CAN LINT CLEANER WASTE BE REDUCED?

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Abstract

Tests were conducted to establish the impact of the number of grid bars on the lint lost by saw-type lint cleaners. Data indicated that the first grid bar removed primarily foreign matter and subsequent grid bars removed more lint than foreign matter. Saw-type lint cleaners have 5 to 8 grid bars, and reducing the number of grid bars (cleaning points) significantly decreased the fiber waste. For 1, 2, 3, 4 and 5 grid bars, material removed was 11.7, 20.3, 21.4, 27.1, and 27.6 pounds per 500 pounds of lint. About 20 million bales of cotton are produced in the U.S. annually and 4 million require less than one complete stage of lint cleaning, yet they receive a full stage. For those 4 million bales, the first cleaning point is nearly always required, and usually no more than two are needed. Lint loss can typically be reduced by 50% or more, or 10 pounds per bale of cotton. For 4 million bales with cotton at $0.75 per pound, this equates to $30,000,000 annually--for a typical gin processing 25,000 bales per year, this is about $200,000. About 10 million bales require less than two complete lint cleaners for a potential savings of about 7 pounds per bale or $50 million annually.

Introduction

Cotton is processed through a standard sequence of cleaning machinery at the gin. Each machine removes trash and some cotton, while it may or may not improve the market value. The standard sequence includes four seed cotton cleaners, gin stand, and two lint cleaners. The USDA has licensed inventions to a commercial firm to monitor and control the quality of cotton by selectively processing cotton through various machines to maximize monetary returns (Anthony and Byler, 1998). Generally with the exception of some commercially available extractors, these machines must either be used or not used because partial use of a machine is not possible with current technology. Based on unpublished data, about 20% of the cotton requires only part of the cleaning available from traditional gin machines. Thus, about 80% of the cotton is over processed, money is lost and fiber is damaged. Of all the gin machines, lint cleaners have the greatest impact on fiber waste. One lint cleaner removes sufficient material (fiber and trash) to reduce bale weight by about 20 pounds per 500-pound bale while two stages reduce bale weight by 30 pounds per bale (Mangialardi, 1972).

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Grid bars used in saw-type lint cleaners control the loss of fiber during the cleaning process because they provide impact points that force trash to be removed from the fiber. Machinery manufacturers have adopted a variety of grid bar arrangements that meet those purposes. Many types and arrangements of grid bars are used, but very little published information is available to document the merits of the various designs or even to quantify the influence of important variables. Ginners are interested in determining how the number of grid bars affects fiber loss and cleaning performance. They already raise questions about the sharpness of the grid bars and their spacing from the saw.

Purpose

The purpose of this research was to establish the impact of number of grid bars and the number of lint cleaners on waste removed by a saw-type lint cleaner.

Discussion

Study A

In Study A, we installed sheet metal devices to capture the waste ejected from each of the five grid bars as shown in Figure 1. The amount of lint processed and the waste material removed from each grid bar were recorded in three replications from Deltapine 5409 variety cotton which was harvested during the 1996 season. Results are shown in Table 1. Average waste removal for bars 1, 2, 3, 4, and 5 were 35.0, 30.5, 40.0, 18.6, and 24.1 grams, respectively, from about 11 pounds of material. The material removed by each grid bar and subsequently separated by hand into lint fractions and foreign matter fractions is shown in Figure 2. It appears that lint cleaner grid bar number one removed almost no fiber, whereas grid bars two through five removed primarily fiber with leaf-type foreign matter decreasing as the number of grid bars increased. The waste samples removed from each grid bar, except grid bar number one because it consisted mostly of plant parts, were processed through the standard Shirley Analyzer. We retrieved 33.3%, 48.6%, 54.8%, and 67.3% of the material as lint from grid bars 2, 3, 4, and 5, respectively.

Study B

Study B was conducted to determine the advantage of using the reduced grid bar lint cleaner before or after the standard lint cleaner. Twenty-five treatments were tested using pre-cleaned and non-pre- cleaned cotton. A complete lint cleaner was used either before or after the modified lint cleaner to ascertain the more advantageous mode for lint cleaners in series. Gin data is presented in Table 2. The gin stand operating alone, lost 13.5 pounds of material per bale. The gin stand plus one lint cleaner lost 33.1 lb/bale and the gin stand plus the first and third lint cleaners lost 46.5 lb/bale. One, two, three, four, and five grid bars lost 11.0, 19.2, 22.6, 25.0, and 27.6 pounds, respectively, when used alone. For the modified lint cleaner preceded by a full lint cleaner (which removed 29.2 to 37.5 lbs and averaged 32.5

lbs), the following losses (pounds) occurred for 1, 2, 3, 4, and 5 grid bars, 3.6, 6.4, 8.3, 10.3 and 10.3, respectively. Total waste (gin stand motes plus number one lint cleaner plus number two lint cleaner with a variable number of grid bars) was 32.7, 37.0, 40.1, 43.5, and 47.7 pounds per 500-lb bale equivalent, respectively, for 6, 7, 8, 9, and 10 grid bars (Table 3).

When the modified lint cleaner preceded the full lint cleaner, the following losses occurred:

Modified lint cleaner		Gin stand plus	Total
Grid bars	Waste, lbs	#3 lint cleaner, lbs.	waste, lbs.
1	11.7	24.2	35.9
2	20.6	27.2	47.8
3	21.4	24.0	45.4
4	27.1	29.9	57.0
5	27.6	26.4	54.0

Thus, it appears that fewer pounds of waste are removed when the partial lint cleaner is used second. However, the relative efficiency of lint cleaners 1 and 3 are not known; they are both Continental Sixteen-D cleaners.

Manual color index was generally 41 (strict low middling) except that one of the 3 observations from the 2, 3, and 4-grid bar treatments was called 42, and one was called 51 for the 5-grid bar treatment (Table 5). For the HVI color grade index (Table 4), one observation was called 51 for the 2-bar treatment and one was called 52 for the 5-grid bar treatment. These trends continued even for the two-lint cleaner treatments, perhaps, due to the high lint moisture during cleaning and/or due to the high foreign matter content.

Leaf grades for the modified lint cleaner treatments were 6, 5.3, 5.5, and 6 for 1, 2, 3, 4, and 5 grid bars, respectively. For the one-lint cleaner treatment, leaf grades averaged 5.3; leaf grade averaged 4.6 for two-lint cleaners. Leaf grades for 1.2 (one lint cleaner plus one grid bar of a second lint cleaner) up to 2.0 lint cleaners also averaged 4.6; i.e., 1.2 lint cleaners gave the same grade as 2.0 lint cleaners but lost less cotton (Table 5). HVI trash was 0.80, 0.90, 0.80, 0.87, and 0.93% for 1, 2, 3, 4, and 5 grid bars, i.e., these values were not statistically different as shown in Table 4. Shirley Analyzer total waste was 6.4, 5.7, 7.0, 5.9, and 6.2%, respectively after 1, 2, 3, 4, and 5 grid bars. The total waste, based on the Shirley Analyzer, averaged 5.6%. The Shirley Analyzer total waste was 4.4% for two stages of lint cleaning as compared to about 6.0% for one stage. Visible Shirley Analyzer waste was 4.8, 4.0, 5.0, 4.1, and 4.5% for 1, 2, 3, 4, and 5 grid bars (Table 4). Apparently the lint moisture content was too high (7.5%) for good cleaning.

Disclaimer

Mention of a trade name, proprietary product, or specific machinery does not constitute a guarantee or warranty by the U.S. Department of Agriculture and does not imply approval of the product to the exclusion of others that may be available.

References

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Table 1. Waste and fiber characteristics after each grid bar for Study A.

Bar	Waste, grams	Fiber from Shirley, %	Visible waste from Shirley, %	Short fiber content by weight, %	Neps per gram
1	35.0	-	-	-	-
2	30.5	32.4	61.5	15.0	215
3	40.0	48.4	47.7	12.8	258
4	18.6	54.9	40.5	12.5	211
5	24.1	64.9	32.8	11.2	235
Total	148.2[1]				

[1)] 11.1 pounds adjusted for a 500-lb bale

Table 2. Gin data for Study B.

Moisture	Lint cleaner			Second lint cleaner grid	Turnout,	Shirley Analyzer, %, for ginned lint	
(lint), %	1	3	2	bar	%	Total	Visible
7.4	0	0	Y	1	36.76	6.38	4.79
7.1	0	0	Y	2	35.76	5.70	3.99
7.6	0	0	Y	3	34.89	6.98	4.96
7.1	0	0	Y	4	34.99	5.90	4.08
8.0	0	0	Y	5	34.30	6.25	4.46
7.8	1	0	N	0	35.06	5.22	3.58
7.3	1	0	N	0	34.94	--	--
8.4	1	0	N	0	34.65	5.22	3.81
7.3	1	0	N	0	34.65	6.13	4308
7.9	1	0	N	0	34.41	5.96	4.30
7.2	0	1	Y	1	34.13	5.04	3.46
7.0	0	1	Y	2	34.07	2.36	2.68
7.0	0	1	Y	3	34.31	3.79	2.36
7.4	0	1	Y	4	33.17	5.23	3.35
7.1	0	1	Y	5	33.15	3.80	2.42
8.7	1	0	Y	1	34.74	4.31	3.10
7.1	1	0	Y	2	34.37	4.33	2.77
7.5	1	0	Y	3	33.92	3.84	2.55
7.6	1	0	Y	4	33.68	4.64	2.94
7.5	1	0	Y	5	33.54	4.05	2.86
7.4	1	1	N	0	34.21	3.30	2.44
7.0	1	1	N	0	33.78	4.16	2.56
8.1	1	1	N	0	33.08	4.67	3.12
6.7	1	1	N	0	33.53	--	--
7.5	1	1	N	0	33.35	4.39	2.70

Table 3. Additional gin data for Study B.

GIN-ID	Number of cleaners	Waste from gin stand and first or third LC			Waste from second LC			Total waste both lint cleaners, lb. per bale
		lb.	%	per bale	lb.	%	per bale	
4	0.2	0.62	1.98	9.92	0.64	2.03	10.16	20.09
9	0.4	0.70	2.32	11.58	1.09	3.57	17.83	29.41
14	0.6	1.28	3.98	19.90	1.54	4.75	23.76	43.66
19	0.8	0.76	2.21	11.07	1.60	4.56	22.82	33.89
24	1.0	1.12	3.05	15.23	2.09	5.53	27.63	42.86
2	1.0	2.02	6.13	30.66	.	.	.	.
7	1.0	1.94	6.06	30.31	.	.	.	.
12	1.0	2.50	6.37	31.86	.	.	.	.
17	1.0	2.72	6.98	34.91	.	.	.	.
22	1.0	2.64	7.55	37.76	.	.	.	.
5	1.2	1.78	4.83	24.17	0.84	2.33	11.66	35.83
10	1.4	1.78	5.45	27.23	1.32	4.11	20.55	47.79
15	1.6	1.58	4.80	24.01	1.40	4.29	21.43	45.44
20	1.8	2.04	5.98	29.91	1.83	5.41	27.06	56.97
25	2.0	2.00	5.29	26.43	2.09	5.51	27.57	54.00
1	1.2	1.86	5.83	29.15	0.21	0.71	3.55	32.70
6	1.4	2.12	6.13	30.64	0.42	1.28	6.39	37.02
11	1.6	1.88	6.35	31.74	0.47	1.66	8.32	40.06
16	1.8	2.38	6.73	33.67	0.69	2.05	10.27	43.94
21	2.0	3.06	7.50	37.48	0.79	2.05	10.25	47.73
3	2.0	2.40	8.36	41.78	.	.	.	.
8	2.0	2.92	9.34	46.68	.	.	.	.
13	2.0	3.02	9.90	49.51	.	.	.	.
18	2.0	3.34	9.38	46.88	.	.	.	.
23	2.0	3.38	9.55	47.77	.	.	.	.

Table 4. HVI classification data from Study B.

Lint cleaner			Grid				Plus	HVI			HVI color
1	2	3	bar	Mic	Strgth	RD	b	trash	Lgth	Unif	index
0	Y	0	1	4.5	28.3	70.3	8.2	0.8	1.11	84.0	94.0
0	Y	0	2	4.7	29.0	69.7	8.4	0.9	1.13	84.0	91.0
0	Y	0	3	4.6	29.7	70.0	8.7	0.8	1.11	84.0	94.0
0	Y	0	4	4.6	28.7	71.7	8.5	0.9	1.13	84.7	94.0
0	Y	0	5	4.7	30.0	68.7	8.9	0.9	1.12	84.0	89.3
1	N	0	0	4.7	29.0	71.0	8.5	0.6	1.12	84.0	91.0
1	N	0	0	4.6	28.3	71.7	8.6	0.8	1.14	84.3	94.0
1	N	0	0	4.6	28.3	70.3	8.7	0.8	1.13	83.3	94.0
1	N	0	0	4.8	29.0	69.7	8.7	0.9	1.12	83.7	94.0
1	N	0	0	4.5	29.0	69.0	8.8	0.7	1.12	83.7	87.7
0	Y	1	1	4.6	28.3	70.3	9.1	0.6	1.11	83.7	90.7
0	Y	1	2	4.6	28.0	69.7	8.5	0.8	1.12	84.0	91.0
0	Y	1	3	4.7	29.0	73.0	8.7	0.5	1.12	84.0	94.0
0	Y	1	4	4.7	29.0	71.3	9.0	0.6	1.11	84.0	92.3
0	Y	1	5	4.5	29.0	71.7	8.8	0.5	1.11	84.0	94.0
1	Y	0	1	4.6	28.3	70.3	8.8	0.6	1.11	84.3	92.3
1	Y	0	2	4.6	29.0	70.0	8.8	0.6	1.11	83.7	91.0
1	Y	0	3	4.6	29.7	73.3	8.9	0.5	1.12	84.0	94.0
1	Y	0	4	4.7	29.3	71.0	8.8	0.6	1.12	84.0	94.0
1	Y	0	5	4.6	31.7	71.3	9.1	0.6	1.12	84.0	92.3
1	N	1	0	4.7	27.7	71.7	9.1	0.6	1.11	83.7	94.0
1	N	1	0	4.7	28.3	72.0	9.0	0.6	1.1	84.0	94.0
1	N	1	0	4.5	29.3	69.3	9.2	0.7	1.11	84.0	87.7
1	N	1	0	4.6	29.0	71.7	8.9	0.6	1.12	84.0	94.0
1	N	1	0	4.6	29.3	71.7	9.2	0.6	1.13	84.0	92.3

Table 5. Manual classification

Lint cleaners			Lint	Leaf	Color grade	Waste	GS + LC	Turn	Total
1	2	3	moist.	grade	index	bale [1]	bale [2]	out	waste [3]
0	Y	0	7.4	6.0	94.0	10.2	9.9	36.8	20.1
0	Y	0	7.1	5.3	92.3	17.8	11.6	35.8	29.4
0	Y	0	7.6	5.0	92.3	23.8	19.9	34.9	43.7
0	Y	0	7.1	5.0	92.3	22.8	11.1	35.0	33.9
0	Y	0	8.0	6.0	91.0	27.6	15.2	34.3	42.9
1	N	0	7.8	5.0	94.0	.	30.7	35.1	.
1	N	0	7.3	5.0	94.0	.	30.3	34.9	.
1	N	0	8.4	5.3	92.3	.	31.9	34.6	.
1	N	0	7.3	5.3	94.0	.	34.9	34.6	.
1	N	0	7.9	5.7	90.7	.	37.8	34.4	.
0	Y	1	7.2	5.0	92.3	11.7	24.2	34.1	35.8
0	Y	1	7.0	5.0	94.0	20.6	27.2	34.1	47.8
0	Y	1	7.0	4.0	94.0	21.4	24.0	34.3	45.4
0	Y	1	7.4	5.0	94.0	27.1	29.9	33.2	57.0
0	Y	1	7.1	4.7	94.0	27.6	26.4	33.2	54.0
1	Y	0	8.7	5.0	92.3	3.5	29.2	34.7	32.7
1	Y	0	7.1	4.7	94.0	6.4	30.6	34.4	37.0
1	Y	0	7.5	4.3	94.0	8.3	31.7	33.9	40.1
1	Y	0	7.6	5.0	94.0	10.3	33.7	33.7	43.9
1	Y	0	7.5	5.0	94.0	10.2	37.5	33.5	47.7
1	N	1	7.4	4.0	94.0	.	41.8	34.2	.
1	N	1	7.0	5.0	94.0	.	46.7	33.8	.
1	N	1	8.1	4.7	90.7	.	49.5	33.1	.
1	N	1	6.7	5.0	94.0	.	46.9	33.5	.
1	N	1	7.5	4.3	92.3	.	47.8	33.3	.

[1] Waste from the modified lint cleaner, lb/bale
[2] Waste from the gin stand and lint cleaner, lb/bale
[3] Gin stand and lint cleaner waste combined, lb/bale

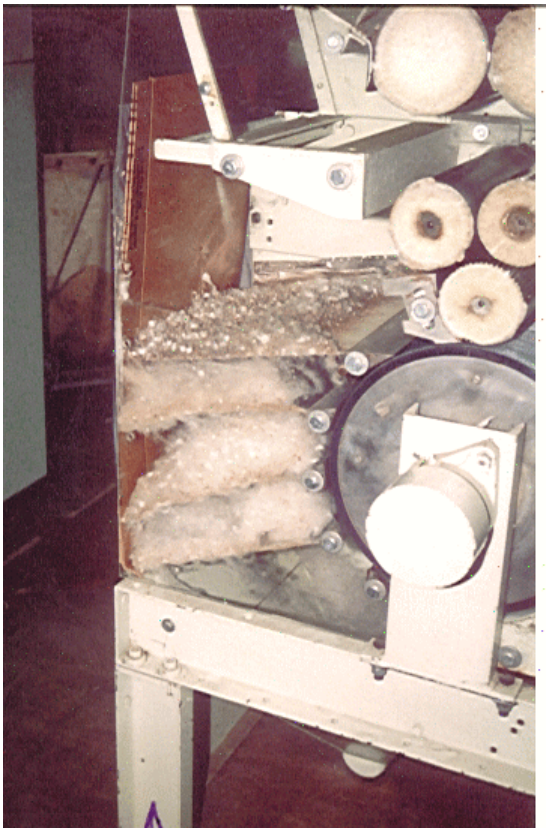

Figure 1. Sheet metal deflectors used to capture trash from each grid bar of a 16-D lint cleaner.

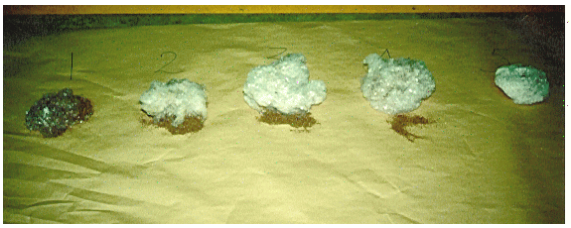

Figure 2. Samples of waste from each grid bar of a 16-D lint cleaner are shown with grid bars from 1 to 5 presented left to right. The four samples on the right were cleaned with a Shirley Analyser and the relative amounts of fiber and plant parts are shown.