The CocoaSoils Core Trials: Early yields and pod counts

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Background

Low cocoa yields are due to many factors, including little or no fertiliser application. Quantifying cocoa nutrient requirements requires long-term, large-scale experiments. The CocoaSoils programme established a global network of large-scale cocoa nutrient response trials (Core Trials) to improve fertiliser recommendations.

Materials & Methods

Eleven Core Trials were established between 2019 and 2022 (Figure 1). Trials had a reduced factorial design with 4 levels of N, P & K (0, 50, 100 & 150% of predicted offtake). Vegetative measurements were collected 2-3 times per year, and yield parameters were collected at each harvest. Linear mixed-effects models were used for analysis.

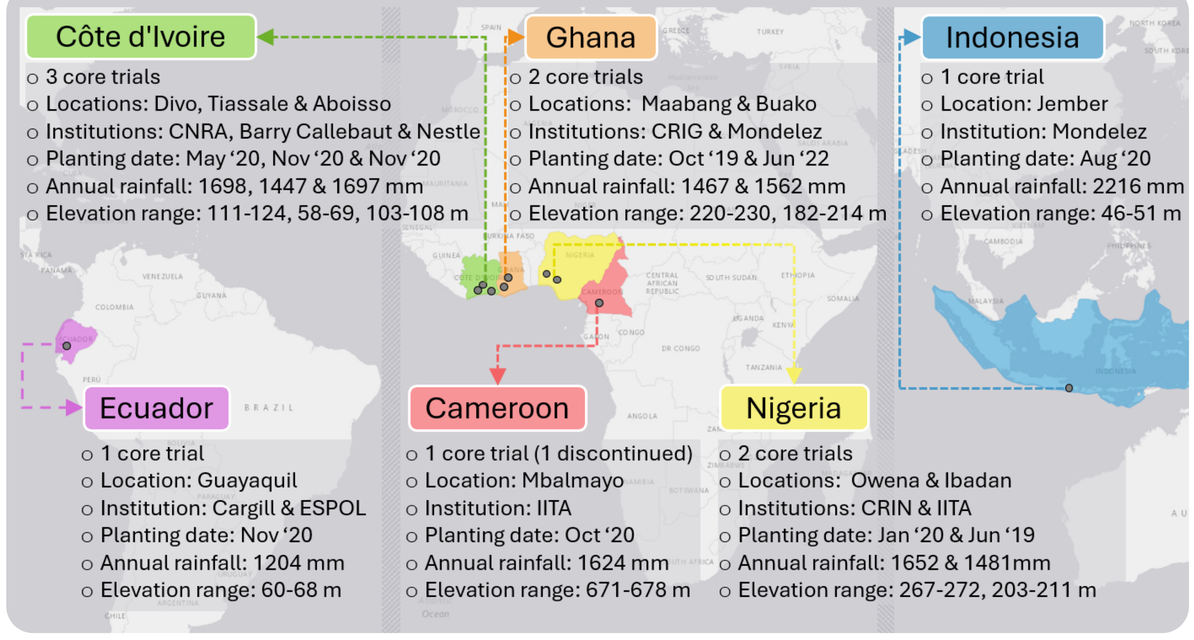

Figure 1. Locations and overview of the CocoaSoils Core Trials

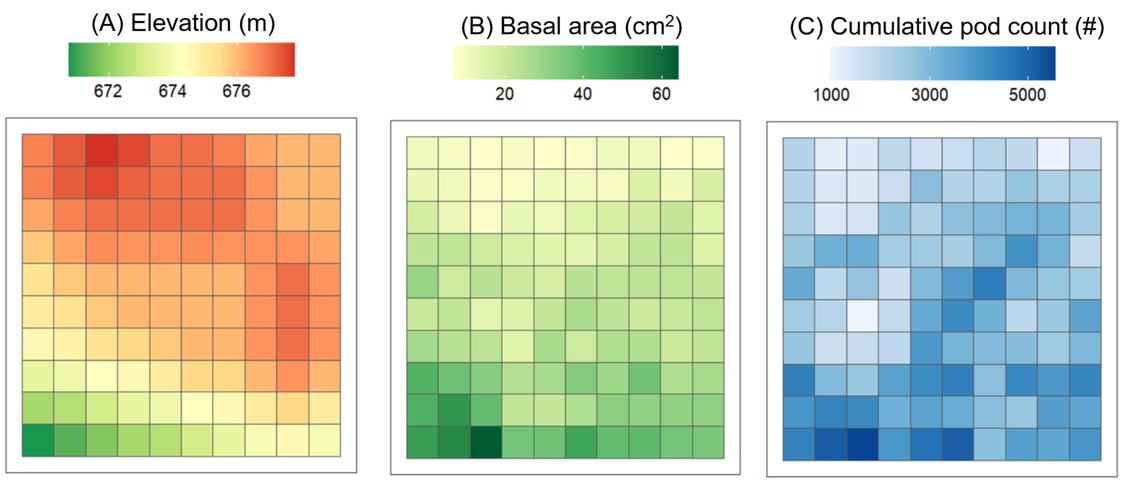

Figure 2. The average elevation (A, D), trunk basal area approx. 2 years after planting (B, E), and cumulative yield (C, F) for each plot in the Cameroon Core Trial.

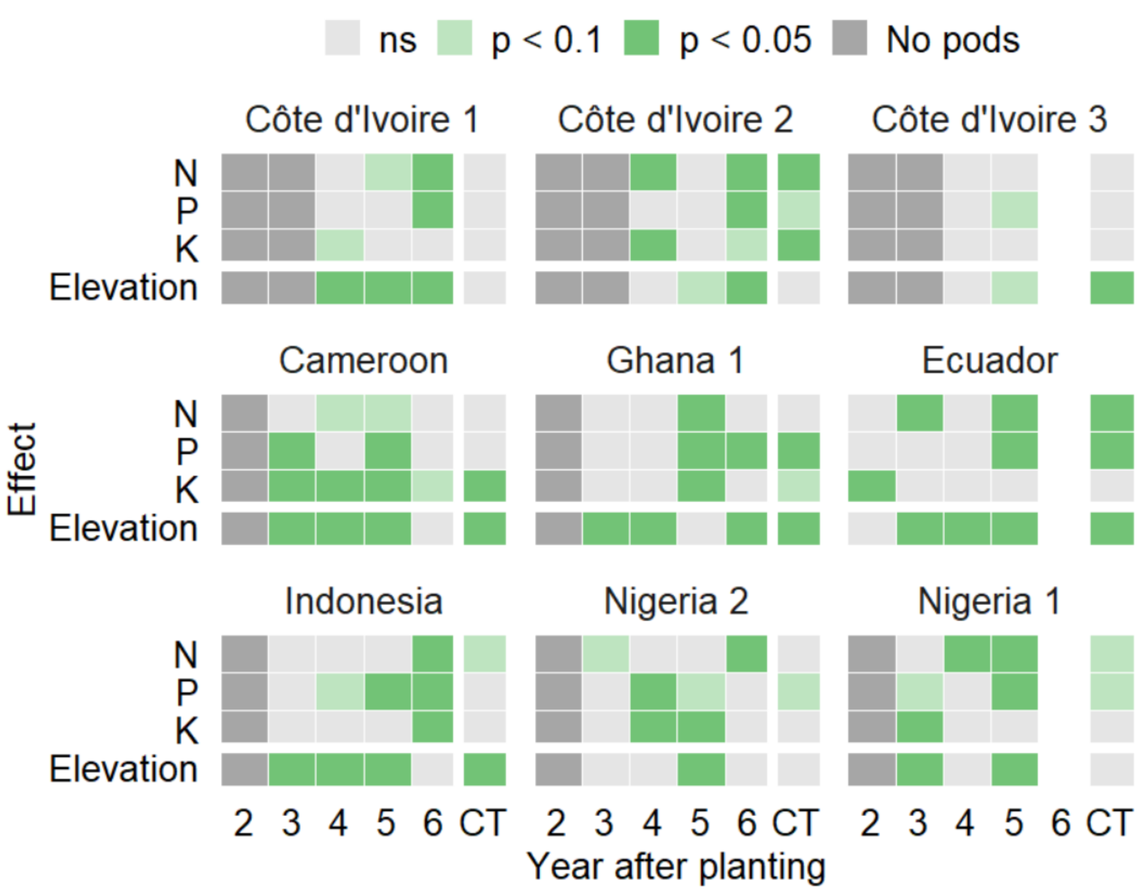

Figure 3. Significant nutrient and elevation effects from linear mixed-effects models for dry bean yield. Tiles indicate significant main or interaction effects involving each factor (e.g. N or N × PK) detected in either the minor or major harvest season each year after planting. CT = cumulative total. There were no significant results for Ghana 2.

Results

- Generally, plots with a lower elevation had more vegetative growth and were more productive than plots with a higher elevation (Figure 2).
- Overall, plot elevation had a greater effect on dry bean yield (DBY) than N, P or K (Figure 3).
- The effects of N, P and K were site- and age-specific (Figure 3).
  - K predominantly affected early harvests (1st or 2nd productive year).
  - P effects were more pronounced in later harvests (years 5 to 6).
  - N affected both early and late harvests.
- For 3-year-old trees, 95% of the maximum predicted DBY (425 kg ha^{-1}) was achieved across the nutrient rates (kg ha^{-1}) of 0–200 N, 10–90 P, and 600 K (Figure 4A).
- For 5-year-old trees, 95% of the maximum predicted DBY (621 kg ha^{-1}) was achieved across the nutrient rates (kg ha^{-1}) 0–400 N, 20–80 P, and 0–600 K (Figure 4B).

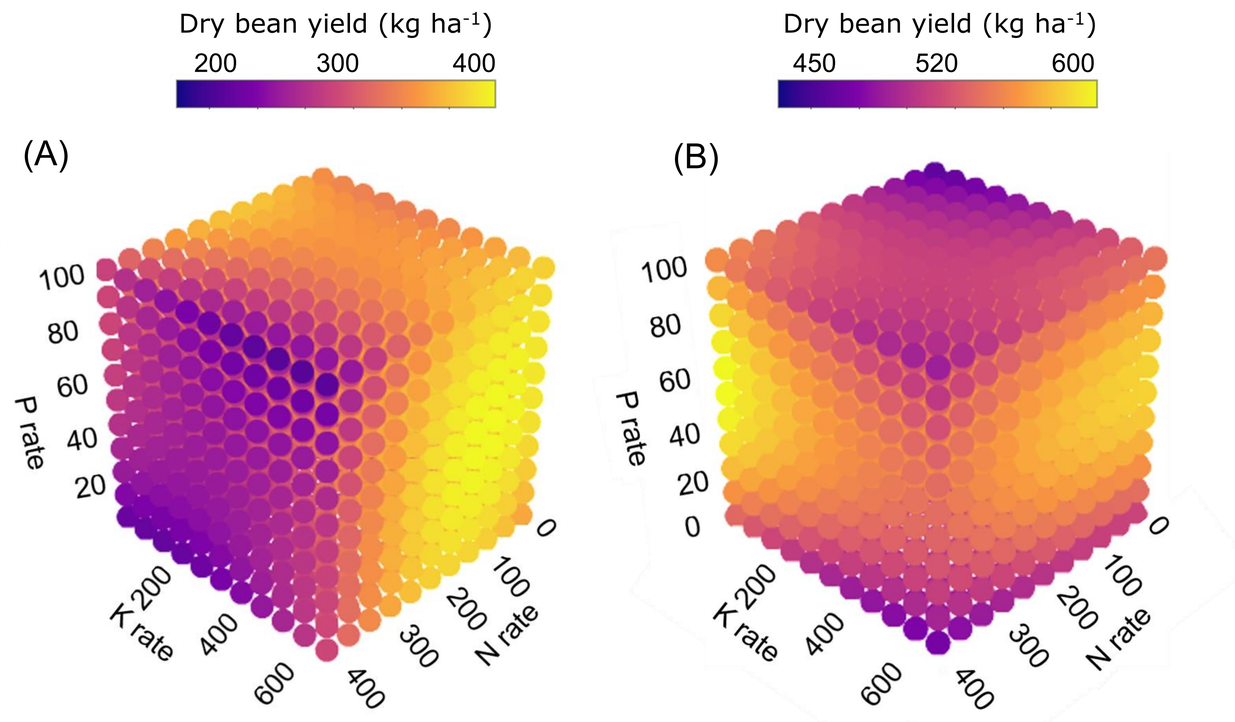

Figure 4. Modelled dry bean yield (kg ha^{-1}) versus N, P and K rates (kg ha^{-1}) at 3 (A) and 5 (B) years after planting. The maximum predicted DBY for 3-year-old trees was achieved with the nutrient rates (kg ha^{-1}) of 80 N, 50 P and 600 K, and for 5-year-old-trees, 400 N, 50 P and 0 K.

Summary

- Elevation exerted a stronger influence on dry bean yield than N, P, or K application and was associated with vegetative vigour, which emerged as a strong predictor of subsequent reproductive development.
- Nutrition responses varied between sites and tree ages, with K effects more pronounced in early harvests and P effects emerging in later harvests.
- Predictive modelling indicated that high yields were associated with high K and moderate N rates in younger trees, but with high N and low K rates in five-year-old trees.