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HARVESTING INSIGHTS: WHAT DRIVES FARMER PROSPERITY?

A CROSS-COUNTRY ANALYSIS OF COCOA FARMING, YIELDS, AND INCOMES

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LIST OF ABBREVIATIONS

AE	Adult Equivalent
CDI	Côte d'Ivoire
CM	Cameroon
FFB	Farmer Field Book
FOB	Free on Board
GH	Ghana
HH	Household
ICCO	International Cocoa Organization
K	Potassium
LI	Living Income
LIB	Living Income Benchmark
mASL	meters Above Sea Level
N	Nitrogen
P	Phosphorus
T	Tonne
USD	United States Dollar
VN	Vietnam
WCA	West and Central Africa

FOREWORD

In a sector as complex and diverse as cocoa, evidence-based decision-making is no longer optional; it's a strategic imperative. To craft effective sustainability policies and deliver impactful farmer support programs, we must understand how cocoa farmers operate in different contexts: what works, what doesn't, and most importantly, why. Tools like Agri-Logic's Farmer Field Book (FFB) methodology make this possible, offering the granular insights needed to align investments, drive convergence, and design interventions that deliver results on the ground.

This report presents the latest findings from research conducted by Agri-Logic in partnership with Barry Callebaut, IDH, and the Rainforest Alliance. Drawing on primary data from cocoa farmers in Côte d'Ivoire, Ghana, Cameroon, and Vietnam during the 2023/24 agronomic season, the study explores the drivers of productivity and income across diverse contexts. One key takeaway is clear: smallholder cocoa farming does not have to be synonymous with poverty, just as land consolidation and large-scale operations are not prerequisites for success. Small farms, when well-supported and efficiently managed, can deliver sustainable yields, generate decent incomes, and enable farmers to thrive.

Now in its tenth year, this collaboration continues to generate evidence that challenges assumptions and drives action. The path forward is equally clear: greater, smarter investment, tailored to local realities, is non-negotiable. Procurement practices and strong policy advocacy must go hand in hand to ensure that farm investment and remunerative prices become the norm, not the exception. We believe the evidence presented here is another step toward unlocking the finance and momentum needed to transform the cocoa sector from within.

Renske Aarnoudse
Cocoa Program Director, IDH

Henk Gilhuis
Monitoring & Tracking Sustainability, Global Programs, Rainforest Alliance

Nicolas Mounard
VP, ESG, Sustainability & Traceability, Barry Callebaut

EXECUTIVE SUMMARY

In 2016, Barry Callebaut launched a partnership in Côte d'Ivoire with the Rainforest Alliance, IDH, and Agri-Logic, an agricultural consultancy firm. The objective of this collaboration was to provide quantitative and qualitative evidence on the cocoa farming model pursued by Ivorian farmers and generate insights on themes essential to farm productivity and sustainability. Over subsequent years, primary data collection expanded to cover Ghana and Cameroon. The resulting evidence base allows identifying factors that drive differences in terms of yields and income levels and enables Barry Callebaut and its partners to make evidence-informed decisions regarding programme design and targeting.

Evidence from a range of sustainability projects assessed so far is mixed and yields remain low, particularly in Ghana and Côte d'Ivoire. In Cameroon, yields are higher, contributing also to higher incomes, however, productivity still falls short of the potential output. In discussion with partners, it was decided to do a one-off survey among a group of 100 cocoa farmers in Vietnam to see how they compare to Barry Callebaut samples in West and Central Africa (WCA).

The study presented here sought to compare farmer profiles, labor and fertilizer investment strategies, yield levels, margins and living income implications. The aim was to explore differences in performance and their drivers, and discuss what this may mean for project design in WCA moving forward. Within this, the following research questions were identified:

1. What are the key similarities and differences of the cocoa farming model across the four countries, particularly in terms of farm management and farm economics?
2. What are the factors contributing to elevated farmer yields and incomes?
3. What is the likelihood that farmers in particular countries are able to earn a Living Income?
4. How can ongoing and future sustainability projects integrate best practices and improve farmer yields and incomes?

A CROSS-COUNTRY FARM AND FARMER PROFILE COMPARISON

Farm and farmer profiles differ significantly between the four countries on a number of aspects known to influence poverty. Farming area and total cocoa production area in WCA is 6.9 times larger and 5.5 times larger, respectively, relative to average farms in Vietnam. However, Vietnamese farms on average had the largest share of land used for cocoa production at 90%, relative to Ghana (87%), Cameroon (67%), and Côte d'Ivoire (65%). Despite small average farm holdings, surveyed farmers in Vietnam have several conditions that render their farms more conducive to higher cocoa yields:

- Vietnamese cocoa farms received around 2,015 mm of rain during the 2023/24 production season, while farms in WCA received less (an average of 1,803 mm for Ghana, 1,614 mm for Cameroon and 1,610 mm for Côte d'Ivoire).
- Vietnamese farms are higher in elevation relative to Côte d'Ivoire and Ghana, which may confer more favorable weather conditions.
- Vietnamese farmers were able to report both the cultivar and the variety of cocoa trees grown, suggesting a greater level of awareness and professionalism than that observed among farmers in WCA.
- In terms of farm age, a factor negatively correlated with yields, farms in WCA are 8-9 years older on average than Vietnamese farms.

LABOR AND FERTILIZER INVESTMENTS

Significant regional differences emerge when comparing the number of labor hours invested on the farm by country. Vietnamese farmers invest more labor hours per hectare on average (slightly over 1,400 h), while in WCA, average labor hours are significantly lower, with farmers in Côte d'Ivoire and Ghana spending 4.2 and 5.4 times less hours per hectare than their counterparts in Vietnam.

Across all activities, we observe that farmers in Vietnam allocated significantly more time than their African counterparts, except for spraying. In terms of pre-harvest activities (which are key to productivity improvements), Vietnamese farmers allocated more time by a factor of 15.6 on pruning than surveyed African farmers, while spending a factor of 14.8 more time on fertilizing.

Interestingly, Vietnamese farmers invested 80 hours/ha in irrigation, whereas sampled African farmers did not allocate labor hours to this activity, possibly suggesting high technological costs, limited access, and challenges in water availability faced by African farmers.

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- Vietnamese farmers also exceeded labor hour investments for every post-harvest activity relative to their African counterparts.

The study compared the application of N, P, and K across the respective fertilizers, manures, and composts used by farmers across countries. Among surveyed farmers, the volumes of nitrogen (N), phosphorus (P), and potassium (K) applied in Vietnam are far higher than in WCA and are better aligned with the ratio at which nutrients are removed from the field during harvest. Key factors driving differences in fertilizer use are likely availability and cost of these crucial inputs between countries.

Overall, investment levels differ significantly between WCA and Vietnamese farmers, with the latter investing more on average by a factor of 5 to 14 times higher. Cost allocation categories also differ, with Vietnamese farmers allocating 89% to investments in inputs, versus 26-34% in WCA.

YIELD LEVELS

In terms of yields, we observe that levels are several factors higher in Vietnam than among sampled farmers in WCA, ranging from a factor of 2.8 in Cameroon to 4.1 in Ghana. Average yields per country varied significantly from 1,688 kg/ha in Vietnam to as low as 413 kg/ha in Ghana and 462 kg/ha in Côte d'Ivoire. These differences can be attributed in large part to high nutrient applications and more intensive farm management among Vietnamese cocoa farmers. Another factor is higher rainfall levels in Vietnam (500 mm on average) and strategically timed irrigation observed among 75% of Vietnamese farms, which can be a crucial factor during times of low rainfall.

IMPLICATIONS FOR LIVING INCOME

Both Vietnam and Cameroon have liberalized internal markets for cocoa, which means that farmgate prices closely track international prices. This means that farmers in these countries received higher farmgate prices compared to Ghana and Côte d'Ivoire. Coupled with higher yields, farmers in Vietnam and Cameroon exceeded on average the Living Income benchmark (40% and 45% respectively), while a combination of low prices and yields in Ghana and Côte d'Ivoire resulted in only 11% and 4% of farmers exceeding the Living Income benchmark, respectively.

The contrast with Ghana and Côte d'Ivoire is stark, with two main factors working against farmers in these countries. Firstly, family sizes are larger in Côte d'Ivoire, translating into more mouths to feed and inflating the family-size adjusted Living Income benchmark. Secondly, despite high international cocoa prices, farmers in Ghana and Côte d'Ivoire are not seeing a meaningful increase in cocoa incomes due to regulated farmgate prices.

CHARTING A WAY FORWARD

The analysis provides the following strategic actions to inform future sustainability interventions and help farmers earn a Living Income:

- Promoting intensified farm management offers the potential to increase yields. This should entail more intensive pruning and nutrient management aligned with expected yield levels.
- Soft loans or conditional grants could support motivated and active farmers facing cash limitations in intensifying labor investments, particularly around pre-harvest activities and fertilizer application.
- Findings on irrigated farms from Vietnam are promising and should be further explored, given that even a small amount of strategically timed irrigation appeared to promote higher yields
- Market conditions in Ghana and Côte d'Ivoire need to be adjusted to ensure that farmers are able to earn a farmgate price that is more aligned with international cocoa prices, while maintaining the safety net of the floor price.

1 INTRODUCTION

In 2016, Barry Callebaut launched a partnership in Côte d'Ivoire with the Rainforest Alliance, IDH, and Agri-Logic, an agricultural consultancy firm. The objective of this collaboration was to provide quantitative and qualitative evidence on the cocoa farming model pursued by Ivorian farmers and generate insights on themes essential to farm productivity and sustainability, ranging from household and farm profiles, farm management practices, to input use, yields, and farm economics. Over subsequent years, primary data collection expanded to cover Ghana and Cameroon. The resulting evidence base is used to identify factors that drive cross-country differences in terms of yields and income levels. Ultimately, these insights support Barry Callebaut and its partners to prioritize investments in factors that enhance farmer cocoa yield productivity and incomes, inform better programme design and targeting for farmer support interventions, and contribute to sectorwide initiatives on Living Income (LI) data collaborations, such as the Cocoa Income Inventory.

In Côte d'Ivoire, Ghana, and Cameroon, data for this cross-country study was gathered from a range of sustainability projects implemented by Barry Callebaut. On most farms in these projects, productivity levels tend to be far below the biophysical potential of the cocoa crop,[1] resulting in low farmer incomes from cocoa that contribute to poverty. A common objective of these projects is to increase productivity, in some cases coupled with paying out higher prices or conditional cash transfers.

Evidence on the effectiveness of interventions so far is mixed and yields remain low, particularly in Ghana and Côte d'Ivoire. In Cameroon, yields are higher, contributing also to higher incomes, however, productivity still falls short of the potential output.

Despite years of investment by a range of stakeholders and the potential for higher yields, further yield improvements remain elusive in all three countries. In discussion with partners, it was decided to do a one-off survey among a group of 100 cocoa farmers in Vietnam to see how they compare to Barry Callebaut samples in West and Central Africa (WCA). Based on Agri-Logic's past work in Vietnam's agricultural sector, the hypothesis was that Vietnamese cocoa farmers perform significantly better in terms of yield and poverty levels relative to their West African counterparts.

The study presented here sought to compare farmer profiles, labor use, investment strategies, margins and poverty. The aim was to explore differences in performance and their drivers, and discuss what this may mean for project design in WCA moving forward.

The report is structured as follows: First, it outlines the methodology used to obtain data and conduct analyses. Subsequently, it describes the primary features of the different cocoa farming models and explores the various factors that contribute to higher yields and incomes among sampled farmers, ranging from investments in pre- and post-harvest labor, fertilizer application, and irrigation use. The report concludes by highlighting priorities for future farmer support interventions to enhance yields and promote the attainment of a Living Income.

[1] See Asante et al.(2022), which seeks to quantify the cocoa yield gap in Ghana and identify factors that can narrow the productivity gap.

2 METHODOLOGY

2.1 DATA COLLECTION APPROACH AND DATA SOURCES

During the eight years of partnership between Barry Callebaut, IDH, the Rainforest Alliance, and Agri-Logic, the latter was engaged to oversee the data collection and analysis process. Barry Callebaut teams in cocoa producing countries gathered most of the data presented in this report by implementing the Farmer Field Book (FFB) data collection method, developed by Agri-Logic. The FFB method, combined with a dedicated FFB software, helps to generate daily information on farm management among surveyed groups. Farmers participating in FFB provide daily recordings of key farm management data, which is then collected and digitized every two weeks using Agri-Logic's FFB software. One advantage of the FFB method is that it facilitates the calculation of key estimations, such as the return on investment, which can be difficult to calculate with large numbers of smallholder farmers. The FFB can also be used to understand the impact of farm inputs on the environment and ways to minimize their impact. This approach is therefore instrumental in generating insights to improve programme design and targeting for farmer support interventions and increase yields.

Data in WCA used for this study was gathered using the FFB method, based on a sample of 1,340 farmers in Côte d'Ivoire, 780 farmers in Ghana, and 373 farmers in Cameroon. The results from WCA were then compared to a set of 100 farmers in Vietnam. The data on farmers in Vietnam was collected using a one-off survey that was conducted at the end of their agronomic cocoa season in April 2024. Since Barry Callebaut does not source directly in Vietnam, farmers were selected by randomly approaching cocoa farmers in the top five cocoa producing districts of Vietnam's Central Highlands. Using these data sources, this report analyses management and performance differentials for the 2023/24 agronomic season, which runs from March 2023 to February 2024 in WCA and from April 2023 to March 2024 in Vietnam. In this report, this period will be subsequently referred to as the 'production season'.

2.2 KEY RESEARCH QUESTIONS

The overarching purpose of this initiative was to better understand factors impacting farmer yields and incomes. Within this, the following research questions were identified:

1. What are the key similarities and differences of the cocoa farming model across the four countries, particularly in terms of farm management and farm economics?
2. What are the factors contributing to elevated farmer yields and incomes?
3. What is the likelihood that farmers in particular countries are able to earn a Living Income?
4. How can ongoing and future sustainability projects integrate best practices and improve farmer yields and incomes?

2.3 STATISTICAL AND ECONOMETRIC METHODS

To help answer the aforementioned research questions, Agri-Logic conducted a series of correlation, regression, and logit analyses using the data collected during the 2023/2024 cocoa production season. Agri-Logic tested key variables, such as the size of farmer investments in pre-harvest activities, fertilizer application, and use of irrigation to determine the impact of said variables on yields and farmer incomes and account for differences in yields and income.

2 METHODOLOGY

2.4 RESEARCH LIMITATIONS

The following limitations to the data sampling, collection, and analysis process are identified:

- Between the four countries, there is an imbalance in the farmer sample size, with Côte d'Ivoire and Ghana having notably larger sample sizes (1,340 and 780, respectively) than Cameroon and Vietnam (373 and 100, respectively). Larger sample sizes minimize statistical error and can provide a more accurate approximation of characteristics and outcomes within the surveyed population, therefore increasing confidence in the findings. Although the Vietnam sample size is sufficiently representative at country level,[2] the size imbalance can undermine cross-country comparisons.
- Participant farmers located in WCA are not randomly selected, as they are all a part of Barry Callebaut's sustainability programmes and receive support to improve farm productivity and sustainability. Consequently, farmers included in the WCA samples may have inflated outcomes for income and other key variables relative to farmers that do not participate in sustainability programmes. In an ideal study design, the sampling of farmers would have been randomized among participants and non-participants of Barry Callebaut interventions.
- Data covering Vietnamese farmers was collected using a one-off survey, while farmers in WCA had data collected on a daily basis. Consequently, data from the Vietnamese sample may be more vulnerable to recall bias.

[2]The Vietnam sample size is sufficiently representative at country level with a confidence level of 95% and an error margin of 5% based on the standard deviation of the key factors defining cocoa income, notably acreage, investment, production and yield.

3 COCOA FARMING MODELS IN WEST AND CENTRAL AFRICA AND VIETNAM

3.1 COMPARING FARM AND FARMER PROFILES ACROSS COUNTRIES

Farm and farmer profiles differ significantly between the four countries on a number of aspects known to influence poverty. The following section explores factors with statistically different results between countries. A summary of these factors is provided in Table A.

During the 2023/24 production season, the average farm size and area devoted to cocoa production varied considerably between countries, with farming area and total cocoa production area in WCA being 6.9 times larger and 5.5 times larger, respectively, relative to average farms in Vietnam. Average farm size was the largest in Cameroon at 6.61 ha, of which 4.47 ha were devoted to cocoa cultivation. In contrast, average farm size was less than 1 ha (0.81 ha) in Vietnam, of which the majority (0.65 ha) was allocated to cocoa production. In theory, larger farm size and cocoa area should put the surveyed African farmers in a better position to reach the Living Income. However, Vietnamese farms on average had the largest share of land used for cocoa production at 90%, relative to Ghana (87%), Cameroon (67%), and Côte d'Ivoire (65%).

Despite small average farm holdings, surveyed farmers in Vietnam have several conditions that render their farms more conducive to higher cocoa yields.[3] On average, Vietnamese cocoa farms were 13 years old, versus an average of over 20 years in surveyed African farms, where the average farm is 21 years old in Côte d'Ivoire and 22 years in Ghana and Cameroon. Cocoa yield productivity peaks between around 10 and 20 years old, but generally declines as trees age, and cocoa tree replanting or renewal is recommended after 25-30 years.

Another factor working in favour of surveyed Vietnamese farms is the amount of seasonal rainfall received, with Vietnamese cocoa farms receiving around 2,015 mm of rain during the 2023/24 production season. In contrast, farms in WCA received less rain, with Ghanaian farms receiving an average of 1,803 mm, followed by Cameroonian farms (1,614 mm) and Ivorian farms (1,610 mm). Based on previous Agri-Logic studies, higher average yields have partially been attributed to better rainfall. For instance, data covering the 2021/22 production season show that surveyed farmers operating in the regions with the five highest average yields in the sample size were located in the western part of Côte d'Ivoire, where average rainfall was between 1,699-2,500 mm (Barry Callebaut, 2023).[4]

TABLE A: CROSS-COUNTRY FARM AND FARMER PROFILES

	Sample Size	FARMER PROFILE			FARM PROFILE					
		Gender	Family size	LIB (family size adjusted)	Total farm area	Total cocoa area	Cocoa farm age	Share of land used for cocoa	Seasonal rainfall	Elevation
Unit	#	% female	#	$/hh/yr	ha	ha	years	%	mm	mASL
CdI	1340	6%[a]	8.18[a]	8,688[a]	5.88[a]	3.53[a]	21[a]	65%*	1,610[a]	180[a]
GH	780	32%[b]	6.31[b]	4,564[b]	3.85[b]	3.20[a]	22[a]	87%*	1,614[a]	169[a]
CM	373	18%[c]	7.03[b]	4,697[b]	6.61[a]	4.47[b]	22[c]	67%*	1,803[b]	576[b]
VN	100	30%[b]	3.55[c]	3,918[c]	0.81[b]	0.65[c]	13[b]	90%*	2,015[c]	484[b]

Different letters denote significant difference at p≤0.05 between all pairwise country comparisons

LIB: Living Income Benchmark

[3]Vietnamese farmers grow grafted Trinitario cultivars of the TD5, 6, 8, 9 and 10 variety, originally imported from Malaysia. For West Africa, it is less clear which varieties are grown, rendering comparisons difficult.

[4]https://www.barry-callebaut.com/system/files/2023-05/Barry%20Callebaut_Agrilogic%20White%20Paper_2023_0.pdf

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Furthermore, Vietnamese farms were also significantly higher in elevation relative to Côte d'Ivoire and Ghana, which may confer more favorable weather conditions. While Cameroon and Vietnam surveyed farms had an average elevation of 576 meters Above Sea Level (mASL) and 484 mASL, respectively, elevation in Côte d'Ivoire and Ghana was around 180 mASL and 169 mASL, respectively. As temperatures rise in Côte d'Ivoire and Ghana due to climatic changes, the accompanying loss in moisture at lower altitudes could have adverse effects on cocoa yields. According to Läderach et al. (2013), rising temperatures will push areas suitable for cocoa production uphill; by 2050, the optimal altitude for cacao production will likely rise in Côte d'Ivoire and Ghana from 100-250 mASL to 450-500 mASL.[5]

Finally, while most surveyed African farmers were unable to identify the cocoa varieties grown on their plots, Vietnamese farmers were able to report both the cultivar and the variety of cocoa trees grown. This suggests a level of awareness and professionalism among Vietnamese farmers that is not observed among farmers in WCA.

Across all four countries during the 2023/24 production season, the majority of surveyed cocoa farmers were men, while female farmer representation ranged from 32% among surveyed farmers in Ghana to as low as 6% in Côte d'Ivoire. Household size differed considerably between surveyed African farmers and Vietnamese farmers – among the latter, average family size was 3.55, while it was double or more in WCA, reaching 8.18 in Côte d'Ivoire.

As a result of larger family size, the Living Income Benchmark (LIB) value per Adult Equivalent (AE) in Côte d'Ivoire is significantly higher than in other countries. Ivorian cocoa households must earn $8,688 per year to meet Living Income standards, relative to a low of $3,918 per household annually in Vietnam, $4,564 in Ghana and $4,697 in Cameroon. All else being equal, this reduces the probability that Ivorian farmers can reach the benchmark.

3.2 COMPARING CROSS-COUNTRY FARM MANAGEMENT: LABOR INVESTMENTS

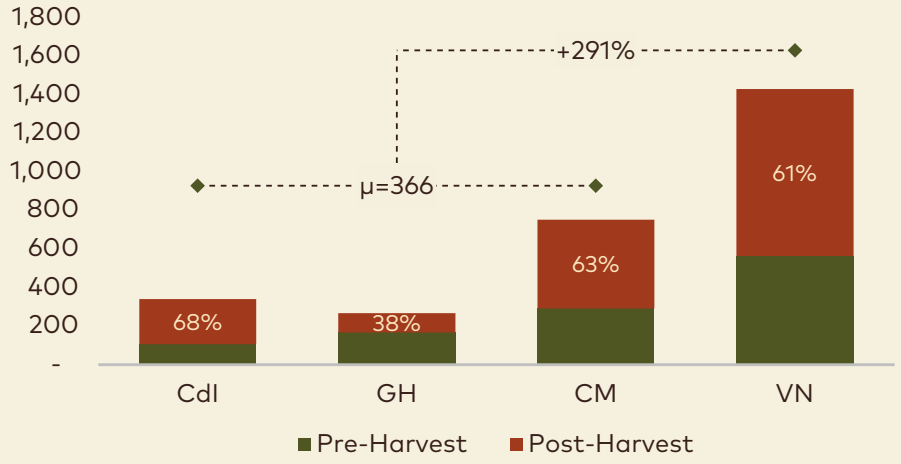
3.2.1 DESPITE SIGNIFICANT REGIONAL DIFFERENCES, DISTRIBUTION OF LABOR HOURS SKEWED IN FAVOUR OF POST-HARVEST ACTIVITIES

Significant regional differences emerge when comparing farm management practices, starting with the number of labor hours by country. In Vietnam, total labor hours per hectare average slightly over 1,400 hours, while in WCA, average labor hours are significantly lower, reaching 735 hours/ha in Cameroon, 341 hours/ha in Côte d'Ivoire, and 267 hours/ha in Ghana (see Figure A). In total, farmers in Côte d'Ivoire and Ghana spend 4.2 and 5.4 times less hours per hectare than their counterparts in Vietnam.

Differences in the division of pre- and post-harvest labor are smaller by country. With the exception of Ghana, on average the majority of labor hours are allocated to post-harvest activities, ranging from 61% of hours in Vietnam and Cameroon to 68% of hours for Côte d'Ivoire.

FIG. A: FARMERS IN VIETNAM SPENT 291% MORE LABOR TIME PER HA THAN THE WCA MEAN

Total labor, pre- and post-harvest, in hours per ha (y) by country (y); Vietnam differential (%) over WCA mean (μ)



[5]https://www.climate.gov/news-features/climate-and/climate-chocolate

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3.2.2 VIETNAMESE LABOR INVESTMENTS IN PRE-HARVEST ACTIVITIES ARE SIGNIFICANT RELATIVE TO SURVEYED AFRICAN FARMERS

The allocation of labor to activities was assessed by averaging the mean hours for the African countries and comparing the results with Vietnam. Across all activities, we find that farmers in Vietnam allocated significantly more time ($p \leq 0.05$) than their African counterparts, with the exception of spraying (see Figure B).

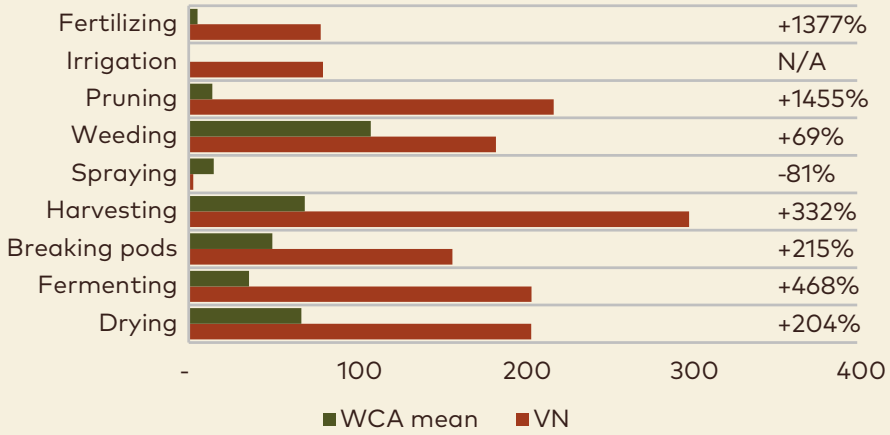
In terms of pre-harvest activities, Vietnamese farmers allocated more time by a factor of 15.6 on pruning than surveyed African farmers, while spending a factor of 14.8 more time on fertilizing. While African farmers in the 2023/24 production season allocated over 100 hours per hectare on weeding, labor investments in fertilizing and irrigation in particular were minimal to zero. These trends have important implications for yield potential and could account in part for some of the differences in yield outcomes between surveyed African and Vietnamese cocoa farmers. Specifically, labor investments in pre-harvest activities, notably fertilizing and pruning, have a significant effect on yield outcomes and constitute activities where most of the yield gains can be achieved. Based on Barry Callebaut and Agri-Logic's (2023) study of Ivoirian farmers during the 2021/22 production season, farmers within the top 20% of yield outcomes invested three times more in pre-harvest labor relative to the bottom 20% of farmers. Top performers allocated an average of 224 hours per hectare in pre-harvest activities, versus only 81 hours on average for farmers with the lowest 20% of yields. This comparison is striking compared to farmers in Vietnam, who spent an average of 564 hours per hectare, or more than double that of top performing Ivorian farmers in the 2023 study.

The only pre-harvest activity where surveyed African farmers outperformed their Vietnamese counterparts was spraying. However, this could speak more to the higher risk posed by pest and disease outbreaks in WCA, notably from black pod fungus and Swollen Shoot Virus Disease. The latter disease has not been reported as a significant problem in Vietnamese cocoa production (Kongor et al, 2024).

It is interesting to note as well that while Vietnamese farmers invested 80 hours/ha in irrigation, sampled African farmers did not allocate labor hours to this activity. This likely speaks to high technological costs, limited access, and challenges in water availability faced by African farmers relative to Vietnamese farmers.

FIG. B: FARMERS IN VIETNAM INVEST MORE LABOR ON ALL ACTIVITIES EXCEPT SPRAYING

Total labor in hours per ha (x) by activity (y); Vietnam differential (%) over WCA mean



Although labor investments in post-harvest activities are not as impactful in boosting yields, surveyed Vietnamese farmers also exceeded labor hour investments for every post-harvest activity relative to their African counterparts. For example, Vietnamese farmers allocated an average of 299 hours/ha on harvesting, versus 69 hours/ha for surveyed African farmers. Vietnamese labor investments in drying were more than three times more than in WCA, while investments in fermenting were more than four times higher in Vietnam than in WCA.

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3.3 LOW LEVELS OF INVESTMENT IN FERTILIZER APPLICATION IN WCA RELATIVE TO VIETNAM

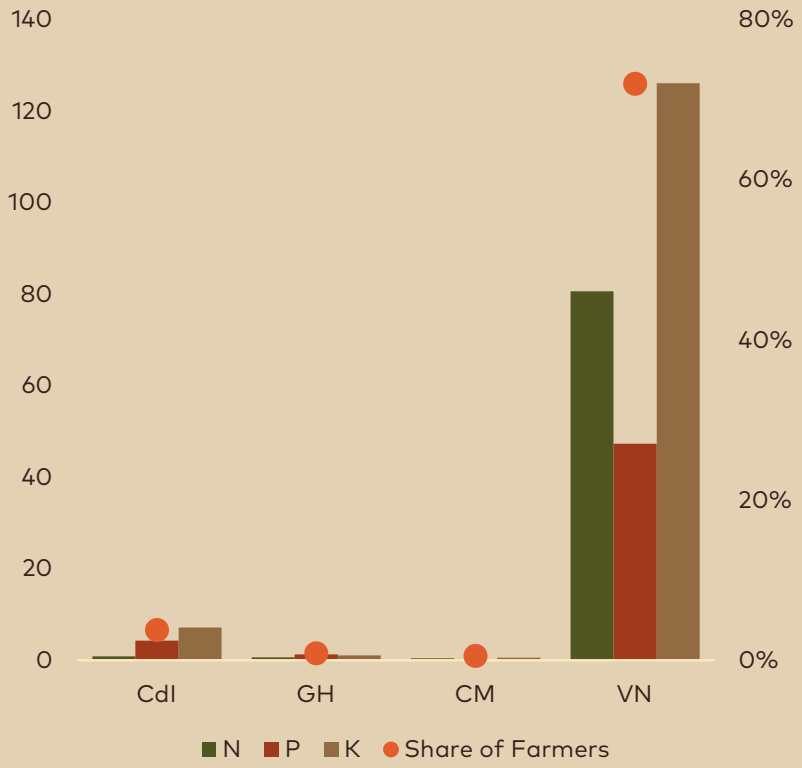
Nutrient management is an important factor that drives higher yields and enhances soil fertility. While application of fertilizer or manure is not a magic bullet that will, for example, offset a lack of pruning, the use of a balanced amount of nitrogen (N), phosphorus (P) and potassium (K) is essential to achieve higher yields. Without these inputs, it becomes difficult to move beyond the base level of yield that a tree will give when it relies solely on naturally available nutrient stocks, such as N deposition from rainfall and soil nutrient stocks.

The study compared the application of N, P, and K across the respective fertilizers, manures and composts used by farmers across countries. Among surveyed farmers, the volumes of N, P, and K applied in Vietnam are far higher than in WCA and are better aligned with the ratio at which nutrients are removed from the field during harvest (see Figure C). In Vietnam, cocoa farmers applied an average of 81 kg/ha of N, 47 kg/ha of P, and 126 kg/ha of K. When analysing the share of farmers who applied over 5 kg/ha for each nutrient, this rate reached 72% in Vietnam; for N application alone, the rate of Vietnamese farmers who apply more than 5 kg/ha is 99%. In contrast in WCA, average application of N, P, and K across all three countries is minimal; in Côte d'Ivoire, which had the highest average application rate among the three African countries, farmers applied less than 10 kg/ha of K, 5 kg/ha of P, and less than 5 kg/ha of N. More broadly, only around 5% of Ivorian farmers applied more than 5 kg/ha of fertilizer, while in Ghana and Cameroon, that number dipped below 5%.

Key factors driving differences in fertilizer use are likely availability and cost of these crucial inputs between countries. While assessing availability was out of the scope of Agri-Logic's study, a comparison of the price of nitrabor - the only fertilizer used by some farmers in all countries – revealed that its price was 17% higher in WCA, costing 0.69 USD/kg and 0.58 USD/kg in Vietnam. Another benefit to Vietnamese farmers is that around 48% of the fertilizer volume applied comes from a range of NPK blends, while the remainder are single element fertilizers such as kali58%, phosphate, SA21%, and urea. Finally, 39% of farmers in Vietnam applied organic material such as manure or compost at an average rate of 1.89 t/ha, which could help further boost yields, compared to just 4% of farmers in WCA, who applied these inputs at an average rate of only 51 kg/ha.

FIG. C: NUTRIENT APPLICATION LEVELS IN VIETNAM ARE A FACTOR 10 TO 90 HIGHER

Volume N, P and K applied in kg/ha (y1) by country (x) and share of farmers applying >5kg/ha of each (y2)



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When examining individual inputs, the predominant trend in WCA was that if fertilizer was applied, farmers were more likely to apply P and K (see Figure D). A detailed examination of efficiency use by input per country revealed that nearly all surveyed African farmers (98-100%) under-applied N – a figure which is 64% among Vietnamese farmers. Only 1% of Ghanaian farmers and 17% of Vietnamese farmers applied the optimal amount of N, versus none of the sampled Ivoirian and Cameroonian farmers. Similarly, most (98-100%) African farmers under-applied K, while this figure declined to 61% among Vietnamese farmers. While outcomes for the optimal application of P were slightly better among African farmers, the majority of farmers (72-99%) under-applied, versus only 34% among Vietnamese farmers.

Observed trends in WCA are mirrored by results of other Agri-Logic studies. For example, in Côte d'Ivoire during the 2021/2022 production season, the majority of sampled respondents underused nitrogen, which may contribute to soil depletion of N for most farms (Barry Callebaut, 2023). Farmers also largely underdosed fertilizer mixes with potassium, and applied phosphorus in excess. Underdosing was reflected in the fertilizer mixes applied, with over 40% of surveyed farmers utilising poultry manure and 25% utilising SuperCao, which offers a mix of potassium and phosphorus. However, only 4% of fertilizers used were nitrogen-based, such as nitrabor.

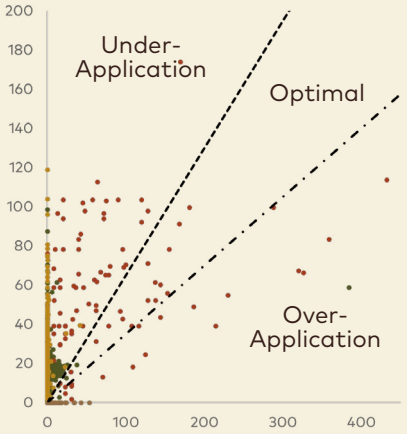
FIG. D: FERTILIZER USE EFFICIENCY BY COUNTRY AND TYPE OF FERTILIZER

Country	N			P			K		
	Over	Optimal	Under	Over	Optimal	Under	Over	Optimal	Under
Côte d'Ivoire	0%[a]	**0%[a]**	100%[a]	23%[a]	**5%[a]**	72%[a]	0%[a]	**2%[a]**	98%[a]
Ghana	1%[a]	**1%[a]**	98%[a]	7%[b]	**2%[a]**	92%[b]	1%[a]	**0%[a]**	100%[a]
Cameroon	0%[a]	**0%[a]**	100%[a]	0%[c]	**1%[a]**	99%[b]	0%[a]	**0%[a]**	100%[a]
Vietnam	19%[b]	**17%[b]**	64%[b]	51%[d]	**15%[b]**	34%[c]	19%[b]	**20%[b]**	61%[b]

Different letters denote significant difference at p≤0.05

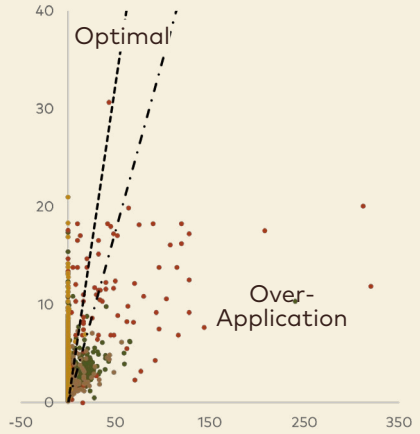
17% OF FARMERS IN VIETNAM APPLY N AT OPTIMAL LEVELS, HARDLY ANY IN WCA DO

Volume N removed in kg/ha (y) versus N applied (x) by country; wedge represents estimated optimum



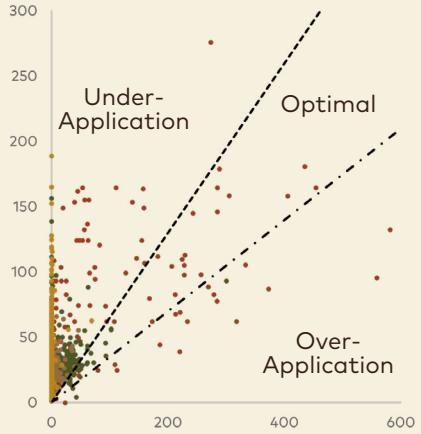
FARMERS IN CÔTE D'IVOIRE AND VIETNAM ARE MORE LIKELY TO OVER-APPLY P

Volume P removed in kg/ha (y) versus P applied (x) by country; wedge represents estimated optimum



A MAJORITY OF FARMERS IN ALL ORIGINS APPLY LESS K THAN IS REMOVED

Volume P removed in kg/ha (y) versus P applied (x) by country; wedge represents estimated optimum



3 COCOA FARMING MODELS IN WEST AND CENTRAL AFRICA AND VIETNAM

3.4 DESPITE LARGER COCOA FARMS IN WEST AFRICA, YIELD LEVELS ARE SIGNIFICANTLY HIGHER IN VIETNAM

As previously discussed, cocoa areas are notably larger in WCA than in Vietnam, with farms in Vietnam smaller by a factor of 5.5 times relative to the average cocoa area in WCA. As a result, a hypothesis coming into this study was that larger cocoa areas would translate into higher production volumes in WCA. Results from cocoa production by country would have contributed to this hypothesis; of all four countries, Vietnam had the lowest overall production of cocoa beans, amounting to 1,180 kg during the analysed production season, relative to 1,519 kg in Côte d'Ivoire and 2,546 kg in Cameroon (see Figure E.1).

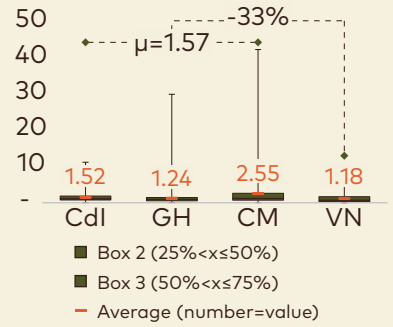
However, yield levels are several factors higher in Vietnam than among sampled farmers in WCA, ranging from a factor of 2.8 in Cameroon to 4.1 in Ghana. Average yields per country varied significantly from 1,688 kg/ha in Vietnam to as low as 413 kg/ha in Ghana and 462 kg/ha in Côte d'Ivoire (see Figure E.2).

These differences can be attributed in large part to high nutrient applications and more intensive farm management among Vietnamese cocoa farmers. Agri-Logic ran a regression to assess the factors influencing yields (p≤.05, Figure E.3). According to their results, factors such as nutrient application played a key role in enhancing yields, notably the use of P and K. Similarly, pruning labor had a positive correlation with yields. In contrast, farm age is negatively correlated with higher yields. As mentioned in a previous section, farms in WCA are 8-9 years older on average than Vietnamese farms. Although the difference is statistically significant, the co-efficient is rather low (-3.71 kg/ha per additional year of farm age), therefore if surveyed African farms are 8 years older than Vietnamese farms on average, they would incur a yield penalty of 8*-3.71=-29.68 kg/ha per year. However, the actual difference in yields is over 1000 kg/ha, which supports the conclusion that farm age does not account for the significant difference in yield between WCA and Vietnam.

FIG. E: COCOA PRODUCTION, YIELD BY COUNTRY, AND REGRESSION MODEL FOR YIELD (2023/24 PRODUCTION SEASON)

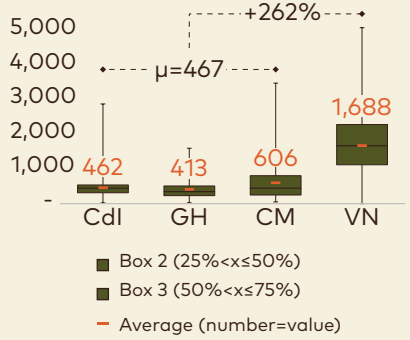
E.1: PRODUCTION LEVELS IN VIETNAM ARE 33% LOWER DUE TO SMALLER FARMS

Production in t (y) by country (x); Vietnam differential (%) over WCA mean (μ)



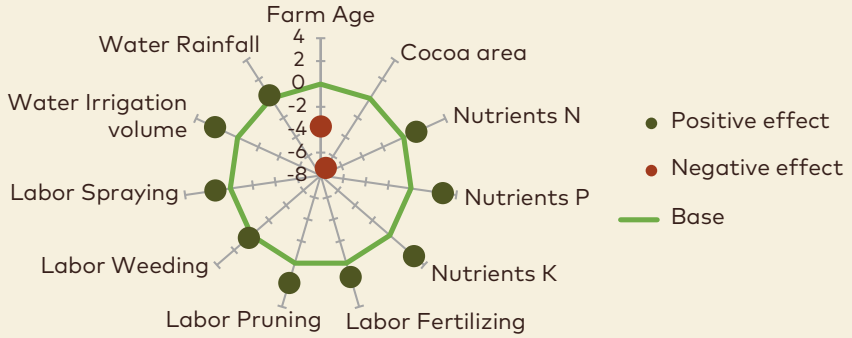
E.2: HIGHER INVESTMENT SEEMS TO PAY OFF, YIELDS IN VIETNAM ARE 262% HIGHER

Yield in kg/ha (y) by country (x); Vietnam differential (%) over WCA mean (μ)



E.3: SEVERAL FARM MANAGEMENT ASPECTS AND WATER AVAILABILITY EXPLAIN 45% OF YIELD VARIABILITY

Expected change in yield in kg/ha with one unit change of listed variables, all else being equal



3 COCOA FARMING MODELS IN WEST AND CENTRAL AFRICA AND VIETNAM

3.4.1 IRRIGATION AND RAINFALL HAVE A POSITIVE IMPACT ON YIELDS IN THE VIETNAMESE CONTEXT

According to the results of the regression analysis, use of irrigation for cocoa is common among sampled Vietnamese farmers and appears to play an important role in influencing higher yields in Vietnam, notably from the perspective of water availability timing. The economic and environmental impacts of irrigation on yields in WCA cannot be assessed due to lack of data, as this is not a common practice among WCA farmers.

Between the three African countries, differences in the amount of rainfall received are limited, with farmers in each country receiving on average a little over 1,500 mm of annual rainfall during the 2023/24 production season. However, in Vietnam, rainfall levels are significantly higher ($p \leq 0.05$) than in each of the African countries, with Vietnamese farms receiving on average nearly 500 mm more rain (see Figure F). As discussed in previous sections, past analyses for each of the countries in WCA showed the importance of rainfall, and more rainfall is generally associated with higher yields – findings that are replicated in the regression analysis.

In Vietnam, 75% of surveyed farmers irrigate their cocoa trees, which adds only 2.4% of additional water on top of the rainfall received throughout the year. On average, and for those that irrigate, this equates to 798 m3/ha. This is applied over 3.8 rounds. On a per tree basis, this equates to 176 l/tree/round. This timing appears to be crucial in driving higher yields, as within Vietnam, irrigated farms have almost double the yields of unirrigated ones. Honing in on the results of the regression yield model, for every additional mm of irrigation, the yield model gives an effect size of 2.18 kg/ha -- much larger than the 0.33 kg/ha for every mm of rainfall. This implies that irrigating during times of low rainfall is likely to contribute to higher yield levels.

When comparing yield performance of the 75% of farmers in Vietnam that irrigated their cocoa with those that did not, the benefit of irrigation becomes clear. The yield level on irrigated cocoa farms is almost double, a significant difference ($p \leq 0.05$; Figure G). When controlling for nutrient input and pruning, the effect declines from 915 kg/ha to 676 kg/ha but remains significant ($p = 0.009$).

FIG. F: WITH HIGHER RAINFALL AND IRRIGATION FARMS IN VIETNAM RECEIVED 28% MORE WATER

Rainfall and irrigation volume in mm (y) by country (x); Vietnam differential (%) over WCA mean (μ)

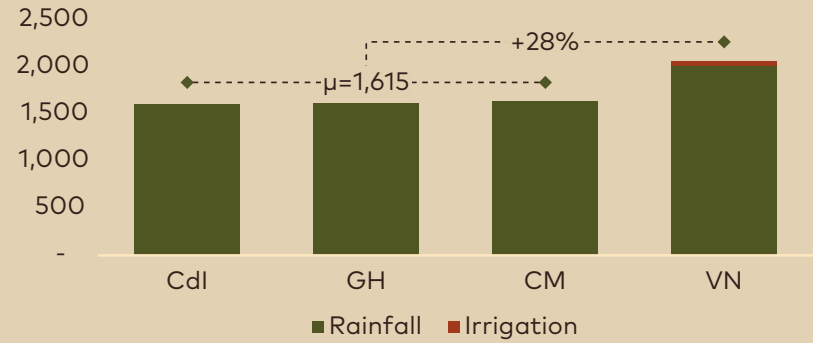
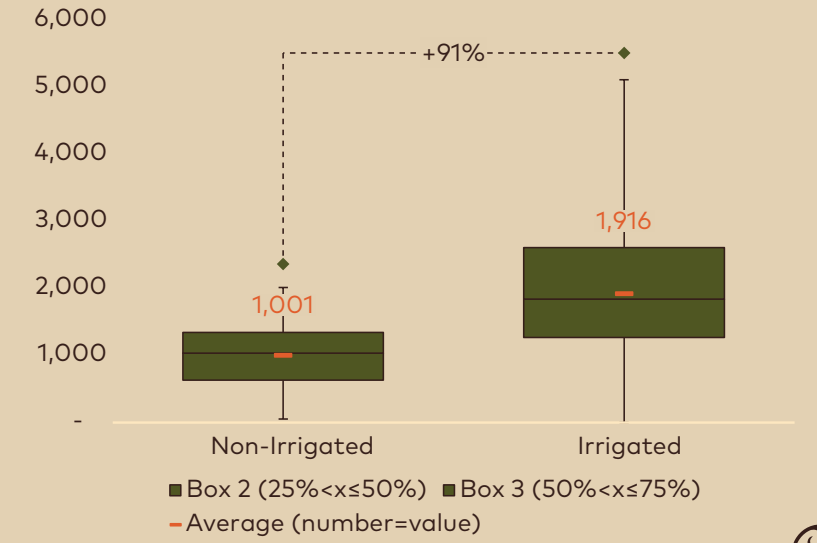


FIG. G: IRRIGATED FARMS IN VIETNAM ACHIEVE 91% HIGHER YIELDS

Yield in kg/ha (y) in Vietnam by irrigation use (x); Irrigated yield differential (%) over non-irrigated



3 COCOA FARMING MODELS IN WEST AND CENTRAL AFRICA AND VIETNAM

3.4.2 HIGH INVESTMENT LEVELS IN VIETNAM TRANSLATE TO HIGHER YIELDS

Between surveyed African and Vietnamese farmers, investment levels differ significantly, with the latter investing more on average by a factor of 5 to 14 times higher (see Figure H). Based on information gathered during the survey, cost allocation categories differ, with Vietnamese farmers allocating 89% to investments in inputs, versus 26-34% in WCA. Additionally, Vietnamese farmers spend only 3% of their investment on hired labor, relative to 46-64% among surveyed African farmers, which can be partially explained by the cost of hired labor being much lower in Vietnam (38 USD/ha) compared to Cameroon (147 USD/ha) and Côte d'Ivoire (81 USD/ha), but similar to Ghana (37 USD/ha).

3.5 IMPLICATIONS FOR LIVING INCOME

Both Vietnam and Cameroon have liberalized internal markets for cocoa, which means that farmgate prices closely track international prices. In this context, prices are significantly higher in Vietnam and Cameroon than in Ghana and Côte d'Ivoire (see Figure I).

The combination of higher farmgate prices and higher yields in Cameroon and Vietnam have ensured that on average, farmers exceed the Living Income benchmark, while a combination of low prices and yields in Ghana and Côte d'Ivoire result in the majority of farmers unable to earn a Living Income.

Figure J illustrates household (hh) income by country, with a red dotted bar overlay that represents the country-specific average family-size adjusted Living Income benchmark. The red number above this shows the average gap to the Living Income, if there is one.

Total income per household, including income from non-cocoa sources is highest in Cameroon, driven in large part by above average cocoa prices, larger cocoa volumes due to larger farms, and relatively high yields. Farmers in Vietnam also have higher incomes, despite having less than 1 ha of cocoa on average. A combination of high yields and high farmgate prices support Vietnamese cocoa farmers in earning on average $4,400/household, 75% of which is derived from cocoa, while much of the other 25% comes from crops such as coffee, durian, or pepper. This contributes to Vietnamese farmers achieving a net cocoa income that is a factor of 2.4 to 7.3 times higher than surveyed WCA farmers on a per ha basis (see Figure K).

FIG. H: THE CASH INVESTMENT DIFFERENTIAL IS VERY HIGH AT 817% AND DRIVEN BY INPUT USE

Cost of production in USD/ha (y) by country (x); Vietnam differential (%) over WCA mean (μ)

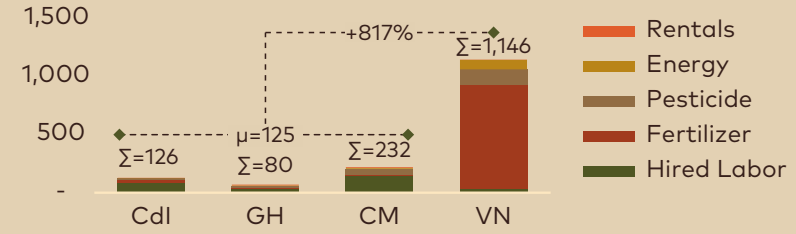


FIG. I: THE 2023 FARM GATE PRICE IN LIBERALIZED MARKETS WAS 109% HIGHER

Farm gate price in USD/t (y) by country (x). Vietnam and Cameroon price differential over Ghana and Côte d'Ivoire in %

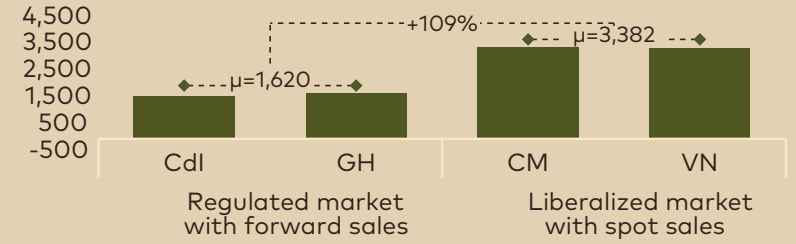
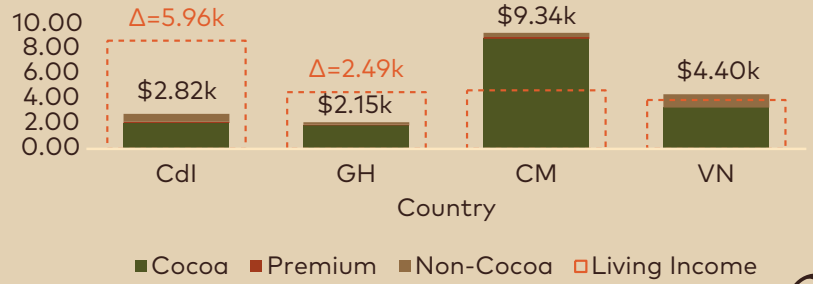


FIG. J: FARMERS IN CAMEROON AND VIETNAM EARN ON AVERAGE A LIVING INCOME

Total household income in '000 USD (y) by country (x) and gap to Living Income (Δ)



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Benefit-cost ratios, i.e. the amount of profit earned per USD invested, is lowest in Vietnam (see Figure K). This is not so much because their investment is unproductive, but rather it points to farmers in WCA investing relatively little. Since even with no or low cash investment cocoa will give some production, farms with low investment can have a very favorable benefit-cost ratio despite earning relatively little.

On average, 45% of Cameroonian farmers and 40% of Vietnamese farmers exceed the Living Income benchmark (see Figure L). Although slightly more than half of farmers in these countries do not earn a Living Income, these results are considerably better than observed results in Ghana and Côte d'Ivoire, where the majority of farmers (89% and 96%, respectively) do not reach a Living Income.

The contrast with Ghana and Côte d'Ivoire is stark, where the gap to the family size adjusted Living Income benchmark is $2,490 and $5,960, respectively, with several factors working against farmers in these countries. Firstly, family sizes are larger in Côte d'Ivoire, translating into more mouths to feed and inflating the family-size adjusted Living Income benchmark. Secondly, despite high international cocoa prices, farmers in Ghana and Côte d'Ivoire are not seeing an increase in cocoa incomes due to regulated farmgate prices, which constrain prices far below the current international prices. To explore the impact of regulated farmgate prices on the achievement of Living Income, Agri-Logic ran a logit model and compared earning a Living Income in a regulated versus liberalized market[6]. The results demonstrated that farmers in a liberalized market are 2.2 times more likely to reach Living Income (p=0.000) in the current circumstances of high international prices.

That said, it is important to note the current context, which is characterised by exceptionally high international cocoa prices that benefit farmers operating in liberalized markets. As a result, it could be argued that the exceptional performance in Vietnam and Cameroon in terms of farmers reaching the Living Income is in large part due to historically elevated international cocoa prices. Agri-Logic tested this hypothesis by running a scenario wherein the price that farmers received for their cocoa was adjusted in 1% increments from -50% to +50%. Agri-Logic assumed that all else remained equal and calculated farmers income levels accordingly, then compared the results to the family-size adjusted Living Income benchmark and calculated the share of farmers that earned a Living Income.

[6]A logit model is a statistical tool used to predict the likelihood of a binary variable outcome (i.e. yes/no) based on certain factors

FIG. K: BETTER YIELDS IN VIETNAM COMFORTABLY OFF-SET THE HIGHER COST WITH MARGIN BEING 483% HIGHER

Cost and Margin in USD/ha (y1) and Benefit-Cost Ratio (y2) by country (x); Vietnam margin differential (%) over WCA mean (μ)

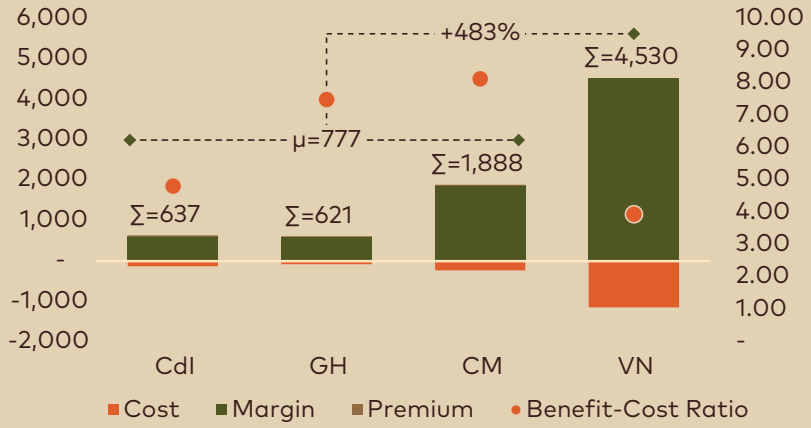
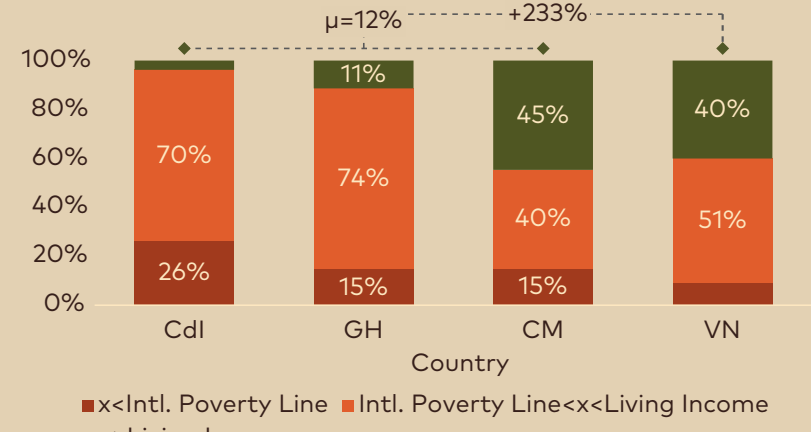


FIG. L: SHARE OF FARMERS EARNING A LIVING INCOME IS 233% HIGHER IN VIETNAM THAN IN WCA

Share of farmers by poverty benchmark (y) and country (x); Vietnam differential (%) over WCA mean (μ)



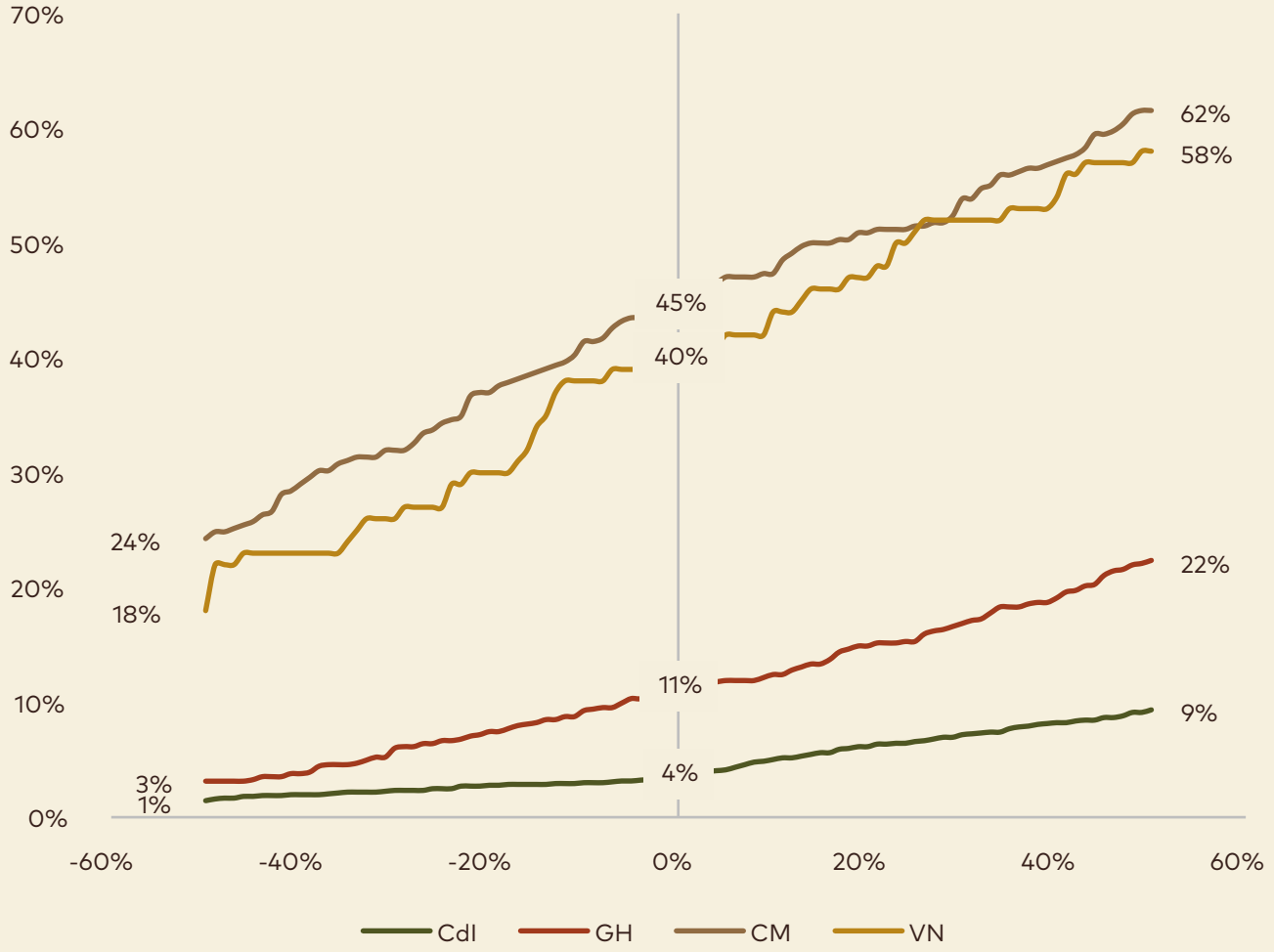
3 COCOA FARMING MODELS IN WEST AND CENTRAL AFRICA AND VIETNAM

In Côte d'Ivoire and Ghana, a 50% increase in the price of cocoa would result in an approximate doubling of the share of farmers that earned a Living Income, while the effect was more muted in Vietnam and Cameroon (see Figure M). However, the absolute difference in performance remained high, irrespective of price. This is largely due to the yield differential, as well as smaller family sizes in Vietnam.

Although downward price pressure would have significant impacts on incomes across all countries, lower yields in Côte d'Ivoire and Ghana translate to a larger impact of lower cocoa prices. Specifically, the share of farmers earning a Living Income would decline by a factor of four in both countries, while higher yields in Vietnam and Cameroon provide more cushion against the effects of declining prices on Living Incomes. In the latter countries, there is a 50% reduction in the proportion of farmers earning a Living Income. Nevertheless, differences between the two market regimes, i.e. liberalized markets in Cameroon and Vietnam versus state controlled in Côte d'Ivoire and Ghana, remain significant under any of the calculated price scenarios, with the former markets outperforming the latter.

FIG. M: HIGHER YIELD AND/OR LARGER FARMS CAN ACT AS A CUSHION WHEN FARM GATE PRICES DECLINE

Share of farmers above Living Income (y) under farm gate price change scenarios in % from 2023 value (x) by country



4 CONCLUSIONS

This study by Barry Callebaut and Agri-Logic demonstrates that with sufficient yield and higher farmgate prices, even farmers with small cocoa areas can earn a Living Income. In Vietnam, where 40% of farmers reached the Living Income Benchmark, cocoa areas are around one hectare, while farmers who were unable to reach the benchmark had plots of only 0.42 ha on average. Given that cocoa areas are much larger in West Africa, the potential to reach sufficient production is undoubtedly there.

Key factors driving higher yields between the four countries include higher rainfall levels and a more intensive approach to farm management in Vietnam across key pre-harvest activities, notably pruning, weeding and fertilizer application. Vietnamese labor hours per ha even outstrip other Barry Callebaut sustainability initiatives in WCA, which provide subsidized pruning labor.

Another crucial factor is the combination of sufficient nutrient application. Almost all Vietnamese farmers apply significant volumes of N, P, and K and are more likely to have a suitable balance between nutrients applied and removed during harvest. Unlike farmers in WCA, they are far less likely to be mining their soil for nutrients.

Cocoa pricing also plays an instrumental role in farmer outcomes. Although data for this study on FOB values for cocoa in Vietnam were unavailable, farmers received an average of 92% of the ICCO daily reference price, which is far higher than what we observe in Ghana and Côte d'Ivoire. Comparing poverty performance in liberalized internal markets (Cameroon and Vietnam) with regulated internal markets shows a sizeable positive effect of liberalisation on farmgate price and significantly lower rates of poverty. This remains the case even in a scenario of depressed international cocoa prices.

4.1 CHARTING A WAY FORWARD: SUPPORTING FARMERS TO EARN A LIVING INCOME

This study offered a unique comparison of cocoa farming practices and outcomes between WCA and Vietnam and delved into the various factors shaping differences in cocoa and yields in the four countries. The analysis provides the following strategic actions to inform future sustainability interventions and help farmers earn a Living Income:

- Promoting intensified farm management offers the potential to increase yields. This should entail more intensive pruning and nutrient management aligned with expected yield levels.
- Given the cash limitations faced by most farmers in WCA, farmers will likely be unable to invest more in labor-intensive activities beyond labor available at the household level. However, soft loans or conditional grants could support motivated and active farmers in intensifying labor investments, particularly around pre-harvest activities and fertilizer application. Providing guidance to farmers using highly qualified field staff with experience of intensive cocoa farming practices can also help yield results.
- Findings on irrigated farms from Vietnam are promising and should be further explored, given that even a small amount of strategically timed irrigation appeared to promote higher yields. These learnings will be crucial in helping cocoa farmers adapt to the realities of climate change, which have already resulted in rainfall variability.
- In parallel to intensified production, market conditions in Ghana and Côte d'Ivoire need to be adjusted to ensure that farmers are able to earn a farmgate price that is more aligned with international cocoa prices. Under current market conditions in both countries, it is unlikely that a majority of even highly productive farms can attain a Living Income. Modelling of Cameroon farmgate price applied to Ghana and Côte d'Ivoire in other Agri-Logic studies showed significantly better performance had such pricing prevailed. The analysis indicates a much higher probability of farmers reaching a Living Income under liberalized internal market conditions. While reforming internal markets is out of reach for this collaborative effort between Barry Callebaut, IDH, the Rainforest Alliance, and Agri-Logic, it is recommended that cocoa industry stakeholders advocate strongly for market liberalisation in public discussions around poverty and the achievement of a Living Income.

5 REFERENCES

Asante, P. A., Rahn, E., Zuidema, P. A., Rozendaal, D. M., van der Baan, M. E., Läderach, P., Asare, R., Cryer, N., & Anten, N. P. (2022). The cocoa yield gap in Ghana: A quantification and an analysis of factors that could narrow the gap. Agricultural Systems, 201, 103473.

Barry Callebaut (2023). Farmer yield and income in Côte d'Ivoire: an analysis of Farmer Field Books (FFBs). Available at: https://www.barry-callebaut.com/system/files/2023-05/Barry%20Callebaut%20Agrilogic%20White%20Paper%202023_1.pdf. (accessed 30 October 2025).

Kongor, J. E., Owusu, M., & Oduro-Yeboah, C. (2024). Cocoa production in the 2020s: Challenges and solutions. CABI Agriculture and Bioscience, 5(1), 102.

Läderach, P., Martinez-Valle, A., Schroth, G., & Castro, N. (2013). Predicting the future climatic suitability for cocoa farming of the world's leading producer countries, Ghana and Côte d'Ivoire. Climatic change, 119(3), 841-854.