A LOOK AT COMBING FIBERS AT COTTON GINS

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Abstract

An apparatus was developed and tested to determine if lint combing of some cottons during gin processing could reduce the number of saw-cylinder lint cleaners now needed at gins. The objective was to blend spots of discoloration from light-spotted cottons and move these bales into the white color grades, and to prevent the classer from discounting samples because of preparation. This paper describes experiences with the apparatus. Although all of the desired results were not obtained, data indicate that work on developing lint combing apparatuses that influence and improve cotton grades at saw ginning plants should continue. These apparatuses could be used to supplement lint cleaning with one saw-cylinder lint cleaner in place of adding a second stage of saw-type lint cleaning. They would also increase the number of cases where maximum returns would be obtained with no saw-type lint cleaning.

Introduction

Saw-type lint cleaners are used in cotton gins to remove leaf particles, bract, seed-coat fragments, motes, grass and bark; comb the fibers to produce a "smooth" appearance; and to blend color spots. Most cotton gins in the United States have lint-cleaning facilities, and most saw-type gins have two or more stages of lint cleaning.

The controlled-batt saw cleaner is the most common in the ginning industry. Lint from the gin stand or a preceding lint cleaner is formed into a batt on a condenser screen drum. The batt is then fed through one or more sets of compression rollers, passed between a very closely fitted feed roller and feed plate or bar, and fed onto a saw-cylinder. The feed roller and plate grip the batt so that a combing action takes place as the sawteeth seize the fibers. While the fibers are on the saw cylinder, they are cleaned by a combination of centrifugal force, scrubbing action between saw cylinder and grid bars, and gravity assisted by an air current. The fibers are usually doffed from the sawteeth by a revolving brush. The number of stages of saw cleaning refers to the number of saws over which the fibers pass.

Lint cleaning generally improves the color and leaf grade classifications of the lint. As the number of lint cleaners increases, classer grade tends to improve. However, as grades improve, bale weights are reduced and staple length may decrease. These opposing factors affect bale value. Occasionally, such offsetting losses may cause the bale value to be reduced by lint cleaning. When price spreads between grades are small, the grower can obtain maximum bale value most often on upland variety cottons by using one saw lint cleaner on early-season clean cottons and two stages of saw lint cleaning on late-season, more trashy, or light spotted cottons (Baker 1972; Mangialardi 1995).

Perhaps the best index to cotton quality is the performance of the fibers during spinning at the textile mill. Increasing the number of saw lint cleaners at the gin decreases the manufacturing waste during spinning, but often has the adverse effects of increasing neps in the card web and lowering yarn strength, appearance, and processing efficiency. A decline in appearance is greater for the finer count carded yarns. From a spinning standpoint, the use of more than two saw lint cleaners in series has been strongly discouraged (Looney, et. al., 1963; Mangialardi 1972).

A two-year study (1971 and 1972) at Stoneville, MS, showed that saw-type lint cleaners are effective in blending out some spots and light spots, and removing some of the grass, stems, and bark from cotton. In the experiments, the total decrease in samples classed as light spotted after 1, 2, and 3 lint cleaners were 28, 44, and 50%, respectively. Samples reduced in grade because of grass, stems, or bark, or traces of these numbered 91, 61, 60, and 53 (per 150 samples tested) after 0, 1, 2, and 3 stages of lint cleaning (Mangialardi 1976).

Beginning with the 1993 crop year, the U.S. Department of Agriculture-Agricultural Marketing Service (USDA-AMS) revised its procedures for the grade classification of cotton. Before 1993, the USDA-AMS assessed the color and leaf grade separately and then combined them into a single “composite” grade weighted in favor of color. The quality factors for color and leaf that have previously been described in combination as a single grade are now reported separately as a color grade and a leaf grade. This new reporting system also eliminates the use of the “Average Rule” by the classer. Bales are no longer reduced in grade because of extraneous matter such as bark, or for preparation, but those are noted on the classification document. The amount of extraneous matter in the cotton is reported as levels 1 or 2 with level 2 indicating the heavier contamination. The degree of abnormal preparation is also noted as levels 1 or 2. Level 1 preparation denotes a moderate degree of roughness, and level 2 indicates excessive roughness. These changes necessitated premium and discount schedules for color grade, leaf content, bark and extraneous matter level, and preparation (USDA 1993).

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The number of bales of cotton in the U.S. classified as rough preparation is generally less than 0.5% of the crop. A definite increase occurred in the 1993 and later crop years. In 1994, at least 12 gins had greater than 5% preparation calls. Individual gins have had 10-25% abnormal preparation. Discounts due to poor preparation are discouraging ginners from using lesser amounts of cleaning and drying as they attempt to gin cotton gently. As a precaution against abnormal preparation, some ginners have gone back to using two or more lint cleaners instead of one stage of saw lint cleaning (Anthony and Mayfield 1996).

This paper discusses the results from the first phase of a study to investigate lint combing at cotton gins. The objective was to reduce the amount of saw-cylinder lint cleaning that is presently required at gins for maximum returns. Specifically, lint combing would eliminate or reduce classer's discounts for abnormal preparation and excessive extraneous matter and blend some spots from light spotted color cottons. Thus, one saw-type lint cleaner and sometimes no lint cleaning would become the norm for gin cleaning instead of the present one or two saw-cylinder lint cleaners.

Materials and Methods

The experimental ginnings were conducted in the small-scale ginning plant at the USDA Cotton Ginning Laboratory, Stoneville, MS. The seed cotton drying and cleaning sequence consisted of 24-shelf tower drier, 6-cylinder cleaner, stick machine, 24-shelf tower drier, 6-cylinder cleaner, and extractor-feeder. There was a 20-saw (40.6 cm or 16-inch diameter) gin stand followed by three saw-cylinder lint cleaners. All ginning machinery was adjusted according to manufacturers' recommendations.

The saw-cylinders on the three lint cleaners were 40.6 cm (16-inches) in diameter and rotated at 874 r/min. This produced saw-tip speeds of 18.6 m/s (3,661 feet-per-minute) and the cleaners operated at combing ratios of 34:1. The lint cleaners had five grid bars spaced 5.1 to 7.0 cm (2 to 2¾ inches) apart and 36.8 cm (14½-inch) working widths.

In this report, the first cleaner in the lint cleaning sequence will be referred to as Unit A, the second cleaner as Unit B, and the third lint cleaner as Unit C. In the experiments, lint cleaner Units A and C operated as standard saw-type lint cleaners (Figure 1). Lint cleaner Unit B was modified to serve as a comber (Figure 2).

This modification of Unit B involved removing the five grid bars and replacing these with a continuous smooth combing plate (shroud). The shroud plate of Unit B followed the curve of the saw-cylinder and was spaced 3.2 mm (1/8-inch) from the tip of the saw teeth. Along the saw cylinder was a 2-inch opening ahead of the shroud plate, and another 5.1 cm (2-inch) opening after the plate. The curved plate was fabricated from 16-gage steel (1.3 mm or 0.005 inch). Cotton fibers are combed by the standard feed works of Unit B, and then carried on the tips of the sawteeth around the shroud plate to the doffing brush.

Procedures

Seed cotton used in the experiments was grown and spindle-harvested by Delta Research and Extension Center, Mississippi Agricultural and Forestry Experiment Station, Stoneville, MS. The cotton was harvested September 13, 1995, and ginned October 23, 1995. The variety was Delta Experiment Station (DES) 119.

Twenty-one 18.1 kg (40-pound) size seed cotton test lots were conditioned for 24 hours at 23.9 °C (75 °F) and 55% relative humidity prior to ginning. These conditions were maintained in the atmosphere within the plant during gin processing. During ginning of the test lots, no heat was used on either of the two tower driers. Test lots were assigned to the experimental treatments in a randomized arrangement to neutralize the effect of the processing order.

There were three replications of seven lint cleaner treatments. The lint cleaner treatments consisted of (1) no lint cleaning (0), (2) combing on modified Unit B (B), (3) one saw-cylinder lint cleaner, Unit A (A), (4) one saw-cylinder lint cleaner, Unit C (C), (5) lint cleaner Unit A followed by comber Unit B (AB), (6) comber Unit B followed by lint cleaner Unit C (BC), and (7) lint cleaner Units A and C in series (AC). These treatments also allowed making comparisons between combing either before and after one stage of saw-type lint cleaning.

During the processing of each experimental lot, three samples were obtained for seed cotton moisture and foreign matter contents before and after seed cotton cleaning, lint moisture contents after ginning, and High Volume Instrument (HVI) classing, lint foreign-matter content, and fiber tests after each lint cleaning treatment. Lint cleaner waste from each test lot was collected and weighed.

Fiber tests included HVI measurements and seed-coat fragment levels. The USDA-AMS classed the samples and made the HVI measurements at Dumas, AR. Lint foreign-matter content and seed-coat fragment counts were made at the U.S. Cotton Ginning Laboratory, Stoneville, MS.

Lint foreign-matter content was determined by the Shirley Analyzer nonlint tests, ASTM Standard Method D2812 (ASTM 1985a). Lint-cleaners' cleaning efficiency was calculated from lint foreign-matter determinations (total and visible). Cleaning efficiency is the ratio of foreign matter removed from cotton to the foreign matter content of the cotton as it entered the cleaner, expressed as a percentage.

Seed-coat fragment, cottonseed, mote, and funiculi counts and weights were made on three-gram lint specimens from

each test sample. Measurements were made by operators using illuminated magnifiers, analytical balances, and forceps as described in ASTM Method D2496 (ASTM 1985b).

The study was designed as a randomized complete block experiment. There were three replications (blocks) of seven lint cleaner treatments. Comparisons were made between lint cleaner treatments at the 0.05 level of probability using Waller-Duncan's multiple range test (Steel and Torrie 1980). In the tables of this report, the study average in a column for the lint cleaner treatments not having a letter in common is significantly different. Where letters are not shown, the differences were not significant at the 5% level.

Results and Discussion

Ginning rates in the small-scale ginning plant averaged 0.58 bale/h that is equivalent to 6.3 kg (13.9 pounds) of lint per saw per hour (356 kg of lint per meter of seed-roll width per hour). This loaded the saw lint cleaners and combing unit at a rate of 0.47 bale/h per foot of saw-cylinder length. Tables 1-6 show the data average for the seven lint cleaner treatments. These data are averaged over the three replication experiments.

Seed Cotton Foreign Matter

Fractionation tests showed that the initial seed cotton foreign-matter contents ranged from 5.3 to 5.9% among the seven treatments and averaged 5.6% for the DES 119 cotton (Table 1). After seed cotton cleaning, corresponding foreign matter contents of the seed cotton ranged from 2.1 to 2.5% and averaged 2.2%.

Cotton Moisture Contents

Moisture determinations showed that the initial seed cotton moisture ranged from 6.8 to 7.1% and averaged 6.9% (Table 1). After seed cotton processing, moisture content of the seed cotton at the feeder apron ranged from 6.3 to 7.0% and averaged 6.8%. Lint samples taken after ginning and lint cleaning showed that the lint moisture contents ranged from 4.5 to 5.0% among the seven lint cleaner treatments and averaged 4.8% for the study.

Lint Foreign Matter Content

Total foreign matter content in ginned lint, as measured by the Shirley Analyzer total waste content, averaged 5.5% with no lint cleaning on the DES 119 cotton (Table 2). Fiber combing reduced the average foreign matter content to 5.0% but this reduction was not statistically significant. One stage of saw-cylinder lint cleaning decreased the foreign matter level to about 2.7% which was significant. After two saw lint cleaners the lint foreign matter content averaged 2.3%. Visible foreign matter content in the ginned lint, based on the Shirley Analyzer waste data, showed the same trend as the total foreign matter content but averaged about 0.8% lower.

Cleaning Efficiency

Foreign matter content (total waste) data, presented as cleaning efficiency, showed that the efficiencies of the lint cleaner treatments ranged from 9% for the combing treatment to 58% for two saw-cylinder lint cleaners (Table 2). The efficiency for one saw lint cleaner was about 50%. Combing in series with one saw lint cleaner improved the efficiency by only 1% over the one saw lint cleaner alone treatment; the increase was not significant. Using the visible waste data to calculate lint cleaner efficiency gave somewhat higher cleaning efficiencies.

Classer's Grades and Staple Lengths

The cotton classers' manual color grade index showed an improvement with lint cleaning (Table 3). Saw-type lint cleaning blended light spots out of some of the test lots and moved these bales into the white grades. The lint cleaners appear to improve the color factor by removing background trash. Two stages of saw-cylinder lint cleaning increased the average color grade index from 96.2 to 101.8; 65% of this improvement was obtained with the first stage, and the remaining 35% with the second stage.

About one-half of the samples were classified as light spotted both before lint cleaning and after the combing alone treatments. Only a few or no samples were classed light-spotted after one saw lint cleaner, and none was light-spotted after two stages of saw-cylinder lint cleaning. Thus, the scrubbing action between the saw-cylinder and grid bars appeared to give more combing and blending of the lint than the combing action at the feed plate. It is also surmised that the cotton classer is influenced by the foreign-matter content and tends to class cleaner cottons after lint cleaning in the white grades.

The leaf grade designation for the cotton test lots averaged one grade lower before lint cleaning than after one saw lint cleaner and 1½ grade lower than those cleaned with two saw lint cleaners. There was a significant improvement in the leaf grade designation when the lint was cleaned with one saw-type cleaner, and adding the second saw lint cleaner gave a further significant improvement in the leaf designation. The leaf grade designation was not significantly affected by the lint combing treatment (treatment B). Leaf grades for the seven experimental treatments were not discounted by the classer for excessive extraneous matter nor for preparation.

There appeared to be a trend toward a shortening of the staple length with the saw-type lint cleaners. Reducing the staple length substantially reduces the market price of the cotton. Average staple length for the study decreased 0.4 mm (0.5 one-thirty-seconds of an inch) with two stages of saw-cylinder lint cleaning; this decrease was not significant at the 5% level. Combing treatment B did not appear to shorten the staple length.

High Volume Instrument Measurements

Some HVI measurements were in agreement with the manual classing and lint foreign matter content data (Table 4). The reflectance (Rd) values increased, % trash area was lowered, and there was some improvement in the color grade index with increased lint cleaning.

The combing treatment alone did not improve the color grade index or reading. However, combing appeared to improve the color data slightly when used in combination with one saw-cylinder lint cleaning.

Micronaire reading averaged 4.6 on the DES 119 variety cotton. The HVI length and length uniformity decreased somewhat with each saw lint cleaner added. The reductions obtained with two saw lint cleaners were significant. Combing of the fibers without lint cleaning also decreased these length measurements.

Fiber strength (3.2 mm or ⅛-inch gage) averaged 30.8 g/tex for the study. These ranged from 30.6 to 31.2 g/tex and were not affected significantly by the lint cleaner treatments.

Seed-Coat Fragments

The number of seed-coat fragments averaged about 90 fragments/3g of ginned lint and appeared to be only slightly affected by the lint cleaner treatments (Table 5). However, the total weight of the fragments decreased from about 47 to 30 mg/3g of ginned lint with two stages of lint cleaning over the whole test. This decrease in fragment weight was significant at the 5% level. As lint cleaning went from none to two stages, motes in the ginned lint ranged from 8 to 6 per 3g lint and funiculi varied from 16 to 6 per 3g lint. The weight of the motes and both the count and weight of the funiculi were reduced significantly by two stages of lint cleaning. Although the counts and weights of the fragments and motes were reduced slightly by combing treatment B, these decreases were not statistically significant.

Lint Turnout and Waste

Based on the three lots ginned with no lint cleaning, lint turnout for the study averaged 37.4%. Net lint weight and lint cleaner waste data were adjusted to 218 kg (480-pound) bales after one saw lint cleaner (Table 6). This procedure showed that the first saw lint cleaner extracted about 6.4 kg (14 pounds) of waste per bale and the second saw lint cleaner removed an additional 2.3 kg (5 pounds.) Although no waste was removed by the combing treatment, combing in combination with one saw lint cleaner increased the amount of waste extracted by the lint cleaner.

Summary and Conclusions

An apparatus was designed and fabricated, and experiments conducted in 1995 to determine if lint combing of some cottons during gin processing could reduce the number of saw-cylinder lint cleaners now needed at gins. The design/modifications involved removing the five grid bars from a saw-type lint cleaner and replacing these with a combing smooth-plated shroud. It was hoped that combing the cotton fibers would (1) blend spots from light-spotted cottons and move these bales into the white color grades, and (2) prevent the classer from discounting samples because of preparation and/or excessive amounts of extraneous matter.

Using a hairy leaf (DES-119) cotton, three replications of seven lint cleaning treatments were performed. The treatments allowed making comparisons between combing the fibers either before or after one stage of saw-type lint cleaning. Experimental lint cleaning comparisons were no lint cleaning, fiber combing but no lint cleaning, one saw-cylinder lint cleaner, combing followed by one saw-type lint cleaner, one saw-type lint cleaner followed by fiber combing, and two stages of saw-cylinder lint cleaning. Measurements included lint foreign matter content, classer's grade, HVI data, and seed-coat fragment content.

Combing of the fibers alone reduced the foreign matter content about 0.5%, which was not significant. This slight reduction is attributed to the removal of fine trash during air and cotton separation at the lint cleaner condenser. Combing in series with one saw lint cleaner improved the cleaning efficiency by only 1% over the one saw lint cleaner alone treatment, which was also not significant. About one-half of the samples were classified as light spotted both before and after combing. The scrubbing action between the saw-cylinder and grid bars during lint cleaning appeared to give more combing and blending than the combing action at the feed plate. Leaf grades were not discounted by the classer for excessive extraneous matter nor preparation on any of the treatments. Combing of the fibers without lint cleaning decreased somewhat the HVI length and length uniformity, but did not appear to shorten the staple length.

Both the count and weight of the seed-coat fragments were reduced slightly but not significantly by the combing treatment. Although no waste was removed by the combing treatment, combing in combination with one saw lint cleaner increased the amount of waste extracted by the lint cleaner.

There were indications that work on developing lint combing apparatus that influence and improve cotton grade and quality for saw ginning plants should continue. These apparatus would be used to supplement lint cleaning with one saw-cylinder lint cleaner in place of adding a second stage of saw-type lint cleaning. New studies on lint combing should include cottons that would be discounted by the cotton classer for preparation and excessive extraneous matter if not subjected to lint cleaning. Modifications of the smooth shroud should be tested using designs that comb and straighten fibers without extracting materials. The designs could incorporate carding actions.

In summary, the combing action produced by the apparatus did not significantly decrease the number of light-spotted samples and preparation was not present before or after combing.

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Disclaimer

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Table 1. Seed-cotton data and lint moisture content for lint cleaner combing experiment, crop of 1995[1]

Treatment		Seed cotton				Lint moisture content, %
		Moisture content (%)		Foreign-matter content (%)		
No.	Desc.[2]	Wag.	Fdr. apron	Wag.	Fdr. apron	
1	0	6.8	6.8ab	5.7	2.4	5.0
2	B	6.8	6.8ab	5.5	2.2	4.8
3	A	7.1	6.8ab	5.3	2.5	4.8
4	C	7.0	6.8ab	5.8	2.1	4.6
5	AB	7.0	6.3b	5.7	2.1	4.8
6	BC	7.0	7.0a	5.3	2.2	4.8
7	AC	6.9	6.9a	5.9	2.2	4.5
Avg		6.9	6.8	5.6	2.2	4.8

[1] Data are the averages of three replications. Means in a column for lint cleaner treatment descriptions followed by different letters are significantly different at the 0.05 level of probability according to Waller-Duncan's multiple range test. Where letters are not show, the differences are not significant.

[2] 0=no lint cleaning, B=combing on unit B, A=one saw lint cleaner (unit A), C=one saw lint cleaner (unit C), AB=saw lint cleaner unit A followed by combing unit B, BC=combing unit B followed by saw lint cleaner unit C, AC=saw lint cleaner units A and C in series.

Table 2. Lint foreign-matter content and cleaning efficiency for lint cleaner combing experiment, crop of 1995[1]

Treatment		Foreign-matter content (%)		Lint cleaning efficiency (%)	
Number	Desc. [2]	Visible waste	Total waste	Visible waste basis	Total waste basis
1	0	4.33a	5.48a	—	—
2	B	4.14a	5.03a	4.5d	8.8c
3	A	1.83c	2.61bc	57.8b	52.1ab
4	C	2.14b	2.82b	50.6c	48.4b
5	AB	1.84c	2.51bc	57.5b	53.9ab
6	BC	2.04bc	2.79b	52.7bc	48.9b
7	AC	1.51d	2.27c	65.2a	58.5a

[1] Data are the averages of three replications.

[2] 0=no lint cleaning, B=combing on unit B, A=one saw lint cleaner (unit A), C=one saw lint cleaner (unit C), AB=saw lint cleaner unit A followed by combing unit B, BC=combing unit B followed by saw lint cleaner unit C, AC=saw lint cleaner units A and C in series.

Table 3. Classer's grade and staple length data for lint cleaner combing experiment, crop of 1995[1]

Treatment		Color grade		Leaf grade	Staple length
No.	Desc. [2]	Index	Desig.	desig.	mm(1/32-in.)
1	0	96.2b	32/31	5.0a	28.5 (35.9)
2	B	97.1b	32/31	5.2a	28.4 (35.8)
3	A	99.7a	31	3.8b	28.0 (35.3)
4	C	100.0a	31	3.9b	28.2 (35.5)
5	AB	100.4a	31	3.7b	28.4 (35.8)
6	BC	99.7a	31	3.8b	28.2 (35.5)
7	AC	101.8a	31/21	3.3c	28.1 (35.4)

[1] Data are the averages of three replications.

[2] 0=no lint cleaning, B=combing on unit B, A=one saw lint cleaner (unit A), C=one saw lint cleaner (unit C), AB=saw lint cleaner unit A followed by combing unit B, BC=combing unit B followed by saw lint cleaner unit C, AC=saw lint cleaner units A and C in series.

Table 4. High Volume Instrument (HVI) measurements for lint samples in lint cleaner combing experiment, crop of 1995[1]

Treatment					Strength 3.2 mm or (⅛-in. gage) (g/tex)	Color grade		Color reading		
No.	Desc. [2]	Micro. rdg.	HVI length mm (in.)	Length uniform. (%)		Index	Desig	Reflec. (Rd) (%)	+b value (units)	Trash area (%)
1	0	4.62	2.845 (1.120a)	84.3a	31.2	98.0d	31-4	73.6d	9.2c	1.0a
2	B	4.65	2.817 (1.109ab)	83.7bc	30.8	97.8d	31-4	73.5d	9.2c	1.0a
3	A	4.60	2.799 (1.102b)	84.0ab	31.0	99.7cd	31-3	75.3bc	9.4b	0.5b
4	C	4.62	2.814 (1.108ab)	83.5bc	30.7	100.0bc	31-3	75.1c	9.4b	0.5b
5	AB	4.66	2.814 (1.108ab)	83.9ab	30.6	101.8ab	31-3	75.9ab	9.5a	0.5b
6	BC	4.69	2.08 (1.104b)	83.8abc	30.7	100.4bc	31-3	75.7abc	9.4b	0.4b
7	AC	4.65	2.797 (1.101b)	83.3c	30.7	102.7a	21-4	76.3a	9.5a	0.4b
Avg.		4.64	2.812 (1.107)	83.8	30.8	100.1	31-3	75.1	9.4	0.6

[1] Data are the averages of three replications.
[2] 0=no lint cleaning, B=combing on unit B, A=one saw lint cleaner (unit A), C=one saw lint cleaner (unit C), AB=saw lint cleaner unit A followed by combing unit B, BC=combing unit B followed by saw lint cleaner unit C, AC=saw lint cleaner units A and C in series.

Table 5. Seed-coat fragments for 3-g-of-lint data for lint cleaner combing experiment, crop of 1995[1]

Treatment		Fragments		Motes		Funiculi	
No.	Desc. [2]	No.	(mg)	No.	(mg)	No.	(mg)
1	0	95.4	46.7a	8	14.3a	16.5a	4.5a
2	B	89.2	43.2ab	7	12.4ab	19.2a	4.7a
3	A	94.4	38.3ab	6.9	9.8ab	8.8a	2.2b
4	C	83.3	33.9ab	5.7	9.9ab	6.8b	1.7b
5	AB	93	33.4ab	5.7	10.9ab	8.5b	2.1b
6	BC	93.5	37.5ab	7.3	9.9ab	8.2b	2.0b
7	AC	90	30.0b	5.5	7.2b	5.7b	1.2b

[1] Data are the averages of three replications.
[2] 0=no lint cleaning, B=combing on unit B, A=one saw lint cleaner (unit A), C=one saw lint cleaner (unit C), AB=saw lint cleaner unit A followed by combing unit B, BC=combing unit B followed by saw lint cleaner unit C, AC=saw lint cleaner units A and C in series.

Table 6. Lint cleaner waste and bale net weights for lint cleaner combing experiment, crop of 1995[1]

Treatment		Lint cleaner waste,	Bale net weight,
No.	Desc. [2]	kg/bale (lb/bale)	kg (lb)
1	0	--	224.1 (494a)
2	B	--	224.1 (494a)
3	A	5.9 (12.9)	217.7 (480b)
4	C	7.0 (15.5)	216.8 (478bc)
5	AB	8.3 (18.4)	215.5 (475bc)
[3]6	BC	9.5 (21.0)	214.5 (473c)
7	AC	8.7 (19.2)	215.5 (475bc)

[1] Data are the averages of three replications.
[2] 0=no lint cleaning, B=combing on unit B, A=one saw lint cleaner (unit A), C=one saw lint cleaner (unit C), AB=saw lint cleaner unit A followed by combing unit B, BC=combing unit B followed by saw lint cleaner unit C, AC=saw lint cleaner units A and C in series.
[3] Only one replication measured.