International Textile Center | Texas Tech University | Lubbock, Texas USA

Sharing current research information and trends in the cotton and textile industries.

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NEW GRADUATE COURSE IN PROGRESS

Eric Hequet, assistant director, is now teaching a graduate level course titled, "Advanced Studies in Cotton Fiber." Topics covered include: fiber properties and their measurement, contaminants, quality, use of data, harvesting and ginning, breeding for quality, and experimental design in cotton testing.

DATES SET FOR TEXAS INTERNATIONAL COTTON SCHOOL

The next Texas International Cotton School will be offered May 15-26, 2000. During an intensive two-week program, students will be provided an integrated understanding of the cotton/textile industry--including plant breeding, growing, harvesting, ginning, marketing and manufacturing. Lecturers will come from across the United States. Additional information is available at www.texasintlcottonschool.com or www.itc.ttu.edu or from Mandy Howell at (806) 763-4646.

DATES SET FOR COTTON FIBER PROPERTIES SEMINAR

The next short course for professionals who work with cotton quality data will be offered July 11-12, 2000. This two-day seminar covers fiber properties, testing, evaluation of data, and the impact of fiber properties in textile processing. A registration form will be in the spring issue of *Textile Topics* or www.itc.ttu.edu or call Pam Alspaugh at (806) 747-3790.

NEW MACHINERY

A narrow-gauge needle loom from Jacob Müller of America, Inc. is the latest addition to ITC machinery. It will allow weaving of samples as wide as 4 inches.

Contracts have been signed with American Suessen Corporation for new ring spinning frames. Installation is targeted for March-April, 2000.

RECENT TRAVEL

In December 1999, Dean Ethridge attended the USDA-ARS National Program Workshop on "Quality and Processing of Agricultural Fibers" in Atlanta, GA.

In January 2000, Dean Ethridge, Eric Hequet, S.S. Ramkumar, James Simonton and Pam Alspaugh attended the Beltwide Cotton Conferences in San Antonio, TX. Five papers were presented.

LOSS OF FRIENDS

We regret to inform readers of the recent deaths of two good friends.

Arnold Lorber, 69, of Los Angeles, CA; founder of Lorber Industries of California and Lorber Industries of Texas.

J.H. Lambright, 90, of Slaton, TX; long-time cotton breeder and owner of Lambright Pedigreed Cottonseed.

These leaders will be missed.

IMPACTS ON YARN QUALITY OF AFIS® MEASUREMENTS OF COTTON FIBER LENGTH DISTRIBUTIONS

Eric F. Hequet, Assistant Director
M. Dean Ethridge, Director

The Texas Food and Fibers Commission provided funding for the project reported here.

This report is adapted from a paper delivered at the Beltwide Cotton Conferences 2000.

INTRODUCTION

During recent years, the Uster AFIS® (Advanced Fiber Information System) has been increasingly used in the research projects carried out at the International Textile Center (ITC), Texas Tech University. Previous research has shown the value of AFIS® measurements such as the short fiber content or the standard fineness (Ethridge and Hequet, 1998; Hequet, 1999).

Unfortunately, information about distributions of fiber properties that are measured by the AFIS® are generally not used, because the data are not available in an electronic file. This article reports on three recent experiments done to investigate the usefulness of the distribution information, each one focused on the impact of the fiber length distribution on yarn quality.

FIRST EXPERIMENT

Using fourteen different USDA (United States Department of Agriculture) standards cottons, the following measurements were made on the fibers:

- AFIS® with 5 replications of 3,000 fibers,
- Sutter Web Fiber Array with 3 replications per technician and two technicians,
- Peyer AL 101 with 6 replications

Exhibit 1 shows a typical AFIS® length distribution by weight for Acala-type cotton. Of the thousands of cotton samples recently analyzed at the ITC using the AFIS®, most of the results indicated a very small percentage of fibers in the 2+ inches length category. Obviously, either those very long fibers really exist or the AFIS® over-estimates lengths of some of the longest fibers. By carefully comparing measurements on the standards cottons from the AFIS® with measurements from the Sutter Web Fiber Array and Peyer AL 101, we determined that the instruments correlate very well for the shortest fiber percentages (Exhibits 2 and 3), although the levels are different. For the very-short-staple cotton (staple 26), the length distributions obtained are very similar (Exhibit 4). For the short-staple cotton (staple 32), AFIS® and Peyer are in good agreement, but the Array method tends to get higher percentages for the longest fibers (Exhibit 5). For the medium (staple 35) and long (staple 40) fibers, the discrepancy between instruments is substantial (Exhibits 6 and 7). Neither the Peyer nor the Array show any fibers in the 2+ inches length category. As shown in Exhibit 8, however, the AFIS® tends to measure a very small percentage (generally less than 1%) of the fibers to be longer than 2 inches. Thus, these results suggest that the AFIS® tends to over-estimate the length of some of the longest fibers. In order to explain this result, one hypothesis is that the speed of the fibers passing trough the sensing device is not constant; i.e., for some of the longest fibers, the friction forces for the air-to-fiber interface delay the movement through the sensing device. This would result in a longer electronic signal, inflating the length measurement on the fiber.

SECOND EXPERIMENT

Given the anomalous result with the AFIS® that was obtained in the first experiment, the question naturally arises whether it is a useless artifact or if it has predictive power. This led to a second experiment. It was done by utilizing variety evaluation tests that were performed at the ITC during the 1998-99 crop year. Eighteen U.S. Upland cotton varieties were represented. Each variety was grown in three locations and two replicated samples were taken at each location. Therefore, a total of 108 cotton samples were collected (18×3 ×2).

The cotton fibers from each variety were processed through the Short Staple Spinning Laboratory at the ITC and were made into both ring-spun (36 and 50 Ne carded, 50 Ne combed) and rotor-spun yarns (36 Ne carded).

The following measurements were performed on fiber and yarn:

Fiber tests:

- Zellweger Uster HVI 900A: 4 mike measurements, 4 color-grade measurements, 10 length and strength measurements.
- Zellweger Uster AFIS® Multidata: 5 replications of 3,000 fibers

Yarn tests:

- Zellweger Uster Tensorapid: 10 breaks per bobbin and 10 bobbins
- Zellweger Uster UT3: 400 yards per bobbin and 10 bobbins

The printout from the AFIS® provides us with a distribution of the length by weight. The histogram is built based upon the percentage of fibers in each of the 40 length categories, from 0 to 2.5 inches with an increment of 1/16th of an inch. In order to get a first look at the data provided on those 108 cotton samples, we limited

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the number of length categories to 10 by aggregating 4 categories together; therefore, the length category increment became 0.25 inch.

A brief statistical summary of fiber properties is given in Exhibits 8 and 9, showing the mean, minimum and maximum values for each characteristic. An examination of this data reveals that all of the cottons exhibit relatively good fiber properties, with a low short fiber content, good length and maturity and high strength levels. The percentages in the last two AFIS® length categories are very low; therefore, they were aggregated in this analysis.

Using the AFIS® multidata, for each of the foregoing length categories, an analysis of variance was done. Exhibits 10, 11 and 12 give the variety and location effects for three selected length categories. For the length category [0.25;0.50[, the variety effect is highly significant, but the location effect and the location×variety interaction effect are not statistically significant. For the length category [1.25;1.50[both the variety and the location effects are highly significant, but the location×variety interaction effect is not. For the fibers longer than 2 inches, the variety effect is highly significant, the location effect is significant and the location×variety interaction effect is not significant. These results lead to at least two very important conclusions:

1. The length distribution by weight is related to the varieties measured. This implies that breeders could modify the length distribution.
2. The longest fibers measured with the AFIS®, although a very small percentage of total fibers, are also related to varieties. This implies that the fibers being measured as too long by the AFIS® cannot be dismissed as meaningless.

To investigate further, we calculated the coefficients of correlation between major yarn characteristics and the percentages of fibers in the different length categories. For Count-Strength Product (CSP), these correlation coefficients are quite similar for all the types of yarns—ring or rotor, carded or combed (Exhibit 13). For the fibers shorter than one inch the correlation coefficients are negative in all cases; therefore, the larger the share of these length categories, the lower the CSP. For fibers in the length category [1.00;1.25[, the correlation coefficients are still negative but are near zero. As the length categories increase above this level, the correlation coefficients become positive and large. The category 2+ inches exhibits the highest positive correlation of all.

Correlation coefficients between the CSP and the various fiber properties used for prediction is given in Exhibit 14. It shows that the AFIS® percent of fibers 2+ inches is the best length parameter to predict CSP. In fact, it performs better than the HVI strength and the AFIS® standard fineness. This is even more startling given that the percentage of fibers 2+ inches averages only 1 percent on the 108 samples tested (Exhibit 8).

Exhibit 15 shows the coefficients of correlation between the UT3 non-uniformity (CV%) and the percentages of fiber in the different length categories. Note the following:

- The carded ring-spun yarns exhibit very similar behavior. The length categories giving the best correlation coefficients with the yarn uniformity are: [0.00;0.25[, [0.25;0.50[and [>2.00], with a positive correlation for the shorter fibers and a negative correlation for the longer fibers. Therefore, the higher the short fiber content, the higher is the yarn CV%; and the higher the long fiber content, the lower is the yarn CV%.
- The UT3 CV% of the combed ring-spun yarn exhibits a very good correlation with the percentage of fibers longer than 2 inches and a quite poor correlation with the shorter fibers. This is logical because a large part of the shorter fibers has been removed during the combing operation.
- For the rotor-spun yarn, the negative effect on the yarn uniformity of the shorter fibers is limited. But the fibers in length category [1.75;2.00[exhibit the highest correlation with the yarn CV%. The fibers longer than two inches give a lower correlation, probably because a part of them (the extremely long fibers) wrap around the yarn and create imperfections. This is likely related to the rotor diameter and it will be necessary to test different rotor diameters to confirm this hypothesis.

Exhibits 16 and 17 show the coefficient of correlation between the UT3 thin and thick places, respectively, and the percentages of fiber in the different length categories. The patterns look very similar to those for the UT3 CV% and similar conclusions can be made.

Exhibit 18 shows the correlation coefficients between the UT3 neps and the percentages of fiber in the different length categories. The correlation levels are generally lower than were exhibited for the previous parameters. However, for the carded ring-spun yarns of 36 Ne and 50 Ne, correlation coefficients of neps with the length category [1.00;1.25[are fairly high. We currently have no coherent hypothesis to explain this.

Exhibit 19 shows the correlation coefficients between the UT3 hairiness and the percentages of fiber in the different length categories. The shapes of the curves are quite similar for all the types of yarns—ring vs. rotor and carded vs. combed. For the fibers shorter than 1/4 inch, the correlation coefficients have positive signs and are very high in all cases. Therefore, these very short fibers are important contributors toward increased yarn hairiness. Conversely, correlation coefficients for the fibers longer than two inches are also high but with negative signs; therefore, these fibers which measure very long are important contributors toward decreased yarn hairiness.

Exhibit 20 shows the correlation coefficients between levels of the combing noils and the percentages of fiber in the different length categories. As expected, the correlation coefficients are very high for the three shortest length categories but are low for the other length categories.

Exhibit 21 shows the multiple regression coefficients between the fiber and yarn parameters and the percentages of fiber in the different length categories (Forward Stepwise regression with Sigma-restricted parameterization). These results reveal that the only statistically significant length parameter related to the CSP is the percent of the fibers longer than 2 inches. For the yarn regularity (CV%, thin places and thick places) the important parameters are the very short fibers (shorter than ¼ inch) and the very long fibers (longer than 2 inches).

THIRD EXPERIMENT

The third experiment was done to obtain further confirmation of effects of the longest fibers on the yarn strength. Using two commercial bales of Upland cotton, ring-spun 30 Ne yarns were made. Then very small amounts (2% and 5%) of ELS cotton fibers were mixed with the Upland cotton and also ring-spun into 30 Ne yarns. The same measurements used in the second experiment were taken on the fibers and yarns. Exhibit 22 gives results on CSP and Exhibit 23 gives results on tenacity. They both show a tendency for increased strength with small additions of ELS. On average for the two bales, adding 2% ELS increased the CSP 3.8% and the tenacity 7.7%. Adding 5% ELS results in average increases of 7.3% in CSP and 8.5% in tenacity. These limited results give encouragement to design a more complete study using larger samples and optimizing the spinning parameters for each mix tested.

CONCLUSION

The length distribution data available with the AFIS® appears to contain information that is useful not only to spinners, but to cotton breeders as well. Since the length distribution clearly appears to be different for different varieties, it may provide a new tool for cotton breeders in their efforts to improve fiber length characteristics.

Other conclusions include the following:

- The causes for the AFIS® measuring some fibers as longer than 2 inches are not known; nevertheless, this anomalous measurement exhibits the highest correlation with the yarn CSP.
- For the carded ring-spun yarns, the shortest fibers and the longest fibers exhibit the highest correlation with the yarn CV%, the number of thin places, and the number of thick places.
- For the combed ring-spun yarns and the rotor-spun yarns, the longest fibers exhibit the highest correlation with the yarn CV%, the thin places, and the thick places.
- The correlation coefficients between the different length categories and the number of neps are generally low.
- The shortest and the longest fibers are highly correlated with the hairiness for all the types of yarns. The shortest fibers increase hairiness and the longest fibers decrease hairiness.
- The three shortest length categories are highly correlated with increased combing noils.

REFERENCES

M. D. Ethridge, E. F. Hequet. "Fineness/Maturity results for the latest generation of AFIS®", 1998. Proceedings of the International Committee on Cotton testing Methods, International Textile Manufacturers Federation, Bremen, Germany, March 10 – 11, 1998. pp. 73-76

E. Hequet. "Applications of the AFIS® multidata", 1999. Proceedings Beltwide Cotton Conferences, pp. 666-670

EXHIBIT 1: AFIS fiber length distribution (Acala type cotton)

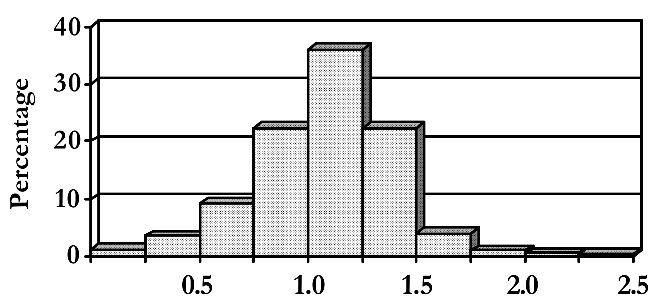

EXHIBIT 2: AFIS SFC(w) vs. Array SFC(w)

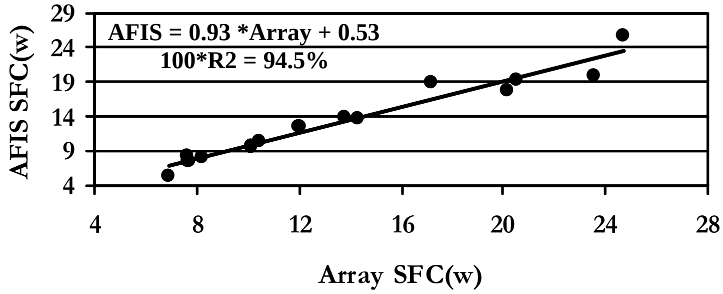

EXHIBIT 3: Peyer SFC(w) vs. Array SFC(w)

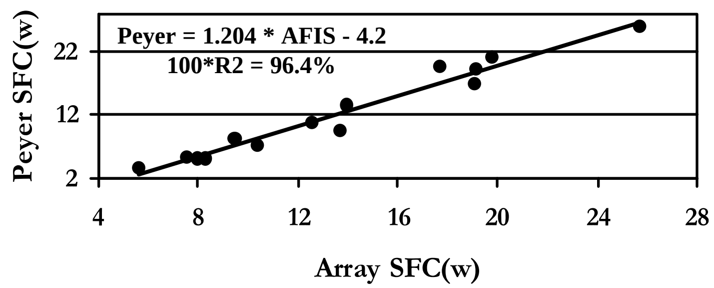

EXHIBIT 4: Length distribution - Staple 26

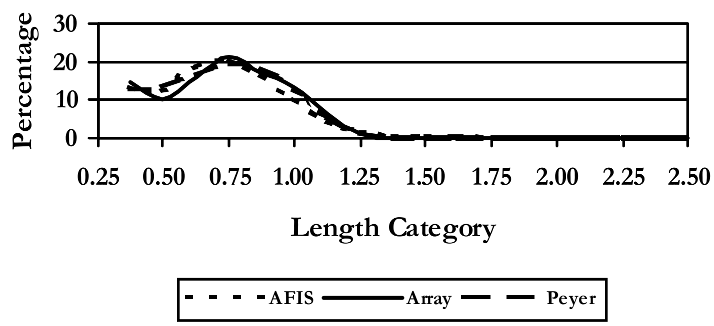

EXHIBIT 5: Length distribution - Staple 32

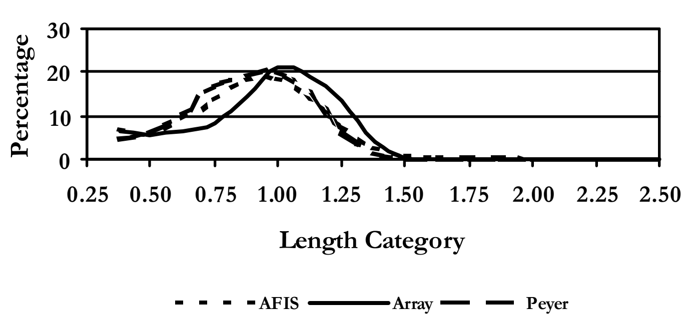

EXHIBIT 6: Lenth distribution - Staple 35

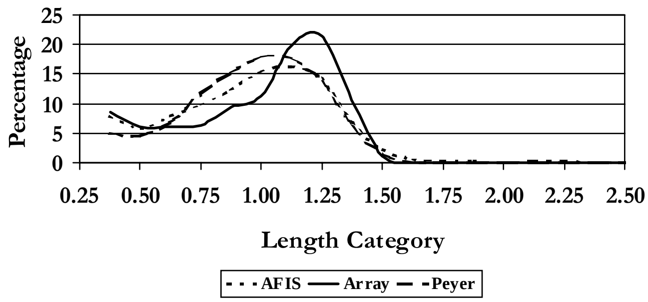

EXHIBIT 7: Length distribution - Staple 40

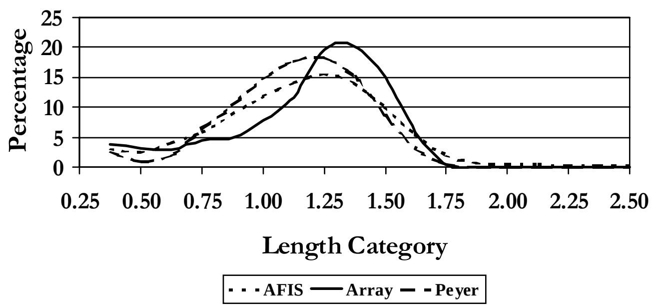

EXHIBIT 8: Raw Fiber Data for 108 Cotton Samples

Instrument & Measurement	Units	Mean	Min	Max
Zellweger Uster HVI 900A				
Micronaire		4.41	3.9	5.1
Leaf Grade		3.2	1.0	4.0
Reflectance	%	75.0	69.0	77.7
Yellowness		8.0	7.3	8.9
Upper Half Mean Length	in	1.18	1.09	1.29
Uniformity	%	83.7	80.8	85.0
Strength	g/tex	34.8	30.3	37.5
Elongation	%	5.8	5.3	6.8
Zellweger Uster AFIS Multidata				
Length (w) [0.00, 0.25[	%	1.1	0.7	1.7
Length (w) [0.25, 0.50[	%	3.4	2.5	5.3
Length (w) [0.50, 0.75[	%	9.2	6.0	13.3
Length (w) [0.75, 1.00[	%	22.4	16.6	28.9
Length (w) [1.00, 1.25[	%	36.1	28.7	43.4
Length (w) [1.25, 1.50[	%	22.2	14.6	31.5
Length (w) [1.50, 1.75[	%	3.8	1.7	10.1
Length (w) [1.75, 2.00[	%	0.9	0.4	1.9
Length (w) [2.00, 2.25[	%	0.6	0.2	0.9
Length (w) [2.25, 2.50[	%	0.4	0.1	0.7
Mean Length (w)	.in	1.08	0.99	1.16
Short Fiber Content (w)	%	4.5	3.3	6.9
Upper Quartile Length (w)	in	1.27	1.19	1.38
Maturity Ratio		0.96	0.92	1.01
Immature Fiber Content	%	5.3	3.9	6.9
Fineness	mtex	172	157	194
Neps	cnt/g	204	98	344
Seed Coat Neps	cnt/g	33	16	54

EXHIBIT 9: Yarn Data for 108 Cotton Samples

Instrument & Measurement	Units	Mean	Min	Max
Rotor-spun Yarn Carded 36Ne				
Count Strength Product	.	2268	1950	2555
Tensorapid Tenacity	cN/tex	14.5	12.8	16.4
Tensorapid Elongation	%	5.3	4.8	5.92
UT3 CV%	%	17.3	16.2	18.5
UT3 Thin Places	cnt/km	136	56	294
UT3 Thick Places	cnt/km	305	194	458
UT3 Neps	cnt/km	103	46	182
Hairiness		3.43	3.21	3.70
Ring-spun Yarn Carded 36Ne				
Count Strength Product	.	2910	2337	3422
Tensorapid Tenacity	cN/tex	17.7	14.8	20.1
Tensorapid Elongation	%	5.1	4.6	5.8
UT3 CV%	%	21.1	19.2	24.1
UT3 Thin Places	cnt/km	375	175	859
UT3 Thick Places	cnt/km	1015	617	1572
UT3 Neps	cnt/km	755	337	1235
Hairiness		4.25	3.88	4.74
Ring-spun Yarn Carded 50Ne				
Count Strength Product	.	2656	2034	3277
Tensorapid Tenacity	cN/tex	16.9	13.5	19.0
Tensorapid Elongation	%	4.4	3.7	5.0
UT3 CV%	%	23.8	21.3	27.0
UT3 Thin Places	cnt/km	822	392	1688
UT3 Thick Places	cnt/km	1712	1104	2480
UT3 Neps	cnt/km	1281	735	1864
Hairiness		3.76	3.44	4.29
Ring-spun Yarn Combed 50Ne				
Count Strength Product	.	2979	2451	3497
Tensorapid Tenacity	cN/tex	18.9	16.0	21.4
Tensorapid Elongation	%	4.6	4.0	5.2
UT3 CV%	%	17.6	16.4	18.86
UT3 Thin Places	cnt/km	166	74	305
UT3 Thick Places	cnt/km	253	136	369
UT3 Neps	cnt/km	151	52	244
Hairiness		3.23	2.89	3.66

EXHIBIT 10: Fiber length [0.25 ; 0.50[% in at least three test sites

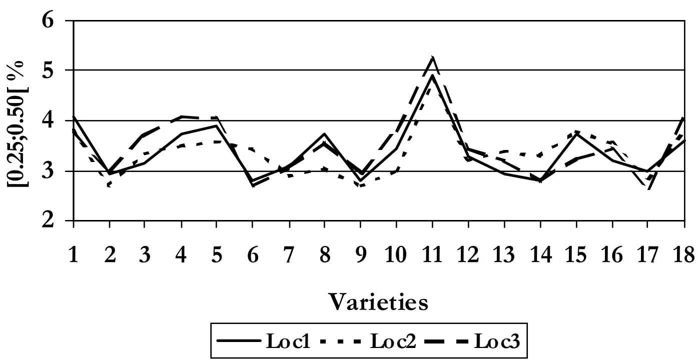

EXHIBIT 11: Fiber length [1.25 ; 1.50[in % at least three test sites

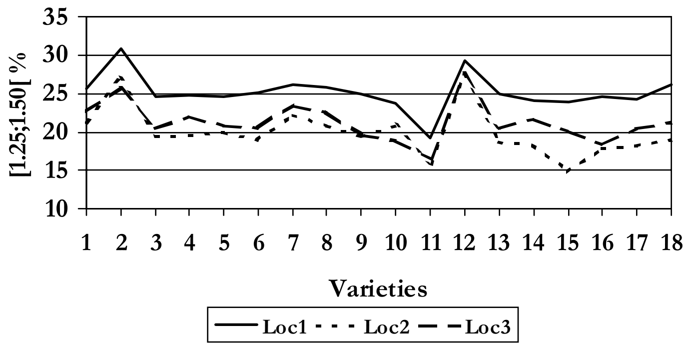

EXHIBIT 12: Fiber longer than 2 inches in % at three test sites

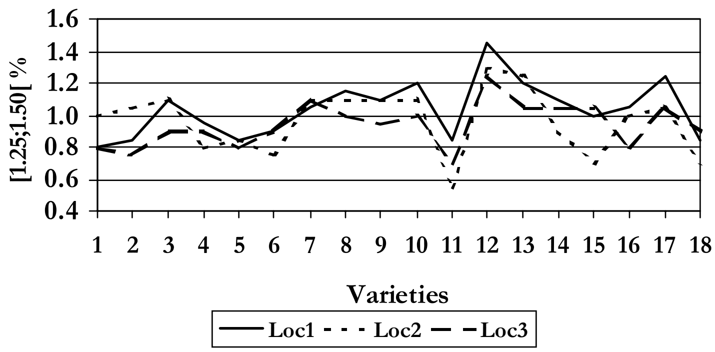

EXHIBIT 13: Coefficients of correlation between the Count Strength Product (CSP) and the percentages of fiber in the different length categories

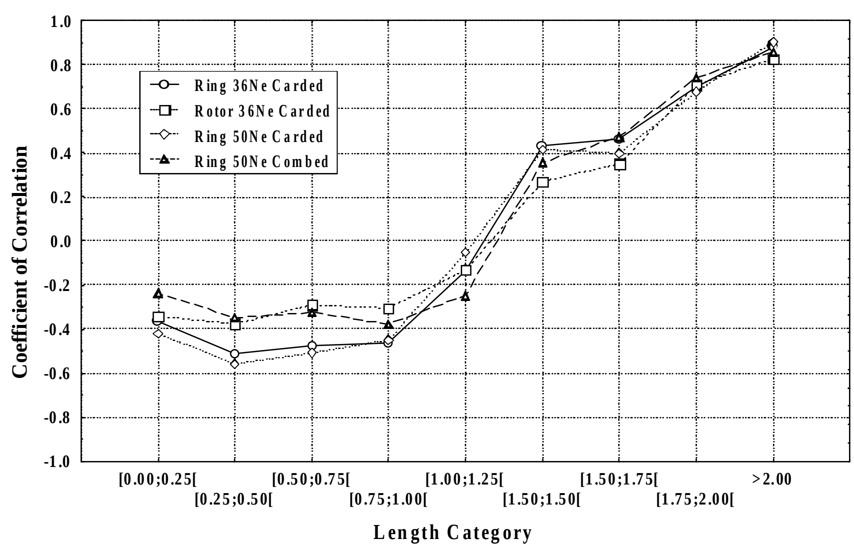

EXHIBIT 14: Correlation coefficients between the CSP and the fiber parameters

	Rotor 36 Ne Carded	Ring 36 Ne Carded	Ring 50 Ne Carded	Ring 50 Ne Combed
HVI Upper Half Mean Length	0.37	0.53	0.48	0.47
HVI Uniformity Index	0.27	0.40	0.46	0.22
HVI Strength	0.76	0.80	0.78	0.80
HVI Micronaire	-0.60	-0.49	-0.49	-0.61
AFIS SFC (w)	-0.35	-0.46	-0.51	-0.30
AFIS Upper Quartile Length	0.38	0.53	0.49	0.48
AFIS Standard Fineness	-0.79	-0.83	-0.78	-0.85
AFIS Length>2.0 in.	0.83	0.88	0.90	0.86

EXHIBIT 15: Coefficients of correlation between the UT3 CV% and the percantages of fiber in the different length categories

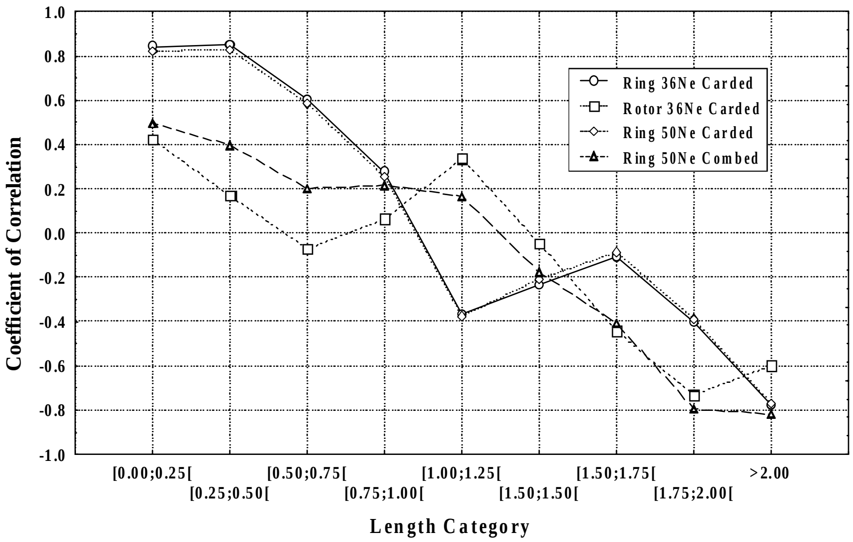

EXHIBIT 16: Coefficients of correlation between the UT3 Thin Places and the percentages of fiber in the different length categories

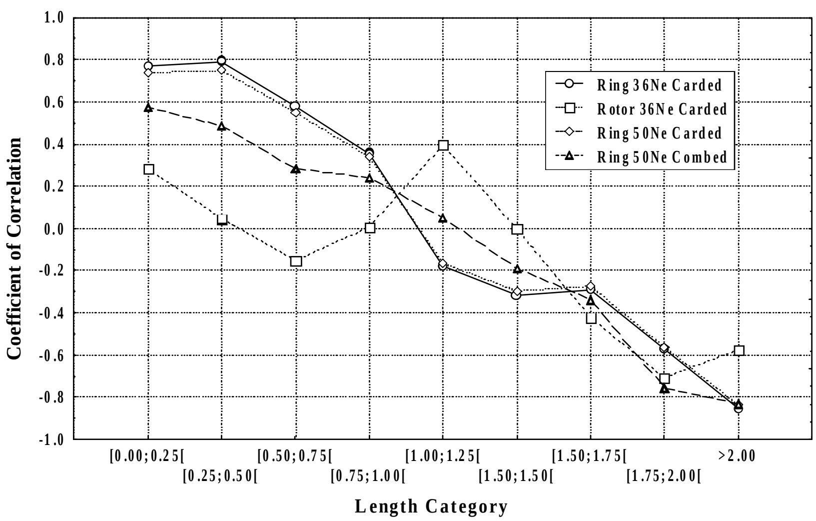

EXHIBIT 17: Coefficients of correlation between the UT3 Thick Places and the percentages of fiber in the different length categories

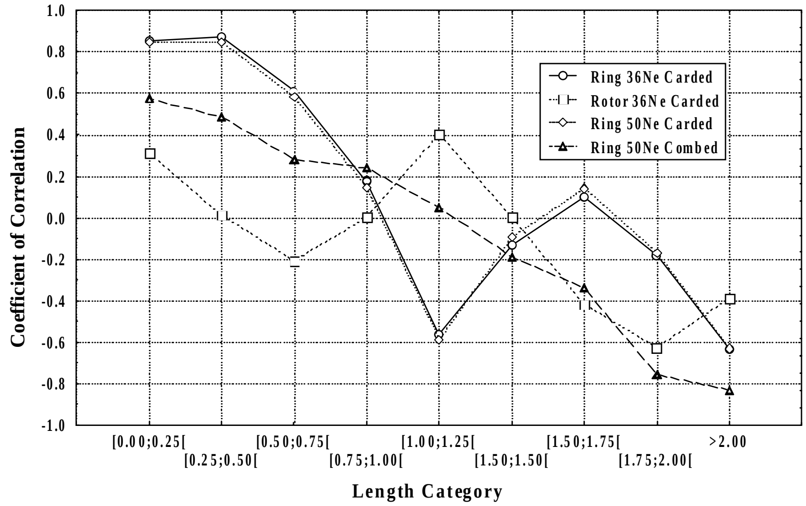

EXHIBIT 18: Coefficients of correlation between the UT3 Neps and the percentages of fiber in the different length categories

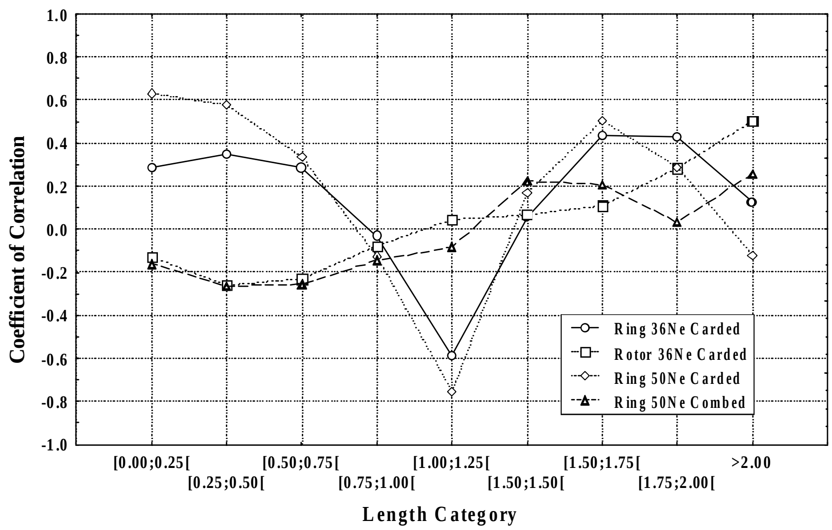

EXHIBIT 19: Coefficients of correlation between the UT3 Hairiness and the percentages of fiber in the different length categories

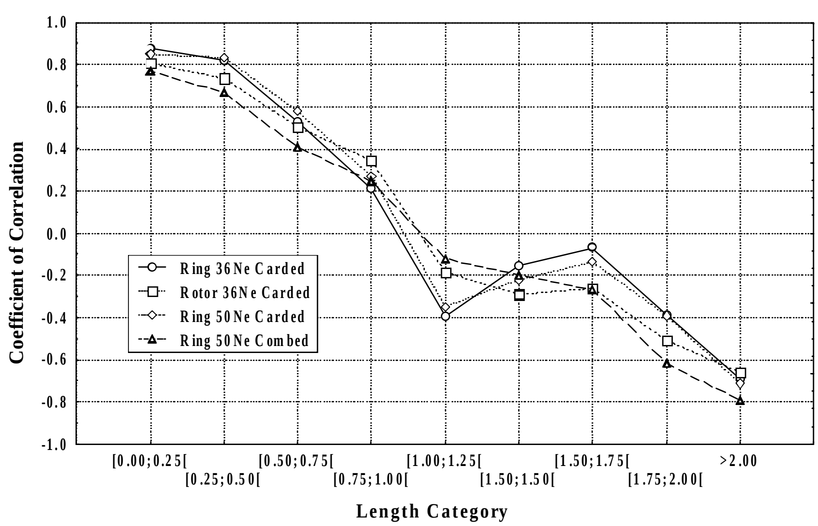

EXHIBIT 20: Coefficients of correlation between the Noils content and the percentages of fiber in the different length categories

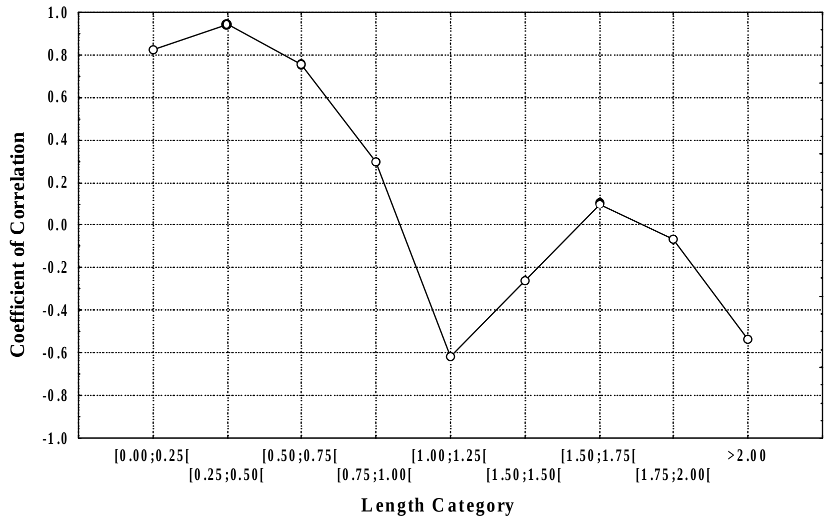

EXHIBIT 21: Multiple regression coefficients between the fiber and yarn parameters and the percentages of fiber in the different length categories (Forward Stepwise regression with Sigma-restricted parameterization).

Parameter	Equation	R^2 %	Prob.
Count Strength Product			
OE 36Ne Carded	1590 + 689.8*(L> 2)	68.3	0.000
RS 36Ne Carded	1785 + 1145.9*(L> 2)	77.9	0.000
RS 50Ne Carded	1413 + 1265.3*(L> 2)	81.5	0.000
RS 50Ne Combed	1797 + 1202.9*(L> 2)	73.8	0.000
UT3 CV%			
OE 36Ne Carded	18.09 + 2.70*[0;0.25[- 0.7*[0.25;0.5[- 1.66*[1.75;2[	84.6	0.000
RS 36Ne Carded	18.08 + 1.04*[0.25;0.5[+ 0.09*[0.125;0.15[- 2.60*(L> 2)	90.4	0.000
RS 50Ne Carded	20.5 + 1.1*[0.25;0.5[+ 0.11*[1.25;1.5[- 2.95*(L> 2)	88.5	0.000
RS 50Ne Combed	20.2 – 2.67*(L> 2)	67.0	0.000
UT3 Thin places			
OE 36Ne Carded	535.6 – 10.1*[0.75;1[- 198.38*[1.75;2[	64.4	0.000
RS 36Ne Carded	480.7 + 317.4*(L< 0.25) – 472*(L> 2)	90.7	0.000
RS 50Ne Carded	1058.7 + 546.3*(L< 0.25) – 868.9*(L> 2)	85.7	0.000
RS 50Ne Combed	618.7 – 17.7*[0.5;0.75[- 297.5*(L> 2)	70.0	0.000
UT3 Thick places			
OE 36Ne Carded	428.6 – 141.04*[1.75;2[	39.3	0.005
RS 36Ne Carded	-203 + 282.06*[0.25;0.5[25.87*[1.25;1.5[- 327.01*(L> 2)	89.9	0.000
RS 50Ne Carded	93.6 + 363.9*[0.25;0.50] + 37.3*[1.25;1.50[- 462.9*(L> 2)	88.4	0.000
RS 50Ne Combed	618.7 – 17.6[0.50;0.75[- 297.5*(L> 2)	70.0	0.000
UT3 Hairiness			
OE 36Ne Carded	3.2 + 0.33*(L< 0.25) – 0.16*[1.75;2[	83.0	0.000
RS 36Ne Carded	3.87 + 0.67*(L< 0.25) – 0.39*(L> 2)	87.5	0.000
RS 50Ne Carded	3.5 + 0.58*(L< 0.25) – 0.4*(L> 2)	85.1	0.000
RS 50Ne Combed	2.97 + 0.45*(L< 0.25) – 0.29*[1.75;2[	87.9	0.000
Noils	3.23 + 2.94*[0.25;0.5[+ 0.12*[1.25;1.5[	91.5	0.000

EXHIBIT 22: Effect of adding ELS on the CSP: Ring spun yarn 30 Ne

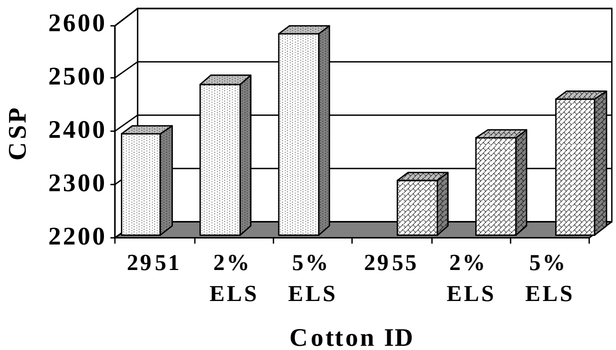

EXHIBIT 23: Effect of adding ELS on yarn tenacity: Ring spun yarn