*The Economics of Short-Season Cotton Production in Arizona**

*by Gayle S. Willett, B. Brooks Taylor & Dwayne R. Buxton***

Arizona cotton producers have historically managed their crop to take advantage of a full growing season. Favorable weather patterns, government programs, and the indeterminate growth behavior of the cotton plant are key factors explaining the predominance of this practice. While full-season production has been (and still remains) the most popular way of growing Arizona cotton, the emergence of harmful pink bollworm populations in the mid-1960's has generated some interest in shortening the growing season.

To prevent serious pink bollworm-induced losses, producers must invest in a rather costly insect control program. Damage to the crop by this insect tends to be concentrated over the latter part of the growing season. Consequently, shortening the growing season enables producers to avoid some insecticide and other late season costs. Also, early crop termination and associated advanced boll maturity has the potential of preventing young pink bollworms from entering bolls. Subsequent starvation reduces the number of larvae reaching diapause and contributes to a lower rate of spring moth emergence, thus reducing control costs for subsequent cotton crops. Yield losses, usually thought to accompany short-season production, represent the principal reason most producers have not shifted to short-season production.

A study was conducted to determine the relationship between various irrigation (and crop) termination dates and per acre profitability. The study was based on a conventional planting of 30,000 plants per acre population and therefore, did not consider early termination in the sense that it may be achieved through narrow row production systems. Terminal irrigation dates examined were July 15, July 31, August 15, August 31, and September 15. A September 15 final irrigation is commonplace for a producer growing full-season cotton; earlier dates are assumed to represent short-season alternatives. Due to space limitations, only the August 15 through September 15 terminations will be considered in this article.

Factors Affecting The Profitability of Short-Season Cotton Production

In evaluating the profitability of making a transition from full to short-season production, there are several cost-return factors that should be considered. These factors and accompanying study assumptions are noted below.

Improved Lint Quality

By terminating early and sacrificing the lint produced during the later stages of the growing season, harvested cotton will usually exhibit improved lint quality. Bolls set late in the season typically contain fibers that (1) are shorter, with less uniformity in length, (2) are lower in strength, and (3) have increased fineness when compared to bolls produced during the main part of the production period [1, 2]. Also, seed cotton harvested later in the season will normally exhibit a lower gin turnout. Inclement weather may cause additional quality deterioration in late-produced cotton. The study utilized data from various sources on grade index, staple length, and 1970-72 Commodity Credit Corporation loan rates to establish price differentials for lint harvested at various dates [2, 7, 8].

Earnings From Earlier Sales

Early harvest permits a producer to realize the revenue from the sale of his crop at an earlier point in time. Thus, he has the option of putting this money to work sooner than would be possible with a late harvested crop. He may, for example, be able to retire a production loan at an earlier date and save interest. If, on the other hand, the money is profitably reinvested, additional earnings will be realized. The length of the time between short and full-season harvesting dates and the productivity of the invested funds will determine the importance of this latter advantage.

Better Management of Crops Following Cotton

Including land preparation, full-season cotton often occupies the land for 10 to 12 months, which makes it difficult to effectively double-crop cotton acreage. Early termination would make it possible to plant late fall and winter crops, e.g., alfalfa, safflower, and barley at an earlier date, thus lengthening the growing season and potentially increasing the profitability of these crops. However, because of the difficulty in placing a monetary value on this potential advantage, it was not considered in the study analysis.

Reduced Costs

There are several expenses that can be reduced by early termination. One of the greatest savings will stem from decreased insecticide expenditures. Effective control of an economically damaging pink bollworm infestation

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generally requires insecticide applications at five-to-seven-day intervals until such time as the bolls become hard enough to prevent larvae entry. For the study analysis, it was assumed that it would be necessary to apply insecticides at seven-day intervals over the period between July 15 and crop termination. The cost of the material and its application was placed at $3.75 per acre per application.

Fewer irrigations are required for a short-season crop; therefore, irrigation costs including water, power and labor will be less. The extent of the savings will depend upon several factors, e.g., soil type, amount of water applied per application, frequency of application, and the source of water. The study considered the following water sources: (1) Salt River Project, (2) Colorado River water, and (3) water pumped from 300, 500, and 700 foot underground. Water requirements were based on published seasonal consumptive rates and a 75 percent efficiency of water use [4]. Also, each two-week shortening of the growing season was assumed to eliminate one irrigation.

Producers managing their crops for late season yields will likely fertilize at a heavier rate than they would with a short-season crop; therefore, some reduction in fertilizer costs can be expected. It was assumed that conversion to short-season cotton would eliminate the need for 50 pounds of nitrogen per acre. Nitrogen was valued at 5 cents per pound, resulting in a $2.50 per acre savings for the short-season alternatives.

Assuming that a yield loss results from early crop termination, some reduction in harvesting and ginning costs can be expected. Custom hire harvesting and ginning rates of $1.50 and $1.40 per hundred weight of seed cotton, respectively, were used along with several different yield losses to derive these savings. Also, lower insecticide, fertilizer, and irrigation costs inherent with short-season cotton will result in lower interest costs on these outlays than incurred with full-season production.

Yield Losses

Most research and experience suggest that yield losses accompany early termination. However, a review of the field experimental work undertaken to identify these losses, as well as discussions with cotton specialists and producers, will reveal considerable variation in the estimated loss. The yield materializing during the latter phases of the growing season depends upon many factors, including the following: (1) the location, (2) precision with which water is applied, (3) moisture-holding capability of the soil, (4) soil fertility, (5) presence of diseases, (6) effectiveness of insect control, (7) date of planting, and (8) the weather. Because of the large number of environmental, biological, and cultural factors that affect late-season production and the variation in these factors over time and space, it is very difficult to establish a single, valid estimate of late-season incremental yields.

Expected lint and cottonseed prices are another important dimension of the economic loss associated with lower yields. As is the case with yields, neither can prices be predicted with absolute precision. The uncertainty surrounding both yield losses and prices suggests that it would be appropriate to examine the economic impact of several different yield and price assumptions. Accordingly, yield losses expressed as a percent of full-season yield, ranging from zero to 40 percent were considered. Base prices for middling, 1-1/16 inch, white lint were allowed to vary between 30 and 60 cents per pound. Cottonseed prices were held constant at $60 per ton.

Table 1. Partial Budget Analysis of the Change in the Annual Per Acre Net Income Realized by Advancing the Terminal Irrigation Date from September 15 to August 15, Assuming a 10 Percent Yield Reduction and 40¢ Base Lint Price.

CREDITS		*DEBITS*	
Added Returns:		*Reduced Returns*:	
Improved quality[a]	$14.87	Yield loss[i]	$54.66
Earnings from earlier sales[b]	5.07		
Reduced Costs:		*Added Costs*:	
Fertilizer[c]	2.50	None	
Insecticide[d]	18.75		
Irrigation (Salt River Project[e]	9.49		
Harvesting[f]	5.32		
Ginning[g]	4.96		
Interest[h]	.70		
Total Credits	$61.66	Total Debits	$54.66

Change in per acre net income = $61.66 − $54.66 = $7.00

[a] *Value of improved quality equals [early termination yield x early termination price] minus [early termination yield x full-season price].*
[b] *Equals* $506.58 (*gross revenue*) x .08 (*earning rate*) x .1250 (*years of earlier receipt*).
[c] 50 *pounds nitrogen at* 5¢ *per pound.*
[d] $3.75 (*cost per application*) *times* 5 *less applications.*
[e] 93¢ (*cost per acre-inch*) *times* 10.2 *fewer acre-inches.*
[f] $1.50 (*harvesting cost per cwt.*) *times* .10 (*percent yield loss*) *times* 35.29 (*full-season seed cotton yield, cwt.*).
[g] $1.40 (*ginning cost per cwt.*) *times* .10 (*percent yield loss*) *times* 35.29 (*full-season seed cotton yield, cwt*).
[h] *Reduced interest charges on insecticide, irrigation, and fertilizer costs.*
[i] *Value of yield loss equals [full-season lint and cottonseed yield times full-season price] minus [short-season lint and cottonseed yield times full-season price].*

Loss of Government Payments

Under the provisions of the Agricultural Act of 1970, which applied to crop years 1971-73, per acre government payments received by producers were dependent upon the payment rate per pound of lint and the producer's yield as projected by the Agricultural Stabilization and Conservation Service committee. The projected yield for a given year was calculated as a simple average of yields produced on the farm over the past three years. Accordingly, early termination and an associated yield loss resulted in payment losses. Thus, past legislation provided a strong economic incentive for producers to lengthen the growing season in the hope of increasing yields and government payments.

New legislation enacted in August 1973 (covering the 1974-77 crop years) substitutes a target price concept for the yield-related payments made under the 1970 Agriculture Act. With this new feature, producers will receive payments from the government if the market price drops below a specified level (38 cents — 1974). The payment will be calculated by multiplying the difference between

the target price and the actual market price times the projected yield (average yield reported on acreage harvested over the last three years) times the base acreage allotment. Accordingly, a lower yielding short-season will reduce producer payments *only* when the market price drops below the target price. Due to the unlikelihood of market prices dropping below the target price in the near future, a potential loss of government payments resulting from an early termination policy was not included in the study analysis.

Study Results

A partial budgeting analysis was utilized to determine the expected changes in per acre net income resulting from early termination. To illustrate how these net income changes were derived and provided some perspective regarding the relative importance of the various individual cost-return changes, the analysis for the August 15 termination is presented in Table 1. As noted, per acre income would increase by $7.00 if the last irrigation was advanced by one month.

Entomologists have noted that pink bollworm larvae begin entering diapause after mid-September. The number entering diapause can be sharply reduced by eliminating young fruiting forms as a source of food at this time. This observation makes August 15 an especially critical terminal irrigation date if future pink bollworm populations are to be controlled. The impact of various base lint prices and percent yield losses on the net income change for this termination date is presented in Table 2.

An examination of Table 2 will reveal that substantial net income changes may occur with an August 15 termination. Whether these changes are favorable or not depends upon the lint price and percent yield loss. For example, assuming 50 cent lint, the change in per acre net income ranges from $54.78 to $180.02 for zero and 40 percent short-season yield losses, respectively. The impact of varying lint prices is less marked, but still significent. Doubling the lint price from 30 to 60 cents at a 10 percent yield loss moves the net income change from a $17.92 gain to a $16.84 loss, for example. Of course, the impact of varying the lint price increases with greater yield losses.

Table 2. Change in Annual Per Acre Net Income Realized by Advancing the Terminal Irrigation Date from September 15 to August 15 at Selected Yield Reductions and Base Lint Prices, Salt River Project Water.[a]

Expected Reduction in Yield (percent)	*Base Lint Price* 30¢	40¢	50¢	60¢
0	$52.38	$53.38	$54.78	$55.98
5	35.15	30.29	25.43	19.57
10	17.92	7.00	—3.92	—16.84
15	.69	—16.29	—33.27	—53.25
20	—16.54	—39.58	—62.62	—89.66
25	—33.77	—62.87	—91.97	—126.07
30	—51.00	—86.16	—121.32	—162.48
35	—68.23	—109.45	—150.67	—198.89
40	—85.46	—132.74	—180.02	—235.30

[a] *To obtain the* total *annual net income per acre for the August* 15 *termination, it would be necessary to add (or subtract if change is negative) the table values to (from) the total per acre net income expected for the September* 15 *termination.*

While the information in Table 2 indicates the change in net income that can be expected for different yield losses, producers may be unsure as to which yield reduction level is most relevant to their particular operation. As mentioned earlier, considerable uncertainty exists about these losses. However producers will likely have an opinion as to whether losses will typically be greater or less than a given amount. Consequently, a break-even yield loss analysis should provide considerable decision-making assistance.

A break-even analysis can be used to identify the percent yield loss which, for a given early termination alternative and lint price, will result in no net income change. By isolating this critical yield loss, cotton growers have only to estimate whether they expect losses to be greater or less than this level. Greater losses imply that early termination will reduce net income; lower losses indicate an increase in net income. Break-even percent yield losses for producers advancing their terminal irrigation by one month (i.e., from September 15 to August 15) are reported in Table 3 for various base lint prices and water sources. The table indicates, for example, that producers terminating at this time and who are using Salt River Project water and have 40 cent lint prices could afford to lose as much as 11.5 percent of their full-season yield and still realize the same per acre net income as with full-season production. If their yield loss is expected to be less than 11.5 percent, it would be to their advantage to apply the final irrigation on August 15. Since the cost of yield losses becomes more significant at higher lint prices, the table indicates a decline in the break-even yield loss with lint price increases. Early termination will permit greater savings where water costs are higher.

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Table 3. Break-Even Percent Yield Losses for Advancing the Terminal Irrigation from September 15 to August 15, Selected Lint Prices and Water Sources.

Water Source	*Base Lint Price* 30¢	40¢	50¢	60¢
	- - - Percent Yield Loss - - -			
Colorado River	14.1	10.7	8.6	7.2
Salt River Project	15.2	11.5	9.3	7.7
300 Foot Well	15.9	12.0	9.7	8.1
500 Foot Well	17.4	13.2	10.7	8.8
700 Foot Well	19.2	14.4	11.6	9.6

Table 4. Break-Even Percent Yield Losses for Advancing the Terminal Irrigation from September 15 to August 31, Selected Lint Prices and Water Sources.

Water Source	*Base Lint Price* 30¢	40¢	50¢	60¢
	- - - Percent Yield Loss - - -			
Colorado River	4.4	3.3	2.7	2.2
Salt River Project	4.9	3.7	3.0	2.5
300 Foot Well	5.2	3.9	3.2	2.7
500 Foot Well	6.0	4.5	3.6	3.0
700 Foot Well	6.7	5.0	4.1	3.4

was obtained by the first of July. During this period the alfalfa goes into the 'summer slump' and forage production is drastically reduced.

These observations should be of interest to the alfalfa producer since the water requirement of a forage crop in the arid southwest is of major importance, both with regard to economics and, more important, availability. They also point out some of the management practices that result in the maximum production of digestible forage per acre at a minimum cost. Although seasonal trends were noted for most of the variables studied, dry forage yield was the dominant factor influencing total ADDM production, or that portion of the forage produced per acre which is utilized by the animal. This was illustrated by the fact that although Mesa-Sirsa generally had a much lower leaflet to stem-petiole ratio (lower quality) than Sonora, Mesa-Sirsa was generally found to be the superior cultivar in ADDM production.

Conclusion

Differences in apparent digestibility among these four cultivars were insignificant. Therefore, from the standpoint of the maximum production of digestible forage, the producer should select among these cultivars based strictly on dry forage yield and water-use efficiency.

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Turfgrass

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nomically, application of this use for effluent is most favorable for small existing communities or communities which are rapidly expanding. It is implied that communities may evaluate the success of their efforts to provide the public with adequate recreation facilities by comparing the existing turfgrass acreage with that required for the disposal of current effluent volumes.

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This explains why larger break-even yield losses are reported for the higher cost water sources. The sources of water reported in Table 3 are arranged from the least to the most expensive source, i.e., Colorado River and 700 foot well, respectively.

Table 4 presents the break-even yield losses for a two-week shortening of the growing season. The change in these losses that is associated with different water sources and lint parallels those noted in Table 3 for the same reasons. Break-even yield losses are less for the two week than the one month earlier termination because the former has less cost savings, thus less yield can be lost.

Summary

Cotton producers electing to shorten their growing season will normally experience a reduction in both production costs and gross returns. Obviously, for early termination to be a profitable practice, costs must be reduced more than returns. This study has indicated the kinds of cost-return (and net income) changes that will likely occur under various early termination circumstances. As demonstrated in Table 2, yield losses are an especially important factor. At a given lint price, early termination can be either a highly profitable or a very costly policy, depending upon the extent of the yield loss. The importance of yield losses is further magnified by higher lint prices. The source and cost of water was also found to be an important factor. For example, with 50 cent lint, producers using cheaper Colorado River water can afford to lose about nine percent of their full-season yield through a one month shortening of the growing season and still break even; this compares to approximately 12 percent for those pumping water from 700 foot underground. Because of the variation over time and space in these and other cost-return factors, it is extremely hazardous to make general recommendations regarding the advisability or inadvisability of shortening the growing season for cotton. However, this study has developed guidelines that should permit producers to make better decisions in light of their unique resources and risk preferences.

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