ECONOMIC IMPACT OF INTEGRATED PEST MANAGEMENT STRATEGIES FOR COTTON PRODUCTION IN THE COASTAL BEND REGION OF TEXAS

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A long-season (160–180 days) cotton variety with a conventional production system was formerly grown in the Texas Coastal Bend Region. Cotton producers in the region used intensive insecticide applications throughout the growing season and harvested in August or September, and occasionally in October. In general, intensive insecticide applications for boll weevil and fleahopper control destroyed the beneficial insects and spiders. Late-season tobacco budworm infestations were thereby aggravated. These late-season insect infestations were a result of the relatively high rainfall during August and September. Moreover, high rainfall during this time not only interfered with harvest, but also reduced both the yield and quality[1] of cotton (Lacewell et al.).

To combat problems of accelerating insect resistance to pesticide, adverse climatic conditions, and high costs of production, new, integrated pest management (IPM) cotton production systems were developed for several regions of Texas, including the Coastal Bend Region. The IPM production strategies for cotton are based on a short-season (120–140 days) production system, which requires cotton varieties that fruit rapidly for a limited period of time and require carefully controlled inputs. The IPM program in cotton involves all phases of production: cultural practices, particularly variety selection and planting date; continued field scouting; biological control using natural beneficial insects; and selected use of insecticides to keep insect population below economically damaging levels. This management system is directed toward carefully controlling inputs for maximum farmer profits (Lacewell and Taylor; Texas Agricultural Extension Service).

The short-season cotton production technique is an integral part of the IPM program, and its success is demonstrated by the very rapid adoption of a short-season cotton production system throughout the Coastal Bend Region of Texas. In addition to adoption of short-season cotton production system, there has been an upward trend in cotton acreage from about 50,000 in 1975, to approximately 300,000 in 1980 (Texas Crop and Livestock Reporting Service, 1970–79). The conventional cotton production system no longer exists in the region because of the complete adoption of the short-season system. Universal adoption of the short-season production system led to all gins converting to stripper harvested cotton.

This study examines the value and economic impact of short-season cotton production system under IPM strategies as it relates to yield and producer returns in the Coastal Bend Region of Texas. The study has implications for cotton producers, industry leaders, and other professionals for a better understanding of the economics of cotton production and for analyzing possible future production decisions relating to cotton.

STUDY AREA AND DATA

The study area is near Corpus Christi and includes three counties of the upper Coastal Bend Region of Texas: Jim Wells, Nueces, and San Patricio. The main agricultural products in the region are cotton and grain sorghum; in addition, flax and pasture are also grown. Cash receipts from farm marketings for crops to area producers were about $112.2 million in 1979 (Texas Crop and Livestock Reporting Service, 1979).

Enterprise budgets developed by Benedict and Lippke for short-season cotton varieties Tamcot SP-37 and CAMD-E[2] were used in this study. The budget for grain sorghum was obtained from the Texas Agricultural Extension Service (Extension Economists-Management). These crop budgets reflected projected dryland costs and returns per acre for 1980. For both Tamcot SP-37 and CAMD-E, separate budgets were prepared for production practices under "IPM" and "Typical" pest management. The use of scouting and

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[1] A decline in cotton grade is primarily the result of weather.

[2] Other commercial cotton varieties may have yields and costs data similar to CAMD-E; however, this study is based on data from cotton variety CAMD-E.

lesser amounts of insecticide and participation in a pest management program were defined for a short-season cotton production system under "IPM" production techniques, while the converse practices were defined for short-season cotton under "Typical" production techniques.

The expected yields for CAMD-E and Tamcot SP-37 cotton grown under IPM and CAMD-E cotton grown under typical conditions were compiled from the results of the yearly uniform Multi-Adversity Resistance (MAR) cotton tests, Texas Agricultural Experiment Station, Corpus Christi.[3] For hand-snapped harvests of cotton varieties CAMD-E and Tamcot SP-37 grown under IPM, a 15-percent-downward-per-acre yield adjustment was made to conform to machine harvest experience. Yield for typical Tamcot SP-37 cotton was the three-county average yields for the period 1975–1978. The expected yield for grain sorghum was established on the basis of projected 1980 yield. In addition to the above enterprise budgets, per-acre costs and returns for conventional or long-season cotton varieties for the Coastal Bend Region were developed for 1980. The conventional production system provided a base for comparison with the new short-season production system. Yield and acreage data for cotton and grain sorghum were collected from county soil surveys and classified by 82 soil types (USDA, 1965, 1979a, b).

The price of cotton lint in the enterprise budget was established on the basis of expected grade, quality, and micronaire differences. The price of grain sorghum in the budget was established on the basis of projected price for 1980.

METHODOLOGY

Per acre-budgets for different cotton varieties under alternative management strategies provided the base data for a budgeting analysis. Table 1 is a summary of the base budgets. The base budgets include average yield and prices for each cropping activity, rather than for specific soil type.

These costs and returns data from enterprise budgets and crop yield and acreage data from soil surveys were utilized to develop a linear programming model for the Coastal Bend Region of Texas. Six production activities included in the linear programming (LP) model were: (1) IPM CAMD-E cotton, (2) IPM Tamcot SP-37 cotton, (3) typical CAMD-E cotton, (4) typical Tamcot SP-37 cotton, (5) conventional cotton, and (6) grain sorghum, on each soil type.[4] For example, this means that a production activity for IPM CAMD-E cotton was developed for each soil type (82 soil types) to reflect yield differences and associated harvesting cost differences among the soil types. The objective function of the model was to maximize producer net returns, subject to the amount of acreage of each soil type.

Cotton yields in the county survey were assumed to be for IPM Tamcot SP-37. Adjustment factors, based on test plot data, reflect the yield relationship between the alternative cotton varieties and production systems.

Costs data necessary for the LP model include: (1) pre-harvest, variable costs of production; (2) defoliation costs for harvest, which do not vary with the yield for a specific cotton management practice; and (3) harvest costs that were assumed to vary with the yield of each crop. The last cost item was (4) non-land fixed costs that include depreciation on tractors and machinery only. These values as shown in Table 1 were taken from the detailed base budgets for the Coastal Bend Region (Extension Economists-Management).

RESULTS

To identify cotton production costs and practices under IPM strategies and compare with the typical production practices, the base budget was utilized. The programming analysis initially considered application of the LP model in an unconstrained mode except for land resources. Last, the effect of cotton and grain sorghum sales to the region and state economies were estimated.

Budgeting Analysis

The analysis of base budgets indicates that IPM strategies for short-season cotton production result in higher expected yields and returns per acre (Table 1). Costs of production per pound of lint are estimated to be \$.40 to \$.42 for the IPM, \$.46 to \$.50 for typical practices, and \$.56 for conventional production practices.

Type, quantity, and costs of insecticide use for short-season cotton under IPM strategies and short-season cotton not under IPM strategies are presented in Table 2. The estimated quantity of insecticide applied per acre is lower with IPM strategies compared with typical management practices.

The total costs of insecticide use are reduced by \$8.72 per acre for IPM strategies as compared to typical practices. However, with a \$3.00-per-acre cost of scouting, which is not included as a part of typical management practices, the net reduction in cost is about \$5.72 per acre for IPM strategies (Table 2).

The decrease in insecticide costs for IPM pro-

[3] These tests are established by Dr. Luther Bird and Lucas Reyes, in conjunction with county agents as part of the MAR Cotton breeding program, Dr. Bird in charge.

[4] Although, in general, cotton is more profitable per acre than grain sorghum, for some soils, grain sorghum is more adaptable. Exclusion of grain sorghum would not be appropriate for the model application, and it would eliminate any per-acre comparisons.

TABLE 1. Expected Price, Yield and Production Cost of Grain Sorghum and Different Cotton Varieties under Alternative Management Strategies, Texas Coastal Bend Region (San Patricio, Nueces and Jim Wells Counties), 1980

				Preharvest Cost		Harvest Cost				
Crop Name	Management Level	Price ($/cwt)	Yield (cwt/acre)	Insecticide and Scouting ($/acre)	Other ($/acre)	Defoliation Cost ($/acre)	Haul, Harvest, Gin, Bag & Ties[b] ($/acre)	Total[c] Variable Cost ($/acre)	Non-Land Fixed Cost ($/acre)	Returns to Land, Management, Overhead and Risk ($/acre)
Grain Sorghum	High Level	4.70	33.0	2.62	57.86	NA	18.15	78.63	28.14	48.33
Tamcot SP-37[a]	IPM	59.50 (Lint)	6.21 (Lint)	10.68[e]	76.27	10.96	129.84[d]	227.75	33.37	158.58
		5.00 (Seed)	9.94 (Seed)							
CAMD-E[a]	IPM	57.91 (Lint)	6.80 (Lint)	10.68[e]	76.27	10.96	142.17[d]	240.08	33.37	174.34
		5.00 (Seed)	10.88 (Seed)							
Tamcot SP-37[a]	Typical	59.50 (Lint)	4.73 (Lint)	16.40[f]	76.27	10.96	98.91[d]	202.54	33.37	83.53
		5.00 (Seed)	7.60 (Seed)							
CAMD-E[a]	Typical	57.91 (Lint)	5.43 (Lint)	16.40[f]	76.27	10.96	113.52[d]	217.15	33.37	106.93
		5.00 (Seed)	8.69 (Seed)							
Cotton	Conventional	60.00 (Lint)	3.50 (Lint)	20.93[g]	70.93	4.38	64.64[d]	160.88	33.37	43.75
		5.00 (Seed)	5.60 (Seed)							

[a] These are specific cultivars of cotton integrated into a new crop production system.
[b] Grain sorghum harvesting costs include custom combine and haul.
[c] Total of pre-harvest and harvest costs.
[d] Based on one hundredweight of lint cotton.
[e] Two insecticide applications, and scouting of cotton field (Research conducted by Texas A&M Research & Extension Center, Corpus Christi).
[f] Four insecticide applications and no scouting of cotton field (Research conducted by Texas Coastal Bend Pest Management Program).
[g] More than five (5.33) insecticide applications, and no scouting of cotton field.

TABLE 2. Per Acre Comparison of Insecticide Use and Costs for Alternative Cotton Production Systems, Texas Coastal Bend Region, 1980

		IPM Strategies		Non-IPM Strategies		
Item	Unit	Optimum CAMD-E	Optimum SP-37	Typical CAMD-E	Typical SP-37	Conventional Cotton
Insecticide Use						
Bidrin	lb./AI	--	--	0.05	0.05	0.05
Pydrin	lb./AI	--	--	0.075	0.075	--
Guthion	lb./AI	0.50	0.50	0.50	0.50	0.75
Methyl Parathion	lb./AI	--	--	--	--	2.00
Insecticide Application	appl.	2.00	2.00	4.00	4.00	5.33
Scouting	acre	1.00	1.00	--	--	--
Insecticide Costs						
Bidrin	$/acre	--	--	.60	.60	.60
Pydrin	$/acre	--	--	4.32	4.32	--
Guthion	$/acre	3.88	3.88	3.88	3.88	5.82
Methyl Parathion	$/acre	--	--	--	--	4.38
Total Insecticide Costs	$/acre	3.88	3.88	8.80	8.80	10.80
Insecticide Application	$/acre	3.80	3.80	7.60	7.60	10.13
Scouting	$/acre	3.00	3.00	--	--	--
Total Costs (Insecticide, Insecticide Application and Scouting)	$/acre	10.68	10.68	16.40	16.40	20.93

grams and the associated increase in cotton yield would result in an increase in net returns for short-season cotton under IPM strategies. For example, net returns for Tamcot SP-37 cotton are estimated to be increased by $75.05 per acre for the IPM compared to typical practice. This is a measure of benefit of IPM programs in the region, because about 90 percent of the current cotton production is in Tamcot SP-37, for which seed is readily available. The remaining 10 percent of cotton in the region is CAMD-E, which represents a potential variety improvement over Tamcot SP-37 and hence could be used to illustrate additional benefits that can be derived from IPM programs. The net returns are increased by $90.81 per acre for CAMD-E cotton under IPM programs, compared to Tamcot SP-37 with best management practices. Hence, the additional benefit for CAMD-E cotton with the IPM is $15.76 per acre.

The number of insecticide applications and insecticide costs per acre is estimated to be higher for conventional cotton production system than for short-season production system, i.e., about 5.33 applications and $20.93 per acre, respectively (Table 2). The higher insecticide costs and lower yields per acre would result in lower net return ($43.75) per acre for conventional cotton. If this net return for conventional cotton is used as a benchmark in the analysis, then a comparison with net return for Tamcot SP-37 and CAMD-E, both with typical management practices, would indicate benefits of the new short-season cotton varieties. These benefits are estimated to be $36.96 and $67.18 per acre for Tamcot SP-37 and CAMD-E cotton, respectively. It is evident from the analysis that conventional cotton is not competitive with short-season production system and hence can be dropped out at this point.

Profit Maximizing Solutions

The baseline solution in which all of the six cropping activities were included indicated that out of the total 1,285,206 acres of land for the 82 soil types, 903,959 acres would be devoted to IPM CAMD-E cotton, 139,690 acres to grain sorghum production, and the remaining 241,557 acres of land to some use other than crop production to maximize net returns throughout the three counties (Table 3). Soils not appearing in the optimal solution are not productive enough for cotton and/or grain sorghum to grow profitably.

The per-acre average yields across all acres in the optimal solution were 462.0 lbs. for IPM CAMD-E cotton, and 27.0 cwt. for grain sorghum. However, for both cropping activities, there were extreme variations in per-acre yields by soil types. The range in per-acre yield for IPM CAMD-E cotton was 301.0 lbs. to 548.0 lbs. and for grain sorghum 22.0 cwt. to 39.0 cwt.

TABLE 3. Optimal Enterprise Combination, Coastal Bend Region, Texas, 1981

Enterprise Combination	Acreage	Quantity	Net Returns (Million Dollars)
1. IPM CAMD-E Cotton	903,959	417,203,707.0 lb. (lint)	
and		333,763.0 ton (seed)	
Grain Sorghum	139,690	3,808,593.0 cwt.	
Total	1,043,649		72.51
2. IPM Tamcot SP-37 Cotton	890,166	376,871,220.0 lb. (lint)	
and		301,497.0 ton (seed)	
Grain Sorghum	144,280	3,950,883.0 cwt.	
Total	1,034,446		62.34
3. Typical CAMD-E Cotton	394,576	157,248,711.0 lb. (lint)	
and		125,799.0 ton (seed)	
Grain Sorghum	574,897	17,497,692.0 cwt.	
Total	969,473		38.31
4. Grain Sorghum	969,473	29,227,086.0 cwt.	35.38

The net return to producers for the optimal solution was $72.5 million. This net return was the maximum that could be attained subject to the resource availability and other restricting factors. The optimal solution has implications for regional farmer net returns possibilities. The impact of adverse climatic conditions and variations in yield may be reduced by a more careful selection of cotton varieties and adoption of the new IPM strategies, thereby reducing per unit costs and increasing yield and net returns.

When IPM CAMD-E cotton was deleted from the cropping options, IPM Tamcot SP-37 and grain sorghum appeared in the optimal solution, and net returns decreased from $72.5 million to $62.3 million, or about 14 percent. The solution indicates that 890,166 acres of land could profitably be devoted to IPM Tamcot SP-37 cotton and 144,280 acres to grain sorghum production (Table 3).

The per-acre average yields for the solution with IPM Tamcot SP-37 in Table 3 were 423.0 lbs. of lint cotton (a decrease of 8 percent compared to the IPM CAMD-E solution in Table 3) and 27.0 cwt. for grain sorghum. The range in per-acre yield in this solution was 275.0 lbs. to 500.0 lbs. for IPM Tamcot SP-37 cotton and 22.0 cwt. to 39.0 cwt. for grain sorghum.

When cropping options that included both CAMD-E and Tamcot SP-37 cotton under IPM strategies were deleted, typical CAMD-E cotton and grain sorghum appeared in the optimal solution, and net returns decreased further from $72.5 million to $38.3 million or about 47 percent (Table 3).

A comparison of the solution allowing IPM CAMD-E cotton with the solution allowing only typical CAMD-E cotton offers some insight into the advantages of an IPM system. Yield per-acre with IPM CAMD-E would increase about 15 percent compared with typical CAMD-E cotton. Further, there would be a larger increase in IPM CAMD-E cotton acreages, about 130 percent, and net returns would increase about 90 percent compared with the solution for typical CAMD-E cotton, which is not produced under IPM strategies. This emphasizes the effectiveness of IPM programs for insect pest control in short-season cotton production techniques and the benefits of IPM, which are increased yield and net returns and reduced pesticide use and per unit costs of production. Because of the large increase in cotton acreages, short-season cotton production techniques apparently result in an increase in total pesticide use in the region although per-acre use declines substantially.

Finally, when IPM CAMD-E, IPM Tamcot SP-37, and typical CAMD-E cotton were deleted from the cropping options, only grain sorghum appeared in the optimal solution (Table 3). For this solution, net returns decreased to $35.4 million. As indicated earlier, the adoption of short-season production technique was a part of IPM programs and, had the new technique, with or without the IPM, not been adopted, the region would have emphasized grain sorghum and cow-calf production.

Regional and State Economic Impact

The average regional and state (Texas) economic impact of the short-season cotton and grain sorghum production corresponding to the optimal LP solution discussed earlier for the Texas Coastal Bend Region is shown in Table 4. The Coastal Bend Region production multipliers used for cotton and grain sorghum were 2.51 and 2.19, respectively (Jones and Williams).[5] The potential economic impact of IPM CAMD-E cotton and grain sorghum in the region is about $729.40 million. This is the maximum impact that could be generated subject to the resource availability and other restricting factors. With IPM CAMD-E cotton deleted from the cropping options, IPM Tamcot SP-37 cotton and grain sorghum production generate the second highest impact, about $679.19 million. When both CAMD-E and Tamcot SP-37 cotton under IPM strategies are deleted from the cropping options, the average regional impact of typical CAMD-E cotton and grain sorghum is $440.05 million. Finally, when IPM CAMD-E, IPM Tamcot SP-37, and typical CAMD-E are deleted from the cropping options, the average regional impact, with grain sorghum only, decreased to $300.84 million or about 41 percent of the maximizing solution, allowing IPM CAMD-E cotton and grain sorghum.

Production multipliers used for cotton and grain sorghum for the state were 3.77 and 3.63, respectively (Jones and Williams). The impact of IPM CAMD-E cotton and grain sorghum is about $1,101.65 million, followed by IPM SP-37 cotton, and grain sorghum ($1,026.46 million). Next, when typical CAMD-E and grain sorghum appeared in the solution, the state economic impact

TABLE 4. Impact of Short-Season Cotton under IPM Strategies and Grain Sorghum Output in the Optimal Linear Programming Solution, the Texas Coastal Bend Region and Texas, 1980

Enterprise Combination	Gross Revenue LP Solution (Million Dollars)	Production Multiplier[a] Coastal Bend	Production Multiplier[a] State (Texas)	Average Regional Impact (Million Dollars) Coastal Bend	Average Regional Impact (Million Dollars) State (Texas)
1. IPM CAMD-E Cotton	$241.60 (Lint)	2.51	3.77	$606.42	$ 910.83
	33.38 (Seed)	2.51	3.77	83.78	125.84
and	$275.98			$690.20	$1,036.67
Grain Sorghum	17.90	2.19	3.63	39.20	64.98
Total	$292.88			$729.40	$1,101.65
2. IPM SP-37 Cotton	$224.24 (Lint)	2.51	3.77	$562.84	$ 845.38
	30.15 (Seed)	2.51	3.77	75.68	113.67
and	$254.39			$638.52	$ 959.05
Grain Sorghum	18.57	2.19	3.63	40.67	67.41
Total	$272.96			$679.19	$1,026.46
3. Typical CAMD-E Cotton	$ 91.06 (Lint)	2.51	3.77	$228.56	$ 343.30
	12.58 (Seed)	2.51	3.77	31.58	47.43
and	$103.64			$260.14	$ 390.73
Grain Sorghum	82.15	2.19	3.63	179.91	298.20
Total	$185.79			$440.05	$ 688.93
4. Grain Sorghum	$137.37	2.19	3.63	$300.84	$ 498.65

[a] Jones and Williams.

[5] 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).

decreased to $688.93 million. Finally, when only grain sorghum could be produced, the state impact is about $498.65 million, or about 45 percent of the maximizing impact that is obtained with IPM CAMD-E cotton and grain sorghum (Table 4).

CONCLUSIONS

This analysis strongly suggests that IPM programs for short-season cotton production techniques result in higher yields and net returns per acre. The estimated quantity of insecticide applied per acre was lower with IPM programs, compared with the short-season production techniques without IPM programs. In addition, the results indicate that IPM programs reduce per unit cost through reduced pesticide use and an increase in yields per acre. However, short-season cotton production techniques would increase total pesticide use for the region as a result of the several-fold increase in cotton acreage.

The results of the study indicate the benefits and economic impact of short-season cotton production under IPM programs and, in particular, the potential for CAMD-E cotton in the region. The benefit in terms of producer net returns of Tamcot SP-37 cotton and short-season production system is $26.9 million and the potential for CAMD-E cotton is $37.1 million, as compared to only grain sorghum. It is apparent that net returns in the region could be increased by about $9.2 million if farmers could produce all CAMD-E cotton or a cotton variety with equal short-season yield potential.

The economic impact of Tamcot SP-37 cotton and a short-season production system, as compared to only grain sorghum, is $378.4 million for the Coastal Bend Region and $527.8 million for the state. The potentials for CAMD-E cotton for the region and state are $428.6 million and $603.0 million, respectively. Thus, the economic impact in the region and state could be augmented by $45.2 million and $67.7 million, each, by a complete adoption of CAMD-E cotton produced with optimal management in a short-season production system.

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