EFFECTS OF LINT-CLEANER OPERATING PARAMETERS ON COTTON QUALITY

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PREFACE

This study is one of a group of tests conducted by the U.S. Department of Agriculture on factors affecting the quality and spinning performance of cotton grown in the United States. The work was done by the Agricultural Research Service and the Economic Research Service in cooperation with the National Cotton Council, gin machinery manufacturers, ginners, and producers.

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INTRODUCTION

The goal of the ginning process is to produce a bale of ginned lint with a minimum of foreign matter in it and with maximum retention of the inherent fiber properties that were present in the cotton as delivered to the ginnery.

Today's gin plant is so engineered that the quantity of drying and cleaning equipment used for a particular lot of cotton may be varied to meet the demands made by the wide range in foreign-matter content of cotton delivered to the gin. One of the recently available techniques for varying the quantity of lint cleaning is a quick-change valve arrangement that permits the ginner to (1) bypass all lint-cleaning equipment, (2) use only one lint cleaner in conventional fashion, (3) use two lint cleaners in conventional tandem or series operation, or (4) use two lint cleaners in split-stream or parallel operation. In split-stream operation of the lint cleaners, a manufacturer recommends halving the feedwork speeds so that the batt thickness remains relatively constant for either split-stream or series operation.

The objectives of this experiment were:

(1) To determine whether operating lint cleaners in split-stream fashion could produce lint of grades comparable to those obtained by operating the lint cleaners in series.

(2) To determine whether the fiber and spinning properties of cotton were different when two lint cleaners were operated in split-stream and in series.

(3) To determine whether cotton passing through one lint cleaner in split-stream operation was different from cotton passing through one lint cleaner in conventional operation.

PROCEDURE

Cotton used for the experiment was obtained from a commercial grower near Leland, Miss., and was ginned at the USDA Cotton Ginning Investigations Laboratory at Stoneville, Miss. It was Stoneville 213 variety, skip-row-planted and spindle-picked. First harvesting and ginning was done October 19 to 23, 1967. The second harvesting and ginning was done November 13 to 15, after a killing frost November 4. Boll development was halted by the frost, and the resulting immature fibers affected some of the results of the experiment.

Each ginning lot size was approximately 650 pounds of lint. It was ginned continuously but was packaged as two 325-pound bales for spinning at the ARS Cotton Pilot Spinning Plant at Clemson University. The order of experimental lint-cleaning treatments was assigned at random within each replication and the cotton was ginned by replications.

The quantity and sequence of seed cotton (overhead) cleaning machinery was standard for Midsouth machine-picked cotton, and the gin stand was of a popular commercial make in new condition. Gin saws were 12 inches in diameter and were turning at 824 r.p.m.

The lint cleaners were of current manufacture. The feed roller was 4 inches in diameter. The wirewound saw cylinder was 16 inches in diameter and rotated at 1,070 r.p.m. When the two lint cleaners were used in parallel (split-stream), the feedworks of each lint cleaner was slowed to half-speed, resulting in a smooth batt feed but with combing ratio twice (2X) the ratio when the cleaner was operating at conventional speed (table 1).

Table 1.—Operating speeds of lint cleaners

Item	1 lint cleaner, conventional feed	2 lint cleaners, split-stream feed		2 lint cleaners, series feed	
		No. 1	No. 2	No. 1	No. 2
Condenser speed.....R.p.m.[1]	16.6	8.0	8.0	16.6	16.6
Feed roller speed.....R.p.m.	187	90	90	187	187
Feed roller speed.....F.p.m.[2]	196	94	94	196	196
Saw cylinder speed.....R.p.m.	1070	1070	1070	1070	1070
Saw cylinder speed.....F.p.m.	4482	4482	4482	4482	4482
Combing ratio[3]	23/1	48/1	48/1	23/1	23/1
Processing rate:					
Lb. lint/min.....	35.5	17.75	17.75	35.5	35.5
Lb. lint/min./ft. of width	7.63	3.82	3.82	7.63	7.63

[1] Revolutions per minute.
[2] Peripheral speed in feet per minute.
[3] Combing ratio defined as the ratio of saw cylinder peripheral speed in feet per minute to that of the feed roller.

Lint and waste samples were collected from each experimental lot for quantitative and qualitative analyses. Lint-cleaner waste was collected by a single 100-mesh screen condenser receiving waste from both lint cleaners. It is assumed that each lint cleaner operating in the split-stream mode processed an equal quantity of cotton and contributed an equal amount of waste.

Each bale lot was processed into a 14-ounce picker lap and was carded into a 50-grain sliver at 9.5 pounds per hour using card crusher rolls. After the card sliver was processed through breaker and finisher drawing, the finisher drawing sliver was made into 1.25 hank roving using a 1.30 twist multiplier.

Each lot was tested with 7,000 spindle hours of processing 40's yarn with a 3.71 twist multiplier on 2-inch rings at 13,000 r.p.m. spindle speed. Yarn tests were made for yarn size, skein strength, yarn appearance, and imperfections.

All results were analyzed by analysis of variance—a split-plot design with units arranged in randomized blocks. The new Duncan's Multiple Range test was used to determine which treatment averages differed significantly.

GINNING PERFORMANCE DATA AND RAW COTTON PROPERTIES

Moisture Content and Processing Rate

A special effort was made to gin the cotton with as much moisture as possible. The first picking was ginned with half the first drier bypassed and with only 150° F. at the drier input to insure ginning without chokeup, and with the second drier bypassed entirely. The lint moisture content at the lint slide averaged 6.1 percent (table 2). The second picking was ginned with no heat on either drier, and the lint moisture averaged 5.6 percent. The variation in moisture content between treatments when pickings were combined was small and statistically insignificant. The overall average of 5.8 percent was lower than the target moisture content of 7 percent, but is considered typical of Midsouth ginning conditions. Moisture content variations that do exist result from (1) progressive natural changes in atmospheric relative humidity during the experiment and (2) differences in lint exposure period caused by changes in transit time between gin stand and press when the lint cleaner treatments were changed. The lint exposure period was increased by 8 seconds and by 17 seconds when one and two stages of lint cleaning were used.

The ginning and lint-cleaner processing rates were similar for all treatments at about 35.5 pounds of lint per minute (table 3). This was equivalent to 4.4 bales per hour and was within the designed capability of the equipment. The second-picking cotton ginned slightly slower than the first-picking cotton, perhaps because of lower moisture content and lightweight fibers (see section on Fiber Fineness).

Table 2.–Lint moisture content of cotton at lint slide, crop of 1967

Lint cleaners used	Lint moisture in cotton from–								Combined pickings average
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
0	6.9	6.3	6.6	6.6	6.2	5.8	5.0	5.7	6.1
1	6.3	6.0	5.3	5.9	6.4	5.7	5.1	5.7	5.8
2 in split-stream	7.0	5.7	5.1	5.9	6.2	5.1	5.1	5.5	5.7
2 in series	6.8	5.4	5.4	5.9	5.5	5.2	5.3	5.3	5.6

Table 3.–Ginning and lint cleaner processing rate of cotton, crop of 1967

Lint cleaners used	Processing rate for cotton from–								Combined pickings average
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	Lb. lint/ min.	*Lb. lint/ min.*	*Lb. lint/ min.*	*Lb. lint/ min.*	*Lb. lint/ min.*	*Lb. lint/ min.*	*Lb. lint/ min.*	*Lb. lint/ min.*	*Lb. lint/ min.*
0	37.30	36.78	37.26	37.11	33.62	35.08	33.85	34.18	35.65
1	36.40	36.92	38.23	37.18	34.71	35.26	32.74	34.23	35.71
2 in split-stream	36.93	36.90	37.69	37.17	34.12	35.30	34.11	34.51	35.84
2 in series	36.18	36.68	36.75	36.53	33.24	32.31	33.92	33.15	34.85

Lint-Cleaner Waste

Some of the principal indicators of lint-cleaner effectiveness are the quantity and composition of waste material removed from the cotton by the lint cleaner.

Lint-cleaner waste data were adjusted to 479-pound net weight bales to provide a common basis for comparison. The overall average of waste removed was 23.7 pounds per bale, ranging from 20.0 pounds for the 1-lint-cleaner treatment to 26.1 pounds for the 2-lint-cleaners-in-series treatment (table 4). Differences between the effects of 1 lint cleaner and both 2 lint cleaners split-stream and 2 lint cleaners in series were statistically significant at the 95-percent confidence level for the second-picking cotton, but were not significant at that level for the first-picking cotton. The combined-picking data averages were significantly different at the 99-percent confidence level when use of one lint cleaner was compared to each of the 2-lint-cleaner treatments. The difference in lint-cleaner waste between 2-lint-cleaners-split-stream and 2-lint-cleaners-in-series treatments was not significant.

The proportion of foreign matter in the lint-cleaner waste was remarkably similar between pickings and between 1 lint cleaner and 2 lint cleaners in series at about 75 percent (table 5). The 2-lint-cleaner-split-stream treatment contained a slightly smaller proportion of foreign matter (greater proportion of fiber) than the conventional lint-cleaner treatments, but the difference was not statistically significant.

Lint Grade, Color, and Foreign Matter Content

The composite lint grades assigned by the cotton classer ranged from Low Middling Light Spot for cotton with no lint cleaning to Strict Low Middling for cotton treated with 2 lint cleaners split-stream or 2 lint cleaners in series (tables 6 and 7). Lint grades were always improved by any amount of lint cleaning over the grades of uncleaned cotton, and the increase was usually statistically significant. Treatments with 2 lint cleaners in series always gave better grades than treatment with 1 lint cleaner, but grades were almost identical for cotton treated with 2 lint cleaners in split-stream and in series.

Colorimeter measurements on clean raw lint for both reflectance (Rd) and yellowness (+b) showed no significant differences due to lint-cleaner treatment. However,

Table 4.—Lint cleaner waste from cotton, crop of 1967

Lint cleaners used	Lint-cleaner waste per 479 pounds lint from—								Combined pickings average[2]
	First picking				Second picking				
	Replication			Average	Replication			Average[2]	
	1	2	3		1	2	3		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1	(1)	21.7	20.7	21.2	19.5	21.1	16.8	19.1a	20.0a
2 split-stream	(1)	22.2	27.6	24.9	26.0	27.2	22.4	25.2b	25.1b
2 in series	(1)	27.1	28.5	27.8	24.1	24.4	26.5	25.0b	26.1b

[1] Trash-collecting system was not operating properly.
[2] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 5.—Foreign matter in lint-cleaner waste from cotton, crop of 1967

Lint cleaners used	Foreign matter in lint-cleaner waste from—								Combined pickings average[1]
	First picking			Average	Second picking			Average	
	1	2	3		1	2	3		
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1	74.6	80.5	78.1	77.7	77.6	73.4	77.4	76.1	76.9b
2 split-stream	72.0	71.5	72.8	72.1	71.4	77.3	70.1	72.9	72.5a
2 in series	71.4	77.1	74.8	74.4	76.8	71.9	78.3	75.7	75.1ab

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 6.—Classification by grade designation of cotton lint, crop of 1967

Lint cleaners used	Grade designation[1] of cotton from—					
	First picking, replication			Second picking, replication		
	1	2	3	1	2	3
0	LM	LMLtSp	LMLtSp	LM	LMLtSp	LM
1	LM+	LMLtSp	LM	LM+	LM+	LM+
2 split-stream	LM+	LM+	LM+	LM+	LM+	SLM
2 in series	SLM	LM+	LM+	LM+	SLM	LM+

[1] LM = Low Middling; SLM = Strict Low Middling; LMLtSp = Low Middling Light Spot

yellowness differences due to pickings were highly significant (tables 8 and 9).

Ginned-lint foreign-matter content as determined by the Shirley Analyzer showed that each lint-cleaner treatment left considerably less foreign matter in the cotton than was in cotton with no lint-cleaner treatment, and each of the 2-lint-cleaner operating methods left a highly significantly smaller amount of foreign matter than did the conventional treatment with 1 lint cleaner (table 10). The 2 lint cleaners split-stream and the 2 lint cleaners in series left almost identical quantities of foreign matter in the lint, about 4.6 percent.

Table 7.—Classification by grade index of cotton lint, crop of 1967

Lint cleaners used	Grade index of cotton from—								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average[1]	Replication			Average[1]	
	1	2	3		1	2	3		
	Index	*Index*	*Index*	*Index*	*Index*	*Index*	*Index*	*Index*	*Index*
0	85	80	80	81.7a	85	80	85	83.3a	82.5a
1	90	80	85	85.0ab	90	90	90	90.0b	87.5b
2 split-stream	90	90	90	90.0bc	90	90	94	91.3b	90.7bc
2 in series	94	90	90	91.3c	90	94	90	91.3b	91.3c

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 8.—Reflectance of raw cotton lint, crop of 1967

Lint cleaners used	Reflectance of raw lint from—								Combined pickings average
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
0	76.7	77.3	77.0	77.0	76.8	76.0	76.2	76.3	76.7
1	76.8	77.3	78.0	77.4	75.8	77.2	76.5	76.5	76.9
2 split-stream	77.5	77.2	78.0	77.6	75.3	76.5	76.8	76.2	76.9
2 in series	77.5	77.8	76.5	77.3	76.3	76.5	75.8	76.2	76.7

Table 9.—Yellowness of raw cotton lint in Hunter's +b, crop of 1967

Lint cleaners used	Yellowness of raw lint from—								Combined pickings average
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	+b	*+b*	*+b*	*+b*	*+b*	*+b*	*+b*	*+b*	*+b*
0	8.8	8.9	8.8	8.8	7.9	7.5	8.1	7.8	8.3
1	8.7	9.4	9.0	9.0	7.7	7.8	8.0	7.8	8.4
2 split-stream	8.5	8.9	9.0	8.8	7.7	7.9	8.0	7.9	8.3
2 in series	8.8	9.0	9.2	9.0	8.2	7.9	8.2	8.1	8.6

Table 10.–Foreign matter in ginned cotton lint, crop of 1967

Lint cleaners used	Foreign matter[1] in ginned lint from–								Combined pickings average[2]
	First picking				Second picking				
	Replication			Average[2]	Replication			Average[2]	
	1	2	3		1	2	3		
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
0	7.5	6.5	9.6	7.9a	8.7	10.6	7.7	9.0a	8.4a
1	4.8	7.1	6.5	6.1ab	6.5	6.1	5.3	6.0b	6.0b
2 split-stream	4.6	3.8	5.3	4.6b	4.6	5.0	4.6	4.7b	4.6c
2 in series	4.2	4.5	5.0	4.6b	4.6	4.5	4.9	4.7b	4.6c

[1] Determined by Shirley Analyzer.
[2] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Bale Value

The value of an individual bale of cotton may be simply calculated by multiplying gross weight times the value of 1 pound of lint as established by classer's grade and staple and Commodity Credit Corporation (CCC) loan value or on some other basis. Bale values for this experiment were calculated from 1967 CCC loan prices, adjusted for micronaire values and using Memphis as the basis location. Gross bale weights were arrived at by assuming 500 pounds gross weight for cotton without any lint-cleaner treatment and subtracting the respective waste weights for the lint-cleaner treatments, as shown in table 4. The adjusted bale weight (rounded) was multiplied by the loan value for that particular bale to arrive at the bale values in table 11.

Although none of the treatment averages were found to be statistically different from the others at the 95-percent confidence level, the differences among the overall treatments are believed to be real. The difference between average values of cotton with 1-lint-cleaner treatment and with none is small but is in favor of the 1-lint-cleaner treatment. Bale values resulting from 2 lint cleaners split-stream and 2 lint cleaners in series are similar, and each is $4 higher than bale values resulting from no-lint-cleaner or 1-lint-cleaner treatments. The difference is statistically significant at the 86-percent confidence level.

Fiber Length

Three methods of determining fiber length were used: Classer's staple length, Suter-Webb length array, and the Digital Fibrograph.

Average staple length as determined by the cotton classer showed no significant differences due to lint-cleaner treatments. The modal staple length was 34/32-inch (table 12).

Table 11.–Bale value of cotton, crop of 1967

Lint cleaners used	Value per bale of cotton from–								Combined pickings average
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
0	(1)	83.50	83.50	83.50	93.25	80.25	90.75	88.08	86.25
1	(1)	79.82	90.05	84.94	89.76	89.57	90.32	89.88	87.90
2 split-stream	(1)	92.49	91.33	91.91	88.64	88.45	98.71	91.93	91.92
2 in series	(1)	93.89	93.69	93.79	89.01	98.29	88.64	91.98	92.70

[1] Values not available because lint-cleaner waste-collection system was not operating properly during ginning of first replication.

Table 12.–Classer's staple length of cotton, crop of 1967

Lint cleaners used	Classer's staple length of cotton from–								Combined pickings average
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	1/32 Inches	1/32 Inches	1/32 Inches	1/32 Inches	1/32 Inches	1/32 Inches	1/32 Inches	1/32 Inches	1/32 Inches
0	34	34	34	34	35	34	34	34	34
1	34	34	34	34	34	34	34	34	34
2 split-stream	34	34	34	34	34	34	34	34	34
2 in series	34	35	35	35	34	34	34	34	34

The array data showed small but statistically significant changes in fiber length due to lint-cleaning treatments. The greatest upper quartile length (UQL) was 1.25 inches and was produced by operating one lint cleaner in conventional fashion (table 13). The no-lint-cleaner and the 2-lint-cleaners-split-stream treatments gave UQL values of 1.24 inches. The 2 lint cleaners in series produced a UQL value of 1.23 inches. The 1.23 value was significantly different from the 1-lint-cleaner value of 1.25, but the differences between UQL values caused by the 2-lint-cleaners-split-stream, 2-lint-cleaners-in-series, and no-lint-cleaner treatments were not significantly different. Differences in UQL between the 2 methods of operation of 2 lint cleaners were not significant; nor was there a significant difference between 1 lint cleaner operated in the conventional way and the 2-lint-cleaners-split-stream treatment, which actually gives the cotton a single stage of lint cleaning.

The array mean length data showed no overall significant differences between no-lint-cleaner, 1-lint-cleaner, and 2-lint-cleaner-split-stream treatments. The average length of 0.99 inch for the 2-lint-cleaners-in-series treatment was significantly shorter than that for no lint cleaner and 1 lint cleaner (table 14). It was not significantly shorter than that for 2 lint cleaners split-stream.

When the original array length groups were combined into larger groups it was possible to examine them for evidence of fiber breakage, using the quantity of fibers shorter than 1/2 inch as the index. The no-lint-cleaner treatment had the lowest short-fiber content of 10.6 percent, and the 2-lint-cleaners-in-series treatment produced the greatest quantity of short fibers at 11.8 percent (table 15). This difference is relatively small, but it is statistically significant. Short-fiber values for 1-lint-cleaner and 2-lint-cleaner-split-stream treatments were not significantly different. The 2.5- and 50-percent span lengths as determined by the Digital Fibrograph were also examined for evidence of the effect of lint-cleaning treatments on ginned lint fiber length. The no-lint-cleaner treatment gave span lengths significantly longer than the other treatments (tables 16 and 17). The difference between averages for 1 lint cleaner and 2 lint cleaners in series was significantly different, but between 1 lint cleaner and 2 lint cleaners split-stream the difference was not statistically significant.

To summarize the fiber-length data, none of the length parameter determinations showed significant differences between the 1-lint-cleaner and 2-lint-cleaners-split-stream treatments, nor between the 2-lint-cleaners-split-stream and 2-lint-cleaners-in-series treatments. In nearly all cases the 2 lint cleaners in series produced lint with slightly shorter fibers than lint that had not passed through two stages of combing-type lint cleaning.

Fiber Strength

Lint cleaning at ginneries is not considered to affect fiber bundle strength. Data developed during this experiment do not show real differences due to lint-cleaner treatments. Overall average values were 78,000 p.s.i. and 22.3 grams/tex for the zero-gage and 1/8-inch-gage Pressley strength values, respectively (tables 18 and 19).

Fiber Fineness

Gin treatments do not change the maturity value or the fineness level of cotton brought to the gin. However, the maturity and fineness of cotton may account for variations in behavior of cotton during gin processing.

Cotton from two harvestings were used in this experiment. The first harvesting was on October 19 and 20, and was from well-matured cotton with a maturity index of 78 and an average micronaire reading of 4.5 (table 20). The second harvesting was on November 13 to 15 from a previously harvested field, in which cotton development had been stopped by frost on November 4. The maturity index of the cotton was 71, and the micronaire reading was 3.3.

Table 13.–Upper quartile length of ginned cotton lint, crop of 1967

Lint cleaners used	Upper quartile length of ginned lint from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average	Replication			Average[1]	
	1	2	3		1	2	3		
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
0	1.26	1.25	1.25	1.25	1.24	1.23	1.23	1.23ab	1.24ab
1	1.25	1.27	1.26	1.26	1.24	1.24	1.23	1.24b	1.25b
2 split-stream	1.25	1.23	1.25	1.24	1.25	1.23	1.24	1.24b	1.24ab
2 in series	1.25	1.24	1.25	1.25	1.21	1.22	1.22	1.22a	1.23a

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 14.–Array mean length of cotton lint, crop of 1967

Lint cleaners used	Average length of ginned lint from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average[1]	Replication			Average[1]	
	1	2	3		1	2	3		
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
0	1.04	1.04	1.05	1.04b	0.99	0.99	0.97	0.98b	1.01a
1	1.03	1.06	1.04	1.04b	.97	.97	.97	.97ab	1.01a
2 split-stream	1.03	1.01	1.02	1.02ab	.99	.97	.97	.98b	1.00ab
2 in series	1.02	1.02	1.01	1.02a	.96	.96	.95	.96a	.99b

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 15.–Percentage of cotton fibers shorter than ½ inch, crop of 1967

Lint cleaners used	Cotton fibers shorter than ½ inch from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
0	9.3	9.4	8.3	9.0	12.0	11.5	13.2	12.2	10.6a
1	9.7	8.0	9.5	9.1	13.2	13.0	13.5	13.2	11.2ab
2 split-stream	9.4	9.7	9.6	9.6	12.3	11.7	13.4	12.5	11.0ab
2 in series	9.6	9.5	11.0	10.0	13.7	13.6	13.3	13.5	11.8b

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

The difference in micronaire fineness accounts for some of the variations in the experiment results and suggests causes for others. The experiment average micronaire value of 3.9 is not a real value. When seeking relationships between other fiber properties and spinning properties that may be related to micronaire fineness it is necessary to use data from the particular replication of cotton concerned.

Table 16.–2.5-percent span length of cotton, crop of 1967

Lint cleaners used	2.5-percent span length of cotton fibers from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average	Replication			Average[1]	
	1	2	3		1	2	3		
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
0	1.14	1.13	1.14	1.14	1.14	1.14	1.13	1.14a	1.14a
1	1.12	1.13	1.12	1.12	1.12	1.11	1.11	1.11b	1.12b
2 split-stream	1.10	1.11	1.12	1.11	1.10	1.11	1.10	1.10bc	1.11bc
2 in series	1.10	1.13	1.12	1.12	1.10	1.08	1.09	1.09c	1.10c

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 17.–50-percent span length of cotton, crop of 1967

Lint cleaners used	50-percent span length of cotton fibers from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average[1]	Replication			Average[1]	
	1	2	3		1	2	3		
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
0	0.52	0.51	0.51	0.51a	0.48	0.48	0.48	0.48a	0.50a
1	.49	.49	.48	.49b	.47	.46	.46	.46b	.48b
2 split-stream	.47	.49	.48	.48b	.46	.46	.45	.46b	.47bc
2 in series	.47	.49	.49	.48b	.46	.44	.44	.45b	.46c

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 18.–Zero-gage Pressley strength of cotton, crop of 1967

Lint cleaners used	Zero-gage Pressley strength value for cotton fibers from–								Combined pickings average
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	1,000 p.s.i.	*1,000 p.s.i.*	*1,000 p.s.i.*	*1,000 p.s.i.*	*1,000 p.s.i.*	*1,000 p.s.i.*	*1,000 p.s.i.*	*1,000 p.s.i.*	*1,000 p.s.i.*
0	78	78	79	78	80	79	78	79	79
1	81	77	79	79	80	80	78	79	79
2 split-stream	76	78	78	77	81	79	76	79	78
2 in series	79	77	78	78	80	79	78	79	78

Table 19.–1/8-inch-gage Pressley strength of cotton, crop of 1967

Lint cleaners used	$\frac{1}{8}$-inch-gage Pressley strength value for cotton fibers from–								Combined pickings average
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	Grams/ tex	*Grams/ tex*	*Grams/ tex*	*Grams/ tex*	*Grams/ tex*	*Grams/ tex*	*Grams/ tex*	*Grams/ tex*	*Grams/ tex*
0	21.8	22.0	22.1	22.0	23.2	22.4	22.8	22.8	22.4
1	21.9	21.5	22.6	22.0	23.0	23.0	22.4	22.8	22.4
2 split-stream	22.0	21.5	21.9	21.9	22.2	23.2	22.0	22.5	22.2
2 in series	22.2	22.2	21.9	22.1	22.7	22.4	22.2	22.4	22.3

Table 20.–Micronaire fineness of cotton, crop of 1967

Lint cleaners used	Micronaire reading for fineness of cotton from–							
	First picking				Second picking			
	Replication			Average	Replication			Average
	1	2	3		1	2	3	
0	4.5	4.5	4.6	4.5	3.2	3.3	3.3	3.3
1	4.5	4.5	4.6	4.5	3.3	3.2	3.3	3.3
2 split-stream	4.6	4.5	4.5	4.5	3.4	3.2	3.4	3.3
2 in series	4.5	4.5	4.6	4.5	3.3	3.2	3.3	3.3

MANUFACTURING PERFORMANCE DATA AND YARN PROPERTIES

Picker and Card Waste

The picker and card waste data are in general agreement with other data affected by lint foreign-matter content, such as Shirley Analyzer data and lint grade index. The least amount of waste was 5.40 percent from the 2-lint-cleaners-in-series treatment (table 21). The 2-lint-cleaners-split-stream treatment gave 5.98 percent waste, which was not significantly different from the 2-lint-cleaners-in-series waste level. Neither was it different from the 1-lint-cleaner waste value of 6.56 percent. As expected, the greatest waste value (8.99 percent) was from the no-lint-cleaner treatment, and was significantly greater than picker and card waste from cottons that had been lint-cleaned.

Card Web Nep Count

Neps in the card web increased as lint cleaning of the cottons increased. The 2-lint-cleaners-in-series treatment had the greatest number at 18 per 100 square inches of web (table 22). However, this value was not significantly different from the 2-lint-cleaners-split-stream value of 16. The 1-lint-cleaner-conventional and 2-lint-cleaners-split-stream treatments had similar nep counts of 16. The no-lint-cleaner treatment contained 14 neps per 100 sq. in. This shows that as a practical matter none of the treatments caused a serious variation in nep count.

The immature second-picking cotton gave nep counts twice as great as first-picking cotton for identical lint-cleaner treatments.

Ends-Down Per 1,000 Spindle Hours

Again, different results were obtained from the two pickings of cotton used. The first-picking cotton spun with an average ends-down count of 21 per 1,000 spindle hours, with averages of the several treatments varying from 19 to 24 (table 23). None of the treatments caused significant difference in ends-down during spinning of first-picking cotton.

Table 21.–Total picker and card waste from cotton, crop of 1967

Lint cleaners used	Total picker and card waste from cotton from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average[1]	Replication			Average[1]	
	1	2	3		1	2	3		
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
0	8.54	8.32	8.71	8.52a	9.77	10.16	8.45	9.46a	8.99a
1	5.76	6.63	6.46	6.28b	7.05	6.97	6.50	6.84ab	6.56b
2 split-stream	4.77	5.04	5.85	5.22c	6.13	8.72	5.35	6.73b	5.98bc
2 in series	5.02	5.41	5.31	5.25c	5.41	5.49	5.79	5.56b	5.40c

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 22.–Neps per 100 square inches of card web in cotton, crop of 1967

Lint cleaners used	Neps per 100 square inches of card web in cotton from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average[1]	Replication			Average	
	1	2	3		1	2	3		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
0	10	10	8	9a	20	16	18	18	14a
1	10	9	10	10ab	26	18	20	21	16a
2 split-stream	11	10	11	11bc	26	18	22	22	16ab
2 in series	13	12	11	12c	23	26	24	24	18b

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 23.–Ends-down per 1,000 spindle-hours in cotton, crop of 1967

Lint cleaners used	Ends-down per 1,000 spindle-hours in cotton from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average	Replication			Average[1]	
	1	2	3		1	2	3		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
0	31	20	20	24	47	24	22	31a	27a
1	19	17	25	20	40	32	37	36a	28a
2 split-stream	16	22	22	20	35	32	41	36a	28a
2 in series	19	18	21	19	90	66	70	75b	47b

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

The second-picking frost-damaged cotton (low immaturity, low micronaire) spun with a significantly greater number of ends-down. The 2 lint cleaners in series caused ends-down to be more than double that for cotton from the no-lint-cleaner, 1-lint-cleaner, and 2-lint-cleaners-split-stream treatments. This is considered to be an interaction between field-damaged cotton and what is termed an excessive quantity of lint-cleaning for that cotton.

Yarn Appearance

Yarn spun from cotton with no lint-cleaner treatment had the highest appearance index, averaging 86 (table 24). Yarns spun from cottons receiving 1-lint-cleaner-conventional and 2-lint-cleaners-split-stream treatments had appearance indexes of 79 and 80, respectively, and were not significantly different. The 2-lint-cleaners-in-series treatment produced yarn with an appearance index of 72, which was significantly lower than that produced by the other treatments.

Neps Per 1,000 Yards

Neps in the yarn followed the same quality pattern of the yarn-appearance index. Fewest neps were found in yarn from cotton having no lint-cleaner treatment; the count was 1,261 neps per 1,000 yards (table 25). The 1-lint-cleaner and the 2-lint-cleaners-split-stream treatments had counts of 1,457 and 1,454, respectively, and were not significantly different. The highest nep count came from cotton given the 2-lint-cleaners-in-series treatment; at 1,647 this count was significantly greater than the others.

Single-Strand Yarn Strength and Yarn-Break Factor

Single-strand yarn strength data showed the strongest yarn to have a breaking strength of 198 grams and to be from cotton receiving no lint-cleaner treatment (table 26). The weakest yarn was from cotton that had the 2 lint cleaners in series and had a breaking strength of 187 grams. The 1-lint-cleaner and 2-lint-cleaners-split-stream treatments produced yarns with strengths of 194 and 192 grams, respectively, and were not significantly different.

Table 24.–Yarn appearance index of cotton, crop of 1967

Lint cleaners used	Appearance of yarn spun from cotton from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average[1]	Replication			Average[1]	
	1	2	3		1	2	3		
	Index	*Index*	*Index*	*Index*	*Index*	*Index*	*Index*	*Index*	*Index*
0	98	90	86	91a	80	79	81	80a	86a
1	89	84	79	84ab	72	72	77	74b	79b
2 split-stream	88	89	84	87a	74	70	73	72b	80b
2 in series	81	77	77	78b	66	69	64	66c	72c

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 25.–Neps per 1,000 yards of cotton yarn, crop of 1967

Lint cleaners used	Neps per 1,000 yards of yarn spun from cotton from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average	Replication			Average[1]	
	1	2	3		1	2	3		
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
0	1012	1114	1114	1080	1418	1426	1482	1442a	1261a
1	1094	1394	1240	1243	1702	1640	1672	1671b	1457b
2 split-stream	1104	1244	1350	1233	1521	1709	1798	1676b	1454b
2 in series	1292	1484	1344	1373	1891	1885	1986	1921c	1647c

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 26.–Single-strand strength of cotton yarn, crop of 1967

Lint cleaners used	Single-strand strength of yarn spun from cotton from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average	Replication			Average	
	1	2	3		1	2	3		
	Grams	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
0	192	192	198	194	206	206	197	203	198a
1	195	192	191	193	193	199	191	194	194ab
2 split-stream	192	186	190	189	204	198	182	195	192ab
2 in series	189	182	192	188	190	186	182	186	187b

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

Table 27.–Yarn-break factor of cotton, crop of 1967

Lint cleaners used	Break factor for yarn spun from cotton from–								Combined pickings average[1]
	First picking				Second picking				
	Replication			Average	Replication			Average[1]	
	1	2	3		1	2	3		
	Units	*Units*	*Units*	*Units*	*Units*	*Units*	*Units*	*Units*	*Units*
0	1903	1998	1992	1964	2051	2036	1955	2014a	1989a
1	1944	1978	1938	1953	1931	2013	1920	1955ab	1954ab
2 split-stream	1903	1917	1938	1919	1933	1960	1871	1921bc	1920bc
2 in series	1907	1951	1963	1940	1816	1835	1866	1839c	1890c

[1] Values within the same column but followed by different letters are significantly different at the 95-percent confidence level. Values followed by the same letter are not significantly different at this level.

The yarn-break factor data reveals an effect of gin processing of immature cotton on yarn-break factor. The well-developed first-picking cotton (maturity index 78, micronaire 4.5) produced 40's yarn with an average break factor of about 1,940, with no significant differences due to gin treatment (table 27). However, the immature second-picking cotton (maturity index 71, micronaire 3.3) gave treatment averages with greater differences. The no-lint-cleaner and 2-lint-cleaners-in-series treatments produced yarns with significantly different strengths of 2,014 and 1,839 break-factor units, respectively. Cotton passing through only one stage of lint cleaning, either 1 lint cleaner or 2 lint cleaners split-stream, gave yarns with break factors that are considered similar: actual values were 1,955 and 1,921, respectively. The effect of data from the second-picking cotton was strong enough to cause the combined pickings data to follow the same pattern of differences as data from the second-picking cotton. Readers are reminded that the physical characteristics of the two pickings were sufficiently different to cause different responses to the gin lint-cleaning treatments.

The single-strand yarn-strength and yarn-break factor patterns generally reflect the short-fiber and fiber-length data, in that yarn strength decreases as average fiber length decreases.

SUMMARY AND CONCLUSIONS

An experiment designed primarily to compare gin operation and quality of lint processed with two lint cleaners operated in parallel (split-stream) and in tandem (series) was carried out in three replications on each of two cottons. When in parallel, each lint cleaner served as a single stage of lint cleaning, receiving half the lint in process and operating with feedworks at half speed. When in series, each lint cleaner processed the full load of lint at conventional operating speeds. The experiment also included cotton that received no lint-cleaning and

cotton treated with one lint cleaner at conventional speed. Data from the cotton with no lint-cleaning is not included in the following comparisons, since this treatment was included only as a control.

None of the following factors were significantly different at the 95-percent confidence level between the two methods of operating 2 lint cleaners.

(1) Lint-cleaner waste.
(2) Nonlint content of lint-cleaner waste.
(3) Composite lint grade classification.
(4) Fiber reflectance and yellowness.
(5) Foreign matter remaining in ginned lint.
(6) Bale value.
(7) Fiber length and strength.
(8) Fiber maturity and fineness.
(9) Picker and card waste.
(10) Card web neps.
(11) Yarn strength and break factor.
(12) Ends down for properly matured cotton.

The two methods of operating 2 lint cleaners gave significant differences at the 95-percent confidence level for:

(1) Yarn appearance. 2 lint cleaners split-stream was superior.

(2) Neps per 1,000 yards of yarn. 2 lint cleaners split-stream was superior.

(3) Ends down for immature cotton. 2 lint cleaners split-stream was superior.

When comparisons were made between 1 lint cleaner in conventional operation and 2 lint cleaners split-stream, no statistically significant differences were found at the 95-percent confidence level for:

(1) Composite lint grade classification.

(2) Bale value. The average difference between 1 lint cleaner and 2 lint cleaners was quite wide—about $4 to $5 per bale. However, individual differences were inconsistent and produced a statistically nonsignificant comparison.

(3) Classer's staple length.
(4) Fiber length and strength.
(5) Fiber maturity and fineness.
(6) Picker and card waste.
(7) Card web neps.
(8) Yarn appearance.
(9) Neps per 1,000 yards of yarn.
(10) Yarn strength and break factor.
(11) Ends-down during spinning.

Comparisons between 1 lint cleaner in conventional operation and 2 lint cleaners split-stream showed significant differences for:

(1) Lint cleaner waste. 2 lint cleaners split-stream was superior.

(2) Nonlint content of lint-cleaner waste. 1 lint cleaner in conventional operation was superior.

(3) Foreign matter in ginned lint. 2 lint cleaners split-stream was superior.

(4) Bale value. Four dollars' difference in favor of 2 lint cleaners split-stream. Significant at the 86-percent confidence level.

In conclusion, this experiment showed that two lint cleaners operated split-stream with twice (2×) the combing ratio can produce lint with grades equivalent to those of lint processed through two lint cleaners in series at conventional operating speeds, and at no significant increase in fiber damage over that caused by one lint cleaner in conventional operation.

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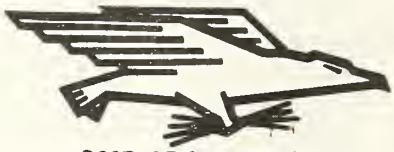

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