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## Micronaire Tests for Cotton and Cotton Quality Relationships

University of Tennessee Agricultural Experiment Station

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# Micronaire Tests for Cotton and Cotton Quality Relationships

by B. D. Raskopf

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## SUMMARY

In recent years the Micronaire test for fiber fineness has become important in the pricing of cotton in the spot cotton markets, and in the government loan program. Increasing discounts have been placed on cotton micronairing below 3.5, and on that above 4.9 micronaire readings. This study shows that as an annual average, 1961 to 1965, about 13.4% of the Tennessee crop or 81,157 bales was subject to discounts for being under 3.5 or over 4.9 micronaire. These discounts amounted to \$433,040 or about \$5.34 per bale and averaged 3.4% of the value of all low and high micronaire cotton sold annually. However, as an annual average, the discounts for low or high micronaire cotton had little effect on the total farm value of the crop. For all cotton the net discounts averaged \$170,080 (28¢ per bale) or only 0.17% of the annual farm value of the Tennessee cotton crop of \$101,054,400.

The micronaire test average of cotton produced in Tennessee from 1947 to 1965 ranged from 3.9 in 1948 to 4.4 in 1947, 1952, 1960, and 1963, and averaged 4.24 annually. The micronaire test average for 224,650 bales of cotton consumed among 15 Tennessee mills in the 1964-65 season varied from 4.0 to 4.4, and averaged 4.2 or the same as the average for the Tennessee 1964 cotton crop.

In Tennessee and other states, during the crop years 1959 to 1965, the micronaire average among 10 cotton varieties, combining locations, differed by 0.8 micronaire units. The micronaire test of individual bales of cotton, within one variety in the same locations, or combining locations, had a range of 3.2 micronaire units.

Wide variations existed in cotton micronaire test averages among states in the same year, and within states by years. From 1959 to 1965 the differences in micronaire test averages of cotton in 19 states varied 0.9 units in 1960 and 1962 and 2.1 units in 1965. Within some states from 1959 to 1965 the differences varied from 0.2 to 1.3 micronaire units.

As an average for the crop years 1963 to 1965, about 72% of the upland cotton in the United States and 82% in Tennessee fell in the micronaire category 3.6 to 4.8, the premium range in the CCC loan schedule; 15% in the United States and 12% in Tennessee averaged 3.3 to 3.5 and 4.9 to 5.1, the ranges where cotton was not discounted for being overly fine or overly coarse in the CCC loan program; and 13% in the United States and 6% in Tennessee averaged very low micronaire (under 3.3) or very high micronaire (over 5.1).

During the years 1959 to 1965, the micronaire readings of samples of Tennessee cotton ginnings averaged 4.45 in August, 4.4 in

September, 4.3 in October, 4.05 in November, 3.85 in December and 3.8 the remainder of the season.

During the years 1959 to 1965, when the micronaire readings of cotton produced in Tennessee fell below 3.5, there was a general decline from annual average in raw cotton grade, staple length, length uniformity, and fiber strength; an increase in nonlint content and picker and card waste; a decrease in yarn strength and yarn appearance grade; and an increase in yarn imperfections or neppiness.

As the micronaire readings of Tennessee cotton tested above 5.1, the cotton remained above average in staple length and length uniformity. However, the cotton tested lower in grade, fiber strength, yarn strength, and yarn appearance grade, and there was some increase in picker and card waste, and yarn imperfections.

Data indicated that micronaire readings were:

- 1) good indicators of the processing tests of yarn appearance grade and yarn imperfections,
- 2) only a fair indicator of picker and card waste, and
- 3) a poor indicator of yarn strength.

One way to reduce the proportions of low and high micronaire cotton is by planting varieties that have micronaire test averages of around 4.2 to 4.4, providing such varieties are well adapted to the location, and are high in yield and other desirable varietal characteristics. Micronaire readings tend to follow a pattern of normal distribution. A variety that has a micronaire test average of around 4.3 with a standard deviation of 0.4 tends to have 95% or more of the cotton in one location falling within the desirable range of 3.5 to 5.1 micronaire readings.

## ACKNOWLEDGEMENT

The author of this bulletin hereby acknowledges the cooperation of the cotton ginners, shippers, and spinners in Tennessee who furnished basic data for the study. Appreciation is expressed to C. R. Graves and P. E. Hoskinson of the Agronomy Department for furnishing data relating to the performance tests of cotton for the period of study. Appreciation is also expressed to members of the Technical Committee SM-31 Regional Cotton Marketing Project and several staff members of the Tennessee Agricultural Experiment Station for suggestions in the preparation of this report.

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# Micronaire Tests For Cotton And Cotton Quality Relationships

B. D. Raskopf\*

## INTRODUCTION

Cotton is Tennessee's leading cash crop. From 1956 to 1965 the cash farm marketings from cotton averaged over \$100 million annually and each year comprised about one-fifth of the cash returns from farm marketings of all crops and livestock.<sup>1</sup>

The major quality factors determining the price of cotton are grade and staple length. However, in recent years the micronaire reading has become important in the pricing of cotton in the Spot Cotton Markets and in the government loan program in 1964 and 1965. Increasing discounts have been placed on cotton with a micronaire test below 3.5 and above 4.9, both in the Memphis market and in the CCC loan program. As a result of these high discounts, there has been increased interest by farmers, ginners, merchants, and spinners in obtaining more data on the factors affecting the micronaire readings of cotton.

### Purpose of Study

The purpose of this study is to show: 1) the development of micronaire testing of cotton and its economic importance in the industry; 2) the variation in micronaire tests of cotton in Tennessee and other states for specified years; 3) the varietal and environmental factors affecting or relating to the micronaire of cotton; and 4) the relationship of the micronaire of cotton to other fiber properties important in cotton mill processing.

### Source of Data

Primary data relating to micronaire and other tests of fiber prop-

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<sup>1</sup> *Tennessee Agricultural Statistics, Annual Summaries, 1956-65*, Tennessee Crop Reporting Service, Nashville, Tennessee.

erties for cotton ginned in Tennessee and other states from 1947 to 1965 were computed from nine major sources.<sup>2</sup>

## MICRONAIRE TESTS OF COTTON IN TENNESSEE

### Development of Micronaire Tests for Cotton

Over 572 agencies in 51 countries owned instruments for testing cotton fiber fineness in 1956 and some of these agencies had been using these tests as early as 1947. The instruments used included the Micronaire and Fibronaire—most commonly used in the industry—and the Arealometer and Speedar, developed by the University of Tennessee. These agencies used these tests in cotton mill production programs in connection with mixing and blending, control of performance in industrial yarns and fabrics, securing greater uniformity in dyeing, better selection of qualities of cotton from various territories, and the development of basic data for use in research.<sup>3</sup>

A survey of cotton shippers and spinners in the United States in 1958 indicated the widespread use of cotton fiber tests for degree of fineness. Of the sample of 166 cotton shippers and 503 spinners, nearly all of the shippers and 79% of the spinners were using commercial laboratory tests for determining the degree of fineness of cotton. This study indicated that micronaire readings of cotton were related to such factors as: grade, fiber length, strength, and maturity; mixing and blending of cotton; picker and card waste; carding speed; ends down in spinning; yarn imperfections, appearance

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<sup>2</sup> *Annual Cotton Quality Surveys*, conducted by the USDA at 2 to 6 different locations in Tennessee, 1947 to 1965; *Cotton Variety Performance Trials*, conducted by the Tennessee Agricultural Experiment Station in 3 to 6 different locations, 1947 to 1965, in the counties of Fayette, Hardeman, Henderson, Lake, Lauderdale, Lawrence, Madison, and Tipton; micronaire tests of Tennessee cotton consumed by cotton mills in the state, based on cotton shipper and spinner surveys made by the Tennessee Agricultural Experiment Station in 1947, 1956, and 1965; summarized results for various proportions of cotton tested from a sample of 15 gins in Tennessee, 1959 to 1965; annual reports of *Performance Trials of Cotton Varieties*, Agricultural Experiment Stations, 19 states, 1959 to 1965; *Regional Cotton Variety Tests*, by Cooperating Agricultural Experiment Stations, Agricultural Research Service, USDA, 1960 to 1965; *Cotton Varieties Planted, 1959 to 1965*, Cotton Division, Consumer and Marketing Service, USDA; weekly and annual reports of *Cotton Classed Under the Smith-Dorey Act, South Central Area*, Cotton Division, Consumer and Marketing Service, USDA, 1961 to 1966; and *Cotton Production in the United States, Crops of 1947 to 1965*, U. S. Department of Commerce.

<sup>3</sup> B. D. Raskopf and Jack Fontana, *Cotton Fiber Testing in Foreign Countries*, Tennessee Agricultural Experiment Station Bulletin No. 271, September, 1957.

grades, and strength; finishing and dyeing; and general mill processing performance.<sup>4</sup>

Most of the cotton marketed in Tennessee since 1956, except for that pledged in the government loan, was micronaired by shippers or spinners. However, little current or weekly data on the micronaire readings of cotton for the state as a whole were available until 1961. Beginning with the 1961 crop year the Cotton Division, the Agricultural Marketing Service, USDA, under the Smith-Doxey Act, made available the micronaire readings of cotton classed by weeks throughout most of the ginning season.

## Definition of Micronaire Tests and Importance

A micronaire reading is defined as a measurement of the degree of cotton fiber fineness by means of an airflow instrument known commercially as the Micronaire. The micronaire reading, which indicates the resistance to the passage of air through a 50-grain specimen compressed to a given volume, is made from one or more samples of each bale or test lot of cotton.<sup>5</sup>

Throughout this report reference is made to micronaire readings, units, or tests, rather than to micronaire degree of fineness. The main reason for this is that micronaire readings, depending on the level of the reading, denote the fineness or coarseness of cotton, or some combination of fineness, coarseness, maturity, or other fiber properties. In general, the higher micronaire readings, above 4.9, denote the coarser cottons, while the lower readings, below 3.5, denote the finer cottons. The micronaire readings of 3.5 to 4.9 are generally considered as being "average or near average" in micronaire.

The economic importance of micronaire readings to cotton farmers is indicated in Table 1. For example, cotton sold in Tennessee in 1965 that micronaired 3.6 to 4.8 brought a premium in the government loan of 14 points per pound or 70¢ per 500-pound bale. On the other hand, cotton with low to very low micronaire, under 3.3, was subject to discounts up to 300 points per pound or \$15 per bale in the government loan; and up to 400 points per pound or \$20 per bale if sold in the Memphis market. Cotton with high to very high

<sup>4</sup> B. D. Raskopf, J. R. Fontana and C. S. Murphy, *Cotton Testing by Shippers and Spinners in Tennessee and the United States*, Tennessee Agricultural Experiment Station Bulletin No. 320, October, 1960.

<sup>5</sup> *Annual Cotton Quality Surveys, Crops of 1947 to 1965*, Consumer and Marketing Service, USDA.



micronaire, 5.2 and above, was subject to discounts up to 50 points per pound or \$2.50 per bale in the government loan; and up to 225 points per pound or \$11.25 per bale in the Memphis market.

If the schedule of premiums and discounts for cotton sold in Tennessee or placed in the government loan in 1964 or 1965 was representative of the market or mill demand for cotton of the micronaire categories indicated in Table 1, the most desirable micronaire average was around 4.2 in these years.<sup>6</sup> This micronaire

<sup>6</sup> Based on the Memphis market quotations of cotton ranging in micronaire from 3.5 to 4.9 and quoted as "even"; or cotton placed in the government loan that ranged from 3.3 to 5.1 and rated as "even" or brought premiums.

Table 1.—Description of micronaire categories and differences in premiums and discounts of cotton sold in the Memphis market or placed in the government loan, Tennessee, 1964 and 1965 crop years

Cotton micronaire readings	Memphis market*	Government loan		Cotton micronaire description	
		1964	1965		
Premiums or discounts in points per pound				Micronaire	Degree of finess
2.6 & below	—325 to —400	—300	—300	Very Low	Very Fine
2.7 to 2.9	—250 to —175	—150	—165	Very Low	Very Fine
3.0 to 3.2	—150 to — 50	— 50	— 60	Very Low	Very Fine to Fine
3.3	— 50 to Even	Even	Even	Low	Fine
3.4	— 50 to Even	Even	Even	Low	Fine
3.5	Even	Even	Even	Average	Average
3.6	Even	Even	+14	Average	Average
3.6 to 4.8	Even	+13	+14	Average	Average
4.9	Even	Even	Even	Average	Average
5.0	— 25 to — 75	Even	Even	High	Course
5.1	— 25 to — 75	Even	Even	High	Course
5.2	— 25 to — 75	—10	—15	Very High	Course
5.3	— 25 to — 75	—10	—15	Very High	Very Course
5.4	— 25 to — 75	—10	—15	Very High	Very Course
5.5	— 75 to —175	—25	—50	Very High	Very Course
5.6	— 75 to —175	—25	—50	Very High	Very Course
5.7 & above	—175 to —225	—25	—50	Very High	Very Course

\*Based on changes in market quotations from August 1964 to July 1966.

Source: *Spot Cotton Quotations*, Cotton Division, Consumer and Marketing Service, USDA, 1964 to 1966; *Survey of Cotton Shippers and Spinners in Tennessee*, Tennessee Agricultural Experiment Station, 1965 and 1966.

average coincided closely with the average micronaire of cotton ginned in Tennessee and the United States in the 1964 and 1965 crop years (Appendixes H and I).

### Seasonality of Micronaire Test Averages

The micronaire test average of cotton ginned in Tennessee during the past 19 years ranged from 3.9 in 1948 to 4.4 in 1947, 1952, 1960, and 1963; it averaged 4.24 for the 1947-65 crop years (Table 2).

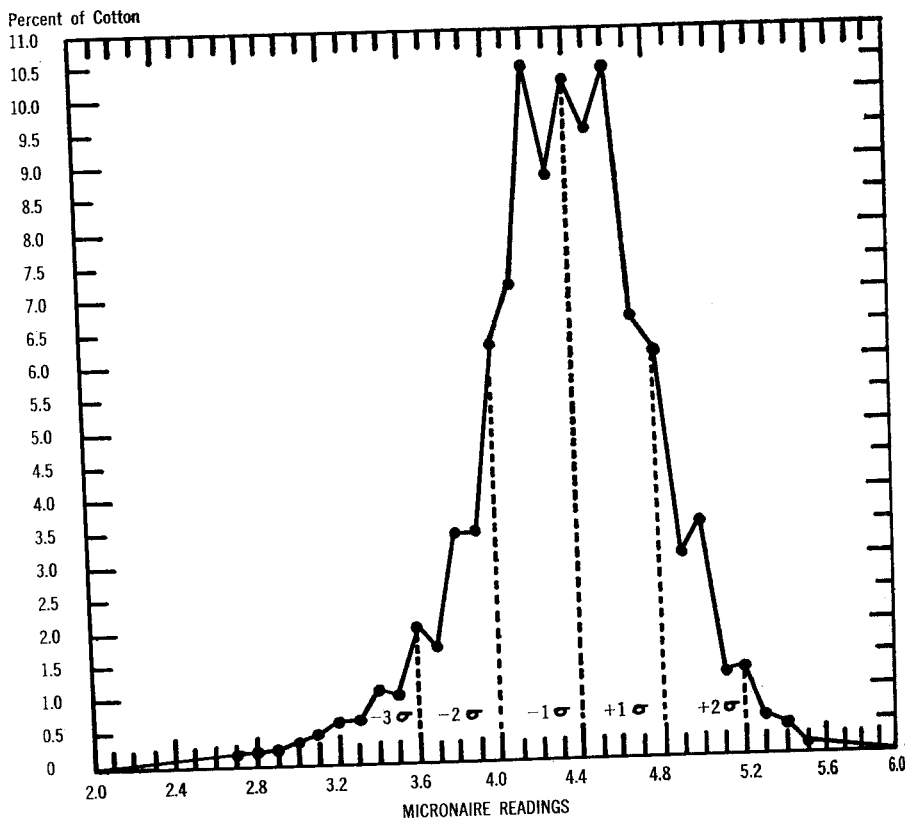
Table 2.—Cotton micronaire tests for early-, middle-, and late-season ginnings, Tennessee, 1947-65

Crop year	September		October		Nov. & later		Season	
	Micronaire average	% of crop	Micronaire average	% of crop	Micronaire average	% of crop	Micronaire average	Running bales ginned
1947	4.6	22.3	4.4	53.0	4.2	24.7	4.4	507032
1948	4.0	22.1	3.9	52.3	3.8	25.6	3.9	641070
1949	4.4	31.9	4.4	34.1	4.1	34.0	4.3	622498
1950	4.2	7.0	4.0	54.6	3.9	38.4	4.0	404411
1951	4.4	21.8	4.2	47.6	4.0	30.6	4.2	525383
1952	4.6	38.5	4.5	43.5	3.7	18.0	4.4	621119
1953	4.2	34.0	4.0	41.7	3.7	24.3	4.0	685751
1954	4.3	43.8	4.4	38.4	4.1	17.8	4.3	534001
1955	4.5	17.6	4.5	42.6	4.0	39.8	4.3	613059
1956	4.4	49.2	4.3	38.8	4.0	12.0	4.3	527484
1957	4.5	17.5	4.3	45.9	4.2	36.6	4.3	404292
1958	4.4	13.4	4.3	57.3	4.2	29.3	4.3	411038
1959	4.4	28.1	4.4	43.1	4.0	28.8	4.3	642245
1960	4.8	23.5	4.4	42.6	4.1	33.9	4.4	570876
1961	4.7	12.1	4.2	51.2	3.5	36.7	4.0	550310
1962	4.2	31.4	4.3	51.7	4.1	16.9	4.2	548408
1963	4.4	31.3	4.5	55.9	4.0	12.8	4.4	644066
1964	4.5	15.8	4.3	52.5	3.9	31.7	4.2	665691
1965	4.3	21.8	4.2	63.9	4.1	14.3	4.3	626913
19-yr. avg.	4.41	25.4	4.29	47.9	3.98	26.7	4.24	565560

Source: Computed from *Annual Cotton Quality Surveys*, Consumer and Marketing Service, USDA, 1947 to 1965; *Performance Trials of Cotton Varieties*, Tennessee Agricultural Experiment Station, 1947 to 1965; and *Cotton Production and Distribution, Crops of 1947 to 1965*, U. S. Department of Commerce.

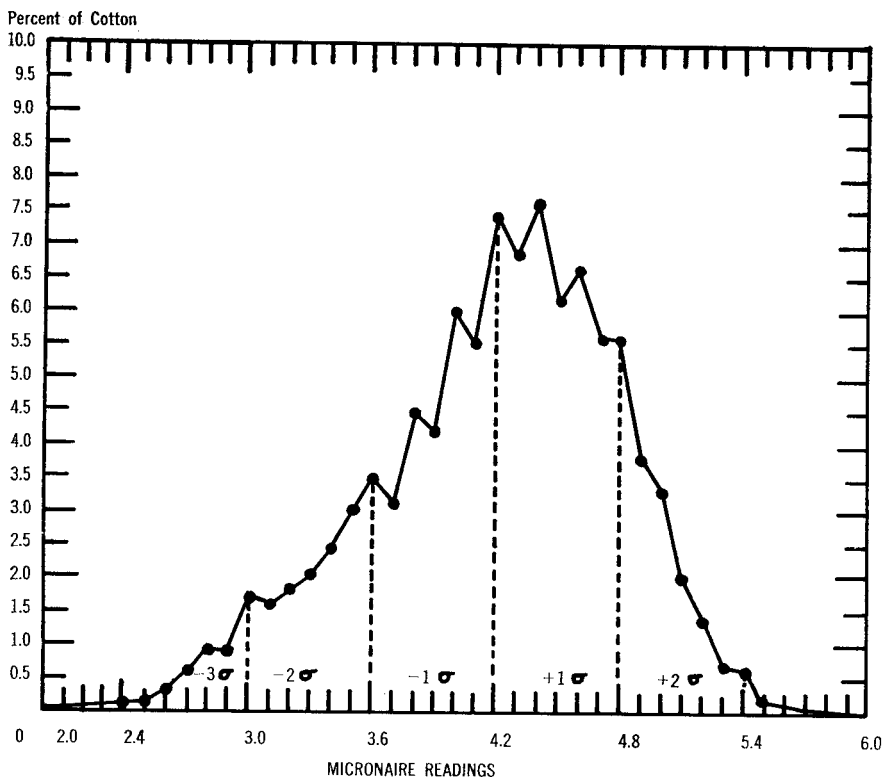
During each of the 19 years the micronaire average of cotton declined from early to late-season ginnings or for cotton ginned from September to November and later. The decline in micronaire readings, from early to late season, averaged about 0.4 micronaire units annually, and varied from 1.2 in 1961 to 0.1 in 1962.

While the micronaire average of cotton in each year declined from early to late-season ginnings, most of this decline occurred during the latter part of the season or during November and later. From the September to October ginnings, for the 19 years, the micronaire weighted average declined in 13 years, remained the same in 3 years and showed a slight increase in 3 years. From October to late-season ginnings the micronaire average declined in each season.



**Figure 1. Percentage distribution of cotton by micronaire readings, crop of 1963, Tennessee.**

Cotton micronaire tests by crop years followed a pattern of normal distribution. The micronaire weighted average was 4.4 with a standard deviation of 0.4 for the 1963 crop year (Figure 1). In the 1964 crop year, the micronaire weighted average was 4.2 with 0.6 standard deviation (Figure 2).



**Figure 2. Percentage distribution of cotton micronaire readings, crop of 1964, Tennessee.**

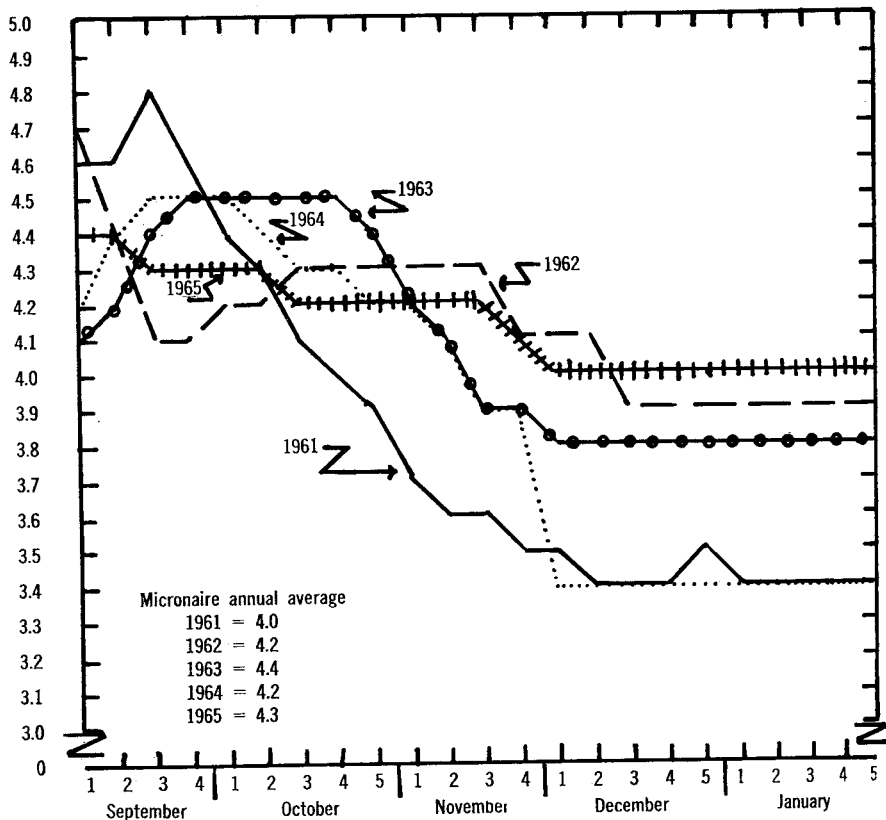
### Weekly Ginnings—Micronaire, Grade, and Staple Length, 1961-1965

The results of micronaire tests of cotton ginned, by weeks, throughout the season, was available for 5 years, 1961 to 1965. The micronaire test averages varied widely by weeks, but during each crop year declined from early or mid-season to late season ginnings (Figure 3).

Cotton ginned in 1961 decreased in average micronaire from the middle of September to the first week of December, and then held about the same level to the end of the season.

In 1962 the cotton decreased in micronaire readings during September, and from mid-season to late season. The 1963 crop increased in micronaire readings from early to mid-season and then declined

Micronaire  
Test Average



**Figure 3. Micronaire test average of cotton, by weeks, Tennessee, crops of 1959 to 1965.**

to the first week of December. Cotton from the 1964 crop increased in micronaire readings from the beginning of the season to the middle of September and then declined to the first week of December. The cotton ginned in 1965 gradually decreased in micronaire readings from the second week of September to the first week of December.

Detailed seasonal data on cotton micronaire, grade, and staple length are given in Appendixes A to E. These data indicate that the seasonal decline in micronaire test average was correlated with the usual seasonal decline in cotton grade and staple length.

## Distribution of Cotton by Micronaire Test Ranges, 1961-1965

The distribution of micronaire readings of cotton ginned in Tennessee for the crop years 1961 to 1965 is given in Table 3.

Table 3.—Major micronaire ranges of cotton ginned in Tennessee, crop years, 1961 to 1965

		Micronaire reading class intervals							Total
		Under 2.7	2.7-2.9	3.0-3.2	3.3-3.4	3.5-4.9	5.0-5.2	Over 5.2	
1961	Bales	3300	11555	38520	40175	436950	14310	5500	550310
	%	0.6	2.1	7.0	7.3	79.4	2.6	1.0	100
1962	Bales	553	1095	6580	9870	505085	17550	7675	548408
	%	0.1	0.2	1.2	1.8	92.1	3.2	1.4	100
1963	Bales	600	2580	8370	10950	577085	38645	5836	644066
	%	0.1	0.4	1.3	1.7	89.6	6.0	0.9	100
1964	Bales	1997	11317	25962	25962	541872	47930	10651	665691
	%	0.3	1.7	3.9	3.9	81.4	7.2	1.6	100
1965	Bales	627	627	5642	9404	568610	32599	9404	626913
	%	0.1	0.1	0.9	1.5	90.7	5.2	1.5	100
4 Years	Bales	7077	27174	85074	96361	2629602	151034	39066	3035388
	%	0.2	0.9	2.8	3.2	86.6	5.0	1.3	100

Source: *Weekly Cotton Market Reviews*, Cotton Division, Market News Section, Agricultural Marketing Service, USDA; *Performance Trials of Field Crop Varieties, 1961 to 1965*, Tennessee Agricultural Experiment Station; *Cotton Quality in Tennessee, 1961 and 1962 Crop Years*, Tennessee Farm and Home Science, Progress Report No. 50, April, May, June, 1964, University of Tennessee, Agricultural Experiment Station; *Cotton Production in the United States, Crops of 1961 to 1965*, U. S. Department of Commerce.

Micronaire readings were divided into ranges from under 2.7 for cotton described as Very Low in micronaire or Very Fine, to over 5.2 for cotton described as Very High in micronaire or Very Coarse. These divisions of micronaire readings were used since cotton varying in these ranges of micronaire readings also varied in degree of discounts reported by shippers and other merchants in the Memphis market.

The bulk of the Tennessee ginnings, 79% to 92% annually, fell in the micronaire ranges 3.5 to 4.9 readings. Cotton of this micronaire range was considered by cotton merchants and spinners as being about Average and desirable in the manufacture of a large variety of cotton products.

Not much cotton in any one year, 0.1% to 0.6% of the crop, was

severely discounted for being Very Fine or under 2.7 micronaire; and only 0.9% to 1.6% of the crop was discounted for being Very High in micronaire, or Very Coarse. During the 5 years, 1961 to 1965, cotton micronairing under 3.5 generally was discounted for being too fine, and cotton micronairing over 4.9 was generally discounted for being too coarse. More cotton was discounted and the discounts were much higher for being overly fine than overly coarse.

### Micronaire Ranges of Cotton Used by Tennessee Mills, 1964-65

The 15 cotton mills in Tennessee reported using 224,650 bales of cotton during the 1964-1965 season of which an estimated 74,900 bales was produced in the state. The micronaire annual average of cotton consumed among mills varied from 4.0 to 4.4 and averaged 4.2, or about the same as the micronaire average for the 1964 Tennessee cotton crop.

The range of micronaire values most desired and used by Tennessee cotton mills was from 3.5 to 5.0, and 83% of the cotton (185,600 bales) fell within this micronaire range (Table 4). Seven of the cotton spinners, however, used 39,050 bales of cotton of Low micronaire—3.4 and below—and High micronaire—5.1 and above. About 80% of these finer and coarser-fibered cottons consisted of sample cotton, mill waste, damaged cotton, or cotton of very low quality purchased either at the very beginning or late in the ginning season.

Considerable progress has been made by several of the Tennessee mills in the mixing and blending of Low with High micronaire cotton and still maintaining satisfactory production and quality of end product.

The data given in Table 4 show that Tennessee produced cotton of micronaire readings desired and used by Tennessee mills, yet only about 11% of the 665,691 bales produced in the state in 1964 was used by Tennessee mills. Of the 224,650 bales consumed by the 15 cotton mills in Tennessee in the 1964-65 season, only 74,900 were produced in the state. The reasons were as follows: 1) 60,500 bales consumed by the Tennessee mills were of staple lengths  $1\frac{1}{2}$  inches or longer<sup>7</sup>, and not much of these staple lengths was grown in the state; 2) 57,700 bales averaged Pressley 0-gauge strength of 82,000 pounds or more per square inch or slightly above the average

<sup>7</sup> 99.5% of the Tennessee crop in 1964 averaged 1 inch to  $1\frac{3}{32}$  inches in staple length.

Table 4.—Cotton of specified micronaire readings used by Tennessee spinning mills and produced in Tennessee, July 1, 1964 to June 30, 1965

Micronaire categories	Number of Tennessee mills reporting the use of cotton micronaire readings									Tennessee cotton	
	5	1	1	2	1	1	1	2	1	1964-65 mill consumption	1964 production
Readings	Micronaire range and average									Bales	Bales
2.2 to 2.9										6,500	13,314
3.0 to 3.4										21,300	51,924
3.5										6,700	17,974
3.6										7,900	21,968
3.7										7,000	19,305
3.8										10,100	28,625
3.9										9,400	27,293
4.0										13,500	39,941
4.1			*		*		*			12,400	37,279
4.2	*	*								16,600	52,590
4.3				*						15,300	46,598
4.4								*		17,100	54,587
4.5									*	13,700	43,270
4.6										14,800	46,598
4.7										12,600	39,941
4.8										12,600	39,276
4.9										8,500	26,628
5.0										7,400	23,965
5.1 to 5.6										11,250	34,615
Average*	4.2	4.2	4.1	4.3	4.1	4.0	4.3	4.3	4.4	4.2	4.2
Total										224,650	665,691
Percent										34	100

\*Weighted micronaire average of cotton.

Source: *Weekly Cotton Market Review*, Volume 46, No. 39, Consumer and Marketing Service, USDA, May 7, 1965; *Cotton Mill Survey*, Tennessee Agricultural Experiment Station, 1965.

strength test of cotton produced in Tennessee in 1964; and 3) 31,550 bales were sample and waste cotton, not available from the Tennessee 1964 crop.

Of the 1964 Tennessee crop of 665,691 bales, 11.2% was consumed by Tennessee cotton mills, 57.6% was sold to spinners in five other states, and 31.2% was placed in the government loan.

## MICRONAIRE TESTS OF COTTON, BY STATES

### Micronaire Averages, 1959-65

The micronaire annual average for all upland cotton ginned in the United States was about 4.2 for the crop years 1959 to 1965.



For the 7-year period the micronaire test average varied from 3.4 in Nevada to 4.6 in Mississippi, and 4.3 in Tennessee.<sup>8</sup>

The micronaire test averages among states in the same year differed by 0.9 to 2.1 units and within some of the states during the 7 years, differed 0.2 to 1.3 micronaire units (Appendix F).

Although the micronaire annual averages varied among states each year, the percentage distribution of micronaire readings were near normal within each state.

### Seasonality of Micronaire Test Averages

Data available from annual cotton quality surveys from other states indicate that seasonal declines occurred in micronaire test averages.<sup>9</sup>

In these surveys, test lots of cotton were collected from several locations at 3-week intervals during the harvesting season in 14 to 17 cotton-producing states, 1947 to 1965. The results of these tests showed:

- 1) micronaire test averages varied widely among locations, regardless of variety grown, but within each location declined from early or mid-season to late season ginnings;
- 2) micronaire test averages, combining locations during the same season, declined from as little as 0.1 micronaire units in one or two states to as much as 1.5 micronaire units in one or two states;
- 3) micronaire test averages within most states, combining locations, tended to decline from 0.1 to 0.2 micronaire units each 3-week period from the beginning to the end of the ginning season, and
- 4) the seasonal decline in micronaire test averages was correlated with the usual seasonal decline in raw cotton quality and fiber, and processing properties.

Data were available by states on the seasonality of micronaire tests of cotton classed under the Smith-Doxey Act for 1964 and 1965. In both crop years, the micronaire test averages for the entire season varied widely among states (Appendix F). Within each state, however, the average micronaire readings generally declined as the ginning season progressed (Table 5).

<sup>8</sup> A difference in micronaire average of 0.1 reading was significant at the 5% level of probability.

<sup>9</sup> *Annual Cotton Quality Surveys*, Consumer and Marketing Service, USDA, 1947 to 1965; and *Cotton Quality Relationships*, Agricultural Information Bulletin No. 257, Agricultural Marketing Service, USDA, April 1962.

In the 1964 crop year the micronaire test average of cotton ginned in the United States declined 0.62 micronaire units from early to late season ginnings. The states showing seasonal declines in micronaire tests greater than the U. S. average were New Mexico, Kentucky, Illinois, Tennessee, Virginia, South Carolina, Louisiana, Nevada, Arkansas, Mississippi, and Texas.

Table 5.—Seasonality of micronaire test averages of cotton ginned, by specified periods, by states, 1964 and 1965 crop years

States	1964 crop year				1965 crop year			
	Before Oct.	Oct.	Nov.	After Nov.	Before Oct.	Oct.	Nov.	After Nov.
Estimated micronaire test averages of cotton by specified periods								
Nev.	ND	3.45	3.22	2.68	ND	ND	2.93	2.61
N. M.	4.18	4.12	3.62	2.75	4.04	3.79	3.20	2.85
Tex.	4.15	4.42	3.73	3.72	4.28	4.17	3.76	3.19
Cal.	4.27	4.19	4.12	3.87	4.32	4.19	4.12	3.69
Okla.	4.52	4.58	4.38	4.05	4.35	4.27	4.14	3.81
N. C.	4.23	4.19	4.11	3.76	4.11	4.22	4.19	4.10
Ariz.	4.61	4.52	4.51	4.19	4.56	4.40	4.29	3.94
S. C.	4.21	4.15	4.13	3.29	4.25	4.21	4.16	4.14
Ky.-Ill.	4.19	4.31	3.96	3.17	4.32	4.21	4.10	3.40
Ga.	4.17	4.05	4.00	3.80	4.24	4.26	4.25	3.84
Tenn.	4.51	4.30	4.00	3.39	4.34	4.25	4.19	4.00
Ala.	4.23	4.02	4.00	3.80	4.30	4.28	4.29	3.66
Fla.	4.20	4.04	4.00	3.90	4.34	4.28	4.00	3.90
Mo.	4.47	4.40	4.12	3.90	4.28	4.34	4.09	4.00
Va.	4.14	4.17	4.14	3.24	ND	4.36	4.36	4.23
La.	4.81	4.48	4.16	4.03	4.58	4.26	4.06	4.02
Ark.	4.69	4.53	4.15	3.93	4.57	4.44	4.22	3.76
Miss.	4.72	4.46	4.40	4.00	4.66	4.44	4.36	4.30
U. S.	4.40	4.37	4.12	3.78	4.39	4.32	4.01	3.57

ND=No data or no cotton ginned.

Source: Computed from *United States Cotton Quality Reports for Ginnings, September to January*, Consumer and Marketing Service, USDA, 1964 to 1966.

In the 1965 crop year the states showing seasonal declines in micronaire tests greater than the U. S. average of 0.82 micronaire units were New Mexico, Kentucky, Illinois, and Texas.

### Distribution of Cotton by Micronaire Test Ranges, 1963-65

The distribution of micronaire readings of cotton ginned, by states 1963 to 1965, is given in Appendixes G, H, and I.

As an average for the U. S. crop years 1963 to 1965, about 72%

of the upland cotton was in the micronaire category 3.6 to 4.8, the premium range in the CCC loan schedule; an additional 15% averaged 3.3 to 3.5 and 4.9 to 5.1, the ranges where cotton was not discounted for being overly fine or overly coarse in the government loan program; and 13% averaged Very Low micronaire—under 3.3, or Very High micronaire—over 5.1, and the short and medium staple cottons were subject to discounts in the government loan program and on the Spot Cotton Markets.<sup>10</sup>

While the proportion of cotton micronairing Low to Very Low varied widely geographically, the major volume was concentrated in five states—Texas, California, Arizona, New Mexico, and Oklahoma. For the 3 years, 1963-65, these states produced 49% of all cotton grown in the U. S. and 83% of all cotton under 3.6 micronaire test.

On the other hand, these five states produced only 24% of the cotton micronairing 5.2 and over. Of the 45,264,744 bales of cotton ginned in the U. S. from 1963 to 1965, about 4.5% or 2,019,488 bales were 5.2 and over in micronaire reading. Of this high micronaire cotton, 33% was ginned in Mississippi, 23% in Arkansas, 13% in Texas, 9% in Louisiana, 8% in Arizona, and 4% in Missouri.

For the 3-year period, 1963-65, Tennessee produced 4.3% of the U. S. crop, 1.9% of the cotton micronairing under 3.6, and 2.6% of the cotton micronairing 5.2 and over.

## FACTORS AFFECTING COTTON MICRONAIRE TESTS

### Micronaire Tests of Cotton Varieties in Tennessee

The results of the micronaire tests of cotton varieties in Tennessee for the years 1959 to 1965 are summarized in Appendix J. During the 7 years the proportion of the state acreage planted to some varieties differed by as much as 57% as shown in Appendix K. These changes in acreages planted to various varieties exerted considerable influence on the micronaire test average of cotton produced in different parts of the state. Some varieties (Stoneville and Empire, as examples) differed materially in micronaire test averages at the same location in one year, or at different locations in the same year.

<sup>10</sup> The long-staple varieties of cotton, finely fibered and high in fiber strength and grown in some areas of Nevada, New Mexico, Texas, and Arizona, generally were not discounted because of low micronaire test readings. As an annual average, 1963-65, the proportion of cotton stapling longer than 1½ inches averaged 60% in Nevada, 40% in New Mexico, 3.2% in Arizona, and 1.4% in Texas.

The difference in micronaire test average of cotton between the prevailing varieties at one location in Tennessee varied considerably from one year to another, but averaged 0.8 micronaire unit annually. For 10 to 21 locations, the differences in micronaire test averages among varieties also averaged 0.8 micronaire units annually. The micronaire test data for varieties were summarized by combining the locations and then showing the range among locations.

During each of the 7 years, combining locations, the Stoneville varieties 213, 7, or 7A, and Fox 4 showed micronaire readings above the state average; the Deltapine, Dixie King, Auburn 56, and Stoneville 3202 varieties micronaired near the state average; and the Rex (S.L.) and Empire (W.R.) micronaired below the state average (Appendix J).

The greatest difference in micronaire test averages among varieties, combining locations, varied from 1.0 in 1961 to 0.65 in 1964 and 1965. In 1961 the average for Stoneville 7 was 4.65, compared with 3.65 for Empire (W.R.); in 1965 the average for Stoneville 7A was 4.60, compared with 3.95 for Empire (W.R.) (Figure 4).

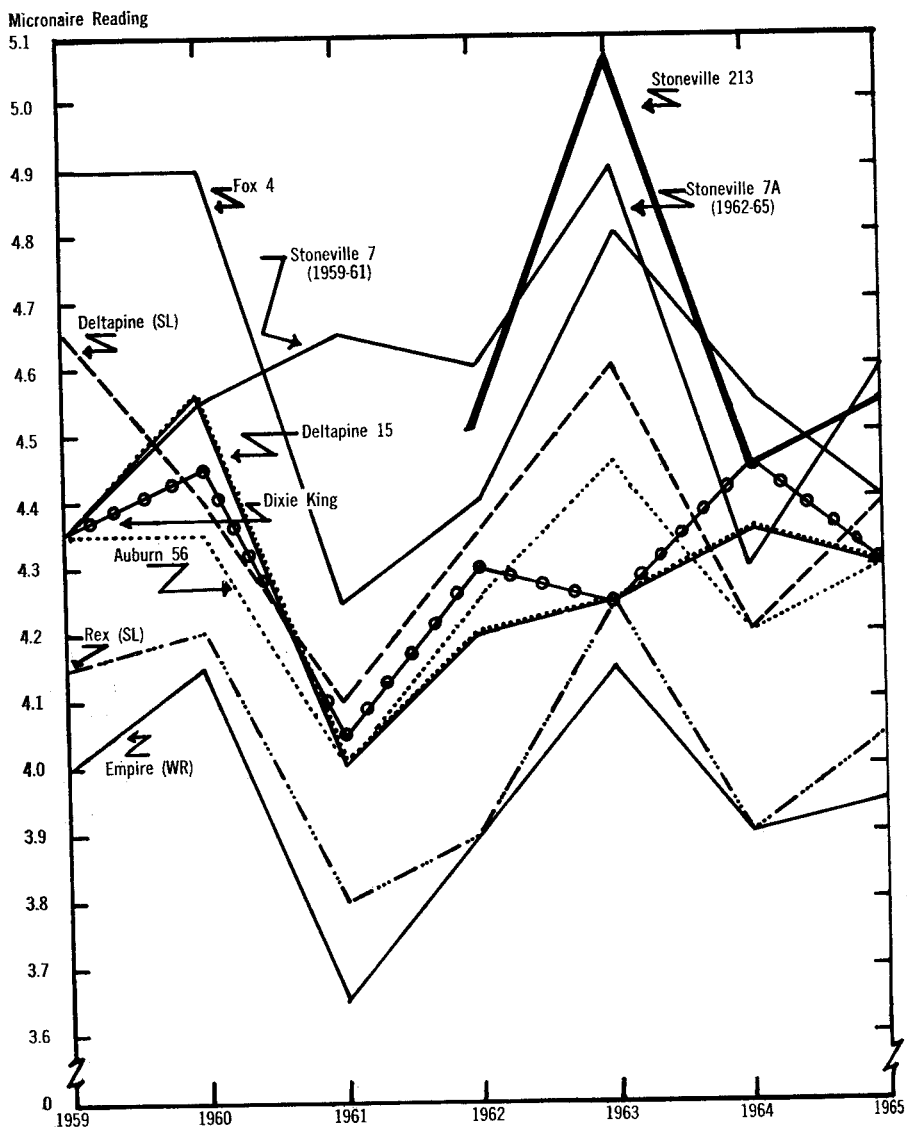
The micronaire average for each of the prevailing varieties varied considerably from one location to another in each year. For example, the average for the Fox 4 variety, combining locations, was 4.9 in 1959; but among locations, the average varied from 4.6 to 5.2, and at some locations the test among individual bales during the season varied as much as 3.2 micronaire units. In the same season (1959), the Empire (W.R.) variety averaged 4.0, combining locations. But among locations the average varied from 3.7 to 4.3, and at some locations the test among individual bales also varied as much as 3.2 micronaire units.

Among varieties at different locations, the micronaire test averages varied up to 1.5 micronaire units during one season. For example, in 1959 the average ranged from 3.7 for Empire (W.R.) at one location to 5.2 for Fox 4 at another location.

The micronaire readings of cotton ginned by varieties during the crop years 1959 to 1965 are shown in Figure 4.

### **Micronaire Tests of Ten Cotton Varieties, Several States**

The micronaire averages of the 10 prevailing varieties in Tennessee were available for tests conducted in many locations in other



**Figure 4. Micronaire test averages of cotton varieties, combining locations, Tennessee, crop years, 1959 to 1965.**

**Source: Appendix J.**

states from 1959 to 1965. The number of tests, variable by years, were obtained in 12 to 19 states for Deltapine 15 and Deltapine Smooth Leaf; 8 to 15 states for Stoneville 213, 7 and 7A; 6 to 15

states for Empire (W.R.); 6 to 14 states for Rex Smooth Leaf; 10 states for Dixie King and Fox 4; and 5 to 10 states for Auburn 56.

The number of tests conducted annually in each state, including Tennessee, varied from 1 to 21 locations. Only those tests were included where some cotton of the variety was grown commercially in the state (Appendix K).

In micronaire readings, as an average for the 7 years, combining locations in all states, the Stoneville and Fox 4 varieties ranked highest; Deltapine, Dixie King, and Auburn 56 were intermediate; while Rex (S.L.) and Empire (W.R.) ranked lowest. Combining locations, the greatest differences among varieties in micronaire averages occurred in 1961 and 1964. In 1961, the Stoneville 7 variety averaged 4.65, compared with 3.90 for Empire (W.R.); in 1964, Fox 4 averaged 4.80, compared with 4.05 for Empire (W.R.). The least difference occurred in 1959 when Fox 4 averaged 4.7, compared with 4.2 for both Empire (W.R.) and Rex (S.L.) varieties (Figure 5).

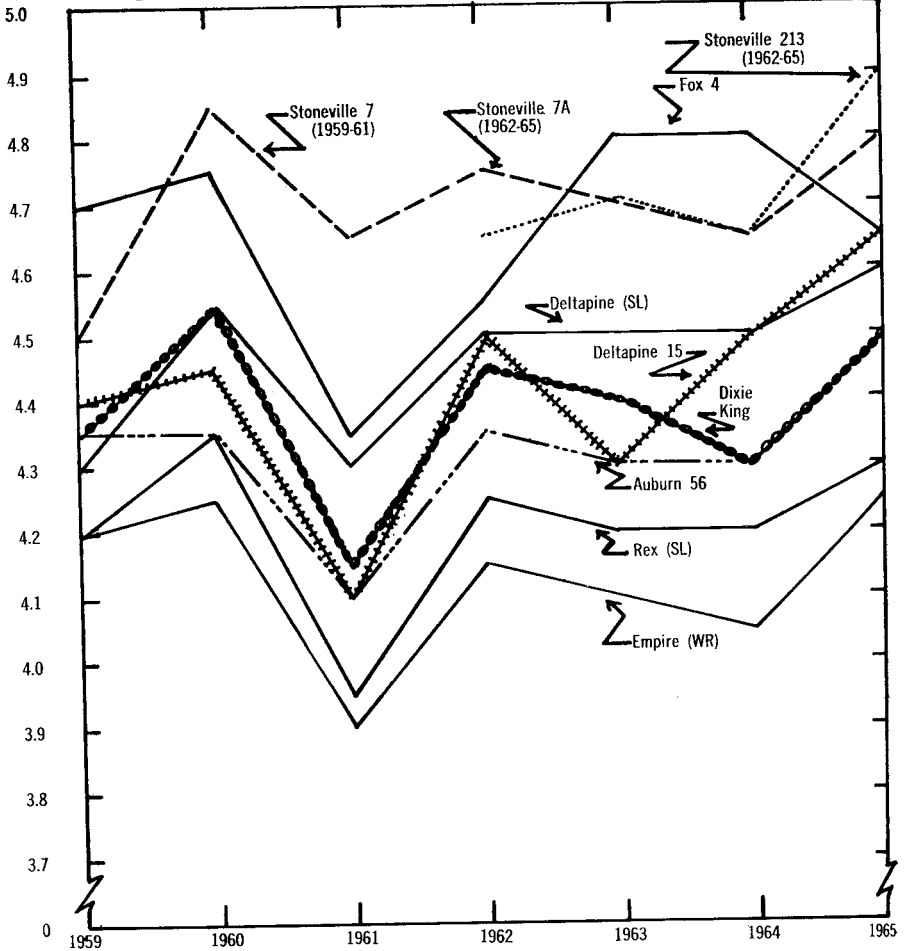
There were wide variations in micronaire averages among locations for a given variety, and between varieties at different locations. In 1962, for example, the micronaire average of Stoneville 7A varied from 3.8 at one location in Arizona to 5.7 at one location in Mississippi. In the same year the micronaire average of Empire (W.R.) varied from 3.7 at one location in Louisiana to 4.6 at one location in South Carolina.

These wide variations in micronaire averages within the variety, between varieties, and between locations, create difficulties for cotton shippers and spinners. Buyers desiring cotton of narrow ranges in micronaire readings and other fiber properties are faced with the problem of the most efficient method of concentrating cottons from different locations into even-running lots. This problem has been particularly acute in recent years since a high proportion of the cotton crop has been placed under Government loan.<sup>11</sup> Cotton acquired by the CCC generally loses its identity with regard to origin—variety, location, or year of growth.

Evaluation of the micronaire test averages did not show a significant trend or change for any one of the 10 varieties from 1959 to 1965 (Figure 5). The annual variation in micronaire test averages within a given variety appeared to be due to the effects of environmental factors.

<sup>11</sup> The proportion of the U. S. Crops received by the Commodity Credit Corporation averaged 34% in 1961, 46% in 1962, 53% in 1963, 49% in 1964, and an estimated 47% in 1965.

Micronaire Reading



**Figure 5. Micronaire test averages of 10 cotton varieties, combining locations, 5 to 19 states, 1959 to 1965.**

### Relative Effects of Variety and Environment

In Tennessee during the crop years 1959 to 1965, the micronaire average among varieties, combining locations, differed by 0.8 units. This difference averaged about 25% of the total range in micronaire units found among individual bales of cotton of one variety in the same locations.

While the differences in micronaire tests of individual bales of cotton within one variety, combining locations, averaged 3.2 micron-

aire units annually, the individual test readings from low to high varied for each variety. For example, combining locations in 1961, the micronaire average for Stoneville 7 was 4.65 (Appendix L), but the tests from individual bales varied from about 2.8 to 6.0 or a range of 3.2 micronaire units.

For all varieties of cotton classed under the Smith-Doxey Act in Tennessee for the crops of 1959 to 1965, the micronaire test average was 4.25; among individual bales of different varieties, the tests varied from as low as 2.0 to as high as 6.0 or a range of 4.0 micronaire units.

For cotton of 10 varieties classed under the Smith-Doxey Act, the micronaire tests in other states tended to follow the same range pattern as in Tennessee. From 1959 to 1965 and in 5 to 19 states, the difference in micronaire test averages within one variety at different locations in one year was as high as 2.4 to 2.5 micronaire units (Appendix L). This constituted about 75% of the observed micronaire test range of 3.2 micronaire units among individual bales of cotton of one variety grown at one location.

## Growing and Harvesting Conditions

The results of this study showed that during the 7 years, 1959 to 1965, there was ample opportunity for environment to exert its effect on the degree of fineness of cotton. In Tennessee the cotton growing season, from first planting to first picking, generally ranged from around 131 to 188 days and averaged 144 days. The harvesting and ginning season among locations ranged from 77 to 211 days and also averaged 144 days.

For the crop years 1959 to 1965, the micronaire test average of cotton ginned in Tennessee, combining locations, declined from 4.45 in August to 3.80 in January and the remainder of the ginning season. Among individual gin locations in some years the micronaire test average declined from as high as 5.3 in August to as low as 3.4 in December or later in the season (Table 6).

## Low Micronaire Cotton

The low micronaire cotton—under 3.5—or that subject to discounts varying from 50 to 400 points per pound on the Memphis Market (Table 1), as an annual average, was ginned late in the



season. Of the 4,248,509 bales ginned in Tennessee from 1959 to 1965, an estimated 7.1% or 302,000 bales tested under 3.5 in micronaire. Of this low micronaire cotton, for all 7 years, only 1,000 bales were ginned in August, 8,500 in September, 51,000 in October, 93,000 in November, and 148,500 from December to March.

The results for various properties of cotton tested from 15 sample gins in 1959 to 1965 showed that of the cotton micronairing under 3.5, only 0.3% came from first-pickings in August; 2.6% mainly from second-pickings in September; 15.8% mainly from second-pickings and hand-snapped cotton in October; 35.5% from second-pickings and hand-snapped cotton in November; and 45.8% from last-pickings and hand-snapped cotton, December to March.

Table 6.—Seasonal conditions relating to variations in micronaire tests of cotton in Tennessee, 1959 to 1965

Growing and harvesting	Months	1959-65	
		Average*	Range**
		(Days)	
Cotton planting	Apr.-June		
First planting to normal stands	Apr.-July	17	10-32
Normal stands to first blooms	Apr.-Sept.	53	42-58
First blooms to first open bolls	June-Nov.	49	34-59
First open bolls to first picking	July-Dec.	25	12-36
Planting to first picking or ginning	Apr.-Dec.	144	131-188
First picking to second picking	Aug.-Sept.	30	12-49
Second picking to hand snapping	Sept.-Oct.	30	12-48
Hand snapping to end of season	Oct.-Mar.	84	0-171
Harvesting and ginning	Aug.-Mar.	144	77-211
Planting to end of season	Apr.-Mar.	288	208-399
Micronaire test average of samples of cotton ginned in Tennessee, 1959 to 1965 crop years	Aug.	4.45	3.6-5.3
	Sept.	4.40	3.8-5.0
	Oct.	4.30	4.0-4.6
	Nov.	4.05	3.6-4.5
	Dec.	3.85	3.4-4.3
	Jan.-Mar.	3.80	3.4-4.2
	Season	4.25	3.4-5.3

\* Average, combining locations.

\*\* Range among gin locations. Wider ranges existed among individual fields.

Source: *Reports of Performance Trials of Cotton Varieties*, Tennessee Agricultural Experiment Station, 1959 to 1965; *Weather Reports—Cotton*, Tennessee Crop Reporting Service, Nashville, Tennessee, 1959 to 1965; *Weekly Cotton Market Reviews*, Cotton Division, Market News Section, Consumer and Marketing Service, USDA, 1959 to 1965; *Cotton Varieties and Related Studies*, Tennessee Agricultural Experiment Station Bulletin No. 211, June, 1949; *Cotton Production in the United States, Crops of 1959 to 1965*, U. S. Department of Commerce; and summarized results for various properties of cotton tested from 15 sample gins in Tennessee, Tennessee Agricultural Experiment Station, 1959 to 1965.

The micronaire test average of all sample cotton ginned from 1959 to 1965 averaged 4.40 for first-pickings, 4.05 for second-pickings, and 3.80 for hand-snapped cotton. As an annual average, about 70% of the cotton was harvested at first-picking, 14% at second-picking, and 16% was hand-snapped. The proportion of hand-snapped cotton during the 7 years varied from 24% in 1962 to 8% in 1965 (Appendix M).

### High Micronaire Cotton

The high micronaire cotton—5.0 and over—or that subject to discounts from 25 to 225 points per pound on the Memphis market (Table 1), came mainly from early and mid-season ginnings. Of the 4,248,509 bales ginned in Tennessee from 1959 to 1965, an estimated 6.3% or 266,000 bales tested 5.0 and over in micronaire.

Of this high micronaire cotton, for all 7 years, 1,600 bales were ginned in August, 105,400 in September, 138,700 in October, 19,000 in November, and 1,300 in December and later.

## RELATION OF MICRONAIRE TESTS TO OTHER FIBER PROPERTIES

Fiber and processing test results of cotton grown in 15 gin areas in Tennessee were summarized for the 7 years 1959 to 1965. The 4,949 tests were grouped by individual micronaire readings ranging from an average of under 3.0 to over 5.1 (Appendix N).

These data showed that as the micronaire test average of cotton produced in the state fell below 3.5, there was: 1) a general decline from average in raw cotton grade, staple length, length uniformity, and fiber strength; 2) an increase in nonlint content and manufacturing waste; 3) a decrease in fiber test performance relating to yarn strength and yarn appearance grade index; and 4) an increase in yarn imperfections or neppiness of cotton.

On the other hand, as the micronaire of cotton rose above 5.1, the staple length and length uniformity tested above average but the cotton declined in grade, fiber strength, and general processing performance tests (Appendix N).

### Grade

Grade index of cotton and other factors were correlated with the

manufacturing properties of picker and card waste, yarn imperfections, yarn strength, and yarn appearance grade.

The grade of lint cotton is an important factor in determining its market value, particularly when the grade falls below Middling White. In 1965 the grade discounts for cotton under Middling White inch averaged \$8.25 per 500-pound bale for Strict Low Middling, \$15.75 for Low Middling, \$25.25 for Strict Good Ordinary, and \$33.75 for Good Ordinary.

As an annual average, 1959-65, about 13% of the Tennessee cotton was Strict Middling White or better in grade, 34% Middling White, 27% Strict Low Middling White, and 26% Low Middling White and under in grade. In terms of "Middling White equals 100", the Tennessee cotton averaged a grade index of 96 or the equivalent of Strict Low Middling plus.

Cotton micronairing under 3.7 showed lower than Strict Low Middling grade index of 94. As the micronaire test average of cotton rose above 5.1, grade index declined from Strict Low Middling plus to Strict Low Middling (Appendix N).

## Staple Length

Staple length, next to grade, is of major importance in determining the market value of cotton. Since the market price of cotton is based on Middling White inch, it is important that the farmer produce cotton stapling above an inch, or in the premium range.

In 1965, the staple length discounts for Middling White cotton under 1-inch averaged \$4.00 per 500-pound bale for 31/32-inch, \$7.00 per bale for 15/16-inch, and \$9.25 per bale for 29/32-inch cotton. On the other hand, premiums per bale for cotton above 1-inch averaged \$4.75 for 1 1/32 inches, \$9.00 for 1 1/16 inches, \$12.00 for 1 3/32 inches, and \$16.25 for cotton 1 1/8 inches in staple. From 1959 to 1965, the Tennessee cotton averaged staple length premiums of \$10.50 per bale. For the years 1959-65, about 99.3% of the Tennessee cotton ranged from 1-inch to 1 5/32 inches in staple length, averaging 33.6 in 32nd inches.

Cotton ginned late in the season declined below average in micronaire readings, staple length in 32nd inches, and grade index, in each crop year, 1961 to 1965 (Appendixes A to E).

## Length Uniformity

Length uniformity tests of cotton are important to merchants and spinners since the higher length uniformity values indicate more uniform fiber length distribution. Low fiber length uniformity tends to increase manufacturing waste, makes processing more difficult, and lowers the quality of the end product. Length uniformity ratio of cotton was correlated with such processing factors as picker and card waste, yarn strength, yarn appearance grade index, and yarn imperfections.

The Digital Fibrograph 50/2.5 uniformity ratio was used in computing length uniformity of cotton. Uniformity values below 43 were considered low, 43 to 45 average, and above 45 high.

As an annual average for the years 1959-65, Tennessee cotton averaged a length uniformity ratio of 44.3 and 99% of the cotton fell within a 43 to 49 length uniformity range.

Cotton micronairing under 3.4 showed lower than average (below 43) in length uniformity ratio. That micronairing over 5.1 maintained a length uniformity ratio of 46 or above average (Appendix N).

## Fiber Strength

Fiber strength in cotton is considered important because it influences spinning quality and yarn strength. Cottons with good fiber strength usually give less trouble in manufacturing than the weak-fibered cottons.

For the years 1959-65, the fiber strength of Tennessee cotton, 0-gauge, averaged 80,400 pounds per square inch. About 92% of the cotton fell within the strength range of 76,000 to 85,000 pounds per square inch, which was considered average for Tennessee medium staple cotton. Cotton micronairing over 5.1 tended to decline in 0-gauge fiber strength and averaged 76,000 pounds per square inch. Cotton micronairing under 3.5 declined in fiber strength from 78,200 pounds per square inch to 60,000 pounds per square inch for cotton micronairing 2.9 and under (Appendix N).

## Nonlint Content

Nonlint content in cotton is considered an important factor since it is related to grade, and influences percent waste, yarn imperfec-

tions, yarn appearance, and spinning quality. Excessive waste also increases the cost of cotton products.

Tennessee cotton for the 1959-65 period averaged a nonlint content of 2.2% or equivalent to the normal for Middling White grade. Cotton micronairing under 4.0 showed an increase above average in nonlint cotton percentage which was due to the lower grade and the immaturity of cotton harvested late in each season.

For the past 18 years there has been a downward trend in the nonlint content of Tennessee cotton. The proportion ranged from an average of 4.1% in 1947 to 1.6% in 1963. The proportion for the crop years 1947-58 averaged 3.2%, compared with 2.2% for the 1959-65 average. The decrease in nonlint content percentage was mainly due to the improvements in gin seed cotton cleaners and extractors and lint cleaning equipment.<sup>12</sup>

### Picker and Card Waste

Manufacturing waste in cotton is important because excessive waste adds to the cost of the finished cotton products. The percentage of waste extracted by the picking and carding process in performing a spinning test provides a measure of the manufacturing waste. Picker and card waste percentage was correlated with such factors as nonlint content percentage, grade index, yarn imperfection count, yarn appearance grade index, micronaire reading, yarn strength, staple length, length uniformity, and fiber strength. Picker and card waste of Tennessee cotton for the 1959-65 crop years averaged 6.6%, or about normal for cotton of Middling White grade.

### Yarn Strength

Yarn strength is one of the most important and reliable tests of yarn quality. It determines the range of usefulness of a particular yarn. The most important indicators of good yarn strength were fiber strength, staple length, and length uniformity.

Yarn break factor was used as a measure of yarn strength. The break factor employed was the average for two yarn counts, 22's and 50's, expressed as pounds strength times yarn numbers. For example, if the yarn strength break of a sample of cotton was 100

<sup>12</sup> B. D. Raskopf, *Factors Associated With Cotton Ginning Problems in Tennessee*, Tennessee Agricultural Experiment Station Bulletin No. 336, Sept. 1963.

pounds for 22's, and 34 pounds for 50's, the yarn break factor was  $1950 (100 \times 22) + (34 \times 50) \div 2$ . For the period 1959-65, the average break factor for Tennessee cotton was 2066 which fell within the 1886 to 2232 range normally obtained for medium staple cotton in Tennessee.

As the micronaire test average showed an increase from 5.0 to 5.2 and over, the yarn break factor showed a decline from 2203 to 1850; as the micronaire of cotton declined from 3.4 to under 3.0, the yarn break factor showed a decrease from 2065 to 1800 (Appendix N).

### **Yarn Appearance Grade**

Yarn appearance grade index value is related to the evenness, smoothness, and freedom from foreign materials of the yarn as evaluated by a visual comparison of the yarn with the standards adopted by the American Society for Testing Materials.

Yarn appearance index values shown in Appendix N represented the average of the appearance indices for 22's and 50's carded yarns. An index of 100 to 108 was considered average. For the years 1959-65, the Tennessee cotton averaged 101 in yarn appearance grade index. Cotton micronairing under 3.7 showed lower than average in yarn appearance index.

### **Yarn Imperfections**

A desirable feature of a particular cotton is its relative freedom from neps or yarn imperfections because of sources of trouble in manufacturing fabrics. A high degree of yarn imperfections detracts from the appearance of finished products when they are to be dyed or printed. When the number of yarn imperfections in the tests of sample cotton run high, the cotton is likely to produce rough and neppy yarns.

Yarn imperfections tests were expressed as the average number of imperfections per 50 yards of yarn, 22's and 50's. Yarn imperfection count of 18 to 28 was considered average for Tennessee medium staple cottons. For the years 1959-65, the yarn imperfection count averaged 22 for Tennessee cotton. Cotton micronairing from 3.5 to 2.9 and under showed an increase in yarn imperfection count ranging from 35 to 48 (Appendix N).

## Important Test Differences

Analysis of the data given in Appendix N indicated that as the micronaire of Tennessee cotton, as an average, declined from 3.5 to 2.9 or lower, each decrease of 0.1 micronaire unit was associated with:

- 1) a decline of nearly 3 in grade index (Middling White = 100);
- 2) a decrease of 0.1 in staple length in 32nd inch;
- 3) a decrease of 0.1 in length uniformity ratio;
- 4) a decrease in 0-gauge strength of 3,000 pounds per square inch;
- 5) a decrease in  $\frac{1}{8}$  inch-gauge strength of 0.8 gram per tex;
- 6) an increase in nonlint content of 0.3%;
- 7) an increase in picker and card waste of 0.6%;
- 8) a decrease in yarn strength of 37 in yarn break factor;
- 9) a decrease of nearly 3 in yarn appearance grade index; and
- 10) an increase of 2 in yarn imperfection count.

## Cotton Quality Relationships

The results of this study (Appendix O) indicated that:

- 1) Good indicators of picker and card waste were the Shirley Analyzer measurement of nonlint content, the grade index of cotton, and to a lesser extent the micronaire reading.
- 2) Good indicators of potential yarn strength were the  $\frac{1}{8}$ -inch gauge fiber strength test, staple length in 32nd inches, and to a lesser extent the length uniformity ratio and grade index.
- 3) The best indicators of potential yarn appearance grades were the micronaire reading, length uniformity ratio, and to a lesser extent the grade index.
- 4) Micronaire reading, grade index, nonlint content percent, and length uniformity were good indicators of the degree of neppiness or yarn imperfection count.

For all cotton ginned in Tennessee, 1959 to 1965, the micronaire readings also showed some correlation with staple length, raw cotton fiber strength, and yarn strength (Appendix O). The data in Appendix N indicated that cotton generally micronairing below 3.5 was lower than average in staple length, raw cotton fiber strength,

and yarn strength. The principal reason for this correlation was because 80% of the low micronaire cotton (below 3.5) came from late season ginnings which was lower than average in grade, staple length, fiber strength, and yarn strength.

## ECONOMIC IMPORTANCE OF MICRONAIRE TESTS

As an annual average for 1961-65, the discounts for cotton of low micronaire—under 3.5 or high micronaire—over 4.9, had little effect on the total farm value of the crop. For all cotton the net discounts averaged only 28¢ per bale, or 0.17% of the annual farm value (\$101,054,000) of the crop (Table 7).

Table 7.—Estimated premiums and discounts for various ranges of micronaire readings of cotton and effects on value of crops, Tennessee, 1961-65 Average

Micronaire range	Bales ginned annual average		Premiums or discounts per bale	Annual value of premiums or discounts	Farm value of crop annual average	Value changed by premiums or discounts
	Number	%	\$	\$	\$	%
Readings						
Under 2.7	1,415	0.2	-16.25	- 22,994	186,800	-12.3
2.7-2.9	5,435	0.9	-10.00	- 54,350	763,600	- 7.1
3.0-3.2	17,015	2.8	- 6.25	-106,344	2,535,200	- 4.2
3.3-3.4	19,272	3.2	- 2.50	- 48,180	2,967,900	- 1.6
3.5-4.9	525,920	86.6	+ 0.50	+262,960	88,156,500	+ 0.3
5.0-5.2	30,207	5.0	- 3.75	-113,276	5,120,100	- 2.2
Over 5.2	7,813	1.3	-11.25	- 87,896	1,324,300	- 6.6
All cotton	607,077	100.0	- 0.28	-170,080	101,054,400	- 0.17

Source: *Cotton Production and Distribution, Crops of 1961 to 1965*, U. S. Department of Commerce; *Spot Cotton Quotations*, Cotton Division, Consumer and Marketing Service, USDA, 1961 to 1966; *Cash Receipts from Farm Marketings*, Tennessee Crop Reporting Service, 1961 to 1966; and Table 3.

There were four important reasons why the micronaire tests in the aggregate had little effect on the annual total value of the crop: 1) only 13.4% of the crop annually micronaired under 3.5 or over 4.9, and only 2.4% fell within the micronaire ranges where discounts amounted to over \$6.25 per bale; 2) the price discounts for both low and high micronaire cotton of \$433,040 annually were greatly offset by the \$262,960 annual premiums paid for some cottons falling within the range of 3.5 to 4.9 micronaire; 3) the proportion of the cotton crop that was very low in micronaire averaged low in value because of being lower in grade, staple length, strength, or un-



desirable because of high waste or poor processing performance; and 4) price discounts for low or high micronaire cotton were relatively low compared with the market price of cotton which was based on Middling White inch.

While the discounts for low and high micronaire cotton were relatively small in relation to the total value of the crop, they were of considerable importance to the producers who grew and sold such cotton. As an annual average, 13.4% of the Tennessee crop or 81,157 bales was subject to discounts for being excessively fine or too coarse for the manufacture of many cotton products. These discounts amounted to \$5.34 per bale or \$433,040 annually, and averaged 3.4% of the value of the low and high micronaire cotton.

While the price discounts for low and high micronaire cottons increased at an increasing rate, the relative importance of the discounts were measurable. Between the micronaire readings of 3.5 and 2.6 and below, each 0.1 decrease in micronaire unit was associated with an increase in price discount averaging 36 points per pound or \$1.80 per bale. Between micronaire readings of 4.9 and 5.8, each 0.1 increase in micronaire unit was associated with an increase in price discount averaging 25 points per pound.

## APPENDIX A

**Micronaire readings, grade, and staple length of cotton ginned in Tennessee,  
by specified periods, crop of 1961**

1961-62 week ending	Cotton ginned in running bales		Micronaire reading class intervals						Micronaire av.	Grade **	Staple length av.	
			Under 3.1	3.1- 3.5	3.6- 4.0	4.1- 4.5	4.6- 5.0	Over 5.0				
	No.	%	Estimated % of cotton						Units	Index	32nd in.	
Sept.	15	2000	0.4	0	0	6	42	46	6	4.6	101.3	34.1
	22	30000	5.4	0	0	1	17	55	27	4.8	102.1	34.2
	29	30200	5.4	0	1	6	37	42	14	4.6	102.1	34.2
Oct.	6	53600	9.7	1	1	15	52	28	3	4.4	102.1	34.2
	13	57500	10.4	0	2	21	54	22	1	4.3	100.4	34.1
	20	63300	11.5	0	4	36	52	7	1	4.1	99.8	34.1
	27	71000	12.9	1	9	40	42	8	*	4.0	100.0	34.0
Nov.	3	57000	10.4	1	16	43	34	5	*	3.9	99.9	34.1
	10	38300	7.0	3	34	45	16	2	0	3.7	98.4	34.0
	17	29500	5.4	7	41	41	10	*	0	3.6	95.2	33.9
	24	22900	4.2	3	40	47	9	1	0	3.6	89.5	33.4
Dec.	1	22500	4.1	12	43	33	11	1	0	3.5	84.7	33.1
	8	22000	4.0	20	43	28	9	*	0	3.4	83.4	33.0
	15	17300	3.1	23	45	26	5	1	0	3.4	80.1	33.0
	22	3800	0.7	27	40	21	10	2	0	3.4	78.2	32.9
	29	3700	0.7	19	38	29	13	1	0	3.5	79.0	32.9
Jan.	5	3600	0.7	26	39	26	6	3	0	3.4	75.9	32.6
	12	3600	0.7	22	40	27	11	0	0	3.4	75.1	32.2
Other***		18510	3.3							3.4	75.1	32.2
Season		550310	100.0	4.4	17.1	30.0	32.4	13.2	2.9	4.0	95.5	33.8

\* Less than 0.5%.

\*\* Middling White grade = 100.

\*\*\* Jan. 13 to end of season.

Source: Computed from weekly reports of *Cotton Classed Under Smith-Dorey Act, South Central Area*, Volume 3, Numbers 1 to 20, Cotton Division, Agricultural Marketing Service, USDA, 1961; and *Cotton Production in the United States, Crop of 1961*, U. S. Department of Commerce, 1962.

## APPENDIX B

Micronaire tests, grade, and staple length of cotton ginned in Tennessee,  
by specified periods, crop of 1962

1962-63 week ending	Cotton ginned in running bales		Micronaire reading class intervals						Micronaire av.	Grade **	Staple length av.	
			Under 3.0	3.0- 3.4	3.5- 3.9	4.0- 4.4	4.5- 4.9	Over 4.9				
			Estimated % of cotton									Units
Aug.	31	1000	0.2	0	0	3	27	47	23	4.7	102.3	34.0
Sept.	7	22100	4.0	0	0	10	50	32	8	4.4	101.3	34.0
	14	22300	4.1	*	5	32	52	10	1	4.1	99.8	33.9
	21	52700	9.6	0	3	28	55	13	1	4.1	98.1	33.9
	28	57800	10.6	*	2	26	56	15	1	4.1	96.6	33.8
Oct.	5	71400	13.0	0	3	22	53	20	2	4.2	96.3	33.8
	12	76800	14.0	*	3	20	49	24	4	4.2	95.9	33.9
	19	68700	12.5	0	4	18	44	27	7	4.3	95.6	33.9
	26	48400	8.8	*	3	17	45	28	7	4.3	95.1	33.6
Nov.	2	41800	7.6	*	2	14	46	31	7	4.3	94.2	33.4
	9	25300	4.6	0	4	16	41	31	8	4.3	93.9	33.2
	16	19700	3.6	*	3	13	43	31	10	4.3	92.7	32.8
	23	12400	2.3	0	4	18	41	28	9	4.3	91.0	32.8
	30	12200	2.2	1	5	26	45	20	3	4.1	90.2	32.7
Dec.	7	5100	0.9	*	8	26	40	22	4	4.1	89.4	32.5
	14	3900	0.7	2	6	30	37	21	4	4.1	89.1	32.5
Other***		6808	1.3							3.9	86.8	32.4
Season		548408	100.0	0.3	3.0	20.6	48.5	23.0	4.6	4.2	95.8	33.6

\* Less than 0.5%.

\*\* Middling White grade = 100.

\*\*\* Dec. 15 to end of season.

Source: Computed from weekly reports of Cotton Classed under Smith-Dorey Act, South Central Area, Volume 4, Numbers 1 to 19, Cotton Division, Agricultural Marketing Service, USDA, 1962; and Cotton Production in the United States, Crop of 1962, U. S. Department of Commerce, 1963.

## APPENDIX C

**Micronaire tests, grade, and staple length of cotton ginned in Tennessee,  
by specified periods, crop of 1963**

1963-64 week ending	Cotton ginned in running bales		Micronaire reading class intervals						Micronaire av.	Grade **	Staple length av.	
			Under 3.0	3.0- 3.4	3.5- 3.9	4.0- 4.4	4.5- 4.9	Over 4.9				
	No.	%	Estimated % of cotton						Units	Index	32nd in.	
Aug.	30	9400	1.5	0	4	17	68	9	2	4.1	99.9	34.1
Sept.	6	13000	2.0	0	4	30	55	10	1	4.1	100.0	34.1
	13	13200	2.0	0	1	19	63	16	1	4.2	100.1	34.0
	20	57800	9.0	0	*	11	51	36	2	4.4	99.7	34.0
	27	75700	11.8	0	1	5	43	42	9	4.5	99.2	33.9
Oct.	4	82700	12.8	0	*	8	43	41	8	4.5	98.9	33.8
	11	94400	14.7	*	1	8	40	41	10	4.5	98.8	33.8
	18	90200	14.0	0	1	6	43	41	9	4.5	98.9	33.8
	25	65200	10.1	*	2	10	44	36	8	4.4	98.5	33.6
Nov.	4	67700	10.5	1	2	15	45	33	4	4.3	97.9	33.5
	8	11900	1.8	*	6	23	49	19	3	4.2	97.6	33.2
	15	18200	2.8	2	9	28	41	18	2	4.1	94.5	33.0
	22	11900	1.9	3	18	29	37	12	1	3.9	92.6	32.8
	29	11700	1.8	4	21	28	34	13	*	3.9	90.2	32.9
Dec.	6	6800	1.1	5	23	32	30	8	2	3.8	86.3	32.8
Other***		14266	2.2							3.8	83.0	32.5
Season		644066	100.0	0.5	2.9	11.5	42.6	35.5	7.0	4.4	98.1	33.7

\* Less than 0.5%.

\*\* Middling White grade = 100.

\*\*\* Dec. 7 to end of season.

Source: Computed from weekly reports, *Quality of Cotton Classed Under Smith-Doxey Act, South Central Area*, Volume 5, Numbers 1 to 17, Cotton Division, Agricultural Marketing Service, USDA, 1963; and *Cotton Production in the United States, Crop of 1963*, U. S. Department of Commerce, 1964.

## APPENDIX D

**Micronaire tests, grade, and staple length of cotton ginned in Tennessee,  
by specified periods, crop of 1964**

1964-65 week ending	Cotton ginned in running bales		Micronaire reading class intervals				Micronaire av.	Grade **	Staple length av.	
			Under 3.0	3.0- 3.4	3.5- 4.9	Over 4.9				
	No.	%	Estimated % of cotton				Units	Index	32nd in.	
Sept.	4	1000	0.2	3	0	88	9	4.2	98.9	33.9
	11	13900	2.1	0	0	76	24	4.4	100.4	33.9
	18	29900	4.5	*	*	71	29	4.5	100.2	34.0
	25	35300	5.3	0	*	75	25	4.5	99.0	34.0
Oct.	2	47500	7.1	0	*	74	26	4.5	98.2	33.8
	9	78100	11.7	0	1	80	19	4.4	96.7	33.8
	16	78200	11.7	0	*	91	9	4.3	96.5	33.8
	23	84900	12.8	0	*	90	10	4.3	95.8	33.8
	30	86200	12.9	*	2	93	5	4.2	95.4	33.7
Nov.	6	58700	8.8	*	4	95	1	4.2	94.8	33.9
	13	68500	10.3	1	9	90	*	4.1	93.9	33.8
	20	12400	1.9	1	24	75	*	3.9	92.9	33.6
	27	12400	1.9	2	29	69	0	3.9	91.0	33.4
Other***	58691	8.8					3.4	83.5	32.7	
Season	665691	100.0	2.0	7.8	81.4	8.8	4.2	94.8	33.7	

\* Less than 0.5%.

\*\* Middling White grade = 100.

\*\*\* Nov. 28 to end of season.

Source: Computed from weekly reports, *Quality of Cotton Classed Under Smith-Dorey Act, South Central Area*, Volume 6, Numbers 1 to 16, Cotton Division, Agricultural Marketing Service, USDA, 1964; and *Cotton Production in the United States, Crop of 1964*, U. S. Department of Commerce, 1965.

## APPENDIX E

Micronaire tests, grade, and staple length of cotton ginned in  
Tennessee, by specified periods, crop of 1965

1965-66 week ending	Cotton ginned in running bales		Micronaire reading class intervals					Micronaire av.	Grade **	Staple length av.		
			Under 3.0	3.0- 3.2	3.3- 3.5	3.6- 4.8	4.9- 5.1				Over 5.1	
			Estimated % of cotton								Units	Index
Sept.	3	1000	0.2	0	0	0	77	21	2	4.4	100.2	34.3
	10	9500	1.5	*	*	1	76	15	8	4.4	98.9	34.0
	17	26300	4.2	0	*	1	85	10	4	4.3	98.4	34.1
	24	53800	8.6	0	0	1	89	7	3	4.3	96.1	33.9
Oct.	1	60800	9.7	0	*	*	87	9	4	4.3	94.4	33.8
	8	103900	16.6	0	*	*	88	8	4	4.3	93.9	33.7
	15	103800	16.5	*	*	1	89	7	3	4.3	93.9	33.5
	22	82600	13.2	1	1	3	87	6	2	4.2	93.6	33.2
	29	74100	11.8	1	1	3	87	6	2	4.2	92.9	33.1
Nov.	5	43800	7.0	1	2	4	86	5	2	4.2	93.4	32.9
	12	31700	5.0	1	2	6	84	5	2	4.2	92.0	32.7
	19	12300	2.0	1	2	6	85	4	2	4.2	90.3	32.9
	26	9100	1.4	*	3	9	83	4	1	4.1	89.3	33.5
Dec.	3	6800	1.1	1	4	8	80	5	2	4.1	89.3	33.0
Other***		7413	1.2							4.0	89.3	32.9
Season		626913	100.0	0.1	0.9	2.7	86.8	6.7	2.8	4.3	93.5	33.4

\* Less than 0.5%.

\*\* Middling White grade = 100.

\*\*\* Dec. 4 to end of season.

Source: Computed from weekly reports, *Quality of Cotton Classed Under Smith-Dorey Act, South Central Area*, Volume 7, Numbers 1 to 18, Cotton Division, Agricultural Marketing Service, USDA, 1965; and preliminary reports, *Cotton Ginnings, Crop of 1965*, U. S. Department of Commerce, 1965-66.

## APPENDIX F

### Micronaire test averages of cotton, by states 1959 to 1965

State	1959	1960	1961	1962	1963	1964	1965	1959-65	Difference
Micronaire test average*									**
Miss.	4.5	4.7	4.4	4.6	4.5	4.6	4.7	4.6	0.3
La.	4.5	4.7	4.3	4.7	4.6	4.6	4.5	4.5	0.4
Ark.	4.3	4.5	4.1	4.3	4.3	4.6	4.6	4.4	0.5
Ariz.	4.1	4.3	4.2	4.2	4.4	4.4	4.3	4.3	0.3
Tenn.	4.3	4.4	4.0	4.2	4.4	4.2	4.3	4.3	0.4
Ala.	4.2	4.5	4.3	4.2	4.2	4.1	4.5	4.3	0.4
Ga.	4.3	4.4	4.3	4.4	4.0	4.1	4.3	4.3	0.4
Mo.	4.4	4.3	3.8	4.1	4.3	4.5	4.4	4.3	0.7
Va.	4.1	4.5	4.2	4.2	4.2	4.0	4.6	4.3	0.6
S. C.	4.2	4.3	4.1	4.6	4.2	4.1	4.2	4.2	0.5
Cal.	4.4	4.2	4.3	4.3	4.3	4.1	4.0	4.2	0.4
Okla.	4.3	4.3	4.2	4.3	4.3	4.2	4.0	4.2	0.3
Ky.	ND	ND	ND	ND	4.1	4.3	4.3	4.2	0.2
N. C.	4.2	4.4	4.0	4.2	4.3	4.1	4.2	4.2	0.4
Ill.	ND	ND	ND	ND	3.9	4.2	4.2	4.1	0.3
Fla.	ND	ND	3.9	3.9	4.2	4.1	4.4	4.1	0.5
Tex.	4.0	4.0	4.0	4.1	3.9	4.0	3.8	4.0	0.3
N. M.	3.5	3.8	3.6	3.8	3.5	3.7	3.3	3.6	0.4
Nev.	3.9	3.9	3.3	3.8	3.3	3.1	2.6	3.4	1.3
U. S.	4.2	4.3	4.3	4.3	4.2	4.2	4.2	4.2	
Difference ***	1.0	0.9	1.1	0.9	1.3	1.5	2.1	2.1	

\* Difference of 0.1 micronaire unit was significant at the 5% level of probability.

\*\* Greatest difference within one state, by years.

\*\*\* Greatest difference among states in one year.

ND=No data.

Source: *Annual Cotton Quality Survey, Crops of 1959 to 1965*, Consumer and Marketing Service, USDA; and Annual reports of *Quality of Cotton Classed Under Smith-Doxey Act, 1960 to 1966*, South Central and Other Areas, Consumer and Marketing Service, USDA.

## APPENDIX G

Percentage distribution of upland cotton, by specified micronaire test ranges, by states, 1963 crop year

State	Running bales ginned	Micronaire readings by class intervals						State micronaire average
		Under 3.0	3.0-3.2	3.3-3.5	3.6-4.8	4.9-5.1	Over 5.1	
	No.	Estimated % of cotton						Reading
Tex.	4,413,166	8.9	12.2	12.1	58.5	5.5	2.8	3.9
Miss.	2,110,642	0.2	0.6	1.2	83.9	11.7	2.4	4.5
Cal.	1,736,221	0.8	2.6	4.1	88.5	3.7	0.3	4.3
Ark.	1,500,900	0.4	1.4	3.2	81.6	10.1	3.3	4.3
Ala.	874,225	0.1	0.9	3.9	93.5	1.4	0.2	4.2
Ariz.	836,047	2.8	4.6	6.3	59.4	18.9	8.0	4.4
La.	675,212	0.3	0.9	1.9	66.6	20.7	9.6	4.6
Tenn.	644,066	0.4	1.3	2.7	85.6	7.7	2.3	4.4
Ga.	604,370	0.3	2.9	9.6	84.1	2.3	0.8	4.0
S. C.	464,274	0.3	2.5	10.2	79.9	5.1	2.0	4.2
Mo.	460,433	1.3	3.3	5.7	76.3	8.8	4.6	4.3
N. C.	361,946	0.7	1.9	4.5	77.0	10.6	5.3	4.3
Okla.	324,589	2.9	4.1	5.9	70.3	12.2	4.6	4.3
N. M.	247,048	17.6	14.7	15.7	51.9	0.1	0	3.5
Fla.	14,936	0.4	1.5	4.9	92.7	0.5	0	4.2
Va.	9,395	2.0	6.3	10.6	61.3	12.5	7.3	4.2
Nev.	5,267	21.2	24.1	18.9	35.8	0	0	3.3
Ky.	5,074	1.2	4.6	5.6	87.5	1.0	0.1	4.1
Ill.	2,175	4.7	9.7	10.0	71.2	4.4	0	3.9
U. S.	15,289,986	3.3	5.1	6.3	74.5	7.9	2.9	4.2

Source: *Weekly Cotton Market Review*, Vol. 45, No. 39, Consumer and Marketing Service, USDA, May 7, 1965; and *Cotton Production in the United States, Crop of 1963*, U. S. Department of Commerce, 1964.



## APPENDIX H

Percentage distribution of upland cotton, by specified micronaire test ranges, by states, 1964 crop year

State	Running bales ginned	Micronaire readings by class intervals						State micronaire average
		Under 3.0	3.0-3.2	3.3-3.5	3.6-4.8	4.9-5.1	Over 5.1	
	No.	Estimated % of cotton						Reading
Tex.	4,079,345	4.9	9.1	12.1	67.4	4.7	1.8	4.0
Miss.	2,223,221	0.3	1.1	1.8	60.4	21.1	15.3	4.6
Cal.	1,787,747	1.6	3.7	6.5	84.6	2.9	0.7	4.1
Ark.	1,583,169	0.9	1.9	2.9	62.6	16.5	15.2	4.6
Ala.	887,462	0.1	2.7	6.1	88.9	1.9	0.3	4.1
Ariz.	793,974	2.6	4.3	6.0	59.7	19.0	8.4	4.4
Tenn.	665,691	2.0	3.9	6.6	74.7	9.7	3.1	4.2
Ga.	616,851	0.3	1.5	4.6	92.8	0.7	0.1	4.1
La.	587,905	1.0	1.4	1.9	57.1	21.9	16.7	4.6
S. C.	564,796	0.3	1.6	4.8	90.4	2.6	0.3	4.1
Mo.	419,088	0.6	1.3	3.1	70.1	15.7	9.2	4.5
N. C.	388,227	0.7	1.8	4.8	91.0	1.6	0.1	4.1
Okla.	278,065	5.0	4.8	6.1	67.3	12.3	4.5	4.2
N. M.	235,512	13.1	11.1	12.0	63.4	0.3	0.1	3.7
Fla.	13,555	0.1	0.6	3.5	93.6	2.0	0.2	4.1
Va.	11,477	0.3	0.7	6.2	92.8	0	0	4.0
Nev.	5,045	28.7	36.3	26.6	8.4	0	0	3.1
Ky.	3,727	0.8	4.7	3.2	79.4	9.5	2.4	4.3
Ill.	2,721	0.7	2.0	2.7	86.0	8.6	0	4.2
U. S.	15,147,578	2.2	4.3	6.5	71.4	9.6	6.0	4.2

Source: *Weekly Cotton Market Review*, Vol. 46, No. 39, Consumer and Marketing Service, USDA, May 7, 1965; and *Cotton Production in the United States, Crop of 1964*, U. S. Department of Commerce, 1965.

## APPENDIX I

### Percentage distribution of upland cotton, by specified micronaire test ranges, by states, 1965 crop year

State	Running bales ginned	Micronaire readings by class intervals						State micronaire average
		Under 3.0	3.0-3.2	3.3-3.5	3.6-4.8	4.9-5.1	Over 5.1	
	No.	Estimated % of cotton						Reading
Tex.	4,598,764	14.0	14.7	12.1	53.9	4.0	1.3	3.8
Miss.	2,010,562	*	0.5	1.1	64.4	20.7	13.3	4.7
Cal.	1,717,361	4.3	6.5	7.7	80.4	1.0	0.1	4.0
Ark.	1,445,430	0.2	1.0	2.0	68.9	15.7	12.2	4.6
Ala.	846,097	*	0.3	0.9	87.8	9.2	1.8	4.5
Ariz.	735,264	3.4	5.2	6.7	66.8	13.0	4.9	4.3
Tenn.	626,913	0.1	0.9	2.7	86.8	6.7	2.8	4.3
La.	558,890	0.2	1.3	2.4	74.7	13.4	8.0	4.5
Ga.	561,543	0.1	0.7	2.3	88.9	6.3	1.7	4.3
S. C.	505,387	0.3	1.3	3.1	88.6	5.9	0.8	4.2
Mo.	393,091	0.2	1.3	3.4	78.8	11.5	4.8	4.4
Okla.	357,735	6.9	6.3	8.0	73.5	4.1	1.2	4.0
N. C.	235,750	0.5	1.7	5.1	87.0	5.0	0.7	4.2
N. M.	205,617	27.4	19.6	17.7	35.3	*	0	3.3
Fla.	12,185	0	0.4	1.0	88.3	8.1	2.2	4.4
Ky.	5,010	0.1	0.8	1.3	93.0	4.8	0	4.3
Va.	6,481	0	0	0.1	82.4	13.3	4.2	4.6
Nev.	3,800	94.2	4.3	0.6	0.9	0	0	2.6
Ill.	1,300	0.8	0.4	2.4	90.0	6.4	0	4.2
U. S.	14,827,180	5.7	6.4	6.4	68.3	8.7	4.5	4.2

\* Less than 0.05%.

Source: U. S. Cotton Quality Report for Ginnings, 1965 Crop, Vol. 39, No. 7, Consumer and Marketing Service, USDA, June, 1966; and Cotton Ginnings, U. S. Department of Commerce, June, 1965 and 1966.

## APPENDIX J

### Micronaire test averages of cotton varieties in Tennessee, 1959 to 1965

Varieties	1959	1960	1961	1962	1963	1964	1965
Micronaire test average, combining locations							
Stoneville: 213	ND	ND	ND	4.50	5.05	4.45	4.55
7	4.35	4.55	4.65	ND	ND	ND	ND
7A	ND	ND	ND	4.60	4.90	4.30	4.60
Fox 4	4.90	4.90	4.25	4.40	4.80	4.55	4.40
Deltapine (SU)	4.65	4.40	4.10	4.35	4.60	4.20	4.40
Dixie King	4.35	4.45	4.05	4.30	4.25	4.45	4.30
Deltapine 15	4.35	4.55	4.00	4.20	4.25	4.35	4.30
Auburn M	ND	ND	ND	4.20	4.45	4.15	4.30
Stoneville 3202	4.40	4.35	4.05	ND	ND	ND	ND
Auburn 56	4.35	4.35	4.00	4.25	4.45	4.20	4.30
Rex (SU)	4.15	4.20	3.80	3.90	4.25	3.90	4.15
Empire (WR)	4.00	4.15	3.65	3.90	4.15	3.90	3.95
Other varieties*	4.30	4.40	4.00	4.15	4.45	4.15	4.25
Micronaire test average range, among locations**							
Stoneville: 213	ND	ND	ND	4.2-	4.8-	4.1-	4.3-
	ND	ND	ND	4.8	5.3	4.8	4.8
7	4.0-	3.8-	4.3-	ND	ND	ND	ND
	4.7	5.3	5.0	ND	ND	ND	ND
7A	ND	ND	ND	4.4-	4.6-	3.9-	4.4-
	ND	ND	ND	4.8	5.2	4.7	4.8
Fox 4	4.6-	4.5-	4.1-	4.0-	4.3-	4.3-	4.1-
	5.2	5.3	4.4	4.8	5.3	4.8	4.7
Deltapine (SU)	4.4-	4.0	4.0	3.9	4.3-	3.7-	4.1-
	4.9	4.8	4.2	4.8	4.9	4.7	4.7
Dixie King	4.1-	4.2-	3.9-	4.1-	4.0-	4.1-	4.1-
	4.6	4.7	4.2	4.5	4.5	4.8	4.5
Deltapine 15	3.9-	4.3-	3.9-	4.0-	4.1-	3.9-	4.1-
	4.8	4.8	4.1	4.4	4.4	4.8	4.5
Auburn M	ND	ND	ND	3.9-	4.2-	3.7-	4.1-
	ND	ND	ND	4.5	4.7	4.6	4.5
Stoneville 3202	4.2-	4.2-	3.9-	ND	ND	ND	ND
	4.6	4.5	4.2	ND	ND	ND	ND
Auburn 56	4.1-	4.1-	3.9-	3.9-	4.2-	3.9-	4.1-
	4.6	4.6	4.1	4.6	4.7	4.5	4.5
Rex (SU)	3.9-	3.8-	3.7-	3.6-	3.9-	3.6-	4.0-
	4.4	4.6	3.9	4.2	4.6	4.2	4.3
Empire (WR)	3.7-	3.8-	3.6-	3.7-	3.9-	3.8-	3.8-
	4.3	4.5	3.7	4.1	4.4	4.0	4.1
Other varieties*	4.1-	3.9-	3.8-	3.6-	4.0-	3.5-	3.7-
	4.5	4.9	4.2	4.7	4.9	4.8	4.8
Av. all varieties	4.29	4.43	3.98	4.22	4.40	4.23	4.31

ND = No data.

\* Other varieties included Carolina Queen, Cobal, Coker, DeKalb, Delfos, Plains, Pope, and Stardel.

\*\* Lowest to highest average among locations.

(For Source, see bottom of page 43.)

## APPENDIX K

Percentage of cotton acreage planted to specified cotton varieties,  
by states, 1959 and 1965

Varieties	Year	Ala.	Ariz.	Ark.	Cal.	Fla.	Ga.	Ill.	Ky.	La.	Miss.
Deltapine	1959	16	*	50	7	2	6	*	82	90	71
	1965	3	6	3	*	1	*	9	15	9	2
Deltapine (SU)	1959	*	*	*	1	*	*	*	*	*	2
	1965	3	69	21	12	*	1	*	40	53	51
Stoneville	1959	2	*	3	*	0	1	*	2	3	4
	1965	3	5	48	1	0	*	34	5	35	40
Rex (SU)	1959	0	0	11	0	0	0	0	2	*	1
	1965	8	0	16	0	0	1	28	36	*	1
Dixie King	1959	9	0	*	0	*	1	0	*	0	3
	1965	27	0	1	0	2	8	0	*	0	2
Empire (WR)	1959	23	0	3	0	15	25	38	0	*	2
	1965	10	0	*	0	5	6	*	*	*	*
Fox 4	1959	1	0	3	0	*	1	62	13	1	4
	1965	*	0	*	0	*	0	28	4	*	*
Auburn 56	1959	2	0	*	0	*	*	0	0	*	*
	1965	7	0	*	0	12	4	0	0	1	1

		Mo.	Nev.	N. M.	N. C.	Okla.	S. C.	Tenn.	Tex.	Va.	U. S.
Deltapine	1959	26	*	*	*	5	*	62	11	*	21
	1965	4	*	*	*	4	*	5	2	1	2
Deltapine (SU)	1959	*	*	*	*	*	*	2	*	*	*
	1965	11	*	*	*	2	*	28	5	*	20
Stoneville	1959	7	*	*	0	5	0	3	3	0	2
	1965	52	*	*	0	3	0	14	12	0	18
Rex (SU)	1959	4	0	0	0	0	*	1	1	0	*
	1965	19	0	*	18	0	2	7	*	17	4
Dixie King	1959	*	0	2	2	0	5	*	0	0	*
	1965	*	0	*	1	0	1	27	0	0	4
Empire (WR)	1959	*	0	2	2	*	2	23		*	3
	1965	*	0	*	1	*	*	12	*	*	*
Fox 4	1959	18	0	0	0	0	*	3	0	0	1
	1965	3	0	0	0	0	*	*	0	0	*
Auburn 56	1959	5	0	0	0	0	*	*	0	*	*
	1965	5	0	0	0	0	0	4	0	*	*

\* Less than 0.5% or not much grown commercially.

Source: *Cotton Varieties Planted, 1959 to 1965*, Cotton Division, Consumer and Marketing Service, USDA.

Source: *Cotton Varieties Planted*, Consumer and Marketing Service, USDA, 1959-1965; Summarized results for various properties of cotton tested at 15 sample gins, Tennessee Agricultural Experiment Station, 1959-1965; *Performance Trials of Field Crop Varieties*, Tennessee Agricultural Experiment Station, 1959-1965; and *Annual Cotton Quality Surveys*, Consumer and Marketing Service, USDA, 1959-66.

# APPENDIX L

Variations in micronaire test averages of 10 cotton varieties, combining locations, and between locations, 5 to 19 states, 1959 to 1965

Varieties	1959	1960	1961	1962	1963	1964	1965
Micronaire test average, combining locations							
Stoneville: 213	ND	ND	ND	4.65	4.70	4.65	4.90
7	4.50	4.85	4.65	ND	ND	ND	ND
7A	ND	ND	ND	4.75	4.70	4.65	4.80
Fox 4	4.70	4.75	4.35	4.55	4.80	4.60	4.65
Deltapine (SI)	4.30	4.55	4.30	4.50	4.50	4.50	4.60
Deltapine 15	4.40	4.45	4.10	4.50	4.30	4.50	4.65
Dixie King	4.35	4.55	4.15	4.45	4.40	4.30	4.50
Auburn 56	4.35	4.35	4.10	4.35	4.30	4.30	4.50
Rex (SI)	4.20	4.35	3.95	4.25	4.20	4.20	4.30
Empire (WR)	4.20	4.25	3.90	4.15	4.10	4.05	4.25

Micronaire test average range, among locations\*

Stoneville: 213	ND ND	ND ND	ND ND	4.0- 5.3	4.1- 5.3	3.8- 5.5	3.9- 5.9
7	3.7- 5.3	4.0- 5.7	3.6- 5.7	ND ND	ND ND	ND ND	ND ND
7A	ND ND	ND ND	ND ND	3.8- 5.7	3.8- 5.6	3.7- 5.6	3.7- 5.9
Fox 4	4.0- 5.4	4.0- 5.5	3.6- 5.1	3.8- 5.3	4.1- 5.5	4.2- 5.4	3.9- 5.4
Deltapine (SI)	3.6- 5.0	3.7- 5.4	3.3- 5.3	3.9- 5.1	3.6- 5.4	3.5- 5.5	3.6- 5.6
Deltapine 15	3.6- 5.2	3.2- 5.7	3.0- 5.2	3.6- 5.4	3.6- 5.0	3.7- 5.3	3.8- 5.5
Dixie King	4.0- 4.7	3.8- 5.3	3.3- 5.0	3.8- 5.1	3.8- 5.0	3.5- 5.1	3.8- 5.2
Auburn 56	3.9- 4.8	3.7- 5.0	3.4- 4.8	3.7- 5.0	3.4- 5.2	3.4- 5.2	3.8- 5.2
Rex (SI)	3.8- 4.6	3.8- 4.9	3.1- 4.8	3.6- 4.9	3.6- 4.8	3.4- 5.0	3.7- 4.9
Empire (WR)	3.8- 4.6	3.5- 5.0	3.2- 4.6	3.7- 4.6	3.4- 4.8	3.4- 4.7	3.6- 4.9

\* Lowest to highest average among locations.

Source: *Annual Reports of Performance Trials of Cotton Varieties*, Agricultural Experiment Stations, 19 states, 1959 to 1965; *Annual Cotton Quality Surveys*, Consumer and Marketing Service, USDA, 1959 to 1965; *Regional Cotton Variety Tests by Co-operating Agricultural Experiment Stations*, Agricultural Research Service, USDA, 1960 to 1965; and Summarized results for various properties of cotton tested at 15 sample gins, Tennessee Agricultural Experiment Station, 1959 to 1965.

## APPENDIX M

Percent of total cotton ginned in Tennessee before specified dates, 1916 to 1965

Crop years av.	Cotton ginned in running bales	Percent of total cotton ginned before:									Percent harvested		
		Sept.		Oct.		Nov.		Dec.		Jan.	HP (a)	HS (b)	MP (c)
		16	1	18	1	14	1	13	16				
1916-25	363508	0.7	18.3	36.4	53.3	66.9	87.5	95.0	93.2	90	10	0	
1926-35	428385	2.5	17.8	43.5	62.4	75.8	86.2	91.3	96.8	90	10	0	
1936-45	510890	7.1	28.9	54.2	71.1	81.4	89.1	92.5	95.9	90	10	0	
1946-55	566427	5.5	24.4	50.9	69.5	80.5	89.8	94.1	98.3	88	11	1	
1956-65	559132	5.9	24.4	54.4	74.7	86.1	93.0	96.4	98.8	58	14	28	
1946	509943	.4	5.0	30.5	47.7	64.8	79.7	86.4	92.7	91	9	0	
1947	507032	.9	22.3	58.3	75.3	79.4	87.9	93.9	98.8	89	11	(d)	
1948	641070	2.1	22.1	51.5	74.4	80.8	86.7	92.6	97.9	90	10	(d)	
1949	622498	7.1	31.9	48.4	66.0	82.6	94.7	98.3	99.4	91	9	(d)	
1950	404411	0.1	7.0	33.9	61.6	71.8	84.5	89.3	97.7	87	13	(d)	
1951	525383	4.2	21.8	53.5	69.4	75.0	87.1	92.5	97.5	83	16	1	
1952	621119	10.3	38.5	64.3	82.0	91.5	96.8	98.4	99.8	87	12	1	
1953	685751	12.0	34.0	61.6	75.7	88.0	95.1	97.8	99.6	91	7	2	
1954	534001	13.8	43.8	67.2	82.2	94.0	98.5	99.5	99.9	89	9	2	
1955	613059	3.8	17.6	39.7	60.2	77.0	86.7	92.0	99.4	78	17	5	
1956	527484	19.2	49.2	75.7	88.0	93.9	97.4	99.2	99.9	90	6	4	
1957	404292	3.0	17.5	47.3	63.4	77.5	85.9	92.2	98.2	81	16	3	
1959	411038	1.6	13.4	48.1	70.7	82.7	90.1	94.2	98.8	85	11	4	
1959	642245	6.9	28.1	51.6	71.2	83.2	91.1	96.8	98.9	76	16	8	
1960	570876	5.1	23.5	45.5	66.1	80.7	94.3	96.6	99.0	65	16	19	
1961	550310	0.4	12.1	37.5	63.3	76.2	86.2	93.1	96.4	54	20	26	
1962	548408	8.9	31.4	65.4	83.1	91.6	97.1	98.7	99.6	35	24	41	
1963	644066	6.1	31.3	66.9	87.2	93.1	97.6	99.2	99.5	44	12	44	
1964	665691	4.5	15.8	44.3	68.3	87.5	92.0	94.2	98.2	28	16	56	
1965	626913	4.0	21.8	61.6	85.2	94.5	98.5	99.5	99.9	22	8	70	

(a) Hand-picked, (b) Hand-snapped, (c) Machine picked, (d) less than 0.5%.

Source: *Cotton Production in the United States, Crops of 1916 to 1965*, U. S. Department of Commerce; and *Charges for Ginning Cotton and Methods of Harvesting*, Consumer and Marketing Service, USDA, 1926 to 1966.

## APPENDIX N

**Relation of micronaire tests of cotton to other fiber properties, by specified micronaire readings, Tennessee 1959 to 1965 average**

Micronaire average	Grade index	Staple length in 32nd.	Length uniformity	Strength		Non-lint content	Picker and card waste	Processing results		
				Zero gauge 1000	1/8" gauge			Yarn break factor	Yarn appear. index	Yarn imperfections
(Reading)	(No.) (a)	(In.) (b)	(Ratio) (c)	(psi) (d)	(Grams per tex) (e)	(%) (f)	(%) (g)	(Av. for 22's and 50's) (h)	(i)	(j)
2.0-2.9	70.0	32.0	42.0	60.0	14.3	4.7	11.0	1800	80	48
3.0	76.0	32.0	42.0	66.0	15.3	3.2	9.7	1850	80	36
3.1	85.0	32.3	42.9	69.0	16.0	3.3	9.3	1870	85	32
3.2	84.0	32.3	42.5	72.0	16.6	3.4	9.0	1900	85	40
3.3	86.9	32.3	42.7	69.4	16.0	3.1	7.7	1812	95	37
3.4	87.8	32.3	43.4	71.6	16.1	3.6	7.9	2065	95	35
3.5	87.2	32.5	42.6	78.2	19.2	3.0	7.6	2022	96	35
3.6	87.9	33.3	43.0	79.0	19.8	2.9	7.2	2005	96	27
3.7	94.0	33.3	43.3	79.6	20.6	2.9	7.5	2004	101	23
3.8	93.6	33.6	43.8	80.6	20.9	2.6	7.2	2036	98	26
3.9	94.5	33.8	43.7	81.3	21.6	2.3	6.6	2187	99	22
4.0	95.9	33.9	44.3	80.3	21.0	2.0	6.6	2033	100	22
4.1	96.7	33.6	44.6	80.5	20.8	2.1	6.5	2067	100	24
4.2	97.1	33.8	44.7	80.9	21.2	2.1	6.5	2025	100	22
4.3	98.7	34.0	44.7	81.5	21.9	2.0	6.5	2071	102	21
4.4	97.5	33.9	44.8	80.7	21.8	2.0	6.5	2067	101	19
4.5	99.2	33.8	44.7	80.5	20.9	1.9	6.5	2025	104	17
4.6	99.1	34.0	44.6	81.1	21.9	1.9	6.3	2133	104	17
4.7	100.8	33.9	46.0	80.8	20.9	1.9	6.2	2052	104	19
4.8	100.0	34.1	45.1	81.5	21.9	1.8	5.9	2158	104	17
4.9	97.0	33.4	44.7	78.9	19.8	1.9	6.4	1958	100	25
5.0	102.1	33.6	45.7	83.2	22.6	1.7	6.0	2203	104	17
5.1	97.6	33.6	45.3	80.9	20.1	2.0	6.4	2049	102	17
5.2-6.0	94.0	33.9	46.0	76.0	17.5	2.4	7.2	1850	95	29
Av. 4.25	96.0	33.6	44.3	80.4	20.9	2.2	6.6	2066	101	22

- (a). White: SM=104, M=100, SLM=94, LM=85, SGO=76, GO=70, Below grade=60.  
 (b). 99.3% of the cotton ranged from 1" to 1-5/32" in staple length.  
 (c). Index below 43=low, 43 to 45= average, above 45=high.  
 (d). Zero gauge psi, 76 to 85=average for Tennessee cotton.  
 (e). 1/8 inch gauge, grams per tex, 20.6 to 22.8=average for Tennessee cotton.  
 (f). 1959-65 av. for White grades: M=2.2%, SLM=3.1%, LM=4.5%, SGO=5.8%.  
 (g). 1959-65 average for Middling White=6.6%.  
 (h). Average for 22's and 50's expressed as pounds strength times yarn numbers. Tennessee medium staple carded yarn break factor 1886 to 2232=average.  
 (i). Average for 22's and 50's carded yarn=100 to 108.  
 (j). Average number of imperfections per 50 yards of yarn, 22's and 50's. Tennessee medium staple carded yarn average=18 to 28.

Source: Cotton fiber test data computed from: *Annual Cotton Quality Surveys*, Consumer and Marketing Service, USDA, 1959 to 1965; Summarized results for various properties of cotton tested at 15 gins and 15 cotton mills, Tennessee Agricultural Experiment Station, 1959 to 1965; and *Cotton Quality Crops of 1959 to 1965*, Consumer and Marketing Service, USDA.

## APPENDIX O

Relationships of simple correlation coefficients of selected cotton fiber tests,  
4,949 samples, 15 gins, Tennessee, 1959 to 1965

Raw cotton fiber tests	Raw cotton fiber tests						Processing tests			
	Grade index no.	Staple length in 32nd in.	Length uniformity ratio	Zero gauge 1000 psi	1/8" gauge grams per tex	Non-lint content %	Picker and card waste %	Yarn strength break factor	Yarn appear. grade index	Yarn imperfection count
								Av. for 22's and 50's		
Simple correlation coefficients (r)										
Mic.* . . . .	+.28	+.11	+.35	+.14	+.16	-.27	-.30	+.16	+.51	-.52
Grade index no. . . .	+.15	+.23	+.17	+.22	-.73	-.67	+.25	+.21	-.43	
Staple length in 32nd in. . . . .		+.21	+.26	+.43	-.10	-.20	+.58	+.14	-.12	
Length uniformity ratio. . . . .			+.34	+.38	-.14	-.20	+.43	+.36	-.29	
Zero gauge strength, 1000 ps . . . . .					-.10	-.15	+.53	+.16	-.11	
1/8" gauge strength, grams per tex . . . . .					-.10	-.19	+.77	+.19	-.13	
Nonlint content, % . . . . .						+.72	-.11	-.20	+.43	
Processing tests:										
Picker and card waste, % . . . . .							-.23	-.34	+.48	
Yarn strength break factor. . . . .								+.15	-.12	
Yarn appearance grade index. . . . .									-.45	

\* Micronaire reading.

*Explanation:* The simple correlation coefficient (r) is a measure of the linear relationship between two variables or cotton fiber tests. A correlation coefficient of 1.0 would be a perfect relationship. Correlation coefficients of 0.20 and over in the table above were significant at the 5% level of probability. Plus signs before the correlation coefficients indicate that the values for both variables changed in the same direction; minus signs indicate that they changed in the opposite direction.

*Examples:* In column 10 in table above the simple correlation coefficient of +.51 indicated that about 26% of the variability in yarn appearance index (+.51)<sup>2</sup> was associated with the variation in micronaire readings, and that as micronaire readings increased, yarn appearance index tended to increase. On the other hand, the simple correlation coefficient of -.52, column 11, indicated that about 27% of the variability in yarn imperfection count (-.52)<sup>2</sup> was associated with the variation in micronaire readings, and that as micronaire readings increased, yarn imperfection count tended to decrease.



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Main Station, J. N. Odom, General Superintendent of Farms, Knoxville  
University of Tennessee-Atomic Energy Commission Agricultural Research  
Laboratory, Oak Ridge, N. S. Hall, Laboratory Director

**Branch Stations**

Dairy Experiment Station, Lewisburg, J. R. Owen, Superintendent  
Highland Rim Experiment Station, Springfield, L. M. Safley, Superintendent  
Middle Tennessee Experiment Station, Spring Hill, J. W. High, Jr.,  
Superintendent  
Plateau Experiment Station, Crossville, J. A. Odom, Superintendent  
Tobacco Experiment Station, Greeneville, J. H. Felts, Superintendent  
West Tennessee Experiment Station, Jackson, B. P. Hazlewood,  
Superintendent

**Field Stations**

Ames Plantation, Grand Junction, James M. Bryan, Manager  
Cumberland Plateau Forestry Field Station, Wartburg, J. S. Kring, Manager  
Friendship Forestry Field Station, Chattanooga  
Highland Rim Forestry Field Station, Tullahoma, P. J. Huffman, Jr.,  
Manager  
Milan Field Station, Milan, T. C. McCutchen, Manager  
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