Economic Analysis of Roundup Ready Versus Conventional Cotton Varieties in the Southern High Plains of Texas

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ABSTRACT

The adoption of Roundup Ready cotton varieties has provided cotton producers alternative weed management options with the potential of lowering overall production costs and increasing lint yields. The objective of this study was to evaluate the cost of production and profitability of Roundup Ready cotton compared to conventional cotton varieties in the Southern High Plains (SHP) of Texas from 1998 to 2000. Individual enterprise and whole farm financial analyses were conducted on irrigated cotton operations and combined into a database to generate aggregate enterprise profitability and production cost data for Roundup Ready and conventional cotton varieties in the SHP. Stochastic simulations were utilized to evaluate the profitability of Roundup Ready and conventional cotton varieties accounting for the variability of prices, yields, and production costs. Stochastic dominance (STODOM) with respect to a function was used to rank the varieties accounting for the inherent stochasticity and different levels of producer risk aversion. Weighted average results indicate that producers in the SHP received, on an aggregated basis, higher net incomes for Roundup Ready varieties compared to conventional varieties. STODOM results were consistent with the "average" results and indicated Roundup Ready varieties dominated conventional cotton varieties when accounting for risk preferences and stochasticity of yields, prices, and production costs.

KEY WORDS: Roundup Ready cotton, Stochastic Dominance, conventional cotton

ABBREVIATIONS: ARAC, Absolute Risk Aversion Coefficient; SHP, Southern High Plains; SPA, Standardized Performance Analysis; SPA-ME, Standardized Performance Analysis for Multiple Enterprises; STODOM, Stochastic Dominance with respect to a function.

INTRODUCTION

The development of transgenic cotton varieties has provided opportunities for cotton producers to increase productivity and efficiency in their farming operations. The introduction of Roundup Ready cotton varieties along with Roundup Ultra (*glyphosate*) has provided cotton producers in the Southern High Plains (SHP) of Texas with an effective tool to help control troublesome weed infestations throughout the growing season (White, Beaty, and Johnson, 2000). Roundup Ready cotton varieties have been widely adopted by Texas cotton producers since being introduced in 1997. The planting of Roundup Ready cotton varieties has increased from 2.5% of Texas cotton acres in 1997 to 62.0% in 2001 (USDA, Cotton Varieties Planted).

The use of Roundup Ready cotton varieties may allow producers to reduce the number of chemical applications and mechanical operations resulting in alternative weed management options and the incorporation of reduced tillage practices into their operations. Alternative weed management options and the opportunity to replace traditional tillage operations has the potential to lower overall production costs, while providing potential environmental advantages compared to conventional weed control systems utilizing pre-plant herbicides and traditional tillage practices (Monsanto, 2001). In addition, the ability to control weed infestations which are resistant to pre-plant herbicides may increase cotton lint yields.

Substantial research has been conducted evaluating the agronomic and environmental aspects of Roundup Ready cotton varieties. However, there has been limited research evaluating cost of production, profitability, and potential economic advantages of planting Roundup Ready cotton varieties. White, Beaty, and Johnson (2000) evaluated the profitability and production costs of Roundup Ready versus conventional cotton varieties in the SHP of Texas for 1998. Results indicated Roundup Ready cotton varieties produced higher net returns to operator labor, management, and risk of $72.55 per acre compared to $58.93 per acre for conventional cotton varieties. However, the authors acknowledged the limitation of only one year of data and emphasized the need for further research with a multi-year database. Slinsky et al. (1998) evaluated cost and returns for Roundup Ready cotton varieties in Tennessee for the 1996 crop year. Results indicated that conventional weed-control practices produced higher lint yields, lint prices, and total revenues compared to Roundup Ready treatments. In addition, their study indicated that Roundup Ready treatments had lower production costs compared to conventional weed-control practices. The results of these two studies were limited by data constraints associated with one year of data.

Cotton producers need reliable information evaluating the profitability and production costs of Roundup Ready versus conventional cotton varieties over a longer time horizon. Therefore, the objective of this study was to evaluate the costs of production and profitability of Roundup Ready cotton compared to conventional cotton varieties in the SHP of Texas from 1998 to 2000.

METHODS AND PROCEDURES

The methods utilized in this study included a combination of the Standardized Performance Analysis-Multiple Enterprises (SPA-ME) computer program, Standardized Performance Analysis (SPA) database, and stochastic simulations. The SPA-ME computer program was utilized to complete all individual analyses used in this study. SPA-ME is an analytical program that allows for individual enterprise and whole farm financial analysis (McGrann, Michalke, and Stone, 1996). The SPA-ME program starts by identifying all enterprises and farming units within a specific farming operation. Additionally, whole farm financial statements (Balance Sheets, Accrual Adjusted Income Statement, Statement of Cash Flows, and Statement of Owner Equity) are developed for the operation according to recommendations from the Farm Financial Standards Council. Upon completion of the financial statements, the SPA-ME program allows for specific enterprise assets, liabilities, revenues, and expenses to be allocated from the whole farm financial statements to the individual enterprises and farming units. The end result for the producer is an assessment of actual production costs and profitability of each

enterprise and farming unit. Individual SPA analyses were entered into a database, which compiled aggregated enterprise profitability and production cost data for Roundup Ready and conventional cotton enterprises within the SHP.

The stochastic simulations were generated with SIMETAR, a risk analysis software add-in for Microsoft Excel (Richardson, 2002). A total of 1000 simulations per year were generated to evaluate the profitability of Roundup Ready and conventional cotton varieties accounting for the stochastic nature of prices, yields, and variable costs. The means and standard deviations of lint prices, cash operating expenses, and yields were obtained from SPA database average results from 1998 to 2000. All stochastic variables were truncated by their absolute minimums and maximums within the dataset for simulation purposes. To account for potential differences in lint quality between Roundup Ready and conventional varieties, lint price distributions were estimated separately. It is important to note that the loan deficiency payments are embedded in lint prices. Government payments, miscellaneous revenues, and overhead expenses were not included in the stochastic simulations. Furthermore, seed revenues were not included in this study as they were netted out against ginning expenses.

Upon completion of the simulations, stochastic dominance (STODOM) with respect to a function was utilized to rank Roundup Ready and conventional cotton varieties. STODOM is a mathematically precise evaluative criterion to rank actions or choices for classes of decision makers defined by specified lower and upper bounds of their absolute risk aversion coefficient (ARAC) (King and Robison, 1981). The ARAC is defined as the –U"(x) divided by U'(x), where U represents a von Neumann-Morgenstern utility function (Segarra, Keeling, and Abernathy, 1991; Giesler, Paxton, and Millhollan, 1993; Richardson, 2002). Hence, a positive ARAC implies a concave utility function resulting in a risk averse decision maker. Conversely, a negative ARAC implies a convex utility function resulting in a risk loving decision maker. Furthermore, the specification of lower and upper bounds places constraints on the range of risk attitudes entering the STODOM analysis (Giesler, Paxton, and Millhollan, 1993). The advantages of STODOM is that it utilizes all simulated observations and provides an indication of the confidence a decision maker has regarding the ranking of alternative variety selections (Richardson, 2002). Furthermore, the results from STODOM are preferred to the simple "average" results, which do not internalize any considerations for risk preferences.

The data utilized in this study were collected for irrigated cotton production under crop share rental agreements in the SHP from 1998 to 2000. The data included detailed production, financial, and marketing information from each individual producer. It is important to note that all results are reported on an aggregate basis to protect the confidentiality of individual producers.

RESULTS

Standardized Performance Analyses of individual farming operations provided 27, 12, and 21 observations for Roundup Ready[1] cotton varieties, and 38, 22, and 15 observations for conventional cotton varieties from 1998 to 2000, respectively. The per acre results are reported on a 75% crop share bases and are given in Tables 1 and 2 for Roundup Ready and conventional cotton varieties, respectively.

[1] None of the Roundup Ready observations included a stacked gene variety.

Table 1. Irrigated Roundup Ready Cotton Results from the Texas Southern High Plains.

	1998	1999	2000	Weighted Average
		(lbs/acre)		
Total Yield	532	405	665	553
Crop Share Yield[1]	399	304	499	415
		($/acre)		
Gross Cash Income				
Cotton Lint[2]	231.29	145.39	242.31	217.97
Program Payments	50.20	81.78	61.02	60.30
Crop Insurance Proceeds	4.11	0.00	1.02	2.21
Other Income[3]	34.32	20.73	48.99	36.74
Gross Accrual Revenue	319.92	247.90	353.34	317.21
Cash Operating Expenses				
Chemicals				
Herbicide	23.21	28.66	24.80	24.86
Insecticide	4.14	3.84	16.35	8.35
Harvest Aide	6.49	3.24	6.90	5.98
Growth Regulator	2.33	2.26	4.46	3.06
Fertilizer & Lime	14.43	14.94	18.82	16.07
Gasoline, Fuel, & Oil	12.10	10.34	14.16	12.47
Seeds & Plants	14.87	12.61	17.72	15.42
Repairs & Maintenance	15.73	14.92	22.83	18.05
Hired Labor & Management	27.82	22.26	30.69	27.71
Irrigation	46.61	33.19	43.79	42.94
Other Operating Expenses[4]	49.20	12.26	38.70	38.14
Total Cash Operating Expenses	216.93	158.52	239.22	213.05
Total Interest Expense	13.66	15.43	20.09	16.26
Depreciation Expense	31.68	14.87	35.05	29.50
Total Overhead Expenses	45.34	30.30	55.14	45.76
Total Enterprise Cost	262.27	188.82	294.36	258.81
Net Income[5]	57.65	59.08	58.98	58.40
Enterprise Cost of Production[6]	173.64	86.31	183.33	159.57

[1]Crop share yield is based on 75% of total yield. [2]Accrual adjusted to account for the entire 1998, 1999 and 2000 crop share yield. [3]Other income includes farm coop distributions, custom hire earnings and miscellaneous income. [4]Other expenses include custom hire, insurance, rent, supplies and miscellaneous expenses. [5]Net income is before family living withdrawals. [6]Enterprise cost of production is total enterprise cost less non-primary enterprise revenues, and represents the cost of production that must be covered with primary enterprise revenues.

Table 2. Irrigated Conventional Cotton Results from the Texas Southern High Plains.

	1998	1999	2000	Weighted Average
	(lbs/acre)			
Total Yield	504	397	409	454
Crop Share Yield[1]	378	298	307	340
Gross Cash Income	($/acre)			
Cotton Lint[2]	222.14	153.93	160.38	189.78
Program Payments	48.03	58.05	46.70	50.70
Crop Insurance Proceeds	0.49	7.96	16.51	5.89
Other Income[3]	32.42	13.57	46.69	29.74
Gross Accrual Revenue	303.08	233.51	270.28	276.11
Cash Operating Expenses				
Chemicals				
Herbicide	15.45	12.63	13.18	14.17
Insecticide	6.64	3.40	17.88	7.43
Harvest Aide	6.59	4.18	6.24	5.81
Growth Regulator	1.73	2.63	2.35	2.12
Fertilizer & Lime	16.93	13.53	14.65	15.48
Gasoline, Fuel, & Oil	9.70	7.58	11.95	9.53
Seeds & Plants	8.99	7.58	9.92	8.76
Repairs & Maintenance	17.43	16.10	11.94	15.94
Hired Labor & Management	28.89	28.05	32.61	29.39
Irrigation	42.66	29.62	38.71	38.04
Other Operating Expenses[4]	48.14	35.31	41.51	43.05
Total Cash Operating Expenses	202.15	160.61	200.94	189.72
Total Interest Expense	10.70	9.31	10.01	10.15
Depreciation Expense	30.96	22.10	34.72	29.11
Total Overhead Expenses	41.66	31.41	44.73	39.27
Total Enterprise Cost	243.81	192.02	245.67	228.99
Net Income[5]	59.27	41.49	24.61	47.12
Enterprise Cost of Production[6]	162.87	112.44	135.77	142.66

[1]Crop share yield is based on 75% of total yield. [2]Accrual adjusted to account for the entire 1998, 1999 and 2000 crop share yield. [3]Other income includes farm coop distributions, custom hire earnings and miscellaneous income. [4]Other expenses include custom hire, insurance, rent, supplies and miscellaneous expenses. [5]Net income is before family living withdrawals. [6]Enterprise cost of production is total enterprise cost less non-primary enterprise revenues, and represents the cost of production that must be covered with primary enterprise revenues.

Gross enterprise accrual revenues for Roundup Ready cotton averaged $317.21 per acre compared to $276.11 per acre for conventional cotton varieties. This was primarily the result of higher primary product income and government payments for Roundup Ready cotton varieties. Crop share yields for Roundup Ready cotton were 75 pounds per acre higher on average compared to conventional cotton varieties, which contributed to the higher primary product income. Crop share yields were 399, 304, and 499 pounds per acre for Roundup Ready varieties, and 378, 298, and 307 pounds per acre for conventional varieties from 1998 to 2000, respectively.

Producers received cotton lint prices of $0.59, $0.52, and $0.52 per pound for conventional varieties compared to $0.58, $0.48, and $0.49 per pound for Roundup Ready varieties from 1998 to 2000, respectively. Government payments for Roundup Ready cotton were $23.73 per acre higher than for conventional cotton varieties in 1999 and $14.32 per acre higher in 2000. However, there is no apparent explanation for the higher government payments other than the possible variability resulting from the random selection of producers across the SHP.

Total cash operating expenses were higher for Roundup Ready cotton varieties at $216.93 and $239.22 per acre compared to $202.15 and $200.94 per acre for conventional cotton varieties in 1998 and 2000, respectively. However, the results indicated that total cash operating expenses were lower for Roundup Ready varieties in 1999 at $158.52 per acre compared to $160.61 per acre for conventional cotton varieties. Herbicide expenses were $10.69 per acre higher on average for Roundup Ready varieties compared to conventional varieties. The higher herbicide expense is primarily the result of increased Roundup herbicide applications. Insecticide expenses were relatively constant across both varieties averaging $8.35 and $7.43 per acre for Roundup Ready and conventional varieties, respectively. In 2000, there was a significant increase in insecticide expenses for both varieties. This increase was the result of several producers in the study who incurred higher insecticide expenses to control boll weevils without the assistance of a Boll Weevil Eradication program.

Producers also incurred higher average seed costs per acre for Roundup Ready varieties of $15.42 per acre compared to $8.76 for conventional varieties. This is consistent with expectations given the technology fees associated with Roundup Ready varieties. Furthermore, producers incurred hired labor and management expenses that were $1.68 per acre lower on average for Roundup Ready varieties. Producers also incurred other cash operating expenses (custom hire, insurance, rent, supplies, and other miscellaneous expenses) that were $4.91 per acre higher on average for conventional varieties. However, there is no apparent explanation for the increased expenditures other than the variability associated with the random selection of producers.

Total overhead expenses were consistent for both varieties averaging $45.76 and $39.27 per acre for Roundup Ready and conventional cotton varieties, respectively. It is important to note that overhead expenses only included interest and depreciation expenses. Family living withdrawals were not included in the overhead expenses due to the significant variation in this expense across producers. Total enterprise costs were $18.46 and $48.69 per acre higher for Roundup Ready varieties compared to conventional varieties in 1998 and 2000, respectively. However, total enterprise costs were lower for Roundup Ready varieties at $188.82 per acre compared to $192.02 per acre for conventional cotton varieties in 1999.

Further analysis suggests that producers faced a total average breakeven cost of $0.62 and $0.67 per pound on average from 1998 to 2000 for Roundup Ready and

conventional varieties, respectively. Total breakeven costs represent the total primary product income, government payments, crop insurance, and other income necessary to cover total costs of production. In other words, the total breakeven cost indicates how much total revenue from all sources is needed to breakeven. The unit cost of production (breakeven price) averaged $0.38 and $0.42 per pound from 1998 to 2000 for Roundup Ready and conventional varieties, respectively. The unit cost of production represents the cotton lint price necessary to cover all costs after accounting for all non-primary product income. In other words, the unit cost of production represents the cotton lint price necessary to breakeven.

Producers in the SHP received, on an aggregate basis, higher net incomes for Roundup Ready varieties compared to conventional varieties in 1999 and 2000. Producers received net incomes of $57.65, $59.08, and $58.98 per acre for Roundup Ready varieties compared to $59.27, $41.49, and $24.61 per acre for conventional varieties from 1998 to 2000, respectively.

The above "average" results evaluate the profitability of Roundup Ready and conventional cotton varieties without any consideration of risk preferences or variability associated with prices, yields, and production costs. Therefore, stochastic simulations were developed to evaluate the variety decision when accounting for variability and different levels of producer risk aversion.

The data used to generate the stochastic simulations for Roundup Ready and conventional varieties are provided in Tables 3 and 4, respectively. The per acre yields, prices, and cash operating expenses were assumed to be stochastic. Again, government payments, miscellaneous revenues, and overhead expenses were not included in the simulations. The input data components of Tables 3 and 4 provide the means, standard deviations, absolute minimums, and absolute maximums associated with the stochastic variables utilized in the simulations. This input data was then utilized to generate the stochastic variables with a truncated normal function. A total of 1,000 net income observations were simulated for each year from 1998 to 2000, while accounting for the stochastic nature of yields, prices, and production costs. The simulated net income observations for Roundup Ready and conventional cotton varieties were then truncated by their respective absolute minimums and maximums observed in each year of the study. All truncated simulated observations from 1998 to 2000 were combined to provide one simulated dataset for Roundup Ready and conventional varieties.

STODOM was used to evaluate and rank Roundup Ready and conventional cotton varieties and compare various levels of risk aversion and risk neutrality. The STODOM analyses were conducted for twenty different alternative levels of risk aversion coefficients (ARAC) ranging from 0 to 0.05. Under all levels of ARAC's evaluated in this study, Roundup Ready varieties dominated conventional cotton varieties when accounting for risk preferences and stochasticity of yields, prices, and production costs. This is supported graphically in Figure 1, which depicts the cumulative probability density functions of the simulated net incomes for Roundup Ready and conventional cotton varieties. Figure 1 indicates that Roundup Ready varieties resulted in higher net incomes for any level of probability. Furthermore, this figure indicates that conventional cotton varieties had roughly a 15% greater probability of generating a negative net income.

Table 3. Dynamic Simulation Data for Roundup Ready Cotton.

	Mean	Standard Deviation	Absolute Minimum	Absolute Maximum
		1998		
Price ($/lb)	0.573459	0.068426	0.456	0.651
Yield (lb/ac)	399	197	165.31	751.61
TCOE[1] ($)	216.93	71.16	137.61	425.37
		1999		
Price ($/lb)	0.478257	0.048045	0.454	0.506
Yield (lb/ac)	304	11	113.4	456.08
TCOE[1] ($)	158.52	49.96	122.32	259.61
		2000		
Price ($/lb)	0.483607	0.055637	0.378	0.518
Yield (lb/ac)	499	298	102.38	1069
TCOE[1] ($)	239.22	98.16	158	297

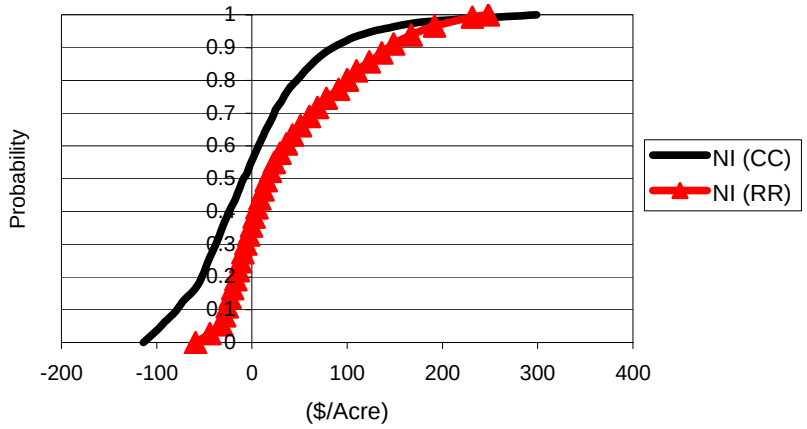
[1]TCOE - Total Cash Operating Expenses

Table 4. Dynamic Simulation Data for Conventional Cotton

	Mean	Standard Deviation	Absolute Minimum	Absolute Maximum
		1998		
Price ($/lb)	0.578677	0.077439	0.481	0.649
Yield (lb/ac)	378	171	161.11	913.84
TCOE[1] ($)	202.15	66.52	144.43	396.78
		1999		
Price ($/lb)	0.516544	0.061953	0.429	0.592
Yield (lb/ac)	298	91	114.95	890.74
TCOE[1] ($)	160.61	56.15	130.65	249.03
		2000		
Price ($/lb)	0.494235	0.078278	0.377	0.584
Yield (lb/ac)	307	129	173.3	747.25
TCOE[1] ($)	200.94	70.67	133.98	256.97

[1]TCOE - Total Cash Operating Expenses

Figure 1. Cumulative Density Functions of Net Incomes for Roundup Ready and Conventional Cotton Varieties.



CONCLUSIONS

The results of this study indicated that Roundup Ready and conventional cotton varieties produced similar net returns in 1998 of $57.65 and $59.27, respectively. However, results indicated that Roundup Ready varieties produced net incomes that were $17.59 and $34.57 per acre higher compared to conventional cotton varieties in 1999 and 2000, respectively. This was primarily the result of higher yields and government payments for Roundup Ready varieties in 1999 and 2000. This result was consistent with the results from White, Jones, and Johnson (2000) and Monsanto (2001). Further, Roundup Ready varieties incurred higher total costs of production with the exception of 1999. This higher production cost was inconsistent with results from Slinsky et al. (1996) and Monsanto (2001). However, results suggest that producers should be willing to accept higher costs of production for Roundup Ready varieties to realize higher lint yields and net incomes. The weighted average results indicated that Roundup Ready varieties produced higher net incomes of $11.28 per acre compared to conventional cotton varieties. While this result may not seem significant on a per acre basis, this would represent $11,280 on a 1000-acre farm.

However, one could make the case that government payments should be excluded from the average results. The exclusion of government payments in the average results would have produced similar net incomes under both varieties. The STODOM results, which did not include government payments, indicated higher net incomes for Roundup Ready varieties for any level of probability. Furthermore, the STODOM results should be preferred to the "average" results, since the STODOM results internalize the year-to-year variability. Finally, for risk averse and risk neutral producers in the SHP of Texas, the optimal strategy appears to be the selection of a Roundup Ready variety.

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