Marketing Research Report No. 655

Effects of

COTTON GINNING PRACTICES

on

Cotton Yarn Properties,
Weaving Performance,
and Fabric Properties

United States Department of Agriculture • Agricultural Marketing Service
Market Quality Research Division

PREFACE

The results reported here deal with the effects of cotton ginning conditions on weaving performance and the relationship of spinning performance and yarn properties to weaving performance and cloth properties. The study on which the report is based is part of a broad program of research by the Agricultural Marketing Service to improve the quality of farm products and to increase efficiency in marketing them.

Three previous studies have been made of the effects of various ginning practices on the fiber properties and processing performance of cotton. The yarns used in this study were obtained from the ginning-spinning study described in Marketing Research Report No. 576.

Earlier reports:

Effects of Cleaning Practices at Gins on Fiber Properties and Mill Performance of Cotton. A Progress Report. U.S. Dept. Agr. Mktg. Res. Rpt. No 269. August 1958.

Cotton Fiber and Spinning Properties as Affected by Certain Ginning Practices in San Joaquin Valley, California, Season 1958-59. U.S. Dept. Agr. Mktg. Res. Rpt. No. 486. July 1961.

Effects of Cotton Ginning Practices on Market Quality of Cotton: A Mississippi Delta Variety, 1958-59. U.S. Dept. Agr. Mktg. Res. Rpt. No. 576. January 1963.

Single copies of these reports may be obtained from the Office of Information, U.S. Department of Agriculture, Washington, D.C., 20250.

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SUMMARY

This study involved 36 bales of DPL-15 cotton ginned under 12 ginning treatments consisting of two levels of seed-cotton cleaning, two levels of drying, and three levels of lint cleaning. At each of three picking dates in 1958, 12 bales were randomly selected from mechanically harvested cotton grown at Robinsonville, Miss.

A portion of each of the three replications from a ginning condition was processed into 40s filling yarn, and the remaining portions were blended at the drawing frame and processed into 30s warp yarn. During the spinning of these yarns, ends down were recorded and converted to ends down per 1,000 spindle hours. This yarn was subsequently woven into an 80 x 80, 40-inch print cloth, and weaving performance was determined from the observation of loom stops.

A 50-yard length of the fabric from each ginning condition was bleached, and one-half of the bleached fabric was dyed with a blue direct dye. Physical tests were made on the yarn and on grey and bleached fabric.

The results of this study indicate that:

(1) Seed-cotton cleaning had no effect upon spinning performance, warp and filling yarn properties, weaving performance, and fabric strength.

(2) The use of lint cleaners caused:

  (a) Only slight differences in ends down per 1,000 spindle hours (EDMSH) and in loom stops per million picks.

  (b) No apparent effect on strength of warp yarn and fabric warp, but as lint cleaners were added, strength decreased in the filling yarn and fabric filling.

(3) With a decrease in moisture at time of ginning:

  (a) EDMSH at spinning decreased for warp and filling yarn, but moisture level had no apparent effect on warp loom stops and only minor effects on filling loom stops.

  (b) Strength decreased for all yarns and for grey and bleached fabrics.

(4) When spinning properties were related to weaving properties:

  (a) EDMSH for warp yarn were not related to warp loom stops, but EDMSH for filling yarn were significantly related to filling loom stops.

  (b) Yarn strength was not related to loom stops.

  (c) Warp yarn strength was significantly related to strength of grey fabric but not to strength of bleached fabric.

  (d) For the filling yarn, the break factor and single strand strength were significantly related to the tear strength of grey fabric but not to the strip strength of the grey fabric. The single strand strength, but not the break factor, was significantly related to tear and strip strength of bleached fabrics.

(5) Ginning conditions had no apparent effect upon fabric elongation, crease angle recovery, and fabric appearance.

EFFECTS OF COTTON GINNING PRACTICES ON COTTON YARN PROPERITIES, WEAVING PERFORMANCE, AND FABRIC PROPERTIES

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BACKGROUND

To reduce operating costs, the cotton producing industry has become highly mechanized. To handle the increased volume of mechanically harvested cotton, the ginning industry has added drying and cleaning equipment. The textile industry, as well as the producer and ginner, has increased production efficiency as a means of reducing operating costs.

This study is a segment of an investigation dealing with weaving performance and fabric properties as affected by certain ginning practices of drying, seed-cotton cleaning, and lint cleaning. The yarns used in this study were obtained from the thirdginning-spinning study conducted by the Pilot Spinning Laboratory. The weaving and finishing investigations were performed by the Textile Research Department of Clemson College under a research contract.

PROCEDURE

This investigation used 36 bales of DPL-15 cotton grown at Robinsonville, Miss., in 1958. The 36 bales came from two fields on one plantation and were grown and mechanically harvested under similar conditions. From cotton harvested on each of three different dates, 12 bales were randomly selected. The cotton was ginned under 12 ginning treatments consisting of two levels of seed-cotton cleaning, two levels of drying, and three levels of lint cleaning.

The 36 bales were processed into 30s warp yarn and 40s filling yarn by personnel of the Department of Agriculture's Pilot Spinning Laboratory. Since the laboratory does not have facilities for weaving and finishing investigations, these yarns were turned over to Clemson College Textile Research Department and were woven into an 80 x 80, 40-inch print cloth. Details of the procedures used in ginning, yarn manufacturing, warp and filling yarn preparation, weaving, finishing, and testing are given in the appendix of this report.

RESULTS

Data for the grade and staple length, yarn properties, and fabric properties are given in the appendix, tables 8 through 14. The effects of seed-cotton cleaning were either minor or nonexistent; therefore, in the text tables, the data were averaged for the seed-cotton cleaning conditions to determine the effects of moisture at time of ginning and the effects of lint cleaning. To determine the relationship between spinning properties and weaving properties, the ends down per thousand spindle hours at spinning were correlated with loom stops, and yarn strength was correlated with strength of grey and bleached fabrics.

Since warp yarn was spun from a composite sample from the three bales that were ginned alike, no valid analysis of variance could be made.

Effect of Ginning Conditions on Ends Down and Looms Stops

Ends down per thousand spindle hours (hereafter referred to as EDMSH) and loom stops per million picks are shown in table 1 for the various moisture and lint cleaning conditions.

TABLE 1.--Ends down per thousand spindle hours and loom stops per million picks for yarns spun from cotton ginned at high and low moisture and with 1, 2, or no lint cleaners

Moisture of cotton in lint slide	Lint cleaners			Average
	None	1	2	
30s Warp Yarn				
Ends down per thousand spindle hours:				
High moisture	20.0	23.0	20.0	21.0
Low moisture	16.0	12.0	11.0	13.0
Average	18.0	18.0	16.0	17.0
Loom stops per million picks:				
High moisture	22.0	20.0	20.0	20.7
Low moisture	23.0	19.0	19.0	20.3
Average	22.5	19.5	19.5	20.5
40s Filling Yarn				
Ends down per thousand spindle hours:				
High moisture	58.0	64.0	66.0	62.7
Low moisture	34.0	35.0	34.0	34.3
Average	46.0	50.0	50.0	48.5
Loom stops per million picks:				
High moisture	9.0	10.0	5.0	8.0
Low moisture	5.0	4.0	6.0	5.0
Average	7.0	7.0	5.5	6.5

Warp yarn.--For the high-moisture ginning condition, lint cleaners had little or no effect upon EDMSH. For the low-moisture ginning condition there was a slight reduction in EDMSH as lint cleaners were added. In every case the low-moisture ginning condition produced fewer EDMSH than did the high-moisture condition. The average EDMSH for low moisture was 13 and for high moisture was 21.

The ginning conditions that affected spinning performance had no apparent effect upon warp loom stops. The average loom stops by ginning conditions were nearly the same for all conditions.

Filling yarn.--For the high-moisture condition, there was a slight increase in EDMSH as lint cleaners were added. For the low-moisture ginning condition, the addition of lint cleaners did not affect EDMSH. Cotton ginned with a low lint moisture is generally expected to produce a greater number of EDMSH than cotton ginned with a high lint moisture content, but in this study the results were reversed: The EDMSH averaged 34 for the low-moisture condition and 63 for the high-moisture condition.

Lint cleaners apparently had no effect upon filling loom stops, while the average loom stops for low-moisture ginning were slightly less than for high-moisture ginning.

Effect of Ginning Conditions on Yarn Strength and Fabric Strength

Warp strength. --The addition of lint cleaners apparently did not affect the average strength of warp yarn or any of the strength measurements of the warp of grey and bleached fabric (table 2). However, ginning with low moisture and two lint cleaners produced a weaker yarn and a weaker fabric than ginning with high-moisture and no lint cleaners. In all cases the low-moisture lint produced yarn and fabrics that were weaker than the high-moisture lint. This condition was prevalent in both grey and bleached fabrics.

TABLE 2.--Strength measurements of 30s warp yarn and fabric warp from cotton ginned at high and low moisture and with 1, 2, and no lint cleaners

Strength measure and moisture of cotton in lint slide	Lint cleaners			Average
	None	1	2	
Break factor:				
High moisture.....units..	2,324	2,393	2,316	2,344
Low moisture.....do..	2,160	2,086	2,096	2,114
Average.....do..	2,242	2,240	2,206	2,229
Single strand strength:				
High moisture.....grams/tex..	14.0	14.7	14.3	14.3
Low moisture.....do..	13.6	13.2	13.3	13.4
Average.....do..	13.8	14.0	13.8	13.8
Strip strength:				
Grey fabrics:				
High moisture.....pounds..	59.4	61.2	61.8	60.8
Low moisture.....do..	57.3	56.0	57.2	56.8
Average.....do..	58.4	58.6	59.5	58.8
Bleached fabrics:				
High moisture.....do..	64.0	63.0	64.0	64.0
Low moisture.....do..	60.0	62.0	61.0	61.0
Average.....do..	62.0	62.5	62.5	62.5
Tear strength:				
Grey fabrics:				
High moisture.....grams..	1,424	1,410	1,394	1,409
Low moisture.....do..	1,342	1,284	1,290	1,305
Average.....do..	1,383	1,347	1,342	1,357
Bleached fabrics:				
High moisture.....do..	476	472	472	473
Low moisture.....do..	459	462	456	459
Average.....do..	468	467	464	466

Filling strength.--The effect of lint cleaners on yarn and fabric strength was more evident in the filling yarn than in the warp yarn (table 3). For example, within each moisture condition, the use of two lint cleaners always produced a weaker yarn or a weaker fabric than ginning without lint cleaning. The average strength measurements for filling yarn and for fillings in grey and bleached fabrics decreased with the addition of lint cleaners.

Except for the strip strength of the grey fabric, the average strength for the yarn and fabric was lower for low-moisture ginning than for high-moisture ginning.

TABLE 3.--Strength measurements of 30s warp yarn and fabric warp from cotton ginned at high and low moisture and with 1, 2, and no lint cleaners

Strength measure and moisture of cotton in lint slide	Lint cleaners			Average
	None	1	2	
Break factor:				
High moisture.....units..	2,136	2,060	2,012	2,069
Low moisture.....do..	1,915	1,955	1,781	1,884
Average.....do..	2,026	2,008	1,896	1,976
Single strand strength:				
High moisture.....grams/tex..	13.8	13.4	13.2	13.5
Low moisture.....do..	12.2	12.2	12.0	12.1
Average.....do..	13.0	12.8	12.6	12.8
Strip strength:				
Grey fabrics:				
High moisture.....pounds..	42.2	41.8	40.3	41.4
Low moisture.....do..	43.6	40.9	41.6	42.0
Average.....do..	42.9	41.4	41.0	41.7
Bleached fabrics:				
High moisture.....do..	45.0	45.0	42.0	44.0
Low moisture.....do..	44.0	41.0	42.0	42.3
Average.....do..	44.5	43.0	42.0	43.2
Tear strength:				
Grey fabrics:				
High moisture.....grams..	766	743	722	744
Low moisture.....do..	724	738	707	723
Average.....do..	745	740	714	734
Bleached fabrics:				
High moisture.....do..	306	304	290	300
Low moisture.....do..	308	292	288	296
Average.....do..	307	298	289	298

Relationship of Spinning Performance and Yarn Properties to Weaving Performance and Fabric Properties

Yarn properties and spinning performance related to weaving performance. --The correlation coefficients showing the relationship of warp loom stops to warp spinning end breakage and warp yarn properties were insignificant (table 4). These results indicated that there was no relationship between warp spinning performance or yarn properties and warp weaving performance for the lots in this study. It is possible that the levels of warp spinning ends down and warp loom stops were too low to get a significant relationship. It is also possible that the slashing operation masked any relationship that might have existed between spinning performance and warp weaving performance.

TABLE 4. --Coefficients of correlation for weaving performance with spinning performance and yarn properties

Item	Loom stops per million picks[1]
	r
Ends down per 1,000 spindle hours:	
30s warp	.09 NS
40s filling	.72 *
Break factor:	
30s warp	-.04 NS
40 filling	.44 NS
Single strand strength:	
30s warp	.03 NS
40s filling	.32 NS

[1] Warp yarn data was correlated to warp loom stops, filling yarn data was correlated to filling loom stops.

NS = not significant.
* = significant at the 95 percent level.

The correlation between filling loom stops and filling spinning end breakage was 0.72, indicating that there is a significant relationship between filling spinning performance and filling breaks at the loom. There was a slight relationship between filling yarn properties and filling loom stops but the correlation coefficients were insignificant at the 95 percent confidence level.

Yarn properties related to fabric properties. --The relationships between yarn properties and fabric properties are given in table 5. For the warp yarn, the break factor and single strand strength were highly correlated with the tear and strip strengths of the grey fabric. When the fabric was bleached, the relationship between yarn strength and fabric strength was insignificant.

Correlation coefficients of yarn properties to fabric properties were lower for filling than for warp and were less consistent. For example, the filling yarn strength was significantly related to tear strength but not to strip strength of the grey fabric. The single strand strength was significantly related to tear and strip strengths of the bleached fabric but the break factor was not significantly related to either property of the bleached fabric.

TABLE 5.--Coefficients of correlation between yarn properties and fabric properties

Yarn strength	Fabric properties[1]			
	Tear strength		Strip strength	
	Grey	Bleached	Grey	Bleached
	r	r	r	r
30s warp yarn:				
Break factor.....units..	.91 **	.26 NS	.87 **	.47 NS
Single strand strength.....grams..	.80 **	.001 NS	.79 **	.52 NS
40s filling yarn:				
Break factor.....units..	.62 *	.46 NS	.26 NS	.34 NS
Single strand strength.....grams..	.64 *	.61 *	.22 NS	.58 *

[1] Strength of warp yarn was correlated with fabric properties of the warp; strength of filling yarn was correlated with fabric properties of the filling.

** = significant at 99 percent level.

* = significant at 95 percent level.

NS = not significant.

APPENDIX

Ginning

The 36 bales of DPL-15 cotton grown on a plantation at Robinsonville, Miss., were mechanically harvested from two separate fields that had received similar application of insecticides and defoliants before harvesting. The cotton was harvested on three different dates. The 12 bales from each picking were distributed at random over 12 ginning organizations.

The 12 ginning organizations consisted of 2 levels of drying, 2 levels of seed-cotton cleaning, and 3 levels of lint cleaning. Three bales from each picking were ginned under each combination of drying, seed-cotton cleaning, and lint cleaning to obtain 3 replications for each picking. The ginning organizations are shown in table 6.

The average moisture content of the 3 replications of seed-cotton and of lint cotton at various stages of ginning and processing are shown in table 7.

Yarn Manufacturing

Each of the three one-bale replications from a ginning condition was processed through the opening and picking line and through the carding operation on an individual bale basis. Part of the card sliver from each bale was processed into 40s filling yarn. The remaining card sliver from the three bales was blended at the drawing and processed into 30s warp yarn.

In the spinning process, 40s filling yarn with a 3.75 twist multiplier and 30s warp yarn with a 4.25 twist multiplier were spun on 2-inch spinning rings at a spindle speed of 11,000 r.p.m. from single creel, 1.25 hank roving.

TABLE 6.--Ginning organization for spinning test for 36 bales of machine-picked Mississippi Delta cotton, season-1958-59

Lint moisture-level and cleaning treatment	Elaborate seed-cotton cleaning and drying equipment[1] Gin stand equipment[2]			
	Seed-cotton drying temperature			
	Dryer intake:[4]		Dryer outlet:[4]	
	1st dryer	2nd dryer	1st dryer	2nd dryer
	°F.	°F.	°F.	°F.
High-moisture lint:				
No lint cleaners	233	88	139	87
1 lint cleaner[5]	183	89	128	88
2 lint cleaners[6]	192	88	126	86
Low-moisture lint:				
No lint cleaners	444	434	252	245
1 lint cleaner[5]	427	413	247	247
2 lint cleaners[6]	411	400	242	240

Lint moisture-level and cleaning treatment	Moderate seed-cotton cleaning and drying equipment[3] Gin stand equipment[2]			
	Seed-cotton drying temperature			
	Dryer intake:[4]		Dryer outlet:[4]	
	1st dryer	2nd dryer	1st dryer	2nd dryer
	°F.	°F.	°F.	°F.
High-moisture lint:				
No lint cleaners	226	85	151	92
1 lint cleaner[5]	259	88	147	93
2 lint cleaners[6]	191	86	132	89
Low-moisture lint:				
No lint cleaners	426	424	244	247
1 lint cleaners[5]	439	436	248	254
2 lint cleaners[6]	430	426	238	241

[1] 1 24-shelf tower dryer, 1 7-cylinder cleaner, 1 master overhead bur extractor, 1 24-shelf tower dryer, 1 72-inch cleaner.

[2] 4 master extractor cleaner feeders, 4 90-saw gin stands.

[3] 1 24-shelf tower dryer, 1 24-shelf tower dryer, 1 7-cylinder cleaner, 1 72-inch cleaner.

[4] Average of 3 readings during ginning for first dryer and for second dryer.

[5] Unit saw-type cleaner.

[6] Battery-type cleaner.

TABLE 7. Average moisture content of three harvests of machine picked seed cotton and of lint cotton at various stages of ginning and processing

Ginning conditions	Moisture content (by oven method)					
	Seed-cotton wagon sample	Roller-ginned lint	Lint-slide sample	Lint moisture removed[1]	Processing	
					Opening room	Finished drawing
	Percent	Percent	Percent	Percent	Percent	Percent
Elaborate seed-cotton cleaning:						
High-moisture lint:						
No lint cleaner	12.5	9.8	6.4	35	4.8	5.6
1 lint cleaner[2]	13.0	10.9	6.2	43	4.4	5.9
2 lint cleaners[3]	13.2	10.0	6.0	40	5.9	6.2
Low-moisture lint:						
No lint cleaner	10.4	9.1	2.6	71	4.3	5.7
1 lint cleaner[2]	11.4	8.0	2.5	69	4.6	5.6
2 lint cleaners[3]	10.8	8.2	2.7	67	4.5	5.7
Moderate seed-cotton cleaning:						
High-moisture lint:						
No lint cleaner	12.4	9.7	6.1	37	4.4	5.8
1 lint cleaner[2]	12.0	10.6	6.3	41	3.2	6.0
2 lint cleaners[3]	11.0	8.2	5.5	33	4.7	5.7
Low-moisture lint:						
No lint cleaner	11.2	9.0	2.4	73	4.4	5.7
1 lint cleaner[2]	11.0	8.8	2.5	72	3.6	5.0
2 lint cleaners[3]	12.2	9.5	2.7	72	4.3	5.9

[1] Percent of lint moisture removed = $\frac{\text{Roller ginned lint moisture - lint-slide-sample moisture}}{\text{Roller-ginned lint moisture}}$

[2] Unit saw-type cleaner.

[3] Battery-type cleaner.

Yarn from each ginning condition was wound onto cones and delivered to the Textile Research Department of Clemson College for warping, quilling, slashing, weaving, finishing, and fabric testing.

Warp Preparation

A Cocker warper[4] was used to beam the yarn from each ginning condition onto six section-beams. The warper speed was 340 yards per minute.

Slashing was done on a seven-can Cocker slasher at a speed of 23 yards per minute. A typical sizing mixture was used for each ginning condition, with a net size pickup of 15.5 percent. The percent stretch of the warp during slashing was approximately 2.5 percent. Moisture regain was measured continuously by a Moisture Monitor and averaged 7.5 percent for all the warps.

Warping and slashing were performed in a room having uncontrolled atmospheric conditions. Temperature and humidity were approximately 80° F. and 50 percent relative humidity. The initial warps were drawn in by hand and all subsequent changes of warps on the looms were made with a tying-in machine.

Weaving

From each ginning condition, 3,500 yards of 80 x 80, 40-inch print cloth were woven on seven Draper X-2 looms adjusted to standard settings and timings recommended by the manufacturer. The loom speed was 188 picks per minute with settings and timings held constant. Atmospheric conditions in the weave room were controlled at 75° F. and 85 percent relative humidity.

In order to minimize the effects of any loom-to-loom variation, the two loom beams per ginning condition were woven on six different looms. For example, the beams were placed on the first two looms and the filling yarn spun from replication 1 of the ginning condition was woven into the warp. When this filling yarn was depleted, the beams were transferred to a second set of two looms, and the filling yarn spun from replication 2 of the ginning condition was used. This procedure was repeated a third time for replication 3.

It should be noted that the same six looms were not used for every ginning condition. One loom was kept available to facilitate an orderly transfer to warps from one loom to another. No single loom was used twice for the same ginning condition.

Loom stops were recorded and classified according to warp or filling stops attributed to yarn defects, preparation defects, and mechanical failure. Causes of stops were further categorized in each of the groups to provide information on specific types of failure.

The number of thousand picks for each warp was recorded by loom pick clocks. Loom stop results were reported as loom stops per million picks.

Estimates of weaving efficiency were made by considering the loom stops caused by yarn failures. Stops caused by preparation defects or mechanical failures were disregarded.

Finishing

Two 25-yard pieces of fabric, woven from filling yarn from replication 1 of each ginning treatment, were selected for finishing. One piece was bleached and the other was bleached and dyed. Two chains of fabric, one for bleaching and the other for bleaching

[4] The use of trade names in this report is for identification purposes only and does not constitute endorsement of the products by the U.S. Department of Agriculture.

TABLE 8.--Grade and staple classification of three harvests of machine- and hand-picked seed cotton after different ginning treatment[1]

Ginning treatment	First harvesting		Second harvesting		Third harvesting	
	Grade	Staple length	Grade	Staple length	Grade	Staple length
		32nds inch		32nds inch		32nds inch
Elaborate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner:	LM	35	LM	34	LM	34
1 lint cleaner[2]	LM+	35	LM	34	LM+	35
2 lint cleaners[3]	SLM	34	LM+	35	SLM	35
Low moisture lint:						
No lint cleaner	LM+	33	LM+	34	SLM	34
1 lint cleaner[2]	SLM Lt Sp	34	SLM	34	SLM	34
2 lint cleaners[3]	M Lt Sp	34	SLM	34	SLM+	34
Moderate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner	LM	34	LM+	35	LM+	34
1 lint cleaner[2]	LM	34	LM+	35	LM+	34
2 lint cleaners[3]	SLM	34	SLM	35	SLM	35
Low moisture lint:						
No lint cleaner	LM Lt Sp	33	LM+	34	LM+	33
1 lint cleaner[2]	SLM Lt Sp	33	LM+	34	SLM	34
2 lint cleaners[3]	SLM	33	SLM+	34	SLM	34

[1] M=Middling; SLM+ = Strict Low Middling plus; SLM = Strict Low Middling; LM+ = Low Middling plus; LM = Low Middling; M Lt Sp = Middling Light Spotted; SLM Lt Sp = Strict Low Middling Light Spotted; LM Lt Sp = Low Middling Light Spotted.

[2] Unit saw-type cleaner.

[3] Battery-type cleaner.

and dyeing, were prepared from the 25-yard pieces and were interspersed with 2-yard control samples to determine the uniformity of bleaching and dyeing. Standard operations and reagents were used to finish the fabric on a continuous finishing range.

Desizing.--Both chains were desized with an enzyme desizing agent before bleaching. The fabric was first wet-out with the appropriate desizing reagents in a two-bowl saturator and was squeezed by pressure rolls as it left each bowl to insure thorough and uniform penetration. After impregnation, both chains were passed into an enclosed box and kept for 17 hours. This aging was followed by washing in a two-bowl washer and by squeezing after each wash. The water in both bowls was at the boiling point. The samples were tested for unconverted starch to insure that the fabrics had been desized thoroughly.

Caustic scouring.--Following desizing, both chains were processed through a 3-percent sodium hydroxide solution and squeezed. When thoroughly saturated, the fabrics

TABLE 9.--Yarn strength and fabric strength of 30s warp yarn spun from machine-harvested cotton ginned under 12 ginning conditions

Ginning conditions	Yarn strength		Fabric warp strength			
			Grey fabric		Bleached fabric	
	Break factor	Single strand strength	Strip strength	Tear strength	Strip strength	Tear strength
	Units	Grams/tex	Lb.	Grams	Lb.	Grams
Elaborate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner	2,281	14.0	57.4	1,414	65	476
1 lint cleaner[1]	2,403	14.7	60.5	1,411	66	468
2 lint cleaners[2]	2,410	14.6	63.5	1,411	65	450
Low moisture lint:						
No lint cleaner	2,158	13.7	56.8	1,370	61	442
1 lint cleaner[1]	2,072	13.3	57.4	1,268	63	476
2 lint cleaners[2]	2,134	13.3	57.2	1,317	59	454
Moderate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner	2,368	13.9	61.5	1,434	63	476
1 lint cleaner[1]	2,383	14.7	61.9	1,410	60	476
2 lint cleaners[2]	2,223	14.0	60.1	1,376	63	493
Low moisture lint:						
No lint cleaner	2,161	13.5	57.8	1,313	60	476
1 lint cleaner[1]	2,100	13.1	54.7	1,299	61	448
2 lint cleaners[3]	2,059	13.3	57.3	1,264	63	459

[1] Unit saw-type cleaner.
[2] Battery-type cleaner.

were stored in a J-box for one hour's steaming at a temperature of 91° C. The fabrics were then washed in boiling water.

Drying.--The opened samples were batched by pulling the fabric over an expander bar and vacuum extractor. Drying was done on a tenter frame using frame settings of 37 inches for the narrower (39-inch) fabrics and 38 inches for the wider (40-inch) fabrics. The drying temperature varied from 99° C. to 115° C. The plain fabric was dried immediately after bleaching, while the dyed fabric was dried only after dyeing.

Dyeing.--The fabric chain to be dyed was batched, placed in a dye jig, and thoroughly rinsed to remove any residual contaminants. The fabric was rinsed for five ends[5] in water at a temperature of 44° C. The jig was emptied and fresh water added after ends 2, 4 and 5.

After the rinsing, the new bath was brought to a depth of 12 inches and set at 60° C. Four gallons of direct dye liquor were added at each half end. The bath temperature was then increased at a rate of 10° C. per end to a temperature of 97.5° C. At this point, an

[5] An end is one complete cycle of the jig, the fabric starting at one side, going to the other, and returning to the starting position.

TABLE 10.--Yarn strength and fabric strength of 40s filling yarn spun from machine-harvested cotton ginned under 12 ginning conditions

Ginning conditions	Yarn strength		Fabric filling strength			
			Grey fabric		Bleached fabric	
	Break factor	Single strand strength	Strip strength	Tear strength	Strip strength	Tear strength
	Units	Grams/tex	Lb.	Grams	Lb.	Grams
Elaborate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner	2,011	14.1	41.1	743	46	312
1 lint cleaner[1]	1,963	13.3	38.5	695	45	292
2 lint cleaners[2]	1,995	13.0	41.9	732	44	284
Low moisture lint:						
No lint cleaner	1,987	12.5	42.8	725	44	316
1 lint cleaner[1]	1,988	12.5	39.7	778	41	300
2 lint cleaners[2]	1,804	11.8	38.9	663	39	279
Moderate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner	2,262	13.5	43.2	789	44	300
1 lint cleaner[1]	2,157	13.4	45.0	791	45	316
2 lint cleaners[2]	2,029	13.3	38.7	711	39	296
Low moisture lint:						
No lint cleaner	1,843	11.8	44.4	722	43	300
1 lint cleaner[1]	1,992	12.0	42.1	698	41	284
2 lint cleaners[2]	1,758	12.2	44.3	751	44	296

[1] Unit saw-type cleaner.
[2] Battery-type cleaner.

aqueous salt solution was added over a period of two ends, 1/4 of the volume being added per half end. The fabric was then given two additional ends, and the dye bath was removed. The samples were rinsed in water with one end in a bath at 45° C. and a second end in a bath at 25° C. Rinsing was followed by a vacuum extraction, batching, and drying.

Testing

All physical tests were performed in a laboratory having controlled conditions of 70° F. and 65 percent relative humidity.

Yarn tests. --Fifteen cones of warp yarn and fifteen cones of filling yarn were selected at random from replication 1 of each ginning condition for testing. From these cones the following yarn properties were determined:

(1) Skein strength (2 skeins per cone)
(2) Yarn size
(3) Break factor
(4) Single-end strength and elongation
(5) Yarn evenness (Uster tester)
(6) Yarn imperfections

TABLE 11.--Evenness and imperfections of 30s warp yarn spun from machine-harvested cotton ginned under 12 ginning conditions

Ginning conditions	Evenness	Imperfections per 500 yards		
		Thin places	Thick places	Neps
Elaborate seed-cotton cleaning:	Percent C. V.	Number	Number	Number
High moisture lint:				
No lint cleaner	20.1	56	126	114
1 lint cleaner[1]	19.5	39	115	127
2 lint cleaners[2]	19.7	51	107	114
Low moisture lint:				
No lint cleaner	19.3	45	135	132
1 lint cleaner[1]	20.7	60	139	113
2 lint cleaners[2]	22.9	141	202	131
Moderate seed-cotton cleaning:				
High moisture lint:				
No lint cleaner	21.2	66	127	90
1 lint cleaner[1]	19.0	41	98	105
2 lint cleaners[2]	20.5	59	124	110
Low moisture lint:				
No lint cleaner	18.9	28	104	93
1 lint cleaner[1]	19.1	29	133	112
2 lint cleaners[2]	22.9	147	172	81

[1] Unit saw-type cleaner
[2] Battery-type cleaner.

Fabric tests. --Tests for fabric properties were made on samples of fabric that were woven with filling yarn from replication 1 of each ginning condition. The following properties were determined:

(1) Fabric strength and elongation for warp and filling
(2) Slubs, neps, trash, and heavy filling
(3) Crease-angle recovery
(4) Stiffness

TABLE 12.--Evenness and imperfections of 40s filling yarn spun from machine-harvested cotton ginned under 12 ginning conditions

Ginning conditions	Evenness	Imperfections per 500 yards		
		Thin places	Thick places	Neps
	Percent C. V.	Number	Number	Number
Elaborate seed-cotton cleaning:				
High moisture lint:				
No lint cleaner	21.2	169	243	175
1 lint cleaner[1]	23.7	193	386	259
2 lint cleaners[2]	22.4	175	276	166
Low moisture lint:				
No lint cleaner	19.9	57	194	122
1 lint cleaner[1]	22.3	264	338	175
2 lint cleaners[2]	23.0	182	291	223
Moderate seed-cotton cleaning:				
High moisture lint:				
No lint cleaner	21.4	164	188	146
1 lint cleaner[1]	22.7	284	275	180
2 lint cleaners[2]	19.9	49	172	118
Low moisture lint:				
No lint cleaner	21.6	124	281	144
1 lint cleaner[1]	21.9	168	329	191
2 lint cleaners[2]	21.8	129	234	123

[1] Unit saw-type cleaner.
[2] Battery-type cleaner.

TABLE 13.--Fabric elongation, slubs, neps, and trash in cloth woven from machine-harvested cotton ginned under 12 ginning conditions

Ginning conditions	Fabric elongation		Total slubs per 100 yards of fabric	Neps per 20 square inches	Trash per 20 square inches	Heavy filling
	Warp	Filling				
	Percent	Percent	Number	Number	Number	Number
Elaborate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner	14.8	13.6	17.3	47	50	5
1 lint cleaner[1]	15.8	16.4	14.6	55	46	9
2 lint cleaners[2]	15.8	14.2	13.3	53	52	6
Low moisture lint:						
No lint cleaner	14.9	14.0	10.3	57	61	10
1 lint cleaner[1]	13.7	14.0	17.6	60	58	14
2 lint cleaners[2]	15.8	15.6	12.9	72	60	5
Moderate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner	17.0	16.4	12.1	51	53	6
1 lint cleaner[1]	16.6	15.8	13.5	49	55	3
2 lint cleaners[2]	15.7	15.8	20.0	58	53	14
Low moisture lint:						
No lint cleaner	15.5	16.2	15.8	48	53	16
1 lint cleaner[1]	16.5	15.1	14.8	56	54	6
2 lint cleaners[2]	16.1	14.9	16.7	57	58	9

[1] Unit saw-type cleaner.
[2] Battery-type cleaner.

TABLE 14.--Fabric elongation, crease angle recovery, and flex stiffness in warp and filling yarns of cloth woven from machine-harvested cotton ginned under 12 ginning conditions

Ginning conditions	30s warp			40s filling		
	Fabric elongation	Crease angle recovery	Flex stiffness	Fabric elongation	Crease angle rec.	Flex stiffness
	Percent	Percent	10^{-4} in. lbs.	Percent	Percent	10^{-4} in. lbs.
Elaborate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner............	15.5	46	1.14	19.6	46	.56
1 lint cleaner[1]............	15.3	45	1.45	20.6	47	.60
2 lint cleaners[2]...........	15.1	44	1.62	22.6	46	.72
Low moisture lint:						
No lint cleaner............	15.7	47	1.28	18.6	47	.73
1 lint cleaner[1]............	16.3	43	1.91	22.8	47	.85
2 lint cleaners[2]...........	14.7	43	1.54	21.4	43	.70
Moderate seed-cotton cleaning:						
High moisture lint:						
No lint cleaner............	16.2	45	1.29	22.9	41	.81
1 lint cleaner[1]............	16.1	42	1.04	20.9	46	.60
2 lint cleaners[2]...........	15.7	42	1.13	20.7	46	.60
Low moisture lint:						
No lint cleaner............	15.9	45	1.58	21.0	47	.71
1 lint cleaner[1]............	11.7	48	1.70	20.0	50	.65
2 lint cleaners[2]...........	14.9	45	1.45	22.6	50	1.00

[1] Unit saw-type cleaner.
[2] Battery-type cleaner.

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