Chapter 8

FACTORS INFLUENCING NET RETURNS TO COTTON HARVEST AIDS

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INTRODUCTION

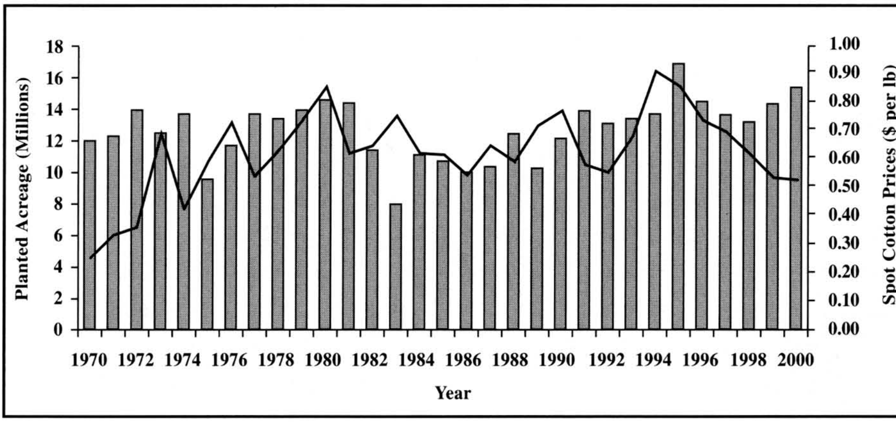
United States cotton [*Gossypium hirsutum* L.] production has rebounded from the lows experienced in the late 1970s and early 1980s. Planted acreage increased from 7.9 million acres in 1983 to a high of 16.7 million acres in 1995 (Figure 1). Higher demand and prices for cotton and new production technologies, which have improved yields, influenced the increase in acreage. However, cotton prices declined sharply after reaching a peak in 1995 (Figure 1), causing the profitability of cotton production to deteriorate.

Because of lower prices and profitability, producers are concerned about reducing the cost of production (Anonymous, 1998a). One input that may influence net returns for cotton farmers is applying a harvest aid before harvest. Many researchers have evaluated harvest aids in cotton production (Teague *et al.*, 1986; Whitwell *et al.*, 1987; Hoskinson and Hayes, 1988; Crawford *et al.*, 1989; Stair and Supak, 1992; Chu *et al.*, 1992; Williford, 1992; Larson *et al.*, 1997; Gwathmey and Hayes, 1997). Most of these studies analyzed the timing of application and the subsequent impact of the chemicals on yield and fiber characteristics.

Larson *et al.* (1997) found that certain harvest aids may enhance net returns by reducing trash, preserving fiber quality, and increasing the proportion of total yield picked at the first harvest under Tennessee growing conditions.

Harvest efficiency also may be positively influenced through harvest aids (Gwathmey and Hayes, 1996). However, prior research also has suggested that mistimed application of a harvest aid can result in significant reduction in yield and fiber quality (Crawford *et al.*, 1989). Also, if harvest is delayed by inclement weather after application, revenue loss in a harvest-aid-treated crop could be greater than in an untreated crop (Stair and Supak, 1992).

In general, information on the costs and returns to alternative cotton harvest-aid treatments is lacking. The purpose of this chapter is twofold: 1) to identify some of the factors that may influence the costs and returns to alternative harvest aids; and 2) to analyze the costs and returns for selected harvest-aid treatments from a five-year field study (1992 through 1996) conducted by the Cotton Defoliation Work Group (Anonymous, 1999).



Source: Anonymous, 2001a; Anonymous, 2001b; and Evans, 2000.

Figure 1. U.S. upland cotton planted acreage and spot market lint prices, 1970-2000.

HARVEST-AID COST AND RETURN CONSIDERATIONS

Partial budgeting can be used to evaluate the profitability of harvest aids (Boehlje and Eidman, 1984). A partial budget includes only the specific items of income and expense that change with the addition of the harvest aid and the effect of these items on profit and loss. Other factors that influence the profitability of production – such as choice of cultivar, fertilization, irrigation, and other inputs for cotton – are not considered in the partial budget.

The following partial budgeting equation can be used to evaluate the costs and returns of harvest aids:

$$\Delta NR_{ij} = \Delta Y_i^{lint} \times (P_j^{base} + \Delta P_{ij}^{diff} - C^{gin}) + \Delta Y_i^{seed} \times P_j^{seed} + \Delta C_i^{hc} - C_i^{ha},$$

where ΔNR_{ij} is the change in cotton enterprise net return ($ per acre) with harvest-aid treatment i using marketing year j cotton prices (August through July of the next year), ΔY_i^{lint} is the change in harvested lint yield (pounds per acre) with harvest-aid treatment i, P_j^{base} is the base quality price (¢ per pound) of lint for marketing year j, ΔP_{ij}^{diff} is the change in premium or discount (¢ per pound) for variation in lint fiber characteristics from the base quality with harvest-aid treatment i using marketing year j prices, C^{gin} is the cost (¢ per pound) of ginning and bale handling per pound of harvested lint yield, ΔY_i^{seed} is the change in harvested cottonseed yield (pounds per acre) with harvest-aid treatment i, P_j^{seed} is the price (¢ per pound) of cottonseed for marketing year j, ΔC_i^{hc} is the change in harvest cost with harvest-aid treatment i, and C_i^{ha} is the materials and application cost ($ per acre) of harvest-aid treatment i.

If $NR_{ij} > 0$ in the equation, then harvest-aid treatment i will increase the profitability of cotton production. Economic tradeoffs influence the decision to apply a harvest aid before cotton harvest. As indicated in the partial budgeting relationship, the net return to a harvest aid is influenced not only by the change in harvested yields and the cost of applying the harvest aid, but also by the change in premiums and discounts for fiber quality and harvesting and handling costs. Weather effects on mature cotton in the field before it is harvested also may have a significant influence on the profitability of harvest aids. The potential impacts that each of these factors has on the harvest-aid decision are discussed in the following sections.

QUALITY PRICE DIFFERENCES

The effective lint price that a farmer receives for cotton is influenced by a number of market factors. The base price, P_j^{base}, indicates general supply and demand conditions for a base quality of cotton (color 41, leaf 4, staple 34, micronaire 35-36 and 43-49, and strength 23.5-25.4). The lint quality price difference, P_{ij}^{diff}, is positive, negative, or zero, depending on the fiber property mix for grade (color and leaf), staple (fiber length), micronaire, and fiber strength. Two or more of these characteristics may be correlated in the market determination of the price difference for a particular attribute (Bowman and Ethridge, 1992). Base quality and quality-difference prices also change with supply and demand conditions (Table 1) (Anonymous, 1993-1998). For example, if base prices are high, suggesting tight supplies, leaf grade discounts may decline, because buyers cannot discount trash as much as when cotton is plentiful.

Table 1. Average U.S. base quality lint prices and example leaf grade price differences, marketing years 1993-1994 through 1997-1998.

Marketing Year[1]	Base Quality Price[2]	Color 41, Staple 34 Price Differences		
		Leaf Grade 5	Leaf Grade 6	Leaf Grade 7
	¢ per lb			
1993-1994	66.12	-4.58	-8.05	-11.50
1994-1995	88.14	-3.28	-6.99	-10.89
1995-1996	83.03	-3.38	-7.32	-10.72
1996-1997	71.59	-3.32	-6.41	-10.12
1997-1998	67.79	-2.70	-5.26	- 8.79

Source: Anonymous, 1993-1998.

[1] August through July.

[2] Color 41, leaf 4, staple 34, micronaire 35-36 and 43-49, and strength 23.5-25.4 cotton quality.

Fiber characteristics – Harvest aids and other factors may affect one or more of the fiber characteristics of cotton. For example, color grade may be affected adversely by exposure to weathering after boll opening (Ray and Minton, 1973). Leaf is one component of trash (cotton plant leaf particles, stalk materials, and extraneous matter such as grass) in cotton lint. Leaf grade is affected by cultivar, harvest methods, and weather conditions at harvest (Anonymous, 1993). Example cotton spot price differences for color 41, staple 34 cotton with different leaf grades are presented for marketing years 1993-1994 through 1997-1998 in Table 1 (Anonymous, 1993-1998). Leaf grade has whole number designations from 1 to 7, with 7 associated with the highest high-volume instrument (HVI) trash content (Anonymous, 1993). Leaf grade 4 is the base quality for this characteristic. Price discounts widen with higher leaf grades, varying in the 1997-1998 marketing year from -3¢ per pound for leaf grade 5 to -9¢ per pound for leaf grade 7 for all of the United States. These premiums and discounts vary by production region. In addition to leaf grade discounts, other trash materials, such as bark and grass, also are discounted. These discounts are especially important in stripper cotton production in Texas and Oklahoma. Harvest aids may have an important impact on reducing price discounts for trash in cotton.

Micronaire (mike) is a measure of fiber fineness and maturity and is affected by variety and by weather and seasonal growing conditions. Fiber fineness is important in determining yarn appearance, yarn uniformity, and yarn strength. U.S. season-average micronaire price differences for marketing years 1993-1994 through 1997-1998 are shown in Table 2 (Anonymous, 1993-1998). The base micronaire range is between 35-36 and 43-49. The micronaire premium range is from 37 to 42. Micronaire values above 49 and below 35 are discounted.

Fiber strength largely is determined by cultivar but also may be influenced by growing conditions, weathering, and ginning. Strength is measured as the force in grams required to break a bundle of fibers one tex unit in size. A tex unit is equal to the weight in grams of 1000 meters of fiber. Fiber strength is important in determining yarn and fabric strength and spinning efficiency when the fiber is processed. U.S. season-average fiber-strength price differences for marketing years 1993-1994 through 1997-1998 are presented in Table 3 (Anonymous, 1993-1998). Strength premiums and discounts relative to other cotton fiber characteristics are relatively small but do vary from year to year.

HARVEST COSTS

As indicated in the partial budgeting equation, harvest aids also may have a positive influence on the cost of cotton harvest. The ability to defoliate and enhance boll opening with certain harvest aids may allow farmers to make only one pass through the field with a picker, rather than two passes. The impact on production costs of eliminating a second picking is illustrated in Table 4. In the example budget, the equipment for estimating seed cotton picking and handling costs includes a four-row, self-propelled cotton picker, a module builder with a tractor, and three trailers with a tractor for overflow when the module builder is full (Larson *et al.*, 1997). This complement is sized to cover 625 acres for the first harvest in 18 field days. Equipment, materials, and labor costs per acre were calculated using machine hours

Table 2. Average U.S. micronaire price differences, marketing years 1993-1994 through 1997-1998.

Marketing Year[1]	Micronaire Units									
	24 & Below	25-26	27-29	30-32	33-34	35-36	37-42	43-49	50-52	53 & Above
	¢ per lb									
1993-1994	-14.08	-12.07	-91.4	-5.01	-2.22	0	0.11	0	-2.99	-4.79
1994-1995	-12.80	-11.93	-97.3	-4.71	-2.16	0	0.09	0	-2.91	-4.73
1995-1996	-14.35	-12.38	-95.6	-4.84	-2.33	0	0.33	0	-3.10	-5.16
1996-1997	-15.65	-12.91	-92.8	-4.81	-2.34	0	0.33	0	-2.97	-5.13
1997-1998	-13.42	-11.97	-96.0	-4.47	-2.02	0	0.14	0	-2.72	-4.68

Source: Anonymous, 1993-1998.
[1] August through July.

Table 3. Average U.S. fiber-strength price differences, marketing years 1993-1994 through 1997-1998.

Marketing Year[1]	Fiber Strength (grams per tex[2])											
	18.5-19.4	19.5-20.4	20.5-21.4	21.5-22.4	22.5-23.4	23.5-25.4	25.5-26.4	26.5-27.4	27.5-28.4	28.5-29.4	29.5-30.4	30.5 & Above
	¢ per lb											
1993-1994	-2.65	-2.65	-1.49	-1.00	-0.42	0	0	0	0.10	0.25	0.43	0.59
1994-1995	-1.67	-1.22	-1.18	-0.76	-0.26	-0.01	0	0	0	0.12	0.27	0.39
1995-1996	-1.11	-0.86	-1.17	-0.69	-0.16	-0.01	0	0	0.01	0.13	0.27	0.39
1996-1997	-1.06	-1.03	-1.15	-0.80	-0.34	0	0	0	0	0.13	0.28	0.41
1997-1998	-0.97	-0.97	-1.11	-0.78	-0.31	0	0	0	0	1.14	0.28	0.41

Source: Anonymous, 1993-1998.
[1] August through July.
[2] The force in grams required to break a bundle of fibers one tex unit in size. A tex unit is equal to the weight in grams of 1000 meters of fiber.

Table 4. Cotton harvest equipment ownership and operating costs.[1]

Item	Once-Over Harvest	Twice-Over Harvest
Picker ownership and operating costs:		
Capital recovery per acre	$38.29	$38.77
Taxes, insurance, and housing per acre	1.64	1.64
Repair & maintenance per acre	6.40	14.59
Fuel & lube per acre	2.33	3.73
Operator labor per acre	1.64	2.62
Total picker costs per acre	$50.30	$61.35
Seed cotton handling costs:		
Capital recovery per acre	$8.25	$9.22
Taxes, insurance, and housing per acre	0.55	0.55
Repair & maintenance per acre	3.24	4.00
Fuel & lube per acre	1.40	2.15
Support labor per acre	3.29	4.29
Total picker costs per acre	$16.73	$22.22
Total ownership and operating costs per acre	$67.03	$81.57

Source: Larson *et al.*, 1997.

[1] Assumed machinery and labor compliment: 1 four-row, self-propelled picker; 1 module builder; 2 125-hp tractors; 3 trailers; 3 laborers for the first harvest, and 2 laborers for the second harvest.

required to cover 625 acres for the first and second harvests. Forgoing the second harvest reduces hours of operation per year and the total costs of picking and handling per acre. In the example budget, the cost for a once-over operation is $67.03 per acre, compared with $81.57 per acre for a twice-over harvest. By avoiding the second harvest, the total cost of picker harvest is reduced by $14.54 per acre.

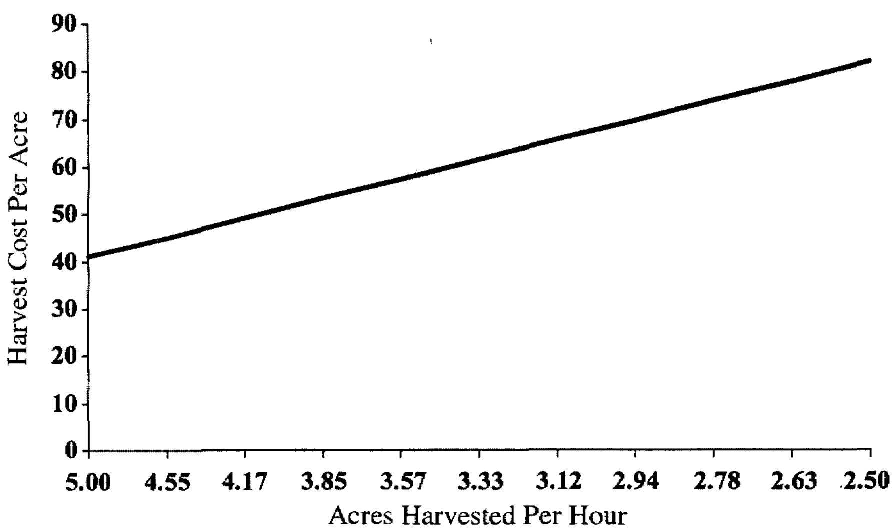
Harvest aids also have an impact on machine efficiency. In undefoliated cotton, more green plant material going into the harvester may force operation of the picker or stripper at reduced speed, cutting field efficiency. Slower picker and stripper speeds and increased downtime cleaning the machine lead to higher picking costs per hour of operation (Boehlje and Eidman, 1984). The effect of reduced field efficiency can be examined using the following relationship:

$$Acres\ picked\,/\,hour = \frac{S \times W \times E}{8.25}$$

The number of acres a picker or stripper can cover in one hour depends on the speed, width, and efficiency of the harvester. This can be expressed as follows: S is speed of the machine in miles per hour, W is width of the harvester in feet, E is machine efficiency expressed as a decimal between 0 and 1, and 8.25 is the number of square feet in an acre (43,560) divided by the number of feet in a mile (5,280). The hours required to cover one acre can be calculated using the reciprocal of acres covered per hour. Consequently, harvest cost per acre can be calculated by dividing the ownership and operating expenses of the machine per hour of operation by the acres harvested per hour:

$$Harvest\ cost/acre = \frac{Ownership\ and\ operating\ cost/hour}{Acres\ picked/hour}.$$

The relationship between acres harvested per hour and harvest cost per acre is illustrated in Figure 2. This example assumes hourly ownership and operating costs of $205 for a four-row, self-propelled cotton picker covering 625 acres per year. A 10 to 20 percent reduction in field speed can raise the cost of harvest by $5 to $10 per acre. A 50 percent reduction in acres harvested per hour – from 5.0 to 2.5 acres per hour, for instance – doubles the cost per acre of running the picker over the field.



Source: Boehlje and Eidman, 1984.

Figure 2. Relationship between acres harvested per hour and harvest cost per acre.

The value of a harvest aid also may be influenced by the method of handling and storage between harvest and ginning. Harvest systems using a module builder to handle seed cotton have become increasingly important, with more than three-quarters of all cotton being moduled nationwide (Glade *et al.*, 1996). The potentially detrimental effect of wet plant material on fiber quality in a tightly packed cotton module may influence the profitability of harvest aids (Valco and Bragg, 1996).

WEATHER

To avoid problems with harvest efficiency in undefoliated cotton, farmers in the more northerly areas of the Cotton Belt have the option of delaying harvest until after a killing freeze. However, delaying harvest also may expose open bolls to excessive weathering. Williford (1992) found that weathering from delayed harvest reduced fiber quality and yields in Mississippi. One important potential benefit of using harvest aids is to expedite harvest to avoid yield losses caused by unfavorable weather late in the fall. Certain practices, including selection of early maturing cultivars, use of plant growth regulators, and timely applications of harvest aids, can be used to prepare the crop for earlier harvest (Gannaway, 1991).

The potential impact of rainfall on lint yield losses and revenues from a delayed harvest is illustrated in Table 5. The delay in cotton harvest while waiting for a killing freeze was assumed to be 28 days (4 weeks). Predicted yield losses from delayed harvest are presented for rainfall amounts ranging from 1 to 6 inches. The yield loss example assumes a 2.15 percent yield loss for each inch of rainfall (Larson *et al.*, 1999). Reductions in yield range from 2 percent for 1 inch of rain to 13 percent for 6 inches of precipitation. Deterioration in fiber quality also can occur with weathering.

The potential impact of lint yield losses and deterioration of fiber quality on net returns because of a delayed harvest also are reported in Table 5. Revenue losses were estimated using the lint price relationship reported by Larson *et al.* (1997) for November 1993 through May 1995. Net return losses are reported for a low cotton base price ($0.57 per pound) scenario and a high cotton base price ($1.07 per pound) scenario. For the low-price scenario, net return losses vary from 2 percent with 1 inch of rain to 17 percent with 6 inches of rain for color 31, leaf grade 4 cotton. The estimated net return loss also is influenced by the leaf grade price discount structure. If the leaf grade is 6 or 7, the potential loss of net returns from precipitation is not as great as for leaf grades 4 or 5.

The probability of receiving rainfall that causes yield damage changes from period to period during the harvesttime for cotton. As an example, Table 6 presents probabilities of getting rainfall amounts of 1 to 6 inches for specified four-week periods in late summer and fall for Jackson, Tennessee (Fribourg *et al.*, 1973). These translate into probabilities of net return losses occurring from rainfall (Table 5). Average rainfall for alternative four-week periods varies from 3 to 4 inches. Probabilities of receiving various precipitation amounts change from period to period. For example, the probability of receiving at least 3 inches of rainfall varies from 33 percent for the periods beginning September 20 and October 4 to 62 percent for the period beginning November 29. Maximum rainfall probabilities during the period for cotton harvest vary by cotton production region. For example, fall precipitation probabilities are at a maximum in mid-October for Central Texas (Dugas, Jr., 1983).

ANALYSIS OF NET RETURNS FOR SELECTED TREATMENTS

Costs and returns for selected harvest aids were evaluated using yield and quality data collected by the Cotton Defoliation Work Group (Anonymous, 1998b). The cotton yield, price, and cost data used to estimate net returns with the partial budgeting equation are presented first, followed by the methods used to analyze lint yields, lint prices, and net returns.

YIELD DATA

Lint yield and fiber quality data were obtained from a five-year harvest-aid study (1992 through 1996) conducted at 16 sites across the U.S. Cotton Belt by the Cotton Defoliation Work Group (Anonymous, 1999). The sites represent a range of production, including picker cotton in the Midsouth and Southeast, stripper cotton in Texas and Oklahoma, and Acala™ cotton in the San Joaquin Valley of California. Seven core harvest-aid treatments were evaluated at each location. In addition to the seven core treatments, researchers in each region included up to eight additional treatments for evaluation in the study.

Table 5. Estimated lint yield and revenue losses due to a delayed cotton harvest.

Loss at harvest	Rainfall during four-week harvest delay period (in)					
	1	2	3	4	5	6
	%					
Lint yield	2	4	6	9	11	13
Revenue (Base lint quality price of $0.57 per lb)[1]						
Pre-delayed harvest quality of color 31, leaf 4	2	4	6	13	15	17
Pre-delayed harvest quality of color 31, leaf 5	2	4	6	10	12	15
Pre-delayed harvest quality of color 31, leaf 6	2	4	6	9	11	13
Pre-delayed harvest quality of color 31, leaf 7	2	4	6	9	11	13
Revenue (Base lint quality price of $1.07 per lb)[1]						
Pre-delayed harvest quality of color 31, leaf 4	2	4	6	14	16	18
Pre-delayed harvest quality of color 31, leaf 5	2	4	6	10	13	15
Pre-delayed harvest quality of color 31, leaf 6	2	4	6	9	11	13
Pre-delayed harvest quality of color 31, leaf 7	2	4	6	9	11	13

Source: Based on an estimated yield loss of 2.15 percent per inch of rainfall (Larson *et al.*, 1999).
[1] Revenue losses were estimated using the lint price relationship reported by Larson *et al.* (1997) for November 1993 through May 1995.

Table 6. Rainfall probabilities for Jackson, Tennessee.

Four-week period starting	Four-week rainfall total (in)						
	1	2	3	4	5	6	Average (in)
	Probability of rainfall (%)						
Sep 06	80	57	38	25	16	10	2.95
Sep 13	80	57	40	27	18	12	3.08
Sep 20	74	51	33	21	14	9	2.72
Sep 27	76	52	35	22	14	9	2.76
Oct 04	77	52	33	20	12	7	2.71
Oct 11	77	53	35	22	13	8	2.79
Oct 18	85	61	40	25	15	9	3.00
Oct 25	88	67	47	31	20	12	3.37
Nov 01	91	72	51	34	22	14	3.58
Nov 08	92	72	51	34	21	13	3.53
Nov 15	97	82	60	39	24	13	3.82
Nov 22	94	77	56	38	24	15	3.78
Nov 29	97	83	62	42	27	16	3.99

Source: Fribourg *et al.*, 1973.

The seven core treatments were evaluated in this analysis to look at differences in cost and returns at and among locations. Stripper cotton data from Texas and Oklahoma and Acala cotton data from the San Joaquin Valley in California were excluded from the assessment of net returns. Information about extraneous matter in lint (bark and grass) that is important in the pricing of stripper cotton was not available for the Texas and Oklahoma locations. Because of the unique cotton variety and climate conditions in the San Joaquin Valley, the seven core treatments did not perform as well when compared with the other regional locations.

The experiment station locations where research for the Midsouth portion of the study was conducted were: the Delta Research Center, Portageville, Missouri; the West Tennessee Experiment Station, Jackson, Tennessee; the Southeast Branch Station, Rohwer, Arkansas; the Delta Research and Extension Center, Stoneville, Mississippi; and the Northeast Research Station, St. Joseph, Louisiana.[1] A map showing the locations of the experiment stations in the Midsouth is presented in Figure 3. The experiment station locations for the Southeast portion of the study were the Peanut Belt Research Station, Lewiston-Woodville, North Carolina; the Tennessee Valley Substation, Belle Mina, Alabama; the Pee Dee Research and Education Center, Florence, South Carolina; the Coastal Plain Experiment Station, Tifton, Georgia; and the West Florida Research and Extension Center, Jay, Florida.[2] A map showing the Southeast experiment station locations is presented in Figure 4.

For each year of the experiment, standard agronomic practices were followed at each site until treatment with alternative harvest aids in the fall. As the crop approached maturity, readiness for treatment with the harvest aid to prepare the crop for picking was determined through daily field inspection. Harvest aids were applied to the crop when approximately 55 to 60 percent of the bolls had opened. Treatment dates varied by site and year.

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[1] Participating Cotton Defoliation Work Group members in the Midsouth were Charles Guy and Eric Webster (Arkansas); Merritt Holman, Steve Crawford, and Dan Reynolds (Louisiana); Charles Snipes (Mississippi); Dave Albers, Gene Stevens, and Bobby Phipps (Missouri); and Bob Hayes and Owen Gwathmey (Tennessee).

[2] Participating Cotton Defoliation Work Group members in the Southeast were Mike Patterson and Charles Burmester (Alabama); John Wilcut and E. Ford Eastin (Georgia); Keith Edmisten (North Carolina); Ken Legé and Mitchell Ruf (South Carolina); and Barry Brecke (Florida).

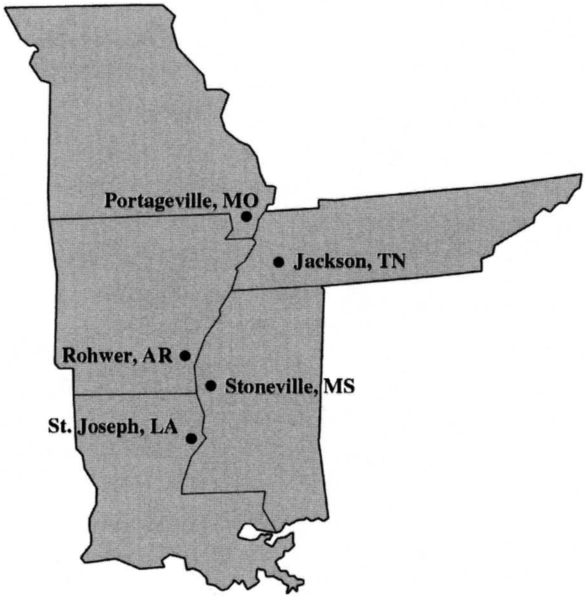

Figure 3. Midsouth cotton harvest-aid study locations.

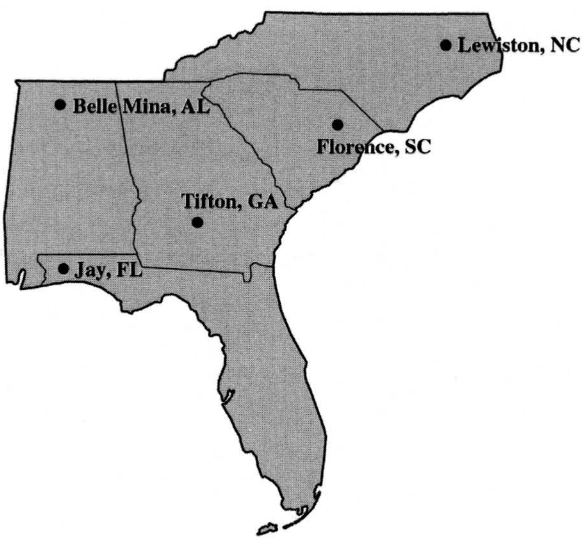

Figure 4. Southeast cotton harvest-aid study locations.

Commercial harvest aids approved for use on cotton and evaluated in this study were: Folex® 6 EC (tribufos), Dropp® 50WP (thidiazuron), Harvade® 5F (dimethipin), and Prep™ (ethephon). Table 7 presents the combinations and application rates used to formulate the treatments. The control was not treated with harvest aids. Application rates for the six other treatments were based on label recommendations current in 1991. Each treatment was replicated four times using a randomized complete block design.

Plots were mechanically harvested approximately two to four weeks after the harvest-aid treatment. The two middle rows were harvested in each plot to determine yields and to obtain seed cotton samples. Seed cotton samples were collected by plot for all treatments and sent to the Texas A&M Research and Extension Center in Lubbock, Texas, for ginning. Fiber characteristics from each treatment were determined using HVI testing (Anonymous, 1993).

Table 7. Treatment descriptions and costs for the cotton harvest-aid analysis.

Treatment Number	Treatment Name	Rate[1]	Treatment Cost ($ per acre)[2]
1	Control	NA	0.00
2	Folex®	1.125	11.01
3	Dropp®	0.100	14.06
4	Harvade®[3]	0.300	10.48
5	Harvade[3]+ Prep™	0.250 1.000	17.18
6	Folex + Prep	0.560 1.000	15.19
7	Dropp+ Prep	0.050 1.000	16.72

Source: Anonymous, 1999.

[1] Pounds of active ingredient applied per acre.

[2] Treatment expenses include the cost of harvest-aid materials (chemicals) and an aerial application cost of $4.07 per acre. Materials costs were based on chemical application rates and 1996 materials prices from an informal survey by the authors and *Agchemprice*. Specific prices used were $37.02 per gallon for Folex, $49.95 per pound for Dropp, $81.64 per gallon for Harvade, and $46.02 per gallon for Prep. The prices farmers currently pay for these harvest aids may be different from those used in this analysis.

[3] The surfactant Agri-Dex® was used with treatments containing Harvade (1 pint of product per acre at a cost of $1.91 per pint).

PRICE DATA

The only published source of producer price data for the study area that also reported premiums and discounts from a base quality (price differences) were quotations collected by Agricultural Marketing Service of the U.S. Department of Agriculture (Anonymous, 1993-1998). These spot price quotations were compiled daily by market reporters for seven major market areas.

Relevant prices for the Midsouth were taken from the North Delta and South Delta market quotations. The North Delta includes northeast Arkansas, Missouri, and Tennessee. The South Delta includes southeast Arkansas, Louisiana, and Mississippi. Southeast quotations are for Alabama, Georgia, North Carolina, South Carolina, Virginia, and Florida.

Under accepted procedure, the area market reporter estimates prices by interviewing market participants and collecting sales information (Kuehlers, 1994). These spot price quotations are not weighted by trading volume, are not based on a statistical sampling procedure and are not reproducible (Hudson *et al.*, 1996). Moreover, in the absence of actual trading in a market, quotations were based on prices paid for other qualities or prices paid for the same quality in other markets. Consequently, the premiums and discounts actually received in a given market may have deviated from those reported in the quotations.

Irrespective of these data limitations, this analysis assumed that spot quotes reflected price differences in the Midsouth and Southeast. Season-average base quality and quality-difference prices for the 1996-1997 marketing year were used for this analysis (Anonymous, 1993-1998). Cottonseed prices for the 1996-1997 marketing year were obtained from USDA's National Agricultural Statistics Service offices in each state included in the study (Anonymous, 2001b).

COST DATA

The specific costs that varied by harvest-aid treatment in this analysis were for the different harvest aids evaluated in the Cotton Defoliation Work Group study (boll opener, defoliant, and desiccant materials), the cost of applying the harvest aid materials, and the ginning and handling costs per pound of harvested lint yield (C_i^{ha} and C^{gin} in the partial budgeting equation). The potential change in harvest cost (picker materials, machinery, and labor expenses) with a harvest aid was not evaluated in this analysis (C_i^{hc} in the equation).

The harvest-aid treatment costs in Table 7 were based on the application rates used in the field study and the cost of aerial application. Prices of harvest-aid materials used to calculate those costs were from an informal survey by the authors and the publication, *Agchemprice* (1996). Ginning and handling costs per pound of harvested lint yield included expenses for ginning, warehouse receiving, compression of the bale to universal density, one month of insured storage, and out-handling before the bale is sold (Glade *et al.*, 1994, 1995, 1996).

ANALYSIS OF LINT YIELDS, LINT PRICES, AND NET RETURNS

Lint Yields – Perhaps the most important factor influencing the profitability of harvest aids is lint yield response. Lint yields from the seven harvest-aid treatments for the Midsouth and Southeast regions are presented in Tables 8 and 9, respectively.

Yield responses to the harvest-aid alternatives were not consistent across the 10 sites. None of the harvest-aid treatments at the North Carolina or South Carolina locations produced lint yields that were higher than the untreated check. All but one of the harvest-aid treatments produced a negative yield response at the Louisiana site. At the other seven sites, two or more of the harvest-aid treatments produced lint yields that were greater than the untreated check. All six of the harvest-aid treatments at the Georgia and Florida sites produced lint yields that were greater than the untreated check. All but one of the treatments at the Missouri, Tennessee, and Mississippi locations produced larger yields than the untreated check.

In general, harvest-aid treatments that combined the boll opener Prep with a defoliant produced the largest numeric yield increase over the untreated check. Treatment 7, combining Dropp (0.05 pound a.i. per acre) and Prep (1.0 pound a.i. per acre), produced the largest numeric lint yield gain at the Florida (144 pounds per acre), Tennessee (127 pounds per acre), and Missouri (67 pounds per acre) sites. Moreover, Treatment 7 produced the second-largest numeric yield gain – 110 pounds per acre – at the Georgia site. However, the yield difference for Treatment 7 was statistically significant at the five percent probability level only at the Florida and Tennessee sites.

By contrast, Treatment 6, combining Folex (0.56 pound a.i. per acre) and Prep (1.0 pound a.i. per acre), produced the largest positive lint yield response over the untreated check at the Georgia (127 pounds per acre), Arkansas (46 pounds per acre), and Mississippi (30 pounds per acre) locations. A numeric yield gain with Folex and Prep also occurred at the Tennessee (99 pounds per acre) and Florida (91 pounds per acre) sites. However, the only location where the yield gain for Treatment 6 was statistically significant was at Georgia ($p<0.10$). Conversely, a statistically significant yield decrease (-84 pounds per acre) resulted from this treatment in Louisiana.

Treatment 5, combining Harvade (0.25 pound per acre) with Prep (1.00 pound per acre), also produced yield gains at the Tennessee (115 pounds per acre), Florida (98 pounds per acre), Georgia (92 pounds per acre), and

Table 8. Average lint yields for alternative cotton harvest-aid treatments for the Midsouth region, 1992-1996.

Harvest-aid Treatment[1]	Location				
	Missouri	Tennessee	Arkansas	Mississippi	Louisiana
	lb per acre				
1	863	885	1,173	903	1,167
2	846	905	1,141	893	1,179
3	879	916	1,185	913	1,149
4	925	878	1,165	905	1,140
5	925	1,000[3]	1,164	920	1,129
6	887	984	1,219	933	1,083[3]
7	930	1,012[2]	1,160	924	1,121

Source: Anonymous, 1999.

[1] See Table 7 for descriptions of the harvest-aid treatments.

[2] [3] Lint yield for the harvest-aid treatment was significantly different from the untreated control (Treatment 1) at the 0.05 and 0.10 probability levels, respectively.

Table 9. Average lint yields for alternative cotton harvest-aid treatments for the Southeast region, 1992-1996.

Harvest-aid Treatment[1]	Location				
	North Carolina	Alabama	South Carolina	Georgia	Florida
	lb per acre				
1	975	1,072	978	1057	831
2	971	1,077	886	1126	839
3	958	1,090	862	1141	836
4	965	1,070	908	1108	865
5	975	1,086	959	1149	929
6	968	1,081	915	1184[3]	922
7	968	1,061	894	1167	975[2]

Source: Anonymous, 1999.

[1] See Table 7 for descriptions of the harvest-aid treatments.

[2] [3] Lint yield for the harvest-aid treatment was significantly different from the untreated control (Treatment 1) at the 0.05 and 0.10 probability levels, respectively.

Missouri (62 pounds per acre) sites. Smaller positive yield differences for Harvade and Prep also were observed at the Mississippi (17 pounds per acre) and Alabama (14 pounds per acre) locations. However, Tennessee was the only site where the yield gain for Treatment 5 was statistically significant at the 10 percent probability level.

Lint Prices – Lint prices for cotton receiving the various harvest-aid treatments, estimated using 1996-1997 marketing year base prices and premiums and discounts, are presented for the Midsouth and Southeast Regions in Tables 10 and 11. As with lint yields, harvest-aid treatments that combined the boll opener Prep with a defoliant tended to yield the highest estimated lint prices among the seven treatments. However, no specific harvest-aid treatment consistently produced higher lint prices than the untreated check across all 10 locations.

Dropp and Prep (Treatment 7) yielded a price gain of 1¢ to 3¢ per pound over the untreated check at the Missouri, Tennessee, Arkansas, North Carolina, South Carolina, and Georgia locations. On the other hand, the estimated price for lint from Treatment 7 (Dropp and Prep) at Mississippi was 2¢ per pound lower than for the untreated check. Folex and Prep (Treatment 6) produced a 2¢ to 3¢ per pound higher lint price at South Carolina, North Carolina, and Missouri. Harvade and Prep (Treatment 5) yielded a 2¢ per pound higher lint price at Missouri when compared to the untreated check. For the other treatments, estimated lint prices varied by only 1¢ per pound across locations. The Dunnett's t-test indicated that none of the harvest-aid treatments produced lint prices at any location that were significantly different from the untreated check ($p<0.10$).

Net Return Differences – The net impacts of yield, price, and cost changes on cotton net returns (profit) from using harvest aids are presented for the Midsouth and Southeast Regions in Tables 12 and 13, respectively. The impacts of harvest-aid treatments on net returns from cotton were not uniform across locations because of the inconsistent effects of harvest-aid treatments on yields and prices.

None of the harvest-aid treatments at the Louisiana, North Carolina, Alabama, or South Carolina sites produced a positive impact on cotton net returns. For these locations, the partial budgeting analysis indicated that the change in yields and prices brought about by harvest aids did not cover the materials and application costs of the chemicals.

In addition, only one of the harvest-aid treatments at the Arkansas and Mississippi locations had a small positive impact on net returns. Folex and Prep (Treatment 6) produced $15 per acre and $11 per acre gains, respectively, at the Arkansas and Mississippi sites. By contrast, all seven harvest-aid treatments produced net return gains at the Georgia location.

Table 10. Lint prices for alternative cotton harvest-aid treatments for the Midsouth region, using 1996-1997 season average prices.

Harvest-aid Treatment[1]	Location				
	Missouri	Tennessee	Arkansas	Mississippi	Louisiana
	¢ per lb				
1	70	70	71	69	72
2	71	70	72	70	71
3	71	71	72	69	72
4	71	71	71	68	71
5	72	69	72	69	71
6	72	70	71	70	72
7	72	73	72	67	72

Source: Anonymous, 1999.

[1] See Table 7 for descriptions of the harvest-aid treatments.

Note: None of the harvest-aid treatment lint prices were significantly different from the untreated control (Treatment 1) at the 0.05 and 0.10 probability levels.

Table 11. Lint prices for alternative cotton harvest-aid treatments for the Southeast region, using 1996-1997 season average prices.

Harvest-aid Treatment[1]	Location				
	North Carolina	Alabama	South Carolina	Georgia	Florida
	¢ per lb				
1	71	73	70	72	73
2	70	72	69	72	73
3	72	72	71	72	73
4	72	72	71	73	72
5	72	73	71	72	73
6	73	72	73	73	73
7	73	73	73	73	72

Source: Anonymous, 1999.

[1] See Table 7 for descriptions of the harvest-aid treatments.

Note: None of the harvest-aid treatment lint prices were significantly different from the untreated control (Treatment 1) at the 0.05 and 0.10 probability levels.

Two treatments combining Prep with a defoliant had the largest positive impact on net returns at the Tennessee, Florida, Missouri, and Georgia locations. Dropp and Prep (Treatment 7) produced the largest gain in net return at the Tennessee ($108 per acre), Florida ($86 per acre), and Missouri ($44 per acre) sites. For Georgia, Treatment 7 also produced a sizable net return gain, $69 per acre. Folex and Prep (Treatment 6) produced the largest net return of $82 per acre at the Georgia location.

Table 12. Net return differences from the untreated check for alternative cotton harvest-aid treatments for the Midsouth region, using 1996-1997 season average prices.

Harvest-aid Treatment[1]	Location				
	Missouri	Tennessee	Arkansas	Mississippi	Louisiana
	$ per acre				
2	-14	11	-23	-12	-15
3	-2	24	-3	-8	-34
4	37	-1	-21	-12	-40
5	33	67	-19	-5	-62
6	15	58	15	11	-79
7	44	108	-17	-18	-52

Source: Anonymous, 1999.
[1] See Table 7 for descriptions of the harvest-aid treatments.

Table 13. Net return differences from the untreated check for alternative cotton harvest-aid treatments for the Southeast region, using 1996-1997 season average prices.

Harvest-aid Treatment[1]	Location				
	North Carolina	Alabama	South Carolina	Georgia	Florida
	$ per acre				
2	-18	-6	-81	36	-6
3	-20	-13	-85	44	-14
4	-11	-12	-53	32	14
5	-13	-3	-24	47	52
6	-4	-13	-37	82	49
7	-7	-21	-53	69	86

Source: Anonymous, 1999.
[1] See Table 7 for descriptions of the harvest-aid treatments.

SUMMARY

Economic tradeoffs influence the decision to apply a harvest aid before cotton harvest. The net return from a harvest aid is influenced not only by the change in harvest yields and the cost of applying the harvest aid, but also by the change in premiums and discounts for fiber quality and harvesting and handling costs. Weather effects on mature cotton in the field before it is harvested also may have an important influence on the profitability of harvest aids.

The cost and return analysis of alternative harvest-aid treatments from a five-year study conducted by the Cotton Defoliation Work Group indicated that no single harvest-aid regime improved net returns at the 10 Southeast and Midsouth sites examined in the analysis. The primary impact of harvest aids was on harvested lint yields. Combining the boll opener Prep with a defoliant was effective in increasing harvested lint yields at several sites that conducted only a once-over harvest. Harvest-aids did not significantly influence lint prices based on fiber quality, when compared to the untreated check.

In general, harvest-aid treatments that combined the boll opener Prep with a defoliant produced the largest net return gains over the untreated check. Dropp (0.05 pound a.i. per acre) and Prep (1.0 pound a.i. per acre) yielded the largest net returns of any harvest-aid treatment at the Tennessee, Florida, and Missouri sites. Folex (0.56 pound per acre) and Prep (1.0 pound a.i. per acre) produced the largest net returns at the Georgia, Arkansas, and Mississippi sites. However, the gain in net returns over the untreated check were relatively small at the Arkansas and Mississippi locations. None of the harvest-aid treatments at the Louisiana, North Carolina, Alabama, or South Carolina sites produced a positive impact on net returns. For these locations, the partial budgeting analysis indicated that the change in yields and prices brought about by harvest aids did not cover the materials and application costs for the chemicals.

No clear-cut recommendation can be made as to which harvest aids maximize cotton net returns in the Midsouth or Southeast regions. Additional research is required to better understand the reasons for the inconsistent effects of harvest aids on net returns at the 10 locations examined in this analysis. Defoliated cotton may have been exposed to more weathering at some locations, compared to other sites in the defoliation field study. On the other

hand, favorable conditions may have led to further yield development in untreated cotton, compared to cotton terminated with harvest aids. A better understanding of these and other factors could lead to more consistent recommendations about harvest aids. Potential reductions in harvest efficiency and yield losses during handling and storage with undefoliated cotton were not measured in the field study and could have an important positive impact on the profitability of harvest aids.

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