FIBER EVALUATION

The following section draws heavily from
The Classification of Cotton
USDA, Agricultural Marketing Service,
Cotton Division, Agricultural Handbook 566,

by Mike Watson, Cotton Incorporated

Every bale of cotton produced in the U.S. is uniquely identified by a Permanent Bale Identification (PBI) tag, since each bale has unique fiber properties. These fiber properties are determined through a combination of instrument evaluations using High Volume Instrument (HVI) technology and grading by a skilled cotton classer. The information gathered on each bale is utilized in marketing that bale and is also used by textile mills when they process that bale. This section describes the cotton fiber properties that are tested and how they are evaluated at a U.S. cotton classing office.

A. INSTRUMENT DETERMINATIONS

Measurements for the following quality factors are performed by high-volume, precision instruments, commonly referred to as "HVI" classification.

STAPLE LENGTH

The staple length of cotton fiber is a critical quality attribute since the length affects yarn strength and evenness as well as the efficiency of the spinning process. Traditionally, the staple length was estimated by the 'hand stapling' process performed by a cotton classer. Now, determination of the cotton staple length is one of the critical functions of the High Volume Instrument system. The staple length is calculated from the length fibrogram sensed by the HVI. The fibrogram is an arrangement of fibers from the shortest to the longest in terms of span lengths (the distances fibers extend from a random catching point) (Table 1).

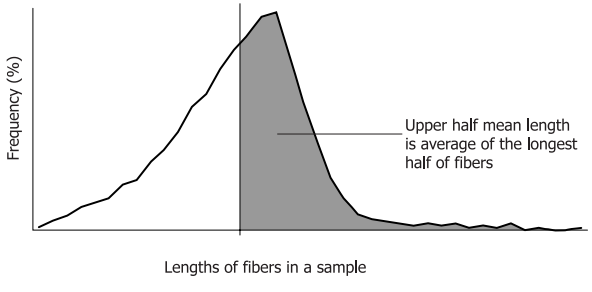

Table 1. Histogram illustrating fiber length distribution

Staple length is reported as the average length of the longer one-half of the fibers (normally called "upper-half-mean" length).

Fiber length is measured by clamping a sample of fibers, then combing and brushing to straighten and parallel those fibers. The resulting

"beard" of fibers is then passed through a sensing point in the HVI length instrument. Fiber length is reported in 100ths of an inch, which is often converted to 32's of an inch, the measurement unit used in traditional hand stapling (Table 2).

Upland Fiber Length Conversion Chart	
Inches	**32nds**
0.79 & shorter	24
0.80 - 0.85	26
0.86 - 0.89	28
0.90 - 0.92	29
0.93 - 0.95	30
0.96 - 0.98	31
0.99 - 1.01	32
1.02 - 1.04	33
1.05 - 1.07	34
1.08 - 1.10	35
1.11 - 1.13	36
1.14 - 1.17	37
1.18 - 1.20	38
1.21 - 1.23	39
1.24 - 1.26	40
1.27 - 1.29	41
1.30 - 1.32	42
1.33 - 1.35	43
1.36 & longer	44 & longer

Table 2.

Fiber length is determined by an interaction of cotton variety, growth environment and crop management. Extreme temperatures, water stress, insect pressure or nutrient deficiencies can all shorten the staple length. Excessive cleaning or drying of cotton fiber at any point in its processing can also reduce the length.

LENGTH UNIFORMITY INDEX

Length uniformity index is the ratio between the "mean length" of the fibers and the "upper half mean length". Both measurements are taken when the fiber beard described above is passed through the length sensor of the HVI system. There is a natural distribution in the length of cotton fibers. The lower the variation in this length distribution, the higher the length uniformity index.

Like staple length, length uniformity (Table 3) affects yarn strength and evenness as well as the efficiency of the spinning process. Cotton with a low length uniformity index (high variance in fiber length) is more likely to be difficult to process and result in lower quality yarn.

Length Uniformity	
Degree of Uniformity	**HVI Length Uniformity Index (%)**
Very High	Above 85
High	83 - 85
Intermediate	80 - 82
Low	77 - 79
Very Low	Below 77

Table 3.

STRENGTH

Fiber strength as measured on the High Volume Instrument is the force in grams required to break a bundle of fibers one tex unit in mass. A tex unit is the weight in grams of 1000 meters of fiber length. Strength measurements are made on the same beard of cotton used by the HVI to measure staple length. After the length measurement is made, the beard is clamped between two sets of jaws that are spaced 1/8th of an inch apart,

then broken. The result is reported in "grams per tex" (Table 4).

Fiber strength is largely determined by genetics, so cotton variety plays an important role in this fiber quality. However, the growing environment and crop management cannot be ignored since they do contribute toward determination of fiber strength.

Fiber Strength	
Degree of Strength	**HVI Strength (grams per tex)**
Very Strong	31 & above
Strong	29 - 30
Average	26 - 28
Intermediate	24 - 25
Weak	23 & below

Table 4.

MICRONAIRE

Micronaire is a measurement of both fiber fineness and maturity. Micronaire is determined by measuring the air permeability of a constant mass of cotton fibers compressed to a fixed volume. Fine or immature fibers that are easily compressed have a lower air permeability and therefore low micronaire. Coarse or mature fibers that resist compression have high micronaire.

Micronaire is the cotton fiber property most influenced by the environmental conditions during the growing season. Various combinations of moisture, temperature, sunlight and length of season all contribute to micronaire level.

Micronaire gives important information about the dyeing characteristics of the cotton products produced from the fiber. Micronaire values are used to assess the market values of cotton (Table 5).Uneven distribution of micronaire within a fabric can result in poor color uniformity of that fabric and problems such as barré or streaks.

While micronaire is not a direct measurement of fiber fineness, it does give some indication of this property. Cotton fiber fineness affects processing performance and the quality of end products in several ways. Fine fibers require careful opening, cleaning and carding to prevent damage, which can result in uneven yarn. However, yarns produced from fine fibers will have more fibers in the yarn cross-section, resulting in improved yarn strength.

Table 5. Relationship of Micronaire Readings to Market Value

HVI COLOR GRADES FOR AMERICAN UPLAND COTTON

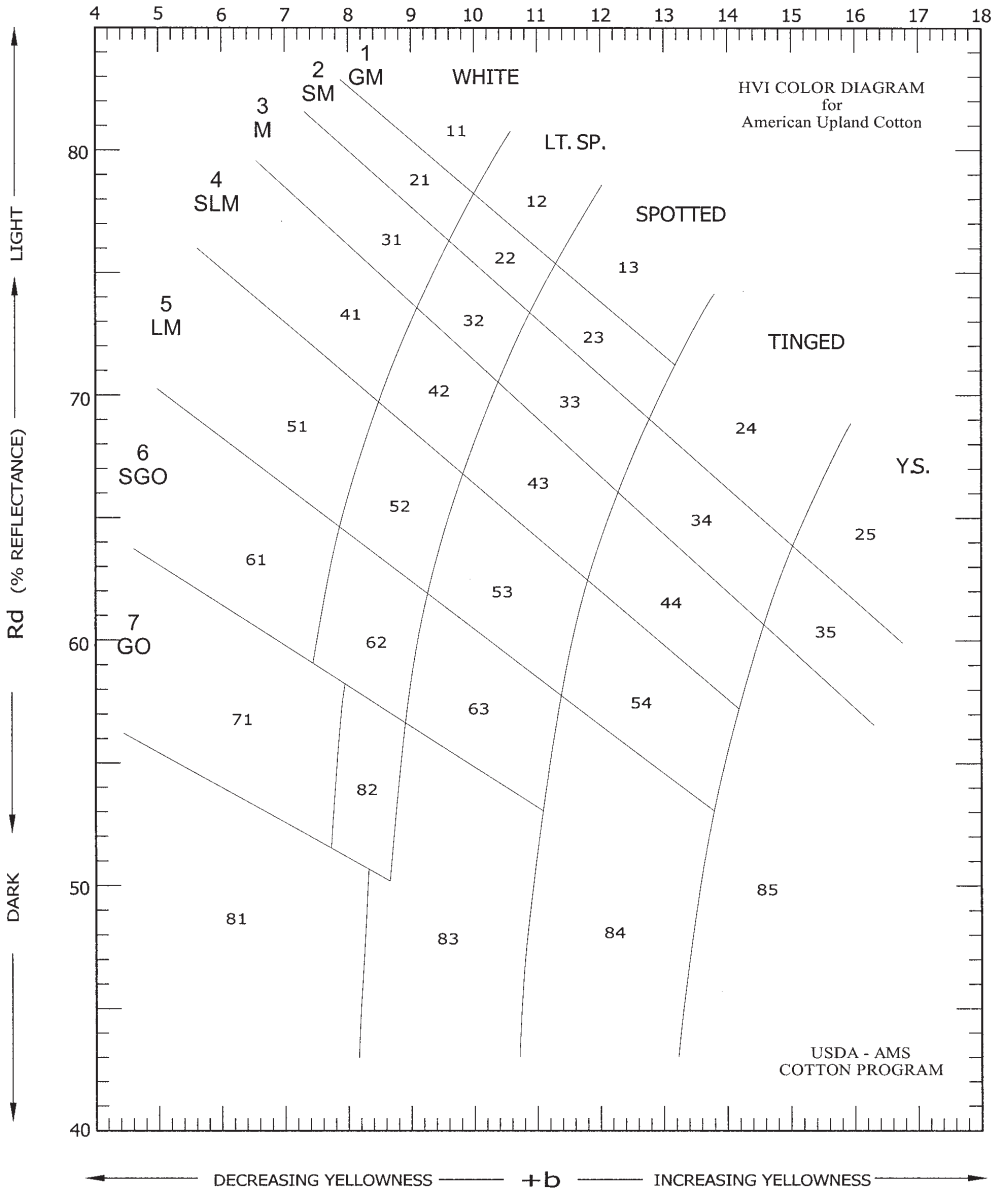

Table 6.

COLOR

The color of cotton is measured using a cotton colorimeter and is expressed by the degrees of reflectance (Rd) and yellowness (+b). Reflectance, which typically ranges between 50 and 85 units, indicates how white or gray a sample is. The higher the Rd value, the whiter the cotton.

In color measurement science, positive "b" values indicate yellowness, so cotton with higher +b measurements is more yellow. The most typical range of +b in upland cotton is from 6 to 12.

COLOR GRADE

Traditionally, cotton classers determined the color grade of cotton by comparing a sample to physical color standards. There are 25 official color grades for American upland cotton, plus five categories of below grade color. The USDA Cotton Program maintains physical standards for 15 of the color grades (Table 7). The instrument color readings of these physical standards have been plotted on a Nickerson-Hunter cotton colorimeter diagram. By utilizing the Rd and +b measurements described above and the colorimeter diagram, we can determine the traditional color grade of the cotton (Table 6).

The color of cotton fibers can be affected by environmental variables such as rainfall, freezes, insects and microorganisms. Sometimes, cotton fiber can be stained on the plant by contact with soil, grass or the leafy portions of the cotton plant. Color can also be affected by high levels of moisture and temperature during storage, both before and after ginning.

Color Grades of Upland Cotton - Effective 1993

	White	Light Spotted	Spotted	Tinged	Yellow Stained
Good Middling	11*	12	13	---	---
Strict Middling	21*	22	23*	24	25
Middling	31*	32	33*	34*	35
Strict Low Middling	41*	42	43*	44*	---
Low Middling	51*	52	53*	54*	---
Strict Good Ordinary	61*	62	63*	---	---
Good Ordinary	71*	---	---	---	---
Below Grade	81*	82	83	84	85

*Physical Standards. All other are descriptive

Table 7.

Relationship of Trash Measurement to Classer's Leaf Grade

Trash measurement (4-year average) (% area)	Classer's Leaf Grade
0.13	1
0.20	2
0.34	3
0.51	4
0.72	5
1.00	6
1.25	7
1.57	8

Table 8.

HVI TRASH

When cotton fiber is tested using HVI instruments, the surface of the sample is scanned by a video camera and the percentage of the surface area occupied by trash particles is determined by image processing software. Trash particles in cotton fiber come from parts of the cotton plant such as leaf and bark that are removed along with the fiber during harvesting. The HVI trash measurement is not part of the official USDA cotton classification, but is provided as additional information. Classer's Leaf Grade, described below is the official classification for trash content. However, there is a correlation between HVI trash measurement and classer's leaf grade as shown in Table 8.

B. CLASSER DETERMINATIONS

Although USDA provides a comparable HVI trash measurement, the traditional method of classer determination for leaf-grade and extraneous matter remains part of the official USDA classification.

LEAF GRADE

The classer's leaf grade is a visual estimate of the amount of cotton plant leaf particles in the cotton. There are seven leaf grades, designated as leaf grade "1" through "7", and all are represented by physical standards. In addition, there is a "below grade" designation which is descriptive.

Leaf content is affected by plant variety, harvesting methods, and harvesting conditions. The amount of leaf remaining in the lint after ginning depends on the amount present in the cotton prior to ginning, and on the type and amount of cleaning and drying equipment used. Even with the most careful harvesting and ginning methods, a small amount of leaf remains in the cotton lint.

From the manufacturing standpoint, leaf content is all waste, and there is a cost factor associated with its removal. Also, small particles cannot always be successfully removed, and these particles may detract from the quality of the finished fabric.

PREPARATION

Preparation is a term used to describe the degree of smoothness or roughness in the cotton fiber sample. Various methods of harvesting, handling, and ginning cotton produce differences in roughness or smoothness of preparation that can be seen in the cotton sample.

EXTRANEOUS MATTER

Extraneous matter is any substance in the cotton other than fiber or leaf. Examples of extraneous matter are bark, grass, spindle twist, seedcoat fragments, dust, and oil. The kind of extraneous matter and an indication of the amount (light or heavy), are noted by the classer on the classification document.