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ECONOMIC POTENTIAL OF A COTTON-CORN ROTATION

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Economic Potential of a Cotton-Corn Rotation

Summary

Producers are constantly trying to improve economic returns. Numerous studies have been conducted to investigate the potential yield benefits of cotton-corn rotations. None of these studies, however, addressed the issues of returns to the producer for performing these rotations. In other words, does the producer make any more money with rotations, or would the producer receive higher returns planting continuous cotton? Interviews conducted with individual producers geographically dispersed throughout the Delta region of Mississippi reported cotton lint yield increases ranging from 150-400 pounds per acre the first year following corn. This analysis allows comparison between base cotton yields and selection of break-even cotton and corn prices. By selecting a yield level and either a cotton or corn price, the break-even price of the other crop is easily determined. The results suggest that corn should be included in all rotations.

Introduction

Producers are constantly trying to maximize economic returns. A common practice for many producers in some parts of the U.S. is to rotate crops. Crop rotation has been shown to increase agronomic yields for many crop combinations (Spugeon and Grissom; Ebelhar and Welch; Kurtz et al.; Funchess; and Boquet). This rotation has been used for various reasons: potential yield increases, nematode reduction, improved weed control, and increased returns (Spugeon and Grissom; Ebelhar and Welch; Kurtz et al.; Boquet, Parvin, and Cooke; Bechel et al.; and Lawrence and McLean).

Several studies have been conducted to investigate the potential yield benefits of cotton-corn rotations in the Mississippi Delta. Spurgeon and Grissom were among the first to document cotton yield responses to crop rotations. Their study, conducted in the 1950s and 1960s, showed an increase in cotton yield of more than 8% following a corn crop on a Bosket very fine sandy loam soil. Additionally, Spurgeon and Grissom reported on a Dubbs silt loam soil a 12% increase in cotton yield the first year following corn and a 7% increase the second year. Spurgeon and Grissom also evaluated a Sharkey clay soil and reported a 6% increase in cotton yield the first year following corn, with a more than 4% increase the second year.

Ebelhar and Welch also investigated the response of cotton to various crop rotation patterns. Their study, conducted in the 1980s with early-maturing cotton varieties, showed a 12% increase in yield the first year following a corn crop and a 2% increase the second year on a mixture of Bosket very fine sandy loam soil and Dubbs silt loam soil.

The Louisiana State University Agricultural Center's Northeast Research Station in St. Joseph, Louisiana, has an ongoing crop rotation study that began in 1980. The station's results show yields increase an average of 12% the first year following corn and 5% the second year for the 1980-2000 period (Boquet).

Materials and Methods

None of these studies, however, addressed the issue of returns to the producer for performing these rotations. In other words, would the producer make more money with rotation, given the above-mentioned yield increases, when compared with the returns from planting continuous cotton? The authors have developed preliminary corn-cotton price analysis tables to address this issue. The tables show returns above specified costs at various cotton and corn prices. Specified costs were based on the 2000 Delta Area, Mississippi State Planning Budgets (MSPB) and include fixed and variable costs but exclude land and management charges. The MSPB costs of production totaled $587 for irrigated cotton and $315 for irrigated corn. The corn budget was based on irrigated production under conventional tillage utilizing eight-row equipment on 40-inch row spacings. Returns to the corn crop are based on the budgeted yield of 135 bushels per acre. The cotton budget was based on irrigated cotton production under conventional tillage using eight-row equipment and 40-inch row spacings.

Preliminary Results

Tables for three different cotton yields are presented: 750, 850, and 1,000 pounds of lint per acre. These yields could be considered as "base" or "normal" yields if no rotation was conducted. These are also the yields used for the continuous cotton returns presented with each table. Tables 1-3 are presented for a 3-year (corn-cotton-cotton) rotation. Tables 4-6 show a 2-year (corn-cotton) rotation. The tables show average per-acre returns for either 2 or 3 years of the rotation. The tables assume corn is produced the first year with a 12% increase in yield for the first year after corn (second crop year). The 3-year tables assume a 6% increase in yield for the second cotton crop following corn.

A few points should be made concerning the tables. The returns from continuous cotton are given in the last row of each table. Each column of the tables presents results from the selected cotton prices. By choosing a cotton price and following it down the column, the returns for the rotation can be compared at each corn price (listed in the left column of each table) to the continuous cotton returns in the last row.

Each column in the tables has a return that is highlighted (bold and underlined). The highlighted return corresponds with the corn price that makes the rotation at least as profitable as continuous cotton at that respective cotton price. Some of the returns in the tables are **negative**. Often, the rotation is more advantageous than continuous cotton due a **reduction in losses**. It should be remembered that these returns do not consider any government support payments associated with either

Table 1. Average annual returns above budgeted costs per acre for continuous cotton and a corn-cotton-cotton rotation (3 years) at selected prices (corn yield = 135 bu/A, cotton yield = 750 lb/A).

Corn price	Cotton prices				
	$0.50	$0.55	$0.60	$0.65	$0.70
	$	*$*	*$*	*$*	*$*
$1.50	**-114**	**-86**	**-59**	**-32**	**-5**
$1.60	-109	-82	-55	-27	0
$1.70	-105	-77	-50	-33	4
$1.80	-100	-73	-46	-18	9
$1.90	-98	-68	-41	-14	13
$2.00	-91	-64	-37	-9	18
$2.10	-87	-59	-32	-5	22
$2.20	-82	-55	-28	0	25
$2.30	-78	-50	-23	4	31
$2.40	-73	-46	-19	9	35
$2.50	-69	-41	-14	13	39
Continuous cotton	-154	-116	-95	-57	-14

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

Table 2. Average annual returns above budgeted costs per acre for continuous cotton and a corn-cotton-cotton rotation (3 years) at selected prices (corn yield = 135 bu/A, cotton yield = 850 lb/A).

Corn price	Cotton prices				
	$0.50	$0.55	$0.60	$0.65	$0.70
	$	$	$	$	$
$1.50	**-71**	**-40**	**-10**	21	51
$1.60	-65	-36	-5	26	56
$1.70	-62	-31	-1	30	60
$1.80	-58	-27	4	**35**	65
$1.90	-53	-22	8	39	69
$2.00	-49	-18	13	44	**74**
$2.10	-44	-13	17	48	78
$2.20	-40	-9	22	52	83
$2.30	-35	-4	26	56	87
$2.40	-31	0	31	61	92
$2.50	-26	5	35	65	96
Continuous cotton	-96	-54	-11	32	74

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

Table 3. Average annual returns above budgeted costs per acre for continuous cotton and a corn-cotton-cotton rotation (3 years) at selected prices (corn yield = 135 bu/A, cotton yield = 1,000 lb/A).

Corn price	Cotton prices				
	$0.50	$0.55	$0.60	$0.65	$0.70
	$	$	$	$	$
$1.50	**-9**	25	63	99	135
$1.60	4	32	67	104	140
$1.70	0	36	72	108	144
$1.80	5	**41**	76	113	149
$1.90	9	45	81	117	153
$2.00	14	50	85	122	158
$2.10	18	54	90	126	162
$2.20	22	58	**94**	131	167
$2.30	27	62	99	135	171
$2.40	32	67	103	140	176
$2.50	36	71	108	**144**	180
Continuous cotton	-9	41	91	141	**191**

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

Table 4. Average annual returns above budgeted costs per acre for continuous cotton and a corn-cotton rotation (2 years) at selected prices (corn yield = 135 bu/A, cotton yield = 750 lb/A).

Corn price	Cotton prices				
	$0.50	$0.55	$0.60	$0.65	$0.70
	$	$	$	$	$
$1.50	**-107**	**-85**	**-64**	-43	-22
$1.60	-99	-78	-57	**-36**	-15
$1.70	-93	-72	-51	-30	-9
$1.80	-86	-65	-44	-23	**-2**
$1.90	-80	-59	-38	-16	4
$2.00	-73	-52	-31	-10	11
$2.10	-66	-46	-25	-3	17
$2.20	-60	-39	-18	3	24
$2.30	-53	-33	-12	10	30
$2.40	-47	-26	-5	16	37
$2.50	-40	-20	1	23	44
Continuous cotton	-154	-117	-79	-41	-3

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

crop. Where government assistance is known, the prices for corn and cotton should be adjusted accordingly and these adjusted prices used for comparisons. At lower cotton yield levels, most corn prices provide an economic advantage for the rotation versus continuous cotton. As cotton yields increase, higher corn prices are needed to make crop rotations more profitable. At the highest yield levels and cotton prices, continuous cotton provides the highest returns. Figures 1 and 2 combine the results from the tables for a 3-year and a 2-year rotation, respectively. This graphical representation allows comparison between base cotton yields and selection of break-even cotton and corn prices. By selecting a yield level and a point on the graph for either a cotton or corn price, the break-even price of the other is easily determined.

Table 5. Average annual returns above budgeted costs per acre for continuous cotton and a corn-cotton rotation (2 years) at selected prices (corn yield = 135 bu/A, cotton yield = 850 lb/A).

Corn price	Cotton prices				
	$0.50	**$0.55**	**$0.60**	**$0.65**	**$0.70**
	$	*$*	*$*	*$*	*$*
$1.50	**-75**	**-51**	-27	-3	21
$1.60	-68	-44	-20	4	28
$1.70	-62	-38	-14	10	34
$1.80	-55	-31	**-7**	17	41
$1.90	-48	-25	-1	23	48
$2.00	-42	-18	8	30	54
$2.10	-35	-12	12	**36**	61
$2.20	-29	-5	19	42	67
$2.30	-22	1	25	49	74
$2.40	-16	8	32	55	80
$2.50	-10	14	39	62	**87**
Continuous cotton	-96	-54	-11	31	82

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

Table 6. Average annual returns above budgeted costs per acre for continuous cotton and a corn-cotton rotation (2 years) at selected prices (corn yield = 135 bu/A, cotton yield = 1,000 lb/A).

Corn price	Cotton prices				
	$0.50	**$0.55**	**$0.60**	**$0.65**	**$0.70**
	$	*$*	*$*	*$*	*$*
$1.50	-27	1	29	58	86
$1.60	-20	8	35	64	92
$1.70	-14	15	41	71	99
$1.80	**-7**	19	50	78	106
$1.90	0	28	57	85	113
$2.00	6	35	63	91	119
$2.10	13	42	70	98	126
$2.20	20	**49**	77	105	133
$2.30	26	56	84	112	140
$2.40	33	62	90	118	146
$2.50	40	69	**97**	125	153
Continuous cotton	-9	44	91	**141**	**191**

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

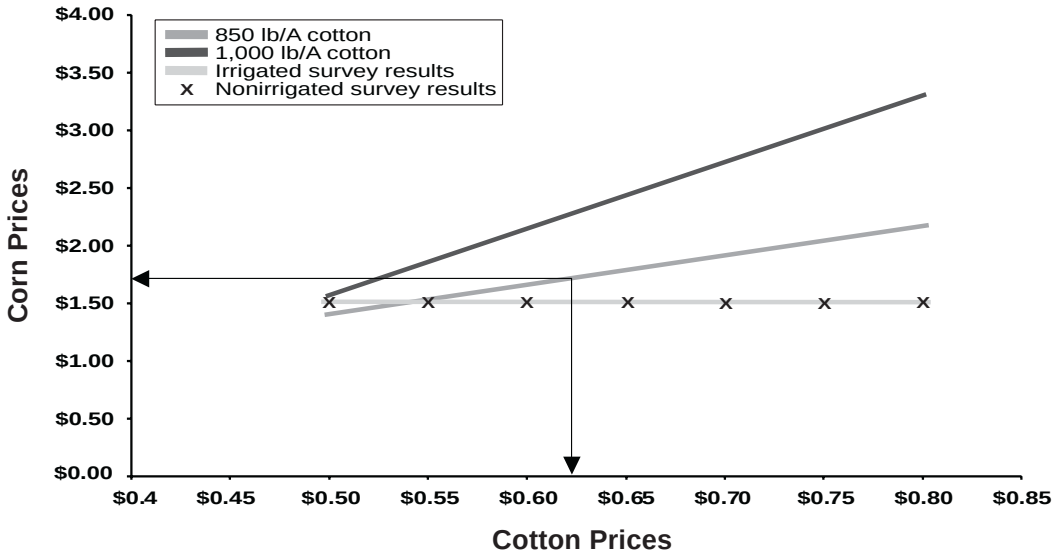

Figure 1. Prices needed for a 3-year (corn-cotton-cotton) rotation to be as advantageous as continuous cotton.

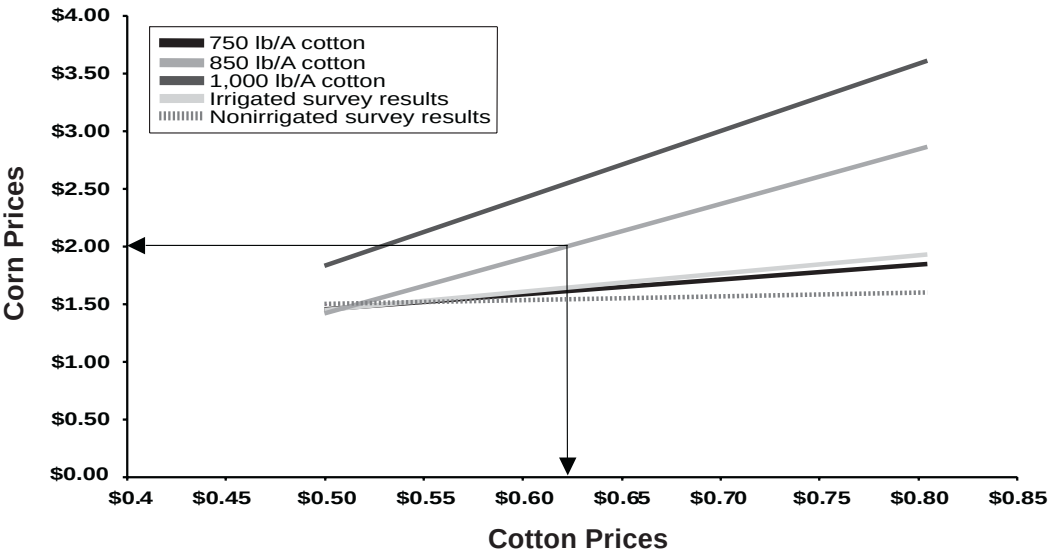

Figure 2. Prices needed for a 2-year (corn-cotton) rotation to be as advantageous as continuous cotton.

PRODUCER INTERVIEWS

These preliminary results suggest the need for further research in this area. The cost of production estimates used in Tables 1-6 are based on the 2000 MSPB. However, for producers engaged in a cotton-corn rotation, costs of production may vary significantly for either corn or cotton or both. Additionally, some local producers have suggested greater yield responses and higher per acre corn yields than those used in the preliminary analysis. Therefore, in the spring of 2001, producers with cotton-corn rotation experience were identified. These producers were interviewed in order to determine production practices and costs for a cotton-corn rotation. Where possible, data was obtained on yield response to the rotation. Also, an attempt was made to identify producers practicing cotton crop rotations other than corn (i.e., rice, grain sorghum, soybeans, wheat, etc.).

Interview Results

Interviews were conducted with 11 individual producers geographically dispersed throughout the Delta region of Mississippi. The results of the interviews were used to develop enterprise budgets for both corn following cotton and cotton following corn.

The producers estimated their cotton lint yields increased from 150-400 pounds per acre the first year following corn. Yield increases as compared with continuous cotton dropped to approximately half these amounts during the second year after corn. Producers also reported corn yields ranging from 135-225 bushels per acre. Based on these interviews, Tables 7-10 were developed to show break-even price combinations for the rotations. For irrigated production, a base cotton yield of 825 pounds per acre was used. A conservative 15% increase in cotton lint yield the first year following corn was used. For the 3-year rotations, a 7% yield increase was used for the second year following corn. For the irrigated rotations, a 165-bushel-per-acre corn yield was used for the comparisons. For nonirrigated production, a 750-pound-per-acre cotton yield and a 135-bushel-per-acre corn yield were used. Figures 1 and 2 include a graphical presentation of these results as well.

The enterprise budgets from the interviews show significant cost reductions from the standard budgets. Tables 11 and 12 compare the budgeted costs of the individuals interviewed with the standard budgets for irrigated and nonirrigated production, respectively. These cost reductions are primarily a result of tillage practices. One of the individuals interviewed practiced complete no-till production, and the remaining 10 practiced some form of reduced tillage. These reductions in tillage help to offset some of the added expenses associated with the rotation, such as increased plant bug insecticide applications on cotton adjacent to corn. Some producers suggested the need for additional tillage to remove corn stubble prior to cotton planting. However, overall tillage expenses were still less than conventional budgets. Most of the producers interviewed suggested some reduction in equipment and labor savings due to the timing of corn planting and harvest compared with a continuous cotton operation. These savings are not documented in this study. However, they are part of a larger research project that the authors have ongoing to address whole-farm analysis.

Results from the interviews suggest that corn should be included in all rotations. The break-even price for corn would have to be less than the corn loan rate in any of the situations for the rotation not to be advantageous. Again, these prices do not include any type of government assistance. The prices do not consider any discounts at the elevator or gin. Any prior knowledge of these premiums or discounts should be used to determine the price(s) used when making the comparisons.

Table 7. Average annual returns above survey costs per acre for continuous cotton and an irrigated corn-cotton rotation (2 years) at selected prices (corn yield = 165 bu/A, base cotton yield = 825 lb/A).

Corn price	Cotton prices				
	$0.50	$0.55	$0.60	$0.65	$0.70
	$	*$*	*$*	*$*	*$*
$1.50	**4**	**25**	**49**	73	96
$1.60	11	33	57	**81**	105
$1.70	18	42	65	89	113
$1.80	26	50	74	97	**121**
$1.90	34	58	82	106	129
$2.00	43	66	90	114	138
$2.10	51	75	98	122	146
$2.20	59	83	107	130	154
$2.30	67	91	115	139	162
$2.40	78	102	123	147	171
$2.50	84	108	131	155	179
Continuous cotton	-48	-6	35	76	118

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

Table 8. Average annual returns above survey costs per acre for continuous cotton and a nonirrigated corn-cotton rotation (2 years) at selected prices (corn yield = 135 bu/A, base cotton yield = 750 lb/A).

Corn price	Cotton prices				
	$0.50	$0.55	$0.60	$0.65	$0.70
	$	$	$	$	$
$1.50	**8**	**30**	**51**	**73**	94
$1.60	15	36	58	79	101
$1.70	21	43	65	86	**107**
$1.80	28	50	71	93	115
$1.90	35	57	78	100	121
$2.00	44	63	85	106	128
$2.10	49	70	92	113	135
$2.20	55	77	98	120	144
$2.30	62	84	105	127	147
$2.40	69	90	112	133	155
$2.50	76	97	119	140	162
Continuous cotton	-44	-7	31	69	106

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

Table 9. Average annual returns above survey costs per acre for continuous cotton and an irrigated corn-cotton-cotton rotation (3 years) at selected prices (corn yield = 165 bu/A, base cotton yield = 825 lb/A).

Corn price	Cotton prices				
	$0.50	$0.55	$0.60	$0.65	$0.70
	$	$	$	$	$
$1.50	**-4**	**26**	**57**	**87**	**118**
$1.60	1	32	62	93	123
$1.70	7	37	68	98	129
$1.80	12	43	73	104	134
$1.90	18	48	79	109	140
$2.00	23	54	84	115	145
$2.10	31	59	90	120	151
$2.20	34	65	95	126	156
$2.30	40	70	111	131	162
$2.40	45	76	116	137	167
$2.50	51	81	122	142	173
Continuous cotton	-48	-6	35	76	118

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

Table 10. Average annual returns above survey costs per acre for continuous cotton and a nonirrigated corn-cotton-cotton rotation (3 years) at selected prices (corn yield = 135 bu/A, base cotton yield = 750 lb/A).

Corn price	Cotton prices				
	$0.50	$0.55	$0.60	$0.65	$0.70
	$	$	$	$	$
$1.50	**0**	**28**	**56**	**84**	**112**
$1.60	5	33	61	88	117
$1.70	9	37	65	93	121
$1.80	14	42	70	97	125
$1.90	18	46	74	102	130
$2.00	23	51	79	106	134
$2.10	27	55	83	111	139
$2.20	32	60	88	115	143
$2.30	36	64	92	120	148
$2.40	41	69	97	124	152
$2.50	46	73	101	129	157
Continuous cotton	-44	-7	31	69	106

Highlighted returns (bold and underlined) correspond to the corn price needed for the rotation to break even as compared with continuous cotton for each respective cotton price.

Table 11. Irrigated production budget comparisons.

Standard cotton budget	Cotton following corn producer budget	Standard corn budget	Corn following cotton producer budget
$587	$517	$317	$270

Table 12. Nonirrigated production budget comparisons.

Standard cotton budget	Cotton following corn producer budget	Standard corn budget	Corn following cotton producer budget
$538	$477	$235	$209

Further Research

Further research is needed in documenting cotton and/or corn yield response to rotations. Other crop mixes also need to be identified and studied (i.e., grain sorghum). These research projects need to be conducted over varying soil types and moisture situations. Additionally, the whole-farm approach needs to be addressed. For example, if it takes X tractors to farm 3,000 acres of continuous cotton, can X-1 be used to farm 2,000 acres of cotton and 1,000 acres of corn? This report is written as a guide and as a prompt to stimulate interest into the potential of these and other crop rotations.

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Appendix Table 1. Summary of interviewed producers' estimated costs per acre for cotton (eight-row, 40-inch, solid, sandy soil) following corn (irrigated BtRR variety), Delta area, Mississippi, 2001.

Item	Unit	Price	Quantity	Amount	Your farm
		$		$	
Direct Expenses					
Custom spray	acre	8.72	1.0000	8.72	_____
Harvest aids	acre	17.25	1.0000	17.25	_____
Gin/dry	acre	66.00	1.0000	66.00	_____
Fertilizers	acre	50.18	1.0000	50.18	_____
Fungicides	acre	16.88	1.0000	16.88	_____
Herbicides	acre	37.36	1.0000	37.36	_____
Insecticides	acre	22.66	1.0000	22.66	_____
Seed/plants	acre	12.30	1.0000	12.30	_____
Technology fee	acre	63.00	1.0000	63.00	_____
Growth regulators	acre	4.62	1.0000	4.62	_____
Service fee	acre	7.00	1.0000	7.00	_____
Adjuvants	acre	0.17	1.0000	0.17	_____
Custom fert/lime	acre	17.44	1.0000	17.44	_____
Custom harvest/haul	acre	16.50	1.0000	16.50	_____
Operator labor	hour	8.76	1.4070	12.32	_____
Hand labor	hour	6.91	0.1870	1.29	_____
Irrigation labor	hour	6.91	0.0400	0.27	_____
Unallocated labor	hour	8.76	1.1256	9.86	_____
Diesel fuel	gal	1.05	21.2031	22.26	_____
Repair & maintenance	acre	31.54	1.0000	31.54	_____
Interest on op. cap.	acre	14.46	1.0000	14.46	_____
Total direct expenses				432.08	_____
Total fixed expenses				84.54	_____
Total specified expenses				516.62	_____

Note: Cost of production estimates are based on 2000 input prices.

Appendix Table 2. Summary of interviewed producers' estimated costs per acre for corn following cotton (irrigated), Delta area, Mississippi, 2001.

Item	Unit	Price	Quantity	Amount	Your farm
		$		$	
Direct Expenses					
Custom spray	acre	4.00	1.0000	4.00	_____
Fertilizers	acre	70.25	1.0000	70.25	_____
Herbicides	acre	22.37	1.0000	22.37	_____
Seed/plants	acre	29.14	1.0000	29.14	_____
Custom harvest/haul	acre	62.70	1.0000	62.70	_____
Operator labor	hour	8.76	0.4937	4.32	_____
Hand labor	hour	6.91	0.1665	1.15	_____
Irrigation labor	hour	6.91	0.0600	0.41	_____
Diesel fuel	gal	1.05	17.9058	18.80	_____
Repair & maintenance	acre	11.64	1.0000	11.64	_____
Interest on Op. Cap.	acre	8.06	1.0000	8.06	_____
Total direct expenses				232.84	_____
Total fixed expenses				37.04	_____
Total specified expenses				269.88	_____

Note: Cost of production estimates are based on 2000 input prices.

Table 3. Summary of interviewed producers' estimated costs per acre for cotton (eight-row, 40-inch, solid, sandy soil) following corn (nonirrigated BtRR variety), Delta area, Mississippi, 2001.

Item	Unit	Price	Quantity	Amount	Your farm
		$		$	
Direct Expenses					
Custom spray	acre	8.72	1.0000	8.72	_____
Harvest aids	acre	17.25	1.0000	17.25	_____
Gin/dry	acre	66.00	1.0000	66.00	_____
Fertilizers	acre	50.18	1.0000	50.18	_____
Fungicides	acre	16.88	1.0000	16.88	_____
Herbicides	acre	37.36	1.0000	37.36	_____
Insecticides	acre	22.66	1.0000	22.66	_____
Seed/plants	acre	12.30	1.0000	12.30	_____
Technology fee	acre	63.00	1.0000	63.00	_____
Growth regulators	acre	4.62	1.0000	4.62	_____
Service fee	acre	7.00	1.0000	7.00	_____
Adjuvants	acre	0.17	1.0000	0.17	_____
Custom fert/lime	acre	17.44	1.0000	17.44	_____
Custom harvest/haul	acre	16.50	1.0000	16.50	_____
Operator labor	hour	8.76	1.4070	12.32	_____
Hand labor	hour	6.91	0.1870	1.29	_____
Unallocated labor	hour	8.76	1.1256	9.86	_____
Diesel fuel	gal	1.05	12.0671	12.67	_____
Repair & maintenance	acre	26.78	1.0000	26.78	_____
Interest on Op. Cap.	acre	13.94	1.0000	13.94	
Total direct expenses				416.98	_____
Total fixed expenses				59.88	_____
Total specified expenses				476.82	_____

Note: Cost of production estimates are based on 2000 input prices.

Table 4. Summary of interviewed producers' estimated costs per acre for corn following cotton (nonirrigated), Delta area, Mississippi, 2001.

Item	Unit	Price	Quantity	Amount	Your farm
		$		$	
Direct Expenses					
Custom spray	acre	4.00	1.0000	4.00	_____
Fertilizers	acre	68.40	1.0000	68.40	_____
Herbicides	acre	22.37	1.0000	22.37	_____
Seed/plants	acre	28.67	1.0000	28.67	_____
Custom harvest/haul	acre	51.30	1.0000	51.30	_____
Operator labor	hour	8.76	0.4937	4.32	_____
Hand labor	hour	6.91	0.1665	1.15	_____
Diesel fuel	gal	1.05	4.2018	4.41	_____
Repair & maintenance	acre	4.50	1.0000	4.50	_____
Interest on Op. Cap.	acre	7.43	1.0000	7.43	_____
Total direct expenses				196.55	_____
Total fixed expenses				12.38	_____
Total specified expenses				208.93	_____

Note: Cost of production estimates are based on 2000 input prices.

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