A Comparison of HVI, AFIS and CCS Cotton Testing Method

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Abstract

Six Egyptian cotton varieties and two Upland cottons (Burkina Faso and Uzbekistan) based on a wide range of fiber properties i.e., fiber length, fiber strength, fiber elongation, short fiber content and micronaire reading measured by HVI, AFIS " as High Volume Instrument" and new device Cotton Classification System (CCS-Textechno) "as Medium Volume Instrument" were analyzed and compared. A comparison of HVI, AFIS and the CCS testing method was made, with emphasis on the measurement of fiber length. The results indicate a strong correlation among the three fiber length testing methods.

The correlation among the three cotton testing methods was determined. The results indicated that HVI measurements was found to be comparable to the CCS except fiber elongation property.

INTRODUCTION

Improvements in fiber quality have long been a primary objective of cotton breeders. One major obstacle for early breeders was the lack of reliable methods to measure fiber characteristics. Those methods have become available with the advent of HVI in the late 1960s and AFIS in the 1980s. There is little information focusing on AFIS data and the benefits of using it in breeding programs. Previous research recognized the need for additional information about AFIS properties and the potential role of AFIS in breeding programs (Meredith et al., 1996).

HVI was developed for the U.S. Department of Agriculture (USDA) in 1969 (Hsieh, 1999; Ramey, 1999). It was designed to be used as a marketing tool with which to evaluate the quality of the fiber within a bale of cotton. HVI evaluates multiple fiber characteristics in a high volume of samples at a relatively high rate of speed in comparison to hand classing.

HVI uses automated sampling techniques and measures fiber properties from a bundle of fibers. This system remains popular today for both marketing and breeding, because it is efficient in terms of time and cost.

The development of AFIS was the result of cooperative efforts between the USDA Agricultural Research Service at Clemson, SC and Schaffner Technologies, with research beginning in 1982 (Bragg and Shofner, 1993). One of the primary objectives in the early design of this instrument was the ability to measure trash and neps. This was followed by efforts to measure fiber dimension, number of short fibers, and eventually a complete fiber length distribution (Bragg and Shofner, 1993; Shofner et al., 1988, 1990). These properties were chosen because of their value in the fiber-to-yarn engineering process. This basic information about the fiber is useful for quality control and production efficiency in mills, as well as for providing information needed to improve product quality (Shofner et al., 1988, 1990).

Hequet (2007), reported that most of the breeders simply ignore fber elongation because the lack of calibration procedures for HVI elongation makes it impossible to rely on such data in an open market. In addition, the literature produced by cotton breeders shows that even when elongation measurements are available

(Stelometer tests) there is a lack of understanding of its meaning. Indeed, because of the negative correlation between elongation and tenacity, they often conclude that there is no need to work on elongation because it could result in lower tenacity.

HVI was developed for measuring large quantities of bale cotton within a minimum time frame whilst AFIS was designed for single fiber testing. Typical HVI measurements include fiber length, length uniformity, bundle tenacity, elongation, micronaire, color, and trash content while AFIS provides fiber measurements including a complete length and diameter distribution, trash content, nep content, fineness and maturity.

Traditional LVI systems used for quality control of cotton fibers have several disadvantages. First, these systems were developed for the classification of cotton for cotton trading and do not allow testing slivers and roving. They are very good tools in highly developed areas (such like Europe and USA), but problematic in daily necessary calibration of such systems requires a stable climate in the laboratory; in case no calibration can be reached, the results are not accurate, (Kothari 1999 and Suh and Sasser 1996).

The Textechno CCS – Cotton Classifying System is an alternative system overcoming the above-mentioned drawbacks. It considers cotton testing from a different point of view, taking the spinning method into account in order to assess the spinnability of fibers within the spinning process. The CCS - a new generation of cotton testing instruments - is designed as a so-called MVI (Medium Volume Instrument), realizing a capacity of 20 tests per hour.

In this paper, HVI, AFIS and Cotton Classification System (CCS-Textechno) cotton testing method were evaluated and compared, with the emphasis on the measurement of fiber length, fiber strength.

MATERIALS AND METHODS

Eight cotton varieties, based on a wide range of fiber length, strength and micronaire (finance) were used for this study.

To test the repeatability of HVI and AFIS fiber properties a representative sample of approximately 50 kg was taken from commercial Egyptian cotton varieties and two Upland cottons. Each sample was homogenized and tests were carried out under standard atmospheric condition of 65% ±2% and 22˚C ±1˚C temperature. The cotton samples were tested on High Volume Instruments (HVI and Advanced fiber information System AFIS in El-Baraka Co. for spinning), with 10 replications for length, uniformity, tenacity, and elongation measurements and 4 replications for micronaire measurements. While, the tested samples on Cotton Classifying System (CCS-Textechno) were carried out on Gaziantep Spinning mill, Turkey.

The varieties include Loose lint cotton was used for HVI and CCS testing, while handmade sliver was used for AFIS testing

High Volume Instrument 1000™

The testing is carried out in the following two stages in the stand-alone mode;

- Fiber finance/micronaire measurement
- Length and strength measurements

High Volume Instrument (HVI) system provides measurement of length, uniformity, strength, elongation, micronaire, color and short fiber content. For each sample, micronaire was determined by testing four properly opened masses of cotton

weighting between 8.5 g and 12 g and by testing four combs for length and strength. Average of these results was reported.

Advanced Fiber Information System "AFIS Pro"

This instrument measures length, fineness maturity, circularity, ect. of each fiber fed, and from the data so obtained provides average length of individual fibers in a sliver fed to the system, as also the length distribution both by number and weight after measuring the individual fiber length for a selected number of fibers. This number can be varied between 1000 and 10000. Other parameters, the instrument can measure are short fiber content, immature fiber content, nep/g and percentage of dust and trash. In the present case, 5000 fibers were used for measurements per sample.

CCS – Cotton Classifying System

The system provides micronaire values (including maturity MA, MA%, and linear density), fiber length properties (including UI, UR, 2,5% SL, 25% SL, 50% SL, UHML, ML, UQL, SFC, SFI), fiber strength properties (strength and elongation), whiteness degree Rd and yellowness degree +b, as well as neps- and trash content.

The modular CCS system determines the quality of the incoming raw cotton fibers and cotton slivers in order to optimize the spinning process. Additionally, the CCS test data can be used to verify the cotton quality according to recommendations by USDA or similar organizations.

The correlation among the parameters under studied testing methods were also investigated. The correlation coefficient (r) inform the strength of the relationship among the testing methods.

RESULTS AND DISCUSSION

1. UHM Length

In this investigation, a comparison between UHM length of the samples estimated by HVI, and AFIS and the fiber length of the samples estimated by the CCS testing method was made. The values of the fiber length of the eight cotton samples measured by the three cotton testing methods were shown in Table 1.

Table1. UHM length measurements

Cotton variety	CCS	HVI	AFIS
Giza 87	35.6	35.3	37.3
Giza 45	35.1	35.1	36.7
Giza 92	34.1	34.1	35.1
Giza H 4	36.5	36.3	37
Giza 94	33.3	33.9	34.8
Giza 90	30.3	30.6	31.4
Uzbekistan "Upland"	29.1	29.2	29.8
Burkina Faso "Upland"	28.3	28.1	29

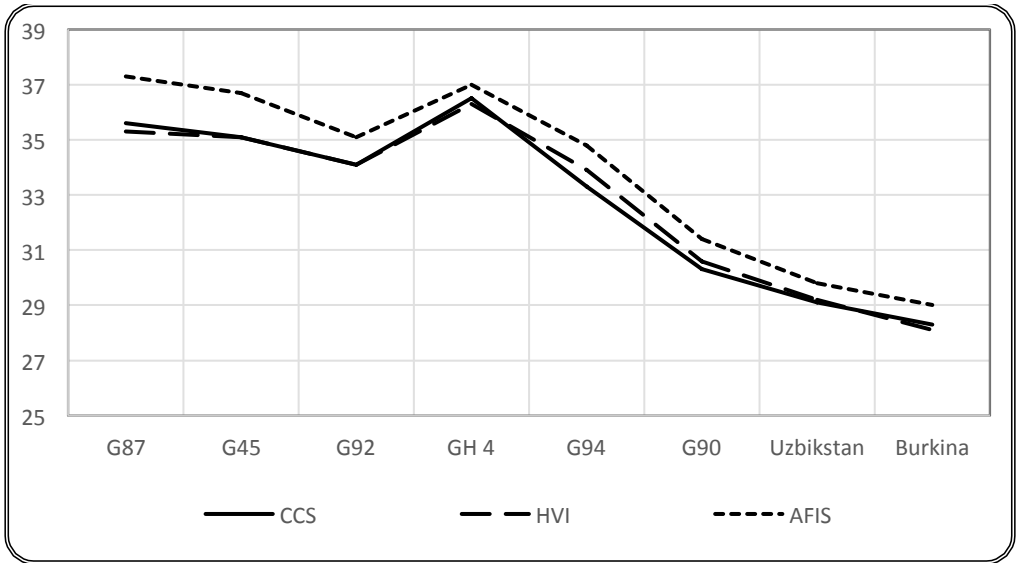

Figure 1. Comparison of HVI, AFIS and CC testing method for fiber length measurement.

The readings derived from the AFIS testing method are slightly larger than those derived from HVI and CCS. As shown in Figure 1, the shape of the three curves is approximately the same. It could be observed that the values of the cotton fiber length derived from the CCS testing method are strongly correlated with those derived from both HVI and AFIS measurements with the correlation coefficients of 0.99 and 0.98 respectively. As can be seen in Figure 4, the values of

the cotton fiber length derived from HVI measurement is also highly correlated with those derived from AFIS measurement with the correlation coefficient of 0.95. This clearly reveals that there is a high correlation among the three fiber length testing methods.

In HVI and CCS fibers caught in the comb at one end while the other end is straightened and takes part in the length determination. For each fiber to get entangled in the comb wire, some length is used. Therefore, UHM by HVI and CCS are bound to give lesser values than those obtained by AFIS. The portion of the fiber caught in the comb appears to be at least 0.6mm up to 2mm.

2. Fiber Strength

Fiber strength is determined by breaking a tuft of fibers held in two jaws separated by 3.2mm. breakage was obtained by pulling the jaws apart using constant rate of loading or constant rate of elongation device. Fiber strength of the tuft so tested was used for the determination of tenacity. The value of strength and its correlation were presented in table 2 and Fig. (2). Fiber strength parameters obtained from HVI and CCS show positive and highly correlation R=0.996102

Table 2. Fiber strength measurements

Cotton Variety	CCS	HVI
Giza 87	42.08	42.8
Giza 45	43.81	43.4
Giza 92	45.61	46
Giza H 4	44.45	44.7
Giza 94	39.91	40.8
Giza 90	35.06	35.3
Uzbekistan "Upland"	30.87	30.4
Burkina Faso "Upland"	28.45	28.65

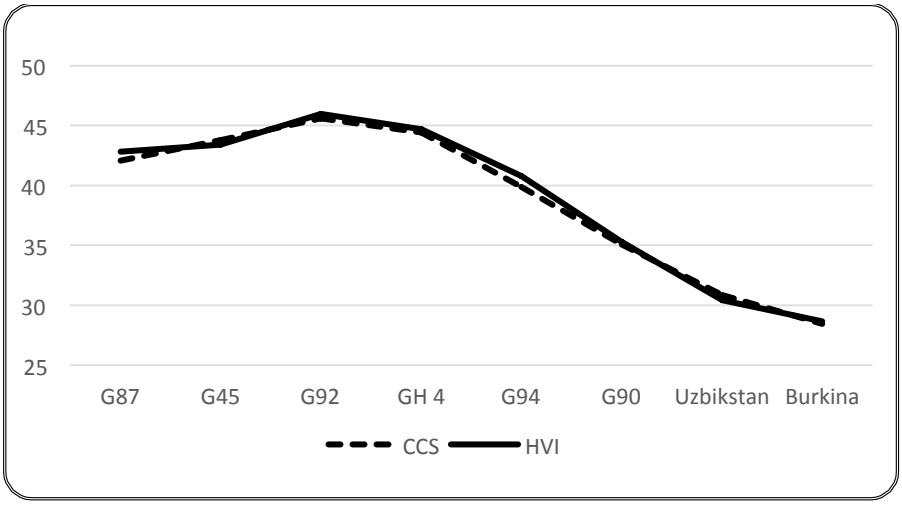

Figure 2. Comparison of HVI and CC testing method for fiber strength measurement.

3. Fiber Elongation

Comparisons of the HVI fiber elongation measurements with CCS-fiber elongation measurement showed high variation levels of elongation in comparison of HVI. May and Taylor (1998), reported negative correlations between fiber elongation and fiber tenacity. This results was harmony between fiber strength and fiber elongation measured by HVI "R= -0.79838" ". While there is positive correlation between fiber elongation and fiber strength measured by CCS "R= 0.685861"

Hequet et. al, 2007 reported that while the improvement of fiber tenacity has been for many years the focus of these programs, elongation has not been included because calibration cottons are lacking. most of the breeders simply ignore fiber elongation because the lack of calibration procedures for HVI elongation makes it impossible to rely on such data in an open market. In addition, the literature produced by cotton breeders shows that even when elongation measurements are available (Stelometer tests) there is a lack of understanding of its meaning. Indeed, because of the negative correlation between elongation and tenacity, they often conclude that there is no need to work on elongation because it could result in lower tenacity.

Table 3. Fiber elongation measurements

Cotton Variety	CCS	HVI
Giza 87	11.27	5.8
Giza 45	11.16	5.6
Giza 92	12.45	5.7
Giza H 4	9.63	5.9
Giza 94	10.77	5.8
Giza 90	10.42	5.9
Uzbekistan "Upland"	10.28	6.2
Burkina Faso "Upland"	8.59	7.3

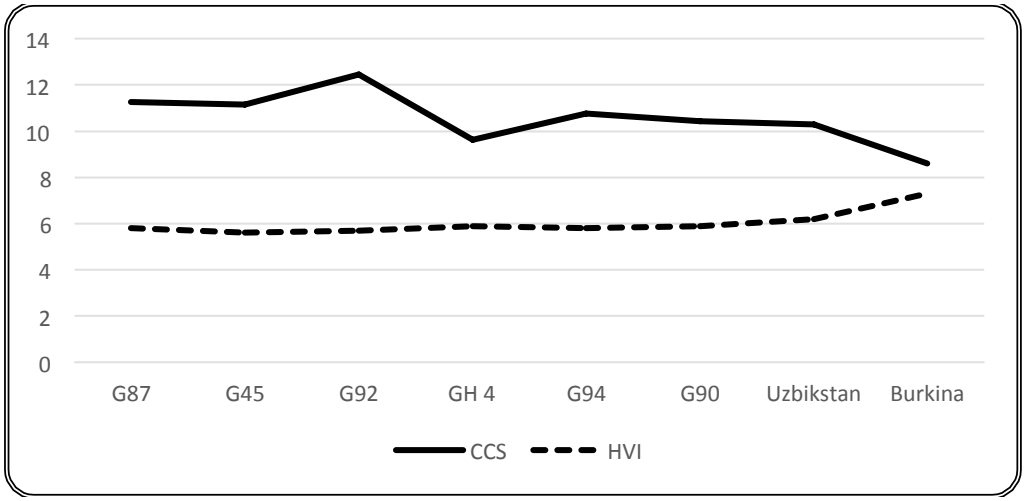

Figure 3. Comparison of HVI and CC testing method for fiber elongation measurement.

4. Color attribute

The degree of reflectance (Rd) determined by the HVI shows the brightness of the sample, which corresponds to the reflectance (Rd) represented in the Nickerson-Hunter color chart. The yellowness (+b) according to the HVI is determined using a yellow filter, which depicts the degree of cotton pigmentation. The yellowness (+b) from the HVI corresponds to the (+b) value represented in the Nickerson-Hunter color chart. The yellowness (+b) is used in conjunction with the reflectance (Rd) value to determine the instrument measured color grade of cotton.

Table 4. cotton color attribute measurements

Cotton Variety	CCS	HVI	CCS	HVI
	Rd	Rd	+b	+b
Giza 87	77.70	75.4	8.90	8.7
Giza 45	75.39	76.4	8.60	9.3
Giza 92	78.83	72.5	9.43	8.7
Giza H 4	78.69	70.8	9.89	8.7
Giza 94	77.13	77.3	10.36	9.4
Giza 90	66.26	66.7	12.00	11.7
Uzbekistan "Upland"	71.29	72.9	13.19	13.2
Burkina Faso "Upland"	78.33	77.4	12.09	11.9

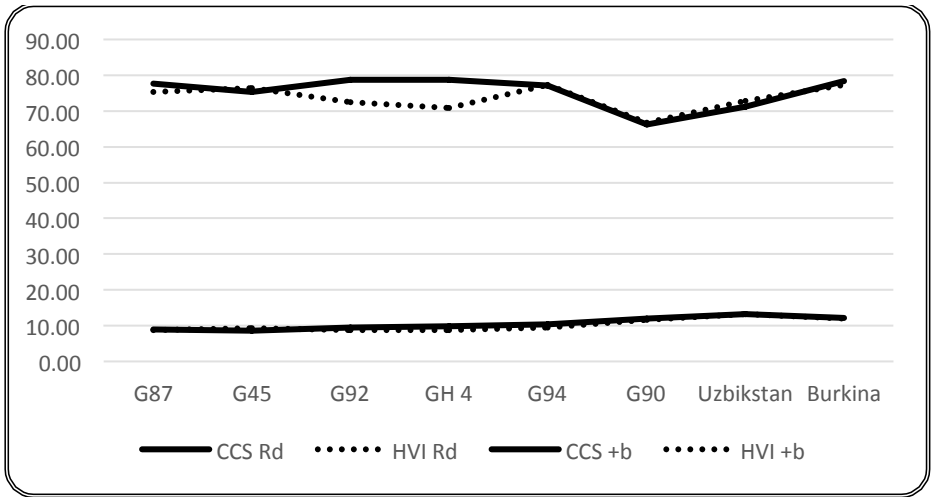

Figure 4. Comparison of HVI and CC testing method for color attribute measurement.

The range of Reflectance (RD) values from the CCS shifted in the direction of higher values in comparison to the range of the HVI. The results indicated a weak correlation "R= 0.64251" between the two Reflectance (RD) testing method, whereas the range of yellowness (+b) from the CCS shifted in the direction of similar values in comparison to the range of yellowness (+b) from the HVI. A correlation analysis showed strong correlation "R= 0.94229" between the values of the degree of reflectance (Rd) between the two yellowness (+b) testing method.

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