B-1481
August 1984

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ACKNOWLEDGEMENTS

Several people gave unselfishly of their time in assisting in various phases of this study. To them we express our sincere appreciation. Particularly, Willis Gass, extension agronomist, Texas A&M University, significantly improved the manuscript through critical review and helpful suggestions . He is among those who encouraged the implementation of the Uniform Planting Date (UPD) cotton production system. The authors are also most grateful to Ray Frisbie, Mike McWhorter, and John Thomas, extension entomologists and Amanda Armstrong, extension agent-entomology(PM), Texas A&M University, for assistance in all aspects of this study. To Lanice Dupuis we express our appreciation for her diligence and patience in typing several drafts of this manuscript.

This work was supported in part by the U.S. Department of Agriculture with a grant to the Consortium of Integrated Pest Management administered through Texas A&M University. The findings, opinions, and recommendations expressed herein are those of the authors and not necessarily those of the U.S. Department of Agriculture.

ECONOMIC IMPLICATIONS OF A DELAYED UNIFORM PLANTING DATE FOR COTTON PRODUCTION IN THE TEXAS ROLLING PLAINS

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The Texas A&M University System
August 1984

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Introduction

Cotton is the major cash crop in the Rolling Plains Region of Texas. This has important economic implications for farmers, ginners and local communities. A high variability in cotton yields for the region is due to unpredictable and volatile fluctuations in temperature and rainfall, low soil fertility and incidence of insect pests. These production limiting factors generally result in relatively low cotton yields. Producers in this region are, therefore, very sensitive to costs of production.

Cotton production in the region prior to 1976 was threatened by increasing damage by the boll weevil, the key cotton insect pest in the region. Certain areas of the region had gone out of cotton production because insecticide application for control of boll weevils reduced predator and parasite populations resulting in increased damage from secondary insect pests such as bollworms, budworms, cabbage loppers and beet armyworms. As a result, production decreased while input use increased and the advantage of producing cotton with minimum inputs in the Rolling Plains was defeated (Boring).

To combat intense infestations of boll weevils and high costs of production, a delayed Uniform Planting Date (UPD) cotton production system, based on integrated pest management, had been recommended by area extension entomologists in the region since 1973. The entomologists suggested that if cotton planting was delayed in time and completed as uniformly as practical, weevils which emerged from overwintering at the usual time would not have fruiting cotton as a food source resulting in suicidal emergence. The weevils that survived in most years would be too few to cause economic damage. By the time populations did build up to damaging levels, most of the cotton crop would have already matured (Boring).

Uniform Planting Date Production System

Most producers in the Rolling Plains during the past 6-8 years have started planting their cotton on the Monday closest to May 20. However, producers in some counties of the region established even later planting dates. The beginning planting date has ranged from May 19 through June 1. The planting date is determined by the county crops committees in each county or by vote of producers at community meetings (Fuchs).

By controlling the boll weevil through a Uniform Planting Date, the need for boll weevil control during the growing season has been greatly reduced, e.g., weevils even in the heavily infested areas can now normally be controlled with just one well timed insecticide application. With less insecticide being used during the growing season, beneficial insect populations are left in the fields to aid with control of bollworms and other insect pests. In addition to reduced boll weevil damage and less insecticide use in the Rolling Plains, other observed advantages of delayed uniform planting for cotton are improved plant stand, reduced seeding rate, improved seedling vigor and less crop cultivation (Boring).

The UPD production system switches cotton planting from a conventional early planting date to a delayed Uniform Planting Date and uses scouting to determine the need for insecticide application. Thus, the delayed Uniform Planting Date may be considered as an improved production technology. This production system enables the cotton producer to reduce production inputs while increasing or maintaining yields compared with the conventional production system. The delayed UPD system enables cotton producers to reduce variable costs per unit of output by reducing insecticide, seed, labor and equipment costs. Although the majority of farmers in the region voluntarily adopted the UPD production system, peer pressure has been effective in bringing essentially 100 percent conformity.

Aggregate Issues

When widespread adoption of the UPD across vast acreages takes place, changes in cropping patterns, crop prices, producer profits and social welfare occur which make the economic analyses more complex. Because of the potential of a reduced price of cotton due to greater supply forthcoming through widespread adoption of a new system, consumers of cotton acquire substantial benefits. The effect of the supply shift on producers' income is less discernable than the effect on consumer and social welfare. Comparing producers' profit (returns to land) under the conventional and the new systems, if producer profits lost exceed producer profits gained then the impact on producers is negative and vice versa (Lacewell and Taylor).

The nature of the supply shift associated with a new technology is very uncertain. Nonparallel supply shifts can result in diminishing producers' profit. Increased production under the new system due to widespread adoption by producers may lower farm prices and the commodity price effect may more than offset the reduced costs and/or higher yields. Consequently, early adopters of the new system will have higher profits, but as more and more producers adopt, price will be negatively impacted. Then, producers must adopt the UPD technology just to remain economically viable. After most or all have adopted the system, profits to the group may be lower than with the old system. Of course, there may be differential profit impact on individual producers, i.e., producers who had serious pest problems with the old but not new system will gain, while others will lose (Lacewell and Taylor). It is assumed that the delayed UPD production system in the Texas Rolling Plains covers such a small region that any changes in cotton yield and production are sufficiently small so as to not affect market prices.

The purpose of this study was to estimate the economic impact of cotton production under the delayed Uniform Planting Date as it relates to yield, net returns and risk as measured by the coefficient of variation of net returns in the Texas Rolling Plains. The study was extended to a projection of the impact of the Uniform Planting Date cotton production system on the region and state.

Study Area

The study area included 27 counties of the Rolling Plains of Texas (Figure 1). In general, the Rolling Plains comprise an eastern section of

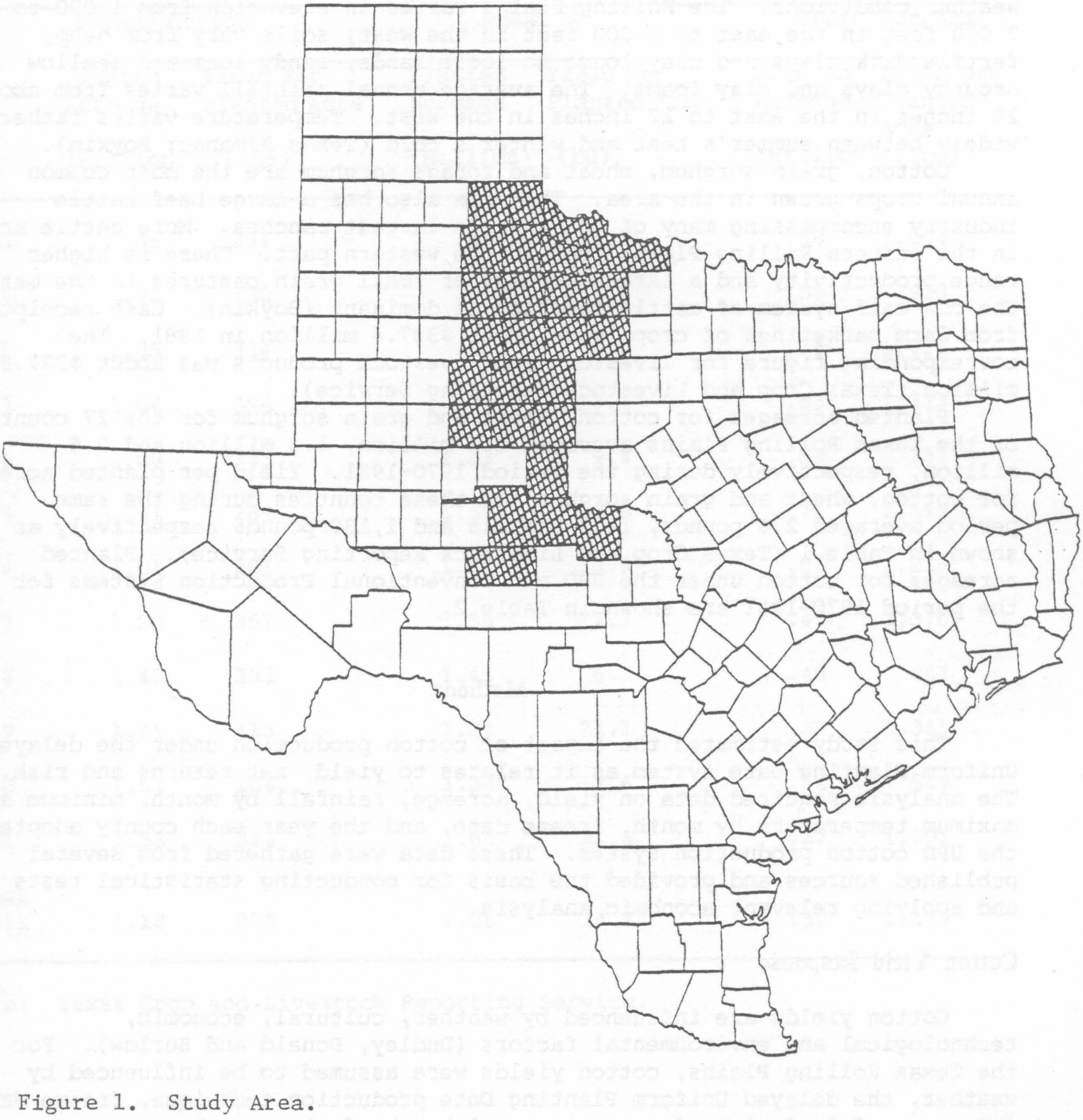

Figure 1. Study Area.

the Great Plains in Northwestern Texas. The area lies west of the North Central and Grand Prairie regions and extends from the edge of the Edwards Plateau in Tom Green County northward into Oklahoma. It includes about 24 million acres, with diversity in topography and soil type and varied weather conditions. The Rolling Plains varies in elevation from 1,000 to 2,000 feet in the east to 3,000 feet in the West; soils vary from deep, fertile dark clays and clay loams to loose sands, sandy loam and shallow drouthy clays and clay loams. The average annual rainfall varies from about 28 inches in the east to 22 inches in the west. Temperature varies rather widely between summer's heat and winter's cold (Texas Almanac; Boykin).

Cotton, grain sorghum, wheat and forage sorghum are the most common annual crops grown in the area. The area also has a large beef cattle industry encompassing many of the state's largest ranches. More cattle are in the eastern Rolling Plains than in the western part. There is higher range productivity and a larger acreage of small grain pastures in the east. The cow-calf system of cattle ranching is dominant (Boykin). Cash receipts from farm marketings of crops were about $387.4 million in 1981. The corresponding figure for livestock and livestock products was about $327.8 million (Texas Crop and Livestock Reporting Service).

Planted acreages for cotton, wheat and grain sorghum for the 27 counties of the Texas Rolling Plains averaged 1.2 million, 1.3 million and 0.6 million, respectively during the period 1970-1981. Yield per planted acre for cotton, wheat and grain sorghum for these counties during the same period averaged 276 pounds, 14.4 bushels and 1,139 pounds respectively as shown in Table 1 (Texas Crop and Livestock Reporting Service). Planted acreages for cotton under the UPD and Conventional Production Systems for the period 1970-1981 are shown in Table 2.

Methods

This study estimated the impact of cotton production under the delayed Uniform Planting Date system as it relates to yield, net returns and risk. The analysis required data on yield, acreage, rainfall by month, minimum and maximum temperature by month, freeze date, and the year each county adopted the UPD cotton production system. These data were gathered from several published sources and provided the basis for conducting statistical tests and applying relevant economic analysis.

Cotton Yield Response

Cotton yields are influenced by weather, cultural, economic, technological and environmental factors (Dudley, Donald and Burlow). For the Texas Rolling Plains, cotton yields were assumed to be influenced by weather, the delayed Uniform Planting Date production technique, freeze date and acres of land planted to cotton. Although factors such as cotton prices and technological changes (trend) can be important in affecting cotton yields, preliminary regression analysis indicated these factors to be not significant in the Texas Rolling Plains.

Weather greatly influences cotton yields. Cotton yield is susceptible to drought, excessive rainfall, and temperature extremes, especially freezing temperatures in the early fall. Insect damage and weather are also

Table 1. Planted Acreage and Yield per Planted Acre for Cotton, Wheat and Grain Sorghum for the 27 Counties of the Texas Rolling Plains, 1970-1981

	Upland Cotton		Wheat		Grain Sorghum	
Year	Planted Acreage (Million)	Yield Per Planted Acre (lbs)	Planted Acreage (Million)	Yield per Planted Acre (bu)	Planted Acreage (Million)	Yield per Planted Acre (lbs)
1970	.96	234	.83	16.5	.68	1,004
1971	.98	190	.87	2.8	.89	913
1972	1.05	334	.91	9.5	.78	1,095
1973	1.04	394	.92	17.1	.83	1,373
1974	1.00	173	1.23	9.4	.69	737
1975	.91	289	1.57	18.8	.71	1,599
1976	1.01	281	1.62	13.9	.66	1,216
1977	1.25	367	1.58	17.7	.45	1,370
1978	1.40	233	1.45	6.1	.46	847
1979	1.45	413	1.34	21.1	.37	1,345
1980	1.61	104	1.38	12.6	.32	549
1981	1.53	314	1.64	21.4	.27	1,801
Average 1970-81	1.18	276	1.28	14.4	.59	1,139

Source: Texas Crop and Livestock Reporting Service.

Table 2. Acres of Land Planted to Cotton Under the Uniform Planting Date and Conventional Production Systems, 27 Counties of the Texas Rolling Plains, 1970-1981

Year	UPD Cotton Acres	UPD Cotton Percent	Counties	Conventional Cotton Acres	Conventional Cotton Percent	Counties	Total Acres
1970	--	--	--	959,500	100	27	959,500
1971	--	--	--	982,850	100	27	982,850
1972	59,000	5.7	2	978,841	94.3	25	1,037,841
1973	60,000	5.8	2	976,550	94.2	25	1,036,550
1974	66,500	6.7	2	930,600	93.3	25	997,100
1975	206,400	22.8	8	700,000	77.2	19	906,400
1976	316,400	31.4	11	689,700	68.6	16	1,006,100
1977	916,900	73.2	18	335,100	26.8	9	1,252,000
1978	1,050,300	75.2	18	347,200	24.8	9	1,397,500
1979	1,112,032	78.4	21	306,800	21.6	6	1,418,832
1980	1,461,400	90.7	25	149,100	9.3	2	1,610,500
1981	1,525,800	100	27	--	--		1,525,800

related; for example, warm wet weather increase the likelihood of insect damage (Evans and Bell). For this study, monthly rainfall and maximum and minimum temperature observations were obtained from Texas climatological reports for the 27 counties of the Rolling Plains for the period 1970-1981. These rainfall and temperature observations were related to preplanting, growing, maturing and harvesting periods of cotton production.

In addition, observation for temperatures were recorded for the first fall minimum of 32°F to show the influence of the first freeze date on cotton yields. The freeze dates were numbered in an ascending order, 1,2,3,4 .... For example, the earliest date for the first fall minimum of 32°F was numbered 1 and the latest date was numbered 53, among the 27 counties for the 1970-1981 period.

One of the most important production techniques influencing cotton yields in the Texas Rolling Plains has been the delayed Uniform Planting Date. This production technique has been recommended as part of the boll weevil management program since the early 1970's. However, not all counties in the region adopted this technique simultaneously. Of the 27 counties studied, only two adopted the Uniform Planting Date in 1972. They are followed by six counties in 1975, three counties in 1976, seven counties in 1977, three counties in 1979, four counties in 1980 and the last two counties in 1981 (Table 2). For the analysis the Uniform Planting Date was included each year as a dummy variable -- 0's for counties that had not adopted the Uniform Planting Date and 1's for counties that had adopted the Uniform Planting Date. Least-squares regression was used to identify cotton yield response to the Uniform Planting Date production strategy. The general form of the cotton yield response function is as follows:

$$Y = b_0 + b_1 UPD + b_2 FRZDT + b_3 RAINL + b_4 RAIN + b_5 MAXT + b_6 MINT + b_7 COTAPL + e$$

where:

Y = cotton yield in pounds of lint per planted acre,
UPD = Uniform Planting Date dummy variable,
0 = counties not adopting UPD
1 = counties adopting UPD
FRZDT = first fall minimum temperature of 32°F,
RAINL = inches of aggregate rainfall for October, November and December lagged one year,
RAIN = inches of rainfall by selected months of the year,
MAXT = maximum temperature in F°, by selected months of the year,
MINT = minimum temperature in F°, by selected months of the year,
COTAPL = acres of cotton planted,
b_0 to b_7 = coefficients to be estimated,
e = random error term.

Annual data for the years 1970-1981 were used in the statistical estimation. Data were drawn from publication of the U.S. Department of Agriculture and Commerce and of the relevant state agencies (Texas Crop and Livestock Reporting Service, U.S. Department of Agriculture and U.S. Department of Commerce).

Budgeting Analysis. Per-acre crop enterprise budgets for cotton with the Uniform Planting Date and the conventional production strategies and grain sorghum were developed from published 1982 Texas Rolling Plains budgets and modified for the UPD cotton. These budgets provided the base data to estimate per-acre economic impacts. The data used to modify the published crop budgets for the region between the Uniform Planting Date and the conventional production strategies included the change in yield, cottonseed, and insecticide application.

Breakeven Analysis. Breakeven analysis was used to estimate the relative economic advantages of producing a particular crop from available crop alternatives. In essence, it is a method of comparing net revenues of alternative cropping options. The analysis was based only on variable costs and harvest costs since fixed costs were deleted from the net return equation.

The breakeven equations were applied by using the cost and yield data from crop enterprise budgets presented in Appendix B Tables 1, 2 and 3. The breakeven equations equate per-acre net returns between two enterprise budgets or two different management practices. In this study, breakeven prices and yields were estimated between grain sorghum and alternative cotton production practices such as grain sorghum compared to cotton produced using the delayed Uniform Planting Date strategy. In general, breakeven condition is satisfied by equation (1)

$$NR_g = NR_c \quad (1)$$

where:

NR_g = per-acre net returns from grain sorghum,
NR_c = per-acre net returns from cotton.

The net returns, ignoring fixed costs, for grain sorghum and cotton are respectively defined as

$$NR_g = (P_g - HC_g)Y_g - PHC_g$$

(2)

$$NR_c = (P_c^L + r_c P_c^S - HC_c)Y_c^L - PHC_c$$

where:

P_g = price per unit of grain sorghum,

HC_g = variable harvest costs per unit of grain sorghum,

Y_g = per-acre yield of grain sorghum,

PHC_g = per-acre variable pre-harvest costs for grain sorghum,

P_c^L = price per unit of lint cotton,

r_c = ratio of seed yield to lint yield for cotton,

P_c^S = price per unit of cottonseed,

HC_c = variable harvest costs per unit of cotton,

Y_c^L = yield per-acre of lint cotton,

PHC_c = variable pre-harvest cost per-acre for lint cotton.

By substituting equation (2) into equation (1) the breakeven condition is defined as:

$$(3) \quad (P_g - HC_g)Y_g - PHC_g = (P_c^L + r_c P_c^S - HC_c)Y_c^L - PHC_c$$

Equation (3) can be solved for breakeven prices (P_g, P_c^L) or yields (Y_g, Y_c^L).

Solving for breakeven price (P_g), equation (3) becomes,

$$(4) \quad P_g = \frac{(P_c^L + r_c P_c^S - HC_c)Y_c^L - PHC_c + PHC_g}{Y_g} + HC_g$$

where:
P_g = price of grain sorghum that would equate grain sorghum net returns with cotton net returns.

Similarly, solving for breakeven yield (Y_g), equation (3) becomes,

$$(5) \quad Y_g = \frac{(P_c^L + r_c P_c^S - HC_c)Y_c^L - PHC_c + PHC_g}{P_g - HC_g}$$

where:
Y_g = yield of grain sorghum that would equate grain sorghum net returns with cotton net returns.

By applying the methodology described above, both a breakeven yield and a breakeven price can be estimated to compare alternative crops or production systems.

Risk Implications

Like any conventional or new crop production system, adoption of the delayed Uniform Planting Date cotton production system involvd some degree of risk for producers. In the present study, risk was estimated by analyses of variation in net returns and yields that arise from variability of product price, input cost and yield. Net returns were estimated for each of the 27 counties for 1970-1981 by using the yield data, differences in variable costs for pesticide and harvesting costs. For the analysis, both the conventional and the Uniform Planting Date cotton enterprise budgets for 1982 were used. Because the nominal prices overestimate the degree of real price variability when there is an upward or downward trend in prices, the nominal prices were deflated by the parity index to 1982 dollars.

Based on county data for 1970-1981, counties were separated by those in the UPD and those out of the UPD by year. The variability of per acre net returns and yields were compared by year for the counties in and out of the Uniform Planting Date Cotton production system. One common measure of relative variability, the coefficient of variation, was used for the annual per-acre comparison of net returns and yields for the UPD and conventional (i.e., out of the UPD) cotton production systems.

Regional and State Economic Impact

The Uniform Planting Date cotton production system in the Texas Rolling Plains has economic impact for the region and state resulting from changes in gross revenue due to changes in yields and acreages. To estimate the regional and state economic impact, the Uniform Planting Date Cotton production strategy was compared to the conventional cotton and grain sorghum production techniques. The comparison involved a simple budgeting analysis specifically used to get total changes in gross revenue. A minimum estimate of changes in gross revenue for the UPD cotton in the Texas Rolling Plains is the yield increase on all acres of cotton times the price. The regional and state economic impact was estimated by multiplying the gross revenue changes by the respective regional and state production multipliers.[1] The following equation was used to estimate regional and state economic impact:

$$\text{Regional or State Impact} = (GR_1 \times M_{ct}) + (GR_2 \times M_{ct}) - (GR_3 \times M_{gs}) - (GR_4 \times M_{cl}$$

where:

GR_1 = increase in cotton revenue from typical cotton acreage,

GR_2 = increase total cotton revenue from acres of other crops converted to cotton,

---

1 Production multipliers are estimates of the total change in the value of production in the Texas economy that results from a change in the value of production in an agricultural sector. Production multipliers within a region are usually smaller than the corresponding state multipliers (Jones and Williams).

GR_3 = total grain sorghum revenue from sorghum acres converted to cotton,
GR_4 = total livestock revenue from pasture acres converted to cotton,
M_{ct} = regional or state production multipliers for dryland cotton,
M_{gs} = regional or state production multipliers for grain sorghum,
M_{cl} = regional or state production multipliers for cow-calf.

The procedure used to estimate each of the gross revenues -- GR_1, GR_2, GR_3 and GR_4 -- is given in the appendix.

Results

Least-squares regression was used to estimate a cotton yield response to the Uniform Planting Date cotton production strategy. For the expected yield of grain sorghum, a sorghum yield response function was also estimated using the least-squares technique. To identify cotton production costs and practices under the Uniform Planting Date system for comparison with the conventional cotton production strategy, the base cotton enterprise budget was utilized. In addition, both a breakeven price and a breakeven yield of grain sorghum were estimated to show when sorghum net returns become equal to cotton net returns. The coefficients of variation of net returns and yields were estimated to identify the risk implication of the UPD cotton production strategy. Finally, the effects of the Uniform Planting Date cotton production system on the region and state economies were estimated.

Cotton Yield Response

The cotton yield response function has important implications for the delayed Uniform Planting Date production system. The cotton yield equation contained a Uniform Planting Date dummy variable, first fall freeze date, aggregate rainfall for October, November and December lagged one year, June rainfall, maximum temperatures for May, June, July, August, and September, minimum temperatures for June and July and acres of cotton planted. Preliminary regression analyses were performed with nearly 100 specifications of the model including separating the Rolling Plains counties into a northen and southern half. Although none of them were very succesful, in most of the model specifications the coefficients of the UPD were positive and ranged from 15 to 50.

The estimated base yield equation is (t - statistics are in parenthesis below the estimated coefficients):

$$
\begin{aligned}
Y = {} & 495.277 + 24.951UPD + 1.764FRZD \\
& (2.00) \quad (2.01) \quad (3.271) \\
& + 4.901RAINL + 8.10JUNRAIN \\
& \quad (1.708) \quad (2.288) \\
& + 1.938MAYMXT + 6.881JUNMXT \\
& \quad (0.923) \quad (2.218) \\
& - 23.886JUNMNT - 16.989JULMXT \\
& \quad (7.078) \quad (7.823) \\
& + 18.395JULMNT - 3.564AUGMXT \\
& \quad (4.764) \quad (1.819) \\
& + 12.649SEPMXT + 0.000747COTAPL \\
& \quad (9.562) \quad (5.199)
\end{aligned}
$$

$R^2 = 0.503$
C.V. = 31.585
MSE = 8208.2
N = 324

where:

Y = cotton yield in pounds per planted acre,
UPD = uniform plant date dummy variable,
FRZD = first fall freeze date,
RAINL = rainfall for October through December lagged one year,
JUNRAIN = June rainfall,
MAYMXT = maximum May temperature,
JUNMXT = maximum June temperature,
JUNMNT = minimum June temperature,
JULMXT = maximum July temperature,
JULMNT = minimum July temperature,
AUGMXT = maximum August temperature,
SEPMXT = maximum September temperature, and
COTAPL = planted cotton acres.

The delayed Uniform Planting Date cotton production system, first fall freeze date, aggregate rainfall from October to December lagged one year, June rainfall, May, June, July, August, September maximum temperatures, June, July minimum temperatures and planted cotton acres explained 50 percent of variation in cotton yields, with a coefficient of variation of 31.6 percent for yields. Except for the coefficient for the May maximum temperature, which was not significant and RAINL and AUGMXT, which were significant at the 10 percent probability level, all other variables were significant at the 5 percent probability level or better and, with exception of JUMNT and JULMXT, most of their signs were reasonable. The delayed Uniform Planting Date, lateness of first fall freeze date, aggregate rainfall during October to December (pre-planting) lagged one year and June rainfall appeared to increase cotton yields. In addition, high June and September maximum temperatures and lower July minimum temperatures indicate increased cotton yields. However, July and August maximum temperatures and June minimum temperature had a deleterious effect on yield. Finally, over the range of observations, increased acres of land planted to cotton increased cotton yields due to a reduction of boll weevil damage in the area. In the yield response equation, the main interest is in the UPD coefficient. The coefficient of a specific other variable is not proposed as having great reliability or being truly representative of that variable affect on yield.

The estimated yield equation emphasized the importance of the UPD for cotton production -- lint yield increased about 25 pounds per-acre for counties following this system. This coefficient was consistently positive ranging between 15 and 50 across many specifications of the model. Thus the authors gained confidence in the 25 pounds yield increase in lint due to the UPD production system. This indicated one of the benefits of the Uniform Planting Date cotton production strategy in the Rolling Plains of Texas where there has been a resurgence of acres of land planted to cotton.

The coefficients of other remaining variables are not easily interpreted. Although they provide indications of yield effect, they were not the focus of this study and it would be incorrect to place great emphasis on the coefficients in the final model selected. The values suggest that lint yields are typically increased for every day the first fall freeze date was delayed beyond the average. The equation also emphasized the importance of preplanting period rainfall and July rainfall on increasing yield.

In general, an increase in cotton acreages would have an adverse affect on yield because marginal land and land more susceptable to boll weevil damage come into production. However, in the Rolling Plains, yield was increased in the face of dramatically higher acreages. This could indicate that the 25 pound per acre lint yield increase is a conservative estimate.

Grain Sorghum Yield Response

The grain sorghum yield response function is useful in estimating the expected yield and is briefly indicated here since it was assumed that increase in cotton acreages were mostly due to a decline in grain sorghum acreages during 1970-1981 (Table 1). While acreages declined substantially, the trend coefficient for the grain sorghum yield function was found not significant.

Per-Acre Net Returns

The cotton yield response function in the previous section indicated a yield advantage for the Uniform Planting Date cotton production system compared to the conventional cotton production system. However, a critical issue is the effect on costs and returns of cotton producers. The budgeting analysis considered per-acre profit for the Uniform Planting Date cotton system and the conventional cotton production system. The grain sorghum budget was included for comparison. This was followed by a breakeven price and yield analysis.

Budgeting Analysis. The analysis of crop enterprise budgets indicated that the Uniform Planting Date cotton production system in the Texas Rolling Plains results in higher expected yields and returns (Table 3). The information in Table 3 was developed from Appendix B, Tables 1, 2, and 3. Costs of production per pound of lint were estimated to be $0.42 for the Uniform Planting Date system and $0.48 for the conventional cotton production system. The estimated cost of insecticide applied and cottonseed (less insectcide and reduced cottonseed) used were reduced to one half, or $5.50 per-acre, for the Uniform Planting Date producton system as compared to $11.00 for the conventional cotton production system. In addition, labor costs (fewer cultivations and fewer trips across the field) were reduced by $2.08 per-acre for the UPD cotton in comparison with the conventional cotton production system.

The decrease in insecticide, cottonseed and labor costs per-acre for the Uniform Planting Date production system and the associated increase in cotton yield resulted in increased net returns for the UPD cotton. For example, net returns were estimated to increase by $21.36 per-acre for the UPD cotton as compared to the conventional cotton. This is a measure of the direct producer benefits of the UPD cotton production system in the region.

Breakeven Analysis. By applying the methodology described earlier, both a breakeven price and breakeven yield can be estimated to compare net return for grain sorghum and cotton under the Uniform Planting Date and the conventional production systems. Per-acre net returns for each crop were estimated by subtracting total variable costs from gross returns. For cotton, the analysis assumed a price of $90.00 per ton of cottonseed.

Breakeven Prices. The breakeven price relationship between (1) grain sorghum and UPD cotton and (2) grain sorghum and the conventional cotton are presented in Table 4. Only comparison between grain sorghum and cotton are thought to be meaningful since a decline in grain sorghum acreages will go to cotton production.

The breakeven price relationships between grain sorghum and the UPD cotton indicated that the UPD cotton has an absolute advantage over grain sorghum. For example, with an average grain sorghum price of ¢4.60/lb, and an estimated base yield of 1500.0 lb/acre, a lint price of ¢27.89/lb for the UPD cotton would be needed to maintain a net return breakeven relationship with grain sorghum. The average price of the UPD cotton was ¢56.0/lb, which is ¢28.11 above breakeven price. Further, the above breakeven relationships indicate that for every ¢1.00/lb increase (or decrease) in the price of grain sorghum, UPD cotton must increase (or decrease) ¢5.00/lb of lint/acre to maintain equal net returns (Table 4).

Similarly, the breakeven prices between grain sorghum and the conventional cotton production system indicate that for a ¢4.60/lb average price of grain sorghum and the estimated yield of 1500.0 lb/acre, the conventional cotton would need a price of ¢33.10/lb to maintain an equal net return relationship with grain sorghum. Since the average price of the conventional cotton was ¢56.00/lb, like the UPD, the conventional cotton has an absolute advantage over grain sorghum. Further, for every ¢1.00/lb increase (or decrease) in the price of grain sorghum, conventional cotton must increase (or decrease) ¢5.45/lb of lint/acre to maintain equal returns (Table 4).

Table 3. Expected Price, Yield and Production Cost for Cotton Under the Uniform Planting Date and Conventional Production Strategies and Grain Sorghum, Texas Rolling Plains, 1982

Crop name	Crop Price	Yield	Preharvest Cost: Insecticide and Cotton seed	Preharvest Cost: Other	Harvest Cost[a]: Gin, Bag Ties, Contract Broker, Tractor, Equipment and labor	Total[b] Variable Cost	Non-land Fixed Cost	Returns to Land, Management, Overhead, and Risk
	¢/lb	lbs/ac	$/acre					
UPD cotton	56.00 (Lint)	300.0 (Lint)	5.50	47.00	38.62	91.12	34.43	64.05
	4.50 (seed)	400.0 (seed)						
Conventional Cotton	56.00 (Lint)	275.0 (Lint)	11.00	49.08	36.60	96.68	34.43	42.69
	4.50 (seed)	440.0 (seed)						
Grain Sorghum	4.60	1500.0	1.20	37.91	15.75	54.86	20.92	-6.78

[a] Harvest cost includes ginning, bag, ties, contract brokers, tractor, equipment and labor. Grain sorghum harvesting costs include custom combine and haul.

[b] Total of pre-harvest and harvest costs.

Table 4. Breakeven Prices for Grain Sorghum and Cotton Under the Uniform Planting Date and Conventional Production Systems, Texas Rolling Plains, 1982[a]

Crop name	Base for Comparisons		Breakeven Prices by Specified Crops[b]		
	Price	Yield	Grain Sorghum	UPD Cotton	Conventional Cotton
	¢/lb	lbs/ac	¢/lb		
Grain Sorghum	4.60	1500.0	4.60	27.89	33.10
UPD Cotton	56.00	300.0	10.22	56.00	63.77
Conventional Cotton	56.00	275.0	8.80	48.88	56.00

[a] The analysis assumes a $90.00 per ton of cottonseed.

[b] Prices required for the crops listed that equates net returns to the base identified in first three columns to the left.

Breakeven Yields. A comparison of breakeven yields between grain sorghum and cotton under the UPD and the conventional production systems in relation to the expected base yields of these crops is presented in Table 5. The breakeven yield of a crop in relation to the expected base yield of another crop, represents the yield where per-acre net returns are equal for both crops, with prices of these two crops given. For example, for a 1500.0 lb/acre base yield of grain sorghum, and the average price of ¢4.60/lb (grain sorghum) and ¢56.00/lb (the UPD cotton), the UPD cotton would need to yield 167.0 lb/acre to maintain a breakeven net return relationship with grain sorghum (Table 5).

Similar interpretations could be made for the breakeven yield relationship between grain sorghum and the conventional cotton. Thus, for the 1500.0 lb/acre base yield of grain sorghum, and the average price of ¢4.60/lb (grain sorghum) and ¢56.00/lb (conventional cotton), conventional cotton would need to yield 175.0/acre to maintain a breakeven net return relationship with grain sorghum (Table 5). Since the average yields of both the UPD cotton and the conventional cotton were well above their respective breakeven yields, the implication is that cotton produced with the UPD and the conventional production system could produce well below their respective average yields and still have per-acre net returns comparable or better than grain sorghum.

Risk Implications

Risk as measured by variations in per-acre net returns and yields for the UPD and conventional cotton was indicated by the coefficient of variation. An annual per-acre comparison of variability of net returns for the UPD and conventional cotton for the period 1972-1980 is presented in Table 6.[2] The standard deviation is an absolute measure of the dispersion of the observations and is useful in measuring relative variability when related to the mean. This relationship is indicated by the coefficient of variation, which is defined as the standard deviation expressed as a percentage of the mean. The results indicate that annual net returns from the UPD cotton during 1972-1980 were less variable in all but one year, 1976, in comparison with the conventional cotton. The highest coefficient of variation (159.84%) in net returns was found in the conventional cotton for 1980, while the lowest coefficient of variation (5.36%) was found in the UPD cotton for 1973.

The annual per-acre comparison of variability of yields for the UPD and conventional cotton for the period 1972-1980 is presented in Table 7. In 6 of the 9 years, yield of the UPD cotton was greater than the conventional production strategy. In general, annual yields per-acre for the Uniform Planting Date cotton production during 1972-1980 were less variable in comparison with the conventional cotton production as indicated by a 6.2 percent higher coefficient of variation. In seven of the nine years during

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[2] While in 1970 and 1971 all of the 27 counties in the Texas Rolling Plains were under conventional cotton production system, in 1981 all of these counties were under the UPD. Consequently, these three periods were omitted from comparison.

Table 5. Breakeven Yields for Grain Sorghum and Cotton Under the Uniform Planting Date and Conventional Production Systems, Texas Rolling Plains, 1982[a]

Crop name	Base for Comparisons		Breakeven Yields by Specified Crops[b]		
	Price	Yield	Grain Sorghum	UPD Cotton	Conventional Cotton
	¢/lb	lbs/ac	lbs/ac		
Grain Sorghum	4.60	1500.0	1500.0	167.0	175.0
UPD Cotton	56.00	300.0	3334.0	300.0	309.0
Conventional Cotton	56.00	275.0	2869.0	266.0	275.0

[a] The analysis assumes a $90.00 per ton of cottonseed.

[b] Yields required for the crops listed that equates net returns to the base identified in first three columns to the left.

Table 6. Estimated Variability of Net Returns (Returns Above Variable Costs) Per-Acre for the Uniform Planting Date and Conventional Cotton Production Strategies, Texas Rolling Plains, 1972-80[a]

Year	Net Returns Per-Acre[b] UPD	Net Returns Per-Acre[b] Conventional	Coefficient of Variation (C.V.) UPD	Coefficient of Variation (C.V.) Conventional
	------dollars------		------percent------	
1972	140.60	87.76	13.41	48.92
1973	419.68	341.54	5.36	29.48
1974	38.44	39.45	43.54	100.50
1975	161.84	150.57	35.84	43.65
1976	173.88	217.04	46.27	40.65
1977	178.18	158.47	29.64	66.00
1978	126.44	106.15	38.13	57.97
1979	207.61	235.96	23.41	33.18
1980	21.01	9.76	115.62	159.84

[a] Based on average yield of counties in UPD and conventional cotton production systems. Lint and seed prices in 1982 dollars are presented in Appendix B, Table 4.

[b] Simple average across counties.

Table 7. Measure of Variability of Yields Per-Acre for the Uniform Planting Date and Conventional Cotton Production Strategies, Texas Rolling Plains, 1972-80[a]

Year	Yield Per-Acre[b]		Coefficient of Variation	
	UPD	Conventional	UPD	Conventional
	--------lbs-------		------percent------	
1972	391.00	299.36	9.77	29.04
1973	416.00	353.84	4.76	25.07
1974	146.00	159.80	18.40	39.84
1975	269.75	265.11	27.06	31.20
1976	217.91	266.75	35.54	31.83
1977	333.89	316.33	22.89	47.85
1978	231.06	214.67	26.94	37.02
1979	377.62	429.67	18.69	26.45
1980	100.00	95.00	33.05	22.33

[a] Based on average yield of counties in UPD and conventional cotton production systems.

[b] Simple average across counties.

the 1972-1980 period, the coefficients of variation of yields for the UPD cotton were lower than the coefficient of variation of yields for conventional cotton.

The variability in per-acre yields in comparison with per-acre net returns were relatively low for both the UPD cotton and conventional cotton as indicated by the coefficient of variation. However, with the exception for 1976 and 1980, the degree of variability was substantially lower for the UPD cotton yields than for the conventional cotton yields.

A comparison of estimated net returns and yields per-acre for the Uniform Planting Date and conventional cotton production systems for selected periods is presented in Table 8. The results based on each year's experience indicate that the UPD cotton production system was on the average $13.45 per-acre more profitable than the conventional cotton production system for the 1972-80 period. In addition, when the 1972-1980 period was subdivided (about one-half of the counties under the UPD in each subdivision), the UPD cotton production strategy was on the average $19.62 per-acre and $5.72 per-acre more profitable than the conventional cotton production strategy for the 1972-1976 and 1977-1980 periods, respectively (Table 8).

The results for the mean per-acre yield showed that the UPD cotton production was higher than the conventional cotton by 9.18 pounds for the period 1972-1980. The mean per-acre yield for the UPD cotton was 19.16 pounds higher than the conventional cotton for the 1972-76 period. However, the mean per-acre yield was lower by 3.28 pounds for the UPD cotton in comparison with the conventional cotton for the 1977-1980 period (Table 8).

Regional and State Economic Impact

The average regional and state economic impacts of the UPD cotton, based on methodology outlined in Appendix A and corresponding to the estimated cotton yield response function discussed earlier, for the Texas Rolling Plains are shown in Table 9. The Rolling Plains Production Multipliers (Regional) used for cotton, grain sorghum and cow-calf on pasture land were 2.39, 2.44 and 2.15 respectively (Jones and William). The average annual economic impact of the UPD cotton in the region is about $192 million based on assumed relationship for the cotton yield response function and total acres of sorghum and pasture land converted to cotton production.

Production multipliers used for cotton, grain sorghum and cow-calf for the state were 3.77, 3.63 and 3.55 respectively (Jones and Williams). Based on the same assumption as for the region, the estimated annual economic impact of the UPD cotton for the state is about $305.19 million. The implications of these results are that the UPD cotton production, has a positive impact both for the region and state.

Summary and Conclusions

This study is concerned with economic implications of cotton production under the delayed Uniform Planting Date (UPD) in the Rolling Plains of Texas. The study estimated the cotton yield response, per-acre profit, breakeven prices and yields, risk as measured by the coefficient of variation and regional and state economic impact.

Table 8. Estimated Net Returns (Returns Above Variable Costs) and Yields Per-Acre for the Uniform Planting Date and Conventional Cotton Production Strategies by Selected Periods, Texas Rolling Plains, 1972-80[a]

Period	Net Returns Per-Acre[b]		Yields Per-Acre[b]	
	UPD	Conventional	UPD	Conventional
	------dollars------		--------lbs--------	
1972-1980	163.08	149.63	275.91	266.73
1972-1976	186.89	167.27	288.13	268.97
1977-1980	133.31	127.59	260.64	263.92

[a] Based on average yield of counties in the UPD and conventional cotton production systems. Lint and Cottonseed prices in 1982 dollars for each year are presented in Appendix B, Table 4.

[b] Simple average across years and counties.

Table 9. Annual Estimated Economic Impact of the Uniform Planting Date Cotton Production System, Texas Rolling Plains and Texas, 1970-1981

Crop Name and Gross Revenue Sources	Gross Revenue Increase	Gross Revenue Decrease	Production Multiplier[a] Rolling Plains	Production Multiplier[a] State (Texas)	Impact Rolling Plains	Impact State (Texas)
	-------$1,000,000-------				------$1,000,000-------	
1. Cotton, Increased Gross Revenue from Cotton Acres, 1970	13.41 (lint) 1.72 (Seed) 15.13		2.39 2.39	3.77 3.77	32.04 4.12 +36.16	50.54 6.50 +57.04
2. Cotton, Gross Revenue from Other Cropland Acres Converted to Cotton, 1970-1981	81.16 (lint) 10.43 (seed) 91.59		2.39 2.39	3.77 3.77	193.97 24.94 +218.91	305.97 39.34 +345.31
3. Grain Sorghum, Gross Revenue from Sorghum Acres Converted to Cotton 1970-1981		17.53	2.44	3.63	-42.76	-63.62
4. Cow-Calf, Gross Revenue from Cow-Calf on Pasture acres Converted to Cotton		9.45	2.15	3.55	-20.31	-33.54
5. Total	106.72	26.98			192.00	305.19

[a] Jones and Williams.

The analyses indicated that the UPD cotton production system would result in higher yields and net returns per-acre. In the yield response function, a 25 pound lint increase was attributed to UPD cotton production. The analysis of base budgets indicated that the estimated costs of insecticide applied and cottonseed used per-acre were reduced to about one-half with the UPD cotton compared with the conventional cotton. In addition, the results indicated that the UPD cotton production system reduced per unit cost through reduced insecticide, cottonseed and labor use and gave an increase in yields. Thus, returns to land, management, overhead and risk were estimated to be higher by $21.36 per-acre for the UPD cotton production as compared to the conventional cotton production strategy. This economic incentive motivated more counties and growers within the counties in the region to adopt the UPD production system. Almost all the current cotton production in the region is under the UPD production strategy.

The breakeven price relationships between grain sorghum and cotton produced under UPD and the conventional systems indicated that both the UPD cotton and the conventional cotton have absolute advantage over grain sorghum. In addition, the breakeven yield relationships of these crops implied that cotton produced with the UPD and the conventional systems could produce well below their respective average yields and still have per-acre net returns comparable to or better than grain sorghum.

To evaluate risk implications of the UPD cotton in comparison with the conventional cotton, the coefficient of variation applied to annual net returns and yields was used. Based on average yield of counties for the UPD and the conventional cotton production systems during the 1972-1980 period, the analysis indicated that the annual coefficients of variation of net returns for the UPD cotton production were lower than the conventional cotton in all but 1976. During the same period, the UPD cotton production on the average was found to be $13.45 per-acre more profitable in comparison with the conventional cotton. In addition, analysis of data for the 1972-1976 and 1977-1980 period indicated that the UPD cotton production on the average was $19.62 and $5.72 per-acre more profitable, respectively in comparison with the conventional cotton production.

The annual coefficients of variation of yields for the UPD cotton production were lower than the conventional cotton production in seven of the nine years for the period 1972-1980. During the same period, the average yield for the UPD cotton was estimated to be higher by 9.2 pounds per-acre as compared to the conventional cotton. In addition, the average yield for the UPD cotton was higher by 19.2 pounds for 1972-1976, but slightly lower for 1977-1980, as compared to the conventional cotton yield. The implication of these results is that the UPD cotton production system on the average provides more stable returns and is more profitable.

The results of the study also indicated a large economic impact of the UPD cotton production. The average annual economic impact of the UPD cotton production strategy is about $192.0 million for the Texas Rolling Plains and $305.0 million for the State. Thus, the UPD cotton production system is beneficial for the producers and has a positive impact both for the region and state.

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Appendix A

Economic Impact Analysis Methodology

Regional and State Economic Impact: Gross Revenue Estimation

A slight overestimation of changes in gross revenue was done using the following procedure:

1. GR_1 = increase in gross revenue from cotton and is calculated as acres of land planted to cotton in 1970 times increase in yield due to Uniform Planting Date times the price of cotton. 2. GR_2 = the increase in gross revenue from new cotton acres is calculated as acres of land planted to cotton in 1981 minus acres of land planted to cotton in 1970 times average yield times the price of cotton. This is cotton on previous acres of land planted to sorghum or pasture . 3. GR_3 = revenue lost from grain sorghum acres that are planted to cotton and first assumes that all acres of land not planted to grain sorghum go to cotton. The decrease in gross revenue from reduced grain sorghum acres is calculated as acres of land planted to grain sorghum in 1970 less acres of land planted to grain sorghum in 1981 times the average yield times the price of grain sorghum. This is a decrease in gross revenue, so the grain sorghum production multiplier was applied to estimate associated reduced economic activity. 4. If acres of land in 2 above is greater than acres of land in 3, then it is assumed that other acres of land planted to cotton would come from pasture and therefore, estimation of expected gross revenue from cow-calf in the Texas Rolling Plains is needed. Enough acres of land from cow-calf grazing would be needed to equalize acres of land planted to cotton in 2 and grain sorghum in 3 above. So, GR_4 = acres of land from cow-calf times annual beef production in pounds times the price of beef. This is also a gross revenue decrease and would go 3 above.

Appendix B
Crop Enterprise Budgets

Appendix Table 1. Estimated Costs and Returns Per-Acre for Uniform Planting Date Cotton Production (Dryland, Solid 40" Rows): Texas Rolling Plains, 1982[a]

Item	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts:				
cotton lint	lb	$0.56	300.00	$168.00
cotton seed	ton	90.00	0.24	21.60
Total Receipts				$189.60
2. Variable Costs:				
Preharvest Costs				
Seed Cotton	lb	0.40	10.00	4.00
Insecticide	appl.	3.00	0.50	1.50
Misc. Expenses	acre	5.00	1	5.00
Herbicide	acre	6.00	1	6.00
Tractor (fuel, lube and repair)	acre			13.52
Equipment (fuel, lube and repair)	acre			3.47
Labor (machinery equipment and other)	hour	5.00	2.71	13.55
Crop Insurance	acre	4.50	1.00	4.50
Operating Capital	dollar	0.074	12.96	0.96
Subtotal, preharvest	acre			$52.50
Harvest Costs				
Gin, Bag & Ties	lb	0.08	300.00	24.00
Contract Broker	bale	.25	.625	.16
Tractor (fuel, lube and repair)	acre			6.39
Equipment (repair)	acre			3.47
Labor (machinery and equipment)	hour	5.00	0.92	4.60
Subtotal, Harvest	acre			$38.62
Total Variable Costs	acre			$91.12
3. Income Above Variable Cost	acre			$98.48

Item	Unit	Price or Cost/Unit	Quantity	Value or Cost
4. Fixed Costs:				
Tractor	acre			$17.40
Equipment	acre			17.03
Total Fixed Costs	acre			$34.43
5. Total Costs:	acre			$125.55
6. Returns to Land, Management, Overhead and Risk	acre			$64.05

[a] Based on Texas Crop Enterprise Budgets, 1982. Texas Agricultural Extension Service, Texas A&M University.

Appendix Table 2. Estimated Costs and Returns Per-Acre for Conventional Cotton Production (Dryland, Solid 40" Rows): Texas Rolling Plains, 1982

Item	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts:				
cotton lint	lb	$0.56	275.00	$154.00
cotton seed	ton	90.00	0.22	19.80
Total Receipts				$173.80
2. Variable Costs:				
Preharvest Costs				
Seed Cotton	lb	0.40	20.00	8.00
Insecticide	appl.	3.00	1.00	3.00
Misc. Expenses	acre	5.00	1.00	5.00
Herbicide	acre	6.00	1.00	6.00
Tractor (fuel, lube and repair)	acre			13.52
Equipment (fuel, lube and repair)	acre			3.47
Labor (machinery equipment and other)	hour	5.00	3.125	15.63
Crop Insurance	acre	4.50	1.00	4.50
Operating Capital	dollar	0.074	12.96	0.96
Subtotal, preharvest	acre			$60.08
Harvest Costs				
Gin, Bag & Ties	lb	0.08	275.00	22.00
Contract Broker	bale	.25	.573	0.14
Tractor (fuel, lube and repair)	acre			6.39
Equipment (repair)	acre			3.47
Labor (machinery and equipment)	hour	5.00	0.92	4.60
Subtotal, Harvest	acre			$36.60
Total Variable Costs	acre			$96.68
3. Income Above Variable Cost	acre			$77.12

Item	Unit	Price or Cost/Unit	Quantity	Value or Cost
4. Fixed Costs:				
Tractor	acre			$17.40
Equipment	acre			17.03
Total Fixed Costs	acre			$34.43
5. Total Costs:	acre			$131.11
6. Returns to Land, Management, Overhead and Risk	acre			$ 42.69

[a] Based on Texas Crop Enterprise Budgets, 1982. Texas Agricultural Extension Service, Texas A&M University.

Appendix Table 3. Estimated Costs and Returns Per-Acre for Grain Sorghum Production: Texas Rolling Plains, 1982

Item	Unit	Price or Cost/Unit	Quantity	Value or Cost
1. Gross Receipts:				
Grain sorghum	cwt	$ 4.60	15.00	$69.00
Total Receipts				$69.00
2. Variable Costs:				
Preharvest Costs				
Grain Sorghum Seed	lb	0.40	3.00	1.20
Misc. Expenses	dollar	1.00	1.00	1.00
Tractor (fuel, lube and repair)	acre			14.63
Equipment (fuel, lube and repair)	acre			4.04
Labor (machinery and equipment)	hour	5.00		14.60
Crop Insurance	acre	3.00	1.00	3.00
Operating Capital	dollar	0.074	8.68	0.64
Subtotal, preharvest	acre			$39.11
Harvest Costs				
Custom Harvest	acre	12.00	1.00	12.00
Custom Haul	cwt	0.25	15.00	3.75
Subtotal, Harvest	acre			$15.75
Total Variable Costs	acre			$54.86
3. Income Above Variable Cost	acre			$14.14
4. Fixed Costs:				
Tractor	acre			$12.31
Equipment	acre			8.61
Total Fixed Costs	acre			$20.92
5. Total Costs:	acre			$75.78
6. Returns to Land, Management, Overhead and Risk	acre			$-6.78

[a] Texas Crop Enterprise Budgets, 1982. Texas Agricultural Extension Service, Texas A&M University System.

Appendix Table 4. Cotton Lint and Seed Price in 1982 Dollars for 1972-82[a]

Year	Lint Price (¢/lb)	Seed Price ($/ton)
1972	.5229	126.20
1973	1.0972	209.18
1974	.5634	236.8
1975	.8006	155.0
1976	1.0340	168.6
1977	.7428	97.6
1978	.7674	171.2
1979	.7014	147.0
1980	.7632	127.4
1981	.4965	87.8
1982	.5600	90.00

[a] Calculated by taking the nominal (actual) price of each year and adjusting by the parity index to 1982 dollars. These prices were used in the risk analysis.

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