Agronomic and economic performances of improved cacao clones under different agro-ecological conditions in Costa Rica

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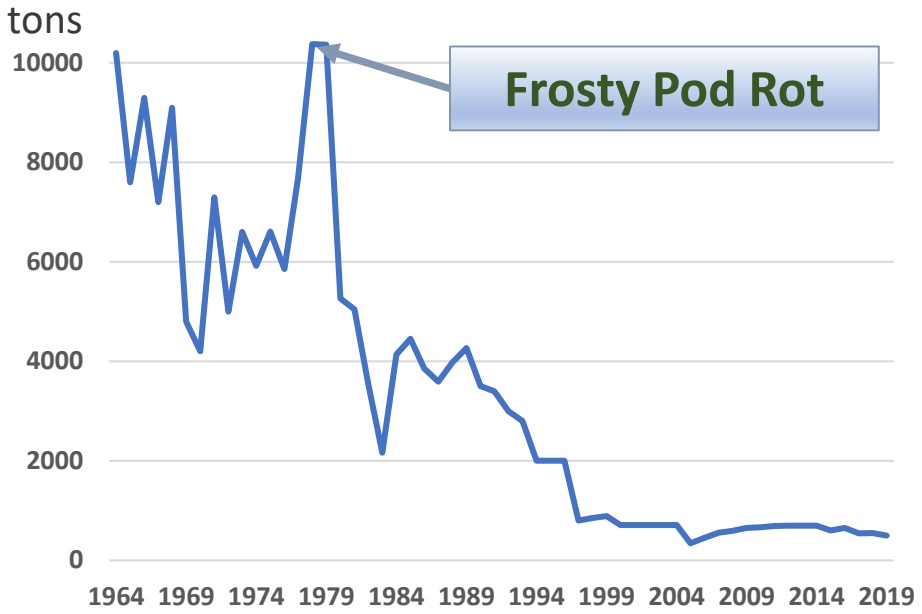
Introduction

Production of dry cacao beans in Costa Rica



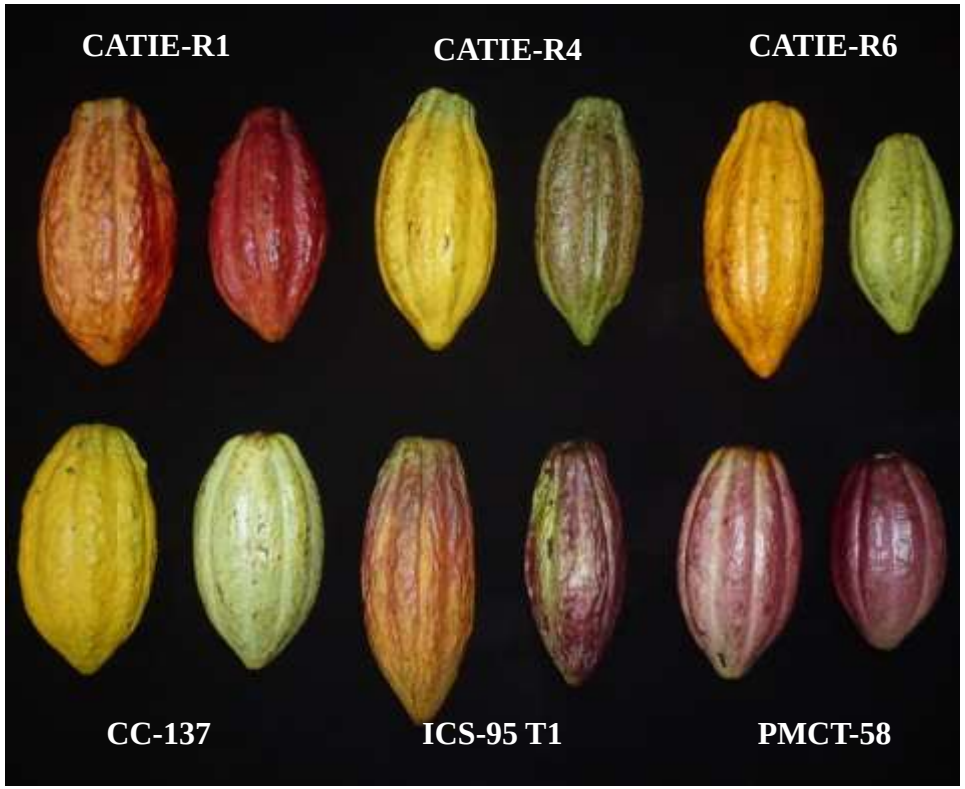
- In 1978, Costa Rica was the 3rd largest cacao producing country in the Mesoamerican and Caribbean Region.
- From 1997, it is the 10th

Extension of Frosty Pod Rot in America

Year	Country
1956	Panama
1978	Costa Rica
1979	Nicaragua
1997	Honduras
2002	Guatemala
2004	Belize
2005	Mexico
2009	El Salvador
2012	Bolivia
2016	Jamaica
2021	Brazil (Municipality of Cruzeiro do Sul, State of Acre)

Context

- In 1996, CATIE initiated a cacao breeding program with the objective of creating highly productive genotypes tolerant to FPR and BPR
- 6 Trinitarios clones with high production, tolerance to FPR and good cocoa quality has been selected
- From 2008, these clones have been distributed in Central America, then in Mexico and Brazil. In Costa Rica the objective was to reactivate cacao production



Objectives

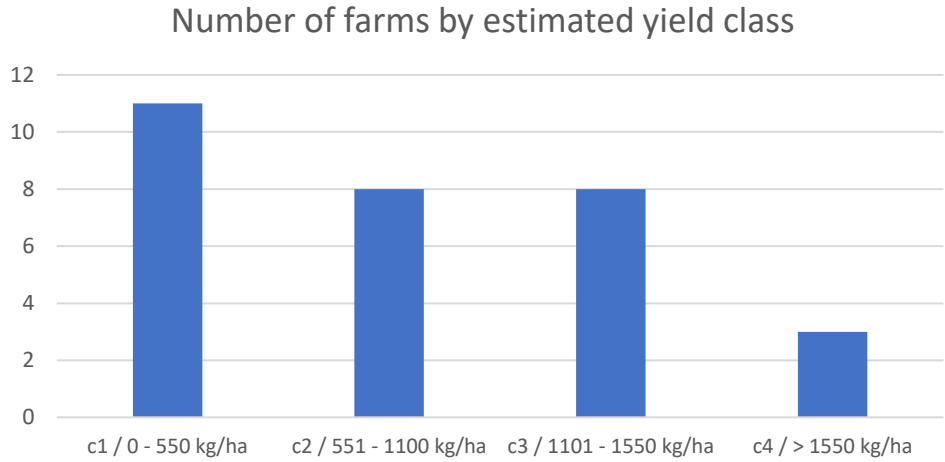
- Evaluate agronomic and economic performance of the 6 clones in the 3 cacao producing regions of Costa Rica
- Assess the adaptability of these clones to diverse agro-environmental conditions and to determine if genotype-environment interactions exist
- Make recommendations to optimize cacao production and producers' income

Methodology

- From 267 farmers growing the CATIE cacao clones provided by MAG, a sample of 30 producers were selected :
  10 producers per Region (growing the 6 clones, planting > 4 years); 15 producers who considered that the clones produced well, and 15 that did not.
- Producer surveys, plantation visits and evaluations (various economic costs and revenues, agroforestry systems, agronomic variables)

Results

- Distribution of farms in *a priori* 4 classes of yields



Anova and Multiple regression of yields & significative agronomic practices

Variables	Class 1	Class 2	Class 3	Class 4	F-value	p-value	t statistic
Estimated dry cacao yield (kg ha^{-1})	268 d	832 c	1428 b	1770 a	131.3	<0.0001	
Frequency of pruning (number)	1.2 b	2.9 a	2.9 a	4.0 a	8.7	0.0004	3.33
Chemical fertilizer dose (g/tree)	0 c	50 c	206 b	400 a	10.5	<0.0001	
Organic fertilizer dose (g/tree)	0 b	125 b	250 b	2333 a	9.1	0.0003	
Frequency of chemical fertilizer (nb)	0 b	0.13 b	0.67 a	1.13 a	9.2	0.0003	3.88
Frequency of organic fertilizer (nb)	0 b	0.13 b	0.25 b	1.00 a	8.9	0.0003	2.77

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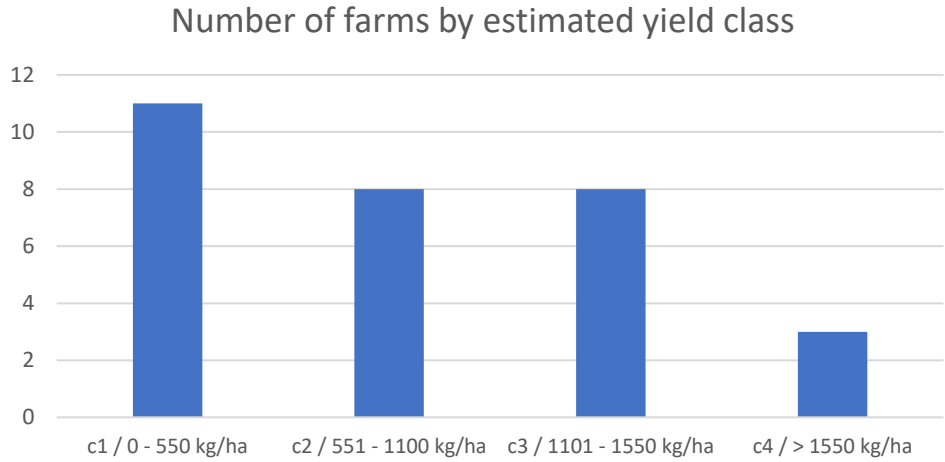

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Results

Anova of economic performance per class (US$)

Variables	Class 1 (11)	Class 2 (8)	Class 3 (8)	Class 4 (3)	F-value	p-value
Cash costs	758 b	905 b	1788 b	3203 a	6.4	0.0022
Gross income	1063 c	3018.98 b	4976 a	4441 a	16.6	<0.0001
Total cost of cacao	1104 c	1818 b	2277 b	4066 a	13.3	<0.0001
Cacao net income	-516 b	488 b	2094 a	147 b	6.1	0.0028
Cacao cash flow	-171 b	1402 a	2583 a	1010 a	12.0	<0.0001
Net Income	-40 b	1201 b	2698 a	375 b	5.7	0.0040
Cash flow	305 b	2114 a	3188 a	1238 a	7.0	0.0013
Household Profit	700 b	2269 a	3201 a	1591 a	4.8	0.0088

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- From class 1 to class 4, agronomic practices intensify (application of fertilizer and pruning), resulting in a significant increase in cacao yields and costs.
- Thus, while revenues increase from class 1 to class 3, they decrease for class 4 whose production costs are exorbitant.

Results: agronomic evaluation of clones

- No significant differences between the Regions.
- Similarly, Clone x Region interactions are not statistically significant.

Anova of agronomic evaluation of cacao clones

Variables	CATIE-R1	CATIE-R4	CATIE-R6	CC-137	ICS-95	PMCT-58	F value	P value
Estimated dry cacao yield (kg/ha)	831 b	1295 a	1308 a	700 c	625 c	505 d	19.21	<0.0001
Plant height (cm)	324 c	392 a	392 a	367 b	357 b	371 b	12.86	<0.0001
Stem diameter (cm)	25.0 c	29.0 a	29.3 a	29.5 a	27.2 b	27.7 b	27.88	<0.0001

- Highly significant differences between clones.
- New clones created by CATIE are significantly the most productive: CATIE-R6 and CATIE-R4 reach an average of 1.3 ton/ha, while CATIE-R1 barely exceeds 800 kg/ha.
- The absence of C x R interaction and the good results of the clones indicate that these clones should be adapted to adverse conditions induced by climate change because the areas evaluated were very contrasted (some drier, others wetter).

Conclusion and Recommandations

- The new clones selected by CATIE have a high yield potential under different agroecological conditions of cacao cultivation in Costa Rica. CATIE-R6 and CATIE-R4 are the most outstanding genotypes.

- The structuring into 4 yield classes demonstrated that reasoned intensification allowed a significant increase in yields and income.

Conclusion and Recommandations

- The management practices that most benefit the potential of cacao clones and the income of producers are **pruning of cacao trees and fertilization:**
  1 maintenance pruning and 2 light prunings during the year, and modest fertilization (starting from 125g/plant/year)

Maintenance pruning:

- If growers with low yields apply these practices, **they could at least triple or quadruple their yields**.

Thank you for your attention

Gracias por su atención

Merci pour votre attention

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