

AN INTERDISCIPLINARY APPROACH TO THE IMPROVEMENT OF FIBRE QUALITY

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INTRODUCTION

Cotton is a crop that has been associated with ancient civilizations and that has contributed greatly to the industrial and economic development of many countries. Its great value and the need for cotton products have ensured its survival as one of the world's most widely cultivated and major cash crops, despite the stiff competition it faces from man-made fibres.

Four of the cultivated species are considered to be of major agricultural importance. They produce spinnable lint which is of great value to the spinning and textile industry. Two of the four species are diploids ($2N = 2X = 26$) and are represented by *Gossypium arboreum* and *Gossypium herbaceum* (L). The diploid cotton is still grown in Asia and is often referred to as Asiatic cotton. The other two species are tetraploids ($2N = 4X = 52$) and are represented by *Gossypium barbadense* (L), often referred to as Sea Island or Egyptian cotton, and *Gossypium hirsutum* (L) or Upland cotton. *Gossypium hirsutum* (L) is by far the most widely cultivated cotton species in the world. It is reported to be contributing over 90% of the total cotton produced worldwide. *G. barbadense* contributes about 5% and diploid or Asiatic cotton also contributes about 5%.

Lint is the most important industrial raw material for which cotton is widely cultivated. It is composed of fibres which are outgrowths from the outer layer of the seed-coat. The fibres increase both in length and thickness, forming lint, which is easily removed from the seed surface by ginning. Lint can naturally be of different colours, but the most widely cultivated cotton produces white lint (Emeetai-Areke, 1999).

FIBRE QUALITY

The following are the main factors that contribute to fibre quality:

➤ **Ginning out-turn**

Ginning out-turn is a useful indicator of the performance of a genotype. Ginning out-turn can be described as the percentage of lint obtained from a sample of seed cotton. Genotypes with high ginning out-turn values are thus preferable, because they yield more lint.

➤ **Fibre length**

This is the length of the fibre or staple length in mm and is one of the fibre quality characters that are important to the textile industry.

➤ **Fibre strength**

This quality characteristic is useful to spinners. High tensile strength of the fibre is needed for good spinning, especially with fast modern spinning machines. The strength of the fibre is determined by securing a bundle of fibre between clamps set 32 mm apart and measuring the force required to break the fibre.

➤ **Micronaire (fibre fineness)**

The texture of cotton fibre is determined. Cotton fibre may be classified as soft and silky or coarse and harsh. Fineness is expressed in micronaire units. Micronaire is a measure of the rate at which air, at standard pressure, flows through a standard volume of cotton lint. The finer the fibre, the slower the rate of airflow and hence the lower the micronaire value. This quality characteristic is also important in the selection of fibre that is suitable for manufacturing a particular product.

➤ **Uniformity of fibre length**

This is also an important lint quality characteristic which is indicative of the maturity of the fibre. The value is taken as a ratio of 50% span length to

2.5% span length of a sample of combed fibre. This value is important in determining the spinning performance and utility of the lint. Higher values are an indication that the yarn spun from such fibre will be uniform in size and strength and that less fibre will be wasted.

The ginning and textile industries are dependent mainly on the above fibre quality characteristics.

YIELD

At the same time, the producer has a different interest, namely yield.

The following aspects determine yield:

➤ **Boll size**

Boll size, determined by weighing the boll, is indicative of the performance of a genotype. The larger the boll, the heavier the yield expected. Large-bolled genotypes are thus considered higher yielders.

➤ **Seeds per boll**

Seeds are the units of lint production. Fibre grows from the outer cells of seed surfaces. The larger the seed surface, the larger the amount of lint produced. The number of seeds per boll is, therefore, another good indicator of the genotype's yield performance.

➤ **Number of bolls**

The number of bolls per plant or per unit area is an important indicator of the performance of a cotton genotype (Emeetai-Areke, 1999).

Yield is a high priority for the producer and quality goes hand in hand with yield.

FACTORS THAT INFLUENCE FIBRE QUALITY

The major factors that influence fibre quality are:

➤ Genetic inheritance

- Growth period
- Moisture
- Fertilizer
- Diseases
- Soil conditions
- Pests
- Weed control

1. Genetic inheritance

Over the last decade, the average strength of US Upland cotton has increased by 3.4 grams/Tex, the average staple length has increased, the average length uniformity index has increased by nearly one index unit and the percentage of white grades in the crop has increased by over 20 per cent (Raleigh, 1996). In South Africa, fibre properties show an increase in strength, micronaire and length, which reflects the improvement brought about by breeding (Fig 1).

The inheritance of fibre properties in selected varietal types of Upland cotton (*Gossypium hirsutum*) indicated that the heritability estimates for these characters ranged from 0.01 for fibre fineness to 0.62 for fibre strength or 1 and 62 per cent respectively (Quisenberry, 1973).

A study indicated that the parental differences in fibre length were controlled by one gene, while differences in fibre strength and fineness were separately controlled by two genes.

Only fibre strength is positively correlated with yield. Negative correlations were observed for micronaire and fibre length.

Percentage ginning out-turn, staple length and fibre fineness exhibited low genetic advances irrespective of their high heritability estimates, probably due to non-additive gene effects (Larik, 1997).

2. Growth period

It is well known that cotton is a warm weather crop, which responds to high heat units.

Fig 2 indicates that a higher temperature regime has a positive effect on micronaire, while in the case of fibre length and strength its effect varies from one season to another.

3. Moisture

Although the cotton plant can survive severe drought, sufficient moisture is critical at certain growth stages. Results indicate that fibre length and strength will be improved by irrigation, while in the case of micronaire, the opposite is true (Fig 3).

4. Fertilizer

Results indicated that P had no positive effect on fibre properties, while N and K improved fibre strength. Recent studies, in which different levels of N were applied under rainfed conditions, showed that N had a positive effect not only on strength, but also on length and micronaire (Fig 4).

5. Diseases

The effect of different cotton diseases on fibre quality was monitored over various seasons and localities and the results indicated that diseases could cause a 10-15% reduction in fibre quality.

6. Soil conditions

Studies conducted in different cotton-producing areas indicated that soil conditions had a minor effect on fibre quality, but only when all the other growing conditions were optimal. Where different cotton cultivars were grown on clay and sandy soils, the micronaire values were higher on clay soil. The effect of soil conditions on fibre length and strength was not clear (Fig 5).

7. Pests

The effect of pests on fibre quality was difficult to determine, because in many cases the bolls had been shed or had produced no fibre. Recent results indicate that micronaire can drop by 20% and yield by 50-80% if pest control is inadequate.

8. Weed control

Proper weed control is extremely important in ensuring a high cotton yield. On the other hand, there was no evidence that weeds had a drastic effect on the fibre quality.

DISCIPLINES INVOLVED IN IMPROVING FIBRE QUALITY

In general, four major disciplines are involved in improving fibre quality, viz. (1) cultivar development, (2) crop science, (3) pest control and (4) plant pathology.

1. Cultivar development

We must acknowledge the contribution of breeding in the development of Bt and non-Bt cotton cultivars. Calculations made over a long period with different parameters show that the genetic potential of a cultivar can account for up to 50% of the fibre quality.

2. Crop science

Crop science makes an 18% contribution to fibre quality. The growth period, moisture, correct fertilization and weed control all play a part in the improvement of fibre quality.

3. Pest control

Although the effect of pests on fibre quality is difficult to determine, studies indicate that pest damage could cause a 20% drop in fibre quality.

4. Plant pathology

As indicated, cotton diseases can cause a 12% drop in fibre quality.

SUMMARY

The gene pool makes the highest contribution to the improvement of fibre quality, but the importance of crop science, pest control and plant pathology in achieving and sustaining high fibre quality must be acknowledged. Even the best-yielding cultivar with the best fibre properties will perform moderately, if all the disciplines are not optimized. I feel we can and must promote an interdisciplinary approach to cotton production.

Plant breeding has made a huge contribution. It is time for agronomy and plant protection to make their contributions (Fig 6).

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