WHAT TO EXPECT IN NEW FIBER QUALITY MEASUREMENTS

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Background

Since 1991, the USDA, AMS Cotton Division has tested practically all bales of cotton produced in the U.S. with high volume instrument (HVI) systems. The fiber properties of micronaire, length and length uniformity, strength, color and leaf (trash) areas have been measured. The properties of micronaire, length and strength along with the classer determined color grade and leaf grade are used to set the market price of the cotton.

In addition to those quality factors mentioned above, many textile manufacturers use AFIS instruments to measure neps, trash particles or other length characteristics. Various measurements of fiber fineness and maturity are also available, but they do not appear to be used extensively.

The purpose of this report is to speculate about what additional fiber quality measurements may come into general use during the next few years.

Short Fiber Content

HVI systems have been reporting short fiber content (SFC) for some time. Since short fiber content is usually defined as the percent by weight (mass) of fibers in the bale that are less than one-half inch in length; and since most HVI systems are unable to "see" fibers shorter than about 0.15 inch in length, the earlier "measurements" of SFC by HVI were by statistical relationships with mean length and upper-half-mean (UHM) length. More recently, algorithms have been developed that use the characteristics of the length fibrogram to predict the SFC. This approach is currently being evaluated for precision, accuracy, repeatability and stability. If the method proves acceptable, it would likely be the next widely used HVI measurement.

Ginning probably has the greatest impact on short fiber content, and the two factors in ginning that affect SFC are fiber moisture content during cleaning and fiber/seed separation, and the number of lint cleaners used.

The SFC of a bale of cotton is also highly related to the staple length (SL) of the cotton in that bale. Figure 1 shows the relationship of staple length to the SFC (measured by Suter-Webb array) for USDA staple standards. The linear regression equation for the line shown on the graph is:

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$$SFC = 41.7 - 0.92\ SL$$

and the R-square value is 0.91. These data were developed in the mid 1980's. Ken Bragg, USDA, ARS Cotton Quality Research Leader at Clemson, SC, found the linear regression equation between SFC and SL to be:

$$SFC = 69.1 - 1.66\ SL$$

with an R-square value of 0.65. He used data from 1001 bales from several commercial crops beginning in 1989 (personal communications). While the earlier data from the staple standards suggest than an increase of 1/32 in staple length would result in a decrease of 0.9 percent in short fiber content, Bragg's data from U.S. crops suggests than an increase of 1/32 in staple length will result in a 1.7% decrease in short fiber content.

The point to be noted here is that variety has an important influence on the short fiber content because of the inverse relationship between staple length and SFC. Because staple length is already reflected in the market price of cotton, if SFC is also to become a factor in the price of cotton, some adjustment should be made for the SL and SFC relationship. For example, if we use the data in Figure 1, the equation can be used to divide the graph into a "discount area" and a "premium area" (see Figure 2). The premium area is for those cottons that have a lower SFC than would normally be expected for a cotton with that staple length. The discount area would contain those cottons that have a higher SFC than would normally be expected at that staple length. Thus, a cotton with a staple length of 36 (1 1/8 inch) will have a "normal" SFC of 8.6%. Cottons of that staple length but with higher SFC would receive a discount in price, and cottons with a lower SFC would receive a premium. Because of the precision with which SFC can be measured, no premium or discount should apply within about ± 1 percent of the normal value. Thus, no price adjustments should be considered between 7.6% and 9.6% SFC for the 36 SL cotton in the example above.

Before SFC can be used to adjust the price of cotton, much work will have to be done to accurately establish the regression line to separate the premium and discount areas for the U.S. cotton crop. However, because SFC has such an important impact on yarn quality and on the economics of combing in yarn manufacturing, you can expect to see textile manufacturers use this technology as soon as the problems of repeatability, calibration, accuracy, etc. have been worked out.

Color Grade

It is time that we moved from using the color grade as determined by the classer to using the color grade computed from color instrument readings for marketing and selecting bales for mill mix laydowns. For almost two decades, the HVI systems have been computing a color grade using colorimeter R_d and +b values. However, there has always been some disagreement between the classer and instrument color grades. This disagreement between classer and colorimeter color grades is not randomly or uniformly distributed among the grades. Table 1 gives the results of a test conducted at Cotton Incorporated using samples from the 1996 crop. Although the results may not represent the entire upland crop, they do illustrate the nature of the disagreement between classer and colorimeter color grade.

To illustrate the data, the classer and colorimeter agreed on the color grade of 84.9% of the middling (31) bales. For the 15.1% of the bales in which there was disagreement, the colorimeter put 89% of those into strict middling (21) and 10% of those bales in strict low middling (41) color grade. When we look at the light spotted grades, we see that there was a much higher level of disagreement. For example, in this test the classer and colorimeter agreed on the middling light spotted (32) color grade for only 13.3% of the bales. For the 86.7% of the bales in disagreement, the colorimeter put 5% in color grade 21, 92% in color grade 31 and 1% in color grade 41. The data in this table illustrate the point that classers and colorimeters "see" the different color grades in different ways. There is considerable research underway to understand why these differences occur and to find the best approach to solving the problems.

These differences seem to have an impact only in the marketing of the cotton. The textile manufacturers seem to operate very well in selecting bales for their laydowns on the basis of colorimeter data. Therefore, when we can solve the problems of how to bring the colorimeter color grade into marketing system use, we will see the elimination of the need for a classer to determine color grade.

Trash Grade

The situation with trash measurement is similar to that of color measurement with some important differences. The similarities include the fact that the classer determines the value used for the marketing of the cotton, but the USDA supplies an instrument Trash Area measurement for use by the industry. As with the case for color grade, the classer has physical standards on which to base her/his determination of trash or leaf grade. One important difference between the determination of the color and trash grades is that the classer also determines something about the "type" of trash. We have not yet been able to develop instruments that can accurately determine the type of trash (grass, bark) that may be in a sample. Since the presence of grass or bark is an important economic factor in both the marketing and processing of cotton, the conversion of the trash determination from classer to instrument will likely have to wait further technical developments.

However, the fact that trash content is important in both pricing and spinning is reason enough to continue efforts to develop this technology. Another reason to continue this developmental work is because no one knows to what extent the amount of color or the amount of trash in a sample has on the determination of the other factor by either classer or instrument. Technology is available that will allow the separation of these components (fiber color and trash content) into separate and independent components. This technology has not undergone field testing.

It is important for ginners, producers and spinners to consider the leaf content of each bale of cotton. Today's cotton marketplaces a high price penalty on a bale of cotton that has a lower leaf grade than color grade. The textile manufacturer pays more for clean cotton, yet it is well known that if the cotton has a low leaf content because of the use of multiple lint cleaners at the gin, the fiber quality relative to neps and short fiber content can be lower. It is obviously important to the competitiveness of both American textiles and American raw cotton in a world textile and fibers market for producers and spinners to carefully evaluate this issue of trash content and lint cleaning.

Our challenge is to obtain the highest possible color grade with the "best" possible trash grade without causing any physical damage to fiber quality or losing price in the market.

In 1993, the USDA separated classer color grade from leaf grade. Table 2 gives a summary of the color grade and leaf grade data for the U.S. upland crop since that time.

It is important to note that during the five years, for which we have data, there appears to be an important trend to higher trash levels in our crop (by instrument percent trash area). By both classer leaf grade and instrument trash area, the 1997 crop will have the highest trash content since these data became available to us beginning in 1993. This high trash level in the 1997 crop is happening even as we have the highest average color grade during the five-year period (80.6% white grades in the crop). Perhaps producers, ginners and spinners are beginning to realize the importance of protecting the quality of the crop by reducing the amount of cleaning at the gin.

Nep Content

The nep content of U.S. upland cotton has remained relatively constant at about 320 neps/gram of fiber (as measured on the AFIS) for the last five years. While nep content has no impact on market price paid for cotton, it has a significant impact on both mill processing costs and yarn quality. Therefore, many textile manufacturers are measuring the nep content of their incoming cotton as well as the nep content of their in-process material. The AFIS instrument (sold by Zellweger Uster) is very widely used for this purpose. The sample processing time is rather long compared to HVI cycle time (approx. 2 min. 45 sec. per specimen when neps, length and trash are measured). We normally test 3 specimens per sample in our lab. Thus, over 8 minutes of instrument time is required for each sample.

The Indian company, Premier Polytronics Ltd. showed a "high speed" nep tester called Rapid Tester 10/30 at the OTEMAS Textile Machinery Show in Osaka in October, 1997. It is reported to process a 10g sample in 30 seconds. No precision and accuracy data are available at this time. If those factors are acceptable and if the test rate is as reported, this measurement of neps could be added to the HVI type systems in the near future.

Stickiness

Competing technologies are being developed to measure stickiness. The CIRAD High Speed Stickiness Detector and the Lintronics, Inc. Fiber Contamination Tester are both in advanced stages of development and testing. Both instruments test a specimen in 35 to 40 seconds, and both methods probably require the testing of two specimens per bale. Thus, cycle times per sample are one minute and 10 to 20 seconds. Both instruments determine the number and size of sticky spots in the specimen. With that information, the instrument microprocessor uses a five level rating system to give each sample a stickiness rating from "Not Sticky" to "Extremely Sticky." The important unanswered question is at what sticky spot level does mill processing and yarn quality become a problem. This question must be answered before the sticky rating levels can be assigned economic value.

There is little doubt that this technology is approaching a stage at which it can be used to the benefit of the cotton industry. However, only a small percentage of the bales in any given crop is contaminated with honeydew stickiness. Since, it will probably double the current HVI testing cost to add a stickiness measurement to the data set, we must develop new testing methodology in order to economically use this technology.

Fiber Elongation

We have the technology to measure fiber bundle elongation. We do not have calibration cottons, and we have not demonstrated the importance of making this measurement in terms of its usefulness to the textile manufacturer. Therefore, it is not likely to be of economic importance in the near future.

Fiber Maturity

Studies have shown that there is a high correlation between micronaire and maturity in our U.S. upland cotton crop. Until varieties are introduced into our crop that reduce that correlation, there is little incentive for the industry to measure fiber maturity even though reliable instruments may be available.

Conclusions

We are approaching the time in which we have the technology available to measure short fiber content, color grade, leaf grade, nep content, stickiness, fiber elongation and fiber maturity. However, much work remains before it is demonstrated that these measurements add significantly to the processing efficiency and value of cottons when their data are added to the already measured HVI properties.

Table 1. Distribution of Bales with Color Grade Disagreement

Classer Color Grade	Percent Bales in Agreement	Percent "Disagree" Bales by HVI Color Grade				
		11	21	31	41	51
21	74.0	84		16		
31	84.9		89		10	
41	85.6			100		
51	81.3				100	
22	11.1	25	67	8		
32	13.3		5	92	1	
42	25.9			5	94	
52	48.9				6	94

Table 2. Classer Color Grade and Leaf Grade, and Instrument Trash Percent For Recent U.S. Upland Crops

	Percent Bales Classed			Classer	Instrument
Crop Year	White	Light Spotted	Other	Leaf Grade Index	Percent Trash Area
1993	79.0	19.9	1.1	2.9	0.29
1994	68.4	29.8	1.7	2.8	0.32
1995	77.1	21.8	1.1	2.9	0.34
1996	76.3	22.3	1.4	2.8	0.31
1997	80.6	17.9	1.5	3.1	0.37

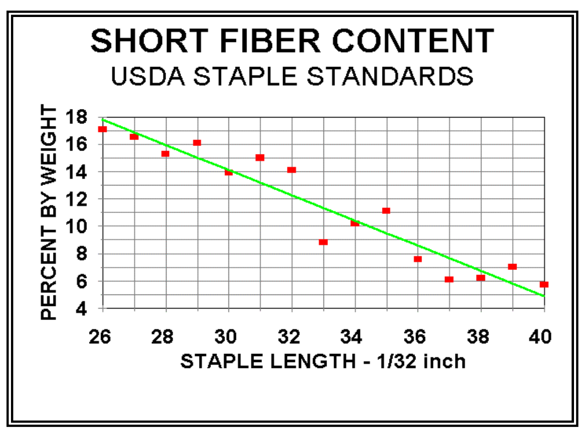

Figure 1. Short Fiber Content – USDA Staple Standards

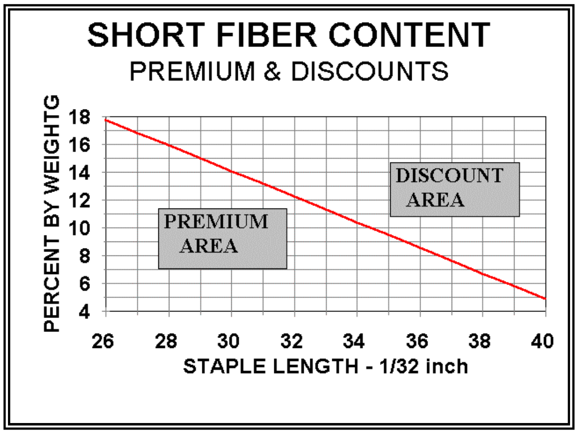

Figure 2. Short Fiber Content – Premium & Discounts