FIBER OF THE FUTURE

O. Lloyd May
Cotton Breeder
Delta and Pine Land Company
Tifton, GA USA
lloyd.may@deltaandpine.com
Anticipating the features of cotton fiber demanded in the future may be a strategy to maintain cotton’s market share in the global textile market. Countries with emerging supplies of fiber to sell in the global marketplace can follow suit in efforts to secure their share of the fiber supply, while navigating discrepancies between fiber valuations imposed by classification systems and fiber properties relevant to fiber processors. Delta and Pine Land Company can only speculate on the features of cotton fiber that will be desired in the future on the basis of trends in the U.S. fiber classification system, evolving fiber classification systems in other countries, plus technological advances that may refine ginning and conversion of fiber into yarn and textiles. Our company is diligently breeding varieties to meet the needs of Brazilian cotton producers and consumers while considering the unpredictable future of fiber. All of D&PL’s 11 breeding programs benefit from fiber testing at the earliest possible stage of development. Vertically integrated mills convert cotton into yarns for specific textile products, while sales yarn enterprises vend yarns to manufacturers that focus on textile products. Various end uses require different yarns and consequently demanded fiber properties. Denim, for example, utilizes coarser yarns compared with the much finer counts composing bed sheets. Relatively short staple length fiber spins well into the coarse count warp and weft yarns woven into denim, while the finer yarns woven into sheets or dress shirts generally require longer staple and finer fiber. An additional consideration is that cotton yarn may be spun with air-jet, ring, or rotor spinning technologies that are frequently portrayed as desiring somewhat disparate fiber property requirements to economically yield strong yarns with few defects. Appreciating the fiber property preferences of these yarn-manufacturing technologies and the yarns they construct can guide crop improvement and management strategies in addition to prioritizing fiber properties in classification systems. The properties of cotton that permit it to be spun into yarn can be broadly categorized as length of the longest fibers, analogous to staple length, length distribution, and strength of the fibers. Genetics determines the potential length of the longest fibers and the strength of fibers with environment and crop management interacting to ultimately establish length, strength, and their variability. Classical breeding, molecular breeding, and possibly transgenic approaches have roles to shape cotton’s fiber properties into the future. But, effects of classification systems and their fiber valuations that can be contradictory to the needs of fiber processors should not be overlooked as forces that could influence tomorrow’s cotton fiber. Beyond the slate of fiber properties currently measured by High Volume Instruments (frequently referred to by the initials HVI), methods to quantify fiber neps, short fiber content, stickiness, fineness, maturity, and non-lint content among others are under research, and may become additional measures of cotton’s monetary value if reliable and rapid methods of measuring such properties can be integrated into classification systems. Classification of cotton at the gin and real-time fiber property measurement at the gin to provide process control are under discussion and may refine fiber preparation to result in cleaner cotton while preserving as much of the fiber quality as possible. These speculations concerning changes to the classification of cotton could segregate the cotton market further into fiber meeting the generally less stringent requirements for coarse count, open-end spun yarns in contrast to demand for longer staple fiber amenable for construction of fine count yarns. Despite the inevitable evolution of cotton classification and the needs of fiber producers and processors, Delta and Pine Land Company stands ready to supply seed of cotton varieties that meet such diverse requirements.
INTRODUCTION

Predicting cotton’s future use as a textile fiber and the requisite fiber properties cannot be performed with certainty by Delta and Pine Land Company, but proposed updates to the U.S. cotton classification system, the evolution of similar classification systems in Australia, Brazil, China, and Uzbekistan among others, plus current market signals provide insight. This insight is utilized in D&PL’s 11 breeding programs and subsequent testing and development. Expansion of the capability of instrument classification to provide measures of fiber length distribution and non-lint content, among other properties are under investigation by fiber technologists and instrument manufacturers alike. The fruition of such changes along with the possibility of worldwide instrument classing of cotton within 10-years potentially heralds increasingly stringent demands for fiber quality. A key challenge will be to have consistency among fiber classification systems of major cotton producing countries lest discrepancies impose non-uniform market acceptance. Plus, as yarn spinning technologies and capacities change over time, processor demand for certain fiber properties may steer variety development and production systems towards those needs. This paper summarizes a number of forces at work in the cotton industry and speculates as to their impact on shaping fiber quality.

EVENTS THAT MAY SHAPE COTTON FIBER

More Comprehensive Fiber Classification

Of all commodities, cotton likely has the most complex requirements for its production and end uses, while competing against man-made fibers that process more economically than cotton is generally capable of. The uniformity of man-made fibers such as polyester makes them simpler and frequently less expensive to construct into yarn and subsequently textiles compared with cotton, thus cotton’s future share of the textile fiber market seems contingent on continually enhancing its processing characteristics and comprehensively conveying the fiber quality of each bale to merchants and yarn manufacturers (Townsend, 2005).

The U.S. cotton classification system in which the USDA Agricultural Marketing Service conducts High Volume Instrument (HVI) testing of nearly every bale has been the global standard for valuing cotton since implementation in 1991 (Knowlton, 2005). The ongoing success of this effort is in part derived from USDA’s meticulous HVI instrument calibration and quality assurance procedures combined with sponsoring cooperative fiber property measurement research at textile technology laboratories operated by the International Textile Center in Lubbock, TX; USDA; CIRAD; CSIRO; the Faserinstitut in Bremen, Germany, among others. On-time delivery, a uniform size and weight bale, plus electronic access to each bale’s fiber properties has facilitated U.S. cotton commerce and the necessary assembly of bale lay-downs in the textile mill. Building on this success, the U.S. cotton classification system took a step towards complete instrument classing when it adopted HVI measurement as the official standard for determination of color grade in 2000, replacing the manual comparison of fiber samples with color standards (Earnest, 2000). Further transition of U.S. cotton classification towards total instrument evaluation may replace fiber leaf grade and extraneous matter, the last manually evaluated fiber properties in the official classification system, with quantitative estimates (Earnest, 2005). Efforts to refine the somewhat subjective manually determined leaf grade into a measure of non-lint content by
HVI or other instrument are under research, but are likely some years away from implementation (Grantham, 2005). According to the USDA, bark and grass are typically the non-lint contaminants in the small portion of U.S. bales so affected, but since official standards are not defined and accepted by the U.S. cotton industry, visual determination of extraneous matter may remain the standard for some years. Ultimately, integration of these measures into classification may provide the market incentives to produce cleaner fiber with less extraneous matter.

Short fiber content is artificially defined as the percent of fibers by weight or number with length less than 12.7 mm (½ inch). Such fibers are a source of waste to the processor and those that escape removal during pre-spinning operations can reduce yarn quality and strength, thus mitigation of short fibers is of keen interest to yarn manufacturers. A suitably rapid and accepted instrument measure of short fiber content has yet to be developed and accepted into cotton classification (Steadman, 1997). The USDA Agricultural Marketing Service continues research to calculate short fiber content with fiber length data available from HVI (Earnest, 2005). Similarly, instrument manufacturers are working to invent reliable means of measuring short fiber content (Riley, 2005; Shofner, 2005), but the suitability of these approaches for cotton classification remains to be determined. It seems reasonable to predict that cotton classifications may some day be expanded to include short fiber content measurement, providing further impetus to enhance fiber quality. Since the cotton variety itself is said to contribute the least to the short fiber content in a bale of cotton, the incentive may develop to implement ginning approaches that minimize fiber breakage.

Globally Standardized Instrument Classification

Initial steps to encourage global standardization in instrument classing began in December of 2003 when the International Cotton Advisory Committee established a panel to pursue such efforts (Townsend, 2005). Several hurdles exist to implement a globally uniform classification system, including establishing instrument calibration and check procedures as rigorous as those currently practiced in the U.S. by the USDA, plus uniformity in model and software of HVI instruments (Knowlton, 2005). While one can only speculate, standardized global classification appears many years from fruition, but one effect could be to reduce the influence of geographical origin as a subjective means of classification.

Progress in Spinning Capacity and Technologies

Cotton in the U.S. is spun into yarn mostly by open-end technologies (about 40%), followed closely by ring spinning (about 33%), while air-jet manufactures cotton and polyester blended yarns accounting for around 24% of domestic spinning capacity (Felker, 2001). Outside the U.S., the figures vary by country, but ring spinning is often the dominant means of manufacturing 100% cotton yarns in developing countries. The relevance of these statistics lies in the fiber properties preferred by the various spinning technologies and how changes in spinning technologies could drive the fiber market. Ring spinning is said to value staple length, followed by fiber strength, and then fineness. Rotor spinning prioritizes fiber strength, followed by fineness, and then staple length, while air-jet systems prefer staple length, then fineness, and lastly strength (Deussen, 1992). The interested reader is referred to Deussen (1992) and Steadman (1997) for details of why such fiber property preferences exist.
Of the three technologies, rotor spinning can successfully convert relatively short staple fiber into coarser count yarns that have application in bath towels and denim-type fabrics. Hence, priorities for enhanced fiber quality for coarse count spinners might entail less short fiber and non-lint content, but not necessarily longer staple length.

An alternative fiber conversion technology receiving attention recently is called compact spinning. The Suessen Elite® compact spinning process is said to be capable of greater productivity compared with the conventional ring spinning frames it has been tested against, while resulting in the same yarn strength and quality (Clapp, 2001). Plus, compact spinning may be less sensitive to variation in fiber length (Krifa and Hequet, 2003). Penetration of this spinning technology seemingly more tolerant of fiber length variation could assist cotton’s competition with man made fibers.

**Fiber Testing at the Gin**

Measuring key cotton fiber properties in a nearly real time manner at the gin seems far-fetched at first thought, but is not beyond the realm of possibilities following recent advances in software and instruments. Coupled with the capability to adjust gin machinery and moisture or temperature conditions as needed, such could further preserve the fiber quality of the variety and render cotton better able to compete with polyester.

Ghorashi (2004) discusses the challenges and potential rewards of on-line fiber testing. Among the challenges for which solutions are under research include repeatability of fiber strength and length measurements, known to be sensitive to fiber moisture content, in the variable environmental conditions present in a gin, how frequently should the fiber stream be sampled and fiber properties measured, plus how to maintain instrument calibration without impacting the ginning progress. Ghorashi (2004) highlights potential benefits beyond the obvious adjustment of ginning and environmental parameters to preserve fiber quality. On-line fiber testing could indicate the variability in fiber properties in bales, becoming another element of cotton classification. Knowledge of the variation in fiber properties could permit the fiber consumer to choose and blend bales in ways that mitigate the effects of fiber variation on yarn strength, quality, and dye retention.

**Innovations In Ginning**

The U.S. cotton industry is blessed by the contributions of cotton ginning research laboratories operated by the USDA and located in Lubbock, TX; Mesilla Park, NM; and Stoneville, MS. Technologies and gin equipment invented in these labs over the years helps growers reap higher profits and bring the fiber quality in the field to the merchant and mill. A prime illustration is provided by Anthony (2005), who reported that his recently invented lint cleaner, when compared with the industry standard lint cleaner, resulted in less fiber waste and thus higher producer returns, without adverse effects on fiber quality.

**Marketplace Signals**

Demand for longer staple length fiber in portions of the U.S. fiber supply has been evident in recent year definitions of the U.S. Commodity Credit Corporation loan schedule (Table 1). In this illustration, point
loss or gains per pound of lint for three common color grades and staple lengths from 33-37 are arrayed in side-by-side comparisons between 2003 and 2004. These data show that recent markets have rewarded portions of the U.S. cotton crop with the longest fiber length. We cannot speculate on the duration of similar market conditions, but present such data to illustrate the effects cotton classification could have on shaping cotton fiber quality.

**SUMMARY**

Since the development of polyester and other man-made fibers introduced competition to natural fibers like cotton, history has shown that cotton’s share of the textile market is in part sensitive to its perceived processing merits. Instrument manufacturers are working to invent acceptable means of measuring fiber properties not currently elements of cotton classification but that impact success and profitability of yarn manufacture. Advances in software, data collection, and calibration methods may permit real time fiber property measurement at the gin, while adoption of innovations in seed cotton and fiber cleaning at the gin appear capable of bolstering grower profits and preserving fiber quality. Finally, while the technologies and fiber preferences that will convert fiber into textiles in the future cannot be predicted with certainty, demand for longer, stronger, cleaner, and possibly finer fiber exhibiting less variance in fiber properties may be among the critical elements of the cotton fiber of the future.
Table 1. 2004-2005 Commodity Credit Corporation point valuation of cotton staple length for leaf grades 1 and 2 and three common color grades†.

<table>
<thead>
<tr>
<th>Color Grade</th>
<th>33</th>
<th>34</th>
<th>35</th>
<th>36</th>
<th>37+</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 &amp; 21</td>
<td>-70</td>
<td>35</td>
<td>230</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>31</td>
<td>-90</td>
<td>10</td>
<td>180</td>
<td>235</td>
<td>355</td>
</tr>
<tr>
<td>41</td>
<td>-165</td>
<td>-115</td>
<td>70</td>
<td>90</td>
<td>200</td>
</tr>
</tbody>
</table>

†Source – USDA Agricultural Marketing Service (www.ams.usda.gov/cotton/).
REFERENCES


