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INFLUENCE OF STAPLE-LENGTH VARIATIONS ON THE SPINNING PERFORMANCE AND YARN QUALITY OF COTTON

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Influence of Staple-Length Variations on the Spinning Performance and Yarn Quality of Cotton

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ABSTRACT

Four natural mixes (each having 100 percent of one staple length), 7 blended mixes with an average staple length of thirty-four thirty-seconds of an inch, and 6 blended mixes with an average staple length of thirty-five thirty-seconds of an inch were established from cottons having all fiber properties, except staple length, within the smallest possible range to determine the influence of staple length and staple-length distribution on spinning performance and yarn quality. The test data showed that the blends with an average staple length of thirty-four thirty-seconds of an inch were equal to or better than the natural mix of the same staple length. However, the weighted average prices of these blends were less than the price of the natural mix; the price difference ranged from 0.29 to 0.84 cent per pound. Among the mixes with an average staple length of thirty-five thirty-seconds of an inch, the natural mix rated best, and it had the highest weighted average price. Generally, the mixes that performed best were those with the highest 2.5-percent span length and highest percentage of long fiber. The results from this study indicate that mixes can be obtained by blending over a range of staple lengths without having a detrimental effect on spinning performance and yarn quality. This information should be useful to researchers and textile-mill operators for determining the most efficient cotton mix and for indicating the relative use values of cottons of varying staple lengths and staple-length distributions. KEYWORDS: cotton (ginned), cotton mixes (natural and blended), spinning performance, staple length, staple-length distribution, weighted average prices, yarn quality.

INTRODUCTION

Textile-mill managers and cotton buyers are continually making decisions on how to best utilize their resources in the manufacturing process. This is often a very difficult task since many alternatives must be considered when selecting cotton mixes and processing organizations. Consideration must be given to the combination of fiber qualities, fiber-quality distribution, and processing organization. Each alternative must be studied from an efficiency standpoint, both operationally and economically. Determining the most economical fiber mix is one of the most important decisions that management must make. Based on prior knowledge, management must select from the available cottons the combination of fiber qualities required to

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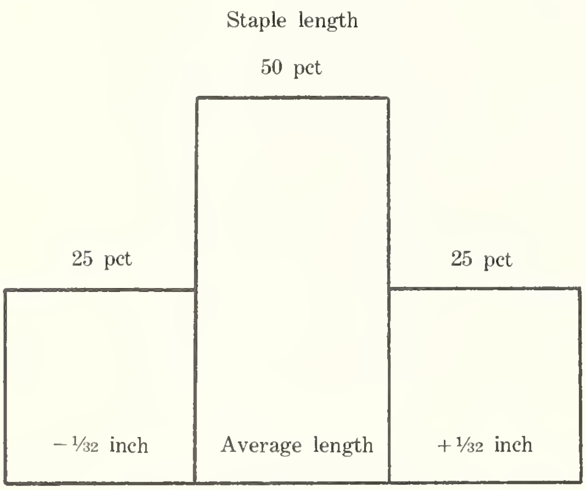
maintain a certain processing performance and product quality. Selected cottons are used in establishing mixes. The laying down of mixes in the opening room is the first step in the manufacturing process. If mixes are not selected properly, problems can occur throughout the manufacturing operation. Consideration must be given to fiber length, fiber-length uniformity, fiber strength, fiber fineness, and grade. These factors contribute to spinning performance and yarn quality (*4*, *7*).[3] Some contribute more than others; thus it is important to combine the above factors in such a way as to obtain the greatest contribution from each.

Spinning performance and yarn quality are also significantly affected by the distribution of fiber qualities for each of the factors mentioned above (*6*). For example, a selected number of bales of cotton with different staple lengths are blended in the opening room. This mix forms a staple-length distribution that is required to manufacture a particular product or group of products. Generally, it is accepted that a cotton mix selected from three or less adjoining fiber-quality categories will perform better than a mix with more or separate categories. For staple length, a typical mix distribution appears as follows:



This illustration indicates that 50 percent of the fiber mix is equal to the average in length. Twenty-five percent of the fibers in the mix are from a category one thirty-second of an inch shorter than the average, and 25 percent are from a category one thirty-second of an inch longer than the average. With these proportions a bell-shaped distribution is attained. Flexibility in selecting mixes may be reduced if the bell-shaped philosophy is adhered to. Usually, several categories are available for possible inclusion in the mix, and if only two or three categories are selected, voids will develop in the inventory distribution. When voids occur, the selection process must be altered and new mixes established, based on what is available and what is needed. It seems that the best situation would be to use cotton in mixes of the same proportions as they exist in the inventory. This would result in a specific mix running for a long period of time, thus allowing time for making finer adjustments in the processing variables.

Criteria that restrict the number of fiber-quality categories in a mix have an impact on establishing the most economical mix. Staple length is one of the most important factors that influence cotton price. As staple length increases, with all other fiber qualities remaining constant, the price of cotton increases. However, the incremental increases in price are not constant. Generally, the price increments are smaller between the longer staple categories. Therefore, the question must be raised as to whether or not a more economical cotton mix can be obtained by blending over a range of staple lengths without having a detrimental effect on spinning performance and yarn quality. The specific purpose of this study was to answer that question.

A second purpose of this study was to determine if cotton mixes having the same average staple length would perform similarly regardless of whether the mix was composed of cottons from a single length category or of cottons from a range of length categories. This question has arisen often where linear programing (LP) techniques have been used in selecting cotton mixes. These LP techniques were used by the former Economic Research Service, U.S. Department of Agriculture, at Clemson, S.C., to develop a preliminary model of a textile spinning plant (*2*, *3*, *5*). Inputs used in developing the model were obtained from Science and Education Administration's Pilot Spinning Laboratory, Clemson, S.C., and industry sources. The LP model was designed to be used by textile-mill management in selecting cottons of various qualities and processing organizations that would result in maximum profits from the yarn to be sold. A refined model of this type, applicable to a particular mill situation, would seem to have

[3]Italic numbers in parentheses refer to items in "Literature Cited" preceding the appendix.

considerable potential. However, the assumption made within the linear-programing framework, that a blended mix performs equally as well as a natural mix, had to be tested. The results of this study are useful in making this comparison.

METHODOLOGY

The cottons used in this study were selected in the Mississippi Delta from the 1974–75 crop. Plans for selecting these cottons were carefully considered so that all fiber properties, except staple length, would be within the smallest possible range. The intent of this study was to have staple length as the only fiber property that would vary over different levels and to include as many staple lengths as possible. Thus, the influence of staple length and staple-length distribution on spinning performance and yarn quality could be analyzed. The selected cottons were mostly Strict Low Middling, and the micronaire reading was largely 4.4. Fiber strength for most of the bales was within the range of 78,000 to 83,000 pounds per square inch. Fiber properties within a specific bale of cotton or within identically classed bales of cotton are not always completely homogenous. In order to minimize the effects of possible within- and between-bale variations on the experiment, bales within each staple-length category were blended and rebaled. Four staple-length categories were chosen; staple lengths of thirty-three, thirty-four, thirty-five, and thirty-six thirty-seconds of an inch were represented in 8, 7, 7, and 8 bales, respectively.

Sampling and Fiber Testing

Four samples were drawn from each of the 30 bales of cotton, and standard measurements were made on each sample. Ginned-lint values for each bale were obtained by taking the average of these four measurements; these data are shown in table A–1 (appendix). Suter-Webb arrays were made on a composite sample of ginned lint. This composite sample was obtained by taking eight subsamples from each of the four bale samples. The 32 subsamples representing each bale were blended before testing. The test data are shown in table A–2 (appendix). Cottons from the 30 bales were mixed in the opening room according to predetermined proportions (see "Mix Preparation"). A finisher-drawing sliver sample was taken from each of 34 spinning lots (17 mixes and 2 replications). Four subsamples were obtained from this sample, and fiber-property measurements were made on each subsample. The values for each mix were obtained by averaging these four measurements. The data shown in table A–3 (appendix) represent the averages of two replications. An additional sample of finisher-drawing sliver was taken from each spinning lot. This sample was divided into two subsamples, and length-array measurements were made on each. Mix values were determined by averaging the subsample measurements. These data are shown in table A–4 (appendix).

Mix Preparation

The bales representing the 4 staple lengths were opened, and 17 mixes were established by weight for processing. Four natural mixes with staple lengths of thirty-three, thirty-four, thirty-five, and thirty-six thirty-seconds of an inch were established, and the remaining 13 mixes were made up from varying percentages of cotton of these staple lengths. Correct proportions of the various staples were selected so that their weighted average would be equal to that of a natural mix. Seven of the 13 blended mixes averaged thirty-four thirty-seconds of an inch in staple length, and the remaining 6 mixes averaged thirty-five thirty-seconds of an inch.

Mix Processing

Each mix was processed into 40s yarn with a 3.89 twist multiplier. The 17 mixes were replicated 2 times for a total of 34 spinning lots. All mixes were processed identically from opening through roving. At spinning, new travelers were used with each spinning lot. In order to break in these new travelers and obtain yarn for sizing, a startup period of about 30 minutes was required. If the yarn was not the specified size, changes in the draft gear were made.

The processing organization was as follows:

Opening: 2 blender feeders, 1 lattice opener.

Picking: 14-oz lap, 1 process picker.

Carding: 50-grain sliver, 20-pound-per-hour production rate.

Breaker drawing: 53-grain sliver, 8 ends up, 265-ft/min front-roll speed.

Finisher drawing: 55-grain sliver, 8 ends up, 265-ft/min front-roll speed.

Roving: 1.00 hank-roving delivered, 1.30 twist multiplier, 900-r/min spindle speed.

Spinning: 1.00 hank-roving fed, 40s carded yarn delivered, 3.89 twist multiplier.

The cradle setting at spinning was adjusted to

TABLE 1.—Order of processing for the cotton mixes and their staple-length distributions

Mix No.[1]	Order of processing		Percentage of mix at staple lengths (32d inch) of —			
	Rep. 1	Rep. 2	33	34	35	36
1	1	20	100.0	....	....	....
2	10	19	....	100.0	....	....
3	6	21	....	....	100.0	....
4	3	22	....	....	....	100.0
5	16	18	25.0	50.0	25.0	....
6	13	27	33.3	33.3	33.3	....
7	4	33	50.0	....	50.0	....
8	14	23	32.0	44.0	16.0	8.0
9	9	30	40.0	40.0	....	20.0
10	11	31	40.0	20.0	30.0	10.0
11	5	25	66.8	....	....	33.2
12	12	32	....	25.0	50.0	25.0
13	7	28	....	33.3	33.3	33.3
14	2	29	....	50.0	....	50.0
15	15	26	20.0	....	40.0	40.0
16	8	24	40.0	....	....	60.0
17	17	34	20.0	....	....	80.0

[1]Mixes 1–4, natural mixes. Mixes 5–11 averaged 34/32 inch in staple length. Mixes 12–17 averaged 35/32 inch in staple length.

TABLE 2.—Average fiber properties, within the four staple-length categories, of the ginned-lint bale samples

Staple length (32d inch)	No. bales	Digital fibrograph		Pressley strength (1,000 lb/inch²)	Micronaire reading
		2.5-pct span length (inches)	Length uniformity (pct)		
33	8	1.05	44	81	4.6
34	7	1.08	45	80	4.4
35	7	1.12	45	81	4.4
36	8	1.16	44	79	4.4

TABLE 3.—Average fiber properties of finisher-drawing samples from the natural mixes[1]

Mix No.	Staple length (32d inch)	No. bales blended	Digital fibrograph		Pressley strength (1,000 lb/inch²)	Micronaire reading
			2.5-pct span length (inches)	Length uniformity (pct)		
1	33	8	1.08	46	77	4.5
2	34	7	1.12	48	76	4.3
3	35	7	1.17	49	76	4.5
4	36	8	1.18	47	75	4.5

[1]Averages of 2 replications.

obtain optimum drafting control for each spinning lot.

Experimental Design and Analysis

The experiment was arranged in 2 randomized blocks of 17 mixes each. In this case blocks were equivalent to replications. Table 1 shows the mixes that were established from the four staple-length categories and their order of processing. For example, mix 1 consisted only of cotton with a staple length of thirty-three thirty-seconds of an inch (100 percent) and is designated as a natural mix. Mix 9 averaged thirty-four thirty-seconds of an inch and consisted of staple lengths of thirty-three (40 percent), thirty-four (40 percent), and thirty-six (20 percent) thirty-seconds of an inch.

Selected processing and yarn-quality data for all mixes were analyzed in four distinct stages. An analysis was conducted for each of the following groups of mixes:

1. Four natural mixes.
2. Mixes with staple lengths averaging thirty-four thirty-seconds of an inch.
3. Mixes with staple lengths averaging thirty-five thirty-seconds of an inch.
4. Mixes with staple lengths averaging thirty-four and thirty-five thirty-seconds of an inch.

Comparisons among the natural mixes provided a base for comparison in the other analyses. Results from this analysis indicate how the cotton performed when 100 percent of a mix was from a specific staple length. All mixes were spun into 40s yarn. Spinning variables were established with cotton from the natural mix having a staple length of thirty-four thirty-seconds of an inch and were held constant throughout the test. Analyses for groups 2 and 3 included the natural mix with the same staple length. In the analysis for group 2, eight mixes were compared, seven blended and one natural. Similar comparisons were made in the analysis for group 3. In the fourth analysis 15 mixes were included. From this analysis comparisons were made among blends of different average staple lengths. Also, the natural mixes were compared with the blends of different average lengths. Analysis of variance and Duncan's multiple-range test were used in each case to determine which of the mix averages were significantly different (*1*).

RESULTS

The ginned-lint fiber qualities of the four staple-length categories indicate that the selection process was effective. That is, fiber qualities that were to be held within a narrow range were within such a range. Average values for the bales of raw stock within each category are shown in table 2. The finisher-drawing data exhibit similar variations to those of the ginned-lint data. These data (table 3) represent an average of two replications for each of the natural mixes. Generally, 2.5-percent span length is expected to increase about 0.03 to 0.05 inch between the ginned lint and finisher drawing. Tables 2 and 3 show that the first three staple-length categories had such an increase. However, the fourth category increased only 0.02 inch. Hence, the 2.5-percent span-length increment between mixes 3 and 4 in the finisher drawing was only 0.01 inch. The variation in length uniformity for ginned lint was 1 percent, and for finisher drawing it was 3 percent. The micronaire and Pressley strength ranges did not change between ginned lint and finisher drawing.

Group 1 Mixes

Natural mix 1, which had a staple length of thirty-three thirty-seconds of an inch, would not normally be spun into 40s yarn. A mix with an average staple length this short is not sufficient in length to obtain acceptable processing performance in manufacturing a yarn count this fine. For this reason mix 1 was omitted from the statistical analysis.

Of the eight variables shown in table 4, only corrected ends down per 1,000 spindle-hours (CEDMSH) for mixes 2, 3, and 4 was significantly different at the 95-percent level. Mix 4 had the fewest spinning end breaks, followed by mixes 3 and 2. Although the statistics indicate no significant differences at the 95-percent confidence level in the mix averages for break factor and neps per 1,000 yards, there appears to be a practical difference. The break factor for mix 3 was 11 percent higher than that for mix 2, and mix 3 also had about 11 percent fewer neps per 1,000 yards than did mixes 2 and 4. Considering the eight test variables, mix 3 would probably be rated best in this group. Differences in these mixes are mainly attributed to variations in the fiber-length distribution, which was a result of the staple lengths selected. The average fiber distributions for ginned lint are shown in table 5. Similar variations exist in the finisher-drawing array data (table A–4, appendix). Correlation analysis of test data and finisher-drawing array data indicates that spinning ends

TABLE 4.—Average fiber and yarn properties of the natural mixes as influenced by four staple lengths[1]

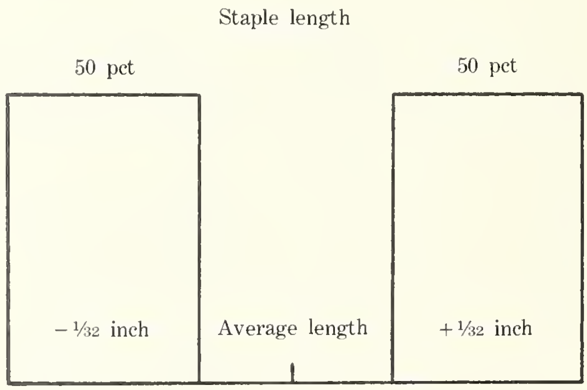
Mix No.[2]	Staple length (32d inch)	Waste (pct)		CEDMSH[4]	Break factor[3]	Yarn appearance index[3]	Single-strand strength[3] (g/tex)	Neps[3] (No./1,000 yd)	Yarn-irregularity CV[3 5] (pct)
		Opening and picking[3]	Card[3]						
1	33	0.81	2.56	306	1,454	82	11.1	1,067	23.6
2	34	.82	2.31	64a	1,628	84	11.8	940	22.9
3	35	.81	2.14	24b	1,814	85	12.7	843	22.4
4	36	.84	1.32	18c	1,761	84	12.3	950	23.0

[1]Averages of 2 replications.
[2]Mix 1 was not included in the analysis.
[3]Averages in column are not significantly different at the 95-percent level.
[4]CEDMSH = Corrected ends down per 1,000 spindle-hours. Averages in column followed by different letters are significantly different at the 95-percent level.
[5]Yarn-irregularity CV is yarn-irregularity coefficient of variation.

down was significantly correlated at the 95-percent level with the percentage of fibers 1 inch or longer. Dividing this 1-inch-or-longer variation into smaller categories shows that natural mix 4 had 20.2 percent of the fibers over 1¼ inches, whereas mixes 3 and 2 had 17.3 and 8.6 percent, respectively. As the percentage of long-fiber content increased, CEDMSH decreased.

GROUP 2 MIXES

The waste at opening and picking was significantly different for mixes 7 and 11 (table 6). The percentage of card waste from mix 11 was significantly higher than that from mixes 5 and 10. These differences were primarily attributed to the differences in the short-fiber contents of the mixes, which were a result of the staple lengths blended and trash contents. The CEDMSH values were within the same general range; however, mix 7, with the smallest number of spinning end breaks, was significantly different from mixes 2, 8, 9, and 11. This mix had the highest 2.5-percent span length, the highest percentage of fibers longer than 1 inch, and the highest Pressley strength value. Break factor was separated into two groups, one above and one below the average of 1,633 units. Average values for mixes 7 and 9 were statistically higher than those for mixes 6, 8, 10, and 11. The analysis revealed that break factor was negatively correlated at the 95-percent level of significance with the percentage of fibers in the ½- to 1-inch range. Single-strand strength values showed a difference of less than 8 percent among mixes. The highest values were for mixes 5 and 7. These two mixes had the highest percentages of fibers longer than 1¼ inches, low-level coefficients of variation (CV), and high mean lengths. No significant differences existed among the mixes for neps per 1,000 yards and yarn-irregularity CV. Considering the eight variables in table 6, natural mix 2 (thirty-four thirty-seconds of an inch) had no clear superiority over the blended mixes. Several of these performed equally as well or better than the natural mix. For this group, mix 7 was rated best. Its staple-length distribution appears as follows:



Reviewing the fiber-quality measurement results for these mixes (table A–3, appendix) shows that those for mix 7 were generally higher than those for the other mixes in this group.

GROUP 3 MIXES

Table 7 gives the test results for mixes 3 and 12 through 17. From these statistics, natural mix 3 was rated best, with several of the other mixes

Table 5.—Average fiber distributions of ginned lint within the four staple-length categories for the natural mixes

Mix No.	Staple length (32d inch)	Fiber length (pct)		
		Less than ½ inch	½ to 1 inch	1 inch or longer
1	33	15.9	41.6	42.5
2	34	13.4	38.6	48.0
3	35	11.6	32.3	56.1
4	36	12.4	30.0	57.6

Table 6.—Average fiber and yarn properties of blended mixes 5 through 11 as influenced by staple lengths averaging thirty-four thirty-seconds of an inch[1]

Mix No.[2]	Waste (pct)		CEDMSH[3]	Break factor	Yarn appearance index	Single-strand strength (g/tex)	Neps[4] (No./1,000 yd)	Yarn-irregularity CV[4] (pct)
	Opening and picking	Card						
2	0.82ab	2.31ab	64a	1,628ab	84b	11.8bc	940	22.9
5	.76ab	2.28ab	49abc	1,643ab	88ab	12.4a	965	22.8
6	.77ab	2.31ab	54abc	1,586b	86ab	12.1abc	912	23.4
7	.70b	2.35ab	40c	1,688a	90ab	12.4a	975	23.2
8	.78ab	2.36ab	59abc	1,612b	84b	11.5c	928	23.2
9	.82ab	2.39ab	62ab	1,695a	94a	11.8bc	1,012	23.2
10	.74ab	2.28b	47bc	1,610b	89ab	12.2abc	934	23.2
11	.84a	2.44a	64a	1,600b	81b	11.7bc	1,018	23.4

[1]Averages in a column followed by the same letter are not significantly different at the 95-percent level. Averages of 2 replications. Data for natural mix 2 were included for purposes of comparison.

[2]Mix numbers correspond to staple-length distributions in table 1.

[3]CEDMSH = Corrected ends down per 1,000 spindle-hours.

[4]Averages in column are not significantly different at the 95-percent level. Yarn-irregularity CV is yarn-irregularity coefficient of variation.

Table 7.—Average fiber and yarn properties of blended mixes 12 through 17 as influenced by staple lengths averaging thirty-five thirty-seconds of an inch[1]

Mix No.[2]	Waste (pct)		CEDMSH[4]	Break factor	Yarn appearance index[3]	Single-strand strength[3] (g/tex)	Neps (No./1,000 yd)	Yarn-irregularity CV[5] (pct)
	Opening and picking[3]	Card						
3	0.81	2.14c	24b	1,814a	85	12.7	843b	22.4b
12	.73	2.20bc	27ab	1,724ab	86	12.1	948ab	23.0ab
13	.78	2.36a	30ab	1,720ab	86	12.1	892ab	22.5b
14	.79	2.33a	34a	1,715ab	89	12.2	984ab	23.2a
15	.82	2.27ab	25b	1,698b	82	12.5	1,024a	23.0ab
16	.82	2.38a	28ab	1,705b	86	12.4	987ab	23.0ab
17	.76	2.34a	26b	1,688b	94	12.3	926ab	22.7ab

[1]Averages in a column followed by the same letter are not significantly different at the 95-percent level. Averages of 2 replications. Data for natural mix 3 were included for purposes of comparison.

[2]Weighted average staple length for mix 16 is slightly shorter than natural mix 3, and weighted average staple length for mix 17 is slightly longer than natural mix 3. Mix numbers correspond to staple-length distributions in table 1.

[3]Averages in column are not significantly different at the 95-percent level.

[4]CEDMSH = Corrected ends down per 1,000 spindle-hours.

[5]Yarn-irregularity CV is yarn-irregularity coefficient of variation.

equally satisfactory for second ranking. Two blended mixes, 16 and 17, were so established that their weighted average staple length would be different from that of natural mix 3. Mix 16 was slightly shorter in staple length than the natural mix, and mix 17 was slightly longer. These two mixes were analyzed in conjunction with mixes 3 and 12 through 15. Means for these data fail to show a clear distinction between these two mixes and the remaining group.

The percentage of card waste from mix 3 was significantly lower than that from mixes 13 through 17. This could be attributed to its lower percentage of fibers shorter than one-half of an inch and its low level of waste. Mix 14 had the highest number of spinning end breaks. The variation in break factor was 126 units. Mix 3, which had the largest break factor, was significantly different from mixes 15, 16, and 17. The differences in CEDMSH and break factor were mainly attributed to differences in uniformity ratio, 2.5-percent span length, and percentage of fibers longer than 1 inch. Mix 3 also had fewer neps per 1,000 yards than did mix 15. The analysis indicates a significant negative correlation (90-percent level) between the percentage of fibers 1 inch and longer and neps per 1,000 yards. The variation in yarn-irregularity CV was only 3 percent, with mix 3 having the lowest value. Generally, natural mix 3 had slightly better fiber characteristics than any of the other mixes having an average staple length of thirty-five thirty-seconds of an inch. For this reason mix 3 should perform better.

Group 4 Mixes

Data from the mixes averaging thirty-four thirty-seconds of an inch (2, 5–11) and thirty-five thirty-seconds of an inch (3, 12–17) were analyzed together for a comparison of these staple lengths. The results of this analysis are shown in table 8. Note that analyzing the two staple lengths together did not necessarily yield the same significant differences as when they were analyzed separately. The variation in card waste was 0.3 percent, with mixes 3, 10, 12, and 15 having the

Table 8.—Average fiber and yarn properties of natural mixes 2 and 3 and all blended mixes as influenced by staple lengths averaging thirty-four and thirty-five thirty-seconds of an inch[1]

Mix No.[2]	Waste (pct)		CEDMSH[4]	Break factor	Yarn appearance index	Single-strand strength (g/tex)	Neps (No./1,000 yd)	Yarn-irregularity CV[5] (pct)
	Opening and picking[3]	Card						
2	0.82	2.31abc	64a	1,628cde	84ab	11.8cde	940ab	22.9abcd
3	.81	2.14d	24c	1,814a	85ab	12.7a	843b	22.4d
5	.76	2.28bc	49bde	1,643bcde	88ab	12.4ab	966ab	22.8abcd
6	.77	2.31abc	54ade	1,586e	86ab	12.1bcd	976ab	23.4ab
7	.70	2.35ab	40bf	1,688bcd	90ab	12.4ab	976ab	23.25ab
8	.78	2.36ab	59ad	1,612de	84ab	11.5e	1,026a	23.25ab
9	.82	2.39ab	62a	1,696bc	94a	11.8cde	1,012ab	23.15abcd
10	.74	2.275bcd	47be	1,610de	89ab	12.1abcd	934ab	23.2abc
11	.84	2.44a	64a	1,600e	81b	11.7de	1,018ab	23.4a
12	.73	2.20d	27c	1,724b	86ab	12.1bcd	948ab	23.0abcd
13	.78	2.36ab	30c	1,720b	86ab	12.1bcd	892ab	22.5cd
14	.79	2.33abc	34cf	1,715b	89ab	12.2abcd	984ab	23.25ab
15	.82	2.27bcd	25c	1,698bc	82b	12.5ab	1,024a	23.0abcd
16	.82	2.38ab	28c	1,705bc	86ab	12.4ab	987ab	23.0abcd
17	.76	2.34ab	26c	1,688bcd	94a	12.3abc	926ab	22.7bcd

[1]Averages in a column followed by the same letter are not significantly different at the 95-percent level. Averages of 2 replications.

[2]Weighted average staple length for mix 16 is slightly shorter than natural mix 3, and weighted average staple length for mix 17 is slightly longer than natural mix 3. Mix numbers correspond to staple-length distributions in table 1.

[3]Averages in column are not significantly different at the 95-percent level.

[4]CEDMSH = Corrected ends down per 1,000 spindle-hours.

[5]Yarn-irregularity CV is yarn-irregularity coefficient of variation.

lowest values. Spinning end breaks for those mixes with the longer average staple length were at a lower level than those with the shorter staple length. Only mix 7, the best in the shorter staple-length category, was statistically equivalent to a mix in the longer staple-length category (mix 14). These two mixes had similar 2.5-percent span lengths. The break factor for mix 3 was significantly higher than for any of the other mixes; however, no other mix in this staple-length group was rated higher than mixes 5, 7, and 9 from the shorter staple-length category. Yarn-appearance grade ranged from D+ to C. Mixes 9 and 17, which had the highest appearance indices, were significantly different from only the mixes with the lowest indices, mixes 11 and 15. Single-strand values for mixes 5, 6, and 10 were comparable to those for the longer staple-length category. Natural mix 3 yielded the fewest number of neps per 1,000 yards, and mixes 8 and 15 yielded the most. No statistical difference was observed for the remaining mixes, which ranged from 892 to 1,018 neps per 1,000 yards. Yarn-irregularity CV ranged from 22.4 to 23.4 percent, with those mixes from the shorter staple-length category having generally higher values.

Ranking or singling out mixes is not easy, since the ordering of mixes is not consistent for all test variables. For these data, natural mix 3 rated best overall. In general, for the test variables considered, mixes with the higher 2.5-percent span lengths and higher percentages of long-fiber content performed equal to or slightly better than the mixes with the lower 2.5-percent span lengths and shorter fiber content. This difference in performance would probably have been even larger if the processing organization had been adjusted to take advantage of the longer fibers.

MIX PRICE COMPARISONS

Prices for the 17 mixes and their price differences are shown in table 9. These data show that the price differences between the natural mixes (1 and 2, 2 and 3, 3 and 4) were 1.50 cents, 0.35 cent, and 0.10 cent per pound, respectively. The price of each blended mix was less than the corresponding natural mix because price differential decreases as staple length increases, all other factors remaining constant. Thus, the prices of the shorter staple-length cottons have a larger influence on weighted average mix price. However, textile mills, because of their stock and the availability of cotton, are not always able to blend cottons to take advantage of these price differentials. But through judicious planning and knowledge of the performance of each mix, mills can be selective in purchasing and blending cottons to take advantage of price differentials.

It was determined in this study that the spinning performance and yarn quality of some blended mixes were equal to or better than the natural mixes. This was particularly true for mixes 5 through 11. Each of these mixes was rated at least equal to natural mix 2. The price of natural mix 2 was 41.86 cents per pound. Mix 5, with a bell-shaped fiber-length distribution similar to a typical mill mix, had the next highest price of the mixes with an average staple length of thirty-four thirty-seconds of an inch—41.57 cents per pound or 0.29 cent less than the natural mix. One of the better performing mixes in this staple-length category was mix 7. Its price was 0.58 cent per pound less than that of the natural mix, and there was no significant difference in the percentage of waste from opening through carding. Mix 11 had the largest price difference from the natural mix, 0.84 cent per pound less. Natural mix 3, which rated best among the mixes averaging thirty-five thirty-seconds of an inch in staple length, also had the highest price in this group. The price difference ranged from 0.06 to 0.68 cent per pound. Typical mix 12, with a bell-shaped distribution, had the second highest price, and mix 16 had the lowest price.

Price comparisons among all the mixes reveal that some of the mixes with an average staple length of thirty-five thirty-seconds of an inch were priced about the same as natural mix 2. Usually, mixes that have longer average staple, other factors held constant, are expected to have higher prices. This is not necessarily the case. Mixes 15, 16, and 17 were established over a range of four staple lengths. Each had a weighted average length of about one thirty-second of an inch longer than that of mix 2. However, the prices of these four mixes were about the same (see table 8), since mixes 15, 16, and 17 contained a percentage of fiber having a staple length of thirty-three thirty-seconds of an inch. Compared with mix 2, mixes 15 and 17 were higher in price by 0.02 and 0.06 cent per pound, whereas mix 16 was 0.33 cent per pound lower. This price factor, plus the fact that the spinning performance and yarn quality of mixes 15, 16, and 17 were at least equal to any of the blended mixes with an average staple length of thirty-four

Table 9.—Weighted average prices and price differences for the cotton mixes[1]

Mix No.[2]	Weighted average price (cents/lb)	Price difference (cents/lb) of more or less than price of mix No.—																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	40.36																	
2	41.86	1.50																
3	42.21	1.85	0.35															
4	42.31	1.95	.45	0.10														
5	41.57	1.21	−.29	−.64	−0.74													
6	41.48	1.02	−.38	−.73	−.83	−0.09												
7	41.28	.92	−.58	−.93	−1.03	−.29	−0.20											
8	41.47	1.11	−.39	−.74	−.84	−.10	−.01	0.19										
9	41.35	.99	−.51	−.86	−.96	−.22	−.13	.07	−0.12									
10	41.41	1.05	−.45	−.80	−.90	−.16	−.07	.13	−.06	0.06								
11	41.02	.66	−.84	−1.19	−1.29	−.55	−.46	−.26	−.39	−.33	−0.39							
12	42.15	1.79	.29	−.06	−.16	.58	.67	.87	.68	.80	.74	1.13						
13	42.13	1.77	.27	−.08	−.18	.56	.65	.85	.66	.78	.72	1.11	−0.02					
14	42.08	1.72	.22	−.13	−.23	.51	.60	.80	.61	.73	.67	1.06	−.07	−0.05				
15	41.88	1.52	.02	−.33	−.43	.31	.40	.60	.41	.53	.47	.86	−.27	−.25	−0.20			
16	41.53	1.17	.33	−.68	−.78	−.04	.05	.25	.06	.18	.12	.51	−.62	−.60	−.55	−0.35		
17	41.92	1.56	.06	−.29	−.39	.35	.44	.64	.45	.57	.51	.90	−.23	−.21	−.16	−.04	0.39	

[1]U.S. Department of Agriculture, Agricultural Marketing Service, Cotton Price Statistics, vol. 56, No. 13, September 1975, p. 15.
[2]Mix numbers correspond to staple-length distributions in table 1.

thirty-seconds of an inch, makes blending over a range of staples economically attractive.

SUMMARY AND CONCLUSIONS

In this study the cottons used were carefully selected so that all fiber properties, except staple length, would be in the smallest possible range. Before mixes were established, bales of cotton within a staple-length category were blended and rebaled. Cotton mixes were established by blending in the opening room according to the prepared plan of study. Two replications of the 4 natural mixes (100 percent of one staple length) and 13 blended mixes were processed into 40s yarn. Spinning performance and yarn quality data show that the blended mixes with an average staple length of thirty-four thirty-seconds of an inch were equal to or better than the natural mix of that staple length (mix 2). Mixes 5 through 7 ranged over three staple lengths, and mixes 8 through 11 ranged over four. Mix 7 was rated best in this category. This mix had a staple-length distribution of thirty-three (50 percent) and thirty-five (50 percent) thirty-seconds of an inch for a weighted average staple length of thirty-four thirty-seconds of an inch. Weighted average prices of all these blended mixes (5–11) were less than the price of the natural mix. The price difference ranged from 0.29 to 0.84 cent per pound. Three of the mixes with an average staple length of thirty-five thirty-seconds of an inch (12–14) were established by blending cotton from three staple-length categories. The remaining three mixes (15–17) were blends from four staple-length categories. Natural mix 3 was rated best in this staple-length group, and it had the highest weighted average price. Generally, the mixes that performed best were those with the highest 2.5-percent span length and highest percentage of long fiber. This was expected, but the fact that all blended mixes within a staple-length category had a lower weighted average price than the corresponding natural mix was not expected. Also, the small difference in prices between some of the mixes in the longer staple-length category and natural mix 2 was surprising. Three of these mixes (15, 16, and 17) had about the same weighted average price as natural mix 2.

The results of this study indicate that mixes can be obtained by blending over a range of staple lengths without having a detrimental effect on spinning performance and yarn quality. Also, mixes composed of cottons from several staple-length categories may perform equal to or better than a mix from a single staple-length category. Two influencing factors are fiber length and fiber-length distribution, both of which contribute significantly to spinning performance and yarn quality. Thus, blending cottons from different staple-length categories to attain a particular fiber distribution should be a goal in addition to blending to obtain a mix with average properties.

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TABLE A-1.—**Average fiber values of ginned-lint bale samples**

Bale No.	Staple length (32d inch)	Grade: Color	Grade: Leaf	Grade: Composite	Shirley analyzer waste (pct)	Digital fibrograph: 2.5-pct span length (inches)	Digital fibrograph: 50-pct span length (inch)	Digital fibrograph: Length uniformity (pct)	Pressley strength (1,000 lb/ inch^2)	Micronaire reading
804860	33	M	SLM	SLM+	4.22	1.05	0.44	42	76	4.4
771596	33	SLM	SLM	SLM	2.71	1.03	.45	43	79	4.6
264173	33	M	SLM	SLM+	2.50	1.06	.47	44	82	4.5
264169	33	M	M	M	2.19	1.06	.47	44	84	4.6
338843	33	SLM	SLM	SLM+	4.17	1.08	.49	45	79	4.4
264181	33	M	M	M	3.00	1.06	.47	44	86	4.6
974476	33	SLM	SLM	SLM	3.26	1.04	.46	44	80	4.8
269616	33	M	SLM	SLM+	3.40	1.04	.47	46	83	4.6
264183	34	M LtSp	M	M LtSp	2.24	1.06	.48	45	80	4.6
264167	34	M	M	M	1.88	1.06	.48	45	83	4.6
264168	34	SLM	M	SLM	2.00	1.05	.47	45	83	4.6
292859	34	M LtSp	SLM	SLM LtSp	3.55	1.08	.49	46	78	4.5
22473	34	M	SLM	SLM+	2.76	1.09	.47	44	80	4.3
871236	34	SLM	SLM	SLM	2.20	1.11	.47	42	77	4.0
820964	34	M LtSp	M	M LtSp	2.32	1.11	.50	46	76	4.2
795291	35	M	LM	SLM	2.83	1.12	.50	44	80	4.5
795289	35	M	SLM	SLM+	2.82	1.12	.52	46	80	4.5
795196	35	M	SLM	SLM+	2.22	1.10	.48	44	80	4.3
795352	35	M	SLM	SLM+	2.44	1.13	.51	45	80	4.5
795287	35	M	SLM	SLM+	2.91	1.12	.51	45	81	4.5
795375	35	M	SLM	SLM+	2.38	1.11	.49	44	82	4.4
795225	35	M	LM	SLM+	2.62	1.12	.50	45	81	4.4
592347	36	SLM	SLM	SLM	2.50	1.16	.53	45	78	4.4
592339	36	SLM	SLM	SLM	3.10	1.16	.51	44	77	4.4
591651	36	SLM	SLM	SLM	2.91	1.17	.52	45	78	4.4
592331	36	SLM	SLM	SLM	2.88	1.16	.52	44	81	4.4
795332	36	M	SLM	SLM+	2.42	1.13	.51	45	86	4.4
591656	36	M	SLM	SLM	2.73	1.16	.52	44	80	4.4
592332	36	M	SLM	SLM	2.77	1.16	.51	44	78	4.4
591624	36	M	SLM	SLM	2.66	1.16	.50	44	77	4.4

Table A-2.—**Ginned-lint array data for bale subsamples**

Bale No.	Upper-quartile length (inches)	Mean length (inches)	Coefficient of variation (pct)	Fiber length (pct)		
				Less than ½ inch	½ to 1 inch	1 inch or longer
804860	1.11	0.83	41	21.0	41.9	37.1
771596	1.13	.87	38	17.9	40.8	41.3
264173	1.16	.92	33	13.0	40.8	46.2
264169	1.17	.93	33	12.8	38.9	48.3
338843	1.16	.89	37	15.5	38.7	45.8
264181	1.14	.88	35	15.8	42.7	41.5
974476	1.09	.86	36	17.9	45.6	36.5
269161	1.13	.90	33	13.2	43.4	43.4
Average[1]	1.14	.88	36	15.9	41.6	42.5
264183	1.15	0.92	34	13.7	37.9	48.4
264167	1.13	.89	35	14.5	42.0	43.5
264168	1.13	.91	32	11.9	43.0	45.1
292859	1.17	.96	30	10.2	36.3	53.5
22473	1.17	.90	37	16.0	40.1	43.9
871236	1.20	.94	36	14.2	35.2	50.6
820964	1.18	.94	34	13.7	35.4	50.9
Average[2]	1.16	.92	34	13.4	38.6	48.0
795291	1.23	1.00	32	10.8	31.0	58.2
795289	1.25	.99	34	11.7	32.4	55.9
795196	1.22	.98	34	12.3	31.3	56.4
795352	1.28	1.03	32	9.9	30.9	59.2
795287	1.20	.96	33	12.1	31.8	56.1
795375	1.22	.96	34	12.3	33.9	53.8
795225	1.24	.97	34	12.4	34.7	52.9
Average[3]	1.23	.98	33	11.6	32.3	56.1
592347	1.25	0.98	35	13.5	30.2	56.3
592339	1.26	1.01	33	12.3	27.7	60.0
591651	1.23	.98	35	12.4	30.2	57.4
592331	1.26	1.00	35	13.1	29.5	57.4
795332	1.26	1.02	33	10.1	29.9	60.0
591656	1.26	1.00	34	12.7	30.6	56.7
592332	1.25	.99	34	13.2	30.8	56.0
591624	1.25	.99	35	12.0	30.8	57.2
Average[4]	1.25	1.00	34	12.4	30.0	57.6

[1]Averages of bales with staple lengths averaging 33/32 inch.
[2]Averages of bales with staple lengths averaging 34/32 inch.
[3]Averages of bales with staple lengths averaging 35/32 inch.
[4]Averages of bales with staple lengths averaging 36/32 inch.

TABLE A-3.—Selected fiber properties of finisher-drawing subsamples from the cotton mixes[1]

Mix No.	Percentage of mix at staple lengths (32d inch) of — 33	34	35	36	Digital fibrograph: 2.5-pct span length (inches)	50-pct span length (inch)	Length uniformity (pct)	Pressley strength (1,000 lb/inch²)	Micronaire reading
1	100.0	....	....	....	1.08	0.50	46	77	4.5
2	....	100.0	....	....	1.12	.54	48	76	4.3
3	....	....	100.0	....	1.17	.58	49	76	4.5
4	....	....	....	100.0	1.18	.56	47	75	4.5
5	25.0	50.0	25.0	....	1.11	.52	47	78	4.4
6	33.3	33.3	33.3	....	1.12	.54	48	79	4.4
7	50.0	....	50.0	....	1.13	.54	48	80	4.5
8	32.0	44.0	16.0	8.0	1.11	.52	46	76	4.5
9	40.0	40.0	....	20.0	1.10	.52	46	76	4.4
10	40.0	20.0	30.0	10.0	1.12	.54	48	78	4.5
11	66.8	....	....	33.2	1.12	.52	46	78	4.5
12	....	25.0	50.0	25.0	1.16	.56	48	76	4.4
13	....	33.3	33.3	33.3	1.16	.56	48	77	4.4
14	....	50.0	....	50.0	1.14	.53	46	76	4.4
15	20.0	....	40.0	40.0	1.16	.56	48	76	4.6
16	40.0	....	....	60.0	1.14	.54	47	78	4.4
17	20.0	....	....	80.0	1.18	.58	48	76	4.4

[1]Averages of 2 replications.

TABLE A-4.—Length-array data for finisher-drawing subsamples from the cotton mixes[1]

Mix No.	Upper-quartile length (inches)	Mean length (inch)	Coefficient of variation (pct)	Fiber length (pct): Less than ½ inch	½ to 1 inch	1 inch or longer	1 to 1⅛ inch	1⅛ to 1¼ inch	1¼ to 1⅜ inch	1⅜ inch or longer
1	1.14	0.88	38	16.4	40.6	43.0	15.0	18.4	7.9	1.6
2	1.16	.91	36	14.0	37.6	48.4	17.4	17.6	6.8	1.8
3	1.21	.96	36	12.2	32.8	55.2	12.2	25.6	12.0	5.3
4	1.22	.97	34	12.2	32.0	55.8	13.2	22.8	14.2	6.0
5	1.18	.92	36	13.4	38.8	47.7	13.4	19.6	11.4	3.2
6	1.18	.92	36	12.9	39.0	48.0	14.8	21.6	8.6	3.0
7	1.18	.94	35	13.2	37.1	49.7	14.7	19.6	12.1	3.2
8	1.16	.90	37	15.8	38.6	45.8	14.3	19.6	9.3	2.6
9	1.17	.91	36	14.0	38.0	48.0	15.8	21.2	7.8	3.0
10	1.17	.92	36	13.0	38.4	48.6	15.0	20.3	10.2	3.0
11	1.16	.89	38	15.4	38.6	45.9	13.8	19.7	9.6	2.8
12	1.20	.96	34	11.6	33.8	54.6	15.8	21.7	13.4	3.6
13	1.22	.96	36	13.2	32.8	54.0	14.4	20.2	14.0	5.4
14	1.23	.96	36	12.8	33.8	53.2	13.2	20.1	16.0	4.0
15	1.21	.95	36	13.0	33.7	53.2	14.2	22.1	12.2	4.7
16	1.20	.94	36	13.9	34.5	51.6	14.6	19.5	12.8	4.6
17	1.21	.96	34	12.0	34.6	53.2	11.6	23.2	13.4	5.0

[1]Averages of 2 replications. Mix numbers correspond to staple-length distributions in table A-3.

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