How many years of evaluation are needed to select new productive cocoa clones?

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CIRAD & CATIE & Bioversity
Introduction

• Banality: Cocoa tree is a perennial plant cultivated for its fruits

• First question: what is the life expectancy of the cocoa tree?

  elements of answers in pictures:
Grande Terre, Guadeloupe : > 130 years
With pods
• Life expectancy of *T. cacao* > life expectancy of *Homo sapiens*

Selected species

Beeder

(but isolated tree)

The life span of a plantation - Breeder activities
is not well known
(30 to 50 years) - (around 20 years)

Breeders are in a hurry to get results, to publish, to propose new varieties

often conclusions after 5 years of data (validity?)
• Tahi et al, 2019. Variation in yield over time in a cacao factorial mating design: changes in heritability and longitudinal data analyses over 13 consecutive years. *Euphytica*

![Graph showing yield over time for different clusters of yielders. The graph indicates that at least 6 years of data are needed to separate high yielders from early yielders.](image)
Objective:

For a clone trial followed during 18 consecutive years tree by tree, how many years are needed to estimate the genetic value of the yield (number of healthy pods produced) assuming that 18 years is sufficient.
Material


46 clones / 32 trees per clone / (3 m x 3 m)

Observations over 18 consecutive years, from 2001 to 2018 (per tree)

Data

Number of healthy pods produced per tree each year (18)
Results

Mean trajectories over the 18 years for the 3 clusters of tree production trajectories obtained by Kmeans classification of longitudinal healthy pod production.
# Results

Evolution of the heritability of annual production

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<tr>
<th>Year</th>
<th>Mean</th>
<th>H²</th>
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<td>0.27</td>
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<td>15.5</td>
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</table>
Results

Genetic correlation:
Cumulative production 1 to x, cum. production 1 to 18 years
Results

For a 10% selection rate:

On 18 years: CATIE R6, CATIE R1, CATIE R4, Arf 4, UF273

Cumulative from 1 to 6 years : 3/5 (CATIE R6, CATIE R1, UF 273)
Cumulative from 1 to 7 years : 3/5
Cumulative from 1 to 8 years : 4/5 (CATIE R6, CATIE R1, CATIE R4, UF 273)
Cumulative from 1 to 9 years : 4/5
Cumulative from 1 to 10 years : 5/5
Discussion

• At least, 8 years of data to predict a good genetic value for yield (on 18 years)

  (It was 6 years for Côte d’Ivoire, but on a total of 13 years)

• Another way:

  a better understanding of the production process
Discussion

- Yield is a complex trait.

\[
\text{number of pods} \times \text{number of seeds per pod} \times \text{seed weight}
\]

Number of pods (main trait)

\[\text{Nb flowers} \rightarrow \text{Nb cherelles} \rightarrow \text{Nb pods} \rightarrow \text{Nb mature pods}\]

- **pollination**
- **cherelle wilt**
- **pest & disease**
Heritability of other traits (other trials)

Nb of flowers: \( h^2 = 0.2 \)

Cherelle Wilt Rate: \( h^2 = 0.5 \) (3 years)

Phytoph. Pod Rot Rate: \( h^2 = 0.3 \) (4 years)

Other diseases (to determine)

And what about the pollination differences between genotypes
Why CCN 51 is high yielder?

- Good flowering
- Self compatible
- Good pollination:

Distribution of seeds per pod
Recommandations

• Breeding to increase resistance to diseases

• To better understand the pollination - differences between genotypes (compatibility and other traits)

• Breeding to decrease wilt level

• …. and what to do to improve the life span of cocoa trees ?
Thank you to

- CATIE – Bioverdity

and thank you
for your attention