COST TRADE-OFFS OF STRIPPER-MOUNTED BUR EXTRACTORS FROM THE PRODUCERS' PERSPECTIVE

Sukant K. Misra, Blake K. Bennett, and Brent D. McPeek, Texas Tech University, Lubbock, TX;
Alan Brashears, USDA-ARS, Lubbock, TX

Abstract

The objective of this study was to evaluate the cost-effectiveness of using a bur extractor in cotton stripping. Results indicate that the bur extractor has a statistically significant effect on bur percent, stick percent, seed cotton percent, and lint turnout. Results also suggest that investment in bur extractors is profitable for both irrigated and dryland cotton producers, depending on their individualized production scenarios.

Introduction

Stripper harvesting is the most prominent means of harvesting cotton in Texas. Seventy-two percent of the cotton produced in Texas is stripper harvested, while the other 28 percent is machine picked (Glade et al., 1993). Stripper harvesting is faster than picker harvesting but removes more extraneous matter with the cotton lint and seed. Most of this extraneous matter (non-lint and non-seed) is composed of plant material such as burs, stems, leaf, and hulls, but could also contain non-plant materials that include sand and rocks. If these extraneous materials are not removed from cotton lint, it may not be usable for certain purposes. The presence of foreign material in cotton lint may also compromise the quality of the products produced by mills.

Research was initiated as early as 1927 to develop a bur extractor that can be used on stripper harvesters for removing some extraneous material at the time of harvesting (Kirk et al. 1970). Currently, bur extractors are commercially available to producers, who have a choice of buying a new stripper with a bur extractor already attached or adding a bur extractor to their existing stripper harvesters.

Cotton producers need to know the effect of a bur extractor on extraneous materials (fractionation attributes) in harvested cotton, on quality attributes of lint (e.g., strength, color grade, trash grade, and micronaire), and on lint turnout to make informed decisions on their cost-effectiveness. Previous studies have addressed the effect of bur extractors and have found that lint turnout can be improved if a bur extractor is used (Richman et al. 1993). However, no published research has focused on the cost-effectiveness of bur extractor utilization which incorporates the effects of bur extractors on lint turnout. The objectives of this study were to estimate the effects of a bur extractor on extraneous material, on both quality attributes of stripper harvested cotton and lint turnout, and to determine the minimum harvested acres a producer must have for a bur extractor to be cost-effective. This study provides a simple method that can be employed by producers to determine the cost-effectiveness of a field cleaner given individualized production scenarios.

Data and Methods

The data for analyzing the effects of a bur extractor on extraneous material, quality characteristics, and lint turnout were collected from the Agricultural Research Service office of the U.S. Department of Agriculture (ARS-USDA) in Lubbock, Texas. The cotton samples used for this analysis were of one cotton variety, Paymaster HS-26, and were all stripper harvested (some with the use of a bur extractor and some without). Once harvested and dumped into trailers, samples were taken at random to obtain the trailer samples. During the ginning process, samples were taken at the feeder apron above the gin stand. For each of these samples, 200 grams of seed cotton were weighed and the burs and sticks were removed by hand. These 200 gram samples were then placed in a pneumatic fractionator that separated the fine trash. Each foreign matter fraction and the seed cotton was then weighed. The cotton was then ginned using the standard sequence used for stripper harvested cotton, which included: airline cleaner, inclined cleaner, combination bur and stick machine, second incline cleaner, stick machine, 178 saw gin and two saw-type lint cleaners. Lint samples collected after the second lint cleaning were used to measure the lint turnout. Samples were then sent to the USDA classing office in Lubbock, Texas, where the quality attributes were measured. The data were compiled for all samples and an average was taken of the samples with similar treatments.

Effects of Bur Extractors on Extraneous Material, Quality Attributes, and Lint Turnout

To analyze the effects of bur extractors on extraneous material, quality attributes of cotton, and lint turnout, several linear regression models were run. Each of the attributes was specified as a function of the bur extractor. The bur extractor (BE) variable was specified as a dummy variable; BE = 1 if the field cleaner was used in harvesting and BE = 0, if otherwise.

Determination of the Minimum Harvested Acres for a Bur Extractor to be Cost Effective

For the purpose of cost analysis, secondary data for average yield and ginning cost, and survey data for bur extractor ownership cost, collected from producers and an area implement company, were used. Average yield per acre for high yielding cultivars (Paymaster HS-26, Paymaster 145,

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and All-Tex Atlas), medium yielding cultivars (Tamcot CAB-CS, Deltapine SR-383, and Deltapine 50), and low yielding cultivars (Lankart LX-571 and Cencot) of cotton were calculated by averaging agronomic yield data for 1988 through 1992 reported by Gannaway et al. (1993). Average yield per acre for high, medium, and low yielding cultivars of cotton were calculated to be 1.5, 1.3, and 0.8 bales for irrigated cotton and 0.7, 0.5, and 0.3 bales for dryland cotton, respectively. A bale of cotton is assumed to weigh 480 pounds.

Lint turnout for the three different groupings of non-bur extracted (stripper harvested without using a bur extractor) irrigated and dryland cotton was also taken from Gannaway et al. (1993). Gannaway et al. (1993) reported lint turnout for non-bur extracted dryland cotton to be 23.4, 21.3, and 17.1 percent for high, medium, and low yielding cultivars, respectively. Similarly, lint turnout for irrigated non-bur extracted cotton has been reported to be 24.5, 21.6, and 16.7 percent for high, medium, and low yielding cultivars, respectively. Lint turnout for bur extracted cotton were calculated by adjusting the reported lint turnouts by the estimated effect of bur extractor on lint turnout provided by the regression model.

To determine the ginning cost savings (GCS) per bale of lint due to the use of a bur extractor, the ginning charges [dollars per hundred weight (cwt.) of seed cotton assessed by the gin] were adjusted for bur extracted cotton by accounting for the difference in lint turnout between bur extracted and non-bur extracted cotton. The ginning cost savings (GCS) per bale was calculated by subtracting ginning cost per bale of bur extracted cotton from the ginning cost per bale of non-bur extracted cotton:

$$GCS = \left(\frac{GCCWT}{LTNBE} * 480\right) - \left(\frac{GCCWT}{LTBE} * 480\right) \qquad (1)$$

where GCCWT is ginning charges in dollars per cwt. of material entering the gin plant, LTBE is lint turnout (lbs. of lint cotton/cwt. of seed cotton) for bur extracted cotton, and LTNBE is lint turnout (lbs. of lint cotton/cwt. of seed cotton) for non-bur extracted cotton. Equation 1 can be simplified (taking a common denominator) to read:

$$GSC = \frac{480 * GCCWT * (LTBE - LTNBE)}{LTBE * LTNBE} \qquad (2)$$

To obtain the break-even number of acres (minimum number of acres required to cover the cost of a bur extractor) over a ten year period (assumed life of a bur extractor), the following equation was used:

$$ACRES = \frac{C_{BE}}{Y * (GCS)} \qquad (3)$$

where C_{BE} is the annual ownership and maintenance cost of a bur extractor and Y is the expected lint yield per acre.

The analysis was further modified to determine how long it would take to recover the cost of a bur extractor for alternative farm sizes. This was accomplished by rewriting equation 3 in the following manner:

$$YEARS = \frac{TC_{BE}}{ACRES * Y * GCS} \qquad (4)$$

where TC_{BE} is the total ownership and maintenance cost of a bur extractor over a ten year period, Acres is the number of acres under production and Y is the expected yield per acre.

Results and Implications

Effects of Bur Extractors on Trash, Quality Attributes and Lint Turnout

The effects of the bur extractor on fractionation and quality attributes of cotton were analyzed with regression procedures. The regression results, presented in Table 1, indicate that the bur extractor has a statistically significant effect (significance level of 0.05 or less) in reducing bur percent, stick percent, and in increasing seed cotton percent and lint turnout, while it showed no statistically significant effect on fine trash.

Specifically, the results (Table 1) indicate that bur percent in cotton can be reduced from 21.70 percent to about 6.54 percent (21.6952 - 15.1571) when a bur extractor is used, representing a decrease of about 70 percent. Also, a bur extractor was found to decrease stick percent in harvested cotton by about 29 percent, and increase seed cotton percent by approximately 27 percent. Further, it was observed that the bur extractor increased the lint turnout by approximately 21 percent (from 21.7 to 26.26), and the relationship was statistically significant. Regression results, presented in Table 2, however, do not reveal any statistically significant relationship between bur extractor and any of the quality attributes (cotton that was bur extracted possessed the same quality attributes as cotton that was not bur extracted).

Cost Effectiveness of Bur Extractors

Costs of Owning and Operating a Bur Extractor:

Survey results indicate the cost of operating a bur extractor is comprised of an initial cost of $11,000 for a new bur extractor with a ten year expected life. Assuming that the bur extractor will have no salvage value at the end of the ten-year time period, the straight-line depreciation cost per year of the bur extractor is $1,100. The repairs to the bur extractor include: replacing all top saws at a cost of $500.00 every two years; replacing all bottom saws at a cost of $500.00 every four years; replacing one and one-half of all brushes each year at a cost of $180.00; replacing two belts per year at a cost of $100.00; replacing four bearings per year at a cost of $160.00; and replacing one and one-half of the reclaimer brushes every year at a cost of $75.00. This yields a total cost of $1,990.00 per year ($19,900.00 for ten years) for using and maintaining a bur extractor during harvest.

Determination of the Ginning Cost Savings and Break-Even Acres:
Ginning charges, including transportation of modules from the field to the gin, was assumed to be $2.00 per hundred weight (cwt.) of material entering the gin (USDA 1992). The ginning cost savings per bale of lint was calculated by using equation 1. Lint turnout for each of the three cultivar groups, for both dryland and irrigated varieties, were adjusted up by 21 percent to account for the effect of a bur extractor in harvesting. Due to lack of data, it was assumed that the effect of a bur extractor in lint turnout does not vary significantly among varieties and between irrigated and dryland management practices.

Ginning cost savings per bale ranged between $7.10 and $9.76 for dryland cotton and between $6.86 and $9.96 for irrigated cotton (Table 3). It is interesting to observe that lower yielding varieties of cotton (with lower lint turnouts) save relatively more in ginning cost per bale than higher yielding varieties. Given the assumption that the effect of a field cleaner on lint turnout is constant among varieties, as might be expected, lower yielding varieties with higher initial ginning cost per bale stand to save more (in absolute terms) than varieties with lower initial ginning cost per bale.

The analysis of the number of acres required to recover the cost of a bur extractor for dryland and irrigated cotton for three different yield categories was accomplished by using equation 2. Results (Table 3) suggest that a producer with an average yield of 1.5 bales/acre (high yielding irrigated) of cotton must harvest at least 193 acres of cotton per year for ten years to recover the cost of a bur extractor. For medium (1.3 bales/acre) and low (0.8 bales/acre) yielding irrigated cotton, a producer would be required to harvest 200 and 250 acres, respectively, of cotton per year for ten years to recover the bur extractor cost. Likewise, a producer must harvest at least 400, 506, and 680 acres of dryland cotton per year for a ten year time period to recover the costs of a bur extractor when using high yielding, medium yielding, and low yielding cotton, respectively.

The alternative analysis examined how long it would take to recover the cost of a bur extractor for various farm sizes by using equation 3. Table 4 presents the results of this analysis. Thus, a producer with 1,000 acres of high yielding (1.5 bales/acre) irrigated cotton will take just under 2 years to recover the cost of purchasing and maintaining a bur extractor and about 4 years for dryland cotton producing 0.7 bales/acre on the same size farm. Likewise, a producer using irrigated cotton with medium yield on 1,000 acres will take about 2 years versus just over 5 years for dryland cotton to recover the costs associated with a bur extractor. Finally, an irrigated, low yielding, 1,000 acre cotton farm will take 2.5 years while the dryland cotton will take nearly 7 years to recover the costs of owning and operating a bur extractor. However, a producer having a low yield on 500 acres of dryland cotton should not purchase a piece of equipment expected to last 10 years when it takes more than 13 years to pay it off.

Summary and Conclusions

Experimental data on cotton attributes, with and without the use of a bur extractor, were collected and analyzed to assess the effects of a bur extractor on extraneous material, quality attributes, and on lint turnout. The analysis suggests that bur percent and stick percent in cotton can be reduced by about 70 percent and 29 percent, respectively, with the use of a bur extractor. Seed cotton percent was found to increase by about 27 percent when a bur extractor is used during harvesting. The analysis also suggests that the use of a bur extractor in harvesting increases lint turnout by about 21 percent. However, bur extractors do not appear to have any statistically significant effect on the quality attributes of cotton.

The findings of this study suggest that investment in bur extractors is profitable for producers in all irrigated and most dryland cotton production situations with an operation of at least 500 acres. The 500 acre farm, with low and medium yield dryland cotton, is the only instance rendering a payback period which exceeds the life of the bur extractor. In all cases of irrigated cotton, the farm recovered the cost of the bur extractor in 5 or fewer years. In dryland cropping practices, the cost of the bur extractor, can be recovered in 9 years or less, with the exception of the low and medium yield cultivars on the 500 acre farm. The most profitable alternative (irrigated, high yielding cotton on a 1,000 acre farm) yields a recovery period of 2 years. Producing beyond these levels of yields, acreages, and break-even time-periods would provide additional returns to capital.

Some policy ramifications emerge from this study. Given that producers using bur extractors save between $7.00 and $10.00 in ginning charges per bale of cotton lint (Table 3), ginners must absorb this loss. The net loss for ginners, however, may not equal to the producers' savings. Since ginners, in most cases, include the cost of module hauling in ginning charges, ginners can save in module transportation costs when a bur extractor is used (Misra et al., 1995). Further, there is some evidence suggesting that ginners can also save on gin machinery maintenance and repair costs if a bur extractor is used in the harvesting stage. If ginners do not make up for the loss in ginning charges by cost savings, then the ginning pricing structure may be expected to change. Further research is thus needed to evaluate the net effect of increased adoption of bur extractors on ginners' revenue.

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Table 1. Regression Results of the Effects of a Bur Extractor on Fractionation Attributes[1].

	N (# of observations)	Constant	BE	R^2
Bur Percent	42	21.6952[2] (0.6604)	-15.1571[2] (0.9339)	0.87
Stick Percent	42	6.048[2] (0.3239)	-1.7762[2] (0.4582)	0.2731
Fine Trash	42	7.3286[2] (0.3839)	-0.0857 (0.5429)	0.0006
Seed Cotton Percent	42	64.019[2] (0.8421)	17.0429[2] (1.1909)	0.8366
Turnout	66	21.7006[2] (0.3241)	4.5585[2] (0.4584)	0.6071

Note: Numbers in parenthesis are standard errors.
1 This table may also be expressed in equation form. An example would be:

$$\text{Bur Percent} = 21.6952 - 15.1571*\text{BE},$$

with the effect of the bur extractor being represented by the BE coefficient. All other regression results presented in Table 1 can also be expressed in the same manner.2 Significance level less than 0.05.

Table 2. Regression Results of the Effects of a Bur Extractors on Quality Attributes[1].

	N (# of observations)	Constant	BE	R^2
Strength	42	23.4762[2] (0.2043)	0.4286 (0.2889)	0.0522
Composite Color	42	39.4762[2] (0.9539)	-0.9048 (1.3491)	0.0111
RD	42	3.7143[2] (0.101)	0.0000 (0.1429)	0.0000
+b	42	1.7619[2] (0.1313)	-0.0952 (0.1857)	0.0065
Trash	42	4.6667[2] (0.1528)	-0.0476 (0.2161)	0.0012
Length	42	101.7143[2] (0.4.8472)	9.3809 (6.8549)	0.0447
Uniformity	42	80.4286[2] (0.2239)	-0.04762 (0.3166)	0.0006
Micronaire	42	35.4286[2] (0.3311)	-0.4762 (0.4683)	0.0252

Note: Numbers in parenthesis are standard errors.
[1] - This table may also be expressed in equation form. An example would be:

$$\text{Strength} = 23.4762 + 0.4286*\text{BE},$$

with the effect of the bur extractor being represented by the BE coefficient. All other regression results presented in Table 2 can also be expressed in the same manner.
[2] - Significance level of less than 0.05.

Table 3. Ginning cost savings and the number of acres required to cover the ownership and maintenance costs of a bur extractor.

	Ginning Cost Savings Per Bale[2]		Acres Required to Break-Even	
Yield Level[1]	Dryland	Irrigated	Dryland	Irrigated
Low	9.76	9.96	680	250
Medium	7.86	7.66	506	200
High	7.10	6.86	400	193

[1] - Average yield levels were assumed to be 1.5, 1.3, and 0.8 bales/acre for high, medium, and low yielding irrigated cotton, and 0.7, 0.5, and 0.3 bales/acre for high, medium, and low yielding dryland cotton, respectively.
[2] - Lint turnouts for non-bur extracted cotton were assumed to be 23.4, 21.3, and 17.1 percent for high, medium, and low yielding dryland varieties, and 26.5, 21.6, and 16.7 percent for high, medium, and low yielding irrigated varieties, respectively. For bur-extracted cotton, turnouts were adjusted up by 21 percent and were calculated to be 28.3, 25.8, and 20.7 percent for dryland and 29.7, 26.1, and 20.2 percent for irrigated high, medium, and low yielding cotton, respectively.

Table 4. Number of years required to cover the ownership and maintenance costs of a bur extractor, by farm size, for irrigated and dryland cotton.

	Cotton Acres					
	500 Acres		750 Acres		1,000 Acres	
Yield Level[1]	Dryland	Irrig	Dryland	Irrig	Dryland	Irrig
	------------------------ Years To Pay-Back ------------------					
Low	13.59	4.99	9.06	3.33	6.79	2.50
Medium	10.13	3.99	6.75	2.66	5.06	2.00
High	8.01	3.87	5.34	2.58	4.00	1.93

[1] - Average yield levels were assumed to be 1.5, 1.3, and 0.8 bales/acre for high, medium, and low yielding irrigated cotton, and 0.7, 0.5, and 0.3 bales/acre for high, medium, and low yielding dryland cotton, respectively.