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CONTENTS

INTRODUCTION

Heredity is the key to the improvement of the cotton crop, but methods of constructive application have also to be devised, to the end that regular production of uniform fiber may be established. Without a system of production that can utilize superior varieties, the refinements of theory and technic in cotton breeding remain futile. The attainment of uniform fiber is a problem that includes not only varietal characters, breeding methods, and effects of different conditions of growth but also the precautions that are necessary in harvesting, ginning, classing, and marketing a cotton of uniform quality. Some of the most important factors of uniformity are found in the field of production, after all of the breeding precautions have been applied.

Varieties with very desirable characters still have little value unless they are utilized to supply fiber of regular quality. Commercial quantities of uniform fiber must be placed in the market and go into use before the better qualities of a variety can receive adequate recognition. Until manufacturers can be assured of being furnished from year to year with fiber of the same quality, there is no basis for establishing the favorable price relations that are necessary to encourage a large-scale production of superior varieties. The actual utilization of superior varieties through periods of years is the test of the practical application of theories of heredity to the cotton industry (*6*, *8*, *11*).[1]

Formerly it was supposed that superior varieties of cotton, once they were bred and small quantities of seed distributed, would be adopted and increased without further attention from the breeder

[1] Italic numbers in parentheses refer to Literature Cited, p. 22.

being necessary; but many obstacles were found that interfered with the utilization of better varieties and restricted the production of better fiber. After many select strains had been distributed by the Department of Agriculture, a canvass showed that none of the improved stocks had been preserved and established in cultivation. The precautions of isolation, roguing, and separate ginning had not been applied. The select seed that had been distributed, instead of being increased separately, had passed into the general mixture of gradually deteriorating seed stocks. The effects of mixing and the differences between uniform and mixed stocks are shown in plates 1, 2, and 3.

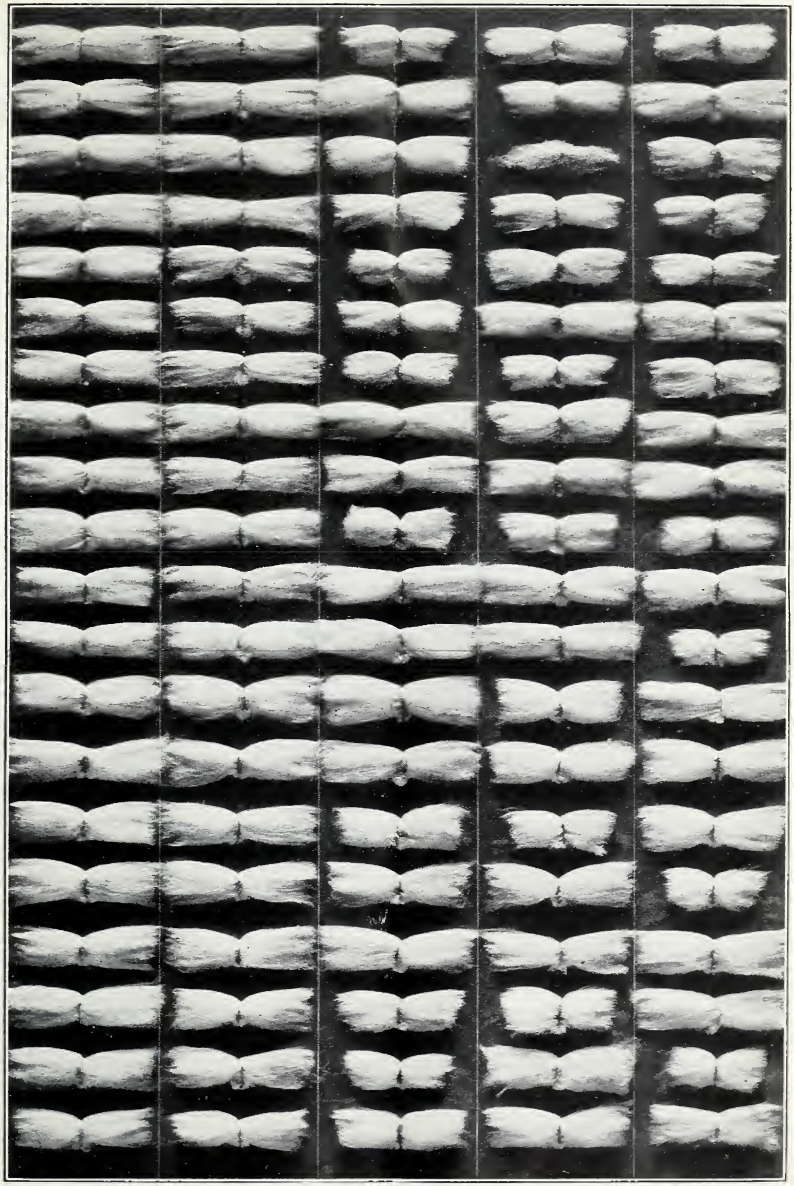
Further study of the problems of improvement led eventually to the plan of community production of a single variety, in order to provide the conditions necessary for increasing and maintaining the stocks of pure seed. Experience in the development of single-variety communities in several of the cotton-growing States has simplified some of the problems and brought out the essential requirements for sustained production of uniform fiber. Production from pure seed and separate ginning, handling, and marketing of the crop are the necessary precautions for supplying uniform fiber and for enabling the communities to obtain the practical advantages of applying such precautions. Field inspection has been necessary to maintain the uniformity of the seed stocks, and the methods developed for that purpose can be used for determining the uniformity of the crop.

Three outstanding new varieties—Durango, Meade, and Acala—were developed by the United States Department of Agriculture in the period 1908–16 and placed in cultivation in several localities. In each case the immediate response was very favorable on account of premiums then being paid for longer fiber, and the yields were larger than from other varieties of comparable staple lengths. But the supplies of pure seed were entirely inadequate, and the sudden popularity of the new varieties was followed by commercial selling of large quantities of mixed seed. The resulting crops showed a serious decline in the quality of the fiber, and the varieties soon fell into disrepute, even in districts where good results had been obtained a few seasons before. No consistent efforts were made by the growers to maintain the seed stocks, and in a few seasons the varieties were practically discarded.

The Acala variety was preserved and the breeding work was continued under conditions of complete isolation of the seed stocks in the Coachella Valley of southern California. An association of growers was established in 1920 for planting the Acala variety exclusively. The stocks of pure seed were increased for use in other districts, and an extensive utilization of the Acala cotton has resulted, with the original Acala community serving as the model for many others, first in the irrigated valleys and later in the eastern Cotton Belt (*14*).

NEED OF UNIFORM COTTON

The lack of sufficient quantities of strong and uniform cotton is recognized as a serious limitation of the textile industry. Unless the manufacturers can obtain regular supplies of suitable raw material, they naturally are unwilling to take the risks involved in



UNIFORM AND MIXED COTTON.

Fiber combed on the seed, each column of 20 combings taken from 20 consecutive plants in a field of cotton, the five columns representing five fields in the same district. The two columns at the left are from fields planted with a uniform seed stock, while the three columns at the right are from fields planted with mixed gin-run seed, some of the plants with fiber as long as the uniform fields, but many other plants with only short fiber. One third natural size.

FIBER DIFFERENCES IN MIXED COTTON.

Natural size of fiber combings as shown reduced in the lower right-hand corner of plate 1, to show the actual extent of fiber-length differences often found in fields of cotton planted from mixed seed, and especially in districts where varieties with longer staple have been introduced, but are planted by only a part of the farmers so that the seed is mixed at the public gins.

establishing lines of goods that require special qualities of fiber. The extent of the demand that might develop for cotton of better quality is only to be determined by the development of an adequate supply. The low quality of much of the American cotton crop has led to injurious competition in foreign markets in recent years, so that the need of improvement is widely recognized, though the requirement of uniformity as an essential factor of improvement is commonly overlooked.

Fiber of even quality is essential for fine spinning and for all purposes that require special strength or durability. Every addition of short or weak fibers means that the threads break more frequently in spinning and weaving, that the costs of manufacture are increased, and that the products are less serviceable and less attractive. Elaborate combing machinery has been invented which is supposed to separate the short fibers, but combing is a slow and expensive process, and manufacturers who use long staples have found that fiber of uniform quality is necessary for satisfactory results.

The traditional willingness of fine spinners to pay more for crop lots of cotton is a long-standing testimony to the value of uniformity. The thread and lace manufacturers who required the longest and most uniform fiber bought their cotton direct from the growers on the Sea Islands of South Carolina, to avoid the danger of different lots being mixed in commercial classing. The former plantation system undoubtedly was better adapted to the production of uniform fiber than the small-farm and tenant system of the present day. Standards of strength and durability that formerly were met by using sea-island cotton are no longer considered attainable.

The art of selection was highly developed on the Sea Islands of South Carolina more than a century ago, in advance of any similar branch of agriculture in the United States or in foreign countries. Many of the Sea Island planters practiced selection and increased the seed of superior individual plants in separate fields, which kept their seed stocks uniform. Care was taken to grow the plantation cotton on good land where uniform fiber could be produced. The fields were carefully inspected during the growing season and any areas that failed to develop normal plants were given special treatment during the winter months, by drainage, manuring, or applications of mud from the salt marshes.

The cotton was picked carefully, was dried in the sun, and was conditioned in storage to the end of the harvest so that the moisture content of the seed cotton was equalized and better ginning could be done. Plantations had their own gins so that the seed stocks were kept apart, while now our public gins mix the seed and mongrelize the varieties, to the general detriment of the crop. Great numbers of cotton farmers unwittingly disregard the Biblical ordinance, "Thou shalt not sow thy field with mingled seed." (Lev. 19:19.)

Production and marketing were disorganized in the Civil War period, and the coming of the bollweevil occasioned a general change to early-maturing varieties, which generally were inferior to the cotton previously grown. Intensive commercial advertising has extended the sale of seed of varieties with very inferior fiber, by lead-

ing the farmers to believe that the turn-out at the gin was the only feature to consider (*4*, *10*, *15*). With the decline of quality and uniformity of the crop, the custom of "hog-round" buying became generally established; that is, paying all the farmers in a local market the same price for their cotton. Short and mixed fiber was taken at the same price as good cotton, so that the incentive for improvement was denied.

Cotton of special quality is needed for making the lighter and more open fabrics that are coming into vogue, now that the wearing of excess clothing is being avoided. Special uses are but little developed, for lack of adequate supplies of special fiber. Cotton still is considered largely a substitute for linen, silk, or wool, instead of being utilized for the qualities which render cotton preferable to other material for many purposes of personal use. The "air-tight" shirtings and other fabrics that are woven very close in order to look like silk or fine linen are an evidence that the special qualities of cotton have not been appreciated by the public. Cotton garments are not shiny or sticky like silk, and do not shrink with repeated washing as do linen or wool fabrics.

RELATION OF BUYERS TO PRODUCERS

Since cotton is raised only to sell, the farmer is interested in improved varieties only to the extent that fiber of superior quality is recognized in the market and brings him a money return in dollars and cents for his efforts and precautions. Thousands of progressive farmers have made the experiment of planting better varieties, but have been discouraged by the commercial custom of indiscriminate buying. Even in districts where the majority of the farmers produced better cotton to the extent that buyers were attracted and competition resulted in higher prices being paid in the local markets, the hog-round system was still followed, and the improvement undertakings eventually lapsed.

The relation of cotton buying to cotton growing was the subject of a publication (*5*) issued by the Bureau of Plant Industry in 1914, in which some of the effects of the commercial system in the field of production were considered. Subsequent experience has led to further recognition of the extent of such influence as a factor of critical importance in the problem of improvement. Not only the prices that are paid to the farmers for particular qualities of cotton have their influence upon production, but also the methods that the buyers use in recognizing these qualities naturally affect the interest and willingness of the farmer to adopt the precautions that are necessary for producing better and more uniform fiber. Experience has shown the futility of urging upon farmers the use of improved methods or varieties unless there can be a definite prospect of selling the improved cotton for better prices than are paid to more backward neighbors who continue to plant inferior varieties or ordinary gin-run seed.

The possibilities of field classing, in order to supplement the current commercial methods and to afford a practical basis for more discriminate buying, were recognized in the publication of 1914 (*5*)

and recommended to the consideration of buyers who might be interested in encouraging the production of better cotton among their farm clients, as the following will explain (*5, pp. 16, 17*):

> As already stated, it is not a question of paying more for the cotton, but of paying more to the farmers who produce good cotton and less to those who produce poor cotton. This simple expedient would do more than any amount of exhortation to increase the proportion of farmers who would take the care that is necessary to produce good cotton. Buyers who really have the powers of discrimination that are needed in their business would have no serious difficulty in learning how to determine the value of the crop in the field much more reliably than they can determine it by drawing samples from the bales. The risks they now take in trusting to bale samples alone could be avoided almost entirely by learning how to judge the cotton in the field. In order to have a beneficial effect on production, discrimination must be based on real differences in the cotton. Arbitrary discrimination is naturally resented by the farmer as a dishonest effort at buying his cotton for less than its actual market value. When different prices are paid for bales that were raised in the same field, gathered by the same pickers, and ginned at the same gin, the farmer is compelled either to doubt the honesty of the buyers or to question their ability to distinguish the quality of cotton in the bale. Differences of 3 or 4 cents a pound in the valuation of the same lots of cotton are common in long-staple markets.
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> In failing to make use of the opportunity of judging cotton in the field the present system of buying becomes wasteful and inefficient. Buying cotton at a flat price without discrimination of quality means that all the different grades and qualities that a region produces are brought together, and then they are sorted out again, though there is much less chance of correct judgment as to quality than before they were brought together. Buying from a knowledge of the cotton in the field would require, no doubt, more work from the buyer than he now applies to his business, but the effort would be worth while and might be expected to find proper remuneration.

Though only a few buyers have made use of this suggestion, notable advantages have been obtained in particular cases which might have served very well to demonstrate the value of the method, except that buyers who have profited by field knowledge of the cotton quality have not been anxious to popularize such information among the farmers or among competing buyers, as that would tend to advance the prices that would need to be paid to growers who produced better cotton than their neighbors. The subsequent experience has shown that discrimination by individual buyers, while it may encourage individual growers to a certain extent, does not produce any general reaction among the farmers toward a sustained production of more uniform cotton by the community as a whole. Only through community cooperation is there a practical prospect of developing satisfactory systems of production and marketing of cotton.

Staple-length differences are now being recognized by the buyers to a much greater extent than a few years ago, though seldom in a constructive manner that would tend to establish production of more uniform fiber. The planting of longer staples by scattered individual growers in short-staple districts does not render the cotton more uniform but more irregular. A few farmers may buy good seed and raise crops of good fiber, but in a season or two the seed is mixed and the fiber becomes irregular, as shown in plate 1. Even before the seed stocks become mixed, the accidental plating of bales from different kinds of cotton following each other at the gin is a frequent cause of lower prices to the farmer and of extra costs for repacking

the mixed bales. The practical outlook to greater uniformity is through localized production in organized, single-variety communities, in order to keep the seed stocks pure and to provide for separate handling and marketing of the uniform fiber.

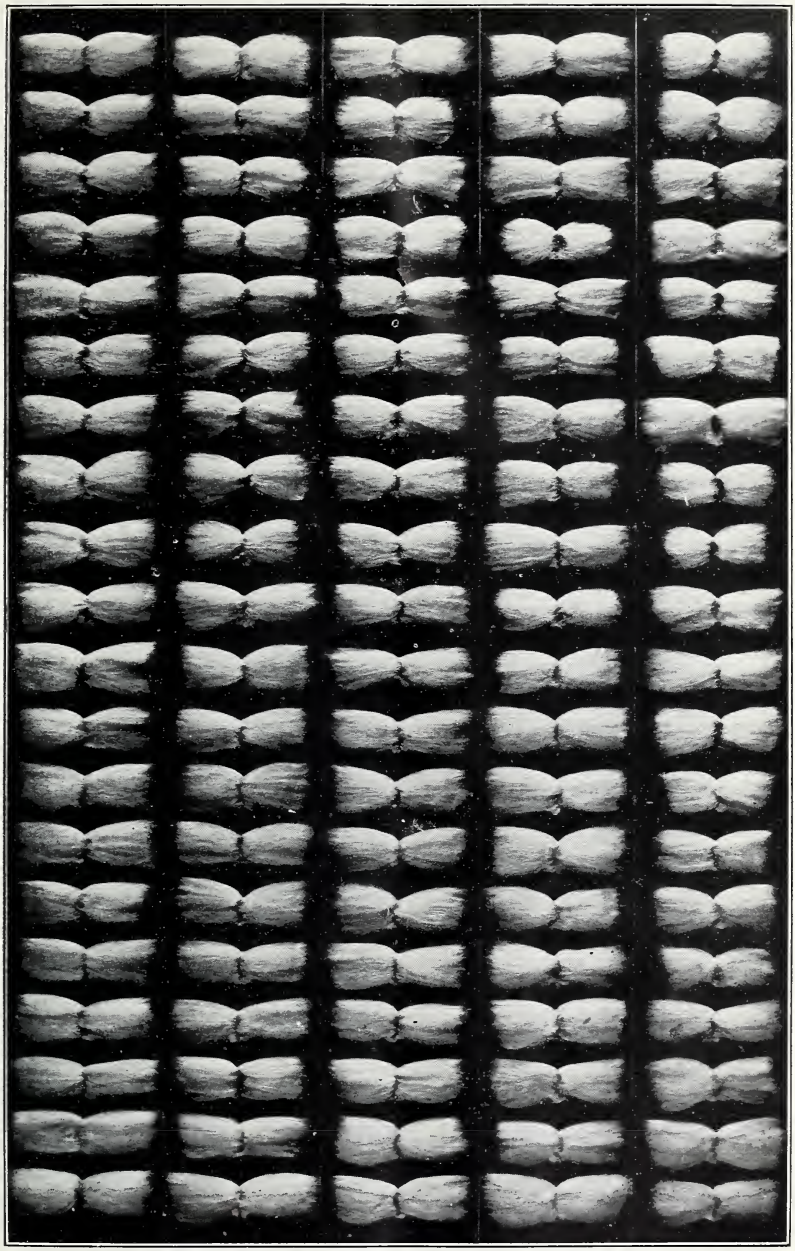
With a standardized community production, the methods that have been used in the commercial classing of cotton can be supplemented by field inspection and rendered much more effective for distinguishing between uniform and irregular fiber. The principal hazards of the existing system of production undoubtedly can be removed by field inspection. Careful picking and ginning of course are required in order to market the cotton in good condition, but the essential quality of the fiber is determined in the growth period. Mixing of seed and unfavorable conditions of growth are the chief causes of irregularity in fiber quality, whose results can be seen and avoided by field inspection and segregation of the different qualities of fiber in advance of ginning and commercial classing. Precautions for producing uniform fiber can be applied to the same advantage through community cooperation as under the old plantation system, if suitable adjustments are made to meet the present conditions.

GENETIC AND ENVIRONMENTAL UNIFORMITY

Pure seed and equable conditions of growth are required to produce uniform fiber. It is useless to argue that one requirement or the other is more important, since both are necessary, and neither can give satisfaction without the other. A stock of seed has genetic uniformity when all of the plants are of the same type and bear the same kind of fiber, but the product may lack uniformity if the conditions of growth are irregular, so that an equal development of the fiber is not obtained. A pure stock grown under unfavorable conditions may be as uneven as a mixed stock under good conditions, though the nature of the irregularity is not the same.

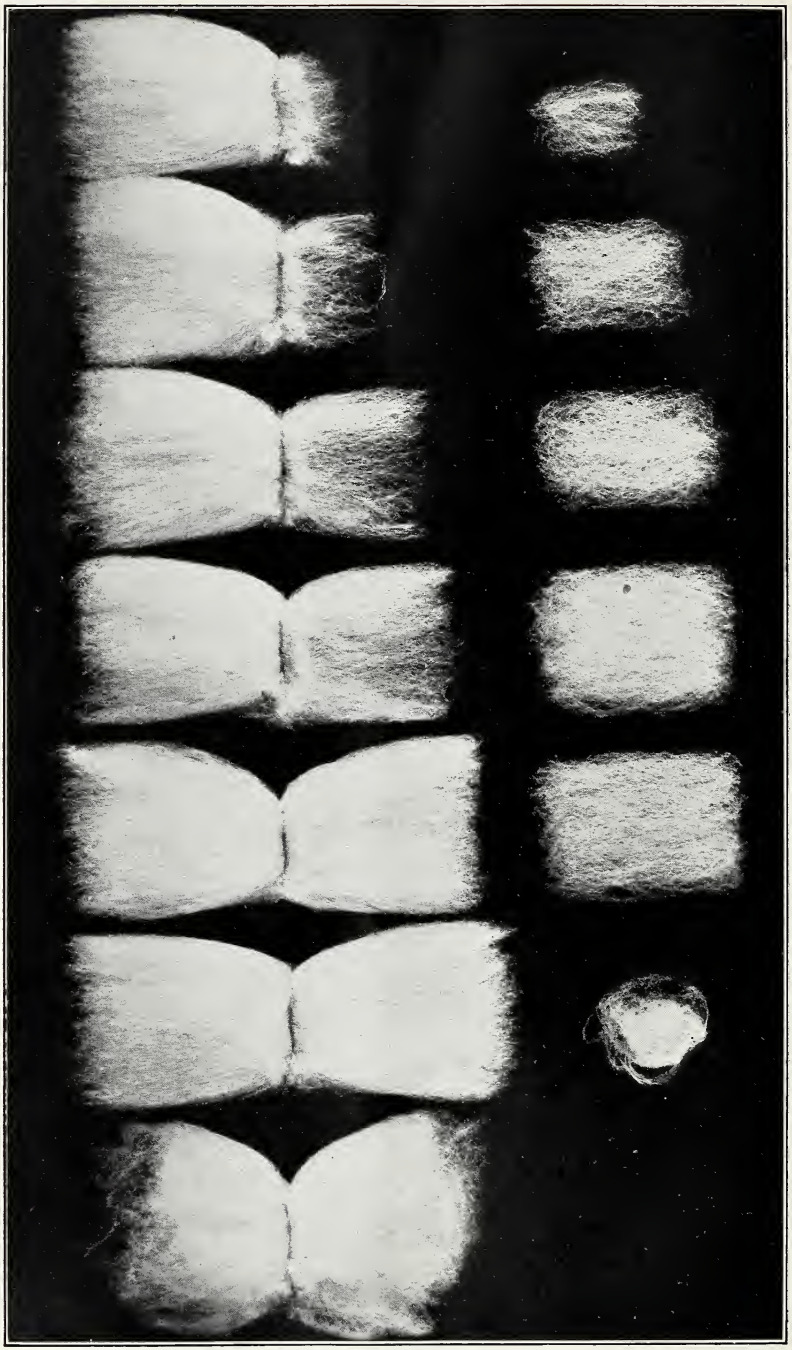
Where notable diversities of fiber length are found between successive plants in a row of cotton, as in the right-hand columns of plate 1, it is plain that the seed is mixed, or that the breeding of the stock has not been carried to a state of uniformity. On the other hand, the plants may be uniform as individuals, but still may yield irregular fiber, since conditions may vary seriously during the growing season. Some of the bolls may produce normal fiber while other bolls on the same plant may be injured so that the fiber does not complete its development. Both classes of irregularity are easily recognized by inspection of the plants in the field.

By the simple expedient of collecting locks of cotton from successive plants, taken as they stand in the field, and combing the fiber on a seed from each plant, a good representation of the uniformity or diversity of the cotton is obtained. Such combings have been used to show the effect of selection in developing uniform seed stocks, and they serve equally well for comparisons of diversity in different fields (*16*, *17*, *20*). The proportions of plants with different staple lengths can be determined with any degree of accuracy that may be desired, by combings from sufficient numbers of plants. Combings from 20 successive plants often are sufficient to show pronounced differences in the uniformity of seed stocks when series of such combings are compared, as in plate 1.



SEED STOCKS FROM A UNIFORM VARIETY.

The original select stock is represented by the column at the left, followed by increase stocks for 3 successive years, grown in a district where gin mixing was avoided, though selection was not continued. The last column, showing markedly irregular fiber, was from another district where the stock was grown without precaution against mixture. One third natural size.



COTTON FIBER COMBED ON THE SEED.

At the bottom a seed with fiber parted, before being combed; next above a seed with all the fibers in place except those combed out in the straightening, rolled together at the side; the other seeds showing successive removals of different lengths of fiber from one side of each seed leaving shorter fiber still attached. Natural size.

The method of combing out the seed cotton from successive plants also serves for the comparison of different seed stocks of the same variety, to determine their condition from the standpoint of selective uniformity and their relative value and suitability for planting. The use of combings for comparing the uniformity of seed stocks is illustrated in plate 3 with reference to the Mexican Big Boll variety developed by the North Carolina Agricultural Experiment Station and planted in several organized communities in that State. Each column of the plate shows fiber of a different stock of seed, as represented by combings from 20 individual plants. The left-hand column shows the original select stock, the right-hand column a mixed seed stock of the same variety. The three intermediate columns are three generations of the original stock as grown in a one-variety community where gin mixing was avoided, though selection was not continued. The third generation, represented in the fourth column, shows a perceptible decline in uniformity from the select breeding stock, but still in notable contrast with the marked irregularity of fiber length in the fifth column, which was grown in another district, where gin mixing occurred.

The uniformity of a well-bred seed stock is a notable achievement of selection, but is limited in most of the producing districts to the relatively few fields that are planted with select seed. The great bulk of the cotton is found to be in a state of genetic diversity, produced from mixed, degenerate seed stocks, with the plants in the fields differing in many characters besides the length and quality of the fiber. The present state of production, with the general lack of uniform seed stocks and the frequent changes of varieties and seed mixtures, affords sufficient explanation of complaints that frequently are heard regarding the deterioration of cotton in particular districts, even where the natural conditions are known to be very favorable for producing uniform fiber. It becomes possible to deal constructively with the environmental requirements for producing uniform fiber in commercial quantities only if the genetic requirements for uniformity of seed stocks are met by community production of a single variety.

Though varieties of cotton have not been found to differ appreciably in requiring soils of particular composition, all varieties suffer if the plants are unable to obtain enough moisture. The long-staple varieties are limited to districts that afford more equable conditions of soil moisture, which are the particular requirement for uniform development of the fiber. Checking of growth, wilting of leaves, blasting of buds, abortion of young bolls, and poor development of the fiber are the usual results of moisture deficiency. Irregular conditions of production in portions of the irrigated valleys are responsible for notable differences of fiber quality which have limited the use of Egyptian cotton grown in Arizona. Periods of high temperature occur in which the growth of the plants may be badly checked and the fiber injured, especially where cotton is planted on the heavier or more impervious soils.

The effects of adverse conditions are readily seen in the fields, yet the cotton from the damaged bolls is picked and ginned with the remainder of the crop and is commonly overlooked in the classification of commercial samples. Hence it is easy to understand that

much of the cotton has been of very irregular quality, and that bales with large proportions of the weak fiber give trouble in spinning. On account of the uneven character of the cotton, some of the manufacturers supposed that different varieties of Egyptian cotton were being grown, though for many years only uniform seed stocks of the Pima variety have been planted. Crops of uniform cotton have been produced in many farms in the irrigated districts, but have not been marketed separately, so that manufacturers have had little opportunity to recognize and appreciate the greater uniformity attainable through community production of a single variety.

STAPLE AND SUBSTAPLE

The customary references to lengths of staple in sixteenths and thirty-seconds of an inch naturally convey the impression of great regularity in the lengths of the individual fibers, which never is the case. The problem of uniformity appears more complicated when it is learned that cotton is not uniform in the way that often is assumed, of having all of the fibers of the same length, even on the same individual seeds. A select seed stock is said to be uniform when all of the plants are uniform, but this does not mean that equality of individual fibers is attained.

The name "substaple" is applied to the shorter fibers that are always to be found among the long fibers on the cottonseeds (*9*). Every seed has fibers of many different lengths, down to the short "fuzz" that covers the seed of upland varieties (pl. 4). Even in the longest sea-island and Egyptian cottons a wide range of length is found, the longest fibers sometimes exceeding 2 inches and the shortest less than a quarter of an inch. On account of the wider range and more complete graduation of fiber lengths on the seeds of these cottons with the very long staples, the proportion of fibers that attain the commercial staple length may be smaller than in the upland type of cotton, though some of the upland varieties have very small proportions of long staple. Some of the upland long staples show the "butterfly" character, with the long fibers confined to the upper part of the seed, while the lower part has only substaple and fuzz.

The substaple is an important genetic factor, not only for the cotton breeder, but for all who are concerned with the problem of obtaining uniformity. On account of the larger proportion of natural substaple in the long-staple types it is even more important that seed stocks be closely guarded against admixture with short staples, to keep from increasing the already large amount of short fiber to the point where it gives trouble in the manufacturing process. The staple length that is recognized in commercial classing may be attained by only a quarter of the fiber, leaving about three quarters to be considered as substaple. When the fibers are pulled from the seed in a uniform stock like Acala, the proportion of staple-length fiber may reach 50 percent. Cotton breeders are familiar, of course, with the normal inequalities of the fiber, though little attention has been given to substaple. Experienced classers know that short fibers can be found in every sample, and this is taken to mean that all cotton is more or less mixed. Breeders make their comparisons with fibers

that are still attached to the seeds, while commercial and technological experts deal with the ginned cotton.

That all of the cotton fibers on the seed should attain the same length would not be expected by any student of plant variation, when the manner of growth is considered. Each fiber is formed by the growth of an individual cell, which can be seen on the surface of the very young seed as a slight protuberance or papilla. The fibers grow to their full length in about 3 weeks but require about 3 weeks more to thicken and harden the walls.

Knowledge of the substaple may be misinterpreted and may lead to a wrong conclusion regarding uniformity. On learning that the ideal of complete equality among the fibers is not to be attained, the impression may be formed that precautions for maintaining uniform seed stocks are not essential in practical breeding work. In reality the need for such precautions is not less on account of the substaple, but greater. The small proportion of long fibers, even in relatively good cotton, leaves no wide margin of safety in further dilution with short fiber, without the cost of uneven yarn and increased breakage in spinning and weaving. That mixed fiber may be bought from the farmers and sold to the manufacturers without being detected should not be taken as evidence against the need of uniformity. If the cotton contains excess substaple, so that it proves wasty or gives trouble in the mills, the demand for it is reduced and the reputation of the variety or of the producing district is impaired.

The need of uniform cotton sometimes is questioned by those who have heard of the custom of mixing several bales together at the mills, which is a partial protection against irregular fiber. A dozen bales may be opened at once, and portions of these are fed into the machinery in turn, instead of feeding continuously from a single bale. This precaution reduces the trouble that may be caused by a single bad bale if run by itself, and it is another indication of the need of uniform quality of fiber.

SUBSTAPLE AS WASTE

Though much of the substaple is utilized with the longer fiber, many of the shorter substaple fibers work out as waste in the processes of manufacture. Where long-staple cotton is combed before spinning, much of the substaple and weak fiber is separated as "comber waste." The proportion of such waste is increased where long staples are allowed to become mixed with short cotton, or are grown under unfavorable conditions that check the development of the bolls and shorten or weaken the fiber. The uniform cotton shown in the first two columns of plate 1 would carry its proportion of natural substaple, but the mixed cotton shown in the three other columns would carry much higher proportions of short fiber, whether considered as substaple or not. Many plants of the mixed stocks produce only short fiber, of the length of the substaple of plants of the better variety, and there is no way to distinguish between the short cotton and the substaple if only the commercial samples are considered, without recognizing the differences in the field or in the combed seed samples between mixed and uniform stocks.

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The combing operation in the mills is only partially effective in the removal of short fibers. Combing is required for fine spinning, but the need of uniform fiber remains. The analysis of combed fiber reported by Cobb (*3*) in 1915 showed that the proportion of short fibers was not reduced to the extent that had been supposed by many writers, and that some of the long fibers were broken in the combing machines. The greater strength of combed yarns is ascribed by Cobb to the straightening of the fibers, rather than to the supposed ability of the combing machines to remove short fibers.

Breeding and cultural precautions undoubtedly can reduce the proportions of short or damaged fiber, though it remains for these beneficial effects to be demonstrated on a practical scale to manufacturers through regular production of commercial quantities of uniform fiber. The full extent of the advantage to be obtained in this way can be definitely determined only as uniform fiber goes into regular use, but there is reason to believe that readily appreciable differences will be recognized as soon as the supplies of fiber of known uniformity are sufficient for the manufacturers to make adequate comparisons in normal mill operations.

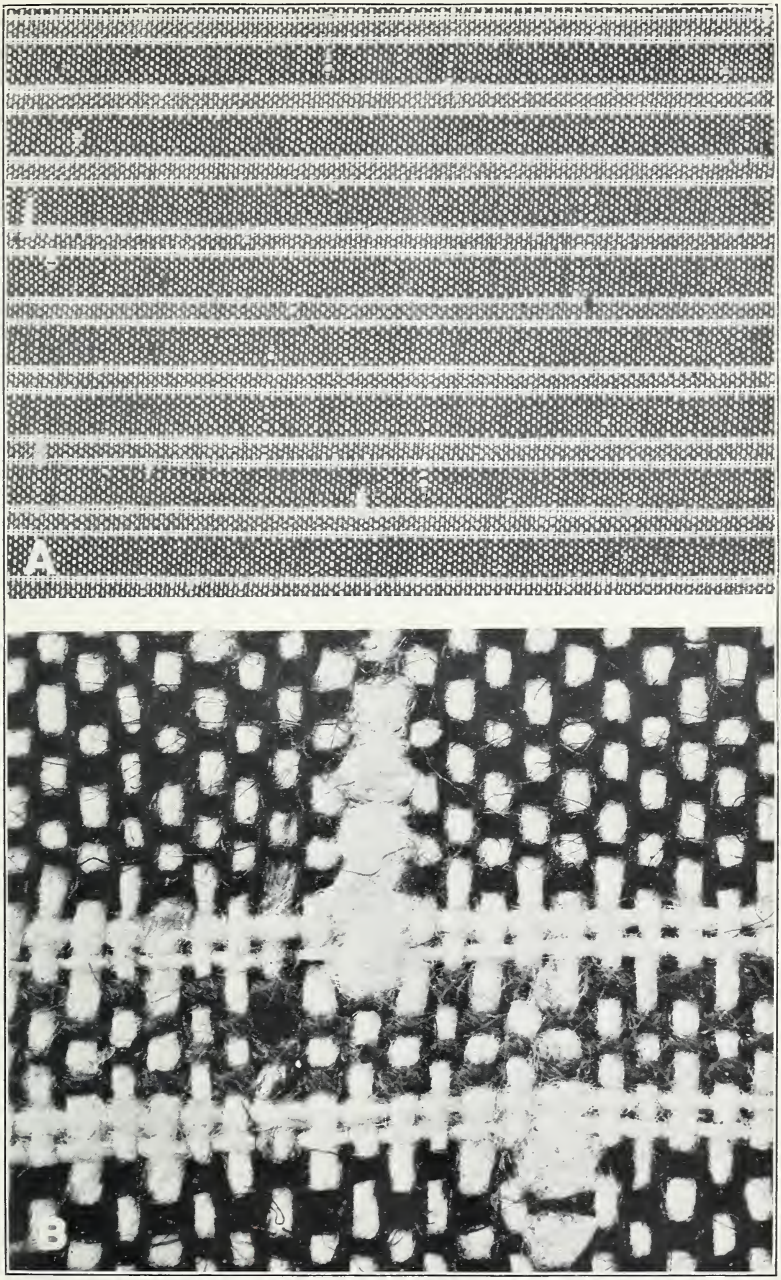
An interesting comparison is reported by G. L. Crawford, of the Bureau of Agricultural Economics, United States Department of Agriculture,[2] between 10 bales of cotton from a field that had been planted with seed of a uniform variety and another lot of 10 bales that had received the same commercial classification as to grade and staple, but were assembled from several different localities. Although all of the 10 bales from the uniform field had not been given the same commercial classification, the results of the mill tests were distinctly in favor of this lot of cotton. A greater breaking strength was obtained with the yarn from the uniform field, and the visible waste was slightly less.

SUBSTAPLE IN RELATION TO CLASSING

Uniformity as a problem of production no doubt has received less attention on account of the popular belief that bales of cotton can be placed in "even-running lots" by the classing of commercial samples. The difficulties of classing are not appreciated until account is taken of the substaple and of the mixed nature of much of the cotton. Variations in classings of the same samples have led to a recognition of the need of more exact methods.

Machines have been invented for sorting fibers from commercial samples so that groups of different fiber lengths can be separated and weighed, but these are laboratory operations which require time and skill and are of limited application. Also, the mechanical analysis of cotton from bale samples may not reveal the lack of uniformity that can be seen by inspection in the field. The larger proportion of short fiber in cotton from a mixed field may even be taken as an indication of uniformity. Suggestions have been made, in the interest of greater accuracy in classing, that the average length of the fibers or the length of the largest proportion of fibers (modal length) should be taken as the true staple length, but either of these methods would be misleading. The conventional staple length or "typical

[2] Personal communication.



FABRIC MADE FROM IRREGULAR COTTON.

A, Fabric natural size, showing defects caused by uneven "cockled" yarn, which results when irregular lots of cotton are used, such as that produced in the fields represented by the three right-hand columns shown in plate 1. The cockled yarn results from too much long fiber being present in the lots of cotton that have been classed as short fiber and used as such by the mill. B, A section of the fabric enlarged 8½ times.

BOLLS OF PIMA COTTON GROWN IN ARIZONA.

At the left three badly damaged, "pinched" bolls, partly opened; in the middle column three "hard-lock" bolls, with more normal opening, but the fiber not fluffed, in contrast with the three normally matured bolls at the right. Natural size.

portion " of a sample has reference to the use of the cotton for spinning, which must take account of the longer fiber.

The modal length of a uniform cotton should approach the commercial staple length, while a mode that diverged from the staple length would suggest a mixed cotton, or an excess of substaple, if the stock were uniform. To disregard the long fiber, and consider mixed cotton " uniform " on account of having a larger proportion of short fiber, invites the danger of irregular " cockled " yarn, with resulting defects in fabrics, as shown in plate 5. The cotton produced in fields of mixed varieties like those represented by the three right-hand columns in plate 1 would be expected to give this trouble in the mill, if spun as short staple.

Field uniformity has reference primarily to the desirability of maintaining uniform proportions of staple-length fibers, rather than to determining the lengths and proportions of the shorter fibers. Analysis of the substaple also is desirable, since differences may be found which will have practical importance in selection, if regular production of superior varieties can be established.

The need of giving more attention to the substaple is being recognized by cotton breeders, and machines are being devised to facilitate the determination of different proportions of fiber lengths produced by individual plants, as a character to be used in selection. The seed with the combed fiber still attached is placed in the machine. The fibers are drawn through a series of combs as in a Baer sorter, but are pulled directly from the seed instead of working with ginned samples. Beginning with the long fibers, a series of pulls is made, thus gradually removing the fibers from the seed and placing them in groups according to length. The amount of staple or substaple of the various lengths can be determined by weighing these groups.[3]

Expert classers can recognize minute differences of staple length in commercial samples, but the value of such determinations rests on the assumption that the cotton in the bales is of uniform quality, which frequently is not the case. The purpose of classing is defeated when the cotton is uneven, whether as the result of seed mixing, irregular conditions of growth, or careless ginning. Greater uniformity of fiber probably existed in the plantation period, when the method of stapling was developed, than at the present day. With the crop becoming more irregular by mixing and mongrelizing through the public gins, the problem of detecting differences between fiber produced from mixed and uniform seed stocks has become more difficult. Even in badly mixed stocks enough long fibers may be present to pass the stapling test, though most of the fibers may be inferior. The slight relations that often exist between the commercial classification of raw cotton and the finished products are recognized in a recent report of the Bureau of Agricultural Economics (*21*).

According to the usual methods of stapling commercial samples, a small mass of cotton is held rather firmly with both hands and with a slight rolling motion is slowly pulled in two, so that the

[3] E. H. Pressley, of the Department of Plant Breeding, University of Arizona, has invented a machine for making such determinations, and a detailed account has been published (*19*). A smaller and simpler device for the same purpose has been devised by Homer C. McNamara and Robert T. Stutts, of the Bureau of Plant Industry, and tested in laboratory use. An application is being made for a public-service patent.

"drag" can be felt in the slipping and breaking of the fibers. The longest and strongest fibers are straightened and exposed at the "break" and are extracted in making the "pull" for judging the length and strength of the staple. The longest fibers may be discarded in "evening the pull", but even with that precaution the stapling operation is more highly selective than usually is recognized, and the result may be misleading. The sample may contain a large proportion of shorter or weaker fibers which do not appear or are not detected in the stapling, but come out as waste or give trouble in the mills. (For a more detailed description of the method of pulling staple see 2.)

RANGE OF FIBER LENGTHS IN CLASSING

Even when commercial quantities of uniform cotton are produced the fact may not be recognized, on account of different staple lengths being reported on the commercial samples, so that the bales do not remain together but are distributed into different lots with other cotton. Even with cotton that is produced from uniform plants and grown under uniform conditions, different classings may be given to the bale samples, and this is not surprising when it is considered that each sample has a range of fiber lengths below and above the commercial staple length. That some of the bales should be stapled on the substaple and some on the superstaple, with the fibers longer than the "typical portion" of the sample, is to be expected.

As an example of the range of differences that may be reported for the same cotton, records of two classings of a series of 223 samples may be noted. Though showing the same general range of staple lengths, the two classings of the individual samples often ran far apart. Different staple lengths were reported in 155 cases and equal staple lengths in 68 cases. The second classer added one thirty-second of an inch to the length in 69 cases, reduced the length by one thirty-second of an inch in 45 cases, added one sixteenth in 16 cases, took away one sixteenth in 25 cases, and in 2 cases made the staple shorter by three thirty-seconds of an inch. The numbers of the samples reported under the different staple lengths were as follows, the figures of the second classer being in parentheses: Staple length $1\frac{1}{16}$, 1 (1) sample; at $1\frac{3}{32}$, 11 (16) samples; at $1\frac{1}{8}$, 124 (85) samples; at $1\frac{5}{32}$, 34 (100) samples; at $1\frac{3}{16}$, 50 (21) samples; at $1\frac{7}{32}$, 3 (0) samples.

A general agreement in the classing of a series of samples is the most that is reasonably to be expected, as in the above instance. The two reports showed an extreme range of only five thirty-seconds of an inch, and this in only a few cases. Most of the samples were placed by both of the classers within three thirty-seconds of an inch of the same length, a large proportion at $1\frac{1}{8}$ or at $1\frac{5}{32}$ inches. If the stapling had been carried only to sixteenths instead of to thirty-seconds of an inch, the samples probably would have been reported in 3 classes, most of them at $1\frac{1}{8}$ and $1\frac{3}{16}$ inches, instead of being distributed into 6 classes. With the fields inspected for uniformity and ginned with the same care the entire series might have been referred to the same staple length.

Classing is a special art that is closely comparable to plant breeding, in requiring a very acute discrimination of slight differences, not perceived by the unaccustomed eye. Variations in classing ability are recognized and are ascribed to ill health or other subnormal conditions affecting the judgment of the classers. Such causes may contribute to particular discrepancies, but with material as irregular as much of the commercial cotton it is easy to understand that even the most competent classers must give varying reports. Much more of the cotton crop corresponds to the samples shown in the three irregular columns of plate 1 than in the two uniform columns.

AVOIDING EXCESS SUBSTAPLE

As already noted, cotton produced from mixed seed stocks may be considered as having more substaple and less staple-length fiber than would be obtained from a pure seed stock. Each of the short-staple plants in a field of a longer variety increases the proportion of short fiber, until the limits are reached where the spinning value of cotton is seen to be definitely impaired. A regular proportion of the longer staple-length fiber is required to give the threads an even strength and carry them through the manufacturing processes without breakage.

The proportions of staple-length fibers are irregularly distributed in cotton from mixed fields because the short-staple plants are not uniformly distributed throughout the fields. Ginning mixes the fiber from the different plants, but not as intimately as the natural substaple is combined with the longer fibers. Not only may accidental mixture at the gin be overlooked in commercial classing, but deliberate additions of short fiber may "get by" with the buyers, so that the farmers do not understand the need of precautions. In some of the former long-staple districts many farmers followed the custom of adding 20 to 25 percent of short-staple seed, to increase the yield, and even larger proportions of short-staple were often overlooked. One farmer declared: "I always mixed my seed 50–50, and never had any trouble selling my cotton." Such incidents may explain why manufacturers have little confidence in the uniformity of our upland long staples, and pay much higher prices for cotton of the same staple length imported from Egypt.

A stabilized production of more uniform cotton is possible through organized effort for maintaining supplies of pure seed, and manufacturers who have need of such fiber should welcome the community product. Buyers who are in touch with single-variety communities may learn how to protect their customers by seeing the cotton in the field and checking the uniformity of the fiber. Professional classers may find it difficult to believe that uniformity can be determined more definitely in the field than from the commercial samples, but may be induced to consider the advantages of such an extension of their art, and to make the test of actual practice in using the new method.

What to look for in the inspection of a cotton field is shown in plate 1 in the contrast between the two columns of uniform fiber and the three columns of mixed fiber. If all of the plants in a field are producing fiber of the same length and quality, as represented in

the first two columns, the cotton in the bales will be uniform, while from the fields that have different kinds of plants the cotton will be irregular.

A hundred or a thousand acres of uniform land planted with the same mixture of seed would yield the same run of irregular fiber. As parts of the same general mixture, all of the bales would be essentially alike, yet differences would be found among the samples, and the bales would be assigned to several staple-length classes and placed in different commercial lots. If the cotton were like that from the three mixed fields shown in plate 1, many of the bales would be classed with that from the two uniform fields shown in the first two columns, while other bales would be considered as shorter staple lengths. None of the cotton would be uniform, and rejections would occur if its irregular nature were detected.

The uniformity of the plants in the field, as indicated by combings of the fiber on the seeds from successive plants, affords a basis for comparison of cotton from different fields or from different districts. The field uniformity of cotton has been greater in some districts than in others and no doubt is an important factor of "extra quality" that has led the manufacturers to pay premiums for cotton of particular districts above other cotton of the same classification as to grade and staple. Though favorable conditions are required for the production of good fiber from any variety of cotton, the differences of varieties and seed stocks are vastly more important than are recognized in the commercial world.

The changes of commercial opinion that have occurred in recent years regarding the relative values of cotton from different districts have resulted very largely from changes of varieties or from inferior varieties being planted to the extent of serious mixture and deterioration of seed stocks. The need of more definite information is being recognized by the manufacturers, even to the extent of making elaborate and expensive tests of each lot of cotton that is purchased. As a result of long experience manufacturers are recognizing that neither the commercial classification of the cotton nor the place of origin affords sufficient evidence of the intrinsic quality of the fiber. The following statement of the reasons that have led the manufacturers to the extra precautions that are now being taken is quoted from a recent address on How Cotton is Bought, by a cotton manufacturer, Philip A. Moreland, of the Pequot Mills, before a meeting of agents, superintendents, and managers of mills in New England and New York State (*18*):

> The cotton buyer today must shop around if he is to be successful. He must keep in mind where the most reasonable cotton can be obtained for his mill without lowering one iota the quality of its product.
>
> In the past and even now the cotton shipped from Memphis market has commanded a premium over most southern markets for cotton of the same grade and staple, this premium running as high as from 25 to 40 points, because the character of the cotton grown in this district had proven to be superior to that grown in many other parts of the Belt, and buyers desiring this extra quality have paid the premium, considering it a sound investment.
>
> This was true of most shipments, but when the premium became high enough, considerable cotton from other sections of the Belt, where freight rates permitted, were shipped to the Memphis market, the local tags removed, replaced with Memphis tags, and then shipped to mills as Memphis District cotton at the prevailing premiums.

In mills where picking, carding, and spinning tests are made of every lot received, many of these other growths proved as satisfactory as the Memphis District cotton. This caused buyers to use these growths also, reasoning naturally "If we are going to receive this cotton anyway, why not benefit by the saving in price?"

One factor in saving is the freight rate which from several Gulf and Texas ports is 35 cents per cwt., as compared with 55 cents per cwt. from Memphis to Boston and vicinity, and translated into cash, amounts to $1 a bale.

Apply this saving to 10,000 or 20,000 bales a year, and you have a sum which by no means can be ignored.

The "shop-around" policy of the manufacturers is a natural result of the lack of continuity in production. That a district furnishes a satisfactory quality of fiber in a particular season affords no assurance for the future, under the usual conditions of unorganized production. Varieties are changed frequently for reasons that have no relation to the quality of fiber, but only to the yield, the gin turnout, and the business efficiency of seed sellers. Most of the crop is grown from gin-run seed, which fluctuates in quality from year to year in every locality where farmers are influenced by commercial advertising or by the popular belief that a frequent "change of seed" is desirable.

These hazards are seen to be unnecessary when the alternative of stabilized community production of a single variety has been recognized. That the raw materials of the textile industry have to be purchased on a speculative market is considered as an economic waste, and the speculative quality of the fiber is another great handicap, yet capable of being removed by organized production in single-variety communities, and checking of fiber quality in the field. To overlook the principal causes of irregularity in variety changing and seed mixing is to leave the problem of fiber improvement beyond the range of practical solution, with only limited and uncertain supplies of good cotton in prospect for the manufacturer, even with the best effort that he can make to search in different districts for cotton adapted to his use.

The advantages of community production of uniform cotton are being recognized by some of the manufacturers who are located in the same districts where single-variety communities are being developed in the southeastern cotton-growing States. Some of the community cotton has been purchased directly by the mills and found satisfactory, but this does not mean that the problems of community production have reached a complete solution. It is necessary that the community precautions be regularly applied during a period of years before their full value can be appreciated. Disappointment is sure to result if too much reliance is placed merely upon the demonstration that more uniform cotton can be produced under the community conditions, without considering that changes in the buying system are necessary to establish a regular production of uniform cotton. The interest of the manufacturer must be enlisted at least to the extent of understanding that the community cotton must be handled and sold separately, as well as separately grown. An agricultural writer (*1*) recently stated very effectively the facts that the manufacturer should consider in relation to community production:

The world will use more cotton as fast as the manufacturer creates new or better products. And in doing this, the manufacturer is helped if he can get hundreds or thousands of bales of the same kind of cotton from the same

community, year after year—without having to collect it in driblets here and there over the cotton belt. In the one-variety community, the manufacturer not only finds it easier to obtain the kind of cotton he wants, but it is better for his purpose—it is all one breed, of the same "character" and spinning quality. It has less waste in spinning, and turns out a better article.

The manufacturer can go back to the one-variety community and get the same sort of cotton next year, and the year after. He must know that, if he is to install machinery to use that cotton, advertise the product that he makes from it, and set up a system to place it in the hands of the public throughout the state, nation or world. These things cannot be done if the manufacturer is doubtful about getting that sort of cotton again next year, as simply and as satisfactory as he got it this year.

No matter how good cotton from a certain community may be this year, if the seed are not kept pure, and new supplies of the same improved seed developed each year, that community will soon slip back to its old "scrub" cotton, and the manufacturer who was so unwise as to depend upon the better cotton and build an expensive program for using it, will be forced to scurry about the country—or pay for somebody else's scurrying—to get cotton which after [all] will not suit his purposes so well.

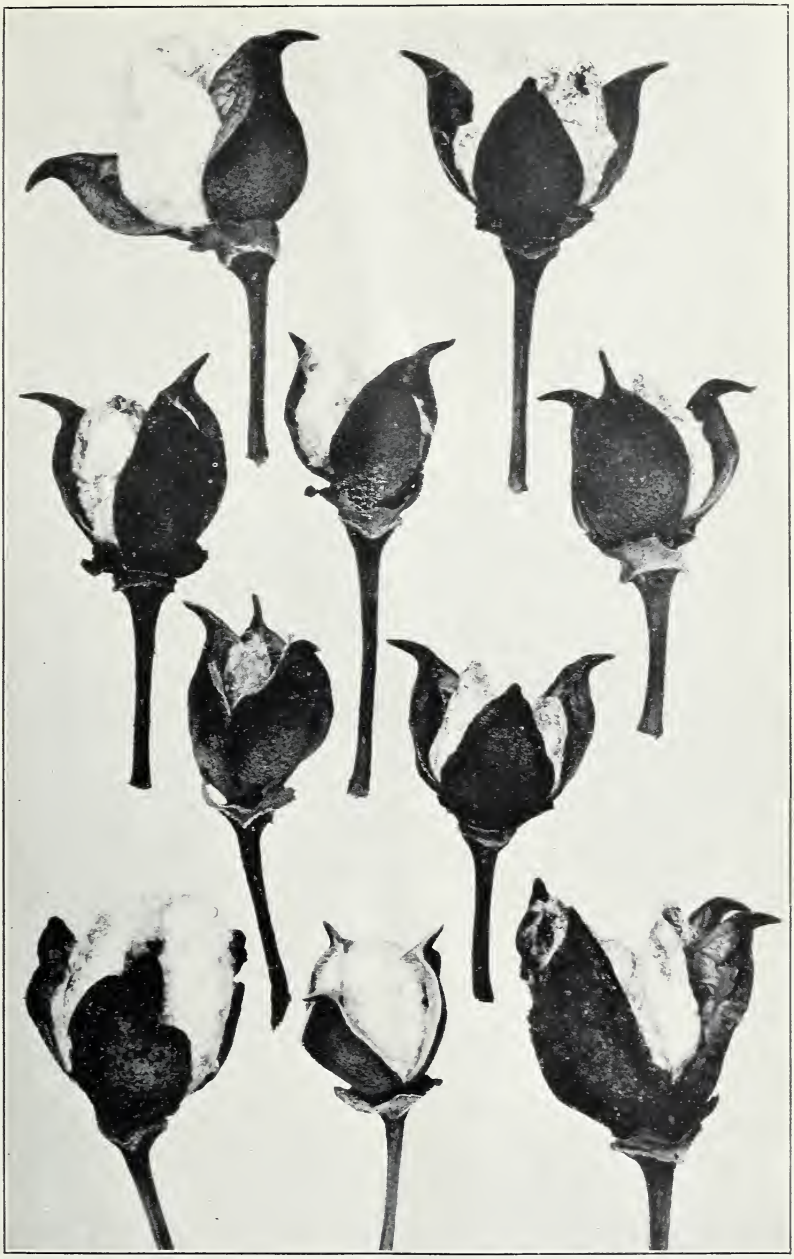
AVOIDING DAMAGED FIBER

Cotton plants that are being injured by drought or other adverse conditions give many signs of distress which are readily recognized by field inspection and indicate the extent of damage that is taking place, especially in communities or districts that grow a single variety. Under the usual conditions of unorganized communities there is too much mixing of seed stocks and too much confusion of the characters of different varieties, combined with various effects of conditions of growth, for such a system to be used.

All kinds of cotton are subject to injury from stress conditions, but some varieties appear to be more resistant than others. The leaves of the Egyptian type of cotton wilt more readily, but experiments have shown that the wilted leaves require less water, so that the Egyptian cotton plants suffer less injury from scarcity of water than the upland group of cottons. The Acala variety of upland cotton has shown the greatest extent of resistance to adverse conditions in the irrigated valleys.

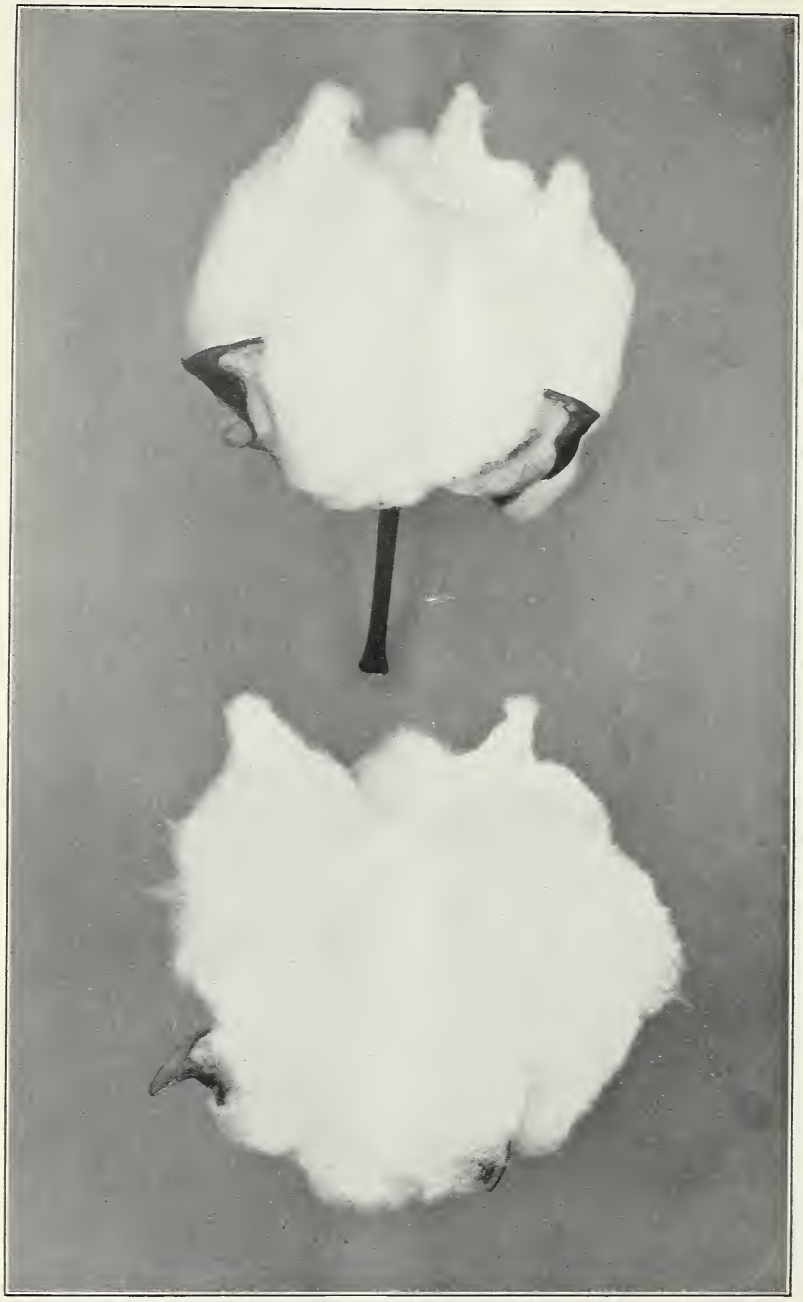
An approaching scarcity of water in the soil of an irrigated field is indicated by slackening of growth so that the flowers appear near the top of the plant, and wilting of leaves is a further sign that the supply of moisture from the soil is becoming inadequate. Shedding of buds and young bolls is a general result of stress conditions, but shedding also occurs when plants are forced into rank growth by warm weather and abundant moisture. Plants that encounter severe conditions of alternate forcing and checking may fail to set any crop, or may produce only a few damaged bolls, with none of the fiber properly matured. Every departure from the normal requirements leaves its effect upon the appearance of the plants as well as upon the quality of the fiber. Equable moderate conditions of growth and gradual development of the plants are more favorable for producing uniform fiber. Irregular conditions may result from soil differences, inadequate leveling, or careless irrigation, or there may be spots of wilt, root rot, crazy top, or other diseases.

The shedding of stress-damaged bolls is limited to the early stages of development, a few days from flowering. After the bolls are half grown they do not fall off, though they may die and shrivel if con-



STRESS-DAMAGED BOLLS OF PIMA COTTON.

From plants severely checked by adverse conditions, so that the bolls did not complete their normal development. The fiber from these "pinched" or "starved" bolls is decidedly inferior, but usually is picked with the normal fiber, in varying proportions with the result of great irregularity in the quality of the fiber. Natural size.



UPLAND COTTON BOLLS SHOWING "WITHER-TIP" DAMAGE.

The fiber in these bolls has a normal development except on one or two seeds at the tip of each lock, where the fiber is weaker and fails to "fluff."

ditions are severe. Even after the bolls have reached nearly full size they may be caught by stress conditions and fail to complete their development. Often the lack of normal maturity is shown by the failure of the stress-damaged or "pinched" bolls to open properly, and the fiber that comes from them is weak and "perished", as classers say when samples of such cotton are examined (pls. 6 and 7). Other terms that are applied to such cotton are "soft", "slick", or "greasy", in reference to the feel when the sample is grasped with the hand.

Growers of Pima cotton in Arizona are familiar with pinched bolls and hard locks, which mean to them a smaller crop and a higher cost of picking, but they are not aware of the impairment of the quality that results from mixing the damaged fiber with the good cotton. Nobody would consider the damaged bolls as a salable product if the marketing of the crop depended upon a pleasing appearance of the fruit, as with apples and oranges. In reality the cotton fiber is impaired as definitely as the damage to the bolls would indicate, and in some of the fields large proportions of the bolls may be injured, often from 50 to 80 percent. Yet the bales from such fields often are passed by experienced classers and are bought from the farmers at the same price as cotton from fields that show little or no damage. When periods of stress have occurred, good and bad fiber may be found in different bolls on the same plant, in addition to the usual inequalities presented by the substaple.

Careless handling of the crop is the natural result of the lack of market discrimination, since the farmers feel no inducement to apply the precautions that are necessary for the production of uniform fiber. Many farmers would select their land and grow their crop with greater care, and separation of the damaged fiber from the good would be practiced, if the quality of the fiber were recognized more definitely in the marketing of the cotton. The need of commercial classing being supplemented by inspection of the crop in the field has been recognized for several years (*5*, *7*, *8*), and the practicability of establishing such a system is receiving further study.

PRECLASSING COMMUNITY COTTON

Methods of conducting the inspection of community cotton and forms of organization to be used in cooperative production are in the tentative stage of development, but practical procedures may be worked out, once the nature of the problem is sufficiently understood. Systems of certification have been established in several States for marketing seeds of alfalfa, sorghum, and other field crops on a basis of field inspection, and in Texas such a system is applied to planting seed of varieties of cotton. Inspection of cotton fields for seed purposes has also been conducted on a considerable scale in single-variety communities, to determine the best fields for roguing, where good yields of well-matured seed could be expected, and also to guard against weed seed, pests, or diseases. Adverse conditions that impair the fiber quality also are likely to have an unfavorable effect on the germination of the seed.

In a community or district where production is based on a single variety of cotton the uniformity or irregularity of the seed stocks and

the effects of growth conditions upon the bolls and the fiber are matters that are easily determined by direct observation in the field, so that the uniformity and character of the fiber can be known in advance of the harvest, and such information can be used as a basis for separating the uniform fiber from the mixed or inferior product. If some of the seed has become mixed, or has deteriorated for the lack of continued selection, diversities among the plants may appear in early stages in habits of growth or branching or in the forms of the leaves. Characters of the flowers or of the immature bolls allow many off-type plants to be detected. With the opening of the bolls fiber differences may be found, and combings made of seed cotton from successive plants will show the extent of uniformity in comparison with other stocks.

In communities where the seed stocks are known to be uniform, the field inspection has the single object of determining the effects of adverse conditions of growth, which differ with the soil and the season. The qualities of the fiber are affected as well as the yields, and the seasonal variations are much greater in some districts than in others. It is to the interest of every community to maintain its standards and reputation in the marketing of its cotton, and for this purpose definite information is required. The knowledge of the relative condition of the different fields exists in every community, and if recorded and verified can be used as a basis for certifying the uniform cotton that has not been damaged by adverse conditions. With cotton that is known to be uniform in the field, the same staple-length determinations can be applied to larger lots of bales.

The planting schedule of an organized community would include the total acreage that each farmer expected to plant, the number of acres to be planted on land that could be expected to produce uniform high-quality fiber, and the expected yields. The designated fields would be inspected during the growing season, the schedule of acreage, quality and yield prospects would be revised, and a complete check-up would be made before picking began, to determine whether the plants had actually come through without damage to the fiber by adverse conditions. Also, necessary arrangements would be completed for proper delivery and identification of approved cotton for classing, tagging, and marketing.

It might be considered desirable to apply the method of field inspection to all of the cotton produced in single-variety districts, but the principal object to be gained at first is that of recognizing the uniform cotton, so that its true quality may be appreciated without the handicap of being mixed with damaged or inferior fiber, or placed in different fiber-length classes. With a uniform seed stock and uniform conditions of growth, the same staple-length classification could be applied to a large body of inspected cotton, and the work of classing thus simplified. Where staple-length differences were found, as a result of soil diversities or seasonal variations, these would be recognized, but such distinctions still would apply to considerable lots rather than to individual bales, so that the number of staple-length classes might be notably reduced in the community cotton.

Even in fields that produce an early crop of first-quality fiber, the later bolls may produce shorter or weaker staple. Plants that are

bearing a heavy crop are more seriously affected by stress conditions, and the fiber from the later bolls may be notably shortened. On the other hand, the early crop may suffer from drought or other adverse conditions, while the later picking may develop in more favorable weather and produce normal fiber. The quality and grade of the fiber are affected by long exposure where picking is delayed, as well as by frost damage to unopened bolls. In organized communities the effects of seasonal differences can be recognized by suitable arrangements for handling the cotton. An injured early crop can be picked separately, or a time limit may be set for receiving first-quality fiber, where damage occurs later in the season.

It is necessary to agree in advance upon the maximum percentage of damaged bolls (pls. 6, 7, and 8) that can be present in fields that are to be certified. If 15 percent of damaged bolls were allowed, this would not mean that the fiber in the bales coming from these fields will contain that percentage of damaged fiber. Since most of the damaged bolls are smaller, with fewer seeds and less fiber than the well-developed bolls, the proportion of damaged fiber would be much lower than the proportion of damaged bolls.

Another factor that tends further to reduce the proportion of damaged fiber in a bale is the difficulty of picking the cotton from the poorly opened burs, so that many of the badly damaged bolls are disregarded, especially when low wages are being paid for picking. Thus in fields showing 30 to 40 percent of damaged bolls only 10 or 12 percent of the cotton might be of the weak and "perished" character.

Precautions could be taken that would reduce to a minimum the danger of bales being placed wrongly in the field classification. The community cotton would be subject to the usual grading and classing of the commercial samples, and each bale could be so tagged as to be definitely identified later and traced back to its origin. In communities definitely enlisted in improving the quality and reputation of their cotton and thereby obtaining better prices, it would seem not impossible to work out practical systems of field inspection and certification of uniform cotton. Although such improvements appear to be practicable only in communities that have established a regular production of one variety, the development of such communities probably would go forward rapidly if a system of separate marketing of uniform cotton were established. Manufacturers undoubtedly would recognize the greater value of certified community cotton, on account of the assurance of being able to obtain more uniform quality of the fiber and more regular results in spinning.

The farmers in the communities where the cotton is grown are familiar with the behavior and condition of the crop and are in the best position to take the primary responsibility for recognizing and certifying the fields of uniform fiber, subject to further inspection and checking of the product by marketing experts. The condition or grade of the inspected cotton would be affected by the weather, by careless or delayed picking, or by bad ginning; but an active interest in protecting the standards of the cotton may be expected as a part of the normal cooperation to be furnished by the community. The

inspection of seed fields is one of the recognized requirements of community production, and the crop inspection is a natural extension of the guarding of the seed stocks.

The other precautions that have brought the cotton to the stage where the uniformity of the fiber can be recognized readily in the field still must fail of their full effect if the cotton is not handled carefully in harvesting and ginning, or is not marketed in the ways that are best calculated to obtain a practical recognition of its value. It is manifestly to the advantage of every producer of uniform fiber to have his product go forward to the market in the best possible condition. The separate handling and marketing of uniform community cotton should be added to the other advantages that are placed within reach through community production (*12*).

COMMUNITY ADVANTAGES IN MARKETING

The need of a better adjustment of production to the industrial demand for improved staples is being recognized as a result of economic investigations of the marketing problems, and also the possibilities of the needed adjustments being reached through standardized community production of superior varieties. More definite information is needed regarding the requirements of the manufacturers and the fiber qualities of the varieties in the different cotton-growing regions, and the way to such knowledge is being opened through community improvement of production. The precautions that are required for the production of uniform fiber are of a nature to develop among the farmers the definite information that they need to have regarding the quality of their cotton, in order to deal constructively with their marketing problems.

Special attention is called in a recent publication from the Georgia Experiment Station to several advantages that farmers in organized communities may obtain by having more definite knowledge of the quality of their cotton in advance of selling, which are stated as follows (*13, pp. 28, 29*):

> The failure of farmers to receive grade differences and staple premiums and discounts equal to those quoted in central markets means that the price incentive to growers for the production of different grades and staple lengths were out of line with the spinning value of cotton as reflected by central market prices. This situation tends to result in the production of larger proportions of the lower grades and shorter staples and smaller proportions of the higher grades and longer staples than would be the case if production were adjusted more accurately to mill demand. The results tend to reduce net income to growers as a group and to increase costs to consumers.
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> * * * * * * *
>
> In order that farmers may sell their cotton in local markets strictly on a quality basis, under the present marketing system, it would be necessary that both growers and local buyers know the quality and commercial value of the cotton at the time of making the transaction. Since farmers and many local cotton buyers are not able to classify cotton accurately, a means of improvement would be to have disinterested, competent, and reliable persons classify the cotton according to a uniform standard and issue a certificate showing the grade, staple length, and character of each bale before it is sold. This classification and certification of cotton while in the possession of the grower would increase the bargaining power of farmers: increase the usefulness of price quotations for grade and staple length: reduce the waste from resampling; improve the use of cotton receipts as collateral for loans; and result in other economies in cotton marketing.
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> * * * * * * *

Discriminate buying in local markets on the basis of quality can be facilitated by producing cotton of more uniform quality in each community. This is being accomplished at the present time in some communities by the standardization of varieties and by reducing the number of varieties grown. Increased profits can be obtained in many communities by standardizing the production of the longer staple varieties.

The "cotton schools" that are held in the summer months in several of the cotton-growing States are a further evidence that the need of more definite knowledge of fiber quality is being recognized in the interest of better marketing and improved production. In some of the States the cotton schools are considered as an important feature of agricultural extension work, though buyers and ginners attend, as well as farmers. Instruction and practice are given in methods of commercial grading and classing of cotton. Such increase of popular knowledge regarding fiber quality is of special value in organized communities where the product is standardized on a single variety, and smaller differences in quality can be recognized than in the handling of a miscellaneous crop.

CONCLUSIONS

Applications of heredity in the improvement of cotton are not accomplished by breeding work alone. Experience has shown that the breeding of superior varieties and the improvement of breeding methods are not effective in themselves as assuring that cotton of uniform quality will be produced. Other requirements must be recognized in the production of uniform fiber, which is the essential feature of all improvement undertakings.

For a regular production of uniform fiber adequate supplies of pure seed must be maintained, and to meet this requirement single-variety communities have been established, first in the irrigated districts of the Southwestern States, and later in the eastern Cotton Belt. During the development of such communities other factors that interfere with the improvement of production were brought to light and further adjustments were found necessary in order to utilize the advantages of community cooperation.

Inspection of seed-increase fields has been a feature of the cotton-breeding work conducted in single-variety communities for the purpose of maintaining large stocks of pure seed, and these inspection methods are applicable also to commercial plantings. It is found that mixed or damaged cotton can be recognized and avoided much more readily by inspection of the plants in the field than after the different lengths and qualities of cotton have been mixed together in picking and ginning.

A uniform product is obtained where pure seed is planted and the growth conditions permit a normal development of the bolls. The plant characters soon become familiar to the growers of a single variety, so that effects of seed mixing and adverse conditions of growth are readily detected and the extent of fiber irregularity can be definitely ascertained before the cotton is picked. The proportion of plants diverging from the normal fiber length of the variety can be shown directly by comparison of combings of the cotton on seeds from successive plants in the fields, and this affords definite indication of fiber uniformity.

The difficulties that arise in commercial classing on account of the natural substaple and the irregularities resulting from mixed seed and adverse conditions of growth are largely to be avoided in single-variety communities through field inspection. Commercial classing is facilitated and rendered more definite by previous field inspection, so that bodies of uniform fiber may be handled together. Definite information regarding the quality and uniformity of the cotton in advance of selling is of value to the growers to facilitate the marketing of the crop. A suitable return must reach the farmers, or the precautions of improved production are not continued.

Separate ginning and marketing of community cotton are found necessary because the improved product must be furnished to the manufacturers in practical quantities in order to become recognized and appreciated. The value of uniform seed stocks is easily obscured if the product is placed in the same commercial lots with irregular fiber. The precautions that are necessary in the growing of uniform cotton must be continued in harvesting, ginning, handling, selling, and manufacturing, in order that regular production of uniform cotton may be established and maintained through periods of years.

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