

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

Christian Cilas, Wilbert Phillips-Mora, Allan Mata-Quirós, Philippe Bastide, Vincent Johnson,
José Castillo-Fernández, Fabienne Ribeyre, Dominique Dessauw

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:

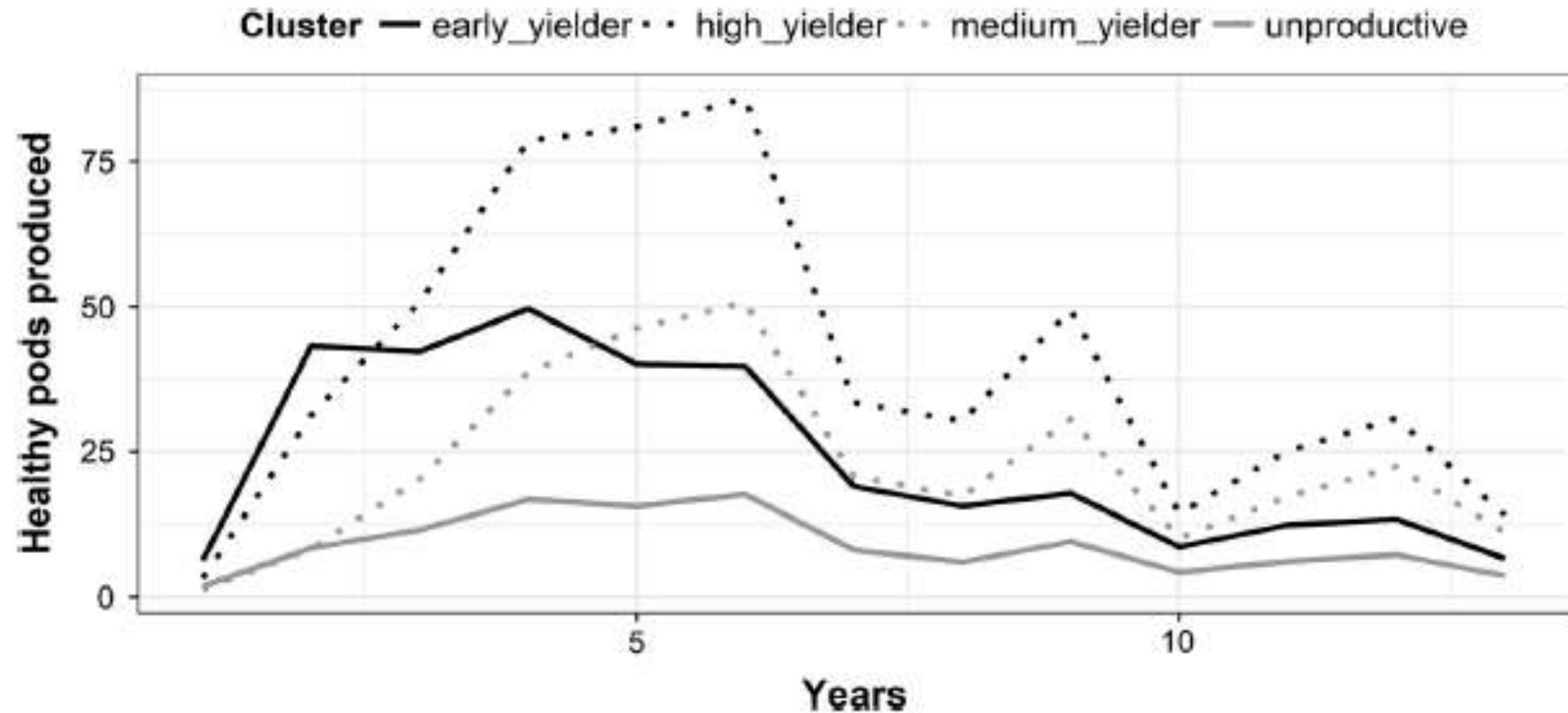


Grande Terre, Guadeloupe : > 130 years



With pods

- 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*



at least 6 years of data are needed to separate high yielders from early yielders

Sustainable agriculture



greater sustainability of production plots

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

**Clonal trial in the station La Lola (CATIE, Costa Rica)
(plantation: 1997/1998)**

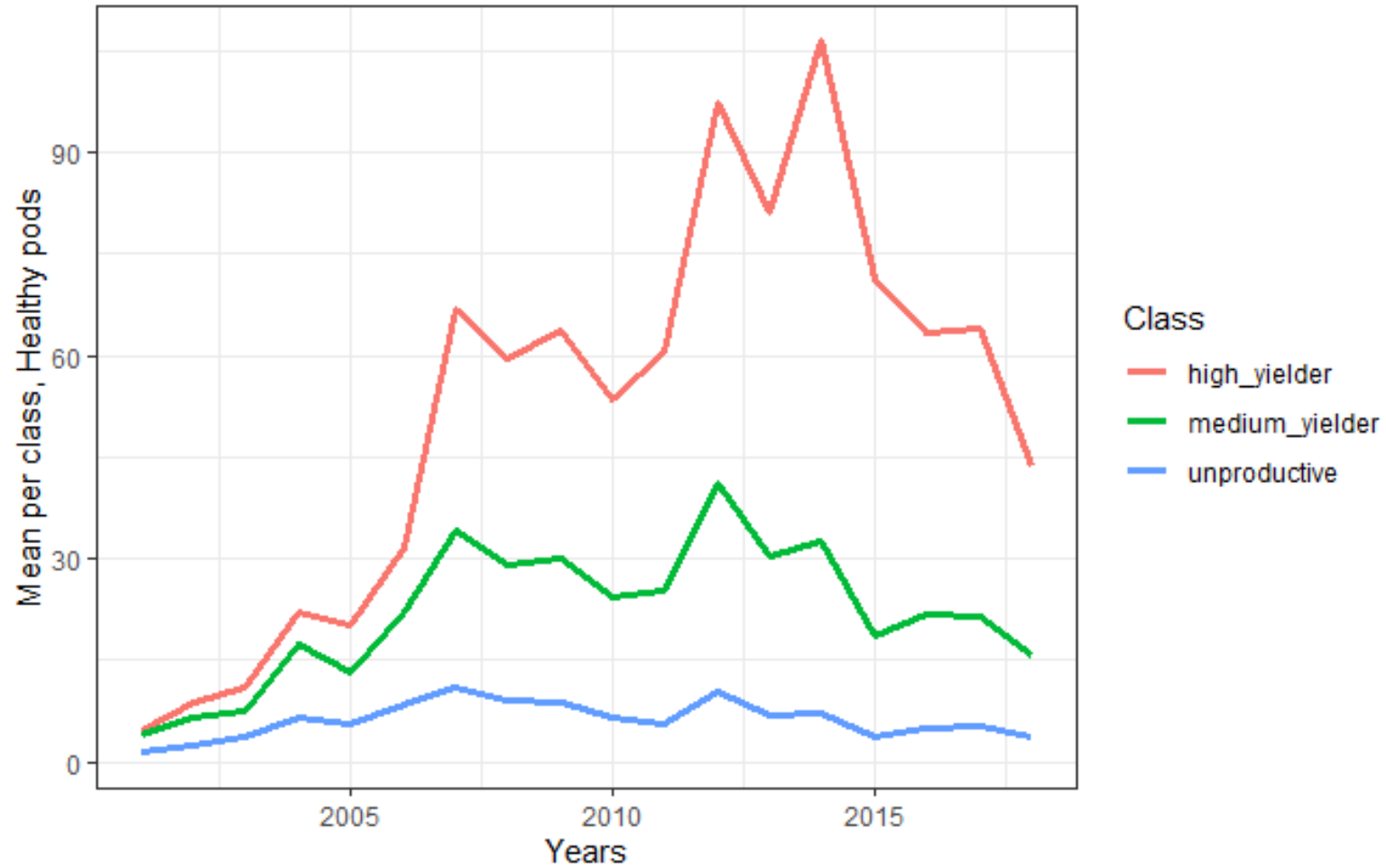
46 clones / 32 trees per clone / (3 m x 3 m)

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

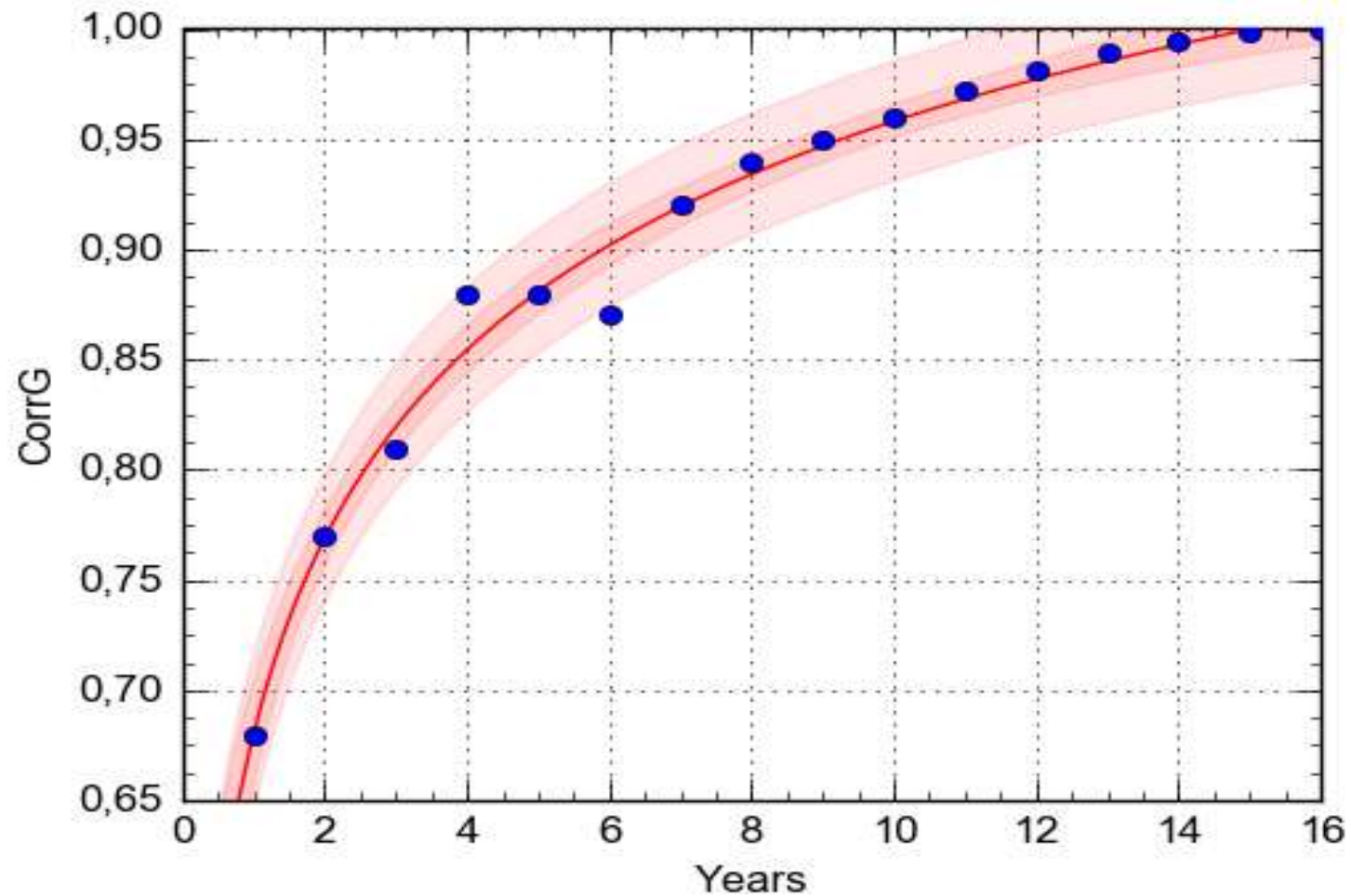
Evolution of the heritability of annual production

Year	Mean	H ²
1	2.0	0.26
2	3.5	0.33
3	4.7	0.27
4	9.5	0.40
5	7.9	0.27
6	12.5	0.28
7	18.3	0.35
8	15.5	0.36
9	15.9	0.41
10	12.4	0.41
11	12.2	0.40
12	20.9	0.35
13	15.2	0.37
14	17.2	0.39
15	9.8	0.40
16	11.1	0.39
17	11.2	0.41
18	8.0	0.46
1-18	207.8	0.52

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)

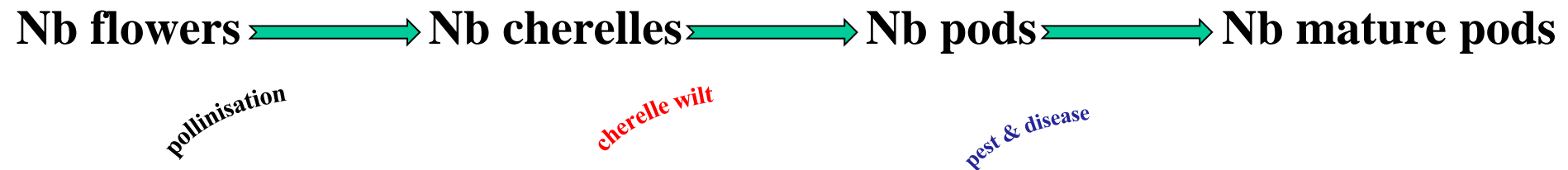
- Another way:
a better understanding of the production process

Discussion

- Yield is a complex trait.

number of pods x number of seeds per pod x seed weight

Number of pods (main trait)



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)

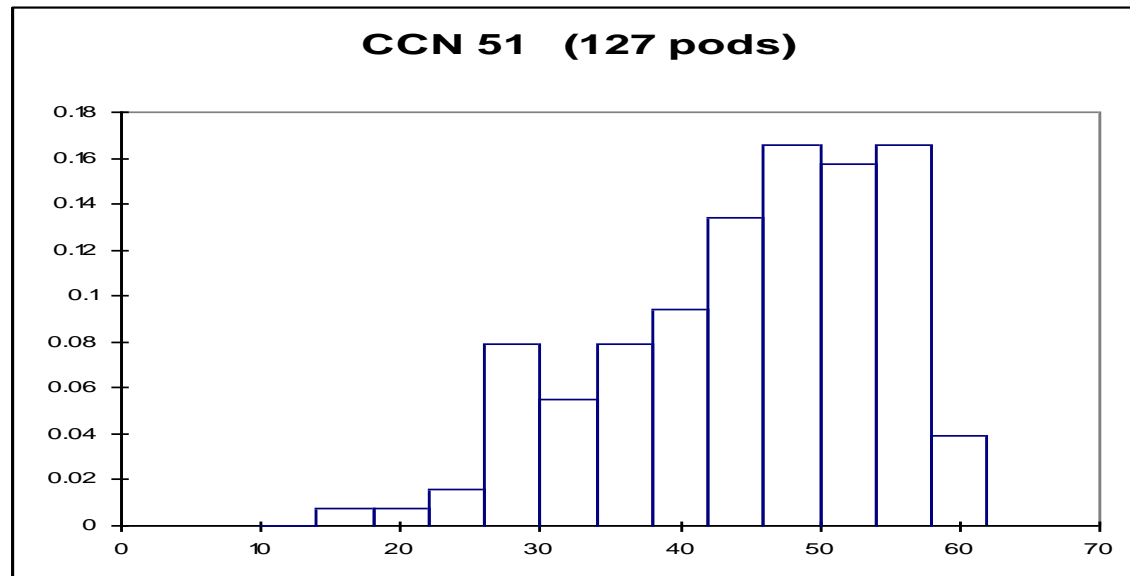
Other diseases (to determine)

**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 – Bioverdivity



*and thank you
for your attention*

