# QUALITY ASSESSMENT FOR BREEDING EGYPTIAN HIGH QUALITY COTTON VARIETIES

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## Abstract

The cotton breeding program in Egypt has developed over a long time. Strong emphasis has always been put on quality and a good deal of improvement with yield potential and agronomic characters.

Methods of quality measurement and evaluation of strains tested in the breeding program have developed through three distinct stages: (i) in the early days, quality assessment depended mainly on the graders skilled judgment and later on fiber length and fineness, (ii) as from 1936, assessment depended on yarn strength supported by fiber length and fineness and (iii) as from the mid 1960s, a new system has been developed that takes into account several important quality parameters including: fiber, length, fineness and maturity, strength and elongation and yarn strength, neppiness and regularity. The system is based on setting up guide-line scales for each of the four quality categories of Egyptian cotton. It is concluded that such systems are helpful but it is the skilled judgement of experienced technologists that counts in giving the breeder the support he needs.

## Introduction

After an experience in cotton breeding in Egypt for about a quarter of a century, Brown (1955) stated "In any work such as the development of new varieties of Egyptian cottons, three natural divisions can be recognized. These are, roughly: the initial selection of types which give *prima facie* evidence of special merit; the accurate testing of these by whatever methods are judged most suitable; and the final market judgment". A new variety, subjected to market judgment, should satisfy both the producers and the spinners, through improvements in agricultural and quality merits, or strikes an appropriate balance such as improvement in yield while maintaining the quality level more or less the same, or in some cases improvement in quality while accepting the same level of yield if the extra quality is required by the spinners and is reflected in higher price. When setting up a breeding program for a country that grows many varieties of a relatively wide range of quality and end users, it is very important to keep in mind two main objectives, firstly to maximize farmers income through higher yield potential and secondly to satisfy the requirements of the users.

The breeding program in Egypt has developed through a long span of time and is generally based on straightforward hybridization, however some modifications such as back-crossing have been adopted recently. Testing, which naturally divides into the two parts of yield and agricultural merits on the one hand, and quality values on the other hand, has become relatively standardized but still subject to modification. The established strains and crosses testing routine relies on two successive field experiments (1) The "Miniature chequers" or for short "Miniatures" which constitute the preliminary tests for new crosses, normally at the $F_5$ stage and sometimes at the $F_4$ stage, later generations of crosses having already survived their first year of test and the grown varieties which serve as controls, (2) "Yield chequers". The breeding program is subdivided into three sub-programs according to geographical region and quality category: (1) Upper Egypt: Long-Staple

cottons, (2) Southern and Central Delta: Long-Staple cottons and (3) Northern Delta: Extra-Long Staple cottons. Usually one or two Miniature experiments and up to six Yield experiments in various locations within the region, are grown for each of the three cotton categories annually.

## Quality Assessment

Methods of quality measurement and strain evaluation are developed through three distinct stages:

*Lint grades and fiber length and fineness*

In the early days of cotton improvement organized work, quality assessment relied mainly on the graders skilled judgment. Laboratory fiber tests came later. Lint measurements started at Giza in a small laboratory in the late 1920s. Fiber length was the earliest to receive the attention of the breeder, measured as halo-length and later on by the "Balls Sorter". Fiber fineness came second and was measured by the routine method of weight per unit length. Balls (l928) came to the conclusion that the cotton breeder could dispense with the graders judgments through all stages of actual plant-breeding and selection. He, further, doubted whether the graders' judgements have been of any real service to the cotton breeder in the past.

*Yarn strength and fiber length and fineness*

"The Experimental Spinning Mill" at Giza was completed by 1936, in which the 60-gram sample spinning technique was adopted (Hancock, 1937) partly to cope with the smaller quantities of cotton available from the families in breeding plots, and also for the sake of speed, and spinning was made on one count 60s (carded) and one twist multiplier (3.6). As the essential aim of all the fiber measurements was to predict the spinning value of a cotton, when actual measurements of yarn strength became available, fiber measurements fell into second place. Selection of strains relied mainly on yarn strength, especially when a strong relationship was found between yarn strength and market price for the commercially grown varieties. When some strains were found to give yarn strength values higher or lower than expected from their fiber length and fineness measurements, Hancock (1938) developed a formula for "Strength Anomaly", (SA = Yarn Strength x Hair Weight/Mean Length) which does not specifically say that fiber strength is the residual factor, though it well could be (Brown, 1955). Yousef (1942) described the method which was developed for use in comparing the quality of the tested strains and selection among them based on the "Strength Anomaly" phenomenon. In this method, yarn strength is plotted against the ratio "Staple length/hair weight" (called staple ratio). The relation between these two variables was found to be high giving correlation coefficients over 0.9. Strains that give higher yarn strength than expected from their staple ratios are considered to be anomalously strong and are to be selected, while those which give lower strength values than expected are to be considered as anomalously weak and are to be discarded. The plotting of yarn strength against staple ratio is done for all cottons of the three categories as one group, but when they are grouped according to quality category , the coefficients of correlation dropped markedly. Abou-Sehly *et al.* (l968) reported that all correlation coefficients could be improved markedly if fiber strength (at 1/8 inch gauge length) is included in the equation to become as follows: (Fiber strength x Fiber length)/Hair weight. This method continued to be the basis for selection till the end of the 1960s when it was replaced by the comprehensive evaluation method.

*The comprehensive quality evaluation*

In the mid 1960s, it was realized that a new system is required for the evaluation of the large numbers of strains tested in the Miniatures and Yield chequers. This system should be: (1) comprehensive and take into account the various measurable quality parameters that are of interest to cotton spinners and end users, (2) simple to be applied, and (3) capable of providing the breeder with a good degree of flexibility in selecting strains that combine the appropriate combinations of quality, yield potential and agronomic characters that lead to the introduction of successful commercial varieties.

Several inherent characters contribute to the economic value of a cotton, the most important of which are: (1) fiber length, fineness and maturity, strength, and elongation and (2) yarn strength, freedom of neps and regularity. The relative importance of each of these parameters varies from one cotton category to another. As an example, neppiness is of relatively little importance in varieties intended for coarse spinning, but it is of high importance in those varieties intended for fine spinning. Extensive work was carried out to elucidate the role of the various quality parameters from the standpoints of varieties and strains, using the strains and varieties tested in the Miniatures and Yield chequers as material, as well as on other materials, which helped in developing a system for comprehensive quality evaluation.

Abdel-Salam *et al.* (1969) developed the comprehensive evaluation method for yield chequers which later on was extended to both Miniatures and Yield chequers (Abdel-Slam and Garawain, l973). The method is based on constructing guide-lines scales for each category of cotton quality. The guide-lines scale takes in consideration the ultimate use of the cotton category, the state of the standard varieties i.e. the commercially grown varieties, and the parameters that require improvement. The cottons were divided into four categories; (1) Long-Staple cottons grown in Upper Egypt, (2) Long-Staple cottons grown in the Delta, (3) Extra-Long Staple cottons and (4) Extra-Long Staple (Extra-fine) cottons grown in the extreme north of the Delta. The following summarizes the guide-lines scales set up and their application on the strains tested in 1968 season:

1. Category I

| | |
|---|---|
| Growing region: | Upper Egypt. |
| Quality category: | Long-Staple. |
| End use: | Local textile industry, mostly for the production of coarse and medium yarns and fabrics for local consumption. |
| Standard varieties: | The commercially grown varieties (in l968: Ashmouni, Dandara and Giza 66). Giza 66 is the best among the three varieties with regard to quality and is replacing Ashmouni, while Dandara is not popular because of its fineness and lower maturity. |
| Quality objectives: | Improving yarn strength so as to improve fabric durability is an advantage and this improvement should come through fiber strength rather than length or fineness as both are of the required level. Neppiness does not need improvement. |

Accordingly, the following points were taken in consideration in setting up the quality levels:

(a) Yarn strength is to be given the first priority, only strains that exceed standard varieties by 10% are to listed in level (A).
(b) Micronaire reading should not be less than that of Dandara, preferably equal or somewhat higher than that of Ashmouni and Giza 66.
(c) Fiber length of level "A" strains should be similar to Giza 66 but should not be less than that of Ashmouni.

Accordingly, for the strains tested in the 1968 season, the guide lines scale set up was as shown in Table 1. When the 30 strains and varieties tested in Miniature chequers and 48 varieties and strains tested in Yield chequers were sorted out according to the quality guide lines scale, six strains in the Yield chequers and 12 strains in the Miniatures were classed as of quality level "A". Thus, the breeder will have a good degree of flexibility to select among them.

2. Category II

| | |
|---|---|
| Growing region: | Southern Delta. |
| Quality category: | Long-Staple. |
| End use: | Local industry - medium and medium/fine counts for local consumption and export. Export as raw cotton. |
| Standard varieties: | The commercially grown varieties Giza 67 and Giza 69. The two varieties are generally of comparable level of quality however Giza 67 is of somewhat longer staple but this compensated for by Giza 69 being of relatively finer fibers and consequently stronger, more regular and less neppy yarns. |
| Quality objectives: | Improvement should be directed towards higher yarn strength through higher fiber strength rather than length or fineness. Other fiber properties could be maintained at the same levels of the standard varieties. |

Accordingly, for the strains tested in the 1968 season, the guide lines scale set up was as shown in Table 2. In the 1968 season, 18 varieties and strains were tested in the Miniatures and 26 were tested in the Yield chequers. By applying the guide-lines scale, three strains in the Yield chequers and 12 strains of their progeny tested in the Miniatures all belonging to the cross "Giza 67 x Giza 69" were selected as of quality level "A". The averages of quality parameters of this selected cross were as follows:

| Fiber | | Yarn | |
|---|---|---|---|
| 2.5 % S.L. (inch) | 1.24 | Strength (g/tex) | 17.8 |
| Micronaire | 4.5 | Neps (per km) | 10.99 |
| Strength (1/8"-g/tex) | 36.0 | Unevenness (CV%) | 21.1 |
| Elongation (%) | 7.2 | | |

When this cross was compared with the averages of the two standard varieties, it was found to be :

(a) of somewhat coarser fiber, but this coarseness is required for this class of cotton,
(b) of comparable fiber length, and
(c) of much stronger fiber (+13%) which more than compensated for the increase in

coarseness, and thus,

(d) its yarns are stronger (+9%) and less neppy.

This cross was later given the commercial name " Giza 75 " and launched for commercial production in 1975. It quickly proved itself as the most successful variety combining higher quality, high yield potential and high adaptability for various regions, and thus occupied the largest part of the cotton grown area till now.

3. Category III

Growing region: Central and Northern Delta.
Quality category: Extra-long Staple.
End use: Fine spinning. Small part for local processing for export, and the majority for export as raw cotton.
Standard varieties: The commercially grown varieties Menoufi, Giza 68 and Giza 70 (newly introduced). Giza 68 and Menoufi are of comparable fiber strength but Giza 68 is of somewhat finer and shorter staple and stronger yarns, while the newly introduced variety Giza 70 is of much higher fiber strength which compensated for its relative coarseness and resulted in its having a higher level of yarn strength. Giza 70 is of a higher level of quality which makes selection for higher quality more difficult.

Objectives:

(a) the level of fiber length of Menoufi and Giza 70 is quite appropriate for this ELS category of cottons, and, thus, there is no need to select for longer staple and a slightly shorter staple length is permissible,
(b) Micronaire reading should not be less than that of Menoufi especially if it is associated with increase in neppiness, while a slight increase is permissible especially if it reflects improvement in maturity rather than coarseness,
(c) a slight increase in yarn strength in the vicinity of 5% over the average of the three standard varieties would be advantageous, and
(d) the three commercial varieties are characterized by a high degree of cleanliness from neps and this merit should be maintained in the new selections.

The guide-lines scale was set up accordingly as shown in Table 3. In the 1968 season, 24 varieties and strains and 33 varieties and strains were tested in the Miniatures and Yield chequers respectively, of which six strains of the Miniatures and ten strains of the Yield chequers were selected as quality level "A".

4. Category IV

Growing region: Northern Delta.
Quality category: ELS, Extra fine.
End use: very fine spinning, export as raw cotton.
Standard varieties: the commercially grown variety Giza 45 and the newly introduced, but not grown commercial Giza 71. Giza 45 is well known as a world top quality, and Giza 71 was introduced but was not launched for commercial growing because it has no

advantages in yield potential over Giza 45.

Objectives: Taking in consideration the importance of maintaining the high quality level of this category;

(a) Staple length should be maintained and there is no need to increase it to avoid a tendency towards neppiness,
(b) Micronaire reading should be maintained. However a slight increase is permissible if it reflects maturity rather than coarseness,
(c) Yarn neppiness in Giza 45 is relatively high, new selections should be less neppy and increase in neppiness is unacceptable, and
(d) Accordingly, improvement in quality should concentrate on fiber strength and, subsequently, yarn strength and reduction in neppiness.

The guide-lines scale set up is given in Table 4. All strains tested in 1968 season failed to fulfil the measures of quality level "A". Unfortunately, the same situation prevailed until very recently when the breeder succeeded in selecting the cross "Giza 77 x Giza 45" (Type A) which possesses the same quality level of Giza 45 but excels it in yield potential (Abdel-Salam, 1992).

Syiam (1980) used two approaches for classifying the various strains in the l976 crop. The first one was based on the level of single strand strength of the strain in relation to the average of the standard varieties , using four yarn counts (60s carded, 60s, 80s and 120s combed). At the finer combed counts (80s and 120s), only fine fibered strains complied with the improved quality levels, while all those strains characterized by relatively higher micronaire readings exceeding 3.0 fell in the standards level, regardless of their high levels of fiber length or strength. The second approach was based on strain deviation from the regression line of the relationship between the actual values of single strand strength and those predicted from fiber properties; length, tenacity and micronaire reading. Strains having actual single strand strength higher than that predicted from fiber properties are regarded as anomalously strong and are further classed into two levels according to their single strand strength in relation to the average value of the actual single strand strength of the standard varieties. Those strains having equal or higher strength than the standard varieties were classed as of level "A" and regarded as improved. When this approach was applied to the ELS cottons, it was observed that the strains occupying level "A" change their position according to yarn count, at 60s carded count six strains occurred at level "A" but at the fine combed count (120s) only the three strains characterized by high level of fiber fineness occurred at level "A".

In subsequent work (Abdel-Salam *et al.*, l985), the second approach of Syiam (1976) was applied to strains tested in the yield chequers of the three cotton categories (ELS, LS Delta and LS Upper Egypt) to test the effect of years (three years), subregions (three subregions for each category) and their interactions. Results of the combined analysis of variances indicated that most of the variation in the quality properties was due to variety effects followed by (varieties x years) and (varieties x subregions) interactions. For ELS category, a strain from the cross Giza 68 x C.B.58 was selected from level "A" which evolved into the new commercial ELS variety Giza 84, which was released for commercial production in l992 (Abdel-Salam, 1992). For LS Delta category a strain from the cross Giza 67 x C.B.58 was selected from level "A" which evolved into the new variety Giza 85 which was released for commercial production in 1992. For LS (Upper Egypt), a strain of low quality, was selected from level "B" which evolved into the new variety Giza 83 which was released for commercial production in 1991 to replace Dandara. Superior yield potential and earliness were more important than quality in this category of cottons. In fact, the level of quality of these cottons is still higher than the real requirements of the industry.

## Conclusion

From the extensive experience gained through more than a quarter century of involvement with the Egyptian cotton breeding program, it could be concluded that in dealing with high quality ELS and LS cottons, breeding offers many valuable opportunities for improvement. Depending on systems based on guide-lines scales or other approaches for selection for quality is undoubtedly helpful. However, in all cases, what is really needed is the skilled judgment of experienced technologists who can use knowledge and vision of the future requirements of the cotton users to make the appropriate interpretation of the various quality measurements and gives the breeder the effective support he needs. Breeders and technologists should work in close collaboration in order to achieve the goals of cotton breeding programs.

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Table 1. Guideline scales for long staple cotton in Upper Egypt.

| Quality parameters | Standard varieties | | | Quality levels | |
|---|---|---|---|---|---|
| | Ashmooni | G.66 | Dandara | "A" | "B" |
| Fiber properties | | | | | |
| (1) 2.5 % S.L.(inch) | 1.15 | 1.21 | 1.20 | 1.20 | 1.15 |
| (2) Micronaire reading | 4.6 | 4.5 | 4.2 | 4.5-5.0 | 4.5-5.0 |
| (3) Strength (1/8")(g/tex) | 29.9 | 31.8 | 30.3 | MT>30.0 | LT<30.0 |
| (4) Elongation(%) | 6.9 | 7.4 | 8.3 | - | - |
| Yarn properties ($60^{S}$ carded) | | | | | |
| (1) Single thread strength(g/tex) | 13.4 | 16.4 | 15.4 | 16.4 | 15-16 |
| (2) Neps (per km) | 0.55 | 1.46 | 1.09 | 0.91 | 1.36 |
| (3) Unevenness(c.v. %) | 23.5 | 23.3 | 22.9 | - | - |

Table 2. Guideline scales for long staple cotton in the Southern Delta, Egypt.

| Quality parameters | Standard varieties | | | Quality levels | |
|---|---|---|---|---|---|
| | Giza67 | Giza69 | Average | "A" | "B" |
| Fiber properties | | | | | |
| (1) 2.5 % S.L.(inch) | 1.28 | 1.24 | 1.26 | MT>1.24 | LT<1.24 |
| (2) Micronaire reading | 4.4 | 4.2 | 4.3 | 4-4.4 | 4-4.8 |
| (3) Strength (1/8")(g/tex) | 32.6 | 32.7 | 32.6 | MT>33.0 | LT<32.0 |
| (4) Elongation(%) | 7.2 | 7.2 | 7.2 | - | - |
| Yarn properties | | | | | |
| (1) Single thread strength(g/tex) | 16.1 | 16.5 | 16.3 | 17.0 | 15.5-17.0 |
| (2) Neps (per km) | 1.27 | 0.91 | 0.09 | 1.36 | 1.82 |
| (3) Unevenness(c.v. %) | 22.7 | 21.9 | 22.3 | - | - |

Table 3. Guideline scales for extra long staple cotton in Central and Northern Delta, Egypt.

| Quality parameters | Standard varieties | | | Quality levels | |
|---|---|---|---|---|---|
| | Menoufi | Giza68 | Giza70 | "A" | "B" |
| Fiber properties | | | | | |
| (1) 2.5 % S.L.(inch) | 1.33 | 1.24 | 1.35 | 1.35 | 1.30 |
| (2) Micronaire reading | 3.2 | 3.4 | 3.8 | 3.2-4.0 | 3.2-4.0 |
| (3) Strength (1/8")(g/tex) | 35.1 | 35.1 | 39.9 | 37.0 | 35.0 |
| (4) Elongation(%) | 6.6 | 6.5 | 5.4 | - | - |
| Yarn properties | | | | | |
| (1) Single thread strength(g/tex) | 18.6 | 19.5 | 20.3 | 20.5 | 19.5-20.5 |
| (2) Neps (per km) | 1.00 | 0.82 | 0.82 | 1.09 | 1.36 |
| (3) Unevenness(c.v. %) | 22.1 | 22.8 | 21.7 | - | - |

Table 4. Guideline scales for extra fine, extra long staple cotton in the Northern Delta, Egypt.

| Quality parameters | Standard varieties | | Quality levels | |
|---|---|---|---|---|
| | Giza 45 | Giza 71 | "A" | "B" |
| Fiber properties | | | | |
| (1) 2.5 % S.L.(inch) | 1.36 | 1.37 | 1.36 | 1.36 |
| (2) Micronaire reading | 3.1 | 3.2 | 3.0-3.4 | 3.0-3.4 |
| (3) Strength (1/8")(g/tex) | 38.0 | 39.6 | 40.0 | 38.0 |
| (4) Elongation(%) | 6.3 | 6.1 | - | - |
| Yarn properties | | | | |
| (1) Single thread strength(g/tex) | 20.4 | 23.0 | 23.0 | 20.4 |
| (2) Neps (per km) | 2.37 | 2.18 | 2.27 | 2.73 |
| (3) Unevenness(c.v. %) | 22.8 | 22.0 | - | - |