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PHYSICAL DESCRIPTION OF RAW COTTON FIBERS: MARKET DEVELOPMENT ISSUES AND IMPLICATIONS FOR THE 1980'S*

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ABSTRACT: Recent historical developments which profoundly affect cotton marketing are considered. These include major technological changes in textile machinery, the re-emergence of the U.S. textile industry as a competitive force in world markets, and significant growth in export markets for raw cotton. Impacts of these developments on raw cotton fiber demand are discussed, with emphasis on implications for more specific requirements of cotton fiber properties. Potential importance of increased physical description of cotton fibers to the futher development of markets is explored. Basic issues include usefulness of additional information, how to best provide it to the market system, and how to foster its use for the greatest benefit to the cotton industry.

KEYWORDS: Cotton Marketing, Technological Change, Textile Industry, Fiber Properties, Market Development

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INTRODUCTION

The decade of the 1980's promises to be an eventful one for the cotton industry. Cumulative influences for change have gathered momentum during the 1970's which may require wide-ranging adjustments by cotton production and marketing sectors.

This paper consists of four major sections. The first section summarizes three recent historical developments in order to identify sources of mounting pressure on the cotton industry to deliver fibers with increasingly specific (and predictable) characteristics. This is followed by a brief elaboration on why the textile manufacturing industry must be a focal point for cotton market development in the years ahead. In the third section some major marketing problems resulting from uncertain fiber properties are explained, followed by an examination of issues concerning (a) the usefulness of additional information on fiber properties and (b) the feasibility of providing such information with necessary speed and accuracy. The paper concludes with a discussion about how to implement changes for the greatest net benefit to the cotton industry.

MAJOR DEVELOPMENTS DURING THE 1970'S

Three major developments affecting the U.S. cotton industry on the threshold of the 1980's are: a) significant growth in export markets for raw cotton, b) dramatic and world-wide technological changes in textile machinery, and c) the emergence of U.S. textile manufacturers as a competitive force in world markets. Each of these is considered in this section.

Growth in Export Markets

Exports of cotton rose to an unusually high level of 9.2 million bales in the 1979-80 crop year. Historically, the 1978-79 year had already been a very good one, with exports of 6.2 million bales (Table 1). Furthermore, raw cotton exports exhibited a definite upward trend throughout the 1970's. Average annual exports were 4.5 million bales per year during the first half of the decade (1970-71 through 1974-75) compared with 5.8 million bales per year during the last half (1975-76 through 1979-80).

Unfortunately, growth in export sales of raw cotton during the 1970's was accompanied by a definite downward trend in domestic consumption of cotton by textile mills

Table 1. U.S. Exports versus Mill Consumption of Raw Cotton, 1970-71 to 1980-81.

Year Beginning August	Exports	Domestic Mill Consumption	Ratio of Exports to Mill Consumption
	-----million bales[1]-----		percent
1970-71	3.9	8.2	47.6
1971-72	3.4	8.3	41.0
1972-73	5.3	7.8	67.9
1973-74	6.1	7.5	81.3
1974-75	3.9	5.8	67.2
1975-76	3.3	7.2	45.8
1976-77	4.8	6.7	71.6
1977-78	5.5	6.5	84.6
1978-79	6.2	6.4	96.9
1979-80[2]	9.2	6.5	141.5
1980-81[3]	5.7	5.9	96.6

1/ 480-pound net weight bales.

2/ Estimated.

3/ Projected.

SOURCES: [23, p. 19; 24, pp. 24 and 37; 25, p. 4]

Table 2. Indexes of U.S. Exports and Mill Consumption of Raw Cotton, 1970-71 to 1980-81[1/].

Year Beginning August	Exports	Domestic Mill Consumption
	percent	
1970-71	97.5	124.8
1971-72	85.0	126.4
1972-73	132.5	118.8
1973-74	152.5	114.2
1974-75	97.5	88.3
1975-76	82.5	109.6
1976-77	120.0	102.0
1977-78	137.5	99.0
1978-79	155.0	97.5
1979-80	230.0	99.0
1980-81[2/]	142.5	89.8

[1/]Base period is 1974-75 through 1976-77.

[2/]Projected.

SOURCE: See Table 1.

(Table 1). Consumption of U.S. cotton by domestic mills has historically been above exports; however, total exports of raw cotton during the last four years (1976-77 through 1979-80) were approximately equal to total U.S. mill consumption over the same period. As a percentage of U.S. mill consumption, cotton exports went from 47.6% in 1970-71 to 71.6% in 1976-77 to 141.5% in 1979-80 (Table 1). Using crop years 1974-75 through 1976-77 as a base period and expressing both cotton exports and domestic mill consumption as an index reveals that (Table 2): a) the index of exports started the 1970's at 97.5 and ended the decade at 230.0, an increase of 132.5 percentage points, while b) the index of U.S. mill consumption began at 124.8 and ended at 99.0, a decrease of 25.8 percentage points. Clearly, the U.S. cotton industry enters the 1980's with a strong vested interest in world markets.

During the 1980-81 crop year domestic mill consumption is projected to decline to about 5.9 million bales while exports fall to about 5.7 million bales (Table 1). If this occurs, the index of domestic mill consumption will fall 9.2 percentage points from the 1979-80 level, to 89.8, and the index of exports will plummet 87.5 points to 142.5 (Table 2). The primary reason for these large decreases is that U.S. cotton production is expected to decline by 3.5 million bales from the 1979-80 level, while production in the rest of the world is expected to increase 3.0 million bales (Table 3). The resulting high prices in the U.S.: a) will certainly result in significantly smaller exports and b) may actually cause a historically high level of cotton imports from other countries. The 1980-81 marketing year may provide an object lesson about the necessity of remaining competitive with world price levels for cotton.

Much of the dynamic export market is attributable in recent years to the developing and centrally planned countries of the world, especially China and other Asian countries. Growth in markets of the industrialized countries has been important but unspectuacular. In several industrialized countries, market penetration by man-made fibers (mainly polyester, nylon and acrylic) has advanced to the point that they dominate the market. Cotton is often declining not only in market share, but also in actual quantity consumed. Clearly the potential also exists for man-made fibers to grow in dominance in many developing countries [14]. If the U.S. cotton industry is going to gain and hold a larger portion of these valuable markets, decisive market development efforts will have to occur during the 1980's.

Technological Change in Textile Machinery

The technology of spinning and weaving has advanced

Table 3. Production of Cotton in U.S. and Rest of World, 1970-71 to 1980-81.

Year Beginning August	United States	Rest of World	TOTAL
	------------million bales[1/]	---------	
1970-71	10.2	42.0	52.2
1971-72	10.5	46.6	57.1
1972-73	13.7	47.8	61.5
1973-74	13.0	49.1	62.1
1974-75	11.5	51.7	63.2
1975-76	8.3	45.6	53.9
1976-77	10.6	46.8	57.4
1977-78	14.4	49.1	63.5
1978-79	10.9	49.3	60.2
1979-80	14.6	51.1	65.7
1980-81[2/]	11.1	54.1	65.2

[1/] 480-pound net weight bales.

[2/] Projected.

SOURCES: [23, p. 18; 24, p. 71; 25, p. 17; 25, p. 40]

so dramatically during the decade of the 1970's that people not directly associated with textile manufacturing may not grasp the "revolution" that has begun and will continue through the 1980's. Much of the innovation and production of new textile machinery has occurred in Switzerland, Czechoslavakia, Japan, Italy and West Germany. General adoption of the new machinery did not really get underway in the U.S. until the mid 1970's, several years behind competing European and Asian countries. Results of the adoption of the new technology have been rapid increases in productivity and rapid delines in man-hours required to produce a given quantity of yarn or fabric [8].

The new technology is, however, putting increased demands on fibers which will be important during this decade. For example, the much faster speeds of spinning and weaving machines increase the likelihood of yarn breakage and unsightly neps. Therefore, the new generation of textile mills generally has less tolerance for fibers that are weak or immature. Also, the high degree of automation in modern textile mills is reducing the number of operations performed on the fiber and the number of stages at which the fiber is handled. In particular, the opening, cleaning and picking operations have been shortened or eliminated. This greatly reduces the opportunity to get a somewhat random blending of many bales of cotton, with the result that the ability to tolerate cotton with a high variability in its fiber characteristics is greatly reduced. The implications are serious not only for all-cotton yarns, but to the various blend-yarns of cotton with man-made fibers. The man-made fibers generally have fairly uniform, predictable characteristics, which encourages many modern textile mills to emphasize 100 percent man-made fibers.

Of singular importance in textile technology during the 1970's was the emergence of the open-end spinning machine. It represents a drastically different technique of spinning fiber staple into yarn than is used in ring spinning, which has dominated in the U.S. textile industry for over a hundred years.

The first commercial open-end spinning plant in the world began operation in 1967 [10, p. 19]. During the 1970's, open-end spinning became recognized as advantageous in the production of coarser yarns spun from cotton, e.g., in denim, corduroy and industrial flannels. The extent to which open-end spinning will be used for finer yarns and with man-made fibers depends on refinements in the technology and improvements in operating techniques [1,5].

As we enter the 1980's, open-end spinning is beyond the "infant" stage. The Japanese textile industry has already invested heavily in open-end spinning. Research conducted in 1979 by a Swiss research institute concluded that: a) the first half of the decade of the 1980's would be a period of large sales of spinning machines to U.S. mills for replacement of old machines and b) the majority of replacement purchases would be open-end spinning machines [6].

The implications of open-end spinning for fiber requirements and specifications are potentially far-reaching. Available evidence suggests that the <u>relative</u> importance of various fiber properties are somewhat altered for open-end spinning versus ring spinning, e.g., Fiber fineness is more important for efficient open-end spinning, non-lint content is more detrimental to open-end spinning, fiber length is less important while length <u>uniformity</u> is more important, etc. [12,17]. It appears quite possible that open-end spinning may be more advantageous to cotton fibers (relative to man-made fibers) than is ring spinning. In any case, it behooves the cotton industry to explore how it may best accommodate this new technology.

<u>Emergence of a Competitive Textile Industry</u>

During the decade of the 1970's, the U.S. textile industry spent well over $1 billion for new plants and equipment. This rate of investment is likely to continue during much of the 1980's [6,8]. One result has been that an industry, which for many years had been retreating in front of increased imports of lower-cost foreign textile products, has reasserted itself in world-wide competition.

Over the past decade, the raw fiber equivalent of U.S. exports of textile manufactures grew from 353.7 million pounds in 1970 to 1,091.1 million pounds in 1979 (Table 4), an increase of over 200 percent. Meanwhile, imports grew from 909.1 million pounds to 1,380.6 million pounds (Table 5), an increase of only about 50%. The resulting trade balance changed from a deficit of 555.4 million pounds in 1970 to a deficit of 290.5 million pounds in 1979, an improvement of almost 265 million pounds (Table 6). If the pace of exports and imports during the first nine months of 1980 continues throughout the year, then the trade deficit would be reduced almost 100 million more pounds from the 1979 level, to 191.7 million pounds (Tables 4, 5, and 6). Clearly the U.S. textile industry will be an important participant in world markets during the 1980's.

While the general condition of U.S. textile manufacturing is improving, a closer examination of the data gives reason for the U.S. cotton industry to be concerned. The trade balance for cotton textiles has not improved over the decade of the 1970's and it is not expected to improve during the 1980 calendar year (Table 6).

Table 4. Raw Fiber Equivalent of U.S. Exports of Textile Manufactures, 1970-1980.

Calendar Year	Cotton	Wool	Man-Made	Total
	-----------million pounds-------------------			
1970	199.2	7.4	147.1	353.7
1971	226.3	12.0	146.7	385.0
1972	290.4	33.3	177.6	501.3
1973	325.2	33.4	288.2	646.8
1974	392.5	26.0	390.7	809.2
1975	353.7	21.4	322.4	697.5
1976	413.2	15.1	352.2	780.5
1977	369.5	13.0	367.6	750.1
1978	355.7	12.6	441.7	810.0
1979	477.9	15.6	596.6	1,090.1
1980 1/	541.6	24.8	755.2	1,321.6

1/ Projected annual exports based on first nine months of 1980.

SOURCES: [16, p. 203; 24, p. 39; 25, p. 10; 26, p. 24]

Table 5. Raw Fiber Equivalent of U.S. Imports of Textile Manufactures, 1970-1980.

Calendar Year	Cotton	Wool	Man-Made	Total
		-----------million pounds------------------		
1970	463.2	111.6	329.3	909.1
1971	492.6	89.7	451.1	1,033.4
1972	610.7	95.4	480.5	1,186.6
1973	563.5	90.0	465.3	1,118.8
1974	502.7	74.2	371.3	948.2
1975	501.3	68.4	400.4	970.1
1976	708.6	98.6	479.5	1,286.7
1977	669.4	116.6	531.1	1,317.1
1978	845.4	129.4	642.6	1,617.4
1979	746.1	109.5	525.0	1,380.6
1980[1/]	849.9	108.9	554.5	1,513.3

[1/] Projected annual imports based on first nine months of 1980.

SOURCES: [16, p. 203; 24, p. 39; 25, p. 10; 26, p. 240

Table 6. U.S. Trade Balance in Textile Manufactures, by Fiber, 1970-1980.

Calendar Year	Cotton	Wool	Man-Made	Total
	-----------	million pounds	-----------	
1970	-264.0	-109.2	-182.2	-555.4
1971	-266.3	-77.7	-304.4	-648.4
1972	-320.3	-62.1	-302.9	-685.3
1973	-238.3	-56.6	-177.1	-472.0
1974	-110.2	-48.3	19.5	-139.0
1975	-147.6	-47.0	-78.0	-272.6
1976	-205.5	-83.5	-127.3	-506.2
1977	-299.9	-103.6	-164.1	-567.6
1978	-489.7	-116.8	-200.9	-807.4
1979	-266.1	-94.0	71.6	-290.5
1980 1/	-308.3	-84.1	200.7	-191.7

1/ Projected annual trade balances based on first nine months months of 1980.

SOURCES: [16, p. 203; 24, p. 39; 25, p. 10; 26, p. 24]

Therefore, the chief beneficiary of the invigorated U.S. textile industry has clearly been the man-made fibers. The trade balance in textile manufactures from man-made fibers was a surplus in 1979 and is expected to grow even faster in 1980 (Table 6).

The U.S. has long been the largest single producer of man-made fibers and yarns, and its proportion of total world production has been maintained throughout the previous decade. Thus, in 1970 the U.S. produced over 3.3 billion pounds of man-made filament yarns and staple fibers while the rest of the world produced about 7.8 billion pounds (Table 7). This gave the U.S. about 30 percent of total world production. By 1979, U.S. production had grown to almost 7.7 billion pounds and the rest of the world's production had grown to about 15.7 billion pounds, giving the U.S. about 32 percent of total world production (Table 7). Production capacity is currently being expanded at rapid rates in all parts of the world [16, p. 117]. Since the supply of man-made fibers is largely a function of installed capacity, the competitive pressure from them will likely be maintained during the 1980's.

It was noted earlier that consumption of cotton by U.S. textile mills trended downward throughout the previous decade (Table 1). The implication is that growth in

Table 7. Production of Man-Made Filament Yarns and Staple Fibers in U.S. and Rest of World, 1970-1979.

Calendar Year	United States	Rest of World	Total
	-------------million pounds	--------------	
1970	3,326.6	7,764.0	11,090.6
1971	3,974.3	9,282.4	13,256.7
1972	4,943.4	9,097.6	14,041.0
1973	5,822.5	11,019.5	16,842.0
1974	5,697.7	10,807.5	16,505.2
1975	5,390.8	10,818.8	16,209.6
1976	6,053.3	12,090.4	13,962.7
1977	6,695.8	13,474.9	20,170.7
1978	7,094.3	15,025.3	22.119.6
1979	7,680.4	15,719.0	23,399.4

SOURCES: [16, pp. 108-110; 25, p. 93; 26, p. 261] mill production has been achieved by using man-made fibers. Cotton comprised 39.5 percent of total U.S. mill consumption in 1970 and man-made fibers accounted for 57.6 percent, leaving about 2.9 percent for wool. By 1979, cotton's share had dropped to 24.2 percent and wool's share to 1.1 percent, while the share of man-made fibers had risen 74.7 percent. (Table 8). It is no wonder that the cotton industry has become increasingly dependent on foreign purchases of U.S. cotton.

The demonstrated inclination of U.S. textile firms to use man-made fibers becomes more troublesome to the cotton industry as they become a more dominant force in world markets. Penetration of foreign markets by U.S. textiles will tend to promote and develop the markets for man-made versus cotton products. This will in turn tend to undermine the demand for raw cotton by foreign textile mills competing to supply these markets, thereby making exportation of raw cotton more difficult. Clearly an acceptable way of changing this scenario is not to prevent effective competition by the U.S. textile industry, but to help the industry improve its ability and motivation to utilize cotton as a raw material.

Table 8. U.S. Mill Consumption of Fibers on a Percentage Basis, 1970-1979.

Calendar Year	Cotton	Wool	Man-Made
	----------------percent----------------		
1970	39.5	2.9	57.6
1971	37.0	2.1	60.9
1972	33.0	2.1	64.9
1973	29.2	1.5	69.3
1974	29.7	1.1	69.2
1975	28.9	1.2	69.9
1976	29.2	1.3	69.5
1977	26.0	1.1	72.9
1978	24.5	1.1	74.4
1979	24.2	1.1	74.7

SOURCE: [16, p. 28]

FOCUSING ON TEXTILE MANUFACTURING

The foregoing discussion of major developments affecting the U.S. cotton industry implies that the future success of cotton is fundamentally dependent upon a more successful competition with man-made fibers. A premise of this paper is that the textile manufacturing sector is the major focal point for such competition. Three basic reasons for this are [14, p. 212]:

(1) Although ultimate guidance of the demand for textile products comes from consumers, the fact is that there are relatively few instances in which the advantages of one fiber over another are obvious and decisive in consumers' minds.

(2) It is primarily textile manufacturers that must confront the complex of demand parameters -- including price, appearance, comfort, durability, ease of maintenance, etc. -- and select the raw materials with which to satisfy the demand. Furthermore, they commonly influence consumers with fashion promotions, advertising, pricing policies, etc.

(3) Except where considerations such as safety, fashion, function, or government policies are dominant enough to dictate which fiber to use, textile manufactures' choices will be based on the relative costs, efficiences and risks involved in processing the raw fibers.

In competitive textile markets, even small differences in such matters may be important enough at the margin to determine which fiber is emphasized.

There are apparently three major reasons for the continuing erosion of cotton's share in textile mill operations [15]:

(1) Unpredictability of processing performance and end-product quality relative to alternative manmade fibers.

(2) Unpredictability of annual cotton production levels, with the attendant price instability.

(3) Environmental concerns relating to lung impairment of textile mill employees who breathe air containing "cotton dust" particles.

The latter two reasons above probably benefit more from awareness by the cotton industry than does the first. Certainly the health threat from cotton dust is generally recognized as a very critical problem facing the cotton industry. Necessary actions to reduce the health risk to an acceptable level are not yet known, but they will certainly result in increased costs of producing and/or processing cotton.

Variable annual supplies of cotton became a serious problem during the 1970's, resulting in part from the discontinuation of high price supports by government. But variations in yields per acre are also a major cause of variations in total production. Thus, the lower production in the 1980-81 crop year resulted from drought-related reductions in per-acre yields. The unpredictable production has resulted in variable and unpredictable prices for cotton, both from one year to another and within a marketing year [11]. The large textile manufacturers, like the retail clothing firms they supply, do their economic planning six to eighteen months ahead. Therefore, price and supply stability are very desirable attributes from their viewpoint.

The man-made fibers are not presently known to constitute a health hazzard to textile workers. Neither is supply and price stability a serious problem since the typically large-scale fiber and filament yarn manufacturers are able to guarantee both quantities and prices several months in advnace. Furthermore, the occasionally expressed hope that rising oil and energy prices will make synthetics significantly more expensive than cotton does not seem probable during the current decade. Although the synthetic fibers are directly affected by high oil prices, current production systems in the U.S. (using fertilizers, insecticides, defoliants, irrigation, etc.) are also going to be adversely affected. And the synthetic fiber manfuacturers generally have been able to use technological advances in their operations to improve productivity, whereas per-acre cotton yields in the U.S. have not changed much over the past decade [14, p. 214].

While the problems of unpredictable production levels and environmental concerns are of great importance, the emphasis of this paper is on the first of the three problems: unpredictability of processing performance and end-product quality. The potential for improved fiber description to alleviate this problem will now be considered.

THE CASE FOR IMPROVED PHYSICAL DESCRIPTION OF COTTON FIBERS

Most textile manufacturers consider cotton to be just one of the alternative industrial fibers available for consideration. However, unlike the man-made fibers, cotton is produced by a living organism so that it inevitably exhibits biological variations caused by both genetic and environmental factors. These factors can be manipulated only within narrow limits and over a period of perhaps many years.

Man-made staple fibers are usually classified by staple length (which is typically quite uniform), fineness (weight per unit length), luster, presence or absence of crimp, cross-sectional configuration, and perhaps other properties deemed important by the manufacturer. Any specific array of properties put into the fiber may be given a "type" designation. Also, a particular production lot, whose properties should be identical throughout, is given a specific "merge number" [7, p.9]. All this information is made available to textile firms, often with technical advice on how to use it to achieve best results in spinning, weaving and finishing operations.

Cotton is produced on thousands of farms all across the cotton belt. In addition to substantial regional variations in fiber properties, there are often significant variations among varieties grown in the same region. There may even be environmentally caused variations among fiber characteristics of cotton grown on the same farm. Furthermore, fiber characteristics within each cotton boll are not all uniform, so that adequate description may require measures of distributions as well as central tendencies.

If the inherent variations in cotton fiber properties are translated into uncertainty about them in the marketing and processing sectors, several undesirable effects may be anticipated:

(1) It greatly complicates the procurement, collection and sorting of cotton. Perhaps the most common adjustment by merchants and mills has been dependence on regional cotton that are known to generally work well in specific

textile operations. However, as mentioned above, there are other important sources of variations in cotton fiber characteristics. The end result is typically the purchasing of much cotton that is better than it needs to be (sometimes referred to in the trade as "over-buying"), yet still ending up with some cotton that causes processing or other quality control problems.

(2) It makes a random blending process, aimed at achieving an "even running" mix of cotton, uncertain even with many bales involved. With relatively few bales, as in the newer textile mills, adequate blending becomes a practical impossibility.

(3) It makes adaptation to new machinery and processes in textile manufacturing difficult and slow. The aforementioned open-end spinning is an excellent example of this, since using cotton that has historically been adequate for a ring spinning operation may prove disappointing for open-end spinning. But an efficient conversion to a more satisfactory type of cotton requires specific information about fiber properties which are important in the context of the different technology.

(4) It often necessitates repeated testing of cotton along the marketing channel and in the textile mills, attempting to give adequate assurance or verification that the cotton is suitable for its intended use. This results

in damage to the bale package, waste of much cotton, and significant expense for additional equipment and labor.
(5) It hampers international trade in raw cotton, because the above problems become much more difficult to resolve across great distances with communication and legal barriers. Being able to procure acceptable cotton by description is a great efficiency in national commerce; in international commerce it is a necessity. As the textile industries in developing regions of the world modernize, they will become increasingly critical of uncertainties in raw materials.

Given the fact that cotton fibers cannot be "manufactured" according to predetermined and uniform standards, a couple of industry-wide objectives seem obvious. One is to promote efforts in cotton research production and handling to deliver the best suited, highest quality cotton possible over time. The other is to promote efforts by the cotton marketing system to alleviate the disadvantages of variable physical properties in cotton fibers. With examination of these two objectives, it becomes clear that they are in reality complementary; i.e., the advancement of either objective makes the task of satisfying the other easier.

The basic question for discussion is: "How can the cotton marketing system help reduce the uncertainty which is entailed by variable fiber properties?" One obvious answer is: "By making improved physical description of cotton fibers available to the industry." The basic issues involved are the usefulness of additional information (or the inadequacy of current information) and the feasibility of providing it in a reliable and equitable manner.

The Issue of Usefulness

Empirical studies have repeatedly corroborated that currently measurable fiber properties impact on yarn properties and spinning efficiency [3,4,9,12,13,17,20,27,28]. For example, there can be no doubt that yarn strength is highly related to the strength of individual fibers. Determination of the more important fiber properties is commonly made by means of statistical correlation coefficients. Though most investigations have dealt with ring spun yarns, some of the more recent ones have considered open-end spun yarns[9,12,17].

The only descriptions of cotton fiber properties which are consistently available within the cotton marketing system are those furnished by the USDA cotton classification system. The information provided includes a grade (which is based on fiber color, trash content and fiber preparation), staple (which is the average length of a typical portion of fibers), and fiber fineness (as measured by the micronaire reading) [18].

There can be no doubt that some fiber properties not included in the USDA cotton classification are important to textile mills. A more complete list of important fiber properties would certainly include fiber strength, fiber length uniformity, and fiber maturity. Other less important additions might be fiber crimp, fiber stickiness, and fiber resiliency.

Even the information which is provided in USDA classification may need refinements. For example, there are two distinct color tendencies in otherwise white cotton: yellowness and greyness. Combining a judgement on these into a single color code may obscure valuable information. Also, a distinction between "larger" and "smaller" trash particles might be worthwhile.

The micronaire is certainly a valuable measurement to textile manufacturers; however, it is handicapped by the fact that it is inherently ambiguous. A given micronaire value may be indicative of either fiber fineness or fiber maturity -- or perhaps a combination of both. To put it another way, when testing cotton fibers known to be of equal maturity, measured micronaire values are indicative of <u>fiber fineness</u>. And when testing cotton fibers known to be of equal fineness, measured micronnaire values are indicative of fiber maturity [2, p. 129]. Obviously the inclusion of a fiber maturity grade would remove most of the ambiguity. But as currently reported, firm judgement about a micronaire value cannot be made without information on the genetic variety of the cotton.

USDA cotton classification, with all its shortcomings, is nevertheless a cornerstone of the cotton marketing system. The vast majority of producer sales of U.S. cotton are negotiated on the basis of the USDA "green cards" containing the classing results. Likewise, the vast majority of export sales agreements are based on stipulated values of the USDA grade, staple and micronaire. But the fact remains that the current system has remained unchanged since a time when synthetic fibers held an inconsequential share of the textile market and when more sophisticated measurements of fiber properties were either technically or commercially infeasible.

The Issue of Feasibility

Are additional and improved measurements of fiber properties now feasible? If so, can they be obtained with necessary speed, accuracy, and cost-effectiveness to make them practical? The answer to the first question is unequivocally "yes". The answer to the second question is apparently "yes, with adequate planning and development."

Although the USDA still relies upon human senses to determine grade and staple, textile research laboratories have been using instruments for many years to measure a variety of fiber properties. During the past fifteen years, modern versions of these instruments have been combined with computer technology to produce high volume instrument (HVI) systems. Current versions are able to provide separate measurements of greyness, yellowness, average fiber length, fiber length uniformity, micronaire, and fiber strength. In repeated tests by the USDA, measurements with HVI systems have been more reliable than measurements by human classers, especially when variability in fiber properties is substantial [14, 16, 17].

Computerization offers the potential for fast, low-cost measurements without compromising accuracy. Furthermore, once an HVI system is in place, it offers the potential of adding new or improved instruments to the systems as they are available. Instrument measurement of trash content may be feasible in the near future. Also, promising developments using "quantitative image analysis systems" give reason to anticipate a fast, reliable indicator of maturity in cotton fibers [12, p. 118].

As previously mentioned, there have been numerous studies about the impact of fiber properties on processing and end-product performance. However, as far as the author is aware, no published studies have emphasized the investigation of functional forms between the principal fiber properties and the performance variables. Yet this step must be taken if results are to be obtained that are specific enough to make them useful for quality control. Perhaps the best current example of a successful application of such results is the American Cotton Growers' Mill, a denim manufacturing operation on the Texas High Plains. Using only fiber measurements from an HVI classing system, computer-selected mill "lay-downs" of 28 bales are spun on open-end spinning machines. This blending process is not a random mixing of cotton, but rather a purposeful selection that allows reliable prediction of spinning performance and product quality. This mill has not suffered the "blow-ups" (requiring a shut-down of machinery) that are so dreaded by textile mills. And the denim produced there has successfully met some of the most stringent quality control standards in the U.S.

METHOD OF IMPLEMENTATION

If it is granted that improved physical description of cotton fibers is both useful and feasible, then issues still exist about how to implement any changes. Should implementation be left to textile mills and/or other participants along the cotton marketing chain? Or should changes be implemented through the existing USDA classification system? These are currently relevant questions because, as of the 1980-81 crop year, the USDA is operating an experimental installation using HVI systems in the cotton classing office at Lamesa, Texas. If the experiment is successful, it could mark the beginning of a fundamental transition in the USDA cotton classification system.

Both economic theory and economic pragmatism indicate that, if the types of changes contemplated are worthwhile, incorporating them into a marketwide grading system is the preferred method. Of course changes must be made with care to avoid "shocks" to the marketing system and to facilitate a smooth, equitable transition for all participants.

An important fact to realize is that a transition is inevitable; indeed, it is now in process. HVI technology has entered a mass production phase. Early adopters are already working to "carve a niche" in the marketing system. Many of the larger cotton merchants, shippers and mills (both domestic and foreign) are examining how they can use such technology to their best advantage. Relevant questions relate to how the transition will proceed; i.e., what kind of direction and impetus will be given, if any.

If a *laissez faire* approach to changing physical description of cotton fibers is taken during the 1980's, likely results are that: (a) some participants in the marketing system will benefit by exploitation of new or improved fiber measurements, while competitive positions of others will suffer; (b) the cotton production sector -- which consists of many independent and relatively unco-ordinated firms -- will participate only indirectly, through a "trickle-down" process; and (c) the transition will take several years with few industry-wide benefits materializing during the current decade.

If, on the other hand, it is resolved to facilitate the transition for the general benefit of the U.S. cotton industry, then an adequate investment in economic research could return big dividends. Obvious research goals would include (a) evaluation of important cost-benefit issues and (b) helping to anticipate and clarify needs of all participants.

To clarify the issues involved, it is helpful to consider what is required of an effective marketing system. In the context of the wholesale cotton marketing system, four major requirements may be given:

(1) Maintain competitive conditions whereby:

(a) Cotton producers have adequate access to the full spectrum of buyers in the market.

(b) Textile mills can obtain cotton for their particular needs from the full spectrum of cotton available for sale.

(2) Provide a continuously operating market that discourages artificial elevation or depression of cotton prices.

(3) Adequately describe the cotton fiber according to important processing characteristics in order to:

(a) Allow assessment of the value of cotton versus other fibers.

(b) Allow efficient procurement and handling of cottons that facilitate quality control in the manufacture of textile products.

(4) Provide appropriate price signals, through effective premiums and discounts, to help guide the production sector toward improved practices and adoption of superior cotton varieties.

It is obvious that fulfilling these marketing requirements involves much more than adequate marketing standards and grades. But neither are these requirements independent of the grading system. Consider how improved physical description of cotton fibers may contribute toward fulfilling each of the four functions and what type of implementation would be advantageous:

(1) The access of both producers and mills to the total market will be enhanced by improved capability to evaluate cotton according to relevant fiber properties --

regardless of production regions, varietal tendencies, and other "rules of thumb" which must be used when working with inadequate information. Perhaps a large portion of the cotton produced in some regions is not generally appropriate for use in manufacturing a certain end-product; however, the production in some years and/or in some subregions may well be appropriate. But the only way to assure the general availability of such information on a timely basis to all participants (producers, merchants, exporters and manufacturers) is to include it in the classing information.

(2) A continuously operating market is also facilitated by expanding the pool of cotton which may be used in selection. To the extent that ability to identify cotton from any source that will satisfy fiber requirements is enhanced, the effect will be similar to a more continuous flow through the market by such cotton. This, in turn, will tend to alleviate price instability. Such benefits, however, are predicated upon timely and generally available information, which implies the use of an unbiased and credible grading system.

(3) Sufficient description to allow efficient selection, procurement and handling of cotton is obviously at the heart of the subject of this paper. It might be suggested that since the textile manufacturers would benefit

from this additional information, they should be responsible for developing their capability to extract such information. However, the fixed investment in an HVI system by each firm would be substantial and the economies to large-scale fiber testing are great. The larger mills and cotton merchants could benefit, but many smaller operators might be left out. Besides, it must be remembered that many firms in the textile industry (either domestic or foreign) do not necessarily want cotton badly enough to make accomodations in order to find and purchase it. Cotton's share of U.S. mill consumption is below 25 percent and still declining (Table 10). The responsibility of market development must be assumed by the cotton industry. This will require creative efforts to generate additional resources and to utilize all available resources to the best advantage. The infrastructure provided by the USDA cotton classification system obviously should not exist to serve anyone's particular vested interest, but it may be a legitimate resource when specific objectives are compatible with improvements in information flows and orderly marketing

(4) Providing appropriate incentives through market prices paid to farmers is basic to the long-term viability of cotton as a major textile fiber. The cotton

marketing system renders its most valuable service when prices paid to farmers are reliable guides in directing both the quantities and qualities of cotton produced. Given the competitive structure of American agriculture, producers cannot be expected to consistently furnish cotton with, say, a strong fiber unless they receive an adequate price incentive. The possibility of receiving such incentive is precluded unless this fiber property is made "visible" within the pricing system. The only available method to do this is through incorporation into marketing standards which are used to negotiate selling prices. This implies, furthermore, that the standard must be meaningful over time to both producers and textile mills if the use-value of cotton is to continue to be reflected in market prices.

In summary, it should be stated that an on-going process during the 1980's of improving the physical description of cotton fibers cannot be expected to result in windfall benefits to any particular sector of the cotton industry. There probably would be little or no demonstrable impact on the average price level, and impacts on regional advantages would probably be small. But, over a period of years, use of superior seed varieties, cultural practices, harvesting and ginning processes could help achieve fiber properties that improve spinning performance. Costs of locating, assembling, sorting, shipping, and other functions could be lower than they would have otherwise been. A foundation could be laid for incorporating cotton into new processing technologies as they are developed. Movement of U.S. cotton in international trade could be facilitated, and leadership in providing both superior fiber information and instruction in its use could help strengthen export markets for raw cotton in developing countries. To the extent that domestic textile manufacturers can be encouraged to use more cotton for their finished-product exports, such exports would cease to undermine world markets for raw cotton. Results such as these would serve to broaden the demand base for U.S. cotton and make it more competitive in the long run; therefore, the entire cotton industry would be more viable for all its participants when the 1990's arrive.

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