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The Classification of Cotton



The administration of the cotton acts and regulations providing for the classing and standardization work explained in this publication has been delegated to the Director of the Cotton Division of the Agricultural Marketing Service. Inquiries relating to any phase of this work or to the contents of the publication should be addressed to:

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The Classification of Cotton

Prepared by the Cotton Division
Agricultural Marketing Service

A. Nature of Cotton and Basis of its Classification

1. The cotton fiber.—Raw cotton, in its usual marketable form, consists of masses of fibers packaged, for convenience of handling, in bales. In a single pound of cotton there may be 100 million or more individual fibers. Although cotton fibers vary greatly in physical properties even in a pure variety of cotton, the individual fiber is the basic unit upon which spinning value depends.

Each fiber is an outgrowth of a single cell that develops in the surface layer of cells of the cottonseed. During the early stages of its growth, the fiber elongates to its maximum length as a thin-walled tube. This fiber wall is then thickened within by depositions of cellulose as it matures. When the growth period ends, the living material dies and shrinks. The fiber then consists of a tubular wall and a central canal. When the bolls open, these fibers, which vary considerably in length and degree of wall thickening, collapse much as does the deflated inner tube of an automobile tire; and in collapsing, they become twisted about their own axes, forming what are known as convolutions (fig. 1).

2. Botanical groups of cotton.—Botanically, there are three principal groups of cotton that are of commercial importance. Those that have been developed in the United States from cotton native to Mexico and Central America (*Gossypium hirsutum*) are known as upland cottons and generally vary in staple length from about $7/8$ to $1\frac{1}{4}$ inches. A second botanical group which is of early South American origin (*G. barbadense*) is generally of longer staple and includes Egyptian, American Pima (American Egyptian prior to July 1, 1970), and Sea Island cottons and some of the Peruvian

and Brazilian varieties. A third group embraces those shorter stapled cottons that are native to India and eastern Asia (*G. herbaceum*).

3. Harvesting, seed cotton storage, ginning, and bale packaging.—Seed cotton that has been harvested mechanically tends to contain more trash and other irregularities than carefully hand harvested cotton. Due to economic factors, however, virtually all of the U.S. cotton crop—99 percent—is now harvested mechanically.

Handpicked cotton is harvested by removing the seed cotton locks from the open boll by hand. This method results in the lowest amounts of trash in the ginned lint. Snapped cotton also is harvested by hand, but the entire boll is broken off the plant. The volume of hand harvesting has declined steadily, and now less than 1 percent of all U.S. cotton is harvested by hand labor.

Most of the cotton crop has been harvested in recent years by mechanical spindle-type pickers (fig. 2) which remove the seed cotton from the opened bolls. Since 1967, an average of over 70 percent of the cotton has been harvested this way.

Mechanical strippers also are important in the harvesting of certain cotton varieties. Since the stripper machine pulls the entire boll from the plant, stripped cotton contains a higher proportion of trash and other material.

Machine-salvaged cotton is cotton which is picked from the ground by special machinery. This method usually results in the highest levels of trash and contamination in the cotton, and therefore is not used very often.

Field storage of harvested seed cotton prior to ginning has become a common practice in many areas, and the percentage of cotton ginned each year from ricks and modules has grown since recordkeeping was begun in 1974. Storing the seed cotton allows the grower to take advantage of good harvesting weather,



Figure 1.—Cotton: A. in a field; B. in an open boll; C. several locks in a boll; D. single fiber, showing wall thickness and convolutions, magnified.

regardless of the capacity of local ginning facilities. This allows the producer to utilize available labor and equipment more efficiently.

Figure 2.—A two-row mechanical spindle-type picker in operation.

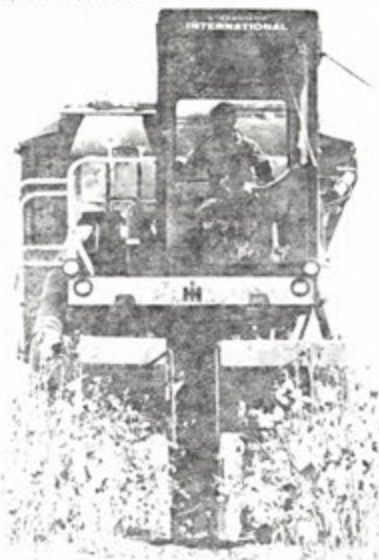
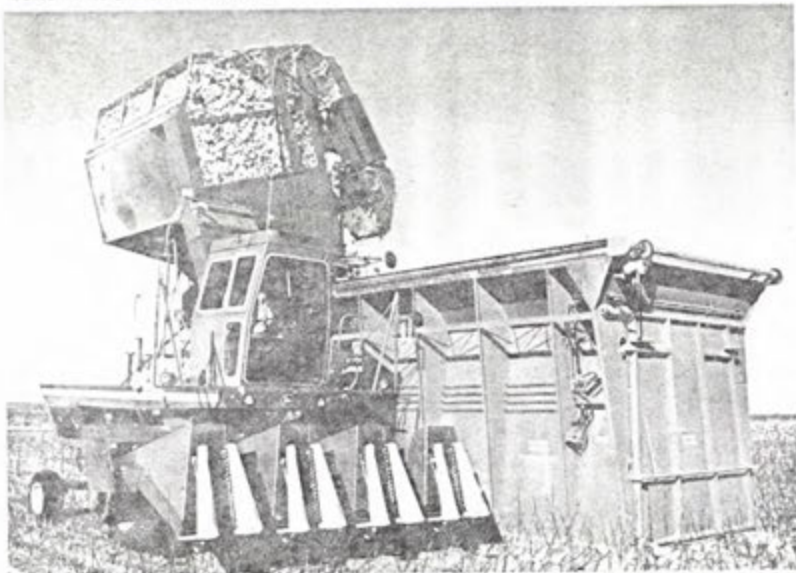


Figure 3.—A four-row stripper unloads cotton into a module builder.



The cotton module is the most commonly used type of field storage system. Harvested seed cotton is dumped into a module builder (fig. 3) which compacts it into a stable, cohesive stack, which can contain as many as 14 bales. The module usually has protective covering and can be stored at any point between the field and gin. They may be transported intact at the grower's convenience without the use of a conventional seed cotton trailer.

Seed cotton also may be stored in ricks. Picked cotton is loosely compacted into a pile of indeterminate length on bare ground and covered. Ricks cannot be transported intact, and the cotton must be rehandled and loaded into a conventional seed cotton trailer for transport. Due to the greater handling ease, modules are becoming more widely preferred for seed cotton storage.

Cotton ginning is the separation of fibers from the seed. Cotton ginning processes have gradually expanded to include drying or conditioning, cleaning, extracting, feeding, ginning, lint cleaning, and packaging as distinct stages.

Table 1 gives a description of American cotton bales, which are illustrated in figure 4.

4. Variations in cotton quality.—About 90,000 farms produce cotton in this country; and in any single year much variation is found in the quality of this production. Variation occurs in the quality of cotton grown on a single farm—in fact it is not unusual to find considerable variation within a single bale. These variations of quality result from differences in varieties planted, soils, rainfall, irrigation practices, fertilizers, temperatures, cultural methods, insect damage, length of growing season, exposure of open cotton before harvest, and method of harvesting and ginning.

Quality—as measured by such factors as length, strength, fineness, and maturity—is governed to a considerable extent by the variety and quality of the seed planted, as well as by the weather and the farming practices followed during the period in which the fibers were developed. The quality factors of color, leaf, and ginning preparation are affected to a great extent by the weather and length of exposure after the bolls open, by plant characteristics, and by harvesting and ginning practices.

5. Classification of cotton.—Cotton classification or classing, for the purpose of this discussion, is the art and science of describing the quality of cotton in terms of grade, staple length and micronaire reading according to the Official Cotton Standards of the United States. Cotton may be classed in terms of other standards or by comparison with types; but in the United States if standards are used, they must be the official standards. For grade, classification is based on appearance, and is accomplished chiefly through the sense of sight by integration of the three factors of grade—color, leaf, and preparation—in the sample. Classification for staple length involves both sight and touch and is made by pulling out and comparing a typical portion of fibers from a sample with the official staple type. The micronaire reading is an airflow measurement which indicates fiber fineness and maturity in combination. Micronaire is determined by using a cotton specimen of standard weight which is compressed to a standard volume and subjected to a standard air pressure. The resultant volume of air-flow through the specimen is measured as the micronaire reading, which is commonly referred to as mike reading or simply mike (fig. 5).

Table 1.—Approximate dimensions, weights, and densities of specified kinds of American cotton bales

Kind of bale	Dimensions (approximate)	Volume Cubic feet	Weight (approximate)		Ties, per bale
			Per bale	Per cubic foot	
Modified gin flat bale	55x25x45	35.8	500	14	6
Compressed universal bale	58x25x21	17.6	500	28.4	8-9
Compressed standard bale	57x29x23	22.0	500	22.7	8
Compressed high-d bale	58x22x21	15.5	500	32.2	9
Gin standard bale	55x21x31	20.7	500	24.2	8
Gin universal bale	55x21x26	17.4	500	28.7	8-9

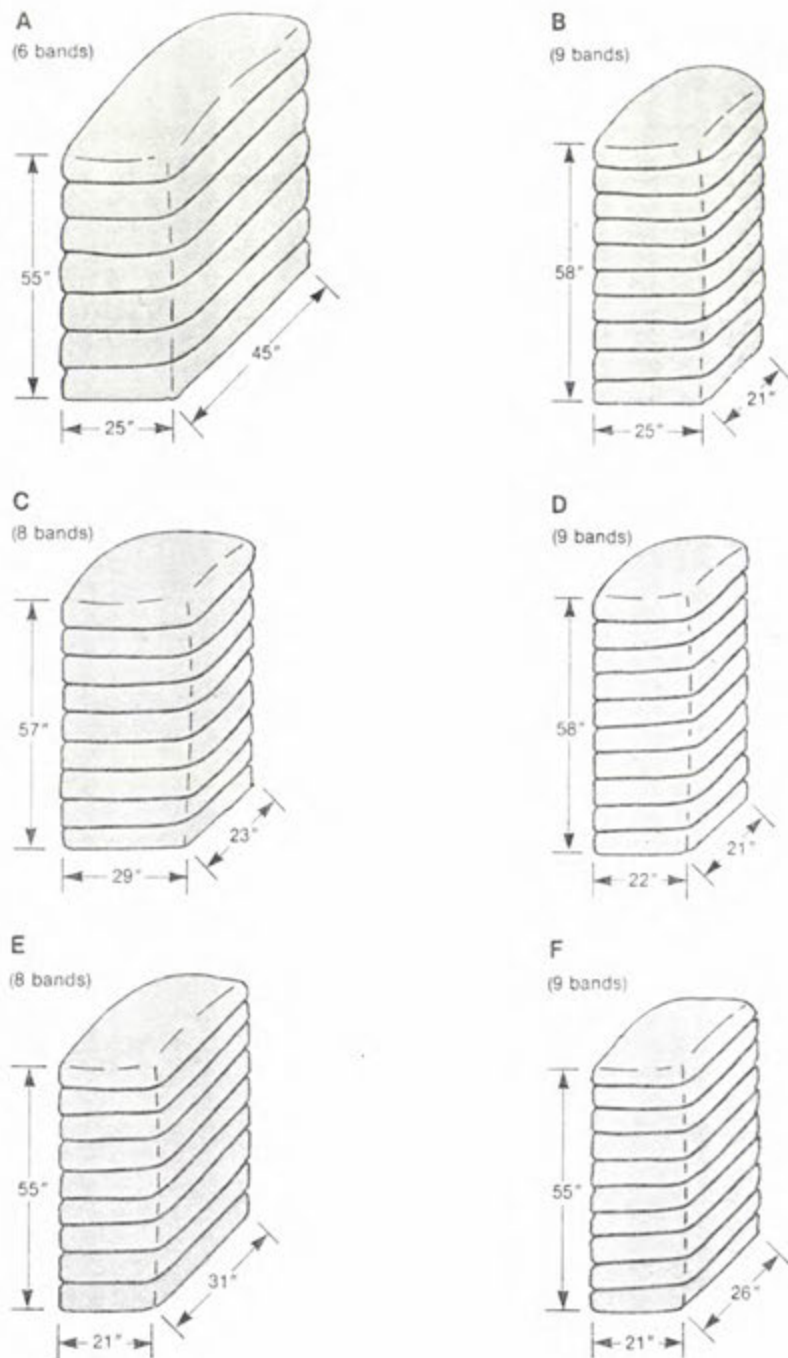


Figure 4.—Bales of cotton: A. modified gin flat bale; B. compressed universal bale; C. compressed standard bale; D. compressed high-D bale; E. gin standard bale; F. gin universal bale.

6. Why cotton is classed.—Cotton is classed to determine the grade, staple length and micronaire reading, which indicate to a large extent the spinning utility and hence the market value of each bale. In recent years the U.S. Department of Agriculture has classed for farmers about 97 percent of the cotton produced. Farmers are interested in the classification of each bale to appraise production, harvesting, and ginning practices and to market their cotton advantageously. Classification is a means by which the cotton merchant efficiently buys and sells cotton. In the processing of cotton, uniformity of quality is desired. While classification remains essential to the pricing system for cotton, additional measurements, particularly fiber strength, often are used in commercial transactions.

B. Sampling

7. General.—Cotton is packaged in bales of approximately 500 pounds. Because of this size and method of packaging, it is impractical for a buyer to inspect actual bales of cotton at the time of purchase. Therefore, it is general practice for market transactions to be made on

the basis of samples drawn from each bale. Samples are satisfactory for this purpose to the extent that they are representative of the bales from which they are drawn.

8. Drawing of samples.—A sample should weigh at least 6 ounces and consist of two parts of 3 ounces each taken from opposite sides of a bale. In drawing the sample, cuts should be made deep enough to reveal a true specimen of the bale, and the face of the sample should be about 6 inches wide. A sample should not be dressed or trimmed. A sample should never be drawn by cutting a second time into an old sample hole. If the sample is improperly drawn, too small, or the face too narrow, it is difficult to determine the correct classification.

Cotton bales may be cut for sampling before or after putting on the bale wrapping. Originally, all sampling involved cutting the wrapping material. Since many users of cotton objected to the losses which could result when the sample holes were left open, and patching the holes is costly, methods for sampling which leave the bale cover intact were developed. Methods which allow the bale to be formed



Figure 5.—The micronaire measures the volume of air-flow through a cotton specimen and indicates both fiber fineness and maturity.

and banded, then cut for sampling, before putting on the bale covering have gained widespread use since their development. Another way to avoid damaging the protective bale covering is by use of mechanical samplers.

Mechanical equipment has been developed for sampling cotton bales during the ginning process, and can be installed in most existing gins. At timed intervals during ginning, small portions of the lint are extracted, automatically accumulated, pressed, and packaged in a wrapper bearing the gin bale number. Two or three samples of appropriate size for sampling are obtained, and the bale covering can be left intact.

9. Handling of samples.—After samples have been properly drawn, they must be handled carefully and in such a manner as to prevent loss of leaf, sand, dust, or other material that would change their representativeness. It is also important to see that no particles of leaf, dust, or sand are dropped upon them, as they may be changed in grade by the accidental accumulation of such trash.

The useful life of a sample will depend to a large extent upon the care given it, and the extent to which it is handled. After several classifications the representativeness of a sample becomes questionable.

The usefulness of a sample also depends upon the preservation of its identity. A tag or coupon showing bale number, name of gin, compress, warehouse, or other identification should be kept between the portions from the two sides of the bale.

10. Care of samples.—If a sample may be needed for future reference after classification, it should be carefully wrapped or rolled to preserve its identity. The sample may be preserved by placing it in an individual container, such as a plastic bag, or by storing it with a group of samples carefully placed in a large container. Samples should not be allowed to remain open on tables as exposure to dust may cause loss of brightness, and exposure to light may cause color changes.

The temperature and humidity under which samples are stored are also important. Excessive drying of cotton samples may shorten the apparent staple length. Excessive dampness may accelerate the rate of increase in yellowness of the cotton. An extremely high temperature may increase the effect of humidity. The validity of any cotton sample is subject, therefore, to the conditions under which it is stored and the length of storage.

C. Factors of Grade

11. General.—Grade is composed of three factors—color, leaf, and preparation.

Color

12. Color in cotton.—When upland cotton opens normally, it is white. Continued exposure in the field to weathering and the action of microorganisms can cause this white cotton to lose its brightness and become darker. Under extreme conditions of weather damage, the color may become a very dark, bluish gray.

Upland cotton in which growth is stopped prematurely by a frost, drought, etc., may have a yellow color that varies in depth. Cotton may also become discolored or spotted by the action of insects, fungi, and soil stains. This cotton will become darker after exposure to adverse conditions in the field.

Discoloration may also be caused by oil or grease used in mechanical harvesting equipment or come from green leaves or other parts of the cotton plant which have been crushed by the machinery. Regardless of cause, any departure from the bright color of normally opened cotton indicates a deterioration in quality.

13. Color groups.—In the grading of U.S. upland cotton, all of these color differences are recognized, divided into categories, and described. The varying amount of yellow color found in cotton forms the basis for the color groups used in the standards for grading upland cotton.

These color groups are: White, Light Spotted, Spotted, Tinged, and Yellow Stained, The Plus, Light Gray, and Gray designations are used to indicate different combinations of color and leaf than those normally found in the White grades.

14. Grades within color groups.—As the cotton in each of the color groups is exposed to weathering, it becomes progressively darker. The degree of darkness is the principal basis for grade divisions within each color group, the higher grades being brighter in color than the lower grades. However, each grade within a color group also contains some chroma differences—for example, the difference between the whitest and the creamiest sample within any one of the grade boxes. Strict Middling, Middling, and Strict Low Middling in each color group are examples of grade divisions within color groups.

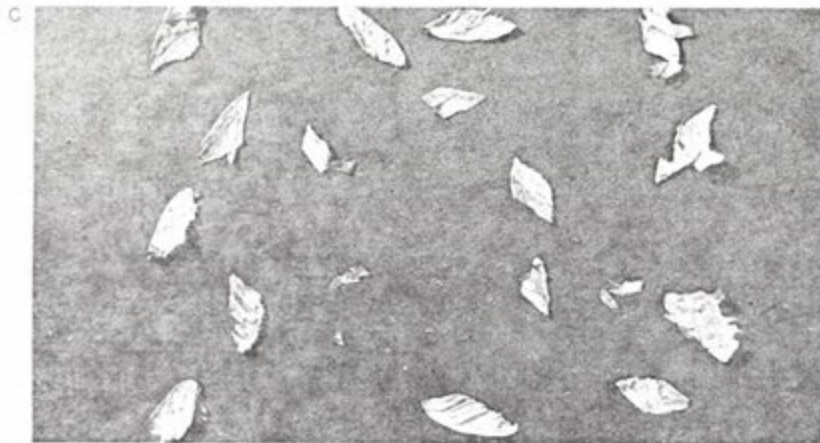


Figure 6.—
A. leaf particles;
B. motes;
C. shale.

Leaf and Other Trash

15. Nature of leaf and other trash.—Cotton usually becomes contaminated by leaf and other trash in various amounts due to exposure in the field and by harvesting methods. The amount of foreign matter remaining in the lint cotton after ginning is largely dependent upon the trash content, the condition of the cotton at the time of harvest, and the amount of cleaning and drying machinery to which it has been subjected during the ginning process. Even when cotton is carefully harvested under ideal field conditions, it is very difficult not to include at least some pieces of leaf and trash. Although much of the foreign matter is removed by the cleaning and drying process during ginning, it is at present impractical to remove all of it.

Leaf includes dried and broken plant foliage of various kinds. Leaf may be divided into two general groups, (1) large leaf and (2) "pin" or "pepper" leaf. Large leaf is generally less objectionable, as large particles are more easily removed by the manufacturer's cleaning process.

In addition to leaf, other trash and material such as stems, hulls, bark, whole seeds, parts of seeds, shale, motes, grass, sand, oil, and dust are sometimes found in raw cotton (fig. 6). Shale is the lining of the bur. Motes are immature undeveloped seeds. (See item F on special-condition cottons.)

16. Importance of leaf and trash as a factor of grade.—Leaf and other trash in cotton represents a loss since it must be removed as waste in the manufacturing process. The small particles of foreign matter that are not removed in manufacturing detract from the quality and appearance of the manufactured yarn and fabric. Cottons which contain the least amount of foreign matter, other conditions being equal, are those with the highest spinning value. It is because of this quality relationship that graduations of leaf and trash are important in grading cotton.

Preparation

Not a factor

17. Preparation defined.—"Preparation" is the term used to describe the degree of smoothness or roughness with which the cotton is ginned, and the relative neppiness of the ginned lint.

18. Effect of preparation on spinning utility.—Various methods of harvesting, handling, and ginning cotton produce differences in roughness or smoothness of preparation that sometimes are very apparent. However, laboratory tests do not support the belief that these easily recognized differences in degrees of preparation in the raw cotton will follow through to produce equally important differences in spinning results. As a general rule, smoothly ginned cotton results in less waste, and produces a slightly smoother and more uniform yarn than roughly ginned cotton. Except for cases in which the roughness is excessive enough to cause the cotton to be reduced in grade materially below that of cotton having normal ginning preparation, laboratory experience does not show significantly lower results for yarn tests. Longer cottons normally will have a rougher appearance after ginning than shorter cottons, but that does not necessarily mean that yarns made from such cottons will be relatively poorer.

19. Neps.—Neps are small tangled knots of fibers (fig. 7) that are visible as dots or specks when a thin web of fibers is held to the light or against a dark background. Neps in lint are undesirable because, if not removed, they will appear as defects in the yarn and fabrics. The removal of neps from the lint is difficult, costly, and frequently impossible. The longer and finer cottons tend to be more "neppy" than the shorter, coarser cottons. Lint having a high percentage of thin-walled immature fibers (low micronaire readings) is especially likely to be neppy. Neps are difficult for the classer to detect or evaluate.

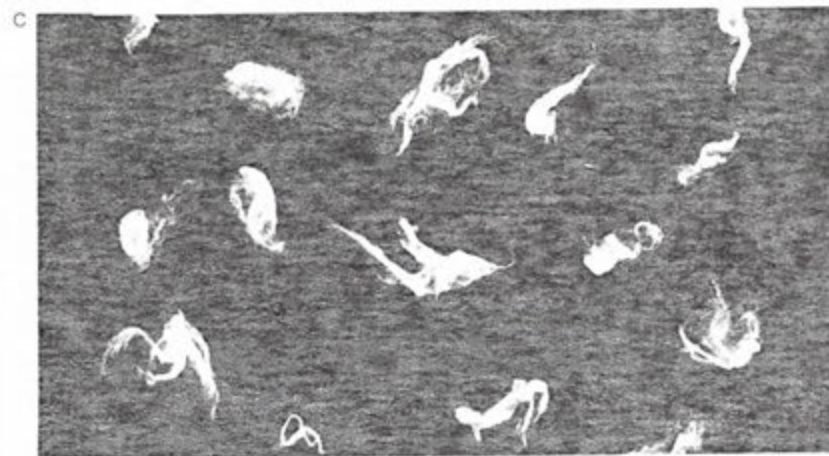
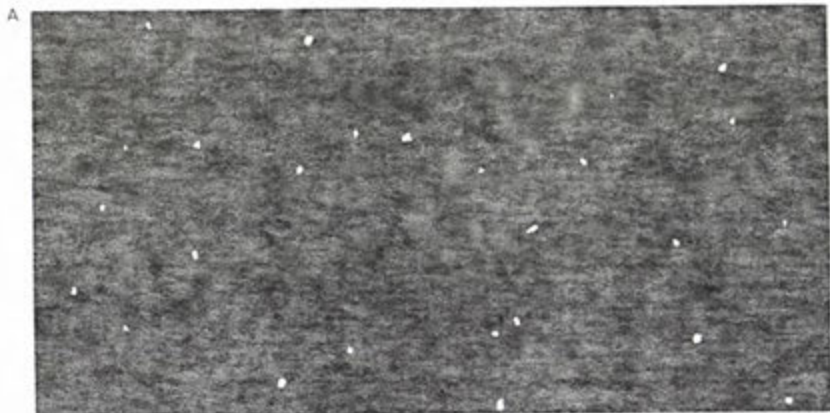


Figure 7.—A. neps are visible as dots or specks in the lint, natural size; B. a nep seen under the microscope showing tangles of fibers, magnified; C. neps are large and matted clumps of fibers, which contribute to the rough appearance of lint cotton, natural size.

20. Naps.—The term "nappy" describes lint that is rough and lumpy, and the term "nap" is applied to large clumps or matted masses of fibers that contribute to the rough appearance of ginned cotton (fig. 7). Their formation is influenced to a large extent by the condition of the seed cotton at the time of ginning. Cotton that is ginned green or wet tends to be nappy. Naps are relatively easy for the classer to detect but are not as detrimental to quality as neps.

D. Standards for Grade

21. Brief history of grade standards.—USDA first established standards for the grade of American upland cotton in 1909. These were for nine grades of white cotton and they were never formally promulgated. The standards were entirely permissive and they were never used to any great extent in either domestic or export trade. The next upland grade standards were promulgated under the U.S. Cotton Futures Act of August 18, 1914 (reenacted August 11, 1916), and their use was made practically compulsory on the cotton futures exchanges in the United States on and after February 18, 1915. Official grade standards for American Pima cotton were first established in October 1918. The U.S. Cotton Standards Act of March 4, 1923, gave further impetus to USDA's cotton standardization work. The grade standards have been expanded in number and revised from time to time since the early days of standardization. A complete listing of symbols, code numbers, and definitions of the official grades may be obtained from: Cotton Division, AMS-USDA, Memphis, TN.

Most of the present standards for grade of American upland cotton were promulgated by USDA in June 1962. The last major revision of grades for American upland cotton occurred at that time, but minor revisions have been made in response to changing production patterns since then. The U.S. Cotton Standards Act provides for one year's notice before any change or

revision of the standards can be made effective.

22. Universal Standards for the grade of American upland cotton.—The Official Cotton Standards of the United States for the Grade of American Upland Cotton are also called Universal Standards. USDA entered into the original Universal Cotton Standards Agreement with nine leading cotton associations in seven major European cotton-consuming countries in 1923 and 1924. The original agreement has been supplemented and revised and now includes cotton associations and exchanges in many of the foreign consuming countries. The agreement provides for (1) the adoption, use, and observance of the Universal Standards in the classification of U.S. upland cotton, (2) the arbitration or settlement of disputes with respect to such classification, and (3) the preparation, distribution, and protection of key copies of the Universal Standards.

Conferences are held every 3 years in the United States to insure accurate reproduction of the standards and to consider any revisions needed in the standards. United States cotton associations and exchanges participate in the conferences and the standards work that is provided for in the agreement. Both U.S. and foreign representatives provide vitally important advice to USDA in standards development.

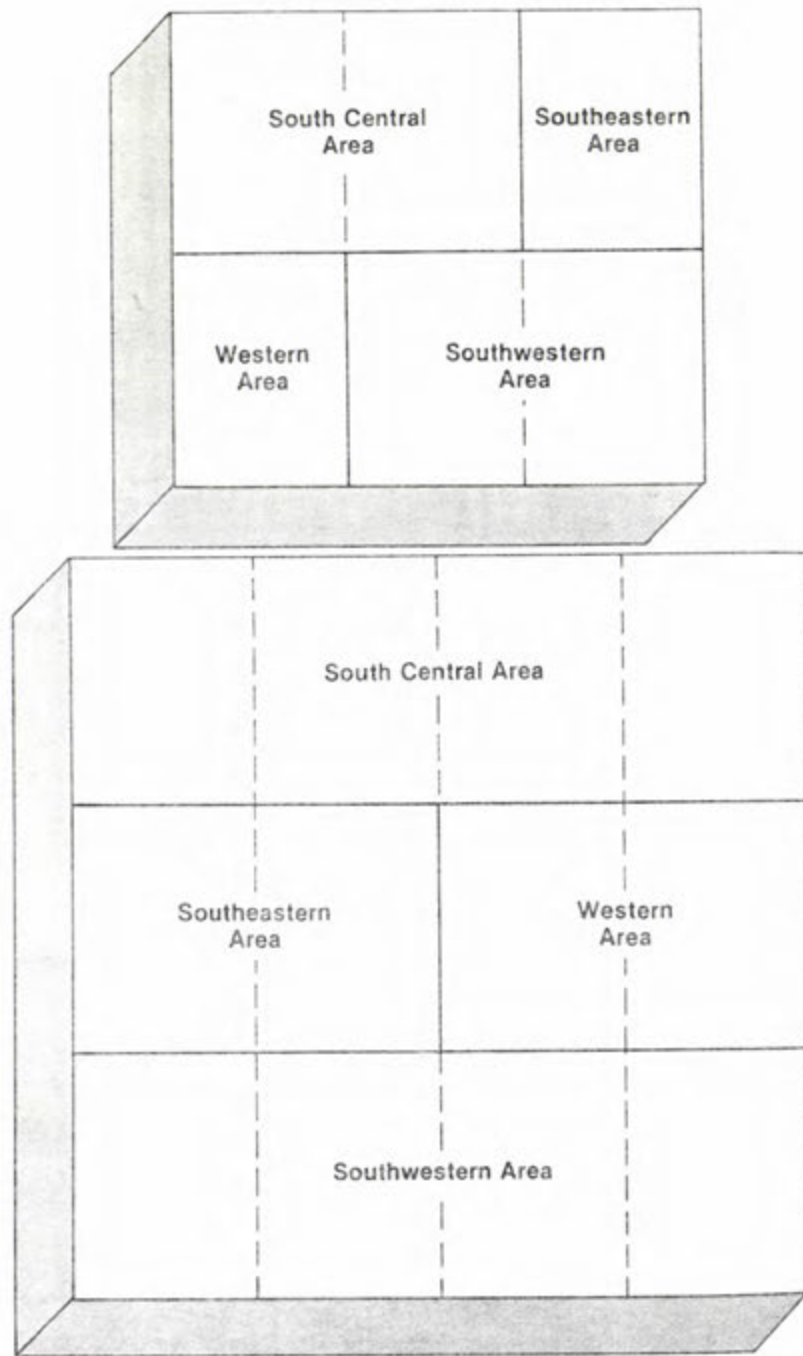


Figure 8.—Diagram of grade standards boxes, both 6- and 12- samples sizes, to show placement in the White grade boxes of cotton from several areas. It is not always possible to follow these diagrams because cottons of all grades are not always available in each area.

23. Physical standards for grade.—As indicated by the listing of cotton grade standards, only a portion of the grades is represented in physical form by samples put up in boxes. The remaining standards for grade are descriptive, and no physical form is produced for these. The range of each grade for which there is a physical standard is represented by 12 samples in the official box. Cottons representing several areas of production are used in each grade. When possible in the White grades, samples are placed in the boxes in the positions shown in figure 8.

The original set of the physical standards currently in effect is sealed and deposited in a vault at the USDA in Memphis or Washington, D.C. Copies of these, known as practical forms, are prepared and sold by USDA. In addition, guide boxes containing six samples are prepared and sold. The utmost care is taken to keep the range of color, leaf, and preparation in all copies of each standard, whether 6 or 12 samples, as nearly the same as possible.

The color of cotton deepens with age—more in the high grades than in the low grades and more in Tinged and Spotted grades than in the Gray grades. The color of the cotton in the standards stored or used under different conditions may differ considerably as time goes on. Standards kept in a cool and dry climate will not change as fast as standards kept in a hot and humid climate. Because of this natural change it is necessary in preparing copies of the standards to keep the color at a level within the range of the original standards at the time they were established. The cotton colorimeter is useful for this purpose. Also, because of the change in color, copies of the standards are prepared annually and are effective for 1 year beginning July 1.

The samples in each standard grade box are photographed, and the photograph is inserted in the cover of the box. A comparison of the photograph with the surface of the

cotton in the box provides a check on its authenticity by disclosing whether the surface of the samples has been disturbed or altered in any way. Thus the photograph affords protection to users of the box. Figure 9 is a photograph of a box representing the grade of Middling White (31) cotton.

24. Descriptive standards for grade.—The descriptive standards for grade are based upon the physical standards. Each of these standards provides a description for cotton in which the factors of grade—color, leaf, and preparation—are not contained in a single physical standard. For example, "Middling Gray (37) is American upland cotton which in color is Strict Good Ordinary (61) and which in leaf and preparation is Middling (31) or better," and "Middling Plus (30), is American upland cotton which is Middling (31) in leaf and preparation with Strict Middling (21) color." A complete listing of physical and descriptive standards with code explanations may be obtained from: Cotton Division, AMS-USDA, Memphis, TN.

25. Grade not specified without reference to all three grade factors.—The grade of cotton is determined in terms of color, leaf, and preparation. Color is used as a part of the grade name except for White cotton which is often specified without the color name. Middling, for example, when used by itself, refers to cotton with color, leaf, and preparation within or averaging within the range of the standard for Middling White (31) cotton.

26. American Pima and upland grade standards differ.—American Pima cotton is naturally of a deeper yellow color than upland cotton. The leaf content of American Pima standards is peculiar to this cotton and does not match that of upland standards. The preparation is very different from the preparation for upland standards, inasmuch as American Pima cotton is ginned on roller gins and, as seen in figure 10, looks more stringy and lumpy.

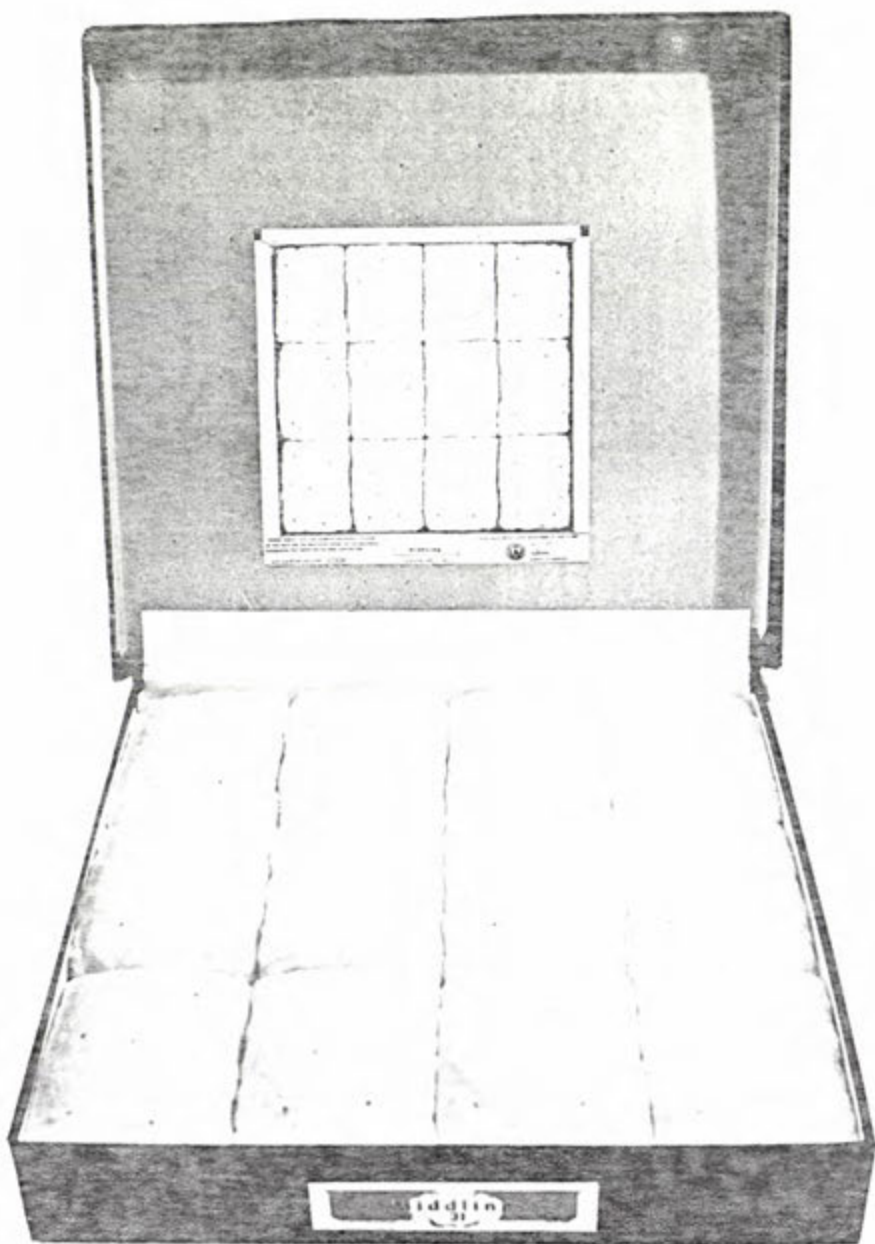


Figure 9.—Practical form for the grade of Middling White (31) upland cotton. A photograph is inserted in the cover of the box to verify the preparation of the cotton and the position of the leaf. Each box carries the seal of the Department of Agriculture and the certificate and signature of the Secretary. Other grades for which practical forms are prepared are represented in the same way.

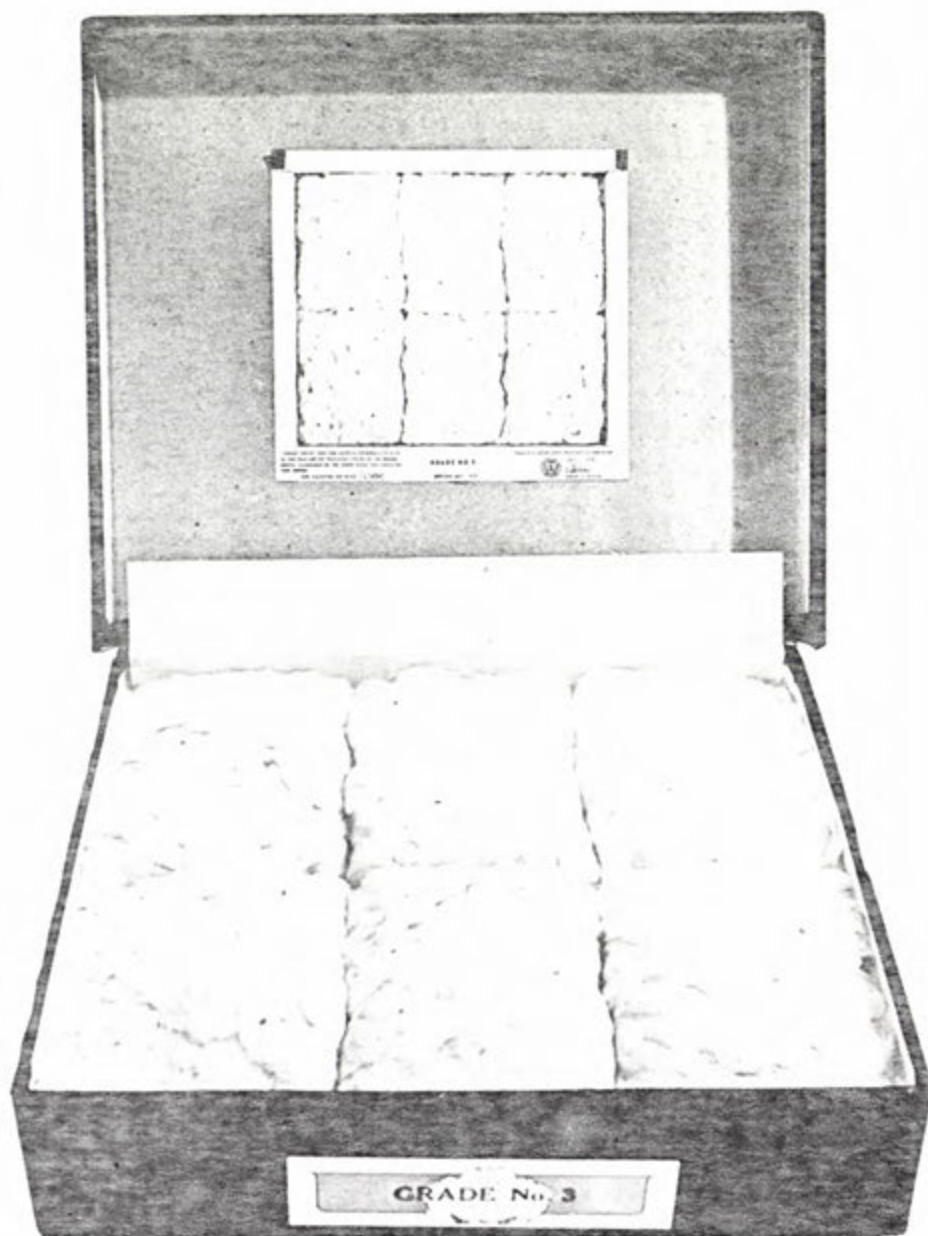


Figure 10.—Practical form of the standard for American Pima cotton grade No. 3. The preparation of this cotton differs from that of the short staple cotton because it is ginned on roller gins instead of saw gins.

27. American Pima grades.—American Pima standards are also prepared in physical form. (A complete listing may be obtained from the address above.) When American Pima cotton is lower in grade than the lowest physical standard, it is given the next lower grade number, which is descriptive.

E. The Determination of Grade

Cotton is classed for grade, staple, and micronaire to arrive at a description of its quality in terms of the official cotton standards.

28. Lighting conditions.—Since the determination of grade is by visual inspection, lighting conditions are very important if uniformity of classification is to be maintained. Lighting not only should be uniform and constant, but any artificial lighting used should provide color rendering equal to that of daylight.

Until 1940, practically all cotton classification was done in daylight,

often under north skylights because they provided the steadiest illumination for the greatest number of hours. Since the color of a light-to-moderately overcast north sky has been found in practice to be the optimum color of daylight preferred by classers, daylight of that color has been established as a standard for artificial lighting used in classing rooms. This standard is described in terms of the International Commission on Illumination (CIE) spectroradiometric curve for daylight at 7500k. — Standard lighting conditions in all USDA classing laboratories are obtained by the use of special lamps designed to duplicate as closely as possible the color quality and spectral distribution of the standard. This allows classing laboratories which are geographically widely separated to have more consistent lighting, so that a classer can go from one classing room to another without having to make constant adjustments for wide differences in the amount and quality of lighting.



Figure 11.—Classing room with artificial lighting.

¹Lighting Cotton-Classing Rooms For Color Grading. American Society for Testing and Materials. AN-SI/ASTM D 1684-71 (Reapproved 1976).

Lighting in the classing room should be diffused, but with enough direction to allow a perception of depth as a classer looks into the cotton. It should be as uniform as practicable over all working areas of the room. There should be no glare or cross-lighting. Brightness contrasts from the light source and surroundings should be at a minimum. Because cotton classing rooms are usually very dusty, lighting units should be enclosed. They should also be easy to install, inspect, and maintain in good order.

A minimum of 60 foot-candles of illumination at the classing level is required. The initial level of light should be at least 100 foot-candles at the time of installation to allow for the 30-percent decrease in light output that is normal during the useful life of many lamps. However, the range within the classing area between the highest and lowest reading should not exceed 20 foot-candles. The exact amount of illumination, if kept at or above the minimum, is not critical.

Surrounding conditions are important. All colors used in classing rooms should be neutral, either white, gray, or black. Walls should be very light in color. A light gray, just off-white, is preferable, so as to conserve the light.

In USDA classing rooms lighting units, which are about 2 by 4 feet, usually are hung with the lower edge 10 feet from the floor, in rows that are on 7-foot centers. Most USDA classing rooms have four rows of lights which allow for efficient use of two rows of classing tables. Some small commercial classing rooms have two rows of four units each. A single 8- to 10-foot classing table in a small room should have at least three lighting units installed end to end.

Figure 11 shows a modern classing room equipped with artificial lighting.

29. Directions for handling samples in grading.—When lifting the sample from the table preparatory to classing, one hand, with the finger spread slightly apart, is placed on the top side of the cotton sample. The sample is held lightly in the hand and turned so that the other side of the sample may be clasped with the free hand and brought to a position slightly below the shoulders and about 15 to 20 inches from the eyes. This position is usually best for classing purposes. The cotton sample should be inspected for color, leaf, and preparation while it is on the table and as it is being picked up.

To open the sample, press the thumbs lightly into the top edge and open and close the layers of cotton gently, as if they were pages of a book. As the sample is opened and closed in this manner, each layer is observed for color, leaf, and preparation.

30. Regulations.—The regulations of USDA under U.S. Cotton Futures Act and the U.S. Cotton Standards Act prescribe that:

(1) The classification of all cotton samples shall be according to the official cotton standards of the United States in effect at that time;

(2) If a sample drawn from one portion of a bale is lower in grade than one drawn from another portion of such bale, except as otherwise provided in the regulations, the classification of the bale shall be that of the sample showing the lower grade; and

(3) If the cotton be reduced in grade, by reason of the presence of extraneous matter or other irregularities or defects, below its grade according to the official cotton standards of the United States, the grade from which it is so reduced, the grade to which it is so reduced, and the condition or reason which so reduces its grade shall be determined and stated.

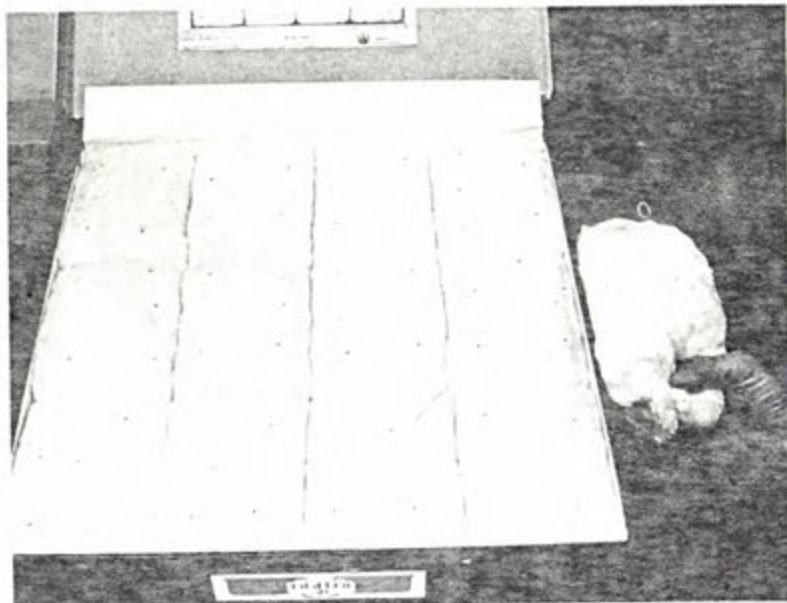


Figure 12.—Proper method of comparing sample with standards for grade. Sample is held by the side of the box in a position that will give the same light to both.

31. Grading on physical standards.—Each of the official physical standards for grade is composed of samples of cotton differing slightly in grade factors, thus creating what is called the range within each box. It is possible to make a comparison with one of the samples in the grade box for color, another for leaf, and still another for preparation. Any cotton that possesses grade factors which come within the range of any single standard, regardless of how these factors are combined, should be classed as of that particular grade.

32. How to compare samples with physical standards.—To compare a sample with one of the official physical standards for grade, the sample should be rolled so as to give it a surface or face as nearly like that of the standards as possible; the sample is then held by the side of the box representing the grade in question in a position that will give the same light to both (fig. 12). In making these comparisons, the faces of the samples in the boxes should never be disturbed; and the classer should exercise care to prevent any foreign substances from falling upon the surface of the samples in the boxes. The standard boxes, when not in use, should be kept closed and should be stored in a convenient place for ready reference.

33. Grading on descriptive standards.—In classing samples of cotton that fall within descriptive standards for grade, comparisons should be made with the boxes of the physical standards adjacent to the sample in question. For example, if a sample appears to be Middling Light Spotted (32), it should be compared with both the Middling (31), and the Middling Spotted (33) boxes to be sure that it falls between these grades for color and matches Middling (31) in leaf and preparation.

34. Samples differing in successive "breaks."—It often happens that different breaks or openings of a sample are unlike in color, leaf, or preparation. The grade of the sample should not be determined by either the grade of the lowest and poorest nor the highest and best opening in the sample. After opening the sample several times, the final decision should be made by averaging the grade of all breaks or openings. This method of classing is not meant to be used in classing two-sided bales, but should be employed in classing cotton that shows slight variations in different breaks.

If a sample shows that the bale is composed of cotton of different grades, such as Strict Middling (21) on one side and Middling (31) on the other side, the grade should be determined according to the cotton on the low side in accordance with regulations.

35. Grading mechanically drawn samples.—In classing mechanically drawn samples, slight variations of color, leaf, and preparation may show in different openings of the sample since the sample segments are taken throughout the bale. The grade of the sample should not be determined by either the highest or the lowest opening of the sample, but on the most typical or representative openings of the sample. However, if either outside segment of the sample, or as much as 1/8 of the interior of the sample, is of an inferior grade, the grade of the in-

ferior cotton will be assigned to the sample.

36. Averaging factors of grade.—Sometimes all grade factors do not fall within the range of any one grade. In White cotton when preparation is normal and the color factor is two or more grades higher than the leaf factor, the grade assigned will be one grade higher than the leaf factor. In White cotton if the leaf factor is two or more grades higher than the color factor, the Gray or Light Gray descriptive standards will apply.

In Light Spotted, Spotted, Tinged, and Yellow Stained cottons, when preparation is normal and the color factor is two or more grades higher than the leaf factor, the grade assigned will be one grade higher than the leaf factor. In these cottons when the leaf factor is two or more grades higher than the color factor, the grade assigned will be one grade higher than the color factor.

The general rule for averaging factors of grade is given in the order of the Secretary of Agriculture promulgating the standards for grade of upland cotton as follows:

American upland cotton which in color, leaf, and preparation is within the range of the standards established by this part, which contains a combination of color, leaf, and preparation not within any one of the standards set out in this part, shall be designated according to the standard which is equivalent to, or if there be no exact equivalent is next below, the average of all the factors that determine the grade of the cotton: *Provided*, That in no event shall the grade assigned to any cotton or sample be more than one grade higher than the grade classification of the color or leaf contained therein.

Classers applying this rule must average the factors of grade in terms of the official grade standards and not attempt to determine

a grade of equivalent price. Price relationships are continually changing and it is impossible to class cotton consistently in terms of money value. When equivalent values are determined, they must be values in terms of the standards and not money values.

F. Grading Irregular and Special Condition Cotton

37. Classification of special condition cotton.—Samples in which special grade conditions are found and which can be described in terms of the standards should be classified as any normal bale. As previously noted in item 30, USDA cotton classing regulations provide that cotton may be reduced in grade because of the presence of extraneous matter or other irregularities or defects below its grade according to the official cotton standards of the United States. When a reduction is made the grade from which and to which it is reduced, and the condition or reason which so reduces its grade is determined and stated. These notations on classification memorandums for bales with special grade conditions make it possible for these bales to be segregated from other bales having normal grade factors.

38. Rough preparation.—“Preparation” has been defined in item 17 as a term used to describe the degree of smoothness or roughness with which the lint is ginned and the relative neppiness or nappiness of the ginned lint. When a sample is reduced one or two grades because of poor preparation, the grade to which reduced, the grade from which reduced, and the designation for “Prep” is entered on the classification memorandum.

Upland cotton ginned on roller gins is not comparable in appearance to the official grade standards for upland cotton which are prepared from saw-ginned cotton. USDA spinning tests indicate that such cotton usually contains fewer neps and naps than saw-ginned cotton that is comparable in other respects.

Upland cotton ginned on a roller gin is not reduced in grade for preparation unless there is a definite evidence of neps and naps.

39. Gin-cut cotton.—Gin-cut cotton is cotton that shows damage in ginning, through cutting by the saws, to an extent that reduces the grade of the cotton by more than two grades. When samples from gin-cut cotton are classed, the grade to which reduced, the grade from which reduced, and the notation for “Gin-cut” is entered on the classification memorandum.

40. Reginned cotton.—Reginned cotton is cotton that has passed through the ginning process more than once. A bale of cotton is considered reginned when it is opened after the initial ginning and baling for the purpose of putting the lint through machinery to regin, clean, blend, or otherwise process the lint, and is then rebaled. Cotton which passes through one or more stages of lint cleaning as a regular part of the initial ginning process is not reginned. The rules of cotton futures exchanges in the United States provide severe penalties for any person who knowingly offers for inspection or delivery on futures contracts any cotton that has been reginned. Samples from reginned cotton are classified as other samples, but the notation for “Reginned” is entered immediately before the grade on the classification memorandum.

41. Repacked cotton.—Repacked cotton is cotton that is composed of factors', brokers', or other samples, or of loose or miscellaneous lots that have been collected and rebaled, or cotton in a bale which is composed of cotton from two or more smaller bales or parts of bales that are combined after the cotton leaves the gin. The classification of repacked cotton is discouraged because it is often so mixed that samples from different parts of the bale are likely to vary widely. If samples from repacked bales are classed, the notation “Repacked” is entered immediately before the quality designation on the classification memorandum.

42. False packed cotton.—False packed cotton is cotton in a bale (a) containing substances entirely foreign to cotton; (b) containing damaged cotton in the interior with or without any indication of such damage upon the exterior; (c) composed of good cotton upon the exterior and decidedly inferior cotton in the interior, in such manner as not to be detected by customary examination; or (d) containing pickings or linters worked into the bale.

If it is known that a sample is from a false packed bale, no grade or staple length is assigned; and the notation “False Packed” is entered on the classification memorandum.

43. Mixed packed cotton.—Mixed packed cotton is cotton in a bale which, in the sample taken therefrom, shows (a) a difference of three or more grades, or (b) a difference of three or more color groups, or (c) a difference in length of staple of one-eighth inch or more.

For purposes of determining mixed packed cotton, White cotton (including the Plus grades), Light Gray cotton, and Gray cotton shall constitute one color group; and Light Spotted cotton, Spotted cotton, Tinged cotton, and Yellow Stained cotton shall each constitute a color group. (See table 20). If a classer determines a sample is mixed packed for grade only, the notation “Mixed Packed” is entered in the grade box or column on the classification memorandum and the sample length is entered as for any normal sample. If the sample is mixed packed for staple length only, the notation “Mixed Packed” is entered in the staple box or column on the

classification memorandum and the grade is entered as for any normal sample. In any event, the codes for the two grades or two staple lengths constituting the mixture are entered in the “Remarks” space on the memorandum.

44. Plated bales.—A plated bale is a bale of cotton which has a layer of decidedly different quality cotton on the outside of one or sometimes both sides of the bale.

Outside plates are primarily attributed to the ginning process when different qualities of cotton are ginned successively. Such conditions may result in a slight overlap between bales which leaves a plate of decidedly different quality cotton.

As a general rule an outside plate consisting of not more than one-fourth of the portion of a standard size cut sample from one side of the bale should be disregarded in classification for grade and staple. This general rule may also be applied to samples from bales with weather or other damage. However, the classer must exercise his judgment on each sample having a plate of inferior or superior cotton.

45. Water-packed cotton.—Water-packed cotton is (a) cotton in a bale that has been penetrated by water during the baling process, causing damage to the fiber, or (b) a bale that, although apparently dry on the exterior, through exposure to the weather or through other means has been damaged by water in its interior.

If it is known that a sample is from a water-packed bale, no grade or staple length is assigned and the notation for “Water-Packed” is entered on the classification memorandum.

Table 2.—Mixed packed cotton

Official Definition of Mixed Packed Cotton.—Cotton in a bale which, in the sample taken therefrom, shows (1) a difference of 3 or more grades, or (2) a difference of 3 or more color groups, or (3) a difference in length of staple of 1/8 inch or more. For purposes of this paragraph, White Cotton, (including the Plus grades), Light Gray Cotton, and Gray Cotton shall constitute one color group, and Light Spotted Cotton, Spotted Cotton, Tinged Cotton, and Yellow Stained Cotton shall constitute a color group.

GRADES	COLOR GROUPS								
	1		2		3		4		5
	White	Plus	Light Gray	Gray	Light Spotted	Spotted	Tinged	Yellow Stained	
1	GM (11).....	.....	.....	.....	GM Lt Sp (12).....	GM Sp (13).....	.....	.....	.....
2	SM (21).....	M + (30)	.....	.....	SM Lt Sp (22).....	SM Sp (23).....	SM Tg (24).....	SM YS (25)	.....
3	M (31).....	SLM + (40)	GM Lt G (16).....	.....	M Lt Sp (32).....	M Sp (33).....	M Tg (34).....	M YS (35)	.....
4	SLM (41).....	LM + (50)	SM Lt G (26).....	GM G (17).....	SLM Lt Sp (42).....	SLM Sp (43).....	SLM Tg (44).....	Below M YS (85)	.....
5	LM (51).....	SGO + (60)	M Lt G (36).....	SM G (27).....	LM Lt Sp (52).....	LM Sp (53).....	LM Tg (54).....	.....	.....
6	SGO (61).....	GO + (70)	SLM Lt G (46).....	M G (37).....	Below LM	Below LM	Below LM	.....	.....
7	GO (71).....	.....	.....	SLM G (47).....	Lt Sp (82).....	Sp (83).....	Tg (84).....	.....	.....
8	Below GO (81) ..	.....	.....	Below SLM G (87)	.....	.....	.....	.....	.....

HOW TO APPLY CHART.—COTTON IS MIXED PACKED WHEN THERE IS A DIFFERENCE OF (1) 3 OR MORE GRADES UP OR DOWN THE CHART, OR (2) 3 OR MORE COLOR GROUPS ACROSS THE CHART

EXPLANATION OF CHART

- Each color group is separated by heavy lines. White, Plus, Light Gray, and Gray are all in one color group.
- For simplification, only the color of the Plus, Light Gray, and Gray grades as defined in the official standards are considered. Examples: (1) The color of Middling Plus is Strict Middling—therefore Middling Plus is listed on the chart opposite Strict Middling. (2) The color of Strict Middling Gray is Low Middling—therefore Strict Middling Gray is listed on the chart opposite Low Middling.

Sand in a sample may be detected by shaking the sample gently over a piece of clean paper, but dust is not so easily detected. The presence of dust is indicated by a dull unnatural color in the cotton and may at times

47. Extraneous matter.—Extraneous matter is any substance appearing in a cotton sample that is not discernible in the official grade standard corresponding to the quality of cotton in the sample. Such material may consist of grass, bark, spindle twist, sand, dust, oil, whole seeds, parts of seeds, moles, stems, etc. Any cotton sample containing an appreciable quantity of such material should be reduced one or more grades in order to reflect properly the reduction in grade on this account. When cotton is reduced in grade because of the presence of extraneous matter, the grade to which reduced, the grade from which reduced, and the specific reason for the reduction is noted on the classification memorandum. The presence of grass, whole seeds, parts of seeds, moles, bark, or stems in a sample can be detected in observing the different layers of the sample in the regular grading operation.

46. Fire-damaged cotton.—Fire-damaged cotton is cotton that has been on fire or cotton that has been damaged from the heat or smoke of a fire. If it is known that a sample is from a fire-damaged bale, no grade or staple length is assigned and the notation for "Fire Damaged" is entered on the classification memorandum. In cases where the cotton has the appearance of being fire damaged but there is some uncertainty as to the actual cause of damage, a grade and staple is assigned and the notation "Has appearance of fire damaged" is entered on the classification memorandum. When a sample does not reveal any fire damage but it is known that the sample is from a bale that has been reconditioned after being damaged by fire, a grade and staple is assigned and the notation "Reconditioned after fire damage" is entered on the classification memorandum.

Cotton classing in its present state of development depends upon human perceptions of sight and touch and involves exercise of human judgment. Thus, the grade determinations of cotton classers are subject to the inexactness and vagaries of the human factor. However, by careful study and by proper use of the grade standards, many of the common inconsistencies in the classing of cotton for grade can be eliminated and many others can be reduced as their nature is recognized, their causes are learned, and remedies are developed.

G. Inaccuracies in Grading Cotton

49. Common errors in grading.—The establishment and distribution of physical standards to which classers can refer for guidance have done much to promote uniformity of classing. However, the usefulness of a system of classification of cotton, as of any other classification, is dependent in large part upon uniformity of application.

Oil-stained cotton is cotton that has become contaminated with oil. It is usually recognized by its appearance, feel, or odor.

be detected by opening the sample and then pushing it together, thus forcing air through the sample. As the air is forced out it carries with it some of the dust which may become visible in the surrounding air.

48. Below grade cotton.—Below grade upland cotton is lower in grade than the lowest grade of the applicable color group of the official cotton standards. When such samples are classed, they are designated as being "Below Grade" by entering the appropriate code in the grade space on the classification memorandum. When cotton contains an excessive amount of grass, bark, or other extraneous matter and is determined to be more than one below the applicable color group, the additional explanatory notation for "Excessive Grass," "Excessive Bark," etc., is shown on the classification memorandum.

50. Sources of variations in grading.—Variations in grading can be traced, in general, to four sources:

(a) The sample. Its homogeneity, representativeness, and in some cases its size and condition.

(b) The classer. This includes the classer's knowledge of standards and skill in applying them, the stability or instability of one's nervous system, and one's susceptibility to influences such as information on previous classifications, or knowledge of conditions under which the cotton was grown,

harvested, or ginned.

(c) The conditions under which the classing is done—light, atmospheric conditions, and so on.

(d) Failure to examine carefully both sides of the sample.

51. Types of variation; causes and remedies.—Some of the common sources of variation in grading, along with causes of variation and a few suggestions as to how variations may be remedied are listed in table 3.

Table 3.—Variations in grading—some causes and remedies

Types of variation	Cause	Remedy
1. Bias. Tendency of classer to be hard or easy.	1. Constitutional tendency. 2. Previous experience or training not in line with standards. 3. Suggestion. 4. Prejudice. 5. Physiological or psychological condition of classer. 6. Misconception of standards.	Recognition of specific tendency, along with complete knowledge of and frequent reference to the standards.
2. Irregularity—erratic classification.	1. Unfamiliarity with standards. 2. Physical or nervous condition of the classer. 3. Lack of care.	Complete knowledge of and frequent use of grade standards.
3. Tendency to group the samples toward modal group or the average of the lot.	Classing too rapidly and assuming a lack of variation between samples in the lot.	Careful examination of each sample for each of the grade factors.
4. Failure to classify both sides of sample.	Classing too rapidly or carelessly because classer thinks cotton is uniform.	Careful classification of both sides of the sample before determination of grade.
5. Tendency to spread close groups of samples into a greater number of grades than are represented.	An effect known to psychologists as "end effect" in which the ends of a series look more different than they are—e.g., in 100 bales of Middling the few best samples would be called Strict Middling and the lowest called Strict Low Middling.	Careful examination of the most widely differing samples in any group, and then comparison to standards to see that the best is not graded too high, nor the lowest is graded too low.

52. Prior experience or knowledge of previous classification as an influence.—Some classers are influenced by the knowledge of where the cotton was grown; for example, a prejudice for or against cotton from a specific district from which they have at some time received good or poor cotton. Sometimes cotton classers are influenced by the knowledge of a previous classification, as for example, when it is known that the cotton has been classed by another as being of a certain grade or grades. In such case a classer may subconsciously tend to look for and find these grades, whereas if he had exercised an independent judgment, unaffected by the judgment of another, the result might have been more accurate.

53. Erratic classification.—There is also a tendency for some classers to be too easy at one time and too hard at another. This may be caused by a vagueness in knowledge of the official standards. Until a classer is thoroughly familiar with the grade and staple standards, it is impossible to proceed with confidence and erratic classification is likely to follow.

54. Failure to use certain standards.—Variation in grading sometimes occurs because of failure to refer to or use some of the official grade standards when making grade classifications.

55. Tendency to group the samples toward one grade.—One common inaccuracy is for the grading to be grouped toward one grade near the center of the range and not give full recognition to characteristics of each individual sample. This is caused by a lack of familiarity with the adjacent standards, or by carelessness. Cotton that should be graded Middling Light Spotted (32), Strict Middling Light Spotted (22), Strict Middling (21), or even Strict Low Middling (41) may be erroneously classed Middling (31).

56. Nonrecognition of grade factors.—Sometimes the grade factors of color, leaf, and preparation

are not recognized or are appraised incorrectly, either because of too rapid classing or impaired vision, or because of lack of understanding of the relative weight of each of the grade factors, or of an inability to apply them correctly in the classification of samples.

57. Carelessness.—Insufficient care in examining samples for special conditions and for plated or two-sided bales is another cause of error in classification. A bale that is Middling (31) on one side and Strict Middling (21) on the other may be inaccurately graded Strict Middling (21) because in a hasty examination the Middling (31) side was improperly inspected.

58. Inadequate samples.—Some variations may be traceable to classing samples that are too small to represent accurately the cotton in the bale. The class of the sample may be correct, but it may not be the true class of the bale from which the sample was drawn. Undoubtedly other differences are due to improperly conditioned, poorly handled, or excessively handled samples which are not representative of the bale.

59. Lack of good light.—Other errors are due to classing under poor lighting conditions, as for example, the failure to recognize spots which would have been readily recognizable under better lighting conditions.

60. Errors can be reduced.—Many of these errors or variations in classing can be reduced if:

(a) the classer will refuse to class under poor light;

(b) the classer will refuse to class small and poorly drawn samples;

(c) each sample is carefully examined for special conditions or irregularities;

(d) each sample is classed on its merits, regardless of any previous knowledge the classer might have concerning growth, prior classification, or other factors irrelevant to the intrinsic properties of the sample;

(e) the grade factors are properly weighed and balanced;

(f) the classer will conscientiously examine the boxes of cotton standards representing the grades of cotton to be classed before starting work in the morning and afternoon;

(g) both sides of every sample are carefully classified;

(h) most important of all, the classer will acquire and maintain a thorough knowledge of the official grade standards.

61. Thorough knowledge of standards necessary.—The importance of a thorough knowledge of the official grade standards for accurate cotton grading cannot be overemphasized. All cotton classers should concentrate on the official grade standards and should use them until they are familiar with each one. The standards should be studied until a picture of each, as well as the set as a whole, is indelibly imprinted on the mind. These official standards are the classer's guide. It is essential that classers develop an ability to state quickly and accurately the grades which most nearly match samples in question. This ability, once acquired, can be retained only by frequent reference to the standards. Many deviations from the standards can be avoided if cottons that are out of the range of qualities being classed are carefully compared with the standards.

H. Standards for Staple

62. Staple length defined officially.—Staple length of cotton is defined in the original order promulgating staple standards as follows:

The length of staple of any cotton shall be the normal length by measurement, without regard to quality or value, of a typical portion of its fibers under a relative humidity of the atmosphere of 65 percent and a temperature of 70° Fahrenheit.

63. Staple length an important quality factor.—Staple length is one of the most important factors of cotton quality because both fiber fineness and fiber tensile strength are associated with staple length in

the principal varieties of cotton now in commercial production. The longer staples are usually finer and stronger than the shorter staples and are required for the manufacture of fine, strong yarns.

64. Promulgation of official standards for staple.—The first official standards for staple length were promulgated by USDA October 25, 1918. The present official standards provide for various lengths in terms of inches and fractions of an inch from 13/16 inch to 1 1/4 inches, generally in gradations of thirty-seconds of an inch. For the sake of standardization, each length is generally referred to by the number of thirty-seconds of an inch that it contains. A staple of one inch is designated as "32"; one and one-sixteenth inches is "34", etc. Cotton that is shorter than 13/16 inch is

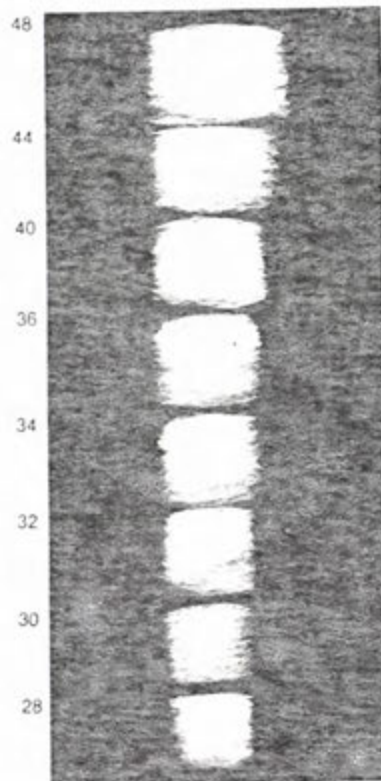


Figure 13.—Staple lengths. Pulls from types representing the official standards for eight selected lengths of staple.

designated as "Below 26."

Since 1918 the original order has been amended from time to time.

Types in physical form are available for American upland cotton of the lengths 13/16, 7/8, 29/32, 15/16, 31/32, 1-1/32, 1-1/16, 1-3/32, 1-1/8, 1-5/32, 1-3/16, 1-7/32, and 1 1/4 inches, and for American Pima cotton of the lengths 1-5/16, 1-3/8, 1-7/16, and 1 1/2 inches. Figure 13 shows pulls from staple types representing eight of these lengths.

Although the linear inch is the basic standard, in determining the normal length by measurement of a typical portion of fibers in a given sample, the process of stapling is facilitated by the use of practical forms, which are also known as staple types. Because of variable atmospheric conditions and of the greater ease

of comparison, the staple types are normally used in staple determination. When the staple type is properly pulled under standard conditions, the classer's pull will measure the length indicated on the label attached to the type.

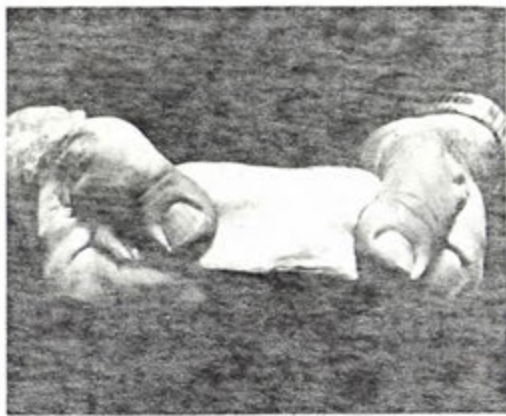
65. Preparation of Staple Types.—Bales are selected by classers for use in preparation of staple types. All bales selected for staple types are laboratory tested for length, fiber fineness, maturity, uniformity, and strength, to see that each falls within certain tolerances for each measurement. Each staple type, as prepared for sale to the public, contains approximately 1 pound of raw cotton and bears on its wrapper a statement of the standard length of staple which it is issued to represent (fig. 14).



Figure 14. A practical form of the official cotton standard for length of staple 1-1/8 inches and a typical pull of fibers from the cotton.



A



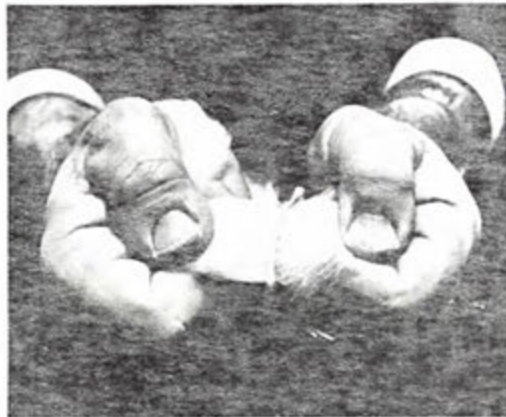
B



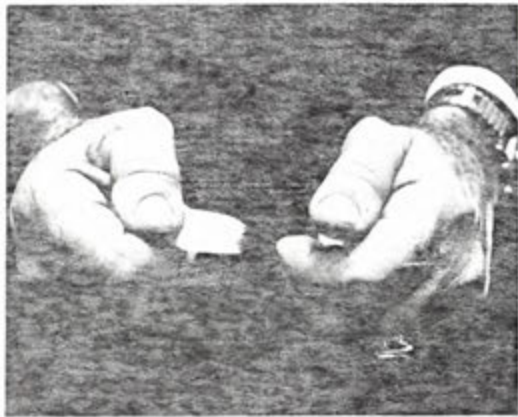
C



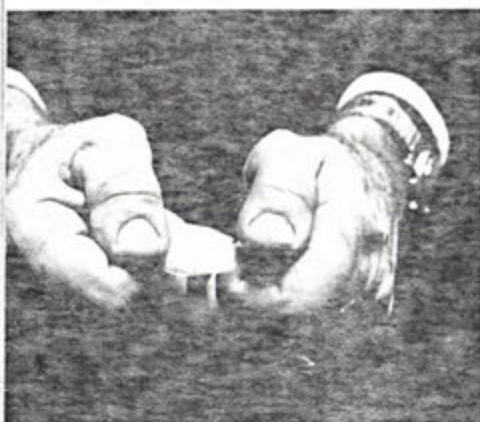
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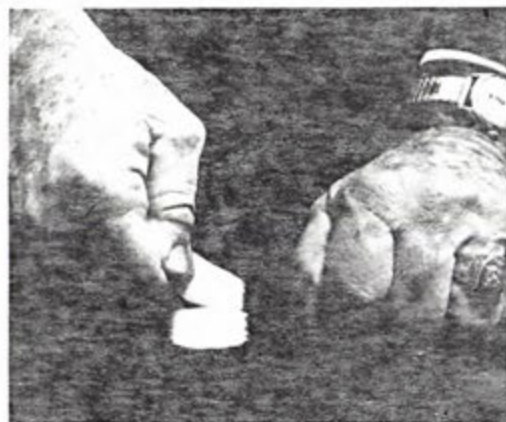
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H

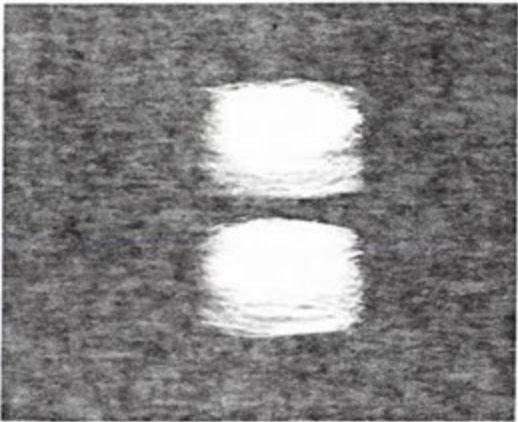


Figure 15.
Method of pulling staple.

I. Determining Staple

66. Regulations concerning stapling.—Cotton is classified for length of staple in accordance with official USDA standards and regulations under the U.S. Cotton Futures Act and the U.S. Cotton Standards Act. Both the official standards and these regulations provide that if the sample drawn from one portion of a bale is shorter in length than one drawn from another portion of the bale, the classification of the bale shall be that of the sample showing the shorter length. Cotton which has a staple length that falls between two adjacent lengths specified in the official standards will be assigned the shorter of the two lengths.

67. Practical application of the staple standards.—In classing cotton for length of staple, the classer makes what is known as a "pull." In other words, the classer pulls a tuft of fibers from the sample; and by a process of tapping, pulling, and discarding, he parallels a typical portion of the fibers. A separate pull is made from the portion of the sample drawn from each side of the bale. Tufts of cotton for these staple pulls should be taken near the middle of each portion of the sample, and thin plates should be avoided.

In determining staple of mechanically drawn samples, two or more pulls should be made from different segments of the sample. If these pulls differ in length, the shorter length will be assigned to the sample.

If the classer is in doubt about the length of a sample, he compares his pulls from the sample with a pull from the official staple type which he believes most nearly corresponds with the length of the sample.

68. Method of stapling.—Classers may make the pulls in their own individual ways or by imitation of methods used by others. They must develop the ability to repeat themselves consistently and thus match the standards.

The method of stapling varies widely but the method most frequently recommended is as follows:

Grasp in the two hands a tuft of cotton of a size convenient for the purpose (about one-fourth of an ounce in weight), holding it firmly between the thumb and forefinger of each hand, with the thumbs placed together, the fingers being turned in toward the palms of the hands, and the middle joints of the second, third, and fourth fingers of each hand touching the corresponding joints of the fingers of the other hand, so as to give a good leverage for "breaking" the cotton (fig. 15, A).

Pull the cotton slowly and smoothly with about the same leverage of each hand on the joints of the fingers, separating the tuft of cotton into two parts (fig. 15, B).

Discard the part remaining in the right hand (fig. 15, C).

Grasp with the thumb and forefinger of the right hand the end of the tuft of the cotton retained in the left hand. Draw a thin layer of fibers with the right hand. The point of pressure on the cotton in the left hand is just below the joint of the thumb and at the nail joint of the forefinger (fig. 15, D).

Retain this layer in the right hand; and repeat this operation about three times, placing each successive layer directly over the fibers previously drawn, using care to see that the ends of all the layers are even with each other between the thumb and forefinger of the left hand (fig. 15, E).

After discarding the cotton in the left hand, hold the fibers thus obtained between the thumb and forefinger of the right hand, smooth them, and make them parallel with the thumb and forefinger of the left hand (fig. 15, F and G).

Still holding the cotton between the thumb and forefinger of the right hand, draw a layer of fibers with the left hand. Retain this layer in the left hand; and repeat this operation about two times, placing each successive layer over the fibers previously drawn, using care to see that the ends of all the layers are even with each other between the thumb and forefinger of the left hand. This operation is the same as shown in figure 15, E, except that the size of the tuft of fibers has been reduced and the layers of fibers are being drawn with the left hand instead of the right hand.

After discarding the cotton remaining in the right hand, the fibers on each end of the pull should be smoothed and evened off by pulling out and discarding a small percentage of fibers that exceed in length the modal group or typical pull.

If there is any question in the classer's mind at this point concerning the proper length, the pull should be placed on a flat, horizontal surface preferably with a black background and compared with a pull from the appropriate official staple type (fig. 15, H and I).

If this method is correctly and consistently followed, the length obtained should be the same for several pulls from the same cotton and should agree with that obtained by comparisons with pulls from the official staple type for that length.

69. The "break" in pulling staple.—In making a classer's "break," fibers are not actually broken in mass, but are pulled apart and separated from each other, in what the classer speaks of as the "break." Some classers obtain an impression of the length from the behavior of the cotton on the "break."

Since weak or irregular fibers do not ordinarily cling or hold together as do cottons with more regular, or stronger fibers, the "break" of any cotton should not be relied upon to determine the fiber length. To make an accurate determination of the fiber length, the classer must complete the process of making a typical "pull" as outlined in item 68.

70. Length of fibers in a sample.—When fibers from a sample of cotton described as being 1-5/32 inches (37) in staple length are arrayed, they have been found to range from less than 1/8 of an inch up to 1-5/8 inches in length (fig. 16).

71. Fibers rejected in classer's pull.—The smooth curved line in figure 17 represents the fibers in the sample from which a pull was made, and the broken curved line is the diagram of the fibers in the pull itself. From this diagram it is easy to see which fibers were rejected and which were retained during the process of pulling or stapling. It will be observed that some of the long and some of the short fibers were disposed of, but that some of both were retained.

J. Inaccuracies in Stapling Cotton

72. Lack of familiarity with standards as an outstanding cause of error.—Errors or variations in stapling cotton may be due to lack of knowledge of the official staple types. Erratic stapling, as well as the tendency to class too hard or too easy, may result from unfamiliarity with the standards. It is important that before each day's work begins and frequently during the day, the classer pull the types representing the range of lengths being classed. Thus classers should be able to adjust accurately their concepts of lengths to the types and thereby avoid departures from them. When a sample is stapled that is out of the prevailing range being classed, one or more of the

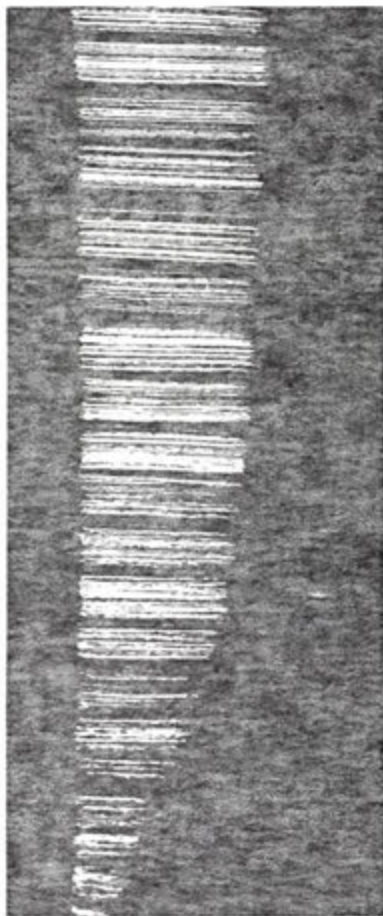


Figure 16.—An array of the fibers found in a sample of cotton called 1-5/32 inches (37) in staple. The fibers range in length from less than 1/8 inch up to 1-5/8 inches.

official staple types should be pulled for comparison with the sample.

73. Tendency to omit certain lengths.—One general tendency is that of classifying cottons in sixteenths of an inch, largely ignoring the odd thirty-seconds. Such a tendency can be avoided by frequent reference to the official stapling types and by analysis of classification results.

74. Tendency to class all staples toward familiar lengths.—Another cause of trouble in classification is the tendency to class all staples toward the lengths with which the classer is most familiar. It is because these inaccuracies arise so subtly that attention must be called to them.

75. Judging on the "break."—As already indicated, some classers become accustomed to determining staple length in part by the "break" of the cotton (particularly for the shorter lengths); that is, judgment is

made on the feel of the cotton as the fibers are pulled apart or separated from each other in a "break" of a sample. Staple length determination of a sample should never be decided on the "break."

76. Other causes of error.—Among the other causes of errors in stapling are:

- failure to condition samples properly;
- classing in a poor light under which it is difficult to make correct appraisals;
- rapid stapling, in which due consideration is not given to irregularities and defects; and
- failure to pull carefully both sides of the sample.

Two segments drawn from the same bale may not be identical in all of the quality elements.

Comparison of Arrays of a 1-inch Staple Length Cotton and of a Classer's "Pull" Made From It

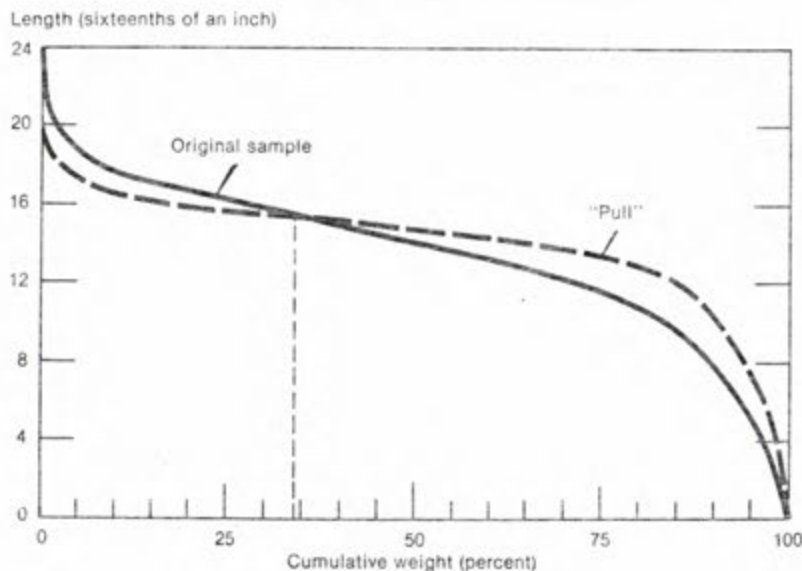
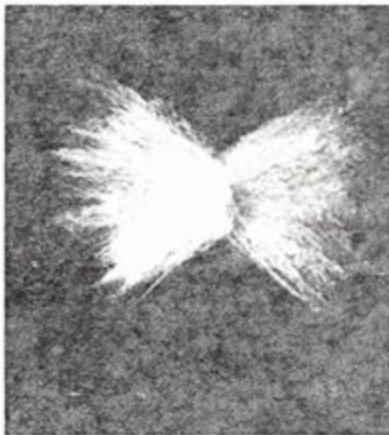


Figure 17.—Diagram of fiber arrays made from a classer's pull and from a sample of the bale from which the pull was made, indicating what part of the fibers the classer discarded in making his pull.

Variability of cotton within a single bale actually is much greater than is usually thought. The length of fibers on a single seed can vary greatly. And some cottons are more uniform than others. (See figure 18.) Fibers from bolls produced on different parts of a single cotton plant develop at different times under different conditions. The length of staple may vary throughout the bale; consequently, two classers or an individual classer in classing different samples from the same bale may assign two different staple lengths, and both may be correct in terms of the standards based on the cotton examined.

K. Effect of Moisture on Staple

77. Physical properties affected by moisture content.—Various properties of cotton are affected by moisture. (The term "moisture content" is sometimes used in referring to the amount of water in cotton. It differs from "regain" only in the base on which it is figured. Regain is figured on a bone-dry-weight, whereas moisture content is figured on the original weight, which includes the moisture.) These properties—pliability, drag, strength, and length—affect each other and together they undoubtedly influence the classer in the process of stapling.



78. Frictional properties.—If a handful of ginned lint is examined closely, it will be observed that the fibers are entangled, a fact which is evident each time a classer breaks a sample in the process of stapling. The individual fibers are wavy, and the waviness is a partial cause of the resistance which the classer notices in breaking a sample. Furthermore, this resistance is influenced by the limberness of the fibers, or the ease with which the individual waves straighten out and allow the fibers to slide past each other. Thus, there is a chain of events depending on the relative humidity of the atmosphere, which causes differences in breaking resistance or drag. Drag depends upon the number and regularity of fiber convolutions as well as the waviness of the fibers and their tangled conditions. The convolutions, in contrast to waviness, are small twists of the fiber that are invisible to the naked eye. The number of these convolutions per inch decreases as the moisture content of the fiber increases.

79. Strength.—The strength of fiber, which is also influenced by moisture content, increases considerably as the humidity of the atmosphere in contact with the fibers is increased.



Figure 18.—Uniformity of length. These illustrations show two cotton seeds with the lint combed out to demonstrate uniformity. The specimen at the right is from a pure strain selected for its regularity. Observe the contrast in the specimen on the left which has degenerated into a "butterfly" type.

The amount of moisture affects the strength and frictional properties of the fibers so that the classer may arrive at different decisions of length for the same sample under different conditions. Stapling under controlled humidity and temperature gives much more consistent results and should be used wherever possible. Classification of wet or extremely dry cotton should be avoided at all times.

L. Micronaire Readings

81. Measuring fineness and maturity of fibers.—Micronaire (mike) readings, as determined by airflow instruments, (see item 5) are measures of the fineness of individual fibers and are used widely in merchandising and manufacturing cotton. This measurement also indicates fiber maturity. Mike readings are the most widely used instrument measurements in domestic and international trade today. This measurement is useful to mills in their quality control program to assure a uniform and even-running mix. It is a reproducible test which is rapid enough to be used on a bale-to-bale basis and has been part of the USDA official cotton classification since 1966.

82. Optimum micronaire.—Optimum micronaire value is dependent upon many things, including the genetic variety of the cotton and the relative importance of strength and appearance required in any specific product. Different cotton varieties vary in micronaire at full maturity. Although very fine yarns require fine fibers for yarn strength, extremely fine fibers may be immature. Immaturity can cause dyeing irregularities, increase manufacturing waste in the picking and carding operations, and lower product appearance. Due to these considerations, upland cotton which mikes in the middle of the scale, from 35 to 49, is usually the most desirable. A mike reading below the middle, or premium, range may in-

ferior. Overmiking above this range may not have the fineness required for the manufacturing of many high-quality products.

83. Factors that affect micronaire.—Fiber fineness is a varietal characteristic. Therefore mike readings differ for the various botanical types and to a lesser extent for the varieties within each type. Growing conditions in the latter stages of development of the fiber can measurably affect the way the fibers fill out as they mature. Favorable growing conditions, which include optimum moisture, temperatures, and sunlight result in a fully mature fiber. Unfavorable conditions such as lack of moisture, early freeze, or any other interruption of plant processes, will result in immature fibers and low micronaire readings.

84. Micronaire development.—The measurement of cotton fiber fineness and maturity was a very slow and tedious task until the air-flow instruments were developed in the late 1940's. Air-flow values were standardized for micronaire readings through the International Cotton Calibration Standards program in 1957. Calibration cottons for mike are available from the Cotton Division's Standards Section in Memphis, Tennessee under this program.