RESEARCH DIRECTIONS IN COTTON STRUCTURE AND QUALITY RESEARCH AT THE USDA SOUTHERN REGIONAL RESEARCH CENTER

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Abstract

The Cotton and Structure (CSQ) Research Unit is a core cotton research unit at the Southern Regional Research Center (SRRC). The mission of the CSQ is to develop and improve the methods for assessing quality and structural attributes of cotton fiber through all stages of production and processing. Specific research and areas of emphasis include the improved understanding of cotton fiber structural components; a more complete understanding of the relationship of water to cotton (to include moisture measurements) and its impact on fiber processing characteristics; determination of the ability to measure key cotton fiber-yarn-fabric properties; demonstration of the value of adding new quality measurements to better predict cotton processing efficiency and product quality (short fiber content, seed coat fragments, etc.); standards feasibility and development; and development of new quality assessment tools for cotton breeders. Cotton quality assessment and processing capabilities have increased sharply with the installation of new instrumentation and equipment in the areas of fiber-to-fabric physical properties, structure analyses, advanced spectroscopy, and modular/small scale processing. In addition, we have focused on strengthening and expanding our extensive network of collaborators.

Introduction

The U.S. cotton industry is a global industry, with over 60% of each year's crop exported overseas—primarily to China. Thus, U.S, cottons are increasingly competing against cotton varieties from other countries, and fiber quality and quality property assessments are becoming increasingly important. In order to successfully and fully compete in the international marketplace, the development of improved quality assessments—to include breeder analyses—and the development of improved, verifiable standards are key objectives of the industry so as to quickly and accurately indicate the true quality of U.S cottons. In addition to the development of improved quality measurements and assessments, fundamental research on "why" certain properties or conditions exist in different varieties and the structural mechanisms leading to the fiber's physical properties must be elucidated. The Agricultural Research Service's (ARS) Cotton Structure and Quality (CSQ) Research Unit of the Southern Regional Research Center (SRRC) is organized to address both the fundamental and applied components. This proceeding is an update on the 2009 research directions and focus for CSQ.

As noted previously (Rodgers, 2008), CSQ is one of three cotton-specific research units at SRRC, with the other two units being Cotton Chemistry and Utilization (CCU) and the new Cotton Fiber Bioscience (CFB). It is composed of the "Structure and Moisture as Determinants of Commercially Important Cotton Fiber Properties" CRIS (primarily fundamental research) and the "Improved Cotton Quality Measurements" CRIS (primarily applied research). The mission of the CSQ is to develop and improve the methods for assessing quality and structural attributes of cotton fiber through all stages of production and processing. Specific research areas include the improved understanding of cotton fiber structural components; a more complete understanding of the relationship of water to cotton and its impact on fiber processing characteristics; determination of the ability to measure and the desirability of measuring key cotton fiber-yarn-fabric properties; demonstration of the value of adding new quality measurements to better predict cotton processing efficiency and product quality; and development of new quality assessment tools for cotton breeders.

CSQ Research Direction and Focus—Present and Future

CSQ is task-oriented, with an emphasis on providing impact for the U.S. cotton industry. Emphasis is also placed on developing new and strengthening present collaboration (stakeholder meetings and technical visits/exchanges in the U. S. and internationally) and on technical support and service programs.

The objectives of the Structure and Moisture CRIS are as follows:

- Characterize how cotton from different cultivars and growth environments respond to moisture.

- Determine how moisture affects fiber structure and relate these changes to breakage.
- Determine the mechanisms of cotton fiber breakage with varying moisture content.

Present research projects include research on 1)structures and structure changes due to moisture and their relationship to fiber properties, 2)computational/structure analyses and mechanisms of fiber breakage, including influences of moisture (Figure 1), 3)correlate moisture properties with fiber physical properties and processing performance, 4)develop an improved reference fiber moisture measurement method (Figure 2), and 5)establish international relationships through technical exchanges and joint research programs.

The objectives of the Improved Quality Measurements CRIS are as follows:

- Demonstrate the utility of adding new fiber quality measurements.
- Develop new quality assessment tools for cotton breeders.

Present research projects include 1)a unified FQEL database to include production, testing, and processing for a diverse set of cottons, 2)develop fiber quality measurements to better predict processing efficiency and product quality (short fiber content/length, seed coat fragments, single fiber measurements, color, etc.; Figures 3-5), 3)develop quality assessment tools for cotton producers to aid in decision making, 4)develop new quality tools for field and at-line measurements, emphasizing new technologies (Figure 6), 5)quantify and determine the quality of U.S. cottons as compared to foreign cottons, 6)establish miniature (50 grams to 2 pounds of fiber) and small-scale textile processing, 7)develop international standards for key fiber measurements, and 8)strengthen the close relationship between the CQRS (Clemson, SC) and CSQ so as to fully utilize the strengths of both units.

In addition, significant improvements in analytical and instrument capabilities have been made in CSQ since 2004 in the areas of fiber physicals, structure analyses, advanced spectroscopy, fabric testing, and processing equipment. New equipment and instrumentation include:

FIBER PHYSICALS:

- USTER® HVI 1000 Fiber Tester
- USTER® AFIS-Pro Fiber Tester
- USTER® UT4 Yarn Tester
- USTER® Tensorapid 4
- Fiber Image Analysis System (FIAS)
- Favimat Automated Single Fiber Tester
- Automated White Speck Analysis System

STRUCTURE ANALYSES:

- Computer Cluster
- Microscope Software Upgrades

ADVANCED SPECTROSCOPY:

- Bruker FT-NIR (Bench-Top)
- Brimrose 5030 NIR (Portable)
- Varian UV/VIS
- Bruker FT-IR
- Bruker FT-IR/NIR Microscope
- Minolta And HunterLab Portable Color Units
- Color Upgrades

FABRIC TESTING:

- Wear/Abrasion Tester
- Burst Tester
- Fadometer/Weatherometer
- Launderometer

PROCESSING EQUIPMENT:

- Card
- Shirley Mini-Drawing
- Shirley Mini-Spinning
- CCI Weaving System

Summary

The Cotton Structure and Quality (CSQ) research unit (CSQ-ARS-USDA) a core cotton research unit at SRRC in New Orleans, LA, with both fundamental and applied research components. The mission of the CSQ is to develop and improve the methods for assessing quality and structural attributes of cotton fiber through all stages of production and processing. Cotton quality assessment and processing capabilities have increased sharply with the installation of new instrumentation and equipment in the areas of fiber physicals, structure analyses, advanced spectroscopy, fabric testing, and processing equipment. In addition, we have focused on strengthening and expanding our extensive network of collaborators.

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Disclaimer

The use of a company or product name is solely for the purpose of providing specific information and does not imply approval or recommendation by the United States Department of Agriculture to the exclusion of others.

Reference

Rodgers, J., Current and Future Directions in Cotton Structure and Quality Research at the USDA Southern Regional Research Center," 2008 Beltwide Cotton Conference, Nashville, TN, January 2008.

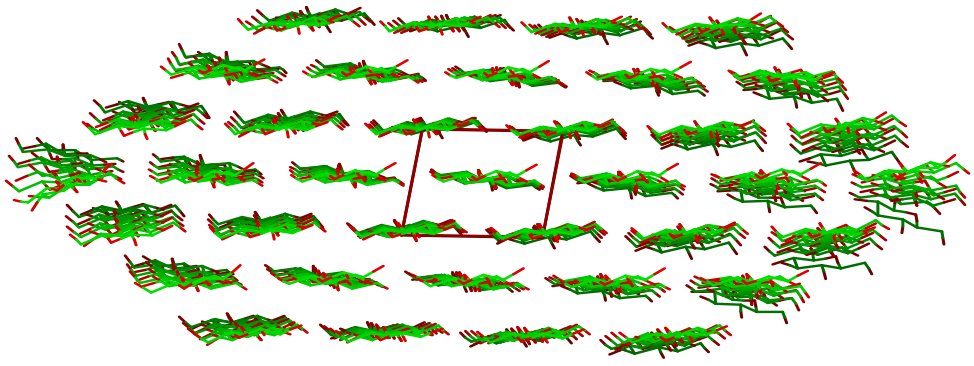

Figure 1. Example of Structure/Computational Analyses. Model of Cellulose Iβ Starting from Crystal Structure. (French)

Figure 2. Method Development for a Reference Moisture Measurement Method with the Karl Fischer Reagent (KFR) Analyzer. (Montalvo)

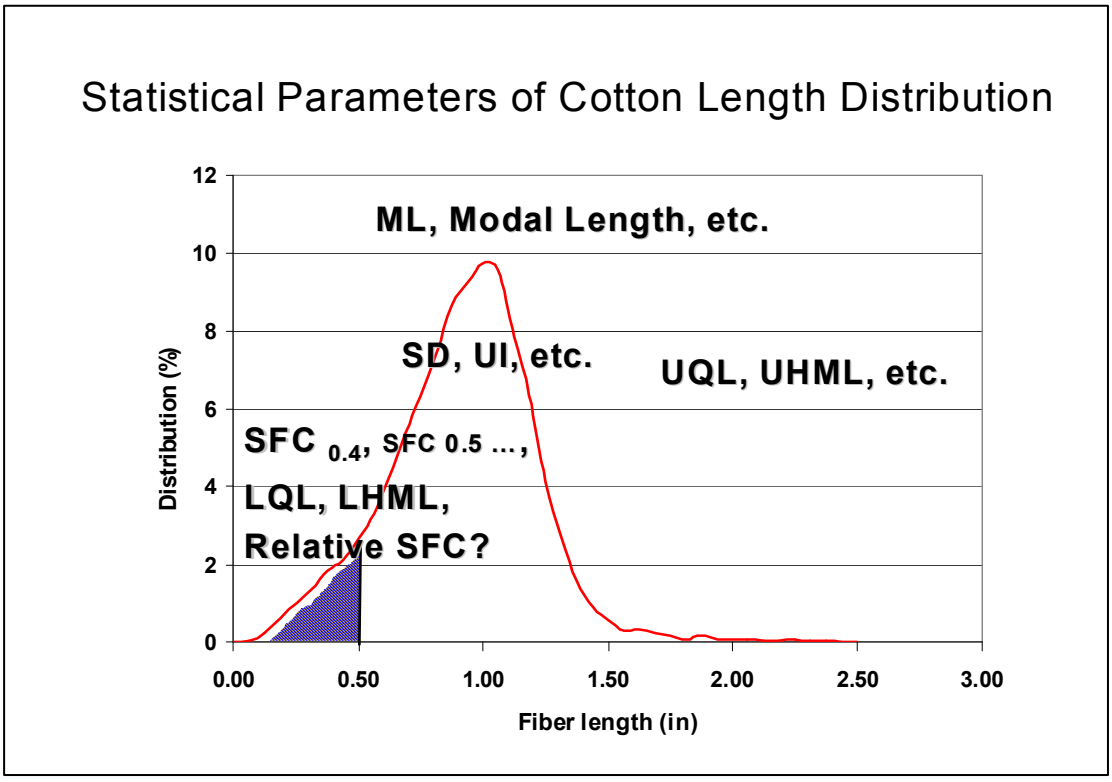

Figure 3. Method Development Parameters for Length Distributions, including Lower Half Mean Length (LHML). (Cui)

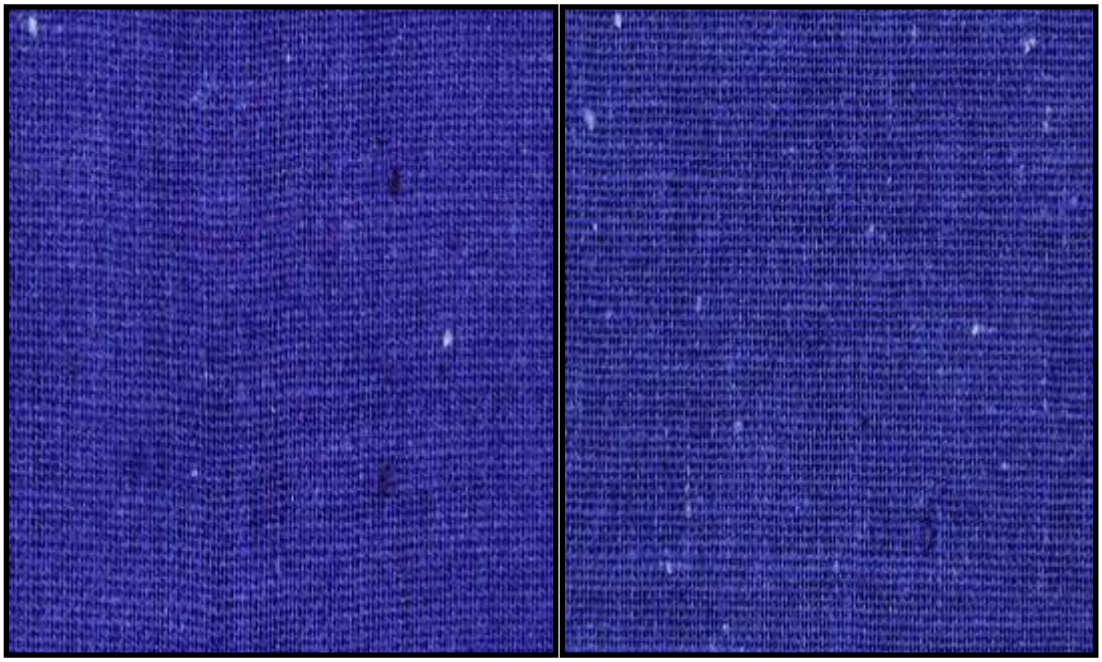

Figure 4. Image Analysis Method Development for White Specks. (Bel)

Figure 5. Favimat, Used for Single Filament Research and Method Development (Delhom)

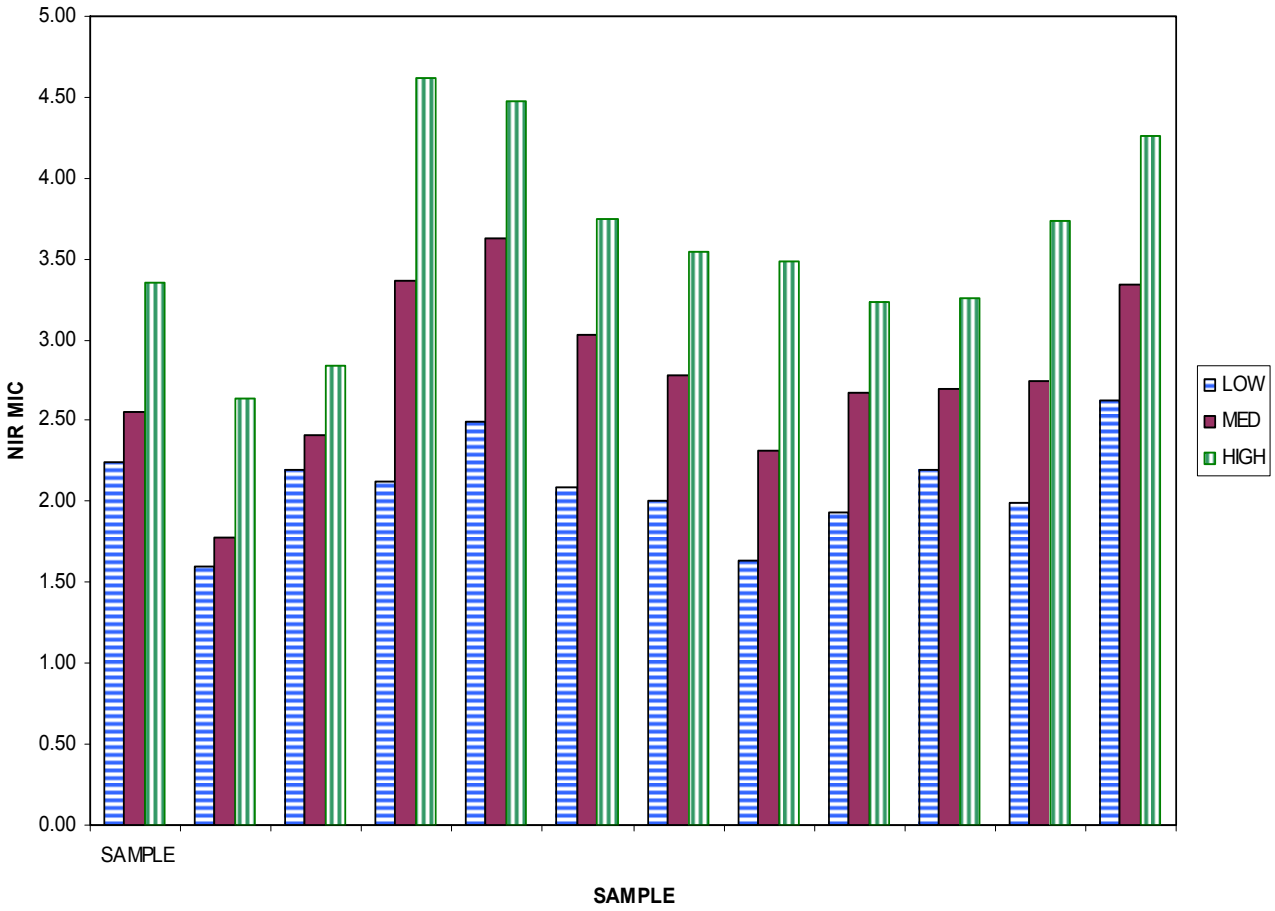

Figure 6. Micronaire Field Analyses of Cotton Fiber by Near Infrared (NIR) Spectroscopy. (Rodgers)