Marketing Research Report No. 690

Effects of Defoliation, Harvesting, and Ginning Practices on Micronaire Reading, Fiber Properties, Manufacturing Performance, and Product Quality of El Paso Area Cotton, Season 1960-61

UNITED STATES DEPARTMENT OF AGRICULTURE • Economic Research Service • Agricultural Research Service

PREFACE

This study of the effects of defoliation, harvesting, and ginning practices on micronaire reading, fiber properties, manufacturing performance, and product quality of El Paso area cotton, season 1960-61, is one of a group conducted by the Department of Agriculture during the last decade. The study was undertaken by the Economic Research Service and the Agricultural Research Service in cooperation with the National Cotton Council, gin machinery manufacturers, ginners, and producers. Results of related studies are given in the following reports:

Effects of Lint Cleaning of Cotton--An Economic Analysis at California Gins. By James St. Clair and Arthur L. Roberts. Mktg. Res. Rpt. 238. May 1958.

Effects of Cleaning Practices at Gins on Fiber Properties and Mill Performance of Cotton. A Progress Report. By Marketing Research Division, Agricultural Marketing Service. Mktg. Res. Rpt. 269. August 1958.

Effects of Tandem Lint Cleaning on Bale Values, Weight Changes, and Prices Received by Farmers. By Zolon M. Looney and Joseph P. Ghetti. Mktg. Res. Rpt. 397. May 1960.

Cotton Fiber and Spinning Properties as Affected by Certain Ginning Practices, San Joaquin Valley, California, Season 1958-59. By John E. Ross, Clarence G. Leonard, and Edward H. Shanklin. Mktg. Res. Rpt. 486. July 1961.

Seed Cotton and Multiple Lint Cleanings at Gins--Effect on Grade, Price, and Bale Value--A Progress Report. By Zolon M. Looney and Edsel A. Harrell. ERS-43. Dec. 1961.

Effects of Cotton Ginning Practices on Market Quality of Cotton--A Mississippi Delta Variety, 1958-59. By Edward H. Shanklin, E. W. S. Calkins, and Oliver L. McCaskill. Mktg. Res. Rpt. 576. Jan. 1963.

Multiple Lint Cleaning at Cotton Gins--Effects on Bale Value, Fiber Properties, and Spinning Performance. By Zolon M. Looney, L. D. LaPlue, Charles A. Wilmot, Walter E. Chapman, Jr., and Franklin S. Newton. Mktg. Res. Rpt. 601. May 1963.

Fiber and Spinning Properties of Cotton as Affected by Certain Harvesting and Ginning Practices, Yazoo-Mississippi Delta, 1959-60. By Franklin E. Newton, E. W. S. Calkins, and Anselm C. Griffin. Mktg. Res. Rpt. 656. June 1964.

Some Effects of Gin Drying and Cleaning of Cotton on Fiber Length Distribution and Yarn Quality. By John E. Ross and Edward H. Shanklin. Mktg. Res. Rpt. 666. July 1964.

ACKNOWLEDGMENTS

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The results relating to combing and comber noils were obtained under a contract between the Textile Research Department, Clemson University, and Agricultural Research Service, U. S. Department of Agriculture.

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SUMMARY AND CONCLUSIONS

Many cotton growers defoliate their crops to facilitate harvesting. Defoliation, like frost, retards or stops the growth of the plant, and consequently, retards or stops the cotton fibers from maturing. In this study, micronaire readings were made after premature defoliation, when only 10 percent of the bolls were open; normal defoliation when 60 percent of the bolls were open; and no defoliation. As the 1960-61 season in the area was unusual, a second application of defoliant was necessary a week later in the premature defoliation plots.

Average micronaire readings from the first harvests were: premature defoliation, 3.47; normal, 3.67; and none, 3.57. Because the range in values was unexpectedly narrow, a second harvest was made later from the same plots. This second-picked cotton was top-crop cotton with less fiber maturity and considerably lower micronaire values as follows: premature, 2.40; normal, 2.70; and none, 2.87. Reductions in micronaire values from first to second harvests were 1.07 for premature, 0.97 for normal, and 0.70 for no defoliation.

A total of 69 bales of cotton were tested. In the first-picked, or bottom-crop, cotton, 54 bales were machine picked and 6 bales hand picked. All 9 bales of second-picked cotton were machine harvested. The bulk of the statistical analyses involved only the 54 bales of first machine-harvested cottons. The two moisture levels were produced by manually adjusting the drier. The resulting lint-moisture contents averaged about 4.4 percent for the normal-moisture and about 2.6 percent for the low-moisture cotton. Cleaning setups were designated as: setup No. 1 - 2 seed-cotton cleaners and 1 lint cleaner; setup No. 2 - 2 seed-cotton cleaners and 2 lint cleaners; and setup No. 3 - 2 seed-cotton cleaners, 2 lint cleaners, and a stick machine.

Variations in lint slide moisture were found to be significantly related to many of the fiber, yarn, and processing characteristics studied. Generally, additional drying was associated with higher grade index, shorter fiber length, less uniformity of fiber length, lower fiber and yarn strength, lower nonlint content, and lower manufacturing waste than was normal drying. A reduction of 1 percentage point in lint slide moisture was associated with a 0.005- to 0.015-inch reduction in the various measurements of length, a 0.5-percentage-point increase in array coefficient of variation and in percentage of fiber shorter than one-half inch, and a 63-unit reduction in break factor of the yarn. Cotton ginned with low moisture was more severely damaged by opening, picking, and carding than was cotton ginned with normal or high moisture. The effects of moisture did not vary among micronaire levels or among cleaning treatments.

Part of the effects of defoliation may be attributed to the fact that undefoliated cotton had a higher moisture content in the seed cotton. Premature defoliation lowered the average micronaire reading by only 0.2 unit, but the yarn break factor was 90 units lower and the yarn appearance index was 6 points lower than that of normal and undefoliated cotton. The manufacturing waste was 0.35 percentage point lower. These facts suggest that this particular crop had a near-critical micronaire level. Acala 1517C, used in this test, has been supplanted by 1517D which may be expected to respond similarly but at a higher average micronaire level.

Normal and premature defoliation seemed detrimental to fiber length and length distribution. Cottons which received these treatments were 1/32- to 1/16-inch shorter than undefoliated cotton and array coefficient of variation averaged 1.7 percentage points higher.

In the ginned lint, minimum cleaning (setup No. 1) produced longer and more uniform fibers than other cleaning treatments. However, after carding or after carding and combing, these differences disappeared. However, cotton which received minimum cleaning had 20 to 30 fewer neps per 100 square inches of card web, about 0.13 percentage point more manufacturing waste, and a 35- to 50-unit higher break factor than cotton which received additional cleaning.

All cotton in the test was combed, using constant comber settings. Possibly for this reason, ends-down per 1,000 spindle hours showed no significant relationship to fiber properties.

The test results did not indicate any consistent difference in the response of undefoliated and defoliated cotton to different cleaning treatments.

There was no significant difference in fiber and yarn properties or processing performance between first hand-picked and first machine-picked cottons.

First machine-picked (bottom-crop) and second machine-picked (top-crop) cottons from the same fields differed in many properties. The differences are not merely the effect of the time of harvest or the frost date, but are caused by the shorter growing season for the top crop. The micronaire values averaged about 0.9 unit lower for the second machine-picked cotton than for the first machine-picked cotton. Also, the micronaire value was 0.47 unit lower for the second machine-picked prematurely defoliated cotton than for the second machine-picked undefoliated cotton.

The amount of comber noils was 0.7 percentage point lower for undefoliated than for defoliated cotton, 0.45 percentage point lower for cleaning setup No. 1 than for the other cleaning treatments, and 0.4 percentage point lower for cotton ginned with normal moisture than for cotton ginned with low moisture. The first-picked cotton made 3.89 percentage points less noils than the second-picked cotton. Approximately 80 percent of the variation in comber noils was associated with variation in percentage of fiber shorter than one-half inch or longer than one inch. This indicates that field treatments (with different levels of micronaire or fiber maturity) and ginning treatments (different drying and cleaning treatments) affected the amount of comber noils by changing fiber-length distribution.

From the producers' standpoint, the most profitable field and ginning conditions for the Acala 1517C variety of cotton grown in the El Paso area were normal defoliation, normal moisture, and minimum cleaning. From the spinner's standpoint, however, the best field and ginning conditions were no defoliation, normal moisture, and minimum cleaning. No defoliation, which produced lower grade cotton than normal defoliation, was best for the spinner but not for the producer. This suggests that market price differentials did not adequately reflect differences in spinning quality. From the standpoint of preserving inherent fiber quality, price differentials were excessive for grade, and not adequate for staple length.

EFFECTS OF DEFOLIATION, HARVESTING, AND GINNING PRACTICES ON MICRONAIRE READING, FIBER PROPERTIES, MANUFACTURING PERFORMANCE, AND PRODUCT QUALITY OF EL PASO AREA COTTON, SEASON 1960-61

By Preston E. LaFerney, Robert A. Mullikin, and Walter E. Chapman 1/

PROBLEMS AND OBJECTIVES

Mechanical harvesting of Acala 1517 cotton has increased substantially in recent years. This has created several problems in connection with both harvesting and ginning which can have an important effect upon cost of production. These problems involve the effects of varying defoliation practices, in combination with varying levels of lint moisture and gin cleaning conditions, on various fiber and spinning qualities.

Acala 1517 cotton is fine-fibered even when mature; this fineness is reflected in lower micronaire values than those of other varieties. 2/ An unusually short growing season, caused by a late start, an early frost, or defoliation, which retards fiber maturity, can further account for relatively low micronaire values. In addition to the long, fine-fibered Acala 1517C, a longer fibered strain with slightly higher micronaire values, Acala 1517D, has been developed. Breeders were largely responsible for developing this strain. It is similar to 1517C in all other respects, including its physiological characteristics.

Also involved in the problems associated with mechanical harvesting are the effects of variations in micronaire, grade, and staple length on market values of raw cotton and on costs of manufucturing cotton.

The primary objective of this study was to determine the effects of different defoliation, gin cleaning, and gin drying treatments, individually and in combination on several fiber, yarn, and processing variables, returns to producers, and costs of manufacturing. Secondary objectives were to compare first machine-picked (bottom- and middle-crop) cotton with second machine-picked (top-crop) cotton from the same plots and to compare first hand-picked cotton with first machine-picked cotton.

TESTING AND PROCEDURE

Source of Cotton

In this study, 69 bales of Acala 1517C variety cotton were tested. The cotton was grown near La Mesa, N. Mex., during the 1960-61 season. It was grown in a field which normally produces a homogeneous crop and was supposedly homogeneous at harvest, except for defoliation and harvesting treatments. Cultivation, irrigation, and fertilization were uniform over the entire field.

1/ Dr. LaFerney is an Agricultural Economist in the Economic Research Service; Mr. Mullikin and Mr. Chapman are Cotton Technologists in the Agricultural Research Service.

2/ Chapman, Walter E. Jr. Cotton Fiber Maturity and Fineness: Both Predicted Separately, Accurately, and Rapidly. Textile Res. Jour., vol. 31, No. 5, May 1961.

Harvesting and Ginning

The first-picked, or bottom- and middle-crop, cotton was harvested in October. A total of 60 bales were harvested, 54 machine picked and 6 hand picked. The mechanical picker, the tapered-spindle type, was carefully cleaned and adjusted prior to harvest. Water was used in the spindle-moistening system. Cotton samples from the field and from the gin were checked in the laboratory as soon as practical to determine the micronaire readings as affected by defoliation treatments. Because the range in micronaire values from these samples was narrow, an additional nine bales were later machine harvested from the same plots to obtain lower micronaire readings.

Weather conditions were uniform and nearly ideal for harvesting during mid-October. Picking was started in midmorning after the relative humidity had reached a stable level, in order to assure as nearly uniform seed-cotton moisture as possible.

The cotton was ginned at the Berino Cooperative Gin, Berino, N. Mex. The gin machinery setup was as follows:

Rock catcher
Separator
Tower drier
7-cylinder inclined cleaner
Stick-and-green-leaf machine
7-cylinder impact cleaner
Distributor
5 extractor-feeders
5 - 90-saw air blast gins
5 unit-type lint cleaners
Bulk saw-type lint cleaner
Flat-bale press

Drying was controlled manually by adjusting the inlet temperature in the tower drier. No heat was applied to cotton from the second picking which was harvested after frost.

Specific harvesting and ginning treatments were as follows:

Defoliation:

None: No defoliant applied.
Normal: Defoliant applied when 60 percent of the crop was open, or 14 days before harvest.
Premature: Defoliant applied when 10 percent of the crop was open, followed by a second application 1 week later. 3/

Cleaning: 4/

No. 1 - 1 lint cleaner and 2 seed cotton cleaners;
No. 2 - 2 lint cleaners and 2 seed cotton cleaners; and
No. 3 - 2 lint cleaners, 2 seed cotton cleaners, and 1 stick-and-leaf machine.

Drying (target levels):

Normal lint slide moisture: 4.5 to 5.0 percent;
Low lint slide moisture: 2.5 to 3.0 percent.

3/ Prematurely defoliated cotton was picked 1 week later than undefoliated or normally defoliated cotton, but no change in weather occurred during that time.
4/ For simplicity, cleaning treatments are subsequently referred to as cleaning No. 1, cleaning No. 2, and cleaning No. 3, or as C_1, C_2, and C_3.

Sampling

Each lot of seed cotton was sampled to determine seed-cotton moisture content, foreign matter content, and lint moisture content. The amount of moisture initially present in the lint was determined by ginning seed cotton on a laboratory size roller gin and measuring the lint moisture content. Subsequent oven lint moisture tests provided a basis for determining the amount of moisture removed by drying.

Samples of seed cotton were taken from the feeder apron just ahead of the gin stand to determine foreign matter and moisture content. Samples were taken from the lint slide to determine the amount of lint moisture after ginning.

Fiber and Spinning Tests

Procedures used in making fiber tests followed those outlined by the U.S. Department of Agriculture for service testing, except for the number of tests made per bale. 5/ In this study, the number of observations per bale were 8 for micronaire, 12 for Suter-Webb array, 16 for Fibrograph, and 24 for Pressley strength.

All lots of cotton in the study were processed identically from opening through spinning, except for changes made in comber settings before four of the bales were combed. Bale ties were broken before processing, which allowed the standard-density compressed bales to bloom and condition. A part of each bale was processed through the Pilot Plant as an individual lot and spun into 60s filling yarn. The remaining parts of each of the three bales representing a specific ginning and harvesting condition were blended in the opening room, processed as a composite, and spun into 60s warp yarn. Both warp and filling yarns were processed through the following organization:

Opening: 2 blender feeders, 1 lattice opener
Picking: 14-ounce lap; 2 section, 1-process picker
Carding: 50-grain sliver, 6.5 pounds per hour
Breaker drawing: 8 ends up, 50-grain sliver fed, 45-grain sliver delivered
Lap winding: 20 ends up, 45-grain sliver fed, 864-grain lap delivered
Combing: 864-grain lap fed, 50-grain sliver delivered
Finisher drawing: 8 ends up, 50-grain sliver fed, 55-grain sliver delivered
Slubber: 55-grain sliver fed, 1.60 hank roving delivered, 1.30 twist multiplier
Spinning: 1.60 hank roving fed, single creel, 60s yarn delivered, 3.90 twist multiplier, 12,000 spindle speed

The warp and filling yarn from each ginning condition was wound onto cones and delivered to the Textile Research Department of Clemson University for warping, quilling, slashing, weaving, finishing, and fabric testing.

METHOD OF ANALYSIS

The main part of the analysis involves the 54 bales of first-picked cotton which were mechanically harvested in October before frost. These bales were arranged

5/ U.S. Department of Agriculture, Agricultural Marketing Service, Cotton Division Instructions No. 918-8. Dec. 1958.

in a balanced statistical design in the field, at the gin, and in the spinning room. 6/ This phase of the analysis was designed to evalute the separate effects of field and ginning treatments, along with possible interaction effects, on fiber, yarn, and processing properties.

The planned split-plot analysis of variance was not appropriate for analyzing the data obtained in the test because lint-slide moisture could not be accurately controlled. Some normal-moisture lots had less moisture than some low-moisture lots. To overcome this problem, a multiple regression analysis was used. Technical aspects of the multiple regression analysis are discussed in appendix A.

In the second phase of the study, two direct comparisons were made: (1) Hand harvesting versus mechanical harvesting of undefoliated, first-picked (bottom-crop) cotton; and (2) first-picked (bottom-crop) versus second-picked (top-crop) cotton, with both lots mechanically harvested and subjected to cleaning setup No. 3 in the gin.

Effects of field and ginning treatments on bale values were studied in phase three through analysis of covariance, as explained in appendix A.

The combing operation was studied in the fourth phase. Effects of field and ginning treatments on percentage of comber noils and on comber-sliver evenness were evaluated through analysis of covariance. Effects of differences in selected fiber properties of ginned lint on comber noils were studied through correlation analysis. Net cost per pound of comber sliver was calculated from price and manufacturing waste data, and related to field and ginning treatments through analysis of covariance.

RESULTS

The detailed analyses of the data and many relevant statistics are presented in appendix B for use by those who may be interested in the more technical aspects of the study. In this section, results from all four phases of the investigation are arranged in a systematic manner and briefly discussed in view of specific questions or problems stated.

Phase One: Relation of Field and Ginning Treatments of Fiber, Yarn, and Processing Variables

The first phase of the study involved analyses of effects of field and ginning treatments on various fiber, yarn, and processing qualities. A total of 52 various measurements of cotton properties were obtained and related to the treatments. The mean values of the measured fiber, yarn, and processing properties resulting from specified treatments are given in table 1. Also, this table shows the results of the regression analyses which indicate differences that were statistically significant. Detailed statistics relevant to each of the 52 cases are given in appendix B.

Results of this phase of the study are discussed under four separate headings: defoliation, cleaning, defoliation x cleaning interactions, and moisture. Direction and magnitude of effects are discussed.

6/ Specifically, the design was split-plot in a randomized block, with lint slide moisture as main plot, cleaning as subplot, and defoliation as sub-subplot. The 3 blocks or replications were harvested on successive days.

Defoliation

Defoliation treatments significantly affected many fiber, yarn, or processing variables measured. Mean values of various properties are given in table 1 for each defoliation treatment, along with significance levels for differences.

Length measurements ranged from 1/32- to 1/16-inch greater for undefoliated than for defoliated cotton. Short-fiber content was about 1 percentge point less for undefoliated than for defoliated cotton at all stages of processing. Array coefficient of variation averaged about 1.7 percentage points lower for undefoliated than for defoliated cotton in card sliver, and about 1 percentage point higher for prematurely defoliated cotton than for other treatments in comber sliver. In the ginned lint, there were no differences in array coefficient of variation among defoliation treatments. Fiber strength was about 77,500 pounds for prematurely defoliated cotton, 84,000 pounds for normally defoliated cotton, and 81,000 pounds for undefoliated cotton at all stages of processing. Break factor was about 90 units lower for premature defoliation than for other defoliation treatments. Micronaire values of prematurely defoliated cotton averaged about 0.2 unit lower than that of other treatments. Yarn appearance index was about 6 points lower, and manufacturing waste 0.35 percentage point higher for premature defoliation than for other treatments.

Thus, both direction and magnitude of differences among defoliation treatments indicated that these treatments were highly related to many of the properties studied. Generally, defoliation appeared to be detrimental to length and length distribution. Premature defoliation was apparently detrimental to micronaire, fiber and yarn strength, and yarn appearance; and it produced more manufacturing waste.

Cleaning

Minimum cleaning which consisted of one lint cleaner and two overhead cleaners was consistently and significantly associated with greater length and better length distribution measurements in the ginned lint (table 1). However, most of these significant differences relating to length did not persist beyond the ginned lint, although there were scattered cases in which cleaning differences were important within a defoliation treatment in either card or comber sliver. In the ginned lint, length of cotton which received cleaning No. 1 was from 0.01- to 0.03-inch longer than for cotton receiving more cleaning. Array coefficient of variation was about 2 percentage points lower and short-fiber content about 1 percentage point lower for cotton which received cleaning No. 1. Thus, although there were, in the ginned lint, some adverse effects on length and length distribution associated with the addition of a second lint cleaner, the differences largely disappeared during opening, picking, and carding.

Although differences in fiber length characteristics disappeared before spinning, important differences among lots subjected to different cleaning practices showed up in processing variables. Yarn break factor was 35 to 50 units higher for cleaning No. 1 than for other cleaning treatments. Cleaning No. 1 also produced 20 to 30 fewer neps per 100 square inches of card web, about 0.13 percentage point more manufacturing waste, and about 0.40 percentage point more Shirley Analyzer waste than did other cleaning treatments. All these relationships were significant.

Defoliation x Cleaning Interactions

Interactions of defoliation or cleaning treatments with either of the moisture variables will be considered later with the effects of differences in lint slide moisture.

Table 1.--Average values for each defoliation and cleaning treatment, regression coefficients for lint slide moisture, and significance levels for effects of treatments on selected properties, 54 lots of cotton, New Mexico, 1960

Variable	Unit	Defoliation			Cleaning			Significance levels 1/			Reg. on lint slide moisture 2/
		None	Normal	Premature	C_1	C_2	C_3	Defol-iation	Clean-ing	Def. x Cleaning	
Moisture											
Fiber	Percent	8.96	6.98	6.79	7.46	7.74	7.54	**	NS	NS	--
Lint slide	do.	4.07	3.56	3.35	3.67	3.73	3.57	**	NS	NS	--
Ginned lint											
Grade	Index	99.167	101.778	100.333	99.000	100.944	101.333	*	3/*	NS	-0.548
Staple length	32d in.	36.056	35.833	35.500	36.167	35.444	35.778	NS	3/*	*	.178
Shirley Analyzer waste	Percent	1.922	1.509	1.661	1.972	1.567	1.553	3/*	3/*	*	.114
Array:											
Upper quartile length	Inch	1.361	1.327	1.337	1.348	1.337	1.340	*	NS	*	.005
Mean length	do.	1.141	1.102	1.103	1.132	1.105	1.109	*	*	NS	.012
Fibers > 1"	Percent	75.6	71.8	71.8	75.0	72.2	72.1	*	3/*	NS	1.316
Fibers < ½"	do.	6.74	7.49	7.87	6.62	7.67	7.82	3/*	*	NS	- .425
Coefficient of variation 5/	do.	28.2	29.2	29.7	27.8	29.5	29.8	*	**	NS	- .593
Fibrograph:											
Upper half mean	Inch	1.213	1.168	1.174	1.198	1.178	1.179	*	*	*	.006
Mean length 5/	do.	.996	.940	.942	.974	.958	.946	**	**	**	.007
Uniformity ratio	Percent	81.9	80.5	80.3	81.3	81.2	80.2	*	NS	*	--
Strength (Pressley):											
0" gauge	1,000 PSI	81.2	84.3	78.3	81.4	80.9	81.5	*	NS	NS	--
1/8" gauge	Gr/tex	23.56	24.39	23.15	23.85	23.72	23.53	3/*	NS	*	.271
Micronaire: 5/	Reading	3.57	3.67	3.47	3.59	3.57	3.55	**	NS	NS	--
Card sliver											
Array:											
Upper quartile length	Inch	1.337	1.295	1.311	1.313	1.317	1.313	*	NS	NS	.014
Mean length	do.	1.074	1.031	1.035	1.048	1.050	1.043	*	NS	NS	.018
Fibers > 1"	Percent	67.3	62.9	62.6	64.9	64.1	63.8	*	3/*	NS	1.876
Fibers < ½"	do.	9.70	10.86	11.23	10.63	10.43	10.72	3/*	NS	NS	- .724
Coefficient of variation	do.	32.4	33.7	34.5	33.5	33.3	33.8	*	NS	*	- .858
Card sliver											
Fibrograph:											
Upper half mean	Inch	1.187	1.146	1.148	1.164	1.158	1.159	3/*	NS	*	.011
Mean length	do.	.935	.902	.896	.914	.908	.911	3/*	3/*	*	.015
Uniformity ratio	Percent	78.8	78.7	78.1	78.4	78.5	78.6	NS	NS	*	.685
Strength (Pressley):											
0" gauge	1,000 PSI	80.9	84.3	78.3	81.0	81.4	81.1	*	NS	*	1.028
1/8" gauge	Gr/tex	24.04	24.59	23.36	24.23	23.84	23.92	*	NS	*	.183
Micronaire:	Reading	3.66	3.69	3.47	3.58	3.61	3.62	*	NS	NS	--
Comber sliver											
Array:											
Upper quartile length	Inch	1.337	1.303	1.308	1.320	1.313	1.316	*	NS	*	.012

Table 1.--Average values for each defoliation and cleaning treatment, regression coefficients for lint slide moisture, and significance levels for effects of treatments on selected properties, 54 lots of cotton, New Mexico, 1960--Continued

Variable	Unit	Defoliation: None	Defoliation: Normal	Defoliation: Premature	Cleaning: C_1	Cleaning: C_2	Cleaning: C_3	Significance levels 1/: Defoliation	Significance levels 1/: Cleaning	Significance levels 1/: Def. x Cleaning	Reg. on lint slide moisture 2/
Mean length	do.	1.110	1.084	1.080	1.095	1.089	1.091	*	NS	*	0.010
Fibers > 1"	Percent	70.8	67.9	67.2	69.3	68.2	68.4	*	NS	*	1.316
Fibers < ½"	do.	5.68	5.60	6.39	5.86	5.79	6.02	*	NS	NS	- .296
Coefficient of variation	do.	27.8	27.6	28.7	28.0	27.9	28.2	3/*	NS	NS	- .279
Fibrograph:											
Upper half mean	Inch	1.203	1.172	1.170	1.188	1.179	1.178	3/*	NS	*	.006
Mean length	do.	.974	.956	.946	.968	.955	.952	NS	NS	*	--
Uniformity ratio 6/	Percent	81.0	81.4	80.8	81.5	81.0	80.7	NS	NS	**	--
Strength (Pressley):											
0" gauge	1,000 PSI	80.9	82.5	77.2	80.7	79.5	80.4	*	NS	*	--
1/8" gauge	Gr/tex	24.52	25.11	23.65	24.74	24.23	24.31	*	*	NS	--
Micronaire	Reading	3.86	3.89	3.69	3.81	3.83	3.82	*	NS	*	--
Comber noils											
Array:											
Upper quartile length	Inch	.807	.784	.773	.801	.796	.768	4/*	NS	*	--
Mean length	do.	.587	.573	.566	.579	.583	.563	4/*	NS	*	--
Fibers > 1"	Percent	15.6	13.8	13.6	15.0	14.8	13.3	4/*	NS	*	--
Fibers < ½"	do.	50.02	51.12	52.30	50.52	50.58	52.33	4/*	NS	*	--
Coefficient of variation	do.	58.61	57.83	58.72	58.94	57.94	58.28	NS	NS	*	--
Micronaire	Reading	2.83	2.83	2.68	2.77	2.78	2.78	*	NS	*	--
Processing data											
Manufacturing waste	Percent	6.373	5.993	6.529	6.235	6.344	6.316	*	NS	NS	.211
Neps, card web	Number	55.3	54.2	71.3	44.7	64.4	71.8	*	3/*	*	--
Comber noils 5/	Percent	12.46	13.38	13.44	12.79	13.24	13.25	**	*	NS	- .403
EDMSH (corrected)	Number	20.1	17.8	22.1	20.1	18.2	21.8	NS	NS	*	--
Break factor 5/	Unit	2348.	2331.	2250.	2337.	2289.	2302.	**	**	NS	63.124
Yarn appearance	Index	91.1	92.8	85.0	94.4	87.8	86.7	*	NS	*	--

1/ Significance levels for the 2 moisture variables were determined by split-plot analysis of variance. For all other variables, stepwise multiple regression was used to establish the significance levels shown, except as explained in footnote 5.

2/ Lint slide moisture was considered as a continuous variable. The coefficient for regression on lint slide moisture shows the estimated unit change in a given property which was associated with 1-percent increase in lint slide moisture when effects of other significant variables are considered.

3/ Interaction of fiber (roller ginned lint) moisture with defoliation or cleaning was significant, and indicated that significant differences existed among defoliation or cleaning treatment means, respectively.

4/ Fiber moisture was shown to have a significant effect, but primarily represented the effect of defoliation treatments.

5/ Due to interactions of moisture variables, analysis of covariance was used to determine significance levels (appendix A). 6/ Because of mechanical error, no regression analysis was obtained. Results reported in this table are from analysis of covariance (appendix A).

** Significant at the 99-percent confidence level. * Significant at the 95-percent confidence level. NS Not statistically significant at the 95-percent confidence level.

In this section, the remaining interaction variables, which involved cleaning x defoliation, are briefly discussed. If any defoliation x cleaning combination produced a value of fiber, yarn, or processing variable which was significantly greater or smaller than other cotton, the defoliation x cleaning column of table 1 contains an asterisk to indicate that at least one such combination was significantly different from others. To determine which of the nine possible interaction terms were significantly different from the rest, see appendix B, table 6.

Each of these interactions was evaluated on the basis of the six lots which received the particular defoliation x cleaning combination in question. They were intended to indicate those cases in which cotton receiving a given defoliation treatment responded differently to the various cleaning treatments.

Some of the directions of effect indicated by significant interactions are not consistent with other findings. For example, the significant interaction between premature defoliation and cleaning treatment 3 for upper quartile length of ginned lint showed that prematurely defoliated cotton given cleaning No. 3 was significantly longer than prematurely defoliated cotton given cleaning No. 2 or normally defoliated cotton given cleaning No. 3. This is not consistent with the other findings of the test concerning the effects of defoliation and cleaning. Since a 5-percent probability of a wrong indication of signficance was allowed in the test and only six bales of cotton were observed in evaluating a given defoliation x cleaning interaction, perhaps some of the interactions that were due to allowable or random error were shown to be significant.

Concerning the entire test, there is insufficient evidence to indicate that response to the various cleaning treatments was consistently different between undefoliated and defoliated cotton.

Moisture

Fiber (roller-ginned lint) moisture content of cotton arriving at the gin ranged from 4.4 to 12.4 percent in the 54 test lots. Undefoliated cotton averaged 9.0 percent in fiber moisture content, normally defoliated cotton, 7.0 percent, and prematurely defoliated cotton, 6.8 percent (table 1). Thus, initial moisture level differed substantially and significantly between defoliated and undefoliated cotton. In fact, 32 percent of the variation in fiber moisture was explained by the defoliation treatments. For this reason, any relationship between differences in fiber moisture level and any fiber, yarn, or processing property reflected to a considerable extent a relationship between defoliation and the property.

Fiber moisture content of cotton as it arrived at the gin was significantly related to only 8 of the 52 cotton properties studied. Six of them involved measurements of comber-noil properties and the rest micronaire measurements (including micronaire of comber noils). In every instance, it appeared that the effects on micronaire and on comber noil properties attributed to differences in initial moisture level arose largely through the different defoliation treatments. The significant positive relationship between initial moisture and micronaire apparently reflected the high-micronaire, high-moisture combination in undefoliated cotton and the low-micronaire, low-moisture conbination in the prematurely defoliated cotton. The noils combed from undefoliated cotton were longer and more uniform in length than noils from defoliated cotton (particularly, prematurely defoliated cotton). This was expected, since undefoliated cotton was shown to be longer and of better length distribution than other cotton. The several significant interactions involving defoliation and initial moisture are also considered to reflect, primarily, effects of defoliation treatments.

Differences in the level of lint slide moisture were significantly related to many of the fiber, yarn, and processing properties (table 1). This indicates that drying was significantly related to many properties studied. Most measurements of fiber length, fiber length distribution, fiber strength before combing, grade index, yarn break factor, and manufacturing waste were significantly related to differences in lint slide moisture content. Directions of all significant relationships were logical; drying was detrimental to fiber length and length distribution and to fiber and yarn strength. Higher grade index and less manufacturing waste were produced through additional drying.

The magnitudes of differences related to drying were not large for most properties. A reduction of 1 percentage point in lint slide moisture decreased the various measurements of length by 0.015- to 0.005-inch, increased the array coefficient of variation and the percentage of short fiber by an average of 0.5 percentage point, decreased break factor by 63 units, decreased manufacturing waste by 0.21 percentage point, and decreased total Shirley Analyzer waste content of ginned lint by 0.11 percentage point. These relatively small differences were probably due, in part, to the fact that all cotton tested was dried to some extent. Lint slide moisture ranged from 2.2 to 4.7 percent for low-moisture lots and 3.8 to 5.6 percent for normal-moisture lots. The mean levels were 2.9 and 4.4 percent.

The changes in length and length distribution of fibers associated with a percentage-point change in lint slide moisture showed a strong tendency to be larger in card sliver than in ginned lint or in comber sliver. This is of considerable interest. It indicates that opening, picking, and carding broke more fibers in cotton ginned with low lint slide moisture than in cottons less severely dried, producing stronger relationships between drying and length or length distribution in card sliver, and that the comber was effective in removing more short fibers from the low-moisture cotton.

Although some of the differences observed for drying treatments were fairly small, they were statistically significant for many properties studied, consistent for all significant properties, and logically sound in direction of association.

There were a few significant interactions involving moisture. They revealed no strong, consistent patterns to indicate that drying was, as a rule, more detrimental to defoliated than to undefoliated cotton, or to cotton which received more cleaning during ginning.

Phase Two: Comparisons of Hand Versus Machine and First Versus Second Harvest

Fifteen additional bales were added to the original 54 bales in order to obtain comparisons of effects of hand versus mechanical harvesting and of first versus second picking. Table 2 contains mean values for several treatment combinations, but the more meaningful averages, along with levels of significance for the differences between means, are given in table 3.

Table 2.--Average fiber and yarn properties of first machine-picked, first hand-picked, and second machine-picked cotton, by type of defoliation treatment, New Mexico, 1960

Variable	Unit	First machine-picked: No defoliation	First machine-picked: Normal defoliation	First machine-picked: Premature defoliation	First hand-picked: No defoliation	Second machine-picked: No defoliation	Second machine-picked: Normal defoliation	Second machine-picked: Premature defoliation
Micronaire:								
Ginned lint	Reading	3.57	3.67	3.47	3.60	2.87	2.70	2.40
Card sliver	do.	3.66	3.69	3.47	3.60	2.90	2.70	2.43
Comber sliver	do.	3.86	3.89	3.69	3.80	3.07	2.87	2.60
Moisture:								
Seed cotton:								
Wagon sample	Percent	10.39	7.94	7.93	7.21	5.70	5.97	6.27
Feeder sample	do.	8.83	6.45	6.54	6.53	5.63	5.87	6.23
Roller-ginned lint	do.	8.96	6.98	6.79	5.80	4.68	4.84	5.19
Lint slide	do.	4.07	3.56	3.35	3.53	4.34	4.61	4.88
Array:								
Short fiber:								
Ginned lint	do.	6.74	7.49	7.87	7.50	11.80	12.47	15.33
Card sliver	do.	9.70	10.86	11.23	10.28	17.40	17.53	21.17
Comber sliver	do.	5.68	5.60	6.39	5.67	9.20	11.47	13.53
Upper quartile length:								
Ginned lint	Inch	1.361	1.327	1.337	1.346	1.287	1.293	1.283
Card sliver	do.	1.337	1.295	1.311	1.325	1.227	1.240	1.220
Comber sliver	do.	1.337	1.303	1.308	1.332	1.240	1.240	1.220
Mean length:								
Ginned lint	do.	1.141	1.102	1.103	1.120	1.017	1.010	.977
Card sliver	do.	1.074	1.031	1.035	1.055	.930	.927	.883
Comber sliver	do.	1.110	1.084	1.080	.965	1.000	.973	.947
Coefficient of variation:								
Ginned lint	Percent	28.22	29.22	29.72	29.33	34.67	36.00	38.67
Card sliver	do.	32.44	33.67	34.50	33.33	40.00	40.67	43.33
Comber sliver	do.	27.78	27.61	28.67	27.67	31.67	34.00	36.33
Fibrograph:								
Upper-half mean:								
Ginned lint	Inch	1.213	1.168	1.174	1.187	1.123	1.133	1.090
Card sliver	do.	1.187	1.146	1.148	1.162	1.063	1.077	1.033
Comber sliver	do.	1.203	1.172	1.170	1.187	1.113	1.103	1.070
Mean length:								
Ginned lint	Inch	.996	.940	.942	.950	.860	.850	.793

Table 2.--Average fiber and yarn properties of first machine-picked, first hand-picked, and second machine-picked cotton, by type of defoliation treatment, New Mexico, 1960--Continued

Variable	Unit	First machine-picked			First hand-picked	Second machine-picked		
		No defoliation	Normal defoliation	Premature defoliation	No defoliation	No defoliation	Normal defoliation	Premature defoliation
Card sliver	Inch	0.935	0.902	0.896	0.927	0.783	0.787	0.730
Comber sliver	do.	.974	.956	.946	.965	.867	.840	.813
Uniformity ratio:								
Ginned lint	Percent	81.94	80.50	80.33	79.67	76.33	74.67	72.33
Card sliver	do.	78.78	78.67	78.06	79.67	74.00	73.00	70.67
Comber sliver	do.	81.00	81.44	80.78	81.17	78.00	76.00	75.67
Pressley strength:								
0" gauge:								
Ginned lint	1,000PSI	81.22	84.30	78.30	81.17	79.33	81.67	80.33
Card sliver	do.	80.89	84.30	78.30	80.83	80.33	82.00	79.33
1/8" gauge:								
Ginned lint	Gr/Tex	23.56	25.39	23.15	23.58	23.90	24.90	25.23
Card sliver	do.	24.04	24.59	23.36	24.35	23.83	25.17	25.23
Comber sliver	do.	24.52	25.11	23.65	24.13	24.10	25.13	25.13
Processing data:								
Manufacturing waste	Percent	6.370	5.993	6.529	6.048	7.59	7.59	9.86
Neps, card web	Number	55.33	54.22	71.27	63.00	117.67	203.67	525.67
Comber noils	Percent	12.46	13.38	13.44	12.93	15.87	14.80	20.77 *
EDMSH (corrected)	Number	20.13	17.84	22.12	21.92	52.5	44.1	109.0
Break factor	Unit	2347.7	2330.7	2250.0	2338.0	2152.0	2142.0	2088.0
Yarn appearance	Index	91.11	92.78	85.00	90.00	60.00	60.00	60.00

* Comber set at 16-3/4 retraction timing.

Table 3.--Average properties of first machine-picked, first hand-picked, and second machine-picked cotton with significance of differences, New Mexico, 1960

Item	Unit	18 undefoliated lots 1/	6 FHP lots 2/	Level of significance	18 lots, cleaning No. 3 1/	9 SMP lots 3/	Level of significance
Array data:							
Upper quartile length:							
Ginned lint	Inch	1.361	1.346	NS	1.340	1.288	**
Card sliver	do.	1.337	1.325	NS	1.313	1.229	**
Comber sliver	do.	1.337	1.332	NS	1.316	1.233	**
Mean length:							
Ginned lint	do.	1.141	1.120	NS	1.109	1.001	**
Card sliver	do.	1.074	1.055	NS	1.043	.913	**
Comber sliver	do.	1.110	1.105	NS	1.091	.973	**
Coefficient of variation:							
Ginned lint	Percent	28.22	29.33	NS	29.80	36.44	**
Card sliver	do.	32.44	33.33	NS	33.80	41.33	**
Comber sliver	do.	27.78	27.67	NS	28.20	34.00	**
Short fibers:							
Ginned lint	do.	6.74	7.50	NS	7.82	13.20	**
Card sliver	do.	9.70	10.28	NS	10.72	18.70	**
Comber sliver	do.	5.68	5.67	NS	6.02	11.40	**
Servo fibrograph data:							
Upper half mean:							
Ginned lint	Inch	1.213	1.187	NS	1.179	1.116	**
Card sliver	do.	1.187	1.162	*	1.159	1.058	**
Comber sliver	do.	1.203	1.187	NS	1.178	1.096	**
Mean length:							
Ginned lint	do.	.996	.950	*	.946	.834	**
Card sliver	do.	.935	.927	NS	.911	.767	**
Comber sliver	do.	.974	.965	NS	.952	.840	**
Uniformity ratio:							
Ginned lint	Percent	81.94	79.67	NS	80.20	74.44	**
Card sliver	do.	78.78	79.67	NS	78.60	72.56	**
Comber sliver	do.	81.00	81.17	NS	80.70	76.56	**
Micronaire:							
Ginned lint	Reading	3.57	3.60	NS	3.55	2.66	**
Card sliver	do.	3.66	3.60	NS	3.62	2.68	**
Comber sliver	do.	3.86	3.80	NS	3.82	2.84	**
Pressley strength:							
0" gauge:							
Ginned lint	1,000 PSI	81.22	81.17	NS	81.50	80.44	NS
Card sliver	do.	80.89	89.83	NS	81.10	80.56	NS
Comber sliver	do.	80.94	82.50	NS	80.40	79.22	NS

Table 3.--Average properties of first machine-picked, first hand-picked, and second machine-picked cotton with significance of differences, New Mexico, 1960--Continued

Item	Unit	18 undefoliated lots 1/	6 FHP lots 2/	Level of significance	18 lots, cleaning No. 3 1/	9 SMP lots 3/	Level of significance
1/8" gauge:							
Ginned lint	Gr/tex	23.56	23.58	NS	23.53	24.68	**
Card sliver	do.	24.04	24.35	NS	23.92	24.74	*
Comber sliver	do.	24.52	24.13	NS	24.31	24.79	NS
Processing data:							
Manufacturing waste	Percent	6.370	6.048	NS	6.316	8.346	**
Neps, card web	Number	55.33	63.00	NS	71.78	282.22	**
Comber noils	Percent	12.46	12.93	NS	13.25	17.14	**
EDMSH (corrected)	Number	20.13	21.90	NS	21.82	68.53	**
Break factor	Unit	2347.67	2338.00	NS	2302.00	2127.33	**
Yarn appearance	Index	91.11	90.00	NS	86.67	60.00	**

1/ First machine-picked lots.
2/ FHP: First hand-picked lots.
3/ SMP: Second machine-picked lots.
* Significant at the 95-percent confidence level.
** Significant at the 99-percent confidence level.
NS Not statistically significant at the 95-percent confidence level.

Hand Versus Mechanical Harvesting

It is obvious from a study of the average fiber, yarn, and processing properties of hand-picked and machine-picked lots that there were few real differences due to method of harvesting.

First Versus Second Harvest

Table 2 reveals two important findings: (1) For practically all fiber quality variables considered, large differences occurred between first and second picking in the same plots; and (2) the combination of premature defoliation and second picking (top crop of plants) further accentuated the lack of maturity and resulting detrimental effects on all fiber length and processing measurements.

Table 3 shows that all fiber length and micronaire measurements for ginned lint, card sliver, and comber sliver and all processing results differed significantly between first and second harvest (99-percent confidence level). The 1/8-inch gauge Pressley strength measurements are the only exceptions. First- and second-picked cottons should not be mixed in order to avoid producing bales containing widely varying fiber properties.

Phase Three: Relation of Field and Ginning Treatments to Bale Weights, Price per Pound, and Bale Value

Drying and cleaning practices usually improve grades of cotton but reduce bale weights as moisture, trash, and lint are removed. Defoliation treatments significantly affected grade and nonlint content. The net effect of such practices may be either to increase or to reduce bale values, depending on the balance of grade improvement, weight losses, and prices per pound.

It was impossible to actually measure the amounts of trash and lint removed from each bale during ginning. Therefore, the losses in weight were estimated by considering nonlint content and the lint slide moisture content. Cotton which received the least drying, no defoliation, and the minimum cleaning had the highest gross bale weight, including moisture and nonlint content, after ginning. The average weight of the three replications of this condition was adjusted to 500 pounds and served as a base for the index of bale weights. Bale weights for cotton which received cleaning No. 2 or No. 3 were reduced by 3 pounds to account for loss of lint through the second lint cleaner.

Comparisons of effects of various experimental treatments on bale weights, prices, and bale values for the 54 bales of cotton mechanically harvested before frost are shown in appendix B, table 7. These data are averages of three replications. Statistical tests of differences were made through analysis of convariance (appendix A). The relationships of different treatments to bale values are briefly discussed below. These data show only values to producers; they do not relate to manufacturing quality of the cotton.

Drying

Although additional drying resulted in slightly improved grades of cotton, bale weights were reduced substantially. At the prices prevalent in the El Paso, Tex., market during November 1960 and November 1963, grade improvement and resulting increases in price per pound were not sufficient to offset the losses in weight. The drier cotton had lower values per bale as follows:

Date	Value of bale (dollars) Normal lint slide moisture	Low lint slide moisture	Difference
November 1960	163.80	161.62	2.18 **
November 1963	180.91	177.97	2.94**

** Significant at the 99-percent confidence level.

Average bale values show that the net effect of differences in grade and weight losses was $2.18 in terms of November 1960 prices and $2.94 in terms of November 1963 prices in favor of normal-moisture cotton.

Since cotton containing normal moisture produced significantly higher bale values than cotton with low moisture, the 27 lots ginned with normal moisture were analyzed by covariance to determine effects of drying, defoliation, and cleaning on bale values. If lint slide moisture were reduced 1 unit, value per bale was reduced $4.92 under November 1960 prices. This reduction was significant at the 95-percent confidence level. Under November 1963 prices, the reduction was $4.88 per bale for each unit decrease in moisture and was significant at the 90-percent confidence level. Even within the 27 bales of cotton containing normal moisture, drying was clearly detrimental to bale value.

Defoliation

Since the interacting effects of defoliation and cleaning on bale values were not significant in the covariance analyses, effects of defoliation and cleaning are discussed separately.

Average bale values using El Paso, Tex., prices for defoliation treatments after adjustment for differences in lint slide moisture for 27 bales were as follows:

Date	Value per bale (dollars), defoliation: None	Normal	Premature	Difference required, 95-percent confidence
November 1960	161.20	166.78	163.36	3.10
November 1963	179.89	182.99	179.81	4.00

The only significant differences due to defoliation treatments were the greater average bale value of normally defoliated cotton than of undefoliated or prematurely defoliated cotton under 1960 prices. Using 1963 prices, none of the differences associated with defoliation treatments were significant.

Cleaning

The following tabulation shows that none of the differences in bale value associated with different cleaning treatments were statistically significant for the 27 bales.

Date	Value per bale (dollars) C_1	C_2	C_3	Difference required, 95-percent confidence
November 1960	162.78	163.14	165.46	3.10
November 1963	181.24	179.46	182.07	4.00

Even the apparent difference of $2.68 between cleaning No. 1 and No. 3 at 1960 prices was not statistically significant.

In summary, the combination of treatments found in this study to be most profitable to the producer, ignoring unknown effects on yields and harvesting costs, was normal defoliation, normal moisture, and minimum cleaning.

Phase Four: Relation of Combing Performance to Field and Ginning Treatments and Fiber Properties

Although some combing data were analyzed in phase one, combing was performed and handled separately. The Textile Research Department of Clemson University did the combing work and gave a formal report.

The test cotton was combed in order to evaluate the effects of field, harvesting, and ginning conditions on comber-processing waste and quality of sliver produced. Two variables, Uster evenness of comber sliver and percentage of comber noils, were measured in order to evaluate the relationships between the combing process and the specified field and ginning treatments and resultant fiber properties. Evenness of comber sliver was not significantly related to any treatment, other than time of harvest. Comber sliver from the second machine-picked cotton was significantly less even than that from first machine-picked cotton.

Percent Noils Related to Field and Ginning Treatments

Percentage of comber noils was significantly related to all the experimental treatments and to several fiber properties of ginned lint and card sliver. The analysis, based on the 54 lots, reveals that comber noils increased 0.4 percentage point with every 1-percentage point decrease in lint slide moisture, and that the relationship was highly significant (table 4). Undefoliated cotton was associated with 0.7 percentage point less comber noils than defoliated cotton. Cotton with cleaning treatment No. 1 was associated with 0.45 percentage point less noils than cotton with more cleaning, after adjustment was made for differences in lint slide moisture.

Percent Noils Related to Selected Fiber Properties

Variation in percent comber noils was related to selected measurements of fiber properties in the ginned lint. These relationships were established through simple correlation analyses. The coefficients of simple correlation and determination were as follows: -

	r	$r^2 \times 100$
Upper quartile length (inches)	-0.64 **	41
Mean length (inches)	- .81 **	66
Coefficient of variation (percent).	- .75 **	56
Fibers >1" (percent)	- .83 **	69
Fibers <1/2" (percent).	- .78 **	61
Micronaire (reading)	- .33 *	11
1/8" gauge strength (gr/tex)	- .16 NS	3

Note: **Significant at 99-percent confidence.
* Significant at 95-percent confidence.
NS Not significant at 95-percent confidence.

The significant relationships indicate that less comber noils was produced from longer, more uniform, or more mature cotton. The relationships of comber noils to fiber measurements in card sliver were not significantly different from those listed above for ginned lint, and they are not discussed separately.

Although the correlations of the different measurements of length and length distribution with percent comber noils did not differ significantly, percentage of fiber longer than 1 inch happened to give the highest correlation. Furthermore, combing the percentage of fiber shorter than one-half inch or coefficient of variation with percentage of fiber longer than 1 inch in a multiple correlation analysis failed to improve the simple correlation coefficient of -0.83. This failure was due to the extremely high correlations, -0.92 and -0.90, of percentage of fiber longer than 1 inch with percentage of fiber shorter than one-half inch and coefficient of variation, respectively. Micronaire and fiber strength were not significantly related to percent comber noils after effects of other variables were considered, although the simple coefficient for micronaire (-0.33) was significantly different from zero at 95-percent confidence.

Thus, it appears that the significant relationships of drying, defoliation, and cleaning treatments to percent comber noils primarily arose through variations in percentage of fiber longer than 1 inch (or shorter than one-half inch) introduced through field and ginning treatments. All these experimental treatments were shown in table 1 to significantly affect the fiber length distribution of the ginned lint.

Comparisons of Average Fiber Properties of Card Sliver, Comber Sliver, and Comber Noils

The average array measurements of fiber length for all 54 lots tested are given in table 5 for card sliver, comber sliver, and comber noils. The upper quartile length and the percentage of fiber 1/2- to 1-inch did not differ significantly between card sliver and comber sliver. The combing process increased the mean length from 1.05 to 1.09 inches, decreased the coefficient of variation from 34 to 28 percent, decreased fiber shorter than one-half inch from 10.6 to 5.9 percent, and increased the fiber 1 inch long and longer from 64.3 to 68.5 percent. Since the upper quartile length was the same for card sliver and comber sliver, these data indicate that the reduction in short fiber caused the higher mean length and the lower coefficient of variation in the comber sliver.

The array measurements of fiber length for comber noils show that about half the fibers by weight were shorter than one-half inch. These data indicate that the

Table 4.--Analysis of variance (randomized complete block with a covariate) for percent comber noils (y), New Mexico, 1960

Source of variation	df	Original sums: Σx^2	Original sums: Σxy	Original sums: Σy^2	df	Adjusted results: s.s.	Adjusted results: m.s.	Adjusted results: F
Total	53	43.6876	-23.0932	37.2083	--	--	--	--
Rep	2	.4499	- .4223	.8344	--	--	--	--
Defoliation	2	4.9274	- 7.1306	10.8700	--	--	--	--
Cleaning	2	.2330	- .1103	2.5211	--	--	--	--
Def. x cleaning	4	.0727	- .1275	.9455	--	--	--	--
Residual error	43	38.0046	-15.3025	22.0373	42	15.8758	.3780	--
Reps + error	45	38.4545	-15.7248	22.8717	44	16.4415	--	--
Adjusted reps	--	--	--	--	2	.5657	.2828	.7481NS
Def. + error	45	42.9320	-22.4331	32.9073	44	21.1854	--	--
Adjusted def	--	--	--	--	2	5.3096	2.6548	7.0233**
Clean. + error	45	38.2376	-15.4128	24.5584	44	18.3458	--	--
Adjusted clean	--	--	--	--	2	2.4700	1.2350	3.2672*
DC + error	47	38.0773	-15.4300	22.9828	46	16.7301	--	--
Adjusted DC	--	--	--	--	4	.8543	.2136	.5651NS
Effect of lint slide moisture (x)								
Due to regression on LSM					1	6.1615	6.1615	16.3003**
Deviations from regression					42	15.8758	.3780	--
Total					43	22.0373	--	--

$$b_{xy} = \frac{-15.3025}{38.0046} = -0.402649$$

$$SSR = b\ xye = (-0.402649)\ (-15.3025) = 6.1615$$

* Significant at 5-percent level.
** Significant at 1-percent level.
NS Not statistically significant at the 95-percent confidence level.

Treatment means adjusted for lint slide moisture

Defoliation

None		Normal	Premature
12.63	<	13.34	13.32

Cleaning

C_1		C_2	C_3
12.80	<	13.27	13.22

Test for significance

95-percent confidence level:

Standard error of mean = $\sqrt{\frac{.378}{18}} = 0.145$

Factor, Duncan's range =	2.86	3.01
Difference required for significance :	0.42	0.44

comber removed a large portion of the long fiber. They also indicate that combing added to the short-fiber content through fiber breakage, as shown below:

	Per 100 pounds of card sliver
Short fiber in card sliver (average of 54 lots)	10.6 pounds
Comber noils.	13.1 pounds
Percent of comber noils shorter than 1/2-inch.	51.1 percent
Short fiber removed by comber (0.511 x 13.1)	6.7 pounds
Short fiber in comber sliver (no breakage: 10.6 - 6.7).	3.9 pounds
Shorter fiber in comber sliver (0.059 x 86.9).	5.1 pounds
Increase in short fiber due to breakage	1.2 pounds

Thus, in removing the 6.7 pounds of fiber shorter than one-half inch from 100 pounds of card sliver, an estimated additional 1.2 pounds of short fiber were created. This left the short-fiber content of comber sliver greater than 3.9 pounds and reduced the average length of fibers to something less than it would have been without the fiber breakage in combing.

Although there were no significant differences between micronaire readings of ginned lint and card sliver within any cleaning or defoliation treatment, there were highly significant differences between micronaire readings of card sliver and comber sliver. Table 5 shows that the comber was effective in removing fine, immature fibers. The thin-walled (low micronaire) fibers are more easily broken in processing and tend to be removed as short fibers in comber noils. This probably helps to explain why combing usually improves the yarn appearance.

Net Cost per Pound of Comber Sliver

Ignoring quality of comber sliver produced by each of the field and ginning treatments, costs per pound of comber sliver were computed to obtain relative net prices per pound paid by manufacturers. By subtracting the percentage of total manufacturing waste and 4.4-percent waste for bagging and ties from 100 percent of ginned lint purchased in a bale of cotton, the percentage yield of card sliver was obtained. This yield was multiplied by 100 percent minus percent comber noils to obtain the percentage turnout of comber sliver from a pound of raw cotton. The price per pound of ginned lint was divided by this turnout percentage to obtain the net cost per pound of comber sliver. These data for yield, price, and net cost are shown in appendix B, table 8.

As shown in the following table, moisture content at the time of ginning had no significant effect on net cost per pound of comber sliver at either 1960 or 1963 prices. A difference of about 0.45 cent per pound was required for significance at the 90-percent confidence level.

El Paso, Tex., prices on specified dates	Average net cost per pound of comber sliver with lint slide moisture level--		Difference
	Normal	Low	
	Cents	Cents	Cents
November 1960.	42.59	42.85	0.26NS
November 1963.	47.04	47.19	.15NS

NS Not statistically significant at the 90-percent confidence level.

Table 5.--Average fiber properties of card sliver, comber sliver, and comber noils, 54 lots of cotton, New Mexico, 1960

Property	1 Card sliver	2 Comber sliver	3 Difference cols. 1 & 2	4 Comber noils 1/
Suter-Webb array:				
Upper quartile length.....inch	1.31	1.32	0.01NS	0.79
Mean length.....do	1.05	1.09	.04**	.58
Coefficient of variation..percent	34.0	28.0	6.0 **	58.0
Fibers< $\frac{1}{2}$".....do	10.6	5.9	4.7 **	51.1
Fibers $\frac{1}{2}$" to 1".....do	25.1	25.5	.4 NS	34.5
Fibers> 1".....do	64.3	68.6	4.3 *	14.4
Micronaire reading	3.60	3.82	.22**	2.78

1/ Average noils removed was 13.1 percent.
NS Not significant.
* Significant at 95-percent confidence level.
** Significant at 99-percent confidence level.

Although moisture did not significantly affect net costs, a separate analysis was made of the 27 bales ginned with normal moisture. This was considered to afford the appropriate comparisons, since average bale value was significantly higher for cotton containing normal moisture than for cotton with low moisture.

Within the 27 bales containing normal lint slide moisture, differences in moisture level had no effect on net cost per pound of comber sliver, given either set of prices.

Defoliation had a significant effect on net cost per pound of comber sliver only under 1960 prices, as shown below.

El Paso, Tex., prices on specified dates	Average net cost per pound of comber sliver, defoliation--			Difference required, 90-percent confidence
	None	Normal	Premature	
	Cents	Cents	Cents	Cents
November 1960	41.98	43.28	42.52	0.67
November 1963	46.79	47.50	46.83	.79

Given the 1960 prices, normally defoliated cotton produced comber sliver at significantly higher cost per pound than did undefoliated or prematurely defoliated cotton. At 1963 prices, there was no significant difference associated with defoliation.

Similarly, cleaning treatments produced significant differences only under 1960 prices as shown below. Given the 1960 prices, cleaning No. 1 produced cotton which was significantly lower in net cost than cotton receiving more cleaning.

El Paso, Tex., prices on specified dates	Average net cost per pound of comber sliver, cleaning treatment--			Difference required, 90-percent confidence
	No. 1	No. 2	No. 3	
	Cents	Cents	Cents	Cents
November 1960	41.89	42.93	42.96	0.67
November 1963	46.64	47.19	47.29	.79

Generally, comber sliver was slightly cheaper with no defoliation, normal moisture, and minimum cleaning. This perhaps suggests that, from the standpoint of preserving inherent fiber properties, differentials in market price were excessive for grade and not adequate for staple length. Principal reasons for this were that normally defoliated cotton had a higher price per pound of ginned lint, a higher net cost per pound of comber sliver, a higher grade index, and a shorter staple length than undefoliated cotton.

APPENDIX A: EXPLANATION OF THE STEPWISE MULTIPLE LINEAR REGRESSION AND COVARIANCE ANALYSES USED IN THE STUDY

The primary method of analysis used in this study is a stepwise multiple linear regression. It is stepwise in that only one variable is entered at a time into the regression equation. The potential of each independent variable to explain variation in the dependent variable is considered, and that variable which reduces variance most in a single iteration is entered in the equation in any given step. This stepwise procedure is continued until no remaining variable is statistically significant at the specified level of confidence. By this procedure, all possible independent variables are considered, and any one which makes a significant reduction in variance when its effect is considered "net" of effects of other variables in the equation, remains in the final equation. Thus, partial regression coefficients are obtained for all significant variables in any relationship specified.

This method assumes that all the relationships are linear. Preliminary graphing of the data did not reveal any relationships that were not linear within the ranges included in this study, and so the assumption of linearity appears to be justified. There was some question as to how serious would have been the application of additional heat to undefoliated cotton to reduce its lint slide moisture level to an average of 3.5 percent, the average for the 36 lots of defoliated cotton. Since no information relevant to this question was available, it was assumed that the linear relationships observed over the ranges of data in the study would have continued.

Although lint slide moisture content of undefoliated cotton was significantly greater than that of prematurely defoliated cotton, the magnitude of difference was not great (table 1). Only 11 percent of the variation in lint slide moisture was explained by defoliation treatments. This indicated that lint slide moisture varied in the test primarily because of different drying treatments and not because of different defoliation treatments. Thus, lint slide moisture content was regarded as a satisfactory index of gin drying in the study.

Discrete or "dummy" variables were included in the analyses of phase one (appendix B, table 6). For example, defoliation was included as three discrete variables; undefoliated (D_1), normally defoliated (D_2), and prematurely defoliated (D_3) cotton. For all 18 bales of undefoliated cotton, variable D_1 was given the value 1, but all 36 observations of the variables D_2 and D_3 were assigned zero values. The stepwise regression procedure allowed any discrete as well as any continuous variable to enter a given equation if its regression coefficient was significant.

Since both discrete and continuous variables, plus interactions of these variables were included as independent variables, interpretations of the various regression coefficients differ. Coefficients of continuous variables are estimates of the average number of units increase (positive sign) or decrease (negative sign) in the dependent variable associated with a unit increase in the independent variable, net of effects of other independent variables in the equation. This is the usual interpretation of partial regression coefficients. However, coefficients of discrete variables are interpreted differently. They are estimates of levels (intercepts) rather than of slopes or rates of change. If D_1, for example, entered an equation with a positive sign while neither D_2 nor D_3 entered, the coefficient for the D_1 variable indicated the extent to which the given property estimated by the equation was higher for undefoliated than for defoliated cotton.

Coefficients for moisture variables, roller-ginned lint moisture (M_1) and lint slide moisture (M_2), were estimated by using all 54 observations. They are estimates of the aggregate or overall relationships between moisture and the dependent variables. Since it is important to know whether or not these relationships with moisture are the same for each defoliation and cleaning treatment, interaction terms were included in an endeavor to detect such differences. Thus, if drying was more detrimental to mean length of undefoliated than of normally and prematurely defoliated cotton, the analysis gave a significant positive coefficient for the variable M_2D_1 in the equation which estimates mean length.

Some of the simple correlation coefficients between moisture variables and interaction variables which involve moisture and a discrete variable are high (table 9). This fact makes it difficult to determine whether the significant coefficients for interaction terms indicate different effects of moisture on the dependent variable in the different discrete groups, or different levels of the dependent variable in the discrete groups. The differences in initial moisture previously were shown to be due largely to defoliation treatments. Thus, the interactions involving initial moisture are interpreted to indicate primarily differences in level of the dependent variable associated with defoliation treatments. Plotting the data revealed that many significant interactions between lint slide moisture and a cleaning or defoliation treatment primarily reflect differences in level of the dependent variable associated with the discrete variables, and that differences in slope are of no great magnitude or importance. Thus, as a rule, interactions of lint slide moisture and either defoliation or cleaning reflect differences in the average level of the dependent variable due to cleaning or defoliation treatments.

Only two simple correlation coefficients between continuous independent variables are above 0.75 (table 9). These are between M_1M_2 and each of the moisture variables. This interaction of moisture variables (M_1M_2) is significant in only 5 of the 52 equations. For these 5 cases, it is not possible to obtain pure estimates of the separate effects of M_1 and M_2 from the regression analyses. Covariance analysis was used to evaluate these five cases, as explained in the latter part of this section.

Coefficients which involve interaction of two discrete variables are estimates of differences in level. They indicate that cotton which received a particular combination of defoliation and cleaning treatments had a significantly higher or lower average value of the dependent variable than did cotton which received any different treatment combination. Since all these coefficients are partials, careful attention must be given coefficients of other variables in the equation when interpreting the coefficients for the interaction variables. These discrete x discrete interactions were based on only six observations each, and some apparently reflected error or chance relationships.

The values of t, beta, and R derived through the stepwise regression analyses and shown in appendix B, table 6 are of the usual form and subject to the usual interpretations. The t ratios are test criteria for significance of regression coefficients; the betas indicate the relative importance of each independent variable in explaining variation in the dependent variable; the R is the multiple correlation coefficient. The square of R indicates the percentage of total variation in the dependent variable which is explained by the significant independent variables collectively. All regression coefficients and all values of R shown in table 6 are statistically significant.

For 5 of the 52 properties studied, regression analyses did not provide a "pure" estimate of the effect of each independent variable, due to interacting effects of moisture variables. These properties included array coefficient of variation, micronaire, and Fibrograph mean length in ginned lint; percent comber noils; and break factor. Effects of treatments on these five properties were evaluated through covariance analysis. Specifically, the design of the analysis was randomized complete block with lint slide moisture included as a covariate. Regarding moisture as a covariate reduced the original 3-factor, split-plot design to a 2-factor, split-plot design, with each subplot carrying lint slide moisture as a covariate. Since an evaluation of effects of lint slide moisture was still desired, it was necessary to pool errors A and B for whole plots and subplots, respectively. This further reduced the design to randomized complete block with a covariate. The complete analysis for comber noils (typical of the five analyses) is shown in table 4, and the essential results of all five analyses are shown in table 1. The same type of analysis was used in evaluating effects of field and ginning treatments on bale values and on net cost per pound of comber sliver.

APPENDIX B: BASIC DATA AND STATISTICS

The following key identifies the 33 independent variables considered in the 52 cases of phase one and included in tables 6 and 9:

M_1 Roller-ginned lint moisture

M_2 Lint slide moisture

D_1 No defoliation

D_2 Normal defoliation

D_3 Premature defoliation

C_1 1 lint cleaner and 2 overhead cleaners

C_2 2 lint cleaners and 2 overhead cleaners

C_3 2 lint cleaners, and 2 overhead cleaners, and 1 stick-and-leaf machine

R_1 Rep 1

R_2 Rep 2

R_3 Rep 3

Interaction variables:

M_1M_2	M_1C_3	M_2C_3	D_2C_3
M_1D_1	M_2D_1	D_1C_1	D_3C_1
M_1D_2	M_2D_2	D_1C_2	D_3C_2
M_1D_3	M_2D_3	D_1C_3	D_3C_3
M_1C_1	M_2C_1	D_2C_1	
M_1C_2	M_2C_2	D_2C_2	

Table 6.--Regression analyses for selected measurements of fiber, yarn, and processing variables, 54 lots of cotton, New Mexico, 1960

Dependent variable	Unit	Independent variable	Constant term	Partial reg coefficient (b)	Student's "t" ratio for b 1/	Standardized partial b (Beta)	R 2/
Ginned lint							
Grade	Index	M_2	102.4896	-0.5478	-2.595	-0.245	0.746
		D_2		1.8686	4.651	.439	
		M_1C_1		- .2742	-5.314	- .502	
Staple length	32d in.	M_2	35.0757	.1782	2.345	.259	.630
		M_1C_1		.0587	3.065	.347	
		D_3C_2		- .6967	-3.119	- .353	
Shirley Analyzer waste:							
Visible	Percent	M_2	0.3821	.1114	5.968	.336	.930
		C_1		.3707	11.140	.586	
		M_1D_1		.0404	9.407	.595	
		M_2D_3		.0371	3.437	.205	
Total	do.	M_2	1.3016	.1136	3.933	.309	.845
		M_1D_2		- .0323	-3.659	- .328	
		M_1C_1		.0428	5.733	.476	
		D_2C_2		- .2248	-2.365	- .214	
		D_3C_3		- .2381	-2.699	- .227	
Array:							
Upper quartile length	Inch	M_2	1.3100	.0050	3.125	.236	.875
		D_1		.0244	7.619	.604	
		M_2C_1		.0047	5.384	.445	
		D_2C_1		- .0162	-3.210	- .267	
		D_3C_3		.0121	2.681	.200	
Mean length	do.	M_2	1.0519	.0122	4.874	.386	.848
		D_1		.0314	6.579	.521	
		C_1		.0245	5.422	.407	
Fibers > 1"	Percent	M_2	66.5185	1.3162	4.868	.402	.833
		D_1		2.6880	5.206	.430	
		M_1C_1		.3397	5.394	.423	
Fibers < ½"	do.	M_2	9.5484	- .4253	-3.775	- .363	.770
		C_1		-1.1257	-5.582	- .504	
		M_1D_1		- .0832	-3.602	- .346	
Coefficient of variation	do.	M_1	40.9251	-1.2388	-3.233	-1.366	.836
		M_2		-2.5062	-3.536	-1.437	
		C_1		-2.1015	-7.622	- .632	
		D_1C_2		-1.4345	-3.202	- .287	
		M_1M_2		.2727	2.854	1.991	
		R_1		- .6024	-2.160	- .181	
Fibrograph:							
Upper half mean	Inch	M_2	1.1418	.0062	2.901	.212	.876
		D_1		.0414	9.834	.741	
		C_1		.0144	3.193	.257	
		D_3C_1		.0165	2.353	.196	
Mean length	do.	M_1	0.6900	.0291	4.530	1.378	.921
		M_2		.0665	5.688	1.639	
		M_1D_1		.0081	10.752	.973	
		D_2C_1		.0298	4.105	.257	
		D_2C_2		.0158	2.172	.136	
		D_3C_1		.0580	8.016	.499	
		M_1M_2		- .0081	-5.169	-2.539	
Uniformity ratio	Percent	D_1	79.2800	4.6170	3.145	1.302	.819
		M_1D_1		.2880	2.366	.756	
		M_2D_1		-1.0860	-3.794	-1.291	

Table 6.--Regression analyses for selected measurements of fiber, yarn, and processing variables, 54 lots of cotton, New Mexico, 1960--Continued

Dependent variable	Unit	Independent variable	Constant term	Partial reg. coefficient (b)	Student's "t" ratio for b 1/	Standardized partial b (Beta)	R 2/
		M_2C_1		.6720	6.253	.731	
		M_2C_2		.2900	3.274	.319	
		D_1C_1		-3.9670	-6.057	- .746	
Strength (Pressley):							
0" gauge	1,000PSI	D_3	81.1744	-2.8410	-4.941	- .445	.826
		M_2D_2		.8853	5.701	.514	
1/8" gauge	Gr/tex	M_2	22.4498	.2712	3.785	.322	.806
		M_1D_2		.1407	7.186	.622	
		D_3C_3		- .6284	-2.973	- .261	
Micronaire:	Reading	M_1D_2	3.3139	.0257	5.482	.571	.686
		M_1M_2		.0061	4.408	.464	
		R_3		.0671	2.007	.209	
Card sliver							
Array:							
Upper quartile length	Inch	M_2	1.2787	.0143	9.320	.571	.904
		D_2		- .0342	-10.251	- .713	
		M_2D_3		- .0048	- 4.994	- .348	
Mean length	do.	M_2	0.9726	.0175	7.966	.563	.878
		D_1		.0306	7.314	.517	
Fibers >1"	Percent	M_2	55.9700	1.8758	6.780	.529	.853
		D_1		3.2738	6.197	.484	
		M_1C_1		.1328	2.061	.153	
Fibers >½"	do.	M_2	13.5490	- .7243	-5.560	- .543	.756
		M_1D_1		- .1012	-3.792	- .370	
Coefficient of variation	do.	M_2	37.2426	- .8579	-5.361	- .519	.762
		D_1		-1.3074	-4.148	- .414	
		D_2C_1		-1.1742	-2.622	- .248	
Fibrograph:							
Upper half mean	Inch	M_2	1.1080	.0107	5.183	.399	.891
		M_1D_1		.0038	9.976	.699	
		D_3C_1		.0148	2.921	.194	
Mean length	do.	M_2	.8422	.0149	5.281	.460	.821
		M_1D_1		.0042	6.361	.636	
		M_1C_1		.0026	3.151	.335	
		D_1C_1		- .0440	-3.977	- .475	
Uniformity ratio	Percent	M_2	76.1190	.6850	3.608	.451	.476
		D_1C_1		-1.1010	-2.026	- .254	
Strength (Pressley):							
0" gauge	1,000PSI	M_2	80.6277	1.0282	4.851	.315	.906
		D_3		-6.2520	-12.891	-1.004	
		M_1D_1		- .4387	- 9.146	- .656	
		D_3C_2		1.5409	2.355	.165	
1/8" gauge	Gr/tex	M_2	22.7777	.1826	2.796	.237	.817
		D_2		1.1612	8.863	.788	
		D_1C_1		1.0208	5.225	.462	
		D_1C_3		.4655	2.403	.211	
Micronaire:	Reading	M_1	3.3008	.0399	4.698	.475	.791
		D_3		- .1049	-3.015	- .340	

Table 6.--Regression analyses for selected measurements of fiber, yarn, and processing variables, 54 lots of cotton, New Mexico, 1960--Continued

Dependent variable	Unit	Independent variable	Constant term	Partial reg. coefficient (b)	Student's "t" ratio for b 1/	Standardized partial b (Beta)	R 2/
		M_2D_2		.0300	3.306	.360	
Comber sliver							
Array:							
Upper quartile length.....	Inch	M_2	1.2701	.0117	5.595	.516	0.878
		D_1		.0503	3.717	1.161	
		M_2D_1		- .0076	-2.211	- .737	
		D_2C_2		- .0204	-4.310	- .314	
		D_2C_3		- .0096	-2.041	- .149	
Mean length...............	do.	M_2	1.0436	.0105	5.322	.461	.815
		D_1		.0242	6.216	.556	
		D_2C_1		.0121	2.194	.186	
Fibers >1"...............	Percent	M_2	62.2397	1.3165	5.128	.452	.812
		D_1		2.8667	5.669	.516	
		D_2C_1		2.4202	3.369	.290	
		R_2		1.0938	2.362	.197	
Fibers < ½"...............		M_2	6.7718	- .2963	-3.666	- .399	.657
		D_3		.6151	3.989	.434	
Coefficeint of variation..	do.	M_2	28.7567	- .2791	-2.198	- .264	.541
		M_1D_3		.1251	3.549	.426	
Fibrograph:							
Upper half mean...........	Inch	M_2	1.1420	.0061	3.090	.256	.843
		M_1D_1		.0037	8.570	.756	
		D_2C_1		.0169	3.046	.249	
		D_3C_1		.0184	3.325	.271	
		R_2		.0078	2.232	.173	
Mean length...............	do.	M_2C_1	.9425	.0060	3.680	.407	.739
		D_1C_2		.0229	2.572	.270	
		D_1C_3		.0396	4.445	.467	
		D_3C_3		- .0254	-2.859	- .300	
Strength (Pressley):							
0" gauge..................	1,000PSI	D_3	82.1667	-10.2510	-5.679	-1.650	.826
		M_2D_3		1.3882	2.737	.780	
		D_1C_2		-2.6667	-3.436	- .286	
		D_3C_1		1.9710	2.271	.211	
1/8" gauge................	Gr/tex	D_3	24.3228	-2.0534	-3.863	-1.155	.811
		C_1		.4809	3.263	.271	
		M_2D_2		.1859	4.061	.387	
		M_2D_3		.3643	2.422	.716	
Micronaire:...............	Reading	M_1	3.6860	.0264	3.055	.324	.712
		D_3		- .1711	-5.347	- .572	
		D_1C_3		- .1145	-2.461	- .255	
Comber noils							
Array:							
Upper quartile length.....	Inch	M_1	.6823	.0117	2.641	.314	.633
		D_1C_2		.0805	3.299	.391	
		D_2C_1		.0718	3.145	.349	
Mean length...............	do.	M_1	.5107	.0072	3.201	.358	.685
		D_1C_2		.0445	3.592	.401	
		D_2C_1		.0428	3.689	.385	

Table 6.--Regression analyses for selected measurements of fiber, yarn, and processing variables, 54 lots of cotton, New Mexico, 1960--Continued

Dependent variable	Unit	Independent variable	Constant term	Partial reg. coefficient (b)	Student's "t" ratio for b 1/	Standardized partial b (Beta)	R 2/
Fibers >1"	Percent	M_1	7.6720	0.7313	3.542	0.398	0.699
		D_1C_2		4.1025	3.662	.406	
		D_2C_1		3.9656	3.746	.393	
		D_3C_1		2.2708	2.130	.225	
Fibers <½"	do.	M_1	58.7593	- .8393	-3.800	- .421	.711
		D_1C_2		-4.1656	-3.476	- .379	
		D_2C_1		-4.7515	-4.195	- .433	
		D_3C_1		-2.3487	-2.060	- .214	
Coefficient of variation	do.	D_1C_1	58.0000	2.0000	3.498	.427	.501
		D_3C_1		1.5000	2.623	.320	
Micronaire	Reading	M_1	2.5900	.0320	3.885	.426	.694
		D_3		- .1297	-4.294	- .470	
		D_1C_1		- .1059	-2.389	- .256	
Processing variables							
Waste:							
Opening and picking	Percent	M_2	.2126	.0155	2.337	.151	.914
		M_1C_1		.0170	11.771	.679	
		M_2D_1		.0213	7.074	.459	
Carding	do.	M_2	5.0240	.2272	5.054	.488	.759
		D_3		.5624	6.401	.634	
		M_1C_1		- .0531	- 3.934	- .466	
		D_1C_1		.4230	2.586	.318	
Total manufacturing	do.	M_2	5.2354	.2114	4.033	.447	.719
		D_3		.5856	5.783	.649	
		M_2D_1		.0696	2.649	.325	
Neps, card web	Number	D_3	61.3515	11.9756	3.654	.335	.853
		M_1C_1		-3.2739	-7.131	- .712	
		D_1C_1		12.0354	2.246	.224	
		D_3C_3		15.6730	3.224	.292	
Comber noils	Percent	M_1	19.0987	- .6586	-3.126	-1.372	.809
		M_2		-1.1479	-2.976	-1.244	
		D_1		- .4059	-2.231	- .230	
		M_2C_1		- .1285	-3.244	- .281	
		M_1M_2		.1224	2.370	1.689	
EDMSH (corrected)	Number	D_3C_3	19.3292	6.2875	2.431	.319	.319
Break factor	Unit	M_2	2162.1273	85.6063	8.143	.924	.930
		D_3		-176.2256	-4.141	.997	
		C_3		-153.4109	-3.107	.868	
		M_1C_2		-8.2821	-4.647	- .377	
		M_1C_3		16.8266	2.617	.739	
		M_2D_3		32.6021	2.723	.644	
		D_1C_2		44.2198	2.071	.167	
		M_1M_2		-3.7952	-4.329	- .522	
		R_3		-31.2110	-3.034	.177	
Yarn appearance	Index	D_3	88.7500	-3.7500	-2.924	- .277	.784
		D_1C_1		7.9167	4.217	.390	
		D_2C_1		11.2500	5.993	.555	

1/ All ratios in the table are significant at the 95-percent confidence level.
2/ Values of R equal to 0.30 or greater were significantly different from zero at the 95-percent confidence level.

Table 7.--Bale weights, prices per pound, and bale values by moisture, defoliation, and cleaning treatments, 54 lots of cotton, New Mexico, 1960

Treatment	Bale weight	November 1960, El Paso		November 1963, El Paso	
		Price/lb	Bale value	Price/lb	Bale value
	Pounds	Cents	Dollars	Cents	Dollars
Normal moisture					
No defoliation:					
C_1	500.0	32.29	161.46	36.30	181.48
C_2	497.9	32.80	163.30	36.50	181.77
C_3	494.6	33.25	164.45	36.79	181.96
Normal:					
C_1	497.5	33.34	165.85	36.53	181.73
C_2	492.1	33.85	166.54	37.05	182.38
C_3	491.8	33.94	166.91	37.40	183.91
Premature:					
C_1	496.6	32.52	161.49	36.44	180.96
C_2	492.6	32.84	161.80	35.80	176.39
C_3	490.6	33.10	162.38	37.22	177.70
Low moisture					
No defoliation:					
C_1	494.3	32.72	161.73	36.63	181.06
C_2	487.5	33.05	161.11	36.30	176.95
C_3	489.0	33.75	162.59	36.79	179.90
Normal:					
C_1	488.6	33.25	162.45	36.79	179.74
C_2	484.1	33.35	161.48	36.64	177.39
C_3	483.4	34.10	164.88	37.47	181.11
Premature:					
C_1	487.3	33.25	162.03	36.79	179.28
C_2	483.6	32.76	158.45	35.43	171.34
C_3	483.0	33.10	159.88	36.22	174.97

Table 8.--Yield of comber sliver per pound of raw cotton, price per pound of raw cotton, and net cost per pound of comber sliver, by moisture, defoliation, and cleaning treatments, 54 lots of cotton, New Mexico, 1960

Treatment	Comber sliver/lb. raw cotton	November 1960, El Paso		November 1963, El Paso	
		Price/lb	Net cost/lb. comber sliver	Price/lb.	Net cost/lb. comber sliver
	Pounds	Cents	Cents	Cents	Cents
Normal moisture					
No defoliation:					
C_1	0.783	32.29	41.26	36.30	46.38
C_2	.773	32.80	42.43	36.50	47.23
C_3	.787	33.25	42.25	36.79	46.75
Normal:					
C_1	.782	33.34	42.63	36.53	46.71
C_2	.772	33.85	43.84	37.05	47.99
C_3	.783	33.94	43.37	37.40	47.79
Premature:					
C_1	.778	32.52	41.78	36.44	46.82
C_2	.772	32.84	42.52	35.80	46.36
C_3	.765	33.10	43.25	36.22	47.33
Low moisture					
No defoliation:					
C_1	.782	32.72	41.86	36.63	46.86
C_2	.788	33.05	41.94	36.30	46.06
C_3	.774	33.75	42.95	36.79	47.52
Normal:					
C_1	.781	33.25	42.57	36.79	47.11
C_2	.773	33.35	43.07	36.64	47.39
C_3	.766	34.10	44.51	37.47	48.90
Premature:					
C_1	.771	33.25	43.14	36.79	47.74
C_2	.767	32.76	42.70	35.43	46.17
C_3	.772	33.10	42.88	36.22	46.92

Table 9.--Coefficients of simple correlation

[illegible]	M_1D_1	M_1D	M_1D_2	M_1C_1	M_1C_2	M_1C_3	M_2D_1	M_2D_2
[illegible]	[illegible]							
[illegible]	-.47	1						
[illegible]	-.[illegible]	-.[illegible]	1					
[illegible]	.1[illegible]	-.[illegible]4	-.[illegible]	1				
[illegible]	.1[illegible]	-.[illegible]7	-.[illegible]	-.[illegible]	1			
[illegible]	.[illegible]	.[illegible]	-.[illegible]	-.47	-.47	1		
[illegible]	.[illegible]	-.47	-.4[illegible]	.10	.12	.06	1	
[illegible]	-.[illegible]	.[illegible]	-.4[illegible]	-.0[illegible]	-.06	0	-.46	1
[illegible]	-.[illegible]	-.47	.97	-.04	-.02	-.06	-.46	-.46
[illegible]	.[illegible]	-.02	-.04	.95	-.45	-.46	.09	.02
[illegible]	.[illegible]	-.[illegible]4	-.01	-.46	.95	-.46	09	.01
[illegible]	.[illegible]	.[illegible]	-.05	-.46	-.46	.98	.05	.01
[illegible]	.[illegible]	-.[illegible]	-.[illegible]5	.61	-.24	-.24	.49	-.24
[illegible]	.[illegible]	-.[illegible]	-.25	-.24	.64	-.24	.49	-.24
[illegible]	.4[illegible]	-.[illegible]	-.25	-.[illegible]4	-.24	.59	.46	-.24
[illegible]	-.[illegible]4	.4[illegible]	-.25	.[illegible]3	-.24	-.24	-.24	.48
[illegible]	-.[illegible]	.46	-.[illegible]5	-.[illegible]4	.39	-.24	-.24	.49
[illegible]	-.[illegible]	.53	-.25	-.24	-.24	.47	-.24	.47
[illegible]	-.[illegible]4	-.[illegible]	.4[illegible]	.40	-.24	-.24	-.24	-.24
[illegible]	-.[illegible]	-.[illegible]5	.52	-.[illegible]4	.42	-.24	-.24	-.24
[illegible]	-.[illegible]	-.[illegible]5	.4[illegible]	-.[illegible]4	-.24	.40	-.24	-.24
[illegible]	.64	-.14	-.[illegible]7	.13	.20	.07	.63	-.09
[illegible]	.[illegible]	.[illegible]	.01	.03	.01	.03	.01	.02
[illegible]	.[illegible]1	.[illegible]1	[illegible]	-.03	.01	.04	.02	0
[illegible]	-.[illegible]4	-.04	-.01	-.01	-.02	-.06	-.03	-.03

between independent variables, New Mexico, 1960

M_2D_3	M_2C_1	M_2C_2	M_2C_3	D_1C_1	D_1C_2	D_1C_3	D_2C_1	D_2C_2	D_2C_3	D_3C_1	D_3C_2	D_3C_3	M_1M_2	R_1	R_2	R_3
1																
-.02	1															
.01	-.46	1														
-.04	-.46	-.46	1													
-.24	.56	-.24	-.24	1												
-.24	-.24	.55	-.24	-.12	1											
-.24	-.24	-.24	.56	-.12	-.12	1										
-.24	.46	-.24	-.24	-.12	-.12	-.12	1									
-.24	-.24	.45	-.24	-.12	-.12	-.12	-.12	1								
-.24	-.24	-.24	.47	-.12	-.12	-.12	-.12	-.12	1							
.47	.41	-.24	-.24	-.12	-.12	-.12	-.12	-.12	-.12	1						
.51	-.24	.43	-.24	-.12	-.12	-.12	-.12	-.12	-.12	-.12	1					
.46	-.24	-.24	.42	-.12	-.12	-.12	-.12	-.12	-.12	-.12	-.12	1				
-.20	.13	.21	.08	.26	.34	.19	-.12	-.14	-.05	-.17	-.11	-.20	1			
0	.04	0	0	0	0	0	0	0	0	0	0	0	.17	1		
-.02	0	-.02	.01	0	0	0	0	0	0	0	0	0	-.01	-.50	1	
.01	-.04	.01	-.02	0	0	0	0	0	0	0	0	0	-.16	-.50	-.50	1

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