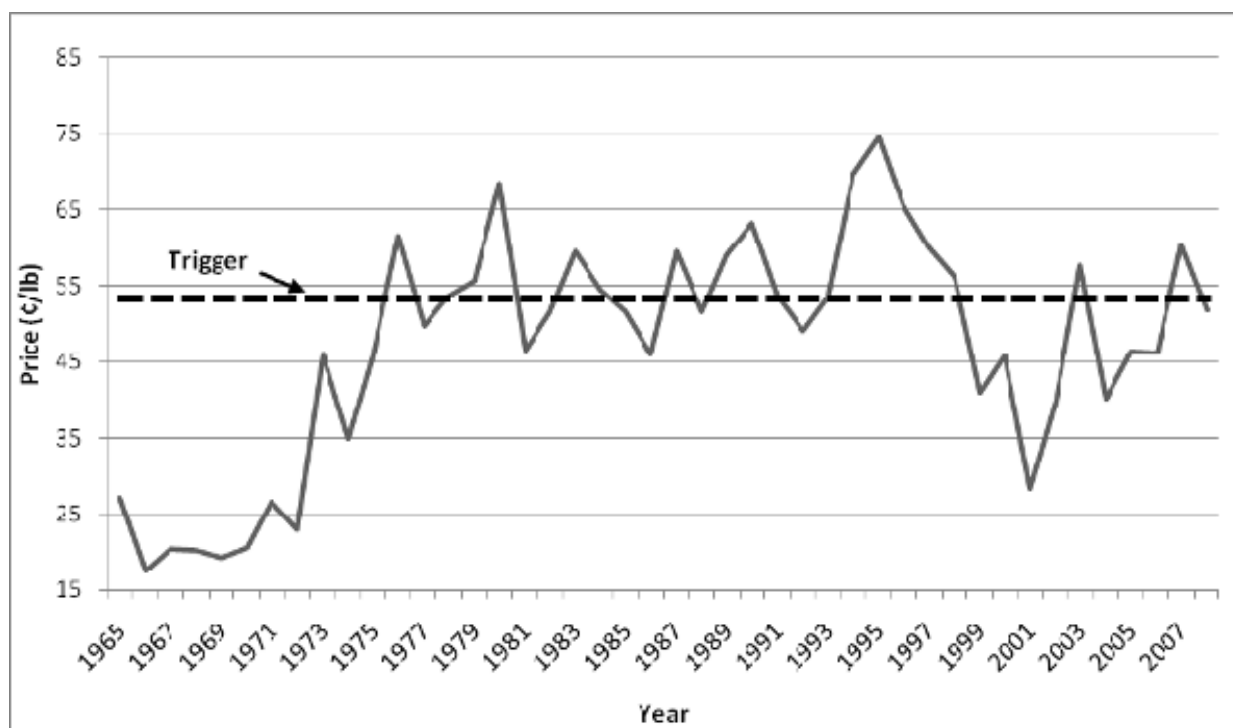


Figure 1. Historic cotton prices and trigger prices for 1.25 gpm/ac irrigation treatment.

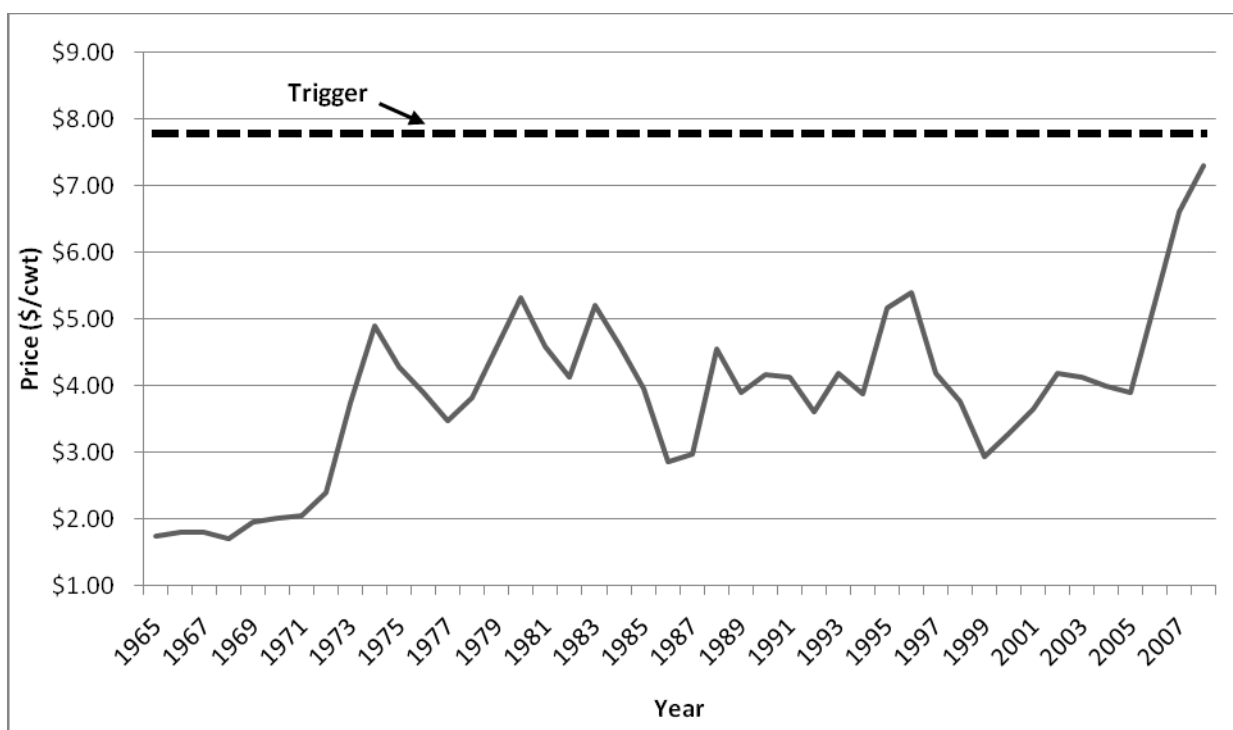


Figure 2. Historic grain sorghum prices and trigger prices for 1.25 gpm/ac irrigation treatment.

Conclusions

The intent of this study was to determine whether continuous cotton production or a cotton-grain sorghum rotation was economically preferred under all irrigation treatments, so that producers facing water usage restrictions can determine the best production strategy. In determining preference, this study verified several items observed on the

Southern High Plains of Texas. As water availability decreases, frequency of continuous cotton production increases. The results determined by this study show that under current prices and costs, continuous cotton production is economically preferred to a 2:1 cotton-grain sorghum rotation. The results of this study show that the producer who is faced with a limited water resource will be the first to switch to a cotton-grain sorghum rotation if cotton prices decrease or grain sorghum prices increase. This shows that grain sorghum production can be profitable, but is a second-best strategy when compared to continuous cotton. Under each scenario other than the aforementioned, cotton price would have to decrease below the current cotton loan price level to induce a switch in production system preference. This suggests that the cotton-grain sorghum production system could only be preferred if cotton prices fell below the current cotton loan price level.

For cotton-grain sorghum rotation to be economically preferred to continuous cotton production, cotton prices would have to decrease significantly below recent price ranges and grain sorghum prices would have to increase significantly above recent price ranges. Thus with current prices and direct expenses, continuous cotton production is economically preferred to cotton-grain sorghum rotation on the Southern High Plains of Texas.

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References

Blackshear, J. and P. Johnson. 2003. Profitability of Irrigated Cotton-Grain Sorghum Rotations in the Southern High Plains of Texas. In 2003 Proc. Beltwide Cotton Conferences, 474-480. Memphis, TN: National Cotton Council.

Francis, C.A., and M.D. Clegg. 1990. Crop rotations in sustainable production systems. pp.107-121. In: Sustainable Agricultural Systems, Soil and Water Conservation Society, Ankeny, IA.

Howell, T.A., Tolk, J.A., Baumhardt, R.L., Evett, S.R. 2004. Furrow irrigated cotton-sorghum rotation for the Texas northern plains. Agronomy Abstracts, ASA-CSSA-SSSA Annual Meeting, Seattle, Washington.

National Agricultural Statistics Service. 2008. USDA National Agricultural Statistics Service – Quick Stats [Online]. Available at http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/ (verified 15 December 2009) United States Department of Agriculture.

Parr, J.F., R.I. Papendick, I.G. Young, and R.E. Meyer. 1990. Sustainable agriculture in the United States. pp. 50-76. In: Sustainable Agricultural Systems, Soil and Water Conservation Society, Ankeny, IA.

Segarra, E., J.W. Keeling, and J.R. Abernathy. 1991. Tillage and Cropping System Effects on Cotton Yield and Profitability on the Texas Southern High Plains. *Journal of Production Agriculture* 4(4):566-571.

Texas Agricultural Statistics Service. 2005. 2004 Texas Agricultural Statistics. Austin, TX: United States Department of Agriculture, National Agricultural Statistics Service.

Texas AgriLife Extension Service. 2008. 2008 Texas Crop and Livestock Budgets: District 2 [Online]. Available at <http://agecoext.tamu.edu/resources/crop-livestock-budgets/by-district/district-2/2008.html> (verified 15 December 2009). The Texas A&M University System