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**ECONOMIC, ENVIRONMENTAL AND ENERGY USE IMPLICATIONS OF
SHORT-SEASON COTTON PRODUCTION: TEXAS LOWER RIO GRANDE VALLEY***

**James L. Larson, Ronald D. Lacewell, James E. Casey,
Marvin D. Heilman, L. Neal Namken, and Roy D. Parker**

INTRODUCTION

Quantities of insecticides used per acre by cotton producers in the Lower Rio Grande Valley of Texas are among the nation's highest. This is due to the presence of many different insect pests and especially to their increasing tolerance to insecticides. As insects become resistant to insecticides, farmers tend to increase the number of insecticide applications, further compounding the problem. Even using large amounts of insecticides, control of damaging insects has been unsatisfactory.

Typically, a long-season cotton variety, requiring a 160 to 180 day season, is grown. Because the probability of rainfall is much greater in August than in July [4], most harvesting can be expected in August.

A delay in harvesting due to rain during August and September is detrimental to cotton yield and quality, leaving a favorable habitat for the boll weevil for an extended period of time. As the number of over-wintering boll weevils increases, insecticide programs must be started early in the following year to combat the problem.

Insecticides thus applied early in the season destroy beneficial insects, virtually eliminating biological control of bollworm and tobacco budworm. This means the cotton producer must use insecticides intensively until harvest. This large quantity of insecticides applied further aggravates the tobacco budworm resistance problem.

PRODUCTION CHARACTERISTICS

The two basic methods of producing cotton considered in this study are: (1) using 38- to 40-inch row spacings with the conventional 160- to 180-day conventional season concept, compared to (2) short season narrow spacing (double rows 7 inches apart on 38-inch rows, for example) with a 120- to 140-day production concept (narrow row-short-season production).¹

The analysis applies to cotton production on medium-textured soils in the Lower Rio Grande Valley and is based largely on research by Namken and Heilman [8]. In addition, enterprise budgets developed by the Texas Agricultural Extension Service for the area provided baseline data for operations [12].

Respectively, Research Assistant, Associate Professor and Research Associate, Department of Agricultural Economics, Texas A&M University; Soil Scientists, Agricultural Research Service, U.S. Department of Agriculture and County Extension Entomologist, Texas Agricultural Extension Service.

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This report is an evaluation of research and extension activities in the Lower Rio Grande Valley. The authors express their appreciation to the many scientists who contributed to the work; particularly Chan Connolly, director of the Texas A&M Agricultural Research and Extension Center at Weslaco and J. Michael Sprott, located at College Station. For estimating energy savings, the assistance of D. Pimentel, Cornell University, and W. D. Von Gonten, Texas A&M University, is gratefully acknowledged.

¹ The early or short-season production concept can be applied to conventional row spacing. Certain row spacings may be more desirable due to available harvesting equipment.

General

General production characteristics refer to all production aspects except insect control. Some of the more important characteristics associated with irrigated cotton production are presented in Table 1. Comparing short-season production to conven-

tional practices, both are spring and summer crops with major operation differences being earlier harvest for short-season varieties. This would not be expected to create any more scheduling problems than presently exist. Even with the earlier harvest of short-season varieties, grain sorghum

Table 1. PER ACRE PRODUCTION CHARACTERISTICS OF IRRIGATED COTTON WITH CONVENTIONAL AND NARROW ROW-SHORT SEASON METHODS; TEXAS LOWER RIO GRANDE VALLEY

Characteristic	Unit	Production Method	
		Conventional ^a	Narrow row-short season ^b
<u>General^c</u>			
seed	lb.	20	30
fertilizer	lb.	60-40-0	60-40-0
irrigations	no.	3	1
times harvested	no.	1.5	1.5
herbicide	times over	1	1
defoliant	times over	1	1
<u>Insect Control^d</u>			
flea hopper ^e	treatments	0.33	0.33
boll weevil ^f	treatments	5	3
boll weevil & bollworm ^g	treatments	5	3

^a Cotton produced on 38- to 40-inch beds with a 160- to 180-day growing season.

^b Cotton produced on 38- to 40-inch beds planted double row (7-8 inches between rows) with a 120- to 140-day growing season.

^c Basic machine operations were similar for both types of cotton.

^d This insect control treatment is for an area with rather several boll weevil infestations. In an area that does not have a severe boll weevil infestation, about ten treatments would be needed for bollworms with conventional cotton varieties and six with short-season cotton varieties.

^e One-third of the acreage treated annually. Dicrotophos is assumed to have been used at rate of 0.1 pound per acre.

^f Methyl parathion applied at rate of one pound per acre per treatment.

^g A mixture of chlordimeform and methyl parathion applied at the rate of 0.17 and 1.25 pounds, respectively, per acre per application.

has already been harvested and cotton harvesting machines and labor used on conventional varieties are available.

Conventional Production: Typical practices as identified by the Texas Agricultural Extension Service were generally accepted. Basically this consisted of three irrigations, preemergence herbicide treat-

ment, defoliant preceding harvest, and fertilizer application of 60 pounds of N and 40 pounds of P per acre.

Short-Season Production: There are two major production differences between short-season and conventional production. Ten more pounds of seed are planted (30 pounds compared to 20 pounds)

and only one irrigation is applied in the former system.

In any particular year the operations and inputs will vary from those used in this study. However, the relationship between the two production systems is expected to remain relatively similar to that presented in Table 1.

Insect Control

The most striking difference between conventional cotton production and short-season cotton production involves opportunities for improved pest management strategies. Table 1 shows expected insect control needed for each type of cotton production.

Conventional: Fleahopper control is normally conducted on only about one-third of the cotton acreage. For boll weevil, application of insecticides is delayed as long as it is felt economically justified to maintain biological control of the bollworm and budworm.

Generally, there are four or five treatments of methyl parathion for control of boll weevil (usually one pound of methyl parathion per acre per application).

Use of methyl parathion for boll weevil control reduces beneficial insect populations, and the bollworm and budworm emerge as economic pests. Therefore, for the rest of the growing season, five to six treatments of a mixture of chlordimeform and methyl parathion (at 0.17 and 1.25 pound per acre, respectively) are applied for control of boll weevils, bollworms and budworms. The number of applications varies considerably and may reach 15 to 20 in a bad insect year.

Short-Season Production: Short-season cotton production is based on high-density plant population and accelerated fruiting. Short-season cotton begins blooming in early May and blooms twice as fast as conventional cotton. The percent of total bolls that set (are not thrown off by the plant) are about the same for both types of cotton; hence, short-season cotton has more bolls much earlier.

The concept of pest control for short-season cotton varieties, not yet totally proven but indicating most promising results, varies significantly from conventional practices.

Overwintering boll weevils begin emerging about March 1, concurrent with development of pinhead squares. About April 15, squares are one-third grown and the boll weevil begins laying eggs. A pest management strategy being developed and tested for short-season cotton suggests that methyl parathion treatment should begin just before the

boll weevil egg deposition begins. A second treatment is applied five days later and a third treatment shortly thereafter. These treatments are designed to reduce subsequent generations.

Even with successful control of the first generation, the bollworm will generally begin to be an economic problem around June 15. Therefore, three treatments for bollworm control could be expected with short-season cotton. However, early boll weevil control (April) seems to result in better biological control of the bollworm via beneficials.

In conventional production of nonirrigated cotton, about one-third is generally treated for fleahopper, followed by two treatments for boll weevils, and three treatments for the boll weevil-bollworm-budworm complex. Short-season nonirrigated cotton production may require fleahopper control on about one-sixth of the acreage plus two treatments for the bollworm-budworm complex.

REVIEW OF LITERATURE

This study is based on research results from the Texas High Plains and especially the Lower Rio Grande Valley, relative to entomological and agronomic characteristics of short-season cotton varieties produced on narrow row spacings. Results from experiments in the Lower Rio Grande Valley relative to lint quantity and quality of short-season cottons were reported by Namken and Heilman [8]. The short-season concept refers to early defoliation and harvest, as compared to conventional cotton production. A short-season cotton variety had the largest yield of all varieties tested, but the shortest staple length. Research on narrow row cotton with increased plant populations indicates an increase in yield and a reduction in costs of production per pound of lint [1, 5, 10, 15].

A detailed report from Arizona evaluates short-season cotton production as compared with conventional production [16]. The study evaluated inputs and associated costs, then calculated per-acre net returns. It assumed alternative yield losses for short-season cotton compared to full-season cotton. Naturally, short-season cotton net returns were sensitive to yield.

METHODOLOGY

Enterprise Budget Generator

The crop budget generator adapted to IBM's 360 computer was used to establish per-acre cost and return budgets of cotton production, under

both production methods, in the Lower Rio Grande Valley [14]. Commonly referred to as the Oklahoma State University Crop and Livestock Budget Generator, this is the same general model that has been installed by several state experiment stations. Use of the enterprise budget generator model is widespread in the U.S. For Texas, it is available for major agricultural areas through the Texas Agricultural Extension Service. Included in stored data are regional typical machinery complements, prices, yields, machinery practices and inputs. These data are periodically revised in Texas, thus relatively current crop enterprise budgets are available, by region. The computer program provides a framework for rapid, accurate enterprise budget calculation using standard enterprise budgeting techniques. There are options included to modify or adjust any of the stored data for a region. In this study input prices, pesticide rates, irrigations, output prices, and yields were changed in accordance with the mode of production to accurately reflect production in the area.

Budgeting Analysis

To investigate economic and environmental implications of narrow row-early maturing deterministic cotton cultivars, compared with conventional non-deterministic cotton cultivars, basic budgeting analysis was applied. This involved (1) collection of cotton production data for both cotton production systems from Cameron, Willacy and Hidalgo Counties in the Lower Rio Grande Valley; (2) computer application of the crop budget generator; (3) estimation of per-acre quantity of insecticide use, fuel use, and net returns; and (4) expansion of per-acre estimates to total applicable acres in the area.

RESULTS AND IMPLICATIONS

Results of this study will be presented in two parts. First is a comparison of insecticide use and production costs and returns. Results in this section are reported on a per-acre basis with subsequent inferences made for the entire Rio Grande Valley. Second are estimates of energy conserved by using the short-season production method.

Insecticide Use, Cost, and Returns

Per Acre: The amount of insecticide applied per acre was lower with short-season production as compared with conventional. On irrigated land under conventional production, 12.13 pounds of insecticides were applied. Only 8.04 pounds were

applied in irrigated short-season cotton production. With no irrigation, conventional production required 6.04 pounds per acre versus 2.35 pounds per acre for short-season production. This represents 33.7 and 60.7 percent reductions in insecticide use on irrigated nonirrigated land, respectively. The reduction of insecticides reduces variable input costs to the producer. Also, an introduction of fewer chemicals into the environment is consistent with many environmentalists' goals.

Total costs of production are reduced primarily through reductions in input use. Production costs are reduced by \$18.50 per acre on irrigated cotton and \$10.17 on nonirrigated cotton using the short-season system compared to conventional production systems. These reductions represent a 10.2 and a 9.5 percent reduction in variable input costs on irrigated and nonirrigated land, respectively. The decrease in production costs resulted in an increase in net returns.

One feature of short-season cotton is that no yields are sacrificed. The change in net returns on conventional varieties versus short-season varieties is due to changes in production costs. Net returns to the producer for conventional irrigated cotton are an estimated \$37.27 per acre. Due to lower costs, net returns for short-season irrigated cotton are about \$55.77. Similarly, for conventional non-irrigated cotton, net returns are \$45.25 compared to \$55.32 for short-season varieties.

The price per pound was held constant between two basic varieties. Short-season varieties are harvested before the relatively large fall rains; hence, a consistent quality is produced. Conventional varieties often are not harvested until after exposure to adverse weather has caused some quality deterioration. This deterioration of conventional varieties due to exposure to rain, in conjunction with technological advances directed at spinning short staple cotton, provides the logic for not considering different prices.

Although a constant price for cotton lint was used in the analysis, it is important to emphasize that a four cent per pound reduction in short-season cotton compared to conventional varieties eliminates any economic advantage of short-season cotton.

Regional: Table 2 shows quantity of insecticide used, costs and returns for short-season and conventional cotton production expanded to the regional cotton acres (184,200 acres irrigated and 91,750 acres not irrigated). These data indicate that if the short-season cotton were produced on all cotton acres in the Lower Rio Grande Valley,

pounds of insecticide applied to cotton would decline from 2,788.5 thousand pounds (applied to conventional varieties) to 1,697.0 thousand pounds. This means a reduction in quantity of in-

secticides used of 39 percent (1,091.5 thousand pounds). In addition, net returns to producers would increase \$4,330.2 thousand (from \$11,017.9 thousand to \$15,348.1 thousand).

Table 2. A REGIONAL COMPARISON OF INSECTICIDE USE, COSTS, AND RETURNS WITH CONVENTIONAL VERSUS SHORT-SEASON COTTON PRODUCTION: RIO GRANDE VALLEY OF TEXAS ^a

Item	Unit	Irrigated Cotton Production			Nonirrigated Cotton Production		
		Conventional	Short-season	Difference	Conventional	Short-season	Difference
Insecticides:							
Bidrin	1,000 lbs	5.5	5.5	0	2.8	1.4	-1.4
Methyl parathion	1,000 lbs	2,072.2	1,381.5	-690.7	504.6	183.5	-321.1
Fundal	1,000 lbs	156	93.9	-62.7	46.8	31.2	-15.6
Total insecticides	1,000 lbs	2,234.3	1,480.9	-753.4	554.2	216.1	-338.1
Costs and Returns:							
Bidrin	\$1,000	27.6	27.6	0	13.8	6.9	-6.9
Methyl parathion	\$1,000	3,770.6	2,514.3	-1,256.3	918.4	334.0	-584.4
Fundal	\$1,000	1,527.0	915.5	-611.5	455.0	303.7	-151.3
Total insecticides	\$1,000	5,325.2	3,457.4	-1,867.8	1,387.8	644.6	-742.6
Other variable costs	\$1,000	28,026.0	26,977.9	-1,048.1	8,251.3	8,071.2	179.9
Total fixed costs	\$1,000	15,706.7	15,214.9	-491.8	5,201.3	5,201.2	0
Total costs	\$1,000	49,057.9	45,650.2	-3,407.7	14,839.6	13,917.1	-922.5
Returns	\$1,000	55,923.1	55,923.1	0	18,992.3	18,992.3	0
Net returns	\$1,000	6,865.2	10,272.9	3,407.7	4,152.7	5,075.2	922.5

^a All values are based on 184,200 acres of irrigated production and 91,750 acres of nonirrigated production [13].

Energy

An important consideration beyond insecticide use, output and producer net returns is energy use implications. With a short-season cotton production system, compared to a conventional one, there are fewer trips across the field and less usage of inputs. This indicates an energy savings in farm operations and in production of inputs that are used by agriculture.

For cotton production without irrigation, there is very little difference in fuel use between short-season and conventional production (about 16.4 gallons of diesel per acre). For irrigated cotton, fuel use is approximately 0.26 gallon per acre

less for short-season cotton (20.93 gallons compared to 20.67 gallons per acre). This suggests a diesel fuel savings of 47,892 gallons annually by shifting irrigated cotton in the area to short-season varieties.

Fewer insecticide applications are made; hence, airplane fuel is saved and less insecticide needs to be produced. With a reduction of 1,091,500 pounds of active ingredient of insecticide produced, 341,765 gallons of petrochemicals are released for some other use.²

CONCLUSIONS

Analysis of data for production of short-

² Based on 11,000 kilocalories required to produce one pound of active ingredient insecticide [9]. Conversions from kilocalories to gallons of petrochemicals were provided by Dr. William D. Von Gonten, Associate Professor, Department of Petroleum Engineering, Texas A&M University.

season and conventional cotton varieties in the Lower Rio Grande Valley indicate that by shifting to a short-season cotton variety: (1) net returns to producers would increase 39 percent (\$4,330.2 thousand). (2) quantity of insecticides introduced into the environment would decline 39 percent (1,091.5 thousand pounds), and at least 389,657 gallons of petrochemicals would be released from cotton production and manufacture of inputs for cotton production in the Lower Rio Grande Valley.

Short-season cotton production systems has some distinct advantages over conventional Rio Grande Valley cotton production: (1) A more consistent quality, since cotton is harvested earlier in the year at a time when rainfall probabilities are low [8]. The crop can be harvested before August. With conventional cotton varieties and production systems, in many years August rain delays harvest, reduces cotton quality, and aggravates the overwintering boll weevil problem. (2) In a good cotton year, yields are about equal be-

tween conventional and short-season cotton, but the short-season yield is expected to exceed conventional cotton in a "poor" year. (3) With short-season varieties harvested before August, stalks can be destroyed earlier and, over time, overwintering boll weevils probably would be reduced and biological control of bollworms and budworms would become more effective because of withdrawal of boll weevil treatments. (4) This suggests fewer insecticides would be introduced into the environment, and (5) costs of cotton production in the area would decrease.

In addition to these direct benefits, there are other favorable spinoffs. For example, adverse effects of insecticides applied to cotton on insect control in other crops are reduced. This is particularly important to citrus producers. With reduced insecticide use on cotton, beneficial insect populations increase, permitting an improved biological pest control system to be used on all agricultural production.

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