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Bulletin 320

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Cotton Fiber Testing By Shippers and Spinners

in

TENNESSEE AND THE UNITED STATES

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Summary

● This bulletin reports the results of a study of the nature and extent of use of cotton fiber testing facilities and practices of 46 shippers and 18 spinners in Tennessee and 120 shippers and 485 cotton spinners in other states.

● In Tennessee all of the 46 shippers and 11 of the 18 spinners used tests for fineness; 36 shippers and 7 spinners used tests for strength; 7 shippers and 6 spinners used tests for length and length uniformity; and from 1 to 3 shippers and spinners used tests for fiber maturity, nonlint content, color, nep count, fluorescence, and elongation.

● The cotton spinning mills in Tennessee processed 213,571 bales of cotton during the 1957-58 season. Of this cotton, 76 percent was tested for fineness, 52 percent for nep count, 51 percent for strength, 31 percent for length uniformity, 11 percent each for nonlint content and color, and less than 1 percent for fiber maturity or other fiber properties.

● Volume of cotton tested for various fiber properties by shippers and spinners, either before or after purchase, does not indicate the real importance of the use of the tests. Many shippers and spinners used samples representative of lots of cotton, tested fixed proportions of all purchases, tested at random throughout the season, or tested every bale for some properties and a random sample for other properties.

● The primary reasons why cotton spinners have increased their use of cotton fiber testing are: 1) To obtain better measures of raw cotton quality, 2) to avoid getting "culls" or cotton not desirable for making particular end products, and 3) to aid in the control of blending and mixing, nep count, ends down in spinning, carding speed, picker and card waste, yarn appearance and strength, and finishing and dyeing. The demand by domestic and foreign mill customers was the major reason why shippers used fiber tests in their merchandising operations.

● Of the 2.7 million bales of upland cotton bought by the 46 Memphis shippers in the open market, about 4.7 percent was discounted for being too fine, 0.1 percent for being too coarse, and premiums were paid on 0.3 percent for being of certain fineness specifications. Cotton falling within the fineness values of 4.9 to 4.0 was not discounted, and within this range two shippers paid

premiums averaging 17 points on 7,290 bales. A pattern of increasing discounts was reported for fineness values of cotton between 3.9 and 2.5, average discounts ranging from 18 points for cotton of 3.9 to 3.7 fineness to 390 points for cotton of fineness values of 2.5 and less. Five shippers discounted 2,130 bales at an average rate of 50 points "off" for being overly coarse or with fineness values of 5.0 or above.

- No discounts or premiums were reported on cotton purchases of average strength test (76,000 to 85,000 pounds per square inch). Seven shippers reported premiums paid on some cotton of strength above 86,000 pounds per square inch in terms of 10 points for each 1,000-pound increase in strength; and cotton falling below 76,000 pounds test was discounted about 20 points for each 1,000-pound decrease in strength test.

- This report includes a table showing the estimated average cost of cotton fiber testing for 10 different tests involving 18 different instruments or methods. The more important factors associated with differences in the cost of fiber testing per sample were: kind of test, cost of instrument or method, labor cost per hour, tests performed per hour, weeks of operation, number of determinations made per sample, degree of specialization, and control of atmospheric conditions in testing. The cotton fiber tests now having the lowest average cost per test, in order, are: fineness, length and length uniformity, color, moisture content, nep count, nonlint content, strength, maturity, and sugar and acid-alkaline values.

Acknowledgment

The authors of this bulletin hereby acknowledge the cooperation of the cotton shippers, spinners, and managers of fiber testing firms who furnished basic data for the study. Appreciation is expressed to Mr. A. H. Bower, Executive Vice President and Secretary of the Memphis Cotton Exchange, for assistance in securing the cooperation of cotton shippers; and to members of the Technical Committee of the SM-18 Regional Cotton Marketing Project and several staff members of the Tennessee Agricultural Experiment Station for suggestions in preparing this report.

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Cotton Fiber Testing By Shippers and Spinners In Tennessee and the United States

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Introduction

In recent years an increasing number of cotton merchants and spinners in Tennessee and other states have bought instruments or used laboratory methods for appraising such qualities of raw cotton as fineness, strength, length, maturity, nonlint content, color, neps, elongation, fluorescence, and moisture. A study was needed to determine: 1) The nature and extent of use of cotton fiber testing facilities and practices, 2) the use of fiber tests in buying, selling, and spinning cotton, 3) the costs of fiber testing, and 4) the desirability of furnishing growers with additional information on the quality of cotton produced.

The results of this study should prove useful in estimating the effects of cotton fiber tests by showing what fiber properties are considered most important by both domestic and foreign mills. Cotton shippers and spinners in Tennessee may observe how their use of fiber tests compares with that of firms in other sections of the nation. The data presented in this bulletin should also prove useful in pointing out the possibility of reducing the cost of fiber testing.

An increasing reliance upon cotton fiber tests as a supplement to grade and staple length classification could alter the methods of production and merchandising of cotton, and in so doing, affect the position of cotton in the highly competitive fiber market.

METHOD AND SCOPE OF STUDY[1]

Data relating to cotton shippers, used in this study, were for the 1956-57 season. Schedules of information relating to cotton

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[1] The research reported in this bulletin is part of the Tennessee contribution to Regional Project SM-18, "The Evaluation of the Use of Fiber Tests in the Marketing of Cotton and the Relation of Fiber Properties to End Product Performance." Cooperating agencies in the project include the Agricultural Experiment Stations of Alabama, Arizona, Arkansas, Georgia, Louisiana, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and the Agricultural Marketing Service of the USDA.

Two regional bulletins have been published dealing with the use of cotton fiber testing by cotton shippers and spinners in the United States:

Use of Cotton Fiber Tests by United States Cotton Shippers, Southern Cooperative Series Bulletin No. 62, June, 1959.

Use of Cotton Fiber Tests by United States Cotton Mills, Southern Cooperative Series Bulletin No. 70, December, 1959.

fiber testing were obtained by members of the Regional Cotton Marketing Technical Committee in personal interviews with officials of 166 cotton shippers of which 46 were in Memphis, Tennessee. The Tennessee shippers handled 5.1 million bales during the season, or about one-third of the upland cotton handled by all shippers (Table 1). In this study a cotton shipper was defined as a cotton merchandising firm which bought odd lots of cotton and sorted, concentrated, and sold it in even-running lots, chiefly to foreign and domestic mills at "landed" prices.

Table 1. Number of Cotton Shippers and Spinners in Tennessee and the United States, Number Included in the Study, and Volume of Upland Cotton Handled by Shippers, 1956-57 Season, and Spinners, 1957-58 Season.

Item	Tennessee	Other states	United States
Cotton Shippers: Total number	46	120	166
Cotton handled, 1956-57 season (bales)	5,106,605	10,697,395	15,804,000
Cotton Spinners: Total number	18	588	606
Included in study—(no.)	18	485	503
(1957-58) (%)	100	82	83
Cotton consumed, total [a] (bales)	170,377	7,802,333	7,972,710
By plants in study (bales)	213,571 [b]	7,123,932	7,337,503
(1957-58) (%)	100	91.3	92.0

[a] Consumption, including foreign cotton, year ending July 31, 1958, reported by U. S. Bureau of the Census.

[b] Tennessee cotton spinning mills in the 1957-58 season consumed 43,194 more bales of cotton than was reported by the Bureau of the Census, largely because of the inclusion of cotton designated as mill waste, fire-damaged, and below grade.

Data relating to cotton spinners, used in this study, were for the 1957-58 season and obtained by personal interview with officials of firms representing 503 cotton spinning mills, which was about 83 percent of the 606 cotton spinning mills in operation during that season. All cotton spinning mills in Tennessee were included in this study, but they represented less than 4 percent of those included in the sample and only 3 percent of the cotton consumed (Table 1).

Data on fiber testing obtained from each shipper included all upland cotton purchased directly from all sources, including both open-market and Commodity Credit Corporation Cotton (CCC). Information obtained from cotton spinners applied to both direct purchases and purchases from shippers.

Of the 15.8 million bales of upland cotton handled by the 166 shippers in the 1956-57 season, about 41 percent were CCC pur-

chases. Of the 7.3 million bales of upland cotton consumed by the 503 cotton spinning mills, 63 percent was bought from shippers, and 37 percent direct by mill firms.

Cotton Fiber Testing Facilities and Practices

INSTRUMENTS USED IN TESTING

Shippers and spinners in this study reported different degrees of ownership and use of 18 kinds of instruments or methods for making 10 different tests on raw cotton (Table 2). In Tennessee all of the 46 Memphis shippers interviewed used tests for fineness, 36 for strength, 7 for length and length uniformity, 3 for fiber maturity, 3 for nonlint content, 2 for color, 2 for nep count, and 1 for elongation. Of the 18 cotton mills in the state, 11 used tests for fineness, 7 for strength, 6 for length uniformity, 3 for fluorescence, 2 for maturity, 2 for color, and 2 for nonlint content. Raw cotton fiber tests for sugar or wax content and acid-alkaline values were made by a few of the cotton spinners in the United States, but none were reported by Tennessee spinners.

Shippers and spinners were not limited to the use of their own instruments for obtaining fiber test results. As shown in Table 2, many firms had such tests made at commercial laboratories. In many cases the firms that owned instruments had some of the less common tests made at a commercial laboratory. In addition to the use of commercial laboratory tests, several agencies used the testing facilities of other shippers or spinners.

Supplementing the methods used for testing raw cotton, many of the spinners performed tests for physical or chemical properties of cotton yarn or finished goods. Some of the more important of these included tests for manufacturing waste, nep count in spinning tests by card web evaluation, spinning twist, yarn skein strength, elongation, abrasion, dimensional change, crease resistance or wrinkle recovery, flammability, snag resistance, and color of finished goods. The extent and use of such tests was not determined.

Among cotton shippers and spinners in Tennessee and the United States there was a relationship between the size of firm and the use of instruments for testing fiber properties; that is, as the volume of cotton handled by shippers increased or the size of the spinning mill increased in number of spindles, greater use was made of cotton fiber testing. This was especially true for tests other than for fineness and strength.

Table 2. Fiber Testing Instruments Owned and Used by 166 Cotton Shippers, 1956-57 Season, and 503 Cotton Spinners, 1957-58 Season, Tennessee and United States.

Type of test	Instrument or method	Tennessee		Other states		United States	
		Shippers	Spinners	Shippers	Spinners	Shippers	Spinners
		46	18	120	485	166	503
		Percent of agencies owning or using					
	Micronaires	58.7	50.0	54.2	65.8	55.5	65.3
	Port-Ars	8.7	11.1	11.7	1.9	11.0	2.2
Fineness	Speedars	0	0	0.8	5.6	0.6	5.4
	Arealometers	0	0	0	4.1	0	4.0
	Use of fee lab	78.3	0	29.2	2.5	42.7	2.4
	Pressleys	8.7	33.3	15.8	41.4	14.0	41.2
Strength	Stelometers	2.2	0	0.8	6.8	1.2	6.6
	Clemson Testers	0	0	0	2.9	0	2.8
	Use of fee lab	78.3	5.6	50.8	[a]	58.5	[a]
Length and length uniformity	Fibrographs	4.3	33.3	7.5	24.7	6.7	25.1
	Suter-Webb Sorters	2.2	11.1	2.5	8.5	2.4	8.5
	Uster Sorters	0	0	0	4.5	0	4.2
	Use of fee lab	8.9	0	0.8	[a]	3.0	[a]
Maturity	Maturity tests[b]	6.5	11.1	0.8	15.1	2.4	14.9
	Use of fee lab	6.5	0	0	0.8	1.8	0.8
Color	Colorimeter	0	11.1	3.3	4.1	2.4	4.4
	Use of fee lab	4.3	0	0	3.1	1.2	3.0
Fluorescence	Ultraviolet light	0	16.7	0	14.4	0	14.5
Nonlint content	Shirley Analyzer	0	11.1	2.5	14.6	1.8	14.5
	Use of fee lab	6.5	0	0.8	[a]	2.4	[a]
Nep count	Neptometer	0	0	0	3.7	0	3.8
	Use of fee lab	4.3	[a]	0	[a]	1.2	[a]
Moisture	Moisture meter	0	0	0	1.2	0	1.2

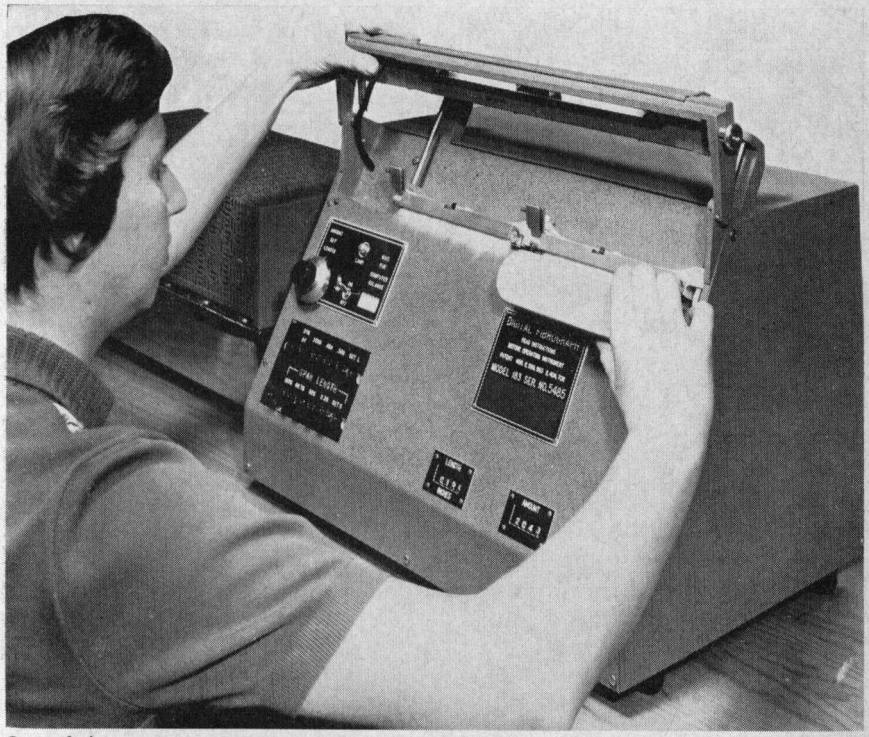
[a] No data.

[b] Arealometer, Microscope, Causticaire, or Differential Dye methods.

LENGTH OF USAGE OF TESTS

Facilities for commercial testing raw cotton for various fiber properties have been available in Memphis since 1947. One commercial fiber testing laboratory was established in 1947 and another in 1949. Both laboratories were equipped for making cotton fiber tests for fineness, strength, length, maturity, foreign matter or nonlint content, color, and other specialized tests for nep count, moisture, sugar or wax content, damage by oxidation, and acid-alkaline values. Although commercial cotton fiber testiny facilities have been available to farmers, seed breeders, ginners, cotton mill operators, and cotton merchants, the most important users have been the cotton merchants.

In 1947, shippers in Memphis began buying Micronaires for



One of the important instruments used commercially in testing cotton fiber for length and length uniformity is the Digital Fibrograph. (Photo courtesy of Spinlab, Inc.)

use in testing cotton for fineness, and Pressleys in testing for strength. By 1957 the number of shippers owning Micronaires had increased to 31; also, 4 shippers reported the ownership of the Port-Ar, a portable instrument used in testing for fineness. Five Memphis shippers in 1957 reported owning instruments used in testing cotton fiber for strength. Three of these had been in use from 7 to 10 years and 2 had been used from 1 to 3 years. Only 3 of the Memphis shippers owned instruments used in testing for length and length uniformity, and these machines had been used 1 to 3 years (Table 3).

For all shippers in the United States in 1947, only five reported owning instruments used in testing cotton for fineness or strength. By 1957 about 67 percent of all shippers in the United States owned one or more different kinds of instruments used in testing for fineness, and 15 percent owned one or more different kinds of instruments used in testing for strength.

As indicated in Table 3, seven Tennessee cotton spinners re-

Table 3. Length of Usage of Fiber Testing Instruments Owned by 46 Cotton Shippers and 18 Spinners, Tennessee, 1957-58.

Type of test	Instruments owned	Years in service of instrument: 1 to 3	4 to 6	7 to 15	Over 15	Total
		Number of shippers reporting, 1957				
Fineness	Micronaires	17	11	3	0	31
	Port-Ars	4	0	0	0	4
Strength	Pressleys	1	0	3	0	4
	Stelometers[a]	1	0	0	0	1
Length and length uniformity	Fibrographs	2	0	0	0	2
	Suter-Webb Sorters	1	0	0	0	1
		Number of spinners reporting, 1958				
Fineness	Micronaires	1	2	3	3	9
	Port-Ars	2	0	0	0	2
Strength	Pressleys	1	1	2	2	6
Length and length uniformity	Fibrographs	0	1	3	2	6
	Suter-Webb Sorters	0	0	2	0	2
Maturity	Maturity tests	1	0	1	0	2
Color	Colorimeters	0	1	1	0	2
Fluorescence	Ultraviolet light	1	2	0	0	3
Nonlint content	Shirley Analyzers	0	1	1	0	2

[a] The Stelometer also is used in testing for elongation.

ported in 1958 that they had owned instruments used in making fiber tests for fineness, strength, and length for over 15 years, or before 1944. For all cotton spinners in the United States there has been a considerable increase in the usage of fiber tests in recent years. During the years 1944 to 1958, the proportion of spinners using fiber tests for fineness increased from 10 to 78 percent; for strength, 16 to 50 percent; for length, 12 to 38 percent; for fiber maturity, 6 to 16 percent; for color, 1 to 7 percent; nonlint content, 2 to 14 percent; and for nep count, none to 4 percent.[2]

In 1956, a study was made of 572 foreign agencies in 51 different foreign countries of the use of cotton fiber testing instruments. Foreign shippers and spinners began using tests for length uniformity, maturity, and nonlint content before 1946, tests for strength in 1947, tests for fineness and color in 1949, and tests for elongation in 1953.[3]

REASONS FOR USING TESTS

A small percentage of the shippers began the use of cotton fiber

[2] Data for 1944 are based upon the report: *Practices of Textile Manufacturers in the Purchase of Cotton*, Processed Report, Cotton Branch, USDA, February, 1952.

[3] Raskopf, B. D. and Fontana, J. R., *Cotton Fiber Testing in Foreign Countries*, Tennessee Agricultural Experiment Station Bulletin No. 271, September, 1957.

testing because it provided better evaluation of quality or enabled them to avoid buying bales of cotton which had been culled by other buying agencies. However, most of the shippers in Tennessee and other states indicated that the demand by domestic and foreign mill customers was the major factor in their decision to use fiber tests.

The primary reasons for this mill demand were to obtain better measures of raw cotton quality, to aid in the control of processing operations, and to avoid getting "culls" or cotton not desirable for making particular end products in which many mills specialized (Table 4).

Table 4. Reasons for Using Fiber Tests Reported by 166 Cotton Shippers, 1956-57 Season, and 503 Cotton Spinners, 1957-58 Season, Tennessee and United States.

Reasons for using fiber tests	Tennessee		Other states		United States	
	Shippers	Spinners	Shippers	Spinners	Shippers	Spinners
	46	18	120	485	166	503
	Percent of agencies reporting[a]					
Demand by mill customers	93	0	75	0	80	0
Better measure of raw cotton quality	13	56	12	60	12	60
Necessary to avoid buying culls	9	50	5	28	6	29
Control of processing operations	0	56	0	62	0	62
Blending and mixing	0	56	0	62	0	62
Nep count	0	39	0	17	0	18
Ends down[b]	0	56	0	31	0	32
Carding speed	0	56	0	16	0	17
Picker and card waste	0	56	0	75	0	74
Yarn appearance	0	50	0	33	0	34
Yarn skein strength	0	56	0	45	0	45
Finishing and dyeing	0	50	0	60	0	60

[a] Some shippers and spinners reported more than one reason; therefore, the percentages in some columns total more than 100 percent.
[b] Refers to the breakage of the yarn at the spinning frame.

In the control of cotton processing operations the spinners indicated many factors of importance, including blending and mixing, nep count, ends down, carding speed, picker and card waste, yarn appearance, yarn strength, and finishing and dyeing.

The difficulty of making an economic evaluation of the use of fiber tests in these various areas of processing control became evident early in this study. This was true for the following reasons: 1) Important factors of spinning performance are closely related to, or affected by, several different fiber characteristics, (see Appendix I); 2) many different types of instruments are used to test the same fiber property and these instruments vary considerably as to cost, speed in operation, purposes, and performance; and

3) the relative importance of the effects of fiber properties varies in relation to the end product manufactured. It was impossible for cotton spinners to indicate what would have been the results financially if cotton fiber tests were discontinued in their operations. On the other hand, most spinners who were using fiber tests could justify their use on the basis of efficiency of control in specific processing operations or general processing performance.

METHOD OF SAMPLING

Several different sampling methods were employed by shippers and spinners in Tennessee and other states in testing cotton fiber properties before and after the purchase of cotton. These were: 1) Testing every bale of particular lots for one or more fiber properties; 2) testing every bale of particular lots for some properties and a sample of the lot for other properties; 3) testing a fixed proportion of all purchases for one or more properties; 4) testing for one or more properties from bales sampled at random throughout the season; 5) testing cotton bought from certain territories only; and 6) a combination of two or more of the above methods. By the method of composite sampling, some shippers and spinners took a small portion of each bale sample to form one laboratory sample representative of an entire lot. In the preparation of cotton samples for testing, some shippers and many spinners were using different types of cotton blenders.

NUMBER OF DETERMINATIONS MADE PER TEST SAMPLE

Of the 46 shippers interviewed in Tennessee, 31 owned instruments for making fineness tests and all of these made one determination per test sample. The other 15 had cotton tested for fineness by a fee laboratory where two or more determinations were made per sample. In testing cotton for fineness, 11 of the shippers indicated that the test sample was from one side of the bale, but 35 included cotton from both sides. In testing cotton for fineness, five test operators knew in advance the hand class for grade and staple length, and seven knew if the sides of the bale tested were of different grades or staple length. Of the 36 Tennessee shippers who tested cotton for strength, all but one used more than one break per test sample; also, all tests included cotton from both sides of the bale. The testing of cotton for properties other than fineness and strength for shippers was performed mainly by commercial laboratories, and the number of determina-

tions made per test sample varied according to specifications of the shippers.

In Tennessee, 9 of the 10 spinners testing cotton for fineness used only one test per sample, and one spinner made four tests. Three of the spinners testing for fineness used a sample from both sides of the bale, five took a sample from one side, and two spinners used blended samples. For the spinners testing cotton for strength, from 1 to 6 breaks were used per sample. For tests other than for fineness and strength, the variation in number of determinations made per sample was related to method of sampling and the purpose of testing. Where cotton samples were mixed or blended, usually only one determination was used.

CHECKING COTTON FIBER TESTING INSTRUMENTS

Several methods were reported as to frequency of using calibration samples for checking cotton fiber testing instruments. These checks were made: daily or several times daily, two or three times weekly, before the testing of new lots of cotton, or when unusual readings occurred. Some firms checked their instruments by having a few samples of cotton tested by commercial laboratories.

LOCATION OF FIBER TESTING INSTRUMENTS

All shippers owning fiber testing instruments had them located in their classing room or small separate rooms in their office space. Only a few of the shippers with larger volume and who used several different types of instruments had air-conditioned, fiber-testing laboratories. The fiber testing performed for shippers by commercial laboratories was done with facilities for maintaining temperature and relative humidity at recommended levels. Most of the cotton spinners that did fiber testing had air-conditioned laboratories in which to conduct the tests.

USE OF FIBER TESTS IN BUYING COTTON

PROPORTION OF ALL COTTON TESTED BEFORE PURCHASE

Shippers. Of the 15.8 million bales of upland cotton handled by 166 shippers during the 1956-57 season, about 41 percent was CCC cotton and no fiber test data were available before purchase. Of the 9.3 million bales of open-market purchases from the interior, brokers, and shippers, fineness data were available before purchase on 52 percent and strength data on 14 percent. Tennessee shippers, compared with those of other states—in their

open-market purchases in the interior and from brokers—reported a higher proportion of cotton tested for fineness and strength (Table 5).

Shippers reported the use of only fineness and strength tests in the purchase of cotton. However, 100,000 bales of cotton were tested for other fiber properties after purchase. This enabled the shippers to supply both domestic and foreign mills with cotton of certain fiber specifications other than fineness and strength.

Spinners. Of the 7.3 million bales of upland cotton purchased by all spinners during the 1957-58 season, 37 percent was bought direct and 63 percent from shippers. Of the cotton purchased direct, fineness information data were available before purchase on 75 percent and strength data on 3 percent. Of the cotton purchased by spinners from shippers, 86 percent was bought on fineness specifications, 10 percent on strength specifications, and slightly over 1 percent on the basis of other tests, including length uniformity, maturity, color, nep count, and nonlint content. Tennessee spinners, compared with those in other states, in their direct purchases reported a higher proportion of the cotton tested for fineness and strength. In their purchases from shippers, the Tennessee spinners reported a somewhat lower proportion based on fineness tests and a higher percentage based on strength tests (Table 5).

Tennessee spinners reported the use of only fineness and strength tests in buying cotton. After purchase, 52 percent of the cotton was tested for nep count, 31 percent for length uniformity, 11 percent each for nonlint content and color, and less than 1 percent for maturity (not indicated in Table 5).

USE OF TESTS AS BUYING GUIDES

Cotton shippers and spinners in Tennessee and other states used fineness and strength tests as buying guides in several different ways. The method used most commonly in making interior purchases was to determine the fineness and strength of randomly-selected cotton in a certain area. Another method was the spot checking of actual samples from a given lot of cotton. The least common method was to test every bale before buying a lot of cotton.

Shippers used fiber tests in two ways when buying cotton through brokers: 1) With spot checks of actual samples from an entire lot of cotton, and 2) by testing each individual bale in a given lot of cotton. In the purchase of cotton from other shippers

Table 5. Volume of Upland Cotton Purchases with Fiber Test Data Available, 166 Cotton Shippers, 1956-57 Season, and 503 Cotton Spinners, 1957-58 Season, Tennessee and United States.

Item	Tennessee	Other states	United States
		Number of bales of cotton	
Shippers, cotton purchased	5,106,605	10,697,395	15,804,000
CCC purchases[a]	2,363,831	4,115,169	6,479,000
Open-market purchases	2,742,774	6,582,226	9,325,000
Interior	1,676,069	5,738,931	7,415,000
Tested for: Fineness[b]	1,118,241	3,294,146	4,412,387
Strength[b]	561,842	568,154	1,129,996
Brokers	1,049,734	512,266	1,562,000
Tested for: Fineness[b]	266,275	14,885	281,160
Strength[b]	120,839	1,161	122,000
Shippers	16,971	331,029	348,000
Tested for: Fineness[b]	5,739	117,861	123,600
Strength[b]	5,674	506	6,180
Spinners, cotton purchased	213,571	7,123,932	7,337,503
Direct purchases	77,313	2,622,887	2,700,200
Tested for: Fineness[b]	67,720	1,959,297	2,027,017
Strength[b]	64,820	18,360	83,180
From shippers	136,258	4,501,045	4,637,303
Based on: Fineness[c]	95,518	3,897,905	3,993,423
Strength[c]	44,400	432,100	476,500
Other tests[c]	0	60,099	60,099

[a] No fiber test data available on cotton before purchase.
[b] Cotton tested before buying or test data available.
[c] Fiber test specifications in contracts.

the transactions were generally on the basis of guaranteed terms as to fineness or strength.

Cotton spinners in Tennessee and other states used contract specifications in their purchases from shippers in obtaining cotton of desired fineness, strength, or other fiber properties. Types of specifications most generally used were for fineness range or minimum, and strength minimum. Of the 4.6 million bales of cotton purchased from shippers by 503 spinners, 57 percent was on fineness range, 32 percent on fineness minimum, and 9 percent on strength minimum. Only 1.3 percent of the purchases on shipper contracts included requirements for fiber properties other than fineness and strength.

SHIPPER PREMIUMS AND DISCOUNTS

Fineness. The 46 shippers in Tennessee in the 1956-57 season bought slightly over 2.7 million bales of cotton in the open market.

An unknown portion of this cotton was not grown in the Memphis territory. Of these purchases an estimated 128,796 bales, or 4.7 percent, were discounted for being too fine and 2,130 bales, or 0.1 percent, were discounted for being too coarse. Differences existed among shippers as to what constituted excessively fine or coarse cotton, depending upon the product being manufactured by the mill customers of individual shippers. However, there was considerable relationship between the Memphis shippers' average discount rate and fiber fineness ratings (Table 6). Average discounts varied from 18 points for cotton of 3.9 to 3.7 fineness to 390 points for cotton of fineness values of 2.5 and less. Between the fineness ratings of 3.8 and 2.5, each 0.1 decrease in fineness was associated with a discount increase of about 28 points.

Table 6. Discounts and Premiums for Fineness of Upland Cotton Reported by 46 Shippers in Tennessee, 1956-57 Season.

Fineness values in micronaire units[a]	Discounts				No. Firms
	Points off		Bales	Value	
	Range	Av.	No.	$	
2.5 and under	350-500	390	376	7,330	2
2.6 to 2.9	150-400	198	9,739	96,242	10
3.0 to 3.3	50-250	87	60,744	263,175	14
3.4 to 3.6	35-100	56	26,141	73,485	11
3.7 to 3.9	15- 25	18	31,796	28,602	4
4.0 to 4.9	even[b]		0	0	46
5.0 and over	0	50	2,130	5,325	4
Total or average		72	130,926	474,159	46

[a] Micrograms per inch of fiber.
[b] Two shippers paid premiums on 7,290 bales of cotton falling within this fineness range.

About 63 percent of the open-market purchases fell within the average fineness range 4.9 to 4.0 and was not discounted (Table 7). Within this fineness range, two shippers paid premiums on 7,290 bales. These premiums ranged from 10 to 50 points "on" and averaged 17 points, or 83 cents per bale. Only 7 percent of the cotton falling within the fineness range of 3.9 to 3.5 was discounted at an average rate of about 26 points "off", or $1.29 per bale. Nearly 41 percent of the cotton in the fineness range 3.4 to 3.0 was discounted for being too fine, and the discount averaged 87 points "off," or $4.35 per bale. Cotton falling below 3.0 in fineness was discounted at an average rate of 205 points "off," or $10.24 per bale. In the latter group the discounts increased to 500 points as the fineness of cotton ranged below 2.5 value in micronaire units.

Table 7. Fineness of Open-Market Cotton Purchased by 46 Tennessee Shippers and Fineness Discounts Reported, Season 1956-57.

Fineness				Discounts	
Description	Values in micronaire units	Purchases			
		Bales	%	Bales	Value per bale
Very fine	Below 3.0	57,598	2.1	10,115	$10.24
Fine	3.0 to 3.4	170,052	6.2	69,371	4.35
	3.5 to 3.9	666,494	24.3	49,310	1.29
Average	4.0 to 4.4	1,297,332	47.3	0	0
	4.5 to 4.9	430,616	15.7	0	0
Coarse	5.0 to 5.9	120,682	4.4	2,130	2.50
Very coarse	6.0 and above	0	0	0	0
Total or average		2,742,774	100.0	130,926	3.62

The discounting of cotton for being overly coarse was not widely practiced. While there were 120,682 bales bought with fineness value over 5.0, only five shippers discounted 2,130 bales at an average rate of 50 points "off", or $2.50 per bale.

During the 1956-57 season, about 400,000 bales of cotton bought by 164 shippers in the United States were discounted for fineness. As indicated in Table 7, the 46 shippers in Tennessee handled 130,926 bales of this cotton. Only 3 of the 164 shippers indicated that they paid premiums to obtain 36,000 bales of cotton of desired fineness values. Two of these were located in Tennessee.

Strength. Data were available for only seven shippers in Tennessee who considered the fiber quality of strength in the pricing of upland cotton purchases. The volume of cotton bought partly on strength specifications, that was given premiums or discounts, was not available. No discounts or premiums were reported on cotton purchases of average strength or cotton with strength (0-gauge) of 76,000 to 85,000 pounds per square inch (Table 8).

Table 8. Discounts and Premiums for Strength of Upland Cotton Reported by Seven Shippers in Tennessee, 1956-57 Season.

Strength description	Strength (0-gauge) 1,000 lb. per square inch	Premiums Points "on"	Discounts Points "off"
Very strong	Above 95	100 to 200	0
Strong	95 to 86	10 to 100	0
Average	85 to 76	even	even
Fair	75 to 66	0	20 to 200
Weak	Below 66	0	220 to 300

The seven shippers reported premiums paid for cotton of strength above 86,000 pounds per square inch in terms of about

10 points for each 1,000-pound increase in strength. Cotton falling below 76,000-pound test was discounted about 20 points for each 1,000-pound decrease in strength test.

SPINNER DISCOUNTS AND DISPUTES OF COTTON PURCHASES

Of the 7.3 million bales of upland cotton bought by 503 spinners during the 1957-58 season, only 17,000 bales were reported to be discounted or disputed for not meeting fineness specifications (Table 9). The low rate of discounts and disputes were attributed to four important reasons: 1) The wide range in products manufactured by many large firms made it possible for them to use the cotton in their overall operation regardless of variation in fiber properties; 2) many firms, particularly the small ones, avoided buying cotton in areas where certain fiber properties were undesirable; 3) the large proportion of cotton tested for fineness and strength made it possible for shippers to sort and concentrate cotton into uniform lots which met mill requirements; and 4) in contract specifications for fineness, strength and other fiber properties, most spinners allow small test deviations or tolerances.

Table 9. Volume of Upland Cotton Purchased, Tested for Specified Fiber Properties, Discounted, and Disputed, 503 Cotton Spinners, 1957-58 Season, Tennessee and United States.

Item		Tennessee	Other states	United States
			Bales of cotton	
Total spinner purchases		213,571	7,123,932	7,337,503
Direct purchases		77,313	2,622,887	2,700,200
Tested before purchase for:	Fineness	67,720	1,959,297	2,027,017
	Strength	64,820	18,360	83,180
Discounted for fineness:	Too fine	0	12,100	12,100
	Too coarse	0	4,000	4,000
Purchases from shippers		136,258	4,501,045	4,637,303
Test data available for:[a]	Fineness	95,518	3,897,905	3,993,423
	Strength	44,400	432,100	476,500
	Other properties	0	60,099	60,099
Disputed purchases on:	Fineness	263	16,756	17,019
	Strength	0	[b]	[b]
	Other properties	0	[b]	[b]

[a] Based on contract specifications.
[b] No data available or none reported.

Use of Fiber Tests in Selling Cotton

PROPORTION OF ALL COTTON SOLD ON TESTS

Of the 15.8 million bales of upland cotton handled by the 166 shippers during the 1956-57 season, about 64 percent was sold on the basis of fineness specifications, 12 percent on strength specifications, and less than 1 percent on the basis of all other tests—length uniformity, maturity, color, nep count, and nonlint content. Considerable variation existed in the proportion of cotton sold on a test basis according to whether the cotton was purchased in the open market or from the Commodity Credit Corporation, and as to whether the sales were to domestic or foreign firms (Table 10).

OPEN-MARKET COTTON

Of the 9.3 million bales of cotton purchased in the open market, test data were available on about 52 percent for fineness, 14 percent for strength, and 0.6 percent for other tests. Of this open-market cotton, 58 percent was sold on fineness, 11 percent on strength, and 0.6 percent on other tests. The Tennessee shippers, compared with those in other states, reported a much higher pro-

Table 10. Volume of Upland Cotton Sold That Was Partly Based on Fiber Test Specifications, 166 Cotton Shippers, 1956-57 Season, Tennessee and United States.

Type of sale and test specification	Tennessee	Other states	United States
		Number of bales of cotton	
Open-Market Cotton	2,742,774	6,582,226	9,325,000
Domestic sales	1,852,728	4,345,272	6,198,000
Fineness	1,490,244	2,091,277	3,581,521
Strength	402,400	143,394	545,794
Other tests[a]	9,500	28,850	38,350
Export sales	890,046	2,236,954	3,127,000
Fineness	650,385	1,135,615	1,786,000
Strength	246,964,	271,036	518,000
Other tests[a]	10,500	9,550	20,050
CCC Cotton	2,363,831	4,115,169	6,479,000
Domestic sales	1,011,632	1,240,368	2,252,000
Fineness	858,367	778,733	1,637,100
Strength	305,743	71,600	377,343
Other tests[a]	8,185	6,265	14,450
Export sales	1,352,199	2,874,801	4,227,000
Fineness	926,942	2,145,958	3,072,900
Strength	261,352	134,400	395,752
Other tests[a]	9,047	18,103	27,150

[a] Length uniformity, maturity, color, nep count, and nonlint content.

portion of both domestic and export sales based on fineness and strength tests.

CCC COTTON

Of the 6.5 million bales of cotton purchased from the CCC, none were tested for fineness, strength, or other fiber properties before purchase. After buying, 73 per cent of the CCC cotton was tested for fineness, 3 percent for strength, and 0.6 percent for other fiber properties. This testing was performed primarily as an aid in sorting and concentrating cotton into uniform lots for resale. Of the CCC cotton, 73 percent was sold on fineness, 12 percent on strength, and 0.6 percent on other tests. The Tennessee shippers, compared with those of other states, reported a higher proportion of domestic sales based on fineness, and a higher proportion of both domestic and export sales based on strength.

Although only 206,000 bales of the CCC cotton were tested for strength, 773,095 bales were sold on strength specifications (Table 10). In the sorting and grouping of cotton into uniform lots to be sold on the basis of strength test specifications, it was generally considered that a 25 percent sample of bales from the same locations would be representative.

Cotton sold on the basis of fiber tests, other than for fineness and strength, generally was reported by the larger shippers. Of the CCC cotton sold on specifications of length uniformity, maturity, color, nep count, and nonlint content, 14,450 bales were domestic sales and 27,150 bales were exported.

FINENESS SPECIFICATIONS IN SALES

Among the 166 shippers a wide variation existed as to fineness specifications on sales. To show this variation a tabulation was made of the volume of cotton sold on fineness minimum or range specifications on domestic and export sales of cotton handled by 46 shippers in Memphis during the 1956-57 season. Of the 5,106,605 bales of cotton, 23 percent was sold without regard to fineness specifications. Of the 3,925,938 bales sold on fineness, data were available on 3,282,899 bales of known fineness specifications in sales (Appendix II).

The more common fineness specifications, in both domestic and export sales, in order of importance of volume sold, were 3.8 to 5.0, 3.5 to 5.0, 3.8 minimum, 3.5 minimum, 3.7 to 5.0, 3.6 to 5.0, 3.7 minimum, 3.5 to 4.0, 3.7 to 4.5, 3.8 to 4.5, and 3.8 to 4.8. Over 2.5 million bales were sold on the above fineness values.

Thirty- nine different specifications in fineness were reported in domestic sales and 36 different fineness specifications in export sales. The more common fineness specifications were in terms of ranges. In many cases these ranges were very narrow.

There was not much cotton sold with fineness specifications under 3.5. Although 227,650 bales handled by the Tennessee shippers fell within this range (170,052 of 3.0 to 3.4 and 57,598 below 3.0, as shown in Table 7), only 124,624 bales were sold on such fineness specifications. The balance of this cotton was sold to foreign and domestic mills that could use the finer cotton.

Of the 3,282,899 bales of cotton sold on known fineness specifications, about 72 percent of the sales were limited as to coarseness. The maximum coarseness values in micronaire units among such sales varied from 3.7 to 5.2. However, many domestic and foreign mills were able to use cotton regardless of its coarseness. Over 40 percent of the 5,106,605 bales of cotton handled by the Tennessee shippers was sold without specification as to fineness.

Spinner Use of Fiber Tests in Controlling Processing Operations

Of the 503 spinning mills studied, 10 of the 18 in Tennessee and 292 of the 485 in other states reported the use of fiber testing to obtain better measures of raw cotton quality. The extent and use of fiber tests by spinners in buying cotton has been previously discussed and summarized in Tables 5 to 9.

Several reasons for testing the cotton after it was purchased were reported by the spinners. The results of tests were used as a basis for mixing and blending operations and for developing information as an aid in controlling other manufacturing operations. The more important areas of processing control include: 1) Blending and Mixing,[4] 2) Nep Count, 3) Ends Down, 4) Carding Speed, 5) Picker and Card Waste, 6) Yarn Appearance, 7) Yarn Skein Strength, and 8) Finishing and Dyeing. Most of the above factors are closely related to each other, and each of the above factors is related to one or more fiber properties as indicated in Appendix I.

BLENDING AND MIXING

Of the 503 cotton spinners included in the study, 10 of the 18 in Tennessee and 302 in other states reported that the results of fiber tests were used as a basis for their blending and mixing

[4] Blending and mixing refer to the process of intermingling fibers from different bales or lots to produce a uniform mixture.

operations. In obtaining basic data on fiber tests for mixing and blending, 78 percent of the spinners owned or used instruments for making tests for fineness, 50 percent for strength, 38 percent for length, 16 percent for maturity, 14 percent each for nonlint content and fluorescence, 7 percent each for color and elongation, 4 percent for nep count, and under 2 percent for moisture.[5]

Of the above 10 fiber tests, the two which were used most extensively as bases for developing formulas for mixing and blending cotton were fineness and strength. Of the 213,571 bales of cotton consumed by Tennessee spinning mills, 42 percent was blended or mixed on the basis of fineness of fiber information and slightly over 7 percent on strength test data. For the 7,123,932 bales of cotton consumed by 485 spinning mills in other states, 68 percent was blended or mixed on the basis of fineness of fiber information and slightly over 2 percent on strength data (Appendix III).

Tennessee spinners, compared with those in other states, reported greater use of fiber fineness test information in the cotton blending and mixing operations in the manufacture of print cloth, fine cotton goods, and colored yarn fabrics. In Tennessee the proportion of mix tested for fineness averaged 100 percent for print cloth and fine cotton goods, 97 percent for colored yarn fabrics, 30 percent for sheeting, 25 percent for sales yarn, and none for other products (Appendix III).

For all spinners in the United States, the proportion of mix tested for strength ranged from about 6 percent in the manufacture of sales yarn to none reported in the manufacture of towels and toweling. Tennessee spinners, compared with those in other states, reported greater use of fiber test strength information in the mixing and blending operations in the manufacturing of sheeting, print cloth, colored yarn fabrics, and fine cotton goods. In Tennessee the proportion of mix tested for strength averaged 52 percent for colored yarn fabrics, 10 percent for print cloth and fine cotton goods, 4 percent for sheeting, under 3 percent for sales yarn, and none for towels and toweling, duck, and other goods.

Many cotton spinners indicated that fiber strength is a very difficult, time-consuming, and costly test to perform. In testing cotton mix for strength the spinners generally tested only a proportion of mix, but these tests usually represented fairly large lots of cotton. For these reasons the low percentages of cotton mix

[5] In addition, all spinners had information on classification for grade and staple length of cotton consumed.

tested for strength, shown in Appendix III, do not exactly indicate the real importance of strength test information used in mixing and blending operations.

NEP COUNT

Neppiness of cotton is associated with fiber fineness, length, and maturity. About 18 percent of the 503 cotton spinners reported that they used some test data for these three fiber properties in estimating nep potential. Only 19 of these spinners reported the use of Neptometers in determining nep count. Many spinners were concerned about obtaining data relating to the susceptibility of cotton to nepping because of sources of trouble in manufacturing yarns and fabrics. When the nep count in card web is high the cotton is likely to produce rough and neppy yarns. High nep count also detracts from the appearance of finished products when they are to be dyed or printed.

ENDS DOWN

Ends down in spinning, or the breakage of yarn at the spinning frame, is influenced by fiber fineness, strength, and length. About 32 percent of the 503 spinners indicated that they used some test data for these three properties in the control of ends down in spinning.

CARDING SPEED

The rate at which cotton is carded is influenced by fiber fineness, strength, length, nonlint content, and neps. About 17 percent of the 503 spinners stated that they used some test data for these five qualities in the control of carding speed.

PICKER AND CARD WASTE

Picker and card waste in the processing operations is influenced by fiber fineness, length, maturity, nonlint content, and neps. Manufacturing waste in cotton is important because excessive waste increases the cost of cotton products. The percentage of waste extracted by the picking and carding processes provided all spinners with a measure of manufacturing waste. Most spinners had other basic data on fiber properties related to picker and card waste. Of the 503 spinners, 78 percent had instruments for making tests for fineness, 38 percent had instruments used in testing for length and length uniformity, and 16 percent were equipped for making maturity tests. In addition, 14 percent of the spinners

reported the use of the Shirley Analyzer for testing the nonlint content of cotton. The results obtained from testing for nonlint content are distinguished from total picker and card waste in that practically no fiber is included in the nonlint content test.

YARN APPEARANCE

Yarn appearance is influenced by many fiber characteristics, including fineness, strength, length, maturity, fluorescence, nonlint content, and neps. As indicated in Table 2, a considerable proportion of the spinners reported many different kinds of instruments used in testing for the seven fiber properties related to yarn appearance. An estimated 34 percent of the 503 spinners used some fiber test data in the control of yarn appearance grades.

YARN SKEIN STRENGTH

The strength of the final product depends basically on fiber strength, but not on strength alone. Yarn strength is influenced by fiber length, fineness, maturity, and fiber service properties. About half of the cotton spinners had or used instruments for making strength tests of raw cotton. Strength test data were used by cotton spinners as an aid in blending and mixing operations, control of ends down in spinning, determining carding speed, estimating yarn appearance grades, finishing and dyeing operations, and governing general processing performance.

FINISHING AND DYEING

A close relationship exists between the finishing and dyeing properties of cotton and fiber fineness, strength, maturity, color, neps, and fiber damage. About 62 percent of the cotton spinners used some cotton fiber test data as an aid in their mixing and blending operations and such information was useful as a basis for selecting cottons of similar finishing and dyeing properties. Different varieties and growths of cotton have different finishing and dying properties. Information about such differences is important to cotton spinners in their mixing and blending operations.[6]

Cost of Cotton Fiber Testing

FACTORS RELATED TO COSTS OF TESTING

An important objective of this study was to determine the cost of cotton fiber testing. Since so many variables were associated

[6] *Annual Cotton Quality Surveys*, Summary of Results of Fiber and Processing Tests from Selected Markets, Agricultural Marketing Service, USDA.

with costs it was believed that the most effective way of presenting these costs was through setting up some models or systems in the form of tables. Basic data are provided in each model or system which may be used by the individual shipper or spinner in estimating expected costs with changes in volume tested and labor inputs.

The results of interviews with shippers and spinners in Tennessee and other states indicated that the more important factors associated with differences in the cost of fiber testing per sample are: 1) Kind of test, 2) cost of instrument or method (fixed cost), 3) labor cost per hour, 4) tests per man hour, 5) weeks of operation, 6) number of determinations made per sample, 7) degree of specialization, and 8) control of temperature and moisture in testing. These eight factors were considered in preparing tables that show the estimated average cost per test (Appendix IV).

The tables include data for 10 different tests involving 18 different instruments or methods. In computing fixed costs, the 1960 prices of instruments and auxiliary equipment were secured from various manufacturers, spinners, and shippers. In figuring annual fixed costs, depreciation is charged at 10 percent, interest 6 percent, repair 2 percent, taxes 1.25 percent, and insurance at 0.8 percent. No charge was made for buildings or rent since the shippers and spinners in this study had ample room for cotton fiber testing instruments in cotton classing rooms or office space.

In this study labor costs are charged at $2.00 an hour per test operator. Other operating costs per hour include utilities, calibration samples, supplies, and sundries. The number of tests per man hour for the various instruments or methods are based upon rates obtained by cotton shippers, spinners, and other workers in classing rooms and laboratories under sustained operations. Average rates take into consideration such factors as rest stops, stops for repair and calibration of instruments, degree of specialization, average efficiency of workers, number of determinations made per test sample, kind of instrument or method, and up to 50 percent variation in daily volume which may occur during a week of operation.

The number of weeks of operation is related to volume tested. The volume of cotton tested during any specified number of weeks of operation is determined by multiplying the number of weeks by 44 times the average number of tests per man-hour. The number of determinations made per test sample varies according to the

type and purpose of the test, the accuracy desired in testing, and the method of sampling.

The degree of specialization in cotton fiber testing relates to such factors as type of test; kind, purpose, and capacity of instrument; auxiliary equipment; and general control of operations. In this study, *Standard* refers to one person performing the entire test, including preparation of samples, testing, and record keeping, and little specialization. *Specialization* refers to two persons performing the test operations and many or most of the processes of testing automatically performed or controlled by self-operating machines or devices.

Many cotton shippers are now performing various types of cotton fiber tests in classing rooms with uncontrolled atmospheric conditions. In this study *No AC* refers to no atmospheric control and *AC* refers to atmospheric control of moisture and temperature in the conditioning of cotton before and during testing. The annual fixed cost of an atmospheric controlled (5,000 cu ft.) laboratory is charged at $500. In Appendix IV, the average cost of fiber testing for each test is given under atmospheric control. Where cotton is tested for more than one fiber property, which is usually the case, only one charge should be considered for the extra cost of testing under atmospheric control.

FINENESS

The four instruments most commonly used in testing cotton fiber properties for fineness are the Micronaire, Speedar, Port-Ar, and Arealometer. Since 1958 an instrument known as the Fibronaire has come into use for fineness testing. The Arealometer, in addition to measuring fineness, also measures immaturity or shape of fibers; from the measured properties of fineness and immaturity, approximate values of other properties—such as weight per inch, perimeter, and wall thickness—may be calculated.[7] The costs of fiber tests with the Arealometer are shown under Maturity Tests, Appendix IV.

When the necessary auxiliary equipment are considered, little difference exists in the annual fixed and operating costs, precision, and performance in tests per man-hour of the instruments—Micronaire, Speedar, Port-Ar, or Fibronaire. The important factors associated with the wide variations in cost per fineness test are volume of tests, degree of specialization, and whether the tests are

[7] *Genetics and Cytology of Cotton, 1948–55,* Southern Cooperative Series Bulletin No. 47.

conducted under controlled or uncontrolled atmospheric conditions (Appendix IV).

Under standard operating conditions, with one person performing all of the testing procedures, no atmospheric control, and one determination per sample, the average cost ranges from 23 cents per test for one 44-hour week of operation or 1,320 tests to 7 cents per test for 50 weeks of operation or 66,000 tests; with atmospheric control, the average cost ranges from 61 cents per test for 1 week of operation to 8 cents per test for 50 weeks.

Under specialized conditions, no atmospheric control, and one determination per sample, the average cost ranges from about 6 cents per test for 1 week of operation or 7,920 tests to 2 cents per test for 50 weeks of operation or 396,000 tests; with atmospheric control, the average cost ranges from 13 cents per test for 1 week of operation to 3 cents per test for 50 weeks. Some large volume shippers were able to reduce the cost of fineness testing, under atmospheric control, to under 2 cents per test by using more than one instrument and with almost complete specialization.

STRENGTH

The three instruments most commonly used in testing cotton fiber properties for strength are the Pressley, Stelometer, and Clemson Flat Bundle Tester. When the necessary auxiliary equipment are considered, little difference exists in the average fixed and annual costs, precision, and performance in tests per man hour of these instruments. The important factors associated with wide variations in costs per strength test are volume of tests, degree of specialization, number of determinations or breaks made per test sample, and whether the tests are conducted under controlled or uncontrolled atmospheric conditions.

Under standard operating conditions, with one person performing all testing procedures, no atmospheric control, and two determinations per sample, the average cost ranges from 78 cents per test for one 44-hour week of operation or 264 tests to 36 cents per test for 50 weeks of operation or 13,200 tests; with atmospheric control the average cost ranges from about $2.70 per test for 1 week of operation to 41 cents per test for 50 weeks.

Under specialized conditions, no atmospheric control, and two determinations per sample, the average cost ranges from 56 cents per test for 1 week of operation or 528 tests to 35 cents per test for 50 weeks of operation or 26,400 tests; with atmospheric

control, the average cost ranges from $1.52 per test for 1 week of operation to 37 cents per test for 50 weeks.

This study revealed that in the past, most fiber strength tests have been performed by shippers and spinners with instruments using the 0-gauge or without any space between the jaws of the instrument. In this study the cost of fiber testing includes the charge for equipping instruments for testing with ⅛-inch gauge. Fiber strength tests obtained at ⅛-inch gauge are more closely correlated with yarn strength than fiber strength tests obtained at 0-gauge.[8]

LENGTH AND LENGTH UNIFORMITY

The three instruments most commonly used in testing cotton fiber properties for approximation of length and length uniformity are the Fibrograph, Suter-Webb Sorter,[9] and the Uster Sorter. The latter is of foreign manufacture. Data were available for estimating the average cost of cotton fiber testing for length and length uniformity with the Digital Fibrograph. The important factors associated with the wide variations in average cost per test for length and length uniformity are volume of tests, degree of specialization, number of determinations made per test sample, and whether the tests are conducted under controlled or uncontrolled atmospheric conditions.

Under standard operating conditions, with one person performing all testing procedures, no atmospheric control, and one determination per sample, the average cost ranges from 45 cents per test for one 44-hour week of operation or 1,320 tests to 8 cents per test for 50 weeks of operation or 66,000 tests; with atmospheric control, the average cost ranges from 83 cents per test for 1 week of operation to 9 cents per test for 50 weeks.

Under specialized conditions, no atmospheric control, and one determination per sample, the average cost ranges from 17 cents per test for 1 week of operation or 3,960 tests to 5 cents per test for 50 weeks of operation or 198,000 tests; with atmospheric control the average cost ranges from 30 cents per test for 1 week of operation to 5 cents per test for 50 weeks.

MATURITY

The four methods used in testing cotton for maturity or immaturity are the Arealometer, Microscope, Differential Dye, and

[8] *Cotton Testing Service*, Agricultural Marketing Service, USDA, AMS No. 16, February, 1955.

[9] The cost of the Suter-Webb Sorter and description of its operation may be obtained from the Alfred Suter Co., 200 Fifth Avenue, New York 10, New York.

Causticaire. The methods differ widely from the standpoint of such factors as principles involved, equipment and materials required, fixed and operating costs, tests performed per man hour, kind and accuracy of results obtained, and the significance of the results in relation to spinning performance.

Under standard operating conditions, with one person performing all testing procedures, no atmospheric control, and one determination per sample, the average cost ranges from $6.19 to $1.11 per test (depending upon method) for one 44-hour week of operation or 44 to 264 tests and from $2.18 to 37 cents per test for 50 weeks of operation or 2,200 to 13,200 tests; with atmospheric control, the average cost ranges from $17.66 to $3.01 per test for 1 week of operation and from $2.51 to 42 cents per test for 50 weeks of operation.

Under specialized conditions, no atmospheric control, and one determination per sample the average cost ranges from $2.29 to 72 cents per test (depending upon method) for 1 week of operation or 176 to 528 tests, and from $1.05 to 35 cents per test for 50 weeks of operation or 8,800 to 26,400 tests; with atmospheric control, the average cost ranges from $5.16 to $1.67 per test for 1 week of operation and from $1.13 to 38 cents per test for 50 weeks of operation.

Maturity testing procedures by the methods of Differential Dye, Microscope, and Causticaire, require from 1 to 4 hours per test, but several tests can be performed concurrently. An increase in the number of operators, machines and auxiliary equipment generally more than doubles the tests per man-hour.

NONLINT CONTENT

Nonlint content is commonly measured by the Shirley Analyzer which is used for separating foreign material from fibers in samples of raw cotton. It requires about 6 minutes to run a 100-gram sample or 10 tests per hour with one operator. The rate cannot be increased by using more than one person with one machine because the operator can perform such testing procedures as weighing, calculating, and recording while one sample is being run through the Shirley Analyzer.

Under standard operating conditions, with one person performing all testing procedures, no atmospheric control, and one determination per sample, the average cost ranges from $1.80 per test for one 44-hour week of operation or 440 tests to 24 cents per test for 50 weeks of operation or 22,000 tests. With atmospheric

control, the average cost ranges from $2.95 per test for 1 week of operation to 28 cents for 50 weeks.

NEP CONTENT

The instrument commonly used by cotton spinners for predicting the potential of cotton fibers to form neps is the Neptometer. It requires about 4 minutes to run a 25-gram sample or 15 tests per hour with one operator. The rate cannot be increased by using more than one person with one machine since the operator can perform other testing procedures while the sample is being run through the Neptometer.

Under standard operating conditions, with one person peforming all testing procedures, no atmospheric control, and one determination per sample, the average cost ranges from 60 cents per test for one 44-hour week of operation or 660 tests to 15 cents per test for 50 weeks of operation or 33,000 tests. With atmospheric control the average cost ranges from $1.36 per test for 1 week of operation to 17 cents per test for 50 weeks of operation.

COLOR

The most commonly used instrument for measuring color of cotton is the Colorimeter. This instrument measures reflectance and the degree of yellowness of cotton electronically. The color value obtained may be plotted on a color diagram for comparison with the color of the cotton in official grade standards.

Under standard operating conditions, with one person performing all testing procedures, no atmospheric control, and one determination per sample, the average cost ranges from 65 cents per test for one 44-hour week of operation or 1,320 tests to 8 cents per test for 50 weeks of operation or 66,000 tests; with atmospheric control, the average cost ranges from $1.04 per test for 1 week of operation to 9 cents per test for 50 weeks.

Under specialized conditions, no atmospheric control, and one determination per sample, the average cost ranges from 24 cents per test for 1 week of operation or 3,960 tests to 5 cents per test for 50 weeks of operation or 198,000 tests; with atmospheric control, the average cost ranges from 37 cents per test for 1 week of operation to 5 cents for 50 weeks.

MOISTURE CONTENT

The amount of moisture in cotton is considered an important factor in ginning, in testing for various fiber properties, and in mill processing. Several moisture meters are being sold for

measuring the moisture content of samples of lint. The accuracy of these meters is readable to the tenth part of 1 percent moisture content in the range of 3 to 20 percent.

Under standard operating conditions, with one person performing all testing procedures, no atmospheric control, and one determination per sample, the average cost ranges from 17 cents per test for one 44-hour week of operation or 1,100 tests to 9 cents per test for 50 weeks of operation or 55,000 tests; with atmospheric control the average cost ranges from 63 cents per test for 1 week of operation to 10 cents per test for 50 weeks.

Under specialized conditions, no atmospheric control, and one determination per sample, the average cost ranges from 13 cents per test for 1 week of operation or 2,200 tests to 8 cents per test for 50 weeks of operation or 110,000 tests; with atmospheric control the average cost ranges from 35 cents per test for 1 week of operation to 9 cents for 50 weeks.

SUGAR CONTENT AND ACID-ALKALINE VALUES

High sugar content is associated with difficulty in textile processing and with lower yarn appearance grades. Sugar content in fiber tests is determined by quantitative analysis. Acid-alkaline values in terms of pH units are determined on water extracts from samples of cotton. The pH values below 7 indicate acidity and those above 7 indicate alkalinity. When associated with low sugar content, values above 7 may indicate deterioration of cotton from the action of micro-organisms.[10]

When the necessary auxiliary equipment is considered, little difference exists in the annual fixed and operating costs, precision, and performance in tests per man-hour between the tests for sugar content and acid-alkaline values.

Under standard operating conditions, with one person performing all testing procedures, no atmospheric control, and one determination per sample, the average cost of testing for either sugar content or acid-alkaline values ranges from 88 cents per test for one 44-hour week of operation or 220 tests to 43 cents per test for 50 weeks of operation or 11,000 tests. With atmospheric control, the average cost ranges from $3.17 per test for 1 week of operation to 50 cents for 50 weeks.

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[10] Raskopf, B. D., *Cotton Yields and Quality in Tennessee*, Tennessee Agricultural Experiment Station Bulletin No. 298, April 1958.

FLUORESCENCE

Fluorescence is the appearance of cotton under ultraviolet light, commonly referred to as "black light." It is being used by about 15 percent of the cotton spinners in fiber testing in determining the presence on cotton of fungi, oil, stem and leaf chlorophyll stains, and other material which may indicate damaged cotton, or in determining whether the cotton has been rapidly dried at high temperatures. As shown in Appendix I, the important factors of processing performance related to fluorescence are blending and mixing, carding speed, yarn appearance, yarn strength, and finishing and dyeing. Ultraviolet light used in cotton testing in a curtained booth can be installed in the classing room for about $100. One operator can examine up to 75 samples per hour for fluorescence or appearance of cotton under ultraviolet light.

EFFECTS OF ATMOSPHERIC CONDITIONS ON TESTING

This study revealed that many shippers and spinners test cotton for fiber properties, particularly fineness, strength, and length and length uniformity, without control of moisture or temperature. Probably the main reason for this, as indicated in Appendix IV, is the higher cost of testing under controlled atmospheric conditions. This is especially true under conditions of small volume tested or only a few weeks of operation.

A study made by the United States Department of Agriculture indicates that when testing raw cotton for fineness, without control of atmospheric conditions, certain correction factors may be used for adjusting test value.[11] Correction factors can be applied to fineness readings for cotton ranging from 3.5 to 5.5 when tested at relative humidities ranging from 20 to 89 percent and within a temperature range of 65 to 90 degrees F. In strength, length, and length uniformity tests, correction factors may be established under standard atmospheric conditions.

The importance of the effects of atmospheric conditions on testing certain fiber properties may be summarized as follows: 1) An increase in relative humidity results in an increase in fineness readings; an increase in temperature results in a decrease of fineness readings in the range of 60 to 70 degrees F. and a slight increase in the range from 70 to 90 degrees F.; 2) an increase in relative humidity and/or temperature results in an increase in the strength

[11] *Effects of Atmospheric Conditions on Testing Certain Cotton Fiber Properties*, Cotton Branch, USDA, October 1953.

of cotton fibers, with the stronger cottons showing the greatest increase; 3) an increase in relative humidity and/or temperature results in an increase of Fibrograph length and length uniformity readings.

EFFECTS OF CHANGES IN VOLUME AND LABOR ON COSTS

Basic data are provided in Appendix IV which may be used by the individual shipper or spinner in estimating the expected costs of cotton fiber testing with variations in volume or labor requirements. The use of these data is indicated in six possible cases in Appendix V. The illustrations show the estimated average costs of cotton fiber testing for fineness with changes in volume and labor, under standard operation conditions, and no atmospheric control. Similar illustrations can be formulated for estimating the cost of fiber testing for fineness under specialized conditions with changes in volume and labor inputs and with atmospheric control; and for any other of the 10 different cotton fiber tests discussed in this report.

The results obtained in examples indicated in Appendix V may be summarized as follows: 1) Changes in large monthly volume of samples tested have little effect on the annual cost of cotton fiber testing per sample; this is generally true even if little or no labor is used to perform other duties when the testing machines are not in operation. 2) Changes in small monthly volume of samples tested also have little effect on the annual cost of cotton fiber testing if the labor can be used to perform other jobs when the testing machines are not in operation. If full-time labor is charged to testing, the cost per sample is high with small volume of tests. 3) With small irregular monthly volume and full-time labor costs charged to testing, it would be cheaper for the shipper or spinner to have fiber tests performed by commercial fee laboratories.

COMMERCIAL FEE LABORATORIES

A higher proportion of cotton shippers, compared with spinners, had fiber tests performed by fee laboratories. Also, a higher proportion of the Tennessee shippers, compared with those of other states, used the services of fee laboratories.

The charge for fiber testing made by commercial firms is shown in Appendix VI. Information presented in Appendixes IV and VI may be used by the individual firm in determining whether it is

more economical to do its own testing or to use a fee laboratory. For example, under specialized conditions, atmospheric control, and the same number of determinations made per test sample, it would be cheaper for a firm to do its own testing, for any particular test, if it made about the following number of tests annually:

Tested for	*Number of Tests*
Fineness	14,400
Strength	275
Length and length uniformity	720
Maturity-(Microscope)	90
(Causticaire)	130
(Arealometer)	70
(Differential Dye)	220
Nonlint content	400
Nep test (Neptometer)	165
Moisture (Moisture Meter)	150
Sugar content or acid-alkaline values	300

In the above example the entire cost of an atmospherically-controlled laboratory is considered in performing the tests for fineness. If a firm is already equipped with an atmospherically-controlled classing room or laboratory, it would be cheaper to do its own fineness testing if it made around 4,100 tests annually.

Important factors to be considered by a firm in deciding whether to conduct its own fiber tests or to use a fee laboratory are: 1) Commercial laboratory technicians are trained specialists; 2) all tests at commercial laboratories are conducted under controlled atmospheric conditions; 3) there is probably less chance for commercial disputes if commercial laboratories test cotton; 4) the volume of cotton to be tested and portability of some kinds of instruments; 5) the importance of speed and convenience in determining the fiber characteristics; and 6) the extent to which test operators can be used to perform other jobs when the cotton fiber testing machines are not operating at capacity.

The price schedule shown in Appendix VI is a sliding rate covering all testing performed for an account during the crop year. The unit price per test decreases with the volume of testing performed during the year. A user of the testing service is billed at the end of each month for all samples tested and reported during that month. The price is based upon the total cumulative number of samples tested for that account since the start of the crop year.

Special discounts are extended for annual contract or volume commitments and combinations of tests.

Discussion

The Smith-Doxey Act of 1937 directed the United States Secretary of Agriculture to make available cotton classification and market news services to any group of producers organized to promote the improvement of cotton and who complied with such regulations as prescribed. In Tennessee the proportion of the state's cotton planted acreage in the Smith-Doxey program increased from 1 percent in 1938 to 97 percent or more during the past 5 years. The proportion of state ginnings classed under the program increased from less than 1 percent in 1938 to 74 percent in 1958.

During the period of the expansion of the Smith-Doxey program, the participating growers have been furnished with a green card (Form I) showing the cotton classification on each individual bale as to grade and staple length. Other cotton fiber properties—such as fineness, strength, length uniformity, and maturity—have not been designated on the Form I or government class card. This may be attributed to several reasons: 1) As indicated in this study, cotton fiber testing by shippers and spinners started several years after the passage of the Smith-Doxey Act of 1937; 2) legislative action is required to amend the Smith-Doxey Act to provide for the testing and recording of fiber properties other than grade and staple length on the Form I card; and 3) the placing of additional information on the government class card is a controversial issue, particularly among cotton merchants.

The results of this study have the following implications:

Use of cotton fiber tests by shippers and spinners to supplement visual grade and staple length evaluations increased considerably during the past 15 years. The change from visual to technical fiber testing methods in merchandising cotton is expected to continue. Important problems relating to these changes are to develop more efficient instruments essential in reducing the cost of fiber testing, better understanding of the use of these instruments, consistent patterns of premiums and discounts given for cotton of various fiber properties, and an accurate, rapid, and economical method for the testing and dissemination of test results to all segments of the cotton industry.

One proposed solution to these problems is to amend the Smith-

Doxey Act to include provision for fiber testing and recording test information on the Form I government class card, and authorization for collection and dissemination of additional market news information relating to discounts and premiums for cotton of different fiber properties. It appears feasible that in the beginning the government testing and market news procedures be limited to fiber testing for fineness for each bale. As faster and more economical methods of testing are developed, additional testing procedures could be added for length uniformity, strength, maturity, nonlint content, nep count, or other important fiber characteristics.

Another proposed solution is to have the cotton fiber testing performed by commercial fee laboratories located at public cotton warehouses where cotton is concentrated in large volume. For example, the 14 cotton compresses and warehouses in West Tennessee have a total storage capacity of over a million bales. These compresses and warehouses perform many cotton services, including physical protection of cotton from weather, mud, dust, fire, mutilation, petty picking and theft; the conversion of warehouse receipts into desirable collateral for loans; distribution of the marketing season over a longer period; facilitating the concentration and movement of cotton through marketing channels; and the storage of a large volume of cotton under government loan.

Consideration of the above proposals appears justified for the following reasons:

1) If the grower is to supply the merchant or mill with cotton of certain fiber properties, it is necessary that the producer and seed breeder be the first to know what these fiber characteristics are and the extent to which these differences may be reflected back to the producer in the form of premiums and discounts. In the 1956-57 season, 166 shippers in the United States sold over 10 million bales with fineness specifications, 1.8 million bales with strength specifications, and 100,000 bales with other fiber test designations.

2) About 60 percent of the 166 cotton shippers in the United States were in favor of recording the fineness values on the government Form I cotton class card.

3) In the 1956-57 season, 6.5 million bales of cotton were exported and sold to domestic spinning mills from Commodity Credit Corporation holdings. No information about cotton fiber tests, such as fineness, strength, length uniformity, or maturity, was available on this cotton prior to its purchase.

4) The recording of cotton fiber test values on the Form I class card should result in less likelihood for mercantile disputes.

5) This study shows that by far the most important factor associated with the cost of cotton fiber testing is the volume of cotton tested. The large quantity of cotton moving through government classing offices and cotton warehouses is sufficient to reduce the cost of testing for some cotton fiber properties to a minimum. For example, under specialized conditions and with atmospheric control, the average cost of testing for fineness is reduced to under 3 cents per test for 396,000 tests and for length and length uniformity to under 6 cents per test for 198,000 tests.

6) As indicated in Tables 5, 9, 10 and Appendix III, some of the cotton handled by shippers and spinners was tested for the same fiber properties as many as four times—before and after purchase by shippers, and before and after purchase by spinners. If the cotton were tested for some of the more important fiber properties after ginning, much of the duplication of testing by merchants and mills could be eliminated.

Appendix I

Important Raw Cotton Fiber Characteristics Measured by Cotton Shippers and Spinners, Instruments Used, and Factors of Spinning Performance Affected by Fiber Tests.

Instrument or method	Fiber property or test	Important factors of processing performance related to fiber property
Micronaire Port-Ar Speedar Arealometer Shirley WIRA Meter[a] Fibronaire	Fineness	General processing performance, blending and mixing, nep count, ends down, carding speed, picker and card waste, yarn appearance, yarn strength, and finishing and dyeing.
Pressley Clemson Tester Stelometer	Strength	General processing performance, blending and mixing, ends down, carding speed, yarn appearance, yarn strength, and finishing and dyeing.
Fibrograph Suter-Webb Sorter Zweigle Sorter[a] Balls Sorter[a] Uster Sorter[a] Shirley Method[a] Electroimpex[a]	Length and length uniformity	General processing performance, blending and mixing, nep count, ends down, carding speed, picker and card waste, yarn appearance, and yarn strength.

Appendix I (Continued)

Instrument or method	Fiber property or test	Important factors of processing performance related to fiber property
Causticaire Arealometer Microscope Differential Dye Acid-Alkaline test Sugar content	Maturity	General processing performance, blending and mixing, nep count, picker and card waste, yarn appearance, yarn strength, and finishing and dyeing.
Colorimeter	Color	Blending and mixing, and finishing and dyeing.
Ultraviolet light	Fluorescence	Blending and mixing, carding speed, yarn appearance, yarn strength, and finishing and dyeing.
Shirley Analyzer[a]	Nonlint content	General processing performance, carding speed, picker and card waste, and yarn appearance.
Neptometer	Neps	General processing performance, nep count, carding speed, picker and card waste, yarn appearance, and finishing and dyeing.
Clemson Tester Stelometer	Elongation	General processing performance, and yarn strength.
Moisture Meter	Moisture	General processing performance.

[a] Instruments of foreign manufacture.

SOURCE: Raskopf, B. D., *Cotton Yields and Quality in Tennessee*, Tennessee Agricultural Experiment Station Bulletin No. 298, April 1959.

Raskopf, B. D. and Fontana, J. R., *Cotton Fiber Testing in Foreign Countries*, Tennessee Agricultural Experiment Station Bulletin No. 271, September 1957.

Cable, Curtis C., Jr. and Holder, H. S., *Use of Fiber Testing in Marketing Arkansas Cotton*, Arkansas Agricultural Experiment Station Bulletin No. 594, November 1957.

Cotton Testing Service, U. S. Department of Agriculture, Agricultural Marketing Service, AMS No. 16, February 1955.

Appendix II

Volume of Cotton Sold on Fineness Minimum or Range Specifications, Domestic and Export Sales, 46 Shippers, Tennessee, 1956-57 Season.

Fineness specifications in micronaire units	Domestic sales	Export sales	All sales
		Bales of cotton	
Under 3.0	738	707	1,445
3.0 min.	1,181	973	2,154
3.0-3.7	7,125	47	7,172
3.0-4.0	6,300	0	6,300
3.0-4.4	800	0	800
3.2 min.	0	54,524	54,524
3.2-4.5	1,200	0	1,200

Appendix II (Continued)

Fineness specifications in micronaire units	Domestic sales	Export sales	All sales
3.4 min.	51,029	0	51,029
3.5 min.	178,074	16,104	194,178
3.5-3.7	13,500	0	13,500
3.5-4.0	65,813	65,225	131,038
3.5-4.3	29,007	4,826	33,833
3.5-4.8	61	12	73
3.5-5.0	229,570	98,642	328,212
3.6 min.	77,413	7,500	84,913
3.6-4.2	1,721	2,511	4,232
3.6-4.4	3,344	21	3,365
3.6-4.5	19,550	22,950	42,500
3.6-4.9	0	31,390	31,390
3.6-5.0	80,950	80,950	161,900
3.7 min.	57,102	76,441	133,543
3.7-4.2	4,134	6,605	10,739
3.7-4.5	68,302	60,776	129,078
3.7-4.8	30,492	0	30,492
3.7-4.9	8,248	2,484	10,732
3.7-5.0	175,782	14,494	190,276
3.8 min.	128,197	167,165	295,362
3.8-4.0	15,525	0	15,525
3.8-4.2	13,875	47	13,922
3.8-4.4	24,055	9,435	33,490
3.8-4.5	74,344	44,116	118,460
3.8-4.6	0	17,306	17,306
3.8-4.7	3,050	5,022	8,072
3.8-4.8	113,161	1,371	114,532
3.8-5.0	445,666	278,257	723,923
3.9 min.	0	8,100	8,100
4.0 min.	10,082	82,696	92,778
4.0-4.5	11,217	4,426	15,643
4.0-4.7	0	28,470	28,470
4.0-4.8	0	65,534	65,534
4.0-5.0	10,646	41,038	51,684
4.1-4.5	1,800	0	1,800
4.1-5.2	7,623	0	7,623
4.2 min.	0	1,806	1,806
4.5 min.	3,973	578	4,551
4.6-5.0	5,700	0	5,700
Known	1,980,350	1,302,549	3,282,899
Unknown[a]	368,261	274,778	643,039
None[b]	515,749	664,918	1,180,667
Total	2,864,360	2,242,245	5,106,605

[a] Cotton tested for fineness but fineness sales data not available.
[b] Cotton not sold on fineness specifications.

Appendix III

Volume of Cotton Consumed and Mix Tested for Fineness and Strength, by Principal End Products, 503 Cotton Spinners in Tennessee and United States, 1957-58 Season.

Item		Tennessee		Other states		United States	
		No.	%	No.	%	No.	%
				Bales of cotton			
All products		213,571	100.0	7,123,932	100.0	7,337,503	100.0
Mix tested for:	Fineness	90,252	42.3	4,854,748	68.1	4,945,000	67.4
	Strength	15,778	7.4	168,222	2.4	184,000	2.5
Sheeting[a]		30,380	14.2	1,979,620	27.8	2,010,000	27.4
Mix tested for:	Fineness	9,161	30.2	1,267,839	64.0	1,277,000	63.5
	Strength	1,161	3.8	44,839	2.3	46,000	2.3
Sales yarn[b]		126,221	59.1	1,252,779	17.6	1,379,000	18.8
Mix tested for:	Fineness	31,051	24.6	634,949	50.7	666,000	48.3
	Strength	3,117	2.5	82,883	6.6	86,000	6.2
Print cloth[c]		32,200	15.1	1,310,800	18.4	1,343,000	18.3
Mix tested for:	Fineness	32,200	100.0	996,800	76.0	1,029,000	76.6
	Strength	3,220	10.0	22,780	1.7	26,000	1.9
Colored yarn fabrics[d]		15,446	7.2	836,554	11.7	852,000	11.6
Mix tested for:	Fineness	15,040	97.4	751,960	89.9	767,000	90.0
	Strength	8,000	51.8	15,000	1.8	23,000	2.7
Fine cotton goods[e]		2,800	1.3	782,200	11.0	785,000	10.7
Mix tested for:	Fineness	2,800	100.0	554,200	70.9	557,000	71.0
	Strength	280	10.0	720	0.1	1,000	0.1
Towels and toweling[f]		6	[i]	300,994	4.2	301,000	4.1
Mix tested for:	Fineness	0	0	108,000	35.9	108,000	35.9
	Strength	0	0	0	0	0	0
Duck[g]		6,158	2.9	162,842	2.3	169,000	2.3
Mix tested for:	Fineness	0	0	144,000	88.4	144,000	85.2
	Strength	0	0	2,000	1.2	2,000	1.2
Other products[h]		360	0.2	498,143	7.0	498,503	6.8
Mix tested for:	Fineness	0	0	397,000	79.7	397,000	79.6
	Strength	0	0	0	0	0	0

[a] Sheeting, osnaburgs, twills, drills, jeans, poplins, gabardines, and sateens.

[b] Knitting, thread, carpet, tufting, cordage, rope, twine, and mop.

[c] Print cloth, tobacco cloth, cheese cloth, bandage cloth, gauze, and corded broadcloths.

[d] Denims, chambrays, ginghams, seersuckers, corduroys, shirting, bed tickings, suitings, cottonades, coverts, and cords.

[e] Combed broadcloths, dimities, lawns, organdies, voiles, marquisettes, oxfords, piques, shirtings, combed poplins, combed sateens, twills, and combed sheetings.

[f] Turkish and terry-woven towels; buck, damask, and jacquard-woven; dishtowels, and dishcloths

[g] Duck, filter cloth, and chafer fabric.

[h] Flannels, blankets, insulation coverings, and miscellaneous.

[i] Less than 0.1 percent.

Appendix IV

Estimated Average Cost of Cotton Fiber Testing by Weeks of Operation for Specified Tests, Tests Per Man-Hour, Number of Determinations Made Per Test Sample, Degree of Specialization, and Atmospheric Control, Shippers and Spinners, 1960.

Item	Annual costs: Fixed	Annual costs: Oper. per hour	Tests per man-hour	Weeks of operation (44-hour week): 1	2	4	8	12	25	50
	$	$	No.	*Average cost per test in cents*						
Fineness Test[a]										
Standard—No AC	212	2.10	30	23.1	15.0	11.0	9.0	8.3	7.6	7.3
AC	712	2.20	30	61.3	34.3	20.8	14.1	11.8	9.5	8.4
Specialized—No AC	313	4.10	180	6.2	4.3	3.3	2.8	2.6	2.4	2.3
AC	813	4.20	180	12.6	7.5	4.9	3.6	3.2	2.7	2.5
Strength Test[b]										
Standard—No AC	114	2.10	6	78.2	56.6	45.8	40.3	38.6	36.7	35.9
AC	614	2.20	6	269.6	153.1	94.9	65.8	56.1	46.0	41.3
Specialized—No AC	114	4.10	12	55.8	45.0	39.6	36.9	36.0	35.0	34.6
AC	614	4.20	12	151.5	93.2	64.1	49.6	44.7	39.8	37.3
Length Test[c]										
Standard—No AC	499	2.10	30	44.8	25.9	16.5	11.7	10.2	8.5	7.8
AC	999	2.20	30	83.0	45.2	26.3	16.8	13.6	10.4	8.8
Specialized—No AC	499	4.10	90	17.2	10.9	7.7	6.1	5.6	5.1	4.8
AC	999	4.20	90	29.9	17.3	11.0	7.8	6.8	5.7	5.2
Maturity Test[d]										
Arealometer: Standard—										
No AC	198	2.10	6	111.4	72.5	53.8	44.4	41.3	38.0	36.5
AC	698	2.20	6	301.1	169.2	103.0	69.8	58.8	47.3	42.0
Specialized—										
No AC	198	4.10	12	71.7	52.9	43.5	38.9	37.3	35.7	34.9
AC	698	4.20	12	167.2	101.1	68.0	51.5	46.0	40.3	37.6
Microscope: Standard—										
No AC	180	2.10	1	619.1	414.5	312.3	261.1	244.1	226.4	218.2
AC	680	2.20	1	1765.5	992.7	606.4	413.2	348.8	281.8	250.9
Specialized—										
No AC	223	4.10	4	229.2	165.9	134.2	118.3	113.1	107.6	105.0
AC	723	4.20	4	515.8	310.4	207.7	156.3	139.2	121.4	113.2

Standard refers to one person performing the test with little specialization.

Specialized refers to two persons performing the test and many or most of the processes of testing automatically performed or controlled by self-operating machines or devices.

No AC refers to no atmospheric control. *AC* refers to atmospheric control or regulation of temperature and moisture in the testing room or laboratory.

[a] Test performed with the Micronaire, Fibronaire, Speedar, or Port-Ar. One determination made per test sample.

[b] Test performed with the Pressley, Stelometer, or Clemson Flat Bundle Tester. Two determinations made per test sample.

[c] Test preformed with the Fibrograph. One determination made per test sample.

[d] Test performed with the Arealometer, Microscope, Differential Dye Technique, or Causticaire Method. One determination made per test sample.

[e] Includes annual fixed costs of depreciation, interest, repairs, taxes, and insurance. Operating costs per hour include labor, utilities, calibration samples, supplies, and sundries.

Appendix IV (Continued)

Item	Annual Costs: Fixed	Annual Costs: Oper. per hour	Tests per man-hour	Weeks of operation (44-hour week): 1	2	4	8	12	25	50
	$	$	No.	*Average cost per test in cents*						
Differential										
Dye: Standard—										
No AC	100	2.25	3	150.8	112.9	93.9	84.5	81.3	78.0	76.5
AC	600	2.35	3	532.9	305.6	192.0	135.2	116.2	96.5	87.4
Causticaire: Standard—										
No AC	201	2.20	2	338.4	173.1	167.1	138.6	129.0	119.1	114.6
AC	701	2.30	2	911.6	513.3	314.1	214.6	181.4	146.9	130.9
Specialized—										
No AC	401	4.70	12	115.1	77.1	58.2	48.7	45.5	42.2	40.7
AC	901	4.80	12	210.6	125.3	82.7	61.3	54.2	46.8	43.4
Nonlint Content Test[f]										
Standard—No AC	702	2.10	10	180.5	99.8	60.9	40.9	34.3	27.4	24.2
AC	1202	2.20	10	295.2	158.6	90.3	56.1	44.8	32.9	27.5
Nep Count[g]										
Standard—No AC	301	2.10	15	59.6	36.8	25.4	19.7	17.8	15.8	14.9
AC	801	2.20	15	136.0	67.8	45.0	29.8	24.8	19.5	17.1
Color Test[h]										
Standard—No AC	769	2.10	30	65.3	36.1	21.6	14.3	11.9	9.3	8.2
AC	1269	2.20	30	103.5	55.4	31.4	19.4	15.3	11.2	9.3
Specialized—No AC	769	4.10	90	24.0	14.3	9.4	7.0	6.2	5.3	4.9
AC	1269	4.20	90	36.7	20.7	12.7	8.7	7.3	5.9	5.3
Moisture Content Test[i]										
Standard—No AC	94	2.10	25	16.9	12.7	10.5	9.5	9.1	8.7	8.6
AC	594	2.20	25	62.8	35.8	22.3	15.6	13.3	11.0	9.9
Specialized—No AC	94	4.10	50	12.5	10.3	9.3	8.7	8.6	8.4	8.3
AC	594	4.20	50	35.4	21.9	15.2	11.8	10.7	9.5	8.8
Sugar Content Test[j]										
Standard—No AC	100	2.10	5	87.5	65.5	53.4	47.7	45.8	43.8	42.9
AC	600	2.20	5	316.7	180.4	112.2	78.1	66.7	54.9	49.5
Acid-Alkaline Values[j]										
Standard—No AC	100	2.10	5	87.5	65.5	53.4	47.7	45.8	43.8	42.9
AC	600	2.20	5	316.7	180.4	112.2	78.1	66.7	54.9	49.5

NOTE: See footnote of preceding page for definitions of *Standard, Specialized, No AC,* and *AC.*

[f] Test performed with Shirley Analyzer. One determination made per test sample.

[g] Test performed with Neptometer. One determination made per test sample.

[h] Test performed with Colorimeter. One determination made per test sample.

[i] Test performed with a Moisture Meter. One determination made per test sample.

[j] Test performed by Chemical Analysis. One determination made per test sample.

Appendix V

Examples of Estimated Average Costs of Cotton Fiber Testing for Fineness with Changes in Volume and Labor Costs, Standard or Non-Specialized Operating Conditions, No Atmospheric Control, Shippers and Spinners, 1960 Season.

		Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Yr.
Example A. *Large regular* monthly volume and *full-time* labor costs														
Tests	No.	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	5500	66000
Fixed costs	$	18	18	18	18	18	18	18	18	18	18	18	18	212
Oper. costs	$	385	385	385	385	385	385	385	385	385	385	385	385	4620
Cost per test	¢	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Example B. *Large irregular* monthly volume and *part-time* labor costs														
Tests	No.	3000	5280	6240	6000	5280	4800	4500	4200	3600	3000	2700	2400	51000
Fixed costs	$	18	18	18	18	18	18	18	18	18	18	18	18	212
Oper. costs	$	210	370	437	420	369	336	315	294	252	210	189	168	3570
Cost per test	¢	7.6	7.3	7.3	7.3	7.3	7.4	7.4	7.4	7.5	7.6	7.7	7.8	7.4
Example C. *Large irregular* monthly volume and *full-time* labor costs														
Tests	No.	3000	5280	6240	6000	5280	4800	4500	4200	3600	3000	2700	2400	51000
Fixed costs	$	18	18	18	18	18	18	18	18	18	18	18	18	212
Oper. costs	$	377	384	387	387	384	383	382	381	379	377	375	374	4570
Cost per test	¢	13.2	7.6	6.5	6.8	7.6	8.4	8.9	9.5	11.0	13.2	14.6	16.3	9.4
Example D. *Small regular* monthly volume and *part-time* labor costs														
Tests	No.	600	600	600	600	600	600	600	600	600	600	600	600	7200
Fixed costs	$	18	18	18	18	18	18	18	18	18	18	18	18	212
Oper. costs	$	42	42	42	42	42	42	42	42	42	42	42	42	504
Cost per test	¢	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Example E. *Small irregular* monthly volume and *part-time* labor costs														
Tests	No.	600	1500	1800	900	300	300	300	300	300	300	300	300	7200
Fixed costs	$	18	18	18	18	18	18	18	18	18	18	18	18	212
Oper. costs	$	42	105	126	63	21	21	21	21	21	21	21	21	504
Cost per test	¢	10.0	8.2	8.0	9.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	10.0
Example F. *Small irregular* monthly volume and *full-time* labor costs														
Tests	No.	600	1500	1800	900	300	300	300	300	300	300	300	300	7200
Fixed costs	$	18	18	18	18	18	18	18	18	18	18	18	18	212
Oper. costs	$	369	372	373	370	368	368	368	368	367	367	367	367	4424
Cost per test	¢	65	26	22	43	129	129	129	129	129	129	129	129	64

NOTE: Tests performed with the Micronaire, Fibronaire, Speedar, or Port-Ar average of 30 tests per hour, standard operating conditions, one person performing all testing procedures, no atmospheric control, and one determination made per test sample. Fixed costs average $17.67 per month and include depreciation, interest, repairs, taxes, and insurance. Operating costs average $2.00 per hour for labor and 10 cents per hour for utilities, calibration samples, supplies, and sundries. Cost figures are rounded.

Appendix VI

Charges for Fiber Testing Per Sample for Specified Tests, by Volume Tested, Commercial Fee Laboratories, 1960.

Number of samples tested from the beginning of the crop year	Fineness (Micronaire) a	Strength (Pressley) a	Length (Fibrograph) a	Maturity (Microscope) b	Maturity (Causticaire) a	Nonlint content (Shirley Analyzer) b	Moisture content (Oven-drying) c	Sugar content (Chemical Analysis) d	Nep Count e	Acid-Alkalinity values (Chemical Analysis) f	Grade (Scanor-Tron) g
	Cents per test										
1-99	20	75	85	350	200	200	75	75	200	75	90
100-499	20	75	85				70	70			80
500-999	20	70	80				60	60			75
1,000-1,999	18	65	75								70
2,000-4,999	18	60	70								70
5,000-9,999	17	55	65								65
10,000-29,999	16	50	60								60
30,000-49,999	15										60
50,000-99,999	13										55
100,000-149,999	11										
150,000-199,999	09										
Over 200,000	08										

[a] Two measurements per sample.
[b] One measurement per sample.
[c] Percentage moisture content of ginned cotton lint.
[d] Percentage of soluble reducing sugar content.
[e] Nep content of ginned cotton lint.
[f] Acid-alkalinity in pH units.
[g] Five different qualities—color or yellowness, brightness or reflectance, character or ginned preparation, leaf area or trash, and leaf count or size of trash particles. Scanor-Tron test performed only by the United States Testing Company.

SOURCE: Based on price lists obtained from the United States Testing Company, Barrow-Agee Laboratories, Inc., Memphis, Tenn., and the U. S. Department of Agriculture. Price schedule effective to July 31, 1960.

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