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Effects of CLEANING PRACTICES at Gins on Fiber Properties and Mill Performance of COTTON

A PROGRESS REPORT

Agricultural Marketing Service
Marketing Research Division

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PREFACE

During the past decade a number of studies have been conducted by the U. S. Department of Agriculture, State agricultural experiment stations, trade associations, and private firms to determine the effects on cotton fiber of such cleaning devices in gins as overhead cleaning equipment, driers, and lint cleaners. Particular attention has been given to evaluations of lint cleaners. However, these studies generally have been developed to show the separate effects from the use of such cleaning devices and most of them have been confined to studies of the effects of such devices on returns to farmers and on fiber properties, as indicated by classers' or standard laboratory determinations.

The study reported here is designed to supplement previous studies by providing measurements of the combined effect of cleaning devices and practices upon fiber properties and upon processing performance of the fiber in mills.

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SUMMARY AND CONCLUSIONS

The growth in recent years in the number of cotton gins installing and using additional cleaning and drying equipment has raised questions as to the effect of these cleaning practices upon the quality and value of cotton fiber. If, as has been alleged, these cleaning practices seriously impair the fibers' processing potential and utility, market outlets for cotton may be seriously affected.

Results of this study indicate that the use of additional overhead cleaning equipment, the reduction in lint moisture, and the use of lint cleaners substantially improve the grade of the cotton, but at the same time other quality changes occur which will significantly increase the cost of processing at the mill.

These general conclusions are based upon data currently available from laboratory and mill tests of lots of cotton harvested by machines from a field in California during the 1957-58 season. These lots were subjected to varying levels of overhead cleaning, drying, and lint cleaning. The most intensive cleaning methods used in the test are in excess of levels usually recommended by ginning laboratories or cotton technologists. Samples of cotton were taken at all stages for laboratory evaluation. All lots were processed under uniform conditions in a commercial mill into a standard print cloth.

The use of additional overhead cleaning equipment in gins and reduction of moisture content of lint adversely affected the length of fiber as determined by the fiber array method. This adverse effect was evident in samples of lint taken as the bale left the gin and also in samples taken at several stages in processing in the mill. Lint cleaners did not appear to exert a significant influence upon length.

A reduction in moisture significantly increased the proportion of fibers shorter than 1/2 inch in the samples taken as the cotton left the gin and at all subsequent stages in mill processing. The adverse effect of the use of additional overhead gin cleaning equipment upon the occurrence of short fibers did not appear in samples taken at the gin, but was evident in samples taken at various stages in processing at the mill. Statistically, lint cleaners did not appear to affect the occurrence of short fibers at any stage.

The results revealed no significant relationship between Pressley strength measurements of fiber as it left the gin and any cleaning methods. However, for samples taken at various levels of mill processing, it was found that there was a slight, but significant, difference in strength due to differences in moisture levels. The analysis indicated that the use of overhead gin equipment and lint cleaners resulted in significant differences in strength, but this result was not consistent at all levels of processing.

Results from the Shirley analyzer indicated, in most instances, that a reduction in moisture and the addition of overhead and lint cleaning equipment all reduced visible foreign matter. However, mill waste was significantly affected only by differences in overhead and lint cleaning equipment.

Use of more elaborate cleaning practices at the gin appeared generally to have a small adverse effect upon the yarn appearance index and upon the break factor but, because of some inconsistencies, these results were not conclusive.

Neps in card web were significantly increased when additional overhead equipment at the gin was used, but did not appear to be affected by lint cleaners or differences in lint moisture levels.

Ends-down in spinning both 30s and 40s yarns were significantly increased when moisture was reduced during ginning and by the use of lint cleaners. Differences in overhead equipment did not appear to be significantly related to the occurrence of ends-down. A high positive correlation was found to exist between the occurrence of ends-down and the proportion of short fibers. About 64 percent of the variation in the ends-down in spinning 30s yarns and 86 percent in spinning 40s yarn was associated with variations in the proportions of fibers shorter than 1/2 inch.

EFFECTS OF CLEANING PRACTICES AT GINS ON FIBER PROPERTIES AND MILL PERFORMANCE OF COTTON

Progress Report

Marketing Research Division, Agricultural Marketing Service, United States Department of Agriculture

INTRODUCTION

For some years, the cotton ginning industry and the U. S. Department of Agriculture have worked to develop improved cleaning and conditioning equipment and ginning techniques that would improve the grade and, at the same time, preserve the inherent fiber qualities of the increasingly large volume of roughly harvested seed cotton. The desire of producers to receive the higher premiums associated with the higher grades has led the ginning industry to install and use more and more drying and cleaning equipment.

Such a development might be expected in an industry where competition is keen, where maintenance of large ginning volumes is essential to a sound financial structure, and where grade frequently is the only quality factor considered by the producer and ginner. It is complicated by the fact that, for the Cotton Belt as a whole, total production has gradually declined for several years, while machinery requirements, investments, and operating costs have increased significantly.

As new gin machinery was developed and put to use in recent years, elaborate fiber tests and small-scale spinning tests were conducted to determine the effects of the new machinery and operating practices on fiber properties of raw cotton and on quality of the products made from it. Standard laboratory measurements and market evaluation processes generally indicated that no significant changes occurred except in grade and staple and in manufacturing waste. However, the mill industry has indicated that the repeated application of gin cleaning equipment and the misuse of it in striving for higher grade levels result in other changes in quality which sharply lower the processing performance of the cotton, thereby increasing mill processing costs and lowering the value of the finished products.

The cotton mill industry, like the ginning industry, is highly competitive in nature. Plants therefore have been modernized and operating practices adjusted to achieve minimum costs. Under normal conditions, mills have been able to increase spinning speeds and at the same time approach the spinnable limits, or full utilization, of the inherent qualities of cotton. Once the plant is geared to high production in order to minimize labor and other costs, it is difficult and costly to reduce production in order to handle cotton of inferior quality. Rather than cut production, therefore, additional labor is employed, job load requirements are decreased, and unit labor costs increase. Since labor costs account for slightly more than half of total manufacturing costs, any increase in this item is of great significance. 1/ Labor costs for spinning, alone, account for about one-third of total labor costs.

In order to provide a basis for dependable conclusions, the Marketing Research Division of the Agricultural Marketing Service, in cooperation with the American Cotton Manufacturers Institute, National Cotton Council, and Institute of Textile Technology, began a test in the fall of 1957 to determine the effects of certain gin drying and cleaning practices on fiber qualities, mill processing performance and costs, and the quality and value of the finished cloth. It was realized that such a test would not answer all the questions that might be raised, but it was deemed essential to restrict the number of variables to such proportions that the effect of any one variable could be properly measured. This progress report covers the findings of only a part of this study. It is not intended to be final or to develop all the interrelationships present in such a study.

OBJECTIVE

The overall objective of the study, a segment of which is covered by this report, is to determine the effect of various combinations of cleaning and conditioning equipment and practices on returns to producers, gin costs, fiber properties, processing costs of mills, and value of end products. This report is confined to that segment of the study relating to the effect of cleaning practices on selected fiber properties and on spinning performance.

METHOD OF STUDY

The test was designed to show the effect of varying overhead equipment for seed cotton cleaning and drying in combination with varying amounts of lint cleaning at the gin. Four bales of cotton for each of 12 test conditions, or a total of 48 bales, were included in the test (table 1). By arrangement with a producer near Tulare, California, the cotton was picked from an undefoliated field of 23 acres, using two single-row pickers, during the week of November 18, 1957.

Approximately two-thirds gallon of water per bale was used during picking. To each tank of water, a cup of liquid soap was added. Picking began during the late afternoon of November 18 and was completed on November 20. No picking was performed at night. Ginning of the test cotton was begun on November 20 and was completed the next day. Weather conditions remained clear during the picking and ginning of the test cotton. Four-bale trailers were used to transport the cotton to the gin. Each picker dumped equally into each trailer during the harvesting of the cotton.

1/ United States Department of Agriculture. 1951. Costs of Manufacturing Carded Cotton Yarn and Means of Improvement. U. S. Dept. Agr. Tech. Bul. 1033. 192 pp., illus.

Table 1.--Cleaning practices and drying temperature, ginning-spinning test, season 1957-58

Cleaning treatment	Drying temperature (F.) Bale number 1	2	3	4
Elaborate overhead equipment				
Low lint moisture:				
No lint cleaner...	--- 1st drier - 480° intake, 225° outlet ---			
	--- 2nd " - 270° " , 200° " ---			
1 lint cleaner....	--- 1st " - 520° " , 250° " ---			
	--- 2nd " - 430° " , 235° " ---			
2 lint cleaners...	--- 1st " - 520° " , 250° " ---			
	--- 2nd " - 430° " , 235° " ---			
High lint moisture:				
No lint cleaner...	1st drier - (180° intake (170° outlet		1st drier - (180° intake (140° outlet	
	2nd drier - (180° intake (160° outlet		2nd drier off	
1 lint cleaner....	--- 1st drier - 175° intake, 140° outlet ---			
	--- 2nd drier off ---------------			
2 lint cleaners...	--- 1st drier - 170° intake, 140° outlet ---			
	--- 2nd drier off ---------------			
Moderate overhead equipment				
High lint moisture:				
No lint cleaner...	510° intake 175° outlet	570° intake 185° outlet	590° intake 190° outlet	590° intake 190° outlet
1 lint cleaner....	------- 580° intake - 190° outlet ------			
2 lint cleaners...	------- 580° " - 190° " ------			
Very high lint moisture:				
No lint cleaner...	------- 190° " - 145° " ------			
1 lint cleaner....	------- 190° " - 145° " ------			
2 lint cleaners...	------- 190° " - 140° " ------			

1/ Elaborate cleaning consisted of 2 full driers, 1 bur machine, and 3 cylinder cleaners, equivalent to approximately 24 cylinders of cleaning.
2/ Moderate cleaning consisted of 1 drier and 2 cylinder cleaners. Only first drier used with moderate overhead setup.

Drier temperatures were regulated by the use of a lint moisture meter to determine moisture content of the ginned lint at the lint slide. In one case, it was not possible to achieve the desired moisture content because of inaccuracy of the meter at levels below 3.0 percent. In some cases, the lack of cotton prevented the attainment of the desired moisture level because of heat buildup which had occurred on the previous lots ginned. For the moderate overhead setup, it was not possible to use two driers to attain a moisture level of 2.5 - 3.0 percent.

Samples of seed cotton were obtained both before cleaning and drying and before ginning. Duplicate lint samples were obtained before each stage of lint cleaning. Several sets of lint samples for classing also were obtained after the bales had been shipped to the warehouse.

Shortly after ginning, a mill purchased the 48 bales of test cotton and moved them to its warehouse for storage until the start of the mill phase of the test on March 22. As the bales were opened at the mill, samples were obtained for fiber property determinations and spinning tests. Samples were drawn also at the picker hopper, picker lap, card, roving frames, spinning frames, and looms for tests of various types. Twenty to 30 cards, equipped with metallic clothing, were used to run each lot. Only 3 of these cards were used to obtain data on waste and for sampling material. Four spinning frames were used for ends-down counts--2 for 30s and 2 for 40s yarn. The spinning was done in an airconditioned, humidity-controlled spinning room. Ends-down counts were made for approximately 21 hours on each frame, after which the roving was creeled in on the second frame for an additional 21 hours. Thus 2 lots were processed simultaneously and frame differences were minimized by changing frames for each count spun. For 30s warp yarn, ends-down counts were made on an average of 9,534 spindle-hours, and for 40s filling yarn, the average spindle hours per lot amounted to 9,490.

Warp yarn was processed through slashing, and was wound on 6 loom beams for each lot. The same slasher was used for all lots and, by using a stretch meter, the percent of stretch present for all lots was kept constant. In addition, samples of starch and sized and unsized yarn were obtained for later tests.

The 6 beams were placed on 6 looms and weaving was performed for 96 hours. Loom stop counts were made for 21 hours for each of the 4 days in which weaving was performed. This procedure provided a total of 504 loom hours per lot in which loom stop counts were made. This figure was more than twice the number of loom hours considered as being necessary by the mill in its calculations concerning changes in work load assignments.

The cloth, 68 x 72 construction, will be evaluated at 3 levels by a committee of selling agents established for this purpose by the Association of Cotton Textile Merchants of New York. An evaluation will be made of the gray goods, and another evaluation after bleaching has occurred. The final evaluation will be made after the bleached goods have been finished. The committee agreed on one finishing company, which will perform all bleaching and finishing.

Additional tests on the cloth are to be made by the Southern Regional Research Laboratory and the Cotton Division, Agricultural Marketing Service.

Throughout the tests, both in the mill and in the laboratory, all lots and samples were processed and tested on the basis of a coded identification. All fiber tests were performed at one laboratory and small-scale spinning tests were made at one laboratory.

This progress report includes only a small proportion of the data which will eventually come from this study. Included are several of the more important quality factors and a few of the more important statistical analyses relating to significance of the results reported. These quality measurements, as well as other factors and their relationships to other measures of processing performance, costs, and value of the end products, will appear in the final report.

The analyses of variance made of the data were limited by the fact that it was not possible to reduce the lint moisture content to the desired 2.5 - 3.0 percent range for the moderate overhead seed cotton cleaning setup. The test lots in this group, which should have been ginned at low moisture levels, actually were ginned at lint moisture levels generally comparable to the lots ginned with elaborate overhead at high moisture levels. The moisture levels for the 2 groups of lots ginned with moderate overhead equipment therefore are described in this report as high and very high. The analyses have been confined to a determination of significance of differences between high and low lint moisture conditions under the elaborate overhead seed cotton cleaning setup and of significance of differences between elaborate and moderate overhead cleaning at the high moisture levels. A more detailed analysis explaining the differences within lots and within lint cleaning stages will be included in a later report.

CONDITION OF SEED COTTON

All lots of cotton used in this study were fairly comparable in original foreign matter content of seed cotton when received at the gin (table 2). Moisture content of the seed cotton at time of ginning also was relatively uniform, except for 2 lots. However, since drying was controlled by the amount of moisture present in the ginned lint, this factor was not of major importance. Seed cotton samples were roller-ginned and the resulting ginned lint was stored in airtight containers for moisture determination by the oven method. A comparison of these data with the original moisture content of the seed cotton indicates that the moisture content in the lint cotton was from 2 to 3 percentage points below that in seed cotton. Of particular interest is the fact that the lots which were dried to low moisture levels at time of ginning gained moisture and reached a moisture content of 5 to 6 percent throughout the bale when the bales were opened for the spinning test. Conversely, those lots which contained 6 to 7 percent at time of ginning remained fairly constant in moisture content.

Table 2.--Moisture and foreign matter content of cotton, ginning-spinning test, season 1957-58

Cleaning treatment	Moisture 1/						Foreign matter in seed cotton	
	Seed cotton		Lint cotton					
	Wagon 2/	Feeder 3/	Wagon 4/	Lint Slide 5/	Opener 6/	Picker 7/	Wagon 2/	Feeder 3/
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Elaborate overhead equipment								
Low lint moisture:								
No lint cleaner	10.7	7.4	7.8	2.6	5.3	5.3	4.6	1.0
1 lint cleaner	10.1	6.2	7.6	1.7	5.0	4.8	4.6	.7
2 lint cleaners	13.6	8.4	10.6	2.8	5.6	5.8	4.2	1.0
High lint moisture:								
No lint cleaner	12.0	9.2	9.1	4.2	5.1	5.4	5.6	1.1
1 lint cleaner	10.6	8.0	8.5	4.9	6.0	5.7	5.4	1.1
2 lint cleaners	10.2	8.6	9.5	5.3	5.2	5.2	4.8	.9
Moderate overhead equipment								
High lint moisture:								
No lint cleaner	13.8	10.6	10.6	6.4	6.4	6.3	5.2	1.4
1 lint cleaner	11.9	9.2	8.9	5.2	5.7	5.3	5.2	1.3
2 lint cleaners	12.5	8.7	9.8	4.4	5.0	5.0	5.6	1.1
Very high lint moisture:								
No lint cleaner	11.7	10.7	10.3	6.9	6.4	6.1	4.9	1.8
1 lint cleaner	11.4	9.8	9.6	6.4	6.4	6.6	5.4	1.5
2 lint cleaners	12.8	10.7	10.2	6.0	6.2	6.2	5.0	2.1

1/ All moisture data based on oven method.
2/ Sample seed cotton taken before any drying or cleaning.
3/ Sample seed cotton taken after all drying and cleaning.
4/ Roller ginned lint sample from wagon before drying.
5/ Sample of lint taken from lint slide just before pressing.
6/ Three samples per bale at each of 1/4, 1/2, and 3/4 levels at opening of bales.
7/ Five samples per lot at each of 1/4, 1/2, and 3/4 levels between opener and picker.

GRADE AND STAPLE

All bales were classed under code by a committee composed of 1 representative from a brokerage organization, 1 from a shipping firm, 1 from a mill, and 1 from the Department of Agriculture. Before classing the cotton, the committee knew that different lots had been subjected to different cleaning practices; however, the identity of individual bales or lots was not known to the committee. On the basis of grade designations assigned by this committee, it is apparent that additional overhead cleaning, reduction in lint moisture, and increased use of lint cleaners all tended to raise the grade (table 3). Larger gains in grade generally were obtained with the first lint cleaner at low moisture levels, but the use of the second lint cleaner also tended to improve grade values. An exception to this general tendency occurred when elaborate overhead and high heat were employed. In this instance, 2 of the 4 bales were cleaned to such an extent that color became predominant and the bales were classed as Light Gray. Of special significance is the fact that grades obtained with moderate overhead cleaning and 2 lint cleaners compared favorably at both moisture levels with grades obtained through the use of elaborate overhead cleaning and 2 lint cleaners when lint moisture was low. Grade values obtained with the moderate overhead setup at very high moisture levels and with 2 lint cleaners were only slightly below those obtained with elaborate overhead, high moisture, and 2 lint cleaners.

Classers' length designations tended to decrease as lint cleaning was added, under practically all conditions. This trend was especially true for the elaborate overhead cleaning setup at both moisture levels. Classers' staple length designations showed moderate differences both between moisture levels and between overhead cleaning setups.

FIBER LENGTH

As determined by the fiber array method, drying to low moisture levels with elaborate overhead cleaning had a highly significant effect upon the upper quartile length, the mean length, and the coefficient of variation at all steps of processing (table 4). Drying to a low moisture level generally accounted for a reduction of approximately .02 of an inch in upper quartile length. The mean length was decreased approximately twice as much.

Lint cleaners had no apparent effect upon either the upper quartile or mean length for the first three stages of processing. Although differences existed among lint cleaner lots in the upper quartile and mean lengths of samples taken from the card sliver, the significant interaction of moisture and lint cleaner variation suggests that lint cleaners alone may not significantly affect length. In fact, for cotton ginned with different overhead treatments but with lint moisture held fairly constant, the influence of overhead seed cotton cleaning machinery was found to be the only factor that was highly significant in reducing the upper quartile length. This level of significance and decrease in length held for all processing stages, and it affected both mean length and coefficient of variation. Lint cleaning, or the interaction of this factor with overhead cleaning, had no effect on these length qualities at the high moisture level.

Table 3.--Grade and staple of cotton, by cleaning treatment, ginning-spinning test, season 1957-58

Cleaning treatment	Classers' designation 1/									
	Bale 1		Bale 2		Bale 3		Bale 4		Lot average	
	Grade	Staple	Grade	Staple	Grade	Staple	Grade	Staple	Grade	Staple
		32nds inch		32nds inch		32nds inch		32nds inch		32nds inch
Elaborate overhead equipment:										
Low lint moisture:										
No lint cleaner	SLM	34	SLM	34	SLM	34	SLM+	34	SLM	34.0
1 lint cleaner	M	34	M	34	M	33	M	33	M	33.5
2 lint cleaners	SM ltgr	34	SM ltgr	33	M	33	M	33	M-	33.2
High lint moisture:										
No lint cleaner	SLM+	35	SLM	35	SLM	35	SLM	34	SLM	34.8
1 lint cleaner	SLM+	34	SLM+	34	SLM+	35	SLM+	34	SLM+	34.2
2 lint cleaners	M	34	M+	33	M	33	M	34	M	33.5
Moderate overhead equipment:										
High lint moisture:										
No lint cleaner	LM+	34	LM+	34	LM+	34	LM+	34	LM+	34.0
1 lint cleaner	M	34	SLM	35	SLM+	34	SLM+	34	SLM+	34.2
2 lint cleaners	M	34	M	35	M	34	SLM	34	M-	34.2
Very high lint moisture:										
No lint cleaner	LM	34	LM	36	LM+	35	LM	35	LM	35.0
1 lint cleaner	SLM+	34	SLM+	34	SLM	34	SLM+	34	SLM+	34.0
2 lint cleaners	SLM+	34	M	34	M	34	SLM+	34	M-	34.0

1/ Coded samples classed by a committee composed of R. W. Smith, Lowenstein Mills; William Dupre, Anderson, Clayton & Company; Terrell Wells, Staple Cotton Association; and Mike Smith, Cotton Division, Agricultural Marketing Service, U. S. Department of Agriculture.

Table 4.--Effect of cleaning treatment on fiber length and length distribution, as measured by the fiber array method at different stages of processing, ginning-spinning test, season 1957-58

Cleaning treatment	Moisture at ginning	Upper quartile length: Ginned lint	Upper quartile length: Picker hopper	Upper quartile length: Picker lap	Upper quartile length: Card sliver	Mean length: Ginned lint	Mean length: Picker hopper	Mean length: Picker lap	Mean length: Card sliver	Coefficient of variation: Ginned lint	Coefficient of variation: Picker hopper	Coefficient of variation: Picker lap	Coefficient of variation: Card sliver
	Percent	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Pct.	Pct.	Pct.	Pct.
Elaborate overhead equipment:													
Low lint moisture:													
No lint cleaner	2.6	1.19	1.19	1.19	1.20	.98	.97	.97	.99	29.8	31.3	31.7	30.0
1 lint cleaner	1.7	1.19	1.18	1.19	1.18	.96	.95	.97	.96	31.2	31.7	31.7	31.3
2 lint cleaners	2.8	1.19	1.18	1.18	1.18	.97	.94	.96	.96	31.5	33.0	32.0	32.0
Mean		1.19	1.18	1.19	1.19	.97	.95	.97	.97	30.8	32.0	31.8	31.1
High lint moisture:													
No lint cleaner	4.2	1.22	1.21	1.21	1.20	1.02	1.00	1.00	1.00	28.2	29.3	29.7	28.7
1 lint cleaner	4.9	1.20	1.20	1.20	1.20	1.01	1.00	1.00	1.00	27.8	28.3	28.7	29.0
2 lint cleaners	5.3	1.21	1.20	1.21	1.21	1.00	1.00	1.00	1.00	29.0	28.7	29.3	29.3
Mean		1.21	1.20	1.21	1.20	1.01	1.00	1.00	1.00	28.3	28.8	29.1	29.0
						Analysis of variance 1/							
(1) Moisture		**	**	**	**	**	**	**	**	**	**	**	**
(2) Lint cleaner		N.S.	N.S.	N.S.	*	N.S.	**	N.S.	*	N.S.	N.S.	N.S.	N.S.
(1) x (2) Interaction		N.S.	N.S.	*	**	N.S.	*	N.S.	*	N.S.	N.S.	N.S.	N.S.
Coefficient of variability		.8	.7	.4	.5	1.5	.6	.7	1.0	5.6	3.2	2.6	2.7
	Percent	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Pct.	Pct.	Pct.	Pct.
High lint moisture:													
Elaborate overhead equipment:													
No lint cleaner	4.2	1.22	1.21	1.21	1.20	1.02	1.00	1.00	1.00	28.2	29.3	29.7	28.7
1 lint cleaner	4.9	1.20	1.20	1.20	1.20	1.01	1.00	1.00	1.00	27.8	28.3	28.7	29.0
2 lint cleaners	5.3	1.21	1.20	1.21	1.21	1.00	1.00	1.00	1.00	29.0	28.7	29.3	29.3
Mean		1.21	1.20	1.21	1.20	1.01	1.00	1.00	1.00	28.3	28.8	29.1	29.0
Moderate overhead equipment:													
No lint cleaner	6.4	1.22	1.22	1.22	1.22	1.03	1.03	1.03	1.03	28.0	27.0	27.7	27.7
1 lint cleaner	5.2	1.22	1.22	1.23	1.23	1.03	1.02	1.03	1.03	27.5	28.0	27.7	27.3
2 lint cleaners	4.4	1.22	1.22	1.23	1.22	1.02	1.02	1.03	1.02	28.5	28.0	28.7	28.3
Mean		1.22	1.22	1.23	1.22	1.02	1.02	1.03	1.03	28.0	27.7	28.0	27.8
						Analysis of variance 1/							
(1) Overhead		*	**	**	**	N.S.	**	**	**	N.S.	**	**	**
(2) Lint cleaner		N.S	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
(1) x (2) Interaction		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Coefficient of variability		.8	.7	.5	.6	1.7	.8	.6	1.1	6.4	2.9	2.0	2.3

1/ ** = significant at 1% level; * = significant at 5% level; N.S. = not significant.

FIBERS SHORTER THAN 1/2 INCH

In recent years, considerable attention has been devoted to the effect of ginning practices on the fiber length distribution of the ginned lint, and to a change in the percentage of short fibers which may result from such practices. In addition, it has been alleged that certain practices in mill processing were more damaging than those employed in the gin, particularly as they might affect the percentage of short fibers present.

For ginned lint, moisture content was highly significant in increasing the percentage of fibers shorter than 1/2 inch when elaborate overhead cleaning was used (table 5). Lint cleaners showed no significant effect, for, although there was a relatively large increase in short fibers as the amount of lint cleaning was increased at the low moisture level, the difference among lint-cleaner lots at the high moisture level was smaller and not consistent. The difference between different moisture levels with no lint cleaning was relatively small, but the difference was considerably larger at the first and second stages of lint cleaning.

At the low moisture level, it appears that short fibers are increased by the opening line, which in this case consisted only of an SRRL opener. However, at the picker and the card, the proportion of short fibers showed a slight decrease. No statistical analysis of this variation between processing stages has been made.

When lint moisture was held relatively constant, it was found that there was no significant difference in the percentage of short fibers in lint at the gin among either different lint cleaning stages or overhead treatments. However, when lint was subjected to mill processing, overhead cleaning was found to have a highly significant effect on percent of short fibers present.

For all lots except those 3 ginned with elaborate overhead and with low moisture content, there was a small but consistent decrease in the proportion of short fibers from the stage of no lint cleaning to the first lint cleaning stage. Moreover, when the second lint cleaning stage was added, the proportion of short fibers was increased to a level exceeding that for the lots of non-lint-cleaned cotton for each moisture range.

FIBER STRENGTH

Fiber strength tests were made on the Pressley tester with 2 different gage lengths. One was the 0 gage, with the results expressed in the familiar terms of 1,000 pounds per square inch, and the other with the 1/8-inch gage, with the results expressed as an index.

Measured with the 0 gage, the fiber strength of ginned lint was not significantly affected by either moisture differences or lint cleaner treatments when associated with elaborate overhead cleaning (table 6). However, at the picker hopper, picker lap, and card sliver, there was a significant difference

Table 5.--The effect of cleaning treatment on percentage of fibers shorter than one-half inch, as determined by Suter-Webb sorter at different processing stages, ginning-spinning test, season 1957-58

Cleaning treatment	Moisture at ginning	Ginned lint	Picker hopper	Picker lap	Card sliver
	Pct.	Pct.	Pct.	Pct.	Pct.
Elaborate overhead equipment:					
Low lint moisture:					
No lint cleaner	2.6	8.8	10.3	10.2	9.0
1 lint cleaner	1.7	10.1	10.6	10.8	10.6
2 lint cleaners	2.8	10.4	11.8	10.7	10.9
Mean		9.8	10.9	10.6	10.2
High lint moisture:					
No lint cleaner	4.2	7.9	8.6	8.4	8.4
1 lint cleaner	4.9	7.5	8.0	8.1	8.6
2 lint cleaners	5.3	8.2	8.1	8.5	8.5
Mean		7.9	8.2	8.3	8.5
		Analysis of variance 1/			
(1) Moisture		**	**	**	**
(2) Lint cleaner		N.S.	N.S.	N.S.	N.S.
(1) x (2) Interaction		N.S.	N.S.	N.S.	N.S.
Coefficient of variability		14.1	7.1	6.0	8.1
	Pct.	Pct.	Pct.	Pct.	Pct.
High lint moisture:					
Elaborate overhead equipment:					
No lint cleaner	4.2	7.9	8.6	8.4	8.4
1 lint cleaner	4.9	7.5	8.0	8.1	8.6
2 lint cleaners	5.3	8.2	8.1	8.5	8.5
Mean		7.9	8.2	8.3	8.5
Moderate overhead equipment:					
No lint cleaners	6.4	7.5	7.1	7.5	7.4
1 lint cleaner	5.2	7.2	7.8	7.2	7.0
2 lint cleaners	4.4	8.1	7.5	7.9	7.8
Mean		7.6	7.5	7.5	7.4
		Analysis of variance 1/			
(1) Overhead		N.S.	**	**	**
(2) Lint cleaner		N.S.	N.S.	N.S.	N.S.
(1) x (2) Interaction		N.S.	N.S.	N.S.	N.S.
Coefficient of variability		13.9	5.6	5.3	8.8

1/ ** = significant at 1% level; * = significant at 5% level; N.S. = not significant.

Table 6.--Effect of cleaning treatment on fiber strength as measured by Pressley method, at different processing stages, ginning-spinning test, season 1957-58

Cleaning treatment	Moisture at ginning	0 gage: Ginned lint	0 gage: Picker hopper	0 gage: Picker lap	0 gage: Card sliver	1/8" gage: Ginned lint	1/8" gage: Picker hopper	1/8" gage: Picker lap	1/8" gage: Card sliver
	Percent	1,000 p.s.i.	1,000 p.s.i.	1,000 p.s.i.	1,000 p.s.i.	Index	Index	Index	Index
Elaborate overhead equipment:									
Low lint moisture:									
No lint cleaner	2.6	93.2	90.7	89.3	90.3	108.0	107.3	103.3	110.7
1 lint cleaner	1.7	91.8	91.0	91.0	87.0	109.0	110.0	112.3	107.7
2 lint cleaners	2.8	92.8	92.0	87.3	89.7	112.5	111.0	110.0	105.0
Mean		92.6	91.2	89.2	89.0	109.8	109.4	108.5	107.8
High lint moisture:									
No lint cleaner	4.2	93.0	91.3	90.3	91.7	111.2	107.0	105.7	107.3
1 lint cleaner	4.9	92.2	90.3	91.3	90.7	110.8	114.7	111.3	114.7
2 lint cleaners	5.3	93.0	96.7	94.3	94.3	113.5	115.7	109.0	116.0
Mean		92.8	92.8	92.0	92.2	111.8	112.4	108.7	112.7
		Analysis of variance 1/							
(1) Moisture		N.S.	*	**	**	*	*	N.S.	**
(2) Lint cleaner		N.S.	*	N.S.	**	**	**	**	N.S.
(1) x (2) interaction		N.S.	*	*	N.S.	N.S.	N.S.	N.S.	**
Coefficient of variability		1.5	1.4	2.0	1.3	1.8	2.2	2.8	2.1
	Percent	1,000 p.s.i.	1,000 p.s.i.	1,000 p.s.i.	1,000 p.s.i.	Index	Index	Index	Index
High lint moisture:									
Elaborate overhead equipment:									
No lint cleaner	4.2	93.0	91.3	90.3	91.7	111.2	107.0	105.7	107.3
1 lint cleaner	4.9	92.2	90.3	91.3	90.7	110.8	114.7	111.3	114.7
2 lint cleaners	5.3	93.0	96.7	94.3	94.3	113.5	115.7	109.0	116.0
Mean		92.8	92.8	92.0	92.2	111.8	112.4	108.7	112.7
Moderate overhead equipment:									
No lint cleaner	6.4	93.5	95.3	92.7	92.3	115.5	109.7	113.3	112.7
1 lint cleaner	5.2	93.2	96.0	93.7	95.3	116.0	113.0	108.3	115.3
2 lint cleaners	4.4	91.8	95.0	95.0	91.3	114.2	119.0	114.0	116.0
Mean		92.8	95.4	93.8	93.0	115.2	113.9	111.9	114.7
		Analysis of variance 1/							
(1) Overhead		N.S.	**	*	N.S.	**	N.S.	*	N.S.
(2) Lint cleaner		N.S.	**	*	N.S.	N.S.	**	N.S.	**
(1) x (2) interaction		N.S.	**	N.S.	**	N.S.	N.S.	**	N.S.
Coefficient of variability		2.2	1.5	1.7	1.6	2.2	2.2	2.3	2.0

1/ ** = significant at 1% level; * = significant at 5% level; N.S. = not significant.

in fiber strength due to differences in moisture content at time of ginning. Differences among lint cleaner lots in strength, as measured by the 0 gage at the picker hopper and card sliver, were statistically significant but not consistent. Samples taken at the picker lap did not differ significantly among lint cleaner groups.

When fibers from lots ginned with elaborate overhead were measured with the 1/8-inch gage, differences in both moisture and lint cleaning significantly affected strength of fiber samples taken at ginning and from the picker hopper. The fibers from lots with high moisture were stronger than those from lots with low moisture; lots subjected to 1 lint cleaner appeared stronger than lots not lint cleaned; and lots subjected to 2 lint cleaners appeared to be strongest of all. In the picker lap, moisture showed no effect on fiber strength, while lint cleaners showed a significant but not consistent effect.

Because of differences in results indicated by the 2 methods, differences among the results at different stages of processing, and inconsistencies among lint cleaner measurements, the results of this analysis are not conclusive. However, it appears that with elaborate overhead, fiber strength of cotton ginned with extremely low moisture will be reduced somewhat as a result of the low moisture. At all stages of processing, and for both strength measurements, the average strength of fibers in the lots ginned with low moisture was lower than that of fibers ginned with high moisture.

For the lots ginned with high moisture, there was no significant difference due to overhead cleaning treatments in ginned lint as measured with the 0 gage. However, the difference in overhead cleaning was highly significant for ginned lint when measured with the 1/8-inch gage. Although results with these treatments are, again, not conclusive, it should be pointed out that the means of the 0 gage tests for all lots ginned with elaborate overhead are lower than those with moderate overhead at all mill processing stages. With the 1/8-inch gauge, means at all stages at both gin and mill, for elaborate overhead are lower than those for moderate overhead. This indicates that fiber strength of cotton ginned with relatively high moisture may be adversely affected by elaborate overhead as compared to moderate overhead cleaning.

VISIBLE FOREIGN MATTER CONTENT

Visible foreign matter content as determined by the Shirley analyzer was used in this analysis. With elaborate overhead cleaning, the combination of drying and lint cleaning significantly reduced the foreign matter content of the ginned lint (table 7). Cotton ginned with a low moisture content consistently contained less foreign matter than did cotton ginned with high moisture at any comparable lint cleaning stage. As more lint cleaning was added, for both high and low moisture, reductions in foreign matter were obtained. At the card sliver, only lint cleaners were found to be highly significant in their effect on foreign matter reduction. The most important reduction in this instance occurred as a result of adding the second lint cleaner.

Table 7.--Effect of cleaning treatment on visible foreign matter content, as measured by Shirley analyzer, at different stages of processing, ginning-spinning test, season 1957-58

Cleaning treatment	Moisture at ginning	Visible foreign matter content: Ginned lint	Picker hopper	Picker lap	Card sliver
	Pct.	Pct.	Pct.	Pct.	Pct.
Elaborate overhead equipment:					
Low lint moisture:					
No lint cleaner	2.6	2.34	2.07	1.38	.180
1 lint cleaner	1.7	1.58	1.53	1.14	.176
2 lint cleaners	2.8	1.10	.94	.87	.136
Mean		1.67	1.51	1.13	.164
High lint moisture:					
No lint cleaner	4.2	3.01	2.53	1.89	.186
1 lint cleaner	4.9	2.05	1.87	1.61	.176
2 lint cleaners	5.3	1.24	1.24	1.39	.113
Mean		2.10	1.88	1.63	.158
		Analysis of variance 1/			
(1) Moisture		**	**	**	N.S.
(2) Lint cleaner		**	**	**	**
(1) x (2) interaction		*	N.S.	N.S.	N.S.
Coefficient of variability		10.2	8.7	14.7	15.9
	Pct.	Pct.	Pct.	Pct.	Pct.
High lint moisture:					
Elaborate overhead:					
No lint cleaner	4.2	3.01	2.53	1.89	.186
1 lint cleaner	4.9	2.05	1.87	1.61	.176
2 lint cleaners	5.3	1.24	1.24	1.39	.113
Mean		2.10	1.88	1.63	.158
Moderate overhead equipment:					
No lint cleaner	6.4	3.82	3.47	2.43	.220
1 lint cleaner	5.2	2.04	1.77	1.62	.150
2 lint cleaners	4.4	1.20	1.12	.92	.126
Mean		2.35	2.12	1.66	.165
		Analysis of variance 1/			
(1) Overhead		*	**	N.S.	N.S.
(2) Lint cleaner		**	**	**	**
(1) x (2) interaction		*	**	**	N.S.
Coefficient of variability		13.3	6.8	12.2	17.6

1/ ** = significant at 1% level; * = significant at 5% level; N.S. = not significant.

When moisture was fairly constant and overhead cleaning was varied, the combined effect of overhead and lint cleaning was quite marked on visible foreign matter content in the ginned lint. The difference between overhead treatments in reducing foreign matter content of non-lint-cleaned cotton was significant; but there was little or no difference between overhead treatments when cotton was subjected to either 1 or 2 lint cleaners. This same relationship was fairly constant for the different stages of processing. Therefore, the use of elaborate overhead cleaning serves no useful purpose in foreign matter removal if lint cleaners are used, as measured by the cotton included in this test.

MILL PROCESSING WASTE

About one-third of the total waste occurring during processing of the test cottons was accounted for by opener and picker waste and about two-thirds by card waste (table 8). The opener and picker waste, consisting of waste removed by machines, sweeps, and invisible loss, ranged from a low of 1.4 percent, for the lot with elaborate overhead and low moisture and 1 lint cleaner, to 3.1 percent for the lot with moderate overhead, very high moisture, and no lint cleaning. Opener and picker waste was not affected appreciably by lint cleaning for the lots ginned with elaborate overhead. However, there was a progressive reduction in opener and picker waste associated with 1 and 2 lint cleaners for those lots ginned with moderate overhead. There was little difference in this waste for lots with 2 lint cleaners, regardless of overhead and drying treatments. This means that if cotton is to be passed through 2 lint cleaners, waste from the opener and picker will not be reduced appreciably as a result of elaborate overhead cleaning and high drying temperatures, as compared with moderate overhead and low drying temperatures.

Carding waste consisted of motes and fly, flat strips, and sweeps. Sweeps were practically the same for all lots. There were, however, successive decreases in motes and fly and flat strips associated with lint cleaners for all overhead and drying conditions. The motes and fly and flat strip waste were almost equal for all of the 4 lots ginned with 2 lint cleaners, even though the lots were subjected to different overhead and drying treatments. Total carding waste was slightly higher for the lots with no lint cleaning and moderate overhead, as compared with those with no lint cleaning and elaborate overhead. However, there was practically no difference in carding waste between heat or overhead cleaning treatments for lots subjected to 2 lint cleaners.

Total waste from processing was less for those lots ginned with elaborate overhead cleaning and no lint cleaning, compared with those with moderate overhead cleaning and no lint cleaning. However, the total processing waste was about the same for lots passed through 2 lint cleaners, regardless of overhead treatment. Similar results are apparent when visible foreign matter contents of ginned lint for the different treatments are compared (table 7). This indicates that if lint cleaning in tandem is employed, processing waste is reduced to the same level with moderate overhead and high moisture, as with elaborate overhead cleaning and low moisture of lint at time of ginning.

Table 8.--The effect of cleaning treatment on mill processing waste, ginning-spinning test, season 1957-58

Cleaning treatment	Opener and picker waste				Card waste as percentage of lap fed				Total waste
	Opener	Picker	Invisible	Total	Motes & fly	Flat strips	Sweeps	Total	
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Elaborate overhead equipment:									
Low lint moisture:									
No lint cleaner	0.3	0.5	1.1	1.9	1.8	2.3	0.3	4.4	6.2
1 lint cleaner	.1	.3	1.0	1.4	1.6	1.9	.3	3.8	5.1
2 lint cleaners	.2	.2	1.5	1.9	1.4	1.9	.3	3.6	5.4
High lint moisture:									
No lint cleaner	.3	.6	0.8	1.7	2.0	2.2	.3	4.5	6.1
1 lint cleaner	.2	.3	1.9	2.4	1.6	1.9	.3	3.8	6.1
2 lint cleaners	.1	.3	1.3	1.7	1.3	1.7	.3	3.3	4.9
Moderate overhead equipment:									
High lint moisture:									
No lint cleaner	.3	.7	2.0	3.0	2.3	2.4	.3	5.0	7.8
1 lint cleaner	.1	.4	1.3	1.8	1.7	1.9	.3	3.9	5.6
2 lint cleaners	.2	.3	0.7	1.2	1.1	1.8	.2	3.1	4.3
Very high lint moisture:									
No lint cleaner	.4	.8	1.9	3.1	2.5	2.2	.3	5.0	7.9
1 lint cleaner	.1	.4	2.2	2.7	1.7	2.2	.3	4.2	6.8
2 lint cleaners	.1	.3	1.7	2.1	1.2	2.0	.2	3.4	5.4

YARN APPEARANCE, BREAK FACTOR, NEPS, AND ENDS-DOWN

The greatest difference in yarn appearance occurred between moisture levels, with only a small difference occurring between overhead treatments. Generally, the highest yarn appearance grade occurred for both 30s and 40s yarn where moderate overhead and high moisture were employed. Effects of lint cleaners were not consistent. There was a slight decrease in appearance of 40s yarn due to lint cleaners for the cotton ginned with elaborate overhead cleaning and low moisture, and for 30s yarn when cotton was ginned with high moisture (table 9).

Similar relationships were generally found to exist when break factors were examined. The highest break factors occurred when moderate overhead equipment was used with high levels of moisture, while the lowest break factors were associated with the elaborate overhead and low moisture ginnings. There appeared to be only a slight and not always consistent change for 30s yarn, within any group, which might be attributable to lint cleaners. In all cases, there was a slight decrease in break factors for 40s yarn when lint was passed through 2 lint cleaners, compared with non-lint-cleaned cotton.

When cotton was passed through an elaborate overhead cleaning setup, neither variations in moisture nor differences in use of lint cleaners significantly affected nep content. At the same moisture levels the combined effect of lint cleaning and the difference in overhead cleaning was highly significant in increasing neps per 100 square inches of card web, but because of the significant interaction, the effect of each could not be determined separately. The general level of neps for all test lots was in a low or average category.

One of the most important elements to the cotton mill industry in measuring the performance of cotton is ends-down in spinning. Not only can this factor have a bearing on quality, but it exerts a most significant influence on manufacturing costs. Therefore, the effects which certain ginning practices might have on ends-down and also the relation of certain quality elements to ends-down are of paramount interest to the industry as a whole, and they account for a significant part of this study.

With elaborate overhead equipment, differences in lint cleaning and lint moisture at the gin had a highly significant combined effect on ends-down in spinning both 30s and 40s yarn. This suggests that not only did moisture itself have an effect on ends-down at the same lint cleaning stages, but that the addition of lint cleaning also had a pronounced effect on the increase in ends-down per 1,000 spindle hours.

Lint cleaners appeared to have less effect on ends-down for 40s yarn than for 30s. For the finer yarn number, moisture appeared to be more important in increasing ends-down. Specifically, for elaborate overhead and with moisture content at approximately 2.7 percent, ends-down per 1,000 spindle hours increased for 30s yarn from 46 when no lint cleaners were used to 71 when 2 lint cleaners were used. The comparable increase for 40s yarn was from 137 to 203.

Table 9.--Effect of cleaning treatment on yarn appearance, break factor, neps per 100 sq. inches of card web and ends-down per 1,000 spindle hours, ginning-spinning test, season 1957-58

Cleaning treatment	Moisture at ginning	Yarn appearance 1/ 30s	Yarn appearance 1/ 40s	Break factor 30s	Break factor 40s	Neps per 100 sq. in. card web 2/	Ends-down (per 1,000 spindle hours) 30s	Ends-down (per 1,000 spindle hours) 40s
	Percent	Index	Index			Number	Number	Number
Elaborate overhead equipment:								
Low lint moisture:								
No lint cleaner	2.6	80	80	2139	1924	19.3	46	137
1 lint cleaner	1.7	80	80	1971	1768	20.3	93	274
2 lint cleaners	2.8	80	70	2055	1816	23.0	71	203
Mean		--	--	--	--	20.9	70	205
High lint moisture:								
No lint cleaner	4.4	90	80	2226	2036	17.0	35	70
1 lint cleaner	4.8	100	90	2223	2024	19.7	54	58
2 lint cleaners	5.3	80	80	2235	1968	20.0	66	74
Mean		--	--	--	--	18.9	52	67
				Analysis of variance 3/				
(1) Moisture						N.S.	**	**
(2) Lint cleaner						N.S.	**	*
(1) x (2) Interaction						N.S.	**	**
Coefficient of variability						11.7	19.6	34.8
	Percent	Index	Index			Number	Number	Number
High lint moisture:								
Elaborate overhead equipment:								
No lint cleaner	4.4	90	80	2226	2036	17.0	35	70
1 lint cleaner	4.8	100	90	2223	2024	19.7	54	58
2 lint cleaners	5.3	80	80	2235	1968	20.0	66	74
Mean		--	--	--	--	18.9	52	67
Moderate overhead equipment:								
No lint cleaner	6.0	90	90	2298	2120	15.3	42	60
1 lint cleaner	5.2	90	90	2256	2080	10.3	43	54
2 lint cleaners	4.4	90	90	2261	2068	16.3	57	72
Mean		--	--	--	--	14.0	48	62
				Analysis of variance 3/				
(1) Overhead						**	N.S.	N.S.
(2) Lint cleaner						N.S.	**	*
(1) x (2) interaction						*	N.S.	N.S.
Coefficient of variability						12.6	22.7	28.0

1/ Based on USDA grade of mill yarn. 100 = average; 90 = fair; 80 = poor; 70 = very poor. 2/ Based on USDA count of mill card nep boards. 3/ ** = significant at 1% level; * = significant at 5 % level; N.S. = not significant.

Overhead cleaning did not have a significant effect on ends-down when moisture content was fairly constant at a relatively high level. However, lint cleaning was highly significant in increasing ends-down for 30s yarn and significant in the increase for 40s yarn.

Preliminary investigations indicate that the added cost of spinning cotton in the lots subjected to elaborate overhead cleaning and reduced to low moisture levels would be significantly higher than the cost of spinning the lots subjected to elaborate overhead cleaning but at high moisture levels. This same relationship would also apply between the lint cleaner lots in the elaborate overhead, low moisture group. The principal increase would be mainly attributable to the added cost involved in spinning 40syarn. However, for a very practical reason, the spinning of cotton with an ends-down capability such as is shown for the elaborate overhead, low moisture group of lots would involve difficulties that could not be fully measured in terms of added costs. Specifically, in spinning these test cottons, as many as 5 spinners were engaged in maintaining production on 1 spinning frame for approximately 30 minutes after each doff. Thus a strict cost approach to decreased job loads, with cotton having high ends-down capabilities, will not present a complete account of the difficulties associated with the manufacture of cloth from such stock.

RELATION OF FIBERS SHORTER THAN 1/2 INCH TO INCIDENCE OF ENDS-DOWN

A question arises as to the factors which may have a direct bearing on ends-down in spinning. Preliminary indications are that both drying and lint cleaning have a significant influence on this factor. It has been suggested that there is a relationship between the number of short fibers present and ends-down in spinning.

Data available from 12 lots show that the percentages of fibers shorter than 1/2 inch in ginned lint were correlated with ends-down per 1,000 spindle hours. It was found that for 30s yarn, 64 percent of the variation in ends-down was associated with variation in the proportion of short fibers. In this small number of observations, the standard error of estimate was ± 10 ends-down.

For 40s yarn, 86 percent of the variation in ends-down was associated with variation in short fibers. The standard error of estimate was ± 24 ends-down.

The next question which logically arises centers around the cause or causes of short fibers other than those of a genetic or climatological nature. Previously it was pointed out that in this particular test, lint moisture had a significant effect on the percentage of short fibers present, but that lint cleaning had no significant effect.

When lint moisture content was correlated with the percentage of fibers shorter than 1/2 inch for the 48 bales involved in this study, it was found that 41 percent of the variation in short fibers was associated with variation in lint moisture content. The standard error of estimate was + 1.09 percentage points of short fiber.

Although a relatively high correlation was obtained for moisture, the findings also suggest that there are other factors which account for the remaining 59 percent. These may be thought of as overhead, lint cleaning, sampling error, and testing error. The fact that lint cleaning, along with moisture, was highly significant for increases in ends-down, and that overhead was not significant, suggests that, statistically, a considerable proportion of the increase in ends-down can be attributed to lint cleaning. This is further substantiated by the fact that, although data are not shown in this report, lint cleaners were almost significant at the 5 percent level for their effect on the percentage of fibers shorter than 1/2 inch.