Effect of Balanced Fertilization on Cocoa Yield

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A long-term study on cocoa fertilization demonstrates the benefits of building soil fertility levels for plantation crops.

Cocoa is either grown in low production systems under shade of other vegetation or in intensive production systems where trees are completely exposed to sunlight. Fertilization of shade cocoa commonly produces only modest yield increments. Fertilization of sunlight-exposed plantations generally results in significant yield responses because of greater photosynthetic activity. Despite their higher yield potential, sunlight-exposed plantations grown without fertilizer experience rapid yield declines with time and often suffer from early senescence. Research on cocoa response to fertilization is scarce in Colombia. This study was designed to evaluate response to balanced nutrition over five consecutive years.

Table 1. Average initial, intermediate and final soil test levels of the treatment plots where the highest yields were obtained (Santander, Colombia).

Year of study	pH	OM, %	P, ppm[1]	Al	K	Ca	Mg
				meq/100 g soil			
1	4.6	9.2	10	2.9	0.12	0.60	0.11
3	5.0	9.7	12	2.4	0.21	0.75	0.19
5	5.6	10.8	14	2.1	0.31	1.01	0.26

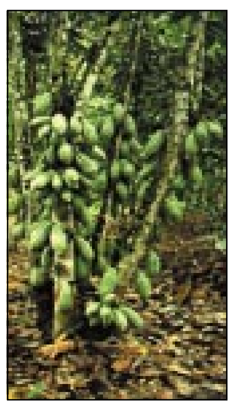
[1]parts per million

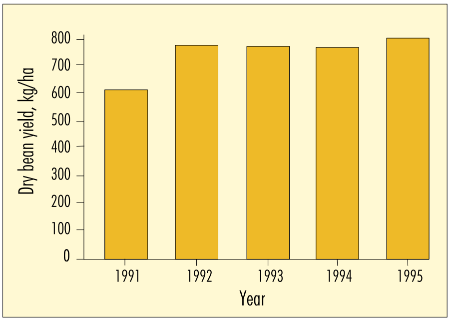
The experiment was conducted in Santander, Colombia, in a four-year old plantation of mixed commercial hybrids. The site is 900 m above sea level. It has a mean annual precipitation of 3,000 mm and a mean annual temperature of 24° C. Soil chemical properties at the beginning and end of the study are presented in **Table 1**. Treatments used in the experiment included three rates of nitrogen (N): 50, 100, and 150 kg/ha; one rate of phosphorus (P): 90 kg P_2O_5/ha; and three rates of potassium (K): 50, 100, and 200 kg K_2O/ha. A check treatment received the common farmer practice of 2 kg chicken manure per tree. All experimental units received an annual application of 200 g dolomite/tree. Fertilizer application was split twice a year with applications made at the beginning of each rainy season.

Long-term Yield and Profitability Benefits

Average cocoa yields during the five-year period are shown in **Table 2**. The 150-90-200 N-P_2O_5-K_2O treatment produced the greatest response with an average over the five-year period of 1,160 kg dry bean/ha, more than double the yield produced by traditional farmer practice. The typically low nutrient content of these soils (**Table 1**) plus

Excellent cocoa production is possible on soils with balanced nutrient content.





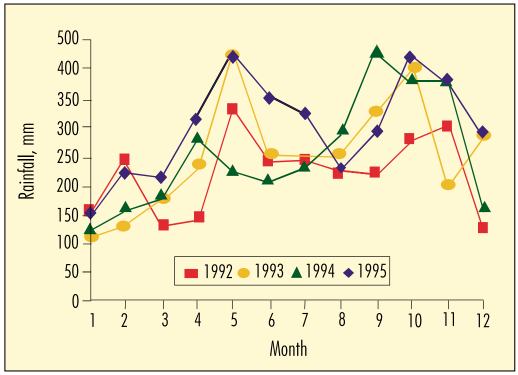


Figure 1. (Left) Average cocoa yields across fertilizer treatments over a five-year period (Santander, Colombia).

Figure 2. (Right) Four-year rainfall distribution pattern in Santander, Colombia.

the large nutrient requirement of the crop demand significant NPK inputs to achieve high yields.

Average yields across fertilizer treatments over the five-year period are shown in **Figure 1**. Highest average yields occurred in year five, 802 kg/ha dry beans. Yields were slightly lower in years two, three and four, and the lowest yield (620 kg/ha) occurred in year one. This suggests that better fertilizer management improves soil fertility and cocoa yields, over time – a phenomenon most likely shared by the majority of plantation crops.

Table 2. Five-year average cocoa yield (Santander, Colombia).

Treatments, kg/ha			Yield of dry beans,
N	P_2O_5	K_2O	kg/ha
Check[1]	–	–	562
50	90	50	560
100	90	50	574
150	90	50	572
50	90	100	601
100	90	100	650
150	90	100	943
50	90	200	819
100	90	200	1,050
150	90	200	1,160

[1]2 kg of chicken manure. All treatments received 200 g of dolomite per plant.

Most cocoa producing areas of Colombia have an average annual rainfall greater than 2,000 mm. This experimental site averaged 2,960 mm over the last four years of the experiment. Rainfall distribution pattern is an important determinant of fertilizer application timing. Fertilizer split applications should coincide with the initiation of each rainy period (**Figure 2**) because it contributes to fertilizer responsiveness.

A simple economic analysis in **Table 3** considers nutrient input cost against crop value. The most economic treatment was 150-90-200 kg

Table 3. Balanced nutrition effect on cocoa yield and income (Santander, Colombia).

	Treatment		Five-year	Total	Cost of	Net
N	P_2O_5	K_2O	average yield	income	fertilizer	income
----------- kg/ha -----------				-------- US $/ha --------		
Check[1]	–	–	562	289	65	224
50	90	50	560	288	57	231
100	90	50	574	295	74	221
150	90	50	572	294	92	202
50	90	100	601	308	65	243
100	90	100	650	334	83	251
150	90	100	943	484	100	384
50	90	200	819	421	84	337
100	90	200	1,050	538	101	437
150	90	200	1,160	596	117	479

[1]2 kg of chicken manure. All treatments received 200 g of dolomite per plant.

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$N-P_2O_5-K_2O$/ha, producing a net profit of US$479/ha, more than doubling income levels compared to common farmer practice.

In K-deficient soils, cocoa production is reduced. Note deficiency symptoms on lower leaves.

Summary

Data obtained in this experiment demonstrate the need of fertilizing full sunlight exposed cocoa plantations. The highest yield was produced with 150 kg of N, 90 kg of P_2O_5 and 200 kg K_2O/ha and affirms that adequate and balanced fertilization of cocoa is not only profitable, but also sustains and builds high yields over time. **BCI**

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