Genetic Progress of Cotton Yield in Brazil

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ABSTRACT
Embrapa’s cotton breeding program has made substantial progress in the last 18 years in developing cotton cultivars with higher yield and fiber properties. A parallel increase in resistance to drought and insect pests has also been obtained. Seed cotton yield and fiber property means of the cotton cultivar regional tests conducted by Embrapa in many locations of Northeast Brazil over the past 18 years was used to estimate the genetic progress achieved.

These data show that the genetic progress for seed cotton yield over the 18 year period was 1.03% a year. Progress in fiber characteristics was also made.

Introduction
The cotton breeding program of Embrapa for Northeast Brazil. At that time Embrapa’s cotton (Gossypium hirsutum L.) breeding program for Northeast Brazil was initiated in 1976. The main emphasis was on developing cotton cultivars with high yield potential and improved fiber properties. Resistance to drought and insect pests was also prime objectives. The programme has been remarkably successful in improving fiber properties and yield potential over the last 18 years. According to the data presented in this paper, seed cotton yield increased at the rate of 1.03% a year. Fiber properties and fiber percentage experienced a significant rate of improvement as well.

There are many reports relating to this subject in the world literature. With respect to cotton, in a classical paper by Meredith & Bridge (1984), an annual progress of 0.74% in fiber yield from 1958 to 1980 in USA was reported. Genetic progress has also been reported in other commercial crops (Vencovsky et al., 1988; Toldeo et al., 1990; Rodrigues, 1990; Abbud, 1991; and Soares & Ramalho, 1994).

The initial analysis of the final stand of each individual experiment revealed levels of significance in relation to this variable in some of them. All the trials were analyzed by using the mean stand as covariate (Vencovsky & Cruz, 1991). Once the adjusted mean for each location was obtained, the mean from each variety was compared across locations in each year. With these data, the Vencovsky et al. (1988) method to calculate the genetic progress was used. This method consists in evaluating the yield difference between genotypes in two consecutive years. This difference is used to calculate the total genetic gain. In each pair of years, the common treatments are used to estimate the annual effect to be subtracted from the total effect.

The method used to calculate the genetic progress is (Vencovsky et al. 1988):

\[ Y_1 = m + a_1 + g_1 + e_1 \]
\[ Y_1 = \text{General mean of trials in year 1} \]
\[ m = \text{General mean} \]
\[ a_1 = \text{The effect of year 1. Common to all treatments} \]
\[ g_1 = \text{Genotypic mean effect of the lines (except the check) evaluated in the 1st year} \]
\[ e_1 = \text{Experimental error of the mean Y1 plus the mean of treatments interaction with year 1} \]

In year 2, the same model was adopted,

\[ Y_2 = m + a_2 + g_2 + e_2 \]

With the effects described previously being the contrast:

\[ Y_2 - Y_1 = (a_2 - a_1) + (g_2 - g_1) + (e_2 - e_1) \] (A)

What is of interest, is the determination of the \( g_2 - g_1 \) difference that was observed between two consecutive years. From contrast “A”, can be seen that the genetic differences are confounded with the environment differences. From the means of the common lines in the two years, and using this model it is possible to define their means as:

\[ Y_c = m + a_1 + g_1 + e_1 \]
used to estimate the genetic progress in seed cotton yield and some fiber characteristics within that period. According to the results, the genetic gain obtained in the whole period was 290kg/ha or 20.71%. This is equivalent to an annual average gain of 1.03% as shown in Table 3. During the whole period the percentage of strains replacement in the Cultivar Regional Test was 45%. This means that 55% of the genotypes were maintained in each pair of years.

Genetic progress has been quantified by breeding programmes for many crops around the world for many reasons, especially for the evaluation of the efficiency of the programme itself.

The genetic progress reported here can be compared to that of 0.7% a year obtained by Meredith & Bridge (1984) for cotton in USA Comparisons with many other commercial crops reveals a close resemblance. Genetic gains of 1.7% and 2.2% were reported by Vencovsky et al. (1988) for corn (hybrid and population); 1.3% to 1.8% for different soybean genotypes (Toledo et al., 1990); 1.9% for Beans (Epaming, 1992); 1.4% to 5.0% for rice (Abbud 1991; Soares & Ramalho, 1994).

The incremental increase in seed cotton yield paralleled those in several other characteristics selected concurrently (Table 2). However, concurrent selection may have contributed to reduced potential yield of seed cotton. Among the characteristics selected with seed cotton yield, earliness as measured by the number of days for first boll opening decreased from 99 to 80 days. Boll weight jumped from 4.9g to 6.2g; fiber percentage from 34.7% to 43.2%; fiber uniformity from 51.2% to 52.8%; fiber micronaire from 4.6 to 3.9 while fiber strength and length were not improved (Table 1).

Recently, selections for higher fiber strength and earliness have been intensified to meet the demands of the textile industry and producers.

**Conclusion**

Results from our studies clearly show that over the 18-year period, the Embrapa breeding programme achieved significant genetic gains and continued improvements in seed cotton yield and fiber properties. Cultivars possessing genes with the potential to enhance fiber strength and resistance to insect pests and diseases will be a challenge for future cotton cultivar developments in Brazil.

**References**


Table 1. Main characteristics of cultivars released by Embrapa in northeast Brazil from 1976 to 1994.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Year Released</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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<tbody>
<tr>
<td>BR - 1</td>
<td>1978</td>
<td>99</td>
<td>4.8</td>
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<td>6.2</td>
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<td>3.9</td>
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</table>

A - Days to first open boll (days)
B - Boll weight (g)
C - Fiber percentage (%)
D - Fiber length (2.5mm)
E - Fiber uniformity (%)
F - Fiber micronaire
G - Fiber resistance (lb/mg)
2 - Mean of 3 years in 25 locals
3 - Mean of 3 years in 13 locals
4 - Mean of 2 years in 6 locals
5 - Mean of years in 18 locals
6 - Mean of years in 18 locals
7 - Mean of 1 year in 2 locals
8 - Mean of 1 year in 2 locals

Table 2. Means of cultivars and strains (Yi) adjusted in relation to the standard average in each year of evaluation and of cultivars and strains which were common in successive pair of years (Yci,i+1, and Yci,i-1), genetic annual gain (Gi,i-1) and total from 1980 to 1994.

<table>
<thead>
<tr>
<th>Year</th>
<th>Y_i</th>
<th>Y_{ci,i+1}</th>
<th>Y_{ci,i-1}</th>
<th>G_{i,i-1} (kg/ha)</th>
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Mean annual genetic gain in kg/ha 20.71
Mean annual genetic gain in percentage 1.03

i = 1, ..., 15.