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LEAF GRADE AND EXTRANEOUS MATTER CLASSIFICATION

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Abstract

The USDA, AMS, Cotton Program currently determines leaf grade and extraneous matter manually. The Program recently initiated studies to determine the potential of replacing manual leaf grade measurements with HVI measurements. The preliminary analysis from the study indicates that the movement to an HVI leaf measurement has the potential of producing results as good as or better than the current manual system.

In addition to the HVI leaf grade initiative, the Program is responding to cotton industry requests by developing classer guides for bark and grass extraneous matter. Currently, only narrative definitions serve to guide manual classers in visually determining extraneous matter for bark and grass. The visual guides will contain digital images of cotton samples depicting the different quantity levels of bark and grass that are acceptable within each established level. This technology has the potential of reducing the level of subjectivity inherent in the current process. The Cotton Program is also developing improved written definitions for extraneous matter in conjunction with these images.

Background

The Cotton Program, within the U.S. Department of Agriculture (USDA), has consistently strived to improve its cotton classification system. One endeavor that has taken over 30 years to implement is the transfer of the manual cotton classification program to an instrument-based system. High Volume Instruments (HVI) currently measure strength, length, length uniformity, micronaire, color RD, and color +b while specialized manual classers determine leaf grade and extraneous matter levels.

Textile manufacturers depend on the USDA Cotton Program to accurately measure the level of leaf and other extraneous matter contained in each tested cotton sample. Manufacturers use this data to enhance their processing performance and to ensure their final product quality. Today the textile manufacturers receive evaluations based on the classers' manual visual comparisons to the historically established Universal Cotton Standards for color and leaf.

In a continuous effort to provide the best quality measurement data to the textile industry, the Cotton Program, in 1991, began utilizing the HVI trashmeter results, which provided percent area of trash, in order to provide the industry with additional comparative data for process assessment. Since its inception, trashmeter technology has evolved to the point where it can provide highly accurate and reliable measures of percent area trash and particle count.

The HVI trashmeter utilizes a black and white camera that scans four surfaces of a cotton sample. The HVI analyzes the scanned image and reports to the Cotton Program computer system in terms of percent area of trash and particle count. The percent area of trash is determined by scanning the four 9-square-inch cotton sample images or a 36-square-inch measured surface occupied by trash particles. The particle count is determined by averaging the number of particles counted on each of the four 9-square-inch images.

The particle count measurement provides an important indicator of not only the number of particles, but also the average size of the particles in the sample. For example, if a sample has a low percent trash area but has a relatively high particle count, the sample contains a high degree of small particles. On the other hand, if a sample has a high percent area of trash and a relatively low particle count, then the sample has large particles. Therefore, in regards to the HVI determined leaf grade, the particle count enhances the predictability of leaf grade by providing valuable particle number and size information that contributes to the determination of leaf grade.

HVI Leaf Grade Study

In order to develop an acceptable HVI determined leaf grade the correlation between HVI measurements of percent trash area and particle count and the classer-determined leaf grade was required. Classer leaf grade is based on the size, amount, and distribution of trash particles observed throughout the cotton sample. The HVI measures particle count and percent area of trash.

Theoretically, we can derive a leaf grade from the HVI data by developing a chart with particle count as the x-axis and percent trash area as y-axis where the intersection of the lines extending from the axis reflects the leaf grade (Figure 1).

The Cotton Program began its study using Cotton Classing Office samples retested in the Quality Assurance Branch (QA) from years 2000, 2001 and 2002 crop years to determine the sufficiency of the correlation between percent area of trash and particle count and the manually retested leaf grade samples. For each year, a chart was constructed by researching the manual leaf determination for each combination of particle count and percent area of trash. These initial charts were refined to establish boundaries for each leaf grade. The charts for the three years showed a high level of agreement, and a final chart was constructed which reflected the most appropriate correlation based on the three years of data. Using this chart, it is possible to find an HVI leaf grade by determining where the particle count and percent area of trash readings for a sample intersect on the chart.

Beginning in the 2003 crop year, the Cotton Program began retrieving and saving particle count data from the HVI in its computer system in each classing offices. Even though the HVI system was measuring particle count before 2003, the classing office computer systems were not recording or maintaining the information. Particle count information was only available for the one percent of cotton samples from the classing offices retested in the QA office in Memphis. Currently, the Cotton Program retrieves the particle count data for analysis and studies but does not provide it as part of the official classification record.

Collecting and storing of particle count data in all classing offices has enabled the Cotton Program to test the HVI leaf chart against a large portion of the 2003 manual leaf grade data (Figure 2). The results show a correlation between manual and HVI leaf grades, and we believe the correlation will become stronger as analysis and more years of data becomes available.

All HVI quality measurements must be reproducible on another HVI before reaching acceptance into the USDA classing system. HVI leaf grade reproducibility is calculated by averaging the particle count data and percent area of trash taken from two QA instruments. The final QA HVI leaf grade results from these averaged measurements. This is the same method used to determine HVI color grade reproducibility. Applying this method to the 2003 data used in Figure 2 results in an overall HVI leaf grade reproducibility of 78%.

The calculation for reproducibility of classer leaf grade versus classer leaf grade is different from that of HVI versus HVI. The classing office classer has two opportunities to achieve reproducibility. First, a certified QA setup classer reviews the sample. If that classer's determination matches the original class, the sample is considered to have reproduced. If the two grades differ, then the sample goes to a QA final classer. If the classing office grade matches the final classer's grade, then the sample is considered to have reproduced. If not, the classing office determination is considered a miss. In order to provide a fair comparison between the HVI and manual class, the Cotton Program obtained HVI data for both single tests of HVI data from QA. For each HVI test, an HVI leaf grade was determined from the count and percent area values. If the classing office HVI leaf grade hit either of these two Quality Assurance HVI leaf grades, then the sample was considered to have reproduced. The results from these analyses are shown in Figure 3. The HVI reproducibility of 85.7% compares with 87% classer reproducibility

Benefits of an Instrument Measured Leaf Grade

There are several significant benefits derived from the implementation of an instrument measured leaf grade. One is a fixed measurement based on stringent setup procedures and monitoring programs. A properly maintained instrument would measure leaf grade the same regardless of where or when the measurements took place. Second, although the HVI sees a smaller part of the sample than in the manual classing system an instrument leaf grade would remove the subjectivity inherent in the current manual classing system. By relying solely on instrumentation, the leaf grade measurement would not be subject to possible human bias or interpretation. Third, is the potential reduction in staffing requirements needed for manual classification. Human classers would continue to be required for identifying extraneous matter until instrument technology is capable of performing that function but the overall training time needed for new classers would decrease.

Improving Classification of Extraneous Matter

Classification of any extraneous matter is subjective given the variety of ways in which extraneous matter can appear in cotton. Standards for any type of extraneous matter have not evolved because of the difficulty of creating consistent standards that represent all of the possible ways that a particular form of extraneous matter can appear in cotton. In March 1993, the Cotton Program developed and presented a pilot set of bark and grass standards to the United States cotton industry but did not receive approval for their use. At the Universal Cotton Standards Conference in 2002, the foreign signatory associations submitted a proposal to the USDA to create physical standards for bark and grass. The official proposal failed to acquire the necessary majority of the votes from the voting representatives at the Conference to reach approval. However, the U.S. textile manufacturers later issued a formal request to explore the possibility of creating extraneous matter standards. As a result, exploratory efforts are now underway to assess the feasibility of using digital imaging for both natural occurring and prepared cotton samples in order to accurately determine the precise content of bark and grass.

The hope is that high quality images of bark and grass samples will provide an objective classer guide. In conjunction with the images, written definitions are also being developed that will provide additional explanation in defining boundary levels.

In 2001, the Cotton Program used a similar approach for maintaining accuracy of leaf grade classing. A booklet was created and printed consisting of digital images representing the seven leaf grades. The manual classers utilized these booklets as a supplement to the Universal Grade Standards in making leaf grade determinations. The leaf guide images, located at each classer station, are a ready reference for classers when questions arise on which leaf grade is appropriate.

Conclusion

Although work is preliminary, the potential appears to be good for utilizing current HVI trashmeter technology for determining leaf grade. The Cotton Program will conduct additional studies using data derived from the 2004 and future crop years. If results continue to be positive, serious consideration will be given to reporting particle count and HVI leaf grade as part of the official classification record. The new measurements will of course be in addition to the currently reported classer leaf grade and HVI percent area of trash measurement. The objective for reporting both classer and HVI leaf grades is to demonstrate to the cotton industry the accuracy of the HVI determined leaf grade. This strategy parallels the previously transitioned transfer of classer color grade to HVI color grade. As was the case in color grade, once the cotton industry adopts the HVI-determined leaf grade as official, the classer- determined leaf grade would discontinue. The function of manually identifying extraneous matter would continue for the foreseeable future. Although research continues to identify bark and grass by instrumentation, developments in instrument identification of other forms of extraneous matter such as preparation, oil, and spindle twist are nonexistent. Therefore, efforts to improve extraneous matter classification will focus on developing classer tools such as digital images and improved extraneous matter definitions.

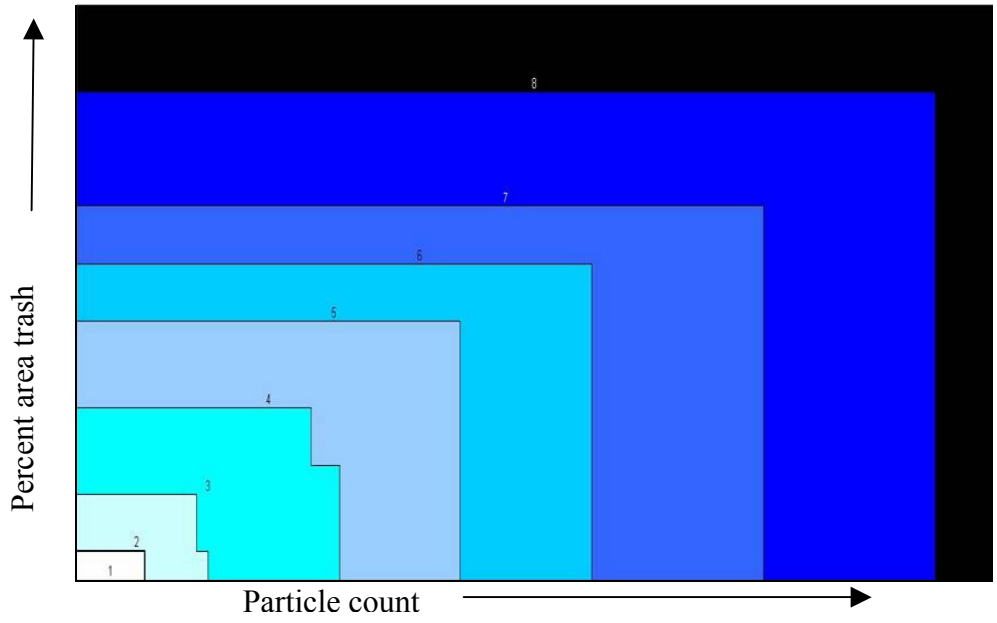

Figure 1. HVI Leaf Grade Chart

Figure 2. 2003 Crop Leaf Grade Distributions – HVI versus Classer

Leaf Grade	1	2	3	4	5	6	7	8
Percent of Crop (Classer leaf)	2.7%	12.3%	55.0%	27.5%	2.4%	0.1%	<0.1%	<0.1%
Percent of Crop (HVI leaf)	0.2%	8.8%	54.7%	34.3%	1.7%	0.1%	0.1%	<0.1%

(Data up to 11/20/2003)

Figure 3. HVI Leaf Grade Reproducibility – One of Two Method

Leaf Grade	1	2	3	4	5	6	7	8	All
Classing Office HVI	259	10,653	63,639	39,380	1,678	21	116	37	115,783
Number Reproduced	110	8,733	57,848	31,608	863	2	36	11	99,211
Percent Reproduced	42.5%	82.0%	90.9%	80.3%	51.4%	9.5%	31.0%	29.7%	85.7%

(Data up to 11/20/2003)