TechnoServe
Business Solutions to Poverty™

Regenerative Coffee Investment Case

Executive Summary

April 2025

Coffee grows on a hillside in Jinotega, Nicaragua. (TechnoServe)

Nestlé

Rudy & Alice Ramsey Foundation
Life Is Not a Zero-Sum Game

JDE Peet's

Coffee Sector Transformation through Regenerative Agriculture

The Challenge

- **Coffee is a vital sector of the economy.** Coffee sustains 12 million smallholder farms supporting 60 million individuals worldwide, while serving as a critical export and foreign currency source for many global south economies.

- **Coffee farming is under pressure.** Long-standing challenges to coffee farmer profitability—like land fragmentation and limited access to best practices or investment—are being intensified by climate change. Most farms are ill-equipped to withstand climate shocks or adapt to rising temperatures and shifting weather patterns.

- **In many regions, current farming practices are depleting the very natural resources farmers depend on.** Carbon emissions, water overuse, soil degradation and natural habitat loss further threaten long-term production viability.

The Opportunity

- **Regenerative agriculture, an approach to farming that regenerates soils, improves the water cycle, and increases biodiversity and climate resilience, is hailed as a solution to these challenges.**
- The objective of this study is to provide the evidence base to assess this opportunity, by addressing a few fundamental questions:
    1. Can environmental, economic, and market priorities be aligned effectively?
    2. How should solutions be adapted across diverse growing regions?
    3. What specific investments are needed to enable a successful transition?
    4. How can the business case resonate with all stakeholders?

This roadmap presents a practical transition to regenerative farming that can be achieved at scale and with a positive investment case for farmers, nature, industry and governments.

Ten Pillars of Regenerative Agriculture for Coffee Farming

REGENERATIVE COFFEE FARMING FRAMEWORK

1 Renovation, Rehabilitation, and Coffee Varieties

Rejuvenating aging and replacing diseased/ poorly managed coffee trees with new trees or improved coffee varieties capable of producing higher yields and/or better qualities

2 Agroforestry Systems and Shade

Growing trees, coffee plants, and other crops within the same plot (intercropped and around edges), creating multiple vegetation layers similar to a natural forest

3 Soil Conservation and Cover Cropping

Activities that protect topsoil against water and wind erosion, as well as improve soil health and water retention

4 Integrated Weed Management (IWM)

Preventative and corrective measures that limit weed introduction and spread, help coffee outcompete undesirable weeds, and prevent weeds from adapting to management measures

5 Integrated Pest & Disease Management (IPDM)

A pest and disease management strategy based on regular monitoring and the timely application of nature-based prevention and control measures

6 Integrated Nutrient Management (INM)

The efficient and balanced use of mineral fertilizers, along with the management of organic resources to ensure optimal crop nutrition, sustain soil health, and minimize negative environmental impacts

7 Efficient Water Use

Minimizing production and post-harvest water footprint by reducing use and loss of water, promoting water recycling, and avoiding contamination of water sources

8 Wastewater Management

Actions to limit or eliminate the negative effects of residual water from postharvest processing on natural resources and human health, and reduce the carbon footprint of coffee production

9 Waterbody Protection[1]

Actions to limit or eliminate the contamination waterbodies that are on or near coffee farms

10 Waste Valorization and Production of Organic Inputs[2]

Recycling and converting organic waste and crop residues into products that can be used on the coffee farm, thereby reducing the need for external inputs

See appendix for additional details on specific practices included under each Pillar and impact on GHG, farmer income, water, soil and biodiversity.

[1] CIAT's Landscape Action practice includes waterbody protection with riparian barriers among other practices that are beyond an individual farmer's control. Protecting waterbodies on or near coffee farms with buffer zones is a feasible practice for most archetypes and is included in other regenerative agriculture assessment frameworks.

[2] Other waste valorization sub-practices mentioned by CIAT include animal feed that includes coffee pulp, compressed husk pellet production, mushroom production, and insect cultivation. These sub-practices have been removed from the Framework because they are not common strategies and not relevant across most archetypes.

Roadmaps for each country identify proven practices relevant to the local context, that benefit both farmer incomes and nature

APPROACH TO DESIGN THE REGENERATIVE TRANSITION

- The ambitious outcomes described in the roadmaps are generated by envisaging a world where farmers in major coffee growing countries adopt a subset of practices from the Regenerative Coffee Farming Framework.

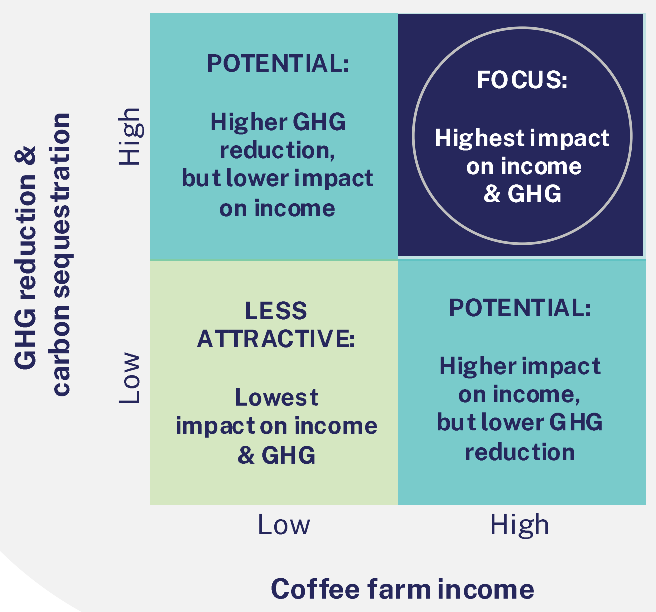
- Practices are selected for each coffee origin based on assessment of relative impact on the environment and coffee farm income. To shortlist practices that can immediately attract investment at scale, GHG mitigation is used as the primary environmental screen and income from coffee and agroforestry are used as the primary source of farm revenue.

- However, these practices also offer substantial benefits for soil health, water use, and biodiversity, which the report describes qualitatively. A future phase of this study would incorporate the costs and benefits of the full transition to regenerative coffee farming, including potential farm income from ecosystem services.

- Additionally, the study focuses on practices that are already being employed and have an evidence base for impact. While additional innovation may be required, scaling existing technologies already offers huge potential, as demonstrated in the quantified impact figures.

GHG & farm income framework

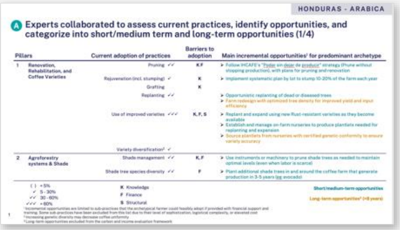
Based on expected incremental impact



Farm-level economic and GHG modeling supports each country roadmap. Resilience, soil, water, and biodiversity impacts are captured qualitatively

GHG EMISSIONS AND FARM INCOME EVALUATION METHODOLOGY

A Establish base practices and identify opportunities

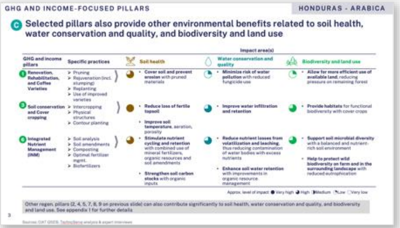


- Document evidence of climate change impact on coffee
- Identify dominant coffee farm archetypes based on size, mechanization
- Assess existing farming practices
- Identify and categorize regenerative opportunities across short vs long term

B Shortlist practices for GHG and farm income

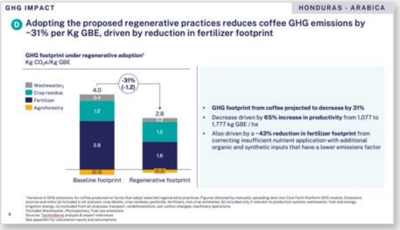
- Evaluate regenerative practices based on feasibility, economic viability, and adoption potential
- Rank practices by impact on GHG reduction, carbon sequestration, farm income

C Assess impact on soil, water, and biodiversity



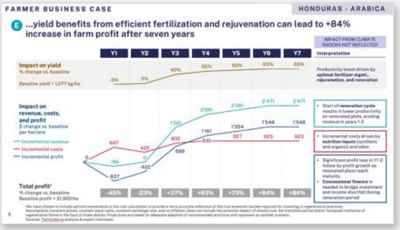
- Qualitatively analyze impact on soil health from increased organic matter
- Evaluate water conservation benefits in retention, runoff, and quality changes
- Assess impacts on efficiency of land use, species diversity and habitat restoration

D Quantify impact on GHG emissions



- Collect farm-level data on synthetic fertilizer use, organic inputs, and emissions
- Model emissions reductions using Cool Farm Platform

E Quantify change in farmer income



- Gather farm data on yields, input and labor costs, and selling prices
- Calculate year by year impact on revenues and costs from new practices
- Forecast long-term profitability shifts

F Estimate investment and incremental costs

- Calculate farmer capital to cover incremental costs, and foregone net income during each transition year
- Estimate costs of technical support to farmers
- Define types of capital required to meet needs

See appendix for additional details on methodology. Individual country reports available with detailed analysis and commentary.

- **Data collection:** Aggregate and anonymize data from TechnoServe farm surveys, partners' farm-level data (i.e., Nestle, JDE Peet's), public research, and expert interviews.
- **Data analysis:** Filter raw datasets received to include only those farms that fit the selected archetype dimensions (e.g., farm size, mechanization, input use, irrigation).
- **Key assumptions:** Constant prices, constant input costs, constant exchange rate, and no inflation. Does not include the cost of inaction, or the potential impact of shocks over the transition period and/or increased resilience of regenerative farms in the face of those shocks. Projections are based on adequate adoption of recommended practices and represent an optimal scenario.
- **Interpretation and recommendations:** Consult with coffee agronomists, practitioners and subject matter experts to validate insights from data analysis, align on selection of practices for GHG and income modeling, provide quantitative inputs to project change in drivers of GHG emissions, yields and costs, and provide qualitative perspectives on impact on soil, water and biodiversity.

Transition to regenerative coffee delivers compelling economic, social, and environmental benefits

ECONOMY

Exports

30%

increase
in coffee exports
for 7 countries[1]

PEOPLE

Farmer Income

62%

increase in income
for 3.2 million farms[2]

NATURE

GHG Emissions

38%

Decrease in coffee emissions[3]
across 2.7 million coffee hectares

[1] Excludes Brazil and Vietnam, where projected gains from regenerative practices are minimal relative to their large production share. Assumes all incremental production is absorbed by export markets
[2] Assumes 50% adoption of regenerative practices among the 6.5 million smallholder farms within selected origins and archetypes
[3] Variance in GHG emissions for coffee produced on farms that adopt selected regenerative practices. Figures obtained by manually uploading data into Cool Farm Platform GHG module. Emissions sources and sinks (a) included in all analysis: crop details, crop residues, pesticide, fertilizers, non-crop estimates; (b) included only if relevant to production system: wastewater, fuel and energy, irrigation energy; (c) excluded from all analyses: transport, re/deforestation, soil carbon changes, machinery operations.

Investment case is positive and supplemented by additional unquantified benefits

TRANSITION

$0.56

Billion investment
p.a. over 7 years[1]

POST-TRANSITION

Additional Benefits of Regenerative Coffee Systems

Growth and Stability

- Multiplier effect on the local economy from increased production and exports
- Without it, some coffee-producing areas will lose their main source of revenue
- Improved sustainability and stability of green coffee supply for industry, retail and consumers

Resilience and Adaptation

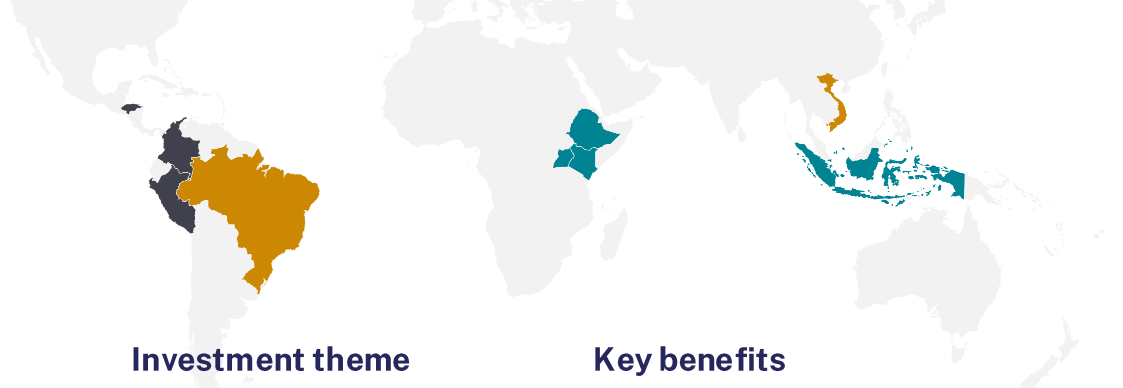
- Farmers not only earn more but also build resilience against extreme weather events
- Adaptive techniques help farmers mitigate impact from gradual climate shifts, ensuring stable long-term earnings
- Higher farm incomes improve social and living conditions

Nature Revitalization

- Improved soil fertility, erosion control and nutrient cycling drives yields, reducing pressure on forests
- Better soil water retention and reduced runoff avoids overuse and contamination of water bodies
- Greater tree cover and less use of chemicals restores habitats for functional and wild biodiversity

[1]Sum of investments needed over a 7-year transition period; [2] Assumes all incremental production is absorbed by export markets; [3]Farmer net income at steady state versus baseline for farms that adopt selected regenerative practices, assumed as 50% of all farms in the archetype [4] Variance in GHG emissions for coffee produced on adopting farms, based on Cool Farm Platform. See appendix for detailed calculation inputs and assumptions.

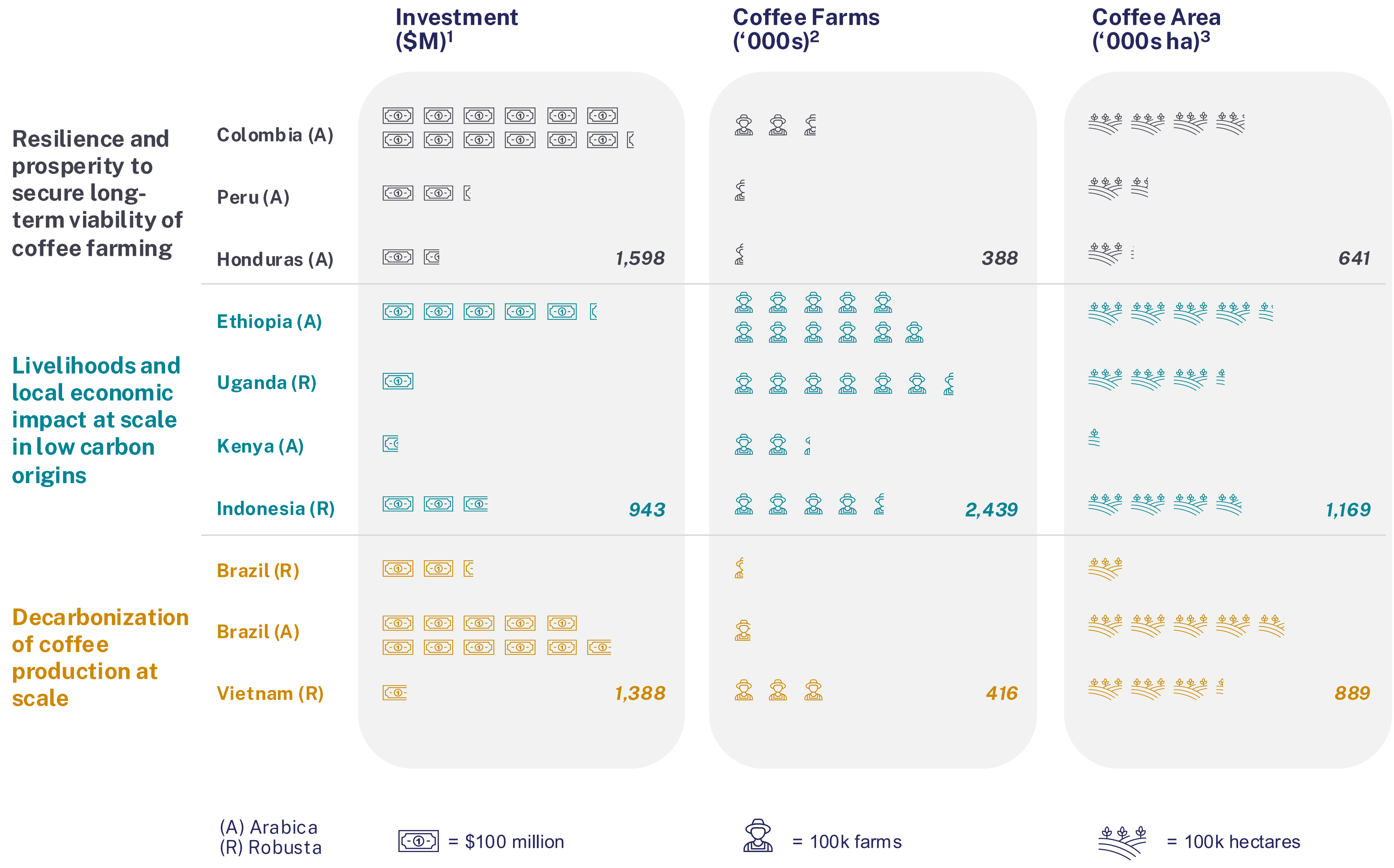
While benefits are universal, the nature of the business case varies across countries



	of which…	driven by…	Investment theme	Key benefits
$2.6b exports impact	**38%**	**Latin America** *Colombia, Peru, Honduras*	**Resilience and prosperity to secure long-term viability of coffee farming**	• 380k farms achieve 40-100% higher incomes • 15-25% increase in coffee exports for local economy • 10-30% GHG reduction
$2.1b livelihoods impact	**62%**	**East Africa** *Ethiopia, Uganda, Kenya* **+ Indonesia**	**Livelihoods and local economic impact at scale in low carbon origins**	• 1.8 million farmers double or triple their income • 46% increase in coffee exports for local economy • 60% of total volume growth, at <1 kg CO_2e/kg GBE
3.5m **MT CO_2e** reduction	**65%**	**World's Largest Producers** *Brazil, Vietnam*	**Decarbonization of coffee production at scale**	• 2.2 million MT CO_2e reduction at $25/MT CO_2e[1] • 300K farms in Vietnam achieve 36% higher incomes

[1] Equivalent abatement cost over a 25-year period once steady-state conditions are reached

Scale of investment and impact varies across regions based on existing coffee cultivation practices



[1]Sum of investments needed over a 7-year transition period. [2] Assumes 50% adoption of regenerative practices among the 6.5 million smallholder farms within selected origins and archetypes. [3]Assumes farmers apply practices across all coffee area.

Scale of investment and impact varies across regions based on existing coffee cultivation practices (2/2)

Theme	Origin	Incremental Exports (%)[1]	Incremental Exports ($M)[1]	Exports total ($M)	Incremental Farm Income (%)[2]	Incremental Farm Income ($M)[2]	Farm Income total ($M)	GHG Emissions Reduction (%)[3]	GHG Emissions Reduction (MT CO_2e)[3]	GHG total (MT CO_2e)
Resilience and prosperity to secure long-term viability of coffee farming	Colombia (A)	14%	432		42%	128		(23%)	333	
	Peru (A)	20%	206		105%	130		(11%)	27	
	Honduras (A)	23%	351	*989*	84%	164	*422*	(31%)	245	*605*
Livelihoods and local economic impact at scale in low carbon origins	Ethiopia (A)	39%	669		88%	679		NA[3]	3	
	Uganda (R)	52%	315		101%	150		NA[3]	(101)	
	Kenya (A)	32%	85		196%	91		(66%)	74	
	Indonesia (R)	49%	302	*1,327*	166%	404	*1,324*	(152%)	654	*631*
Decarbonization of coffee production at scale	Brazil (R)	1%	13		13%	21		(18%)	158	
	Brazil (A)	0%	16		10%	64		(46%)	1,676	
	Vietnam (R)	6%	181	*210*	36%	312	*397*	(15%)	387	*2,221*

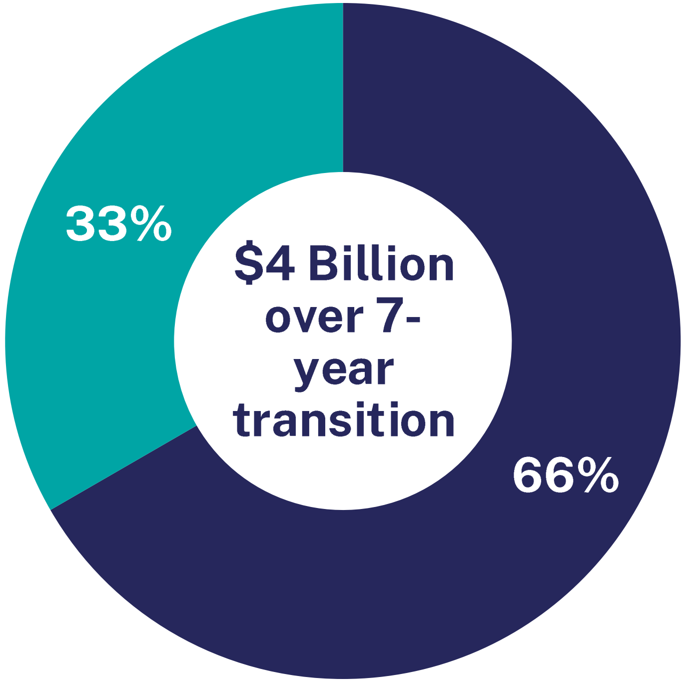
(A) Arabica
(R) Robusta

[1]Assumes all incremental production is absorbed by export markets. [2]Farmer net income at steady state versus baseline for farms that adopt selected regenerative practices [3]Variance in GHG emissions for coffee produced on adopting farms, based on Cool Farm Platform. See appendix for detailed calculation inputs and assumptions. Uganda: from 0.02 to 0.3 Kg CO_2e/Kg GBE due to optimization of organic and synthetic fertilizer application. Ethiopia: from 0.0 to -0.01 Kg CO_2e/Kg GBE.

Total investment amounts to $4 billion, of which 2/3 is for farmer capital and 1/3 is for technical support

Technical Assistance

Technical support to educate and guide farmers on technical aspects and economic case of new practices, including on-farm demonstration plots, throughout the transition period

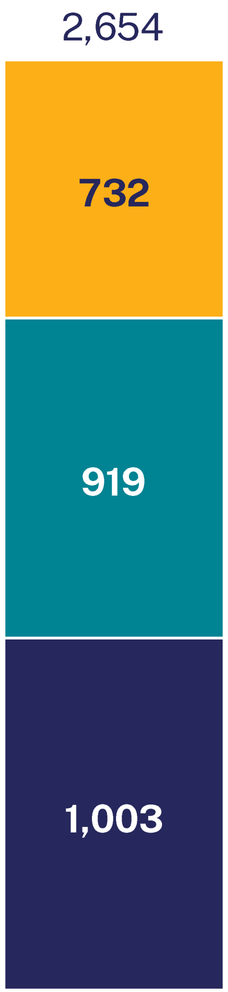


Farmer Capital

On-farm investments in equipment, seedlings, cover crop seeds, soil testing services, biological and other inputs, labor for planting, maintenance and harvesting, as well as temporary income losses if dip in productivity

Farmer capital need of $2.7 billion remains unmet due to subscale or inadequate financing

Farmer Capital
$ millions



Total over 7-yr transition period

	Purpose of Investment	Gap in Finance Available
Foregone net income	Losses during initial years where yield drops below baseline, until regenerative benefits materialize and yield recovers	• **Government-backed subsidies** present in other geographies are largely **absent in coffee growing countries**
Upfront investment	One-off investments to enable new practices	• **Limited smallholder finance available**: when available, either **too short-term** or prohibitively **expensive** • **Climate risks** worsen lending conditions. Absence of state-backed insurance compounds issue • **Roaster-led incentives** exist but cover only a very small share of the need
Transition operating expenses	Incremental costs in inputs and labor while conventional practices phase out and regenerative methods ramp up	

Investment models to scale regenerative coffee production require close collaboration between investors, industry, government and service providers

Blend finance to sources of value

De-risk and crowd in investment by aligning public and private capital around both financial returns and measurable impact, such as nature-based farmer finance and outcomes-based technical assistance.

Build new financial products that address needs

Deploy capital through instruments that respond to farmers' cash flow patterns and unlock further upside potential, such as flexible repayment mechanisms and ecosystem service payments.

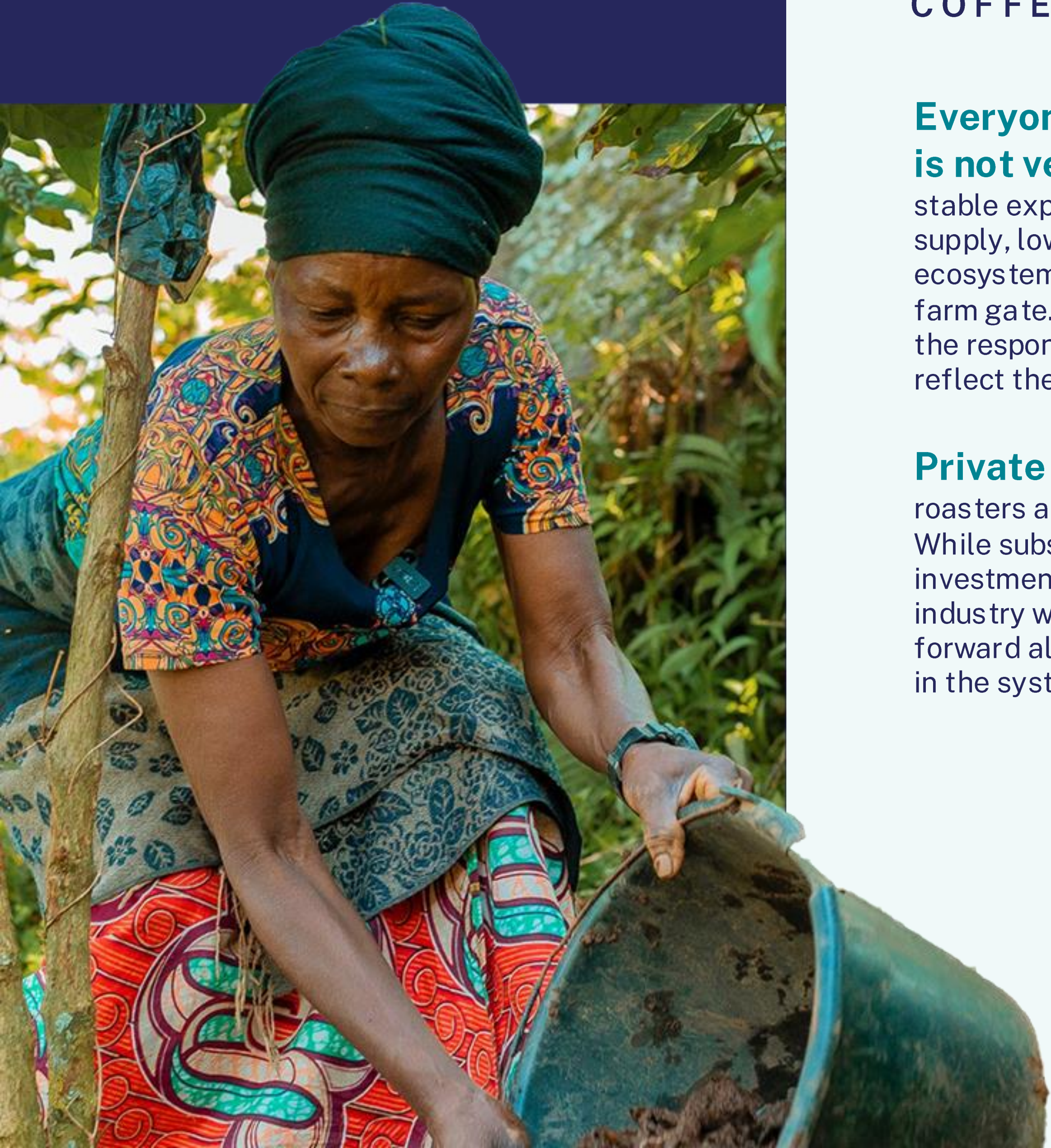
Flow capital through locally relevant intermediaries

Establish capital deployment mechanisms that reach smallholders cost-efficiently, leveraging agri-fintech platforms or existing supply chain relationships.

Incentivize right use with knowledge and measurement

Deliver fit-for-purpose training that drives real behavior change and accelerates adoption. Pair this with tech-enabled systems to verify impact for different funders and identify highest-return solutions for future scale-up.

Call to action



THE TRANSITION TOWARD REGENERATIVE COFFEE WARRANTS IMMEDIATE ACTION:

Everyone wins and it is not very expensive:
stable exports, resilient coffee supply, lower emissions, and healthier ecosystems extend far beyond the farm gate. The cost is modest, and the responsibility for funding should reflect the shared gains.

Existing technologies get us far:
the solutions described here already exist and can be adopted at scale. While some involve transition costs, they all leave farmers better off financially.

Private capital is waiting:
roasters are already investing. While substantially more private investment is needed, there is industry willingness to drive this forward alongside other actors in the system.

Growth is not at odds with GHG emissions:
delivering on the roadmap would meet growing consumer demand by increasing production in low carbon coffee growing regions.

It is also true that, in some countries, the selected regenerative practices are insufficient to achieve comprehensive transformation goals. Further progress will require R&D, technical innovation and/or enabling environment reforms that address tensions between nature and economics. Quantifying and detailing plans for soil health, water and biodiversity for fully regenerative landscapes is also required.

But these additional challenges should not be a barrier to making progress where it is possible now.

Appendix 1

REGENERATIVE COFFEE FARMING FRAMEWORK

Rito Girón Hernández (right) learns techniques to improve his coffee production in the department of Intibucá, Honduras. (TechnoServe / Olivia Sakai)

Ten Pillars of Regenerative Agriculture for Coffee Farming

1 Renovation, Rehabilitation, and Coffee Varieties

Rejuvenating aging and replacing diseased/ poorly managed coffee trees with new trees or improved coffee varieties capable of producing higher yields and/or better qualities

- Pruning
- Rejuvenation, including stumping
- Grafting (in nurseries or topworking for adult plants)
- Replanting old/diseased coffee trees
- Use of improved varieties
- Variety diversification

2 Agroforestry Systems and Shade

Growing trees, coffee plants, and other crops within the same plot (intercropped and around edges), creating multiple vegetation layers similar to a natural forest

- Shade management
- Shade tree species diversity

3 Soil Conservation and Cover Cropping

Activities that protect topsoil against water and wind erosion, as well as improve soil health and water retention

- Cover cropping[1]
- Intercropping[2]
- Physical structures (such as live and dead barriers, terraces, living fences, windbreaks)
- Contour planting
- Minimizing soil disturbance

4 Integrated Weed Management (IWM)

Preventative and corrective measures that limit weed introduction and spread, help coffee outcompete undesirable weeds, and prevent weeds from adapting to management measures

- Mulching with organic residue
- Physical control of weeds (such as trimming, mowing, slashing, uprooting)
- Spot chemical applications on aggressive weeds

5 Integrated Pest & Disease Management (IPDM)

A pest and disease management strategy based on regular monitoring and the timely application of nature-based prevention and control measures

- P&D identification and monitoring
- Field hygiene practices (such as removal of diseased parts, sanitation of farm tools, timely harvesting and disposal of fallen cherries)
- Biological control (such as biocontrol agents, biopesticides, insects)
- Traps
- Precision applications of selective pesticides

[1] Focus on service crops.
[2] Focus on ground crops grown for income or consumption purposes.

Ten Pillars of Regenerative Agriculture for Coffee Farming (2/2)

6 Integrated Nutrient Management (INM)

The efficient and balanced use of mineral fertilizers, along with the management of organic resources to ensure optimal crop nutrition, sustain soil health, and minimize negative environmental impacts

- Soil analysis and field observation
- Soil amendments (e.g., lime)
- Composting and vermi-composting
- Optimal fertilizer[3] management (4R strategy)
- Application of biofertilizers and/or beneficial microorganisms

7 Efficient Water Use

Minimizing production and post-harvest water footprint by reducing use and loss of water, promoting water recycling, and avoiding contamination of water sources

- Rainwater harvesting (such as reservoirs or collection basins)
- Improved irrigation management (efficient systems, water quality, maintenance)
- Efficient water use in postharvest processing (such as water recycling/ recirculation systems, dry fermentation tanks, special milling machines, honeys/ naturals)

8 Wastewater Management

Actions to limit or eliminate the negative effects of residual water from postharvest processing on natural resources and human health, and reduce the carbon footprint of coffee production

- Wastewater treatment (such as lime, biodigesters, oxidation tanks, ecomills, vetiver grass)

9 Waterbody Protection[1]

Actions to limit or eliminate the contamination waterbodies that are on or near coffee farms

- Riparian buffers of natural vegetation

10 Waste Valorization and Production of Organic Inputs[2]

Recycling and converting organic waste and crop residues into products that can be used on the coffee farm, thereby reducing the need for external inputs

- Biochar production
- Anaerobic digestion of wastewater

[1] CIAT's Landscape Action practice includes waterbody protection with riparian barriers among other practices that are beyond an individual farmer's control. Protecting waterbodies on or near coffee farms with buffer zones is a feasible practice for most archetypes and is included in other regenerative agriculture assessment frameworks.
[2] Other waste valorization sub-practices mentioned by CIAT include animal feed that includes coffee pulp, compressed husk pellet production, mushroom production, and insect cultivation. These sub-practices have been removed from the Framework because they are not common strategies and not relevant across most archetypes
[3] Includes both organic and synthetic fertilizers

Beyond GHG, these 10 regenerative pillars deliver significant environmental benefits across soil health, water conservation and quality, and biodiversity and land use

Impact area(s)

#	Pillars		Soil Health		Water Conservation and Quality		Biodiversity and Land Use
1	Renovation, Rehabilitation, and Coffee Varieties	◕	• **Cover soil and prevent erosion** with pruned materials	◔	• **Minimize risk of water pollution** with reduced fungicide and insecticide use[2]	◔	• **Allow for more efficient use of available land**, reducing pressure on remaining forest
2	Agroforestry	●	• **Protect soil** against water and wind erosion • **Enhance soil life**, fertility, and nutrient cycling	◑	• **Improve water regulation and retention** ("hydraulic lift" and "nutrient pump" effects)	●	• **Provide habitats** for insects, plants, birds, soil fauna, and microbes with tree canopies and litter
3	Soil Conservation and Cover Cropping	●	• **Reduce loss of fertile topsoil** • **Improve soil temperature**, aeration, porosity	◕	• **Improve water infiltration and retention**	◕	• **Provide habitats** for functional biodiversity with cover crops
4	Integrated Weed Management (IWM)	●	• **Help control soil erosion and runoff** with mulching cover	◕	• **Minimize risk of contamination of water bodies** with reduced use of herbicides[1] • **Improve water infiltration** with mulching cover	◕	• **Support functional biodiversity** (pollinators and natural enemies of pests) with reduced use of herbicides[1]
5	Integrated Pest & Disease Management (IPDM)	●	• **Increase soil biodiversity** with reduced use of harmful insecticides and fungicides[1]	◕	• **Minimize risk of contamination of surface and groundwater** with reduced use of insecticides and fungicides[1]	◕	• **Support functional biodiversity** (pollinators and natural enemies of pests) with reduced use of insecticides and fungicides[1]

Approx. level of impact: ● Very high ◕ High ◑ Medium ◔ Low

[1] Impact level vary per archetype depending on level of synthetic input use; 2Impact area only relevant for archetypes with irrigation and/or wet milling
Sources: CIAT (2023), TechnoServe analysis & expert interviews

Beyond GHG, these 10 regenerative pillars deliver significant environmental benefits across soil health, water conservation and quality, and biodiversity and land use (2/2)

Impact area(s)

#	Pillars	Soil Health		Water Conservation and Quality		Biodiversity and Land Use	
6	Integrated Nutrient Management (INM)	High	• **Stimulate nutrient cycling and retention** with combined use of mineral fertilizers, organic resources and soil amendments[1] • **Strengthen soil carbon stocks** with organic inputs	High	• **Reduce nutrient losses from volatilization and leaching**, thus reducing contamination of water bodies with excess nutrients • **Enhance soil water retention** with improvements in organic resource management	Low	• **Support soil microbial diversity** with a balanced and nutrient-rich soil environment • **Help to protect wild biodiversity on farm and in the surrounding landscape** with reduced eutrophication and chemical dependency[1]
7	Efficient Water Use	Low	• **Help limit GHG emissions from postharvest wastewater** with reduced water consumption[2]	Very high	• **Prevent aquifer depletion and secure water availability in watersheds**	Very high	• **Help protect and restore wild biodiversity** with conservation of water sources
8	Wastewater Management	Low	• **Improve soil** health with reuse of byproducts from coffee processing as compost[2]	Very high	• **Protect water resources** from overuse and contamination	High	• **Help conserve aquatic life**
9	Waterbody Protection	Medium	• **Support control of soil erosion and landslides**	Very high	• **Decrease sedimentation and contamination of water bodies**	High	• **Enhance biodiversity** with improved aquatic habitats
10	Waste Valorization and Production of Organic Inputs	High	• **Replenish soil** with essential nutrients • **Enhance nutrient cycling** with source of energy for soil biota	Medium	• **Help prevent watershed contamination** from untreated wastewater[2]	High	• **Help protect and restore wild biodiversity** with reduced negative effects of unprocessed coffee waste disposal

Approx. level of impact: Very high · High · Medium · Low

[1]Impact level vary per archetype depending on level of synthetic input use.
[2]Impact area only relevant for archetypes with irrigation and/or wet milling.
Sources: CIAT (2023), TechnoServe analysis & expert interviews

Appendix 2

ADDITIONAL DETAILS ON METHODOLOGY

From right: Vicky Tarime and Gadi Swai prepare coffee beans for drying in the foothills of Mt Kilimanjaro, Tanzania. (TechnoServe / Naashon Zalk)

Study Covers Arabica and Robusta Production

ACROSS 9 COFFEE PRODUCING COUNTRIES — 4 IN LATIN AMERICA, 3 IN EAST AFRICA, 2 IN SOUTHEAST ASIA

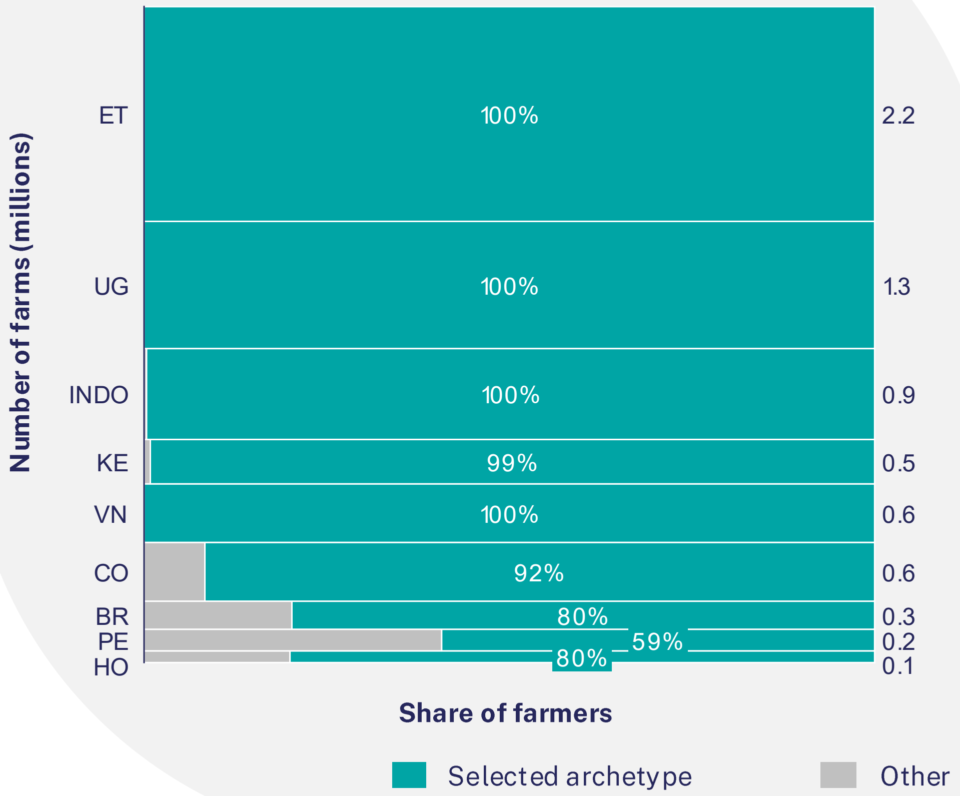
Base map: ©United Nations, published 2023, Map no. 4651. TechnoServe uses the official world map published by the United Nations. The boundaries and names shown and the designations used on this map do not imply endorsement or acceptance by TechnoServe. Certain boundaries and designations on this map are disputed.

The 10 archetypes selected represent ~6.5M coffee farms, or ~97% of coffee farms across the 9 countries of study...

Farm archetypes included in study

Country		Variety	Size
ET	Ethiopia	Arabica	<2 ha
UG	Uganda	Robusta	<2 ha
INDO	Indonesia	Robusta	<2 ha
KE	Kenya	Arabica	<2 ha
VN	Vietnam	Robusta	<2 ha
CO	Colombia	Arabica	<5 ha
BR	Brazil	Arabica	<10 ha
BR	Brazil	Robusta	<10 ha
PE	Peru	Arabica	<5 ha
HO	Honduras	Arabica	< 3 ha

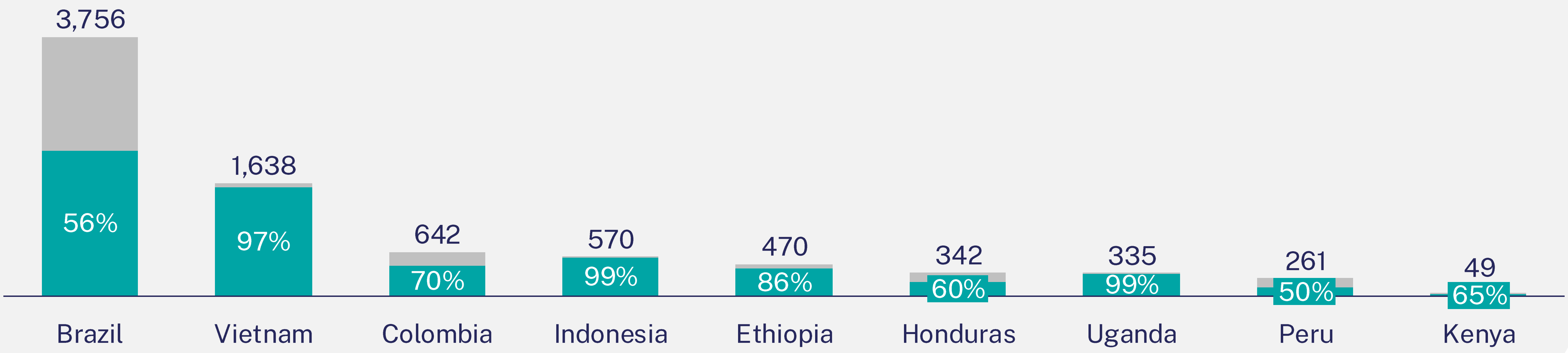
Archetype selected as % of total Arabica and/or Robusta farms[1]



[1] Total Arabica and/or Robusta farms based on archetype included in study. Where 100%, it means the share of larger farms is <0.5% of farms in that country

...and account for 5.8M MT of coffee, or ~70% of total production

Archetype selected as % of total coffee production[1]
('000 MT GBE)



- Brazil and Vietnam dominate global coffee production, together accounting for ~50% of global production
- The definition of smallholder varies by region with East Africa at one end of the spectrum (<2ha) and Brazil at the other (<10ha)
- While smallholders have high potential for impact based on the number of farms and percentage of production they represent, they face a unique set of challenges that need to be overcome during implementation (e.g., highly fragmented, limited knowledge of agricultural best practices and financial literacy, lack of access to finance)

[1] Total Arabica and/or Robusta production based on archetype included in study.

Climate change is already impacting coffee production across countries of study

Likely effects of climate change on coffee production
absent adoption of regenerative practices to fuel adaptation

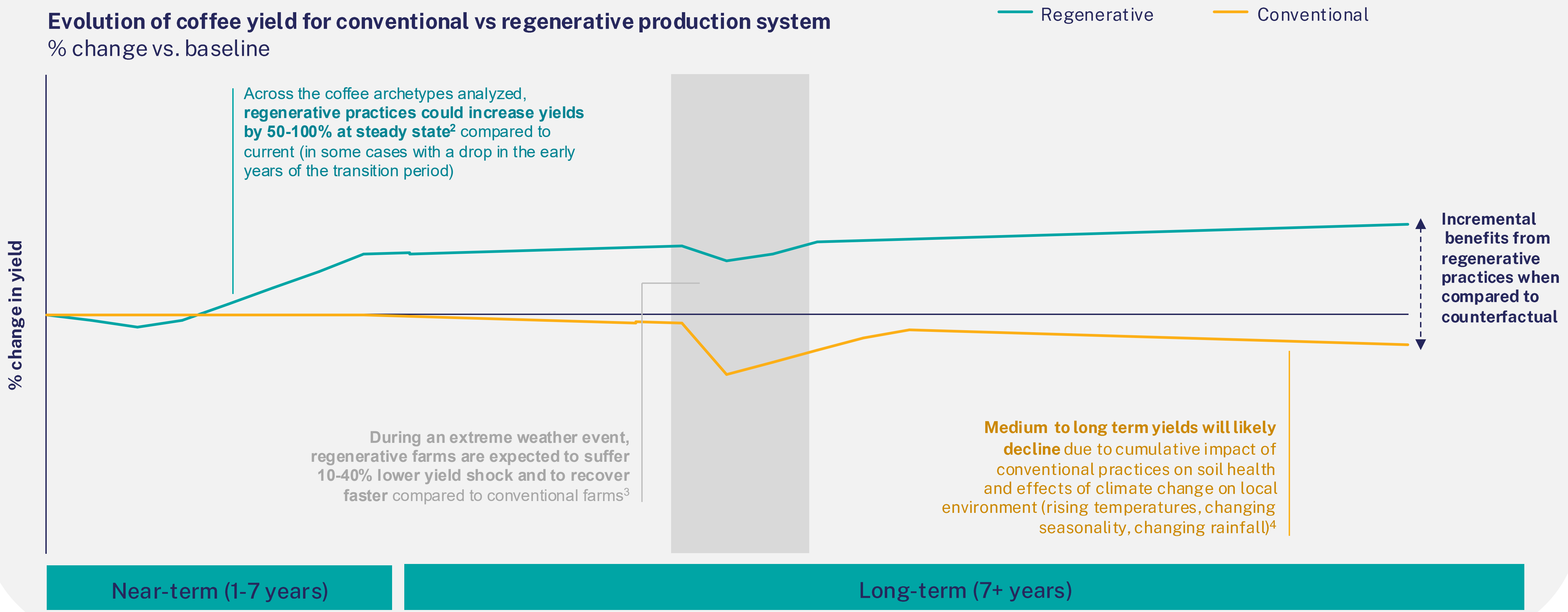
- Net area loss/shift
- Poor flowering/ cherry development
- Increased pest and disease
- Increased water use

Sources: Coffee production in the face of climate change: country profiles (IDH, 2019); Climate change affecting Kenya's coffee output (Reuters, 2010); The Impact of Climate Change on Indigenous Arabica Coffee: Predicting Future Trends and Identifying Priorities (Davis, A. P., Gole, T. W., Baena, S., & Moat, J., 2012); Coffee Farmer Income Resilience Program: Baseline Report (IDH, 2022)

Research suggests that regenerative transition leads to higher and more stable long-term yields compared to conventional agriculture

Directional Estimates[1]

Evolution of coffee yield for conventional vs regenerative production system
% change vs. baseline



[1]This report focuses on years 1-7 and does not consider the impact of falling yields for conventional coffee production in the medium to long term. [2]Projected increase excludes highly technified countries (e.g., Brazil, Vietnam)
[3]Data on ranges outlined in subsequent slides [4]Experts contracted expressed a wide range of possible outcomes for medium to long term yield decline. See appendix for sources consulted

Recent weather events have decreased production volumes in affected regions by ~10-30%

Country	Type of Event	Date(s)	Intensity of Event	Impact on Coffee Production (%)	Source
Brazil	Frost	2021	Severe frost with temperatures below 0˚C	~29% decrease in Arabica volumes	USDA Brazil Coffee Report
Brazil	Drought	2021, 2023	~60% lower-than-normal rainfall in critical months, particularly during winter months	~10-15% reduction in production volumes	USDA Brazil Coffee Report USDA Brazil Coffee Report
Colombia	La Niña	2021-2022	Persistent heavy rains	~10% decrease in output	USDA Colombia Coffee Report
Ethiopia	Drought	2020-2022	Extended dry spells affecting key coffee zones	Minimal changes to production volumes	USDA Ethiopia Coffee Report
Honduras	Drought	2018, 2020	Consecutive dry months	~8% decrease in output	USDA Coffee Production Data
India	Erratic Monsoon	2019	Delayed and inconsistent monsoon	Minimal changes to production volumes	USDA India Coffee Report
Indonesia	Drought	2019	~30% below-normal rainfall	~10% decrease in output	USDA Indonesia Coffee Report
Peru	Frost	2021	Recurrent frost events in Andean regions	~10% decrease in output	USDA Peru Coffee Report
Kenya	Drought	2019, 2021	Extended droughts	Minimal changes to production volumes	USDA Kenya Coffee Report
Uganda	Drought	2017, 2020	Dry spells, 40% below normal rainfall	~15% decrease	USDA Uganda Coffee Report
Vietnam	Drought	2023	Periods of dry weather and erratic rainfall	~20 decrease in volumes	USDA Vietnam Coffee Report

Note that the 2024/25 Vietnam harvest was ~5% smaller than initially anticipated due to a lack of rain and above normal temperatures, worsened by the effects of El Niño in the second half of 2024. MY 2023/24 Vietnamese coffee production fell by 3.8 million bags to 27.5 million bags (~10%) due to unfavorable weather conditions as a result of climate change and El Nino climate patterns.

Regenerative practices have been shown to decrease loss from extreme weather events by 10-40%

	Regenerative Practice	Description	Evidence of Resilience (Drought, Floods, Severe Storms)	Supporting Studies and Links
1	**Renovation, Rehabilitation, and Coffee Varieties**	Practices include pruning, stumping, replanting old/diseased trees, and using improved varieties	• Improved coffee varietals demonstrate 10-15% greater resistance to drought and pest outbreaks • Farms that rejuvenate plants have 20-30% yield stability even under water stress conditions	• Rodale Institute FST Report
2	**Agroforestry Systems and Shade**	Growing coffee with shade trees for a layered canopy that improves biodiversity and soil health	• Shade trees mitigate extreme temperature and drought impacts, stabilizing yields during droughts • Reduced storm damage to coffee plants; up to 15% better resilience during extreme rainfall events	• Nature Communications on Agroforestry • FAO Agroforestry Study
3	**Soil Conservation and Cover Cropping**	Practices to protect soil from erosion, improve water retention, and maintain nutrient levels	• Improved water retention mitigates drought-related yield drops by up to 25% • Erosion control reduces soil loss in floods by 60%, maintaining productivity post-storms	• Soil and Tillage Research Study • USDA Soil Health Report
4	**Integrated Weed Management (IWM)**	Using organic residue mulching, selective weed control, and spot herbicide applications	• Mulching increases soil moisture retention by up to 30%, critical during droughts • Reduced soil exposure supports soil structure, minimizing erosion and flood damage	• USDA Weed Management Report • FAO IPM Guide
5	**Integrated Pest & Disease Management**	Monitoring pests, field hygiene, and selective biological pest control	• Balanced ecosystems reduce pest outbreaks post-storm, lowering reliance on chemical interventions • Decreased yield loss from pests by 20-40% in storm-prone regions	• FAO IPM Benefits • USDA IPM Case Studies

Regenerative practices have been shown to decrease loss from extreme weather events by 10-40% (2/2)

	Regenerative Practice	Description	Evidence of Resilience (Drought, Floods, Severe Storms)	Supporting Studies and Links
6	**Integrated Nutrient Management (INM)**	Using soil amendments, composting, and optimizing fertilizer usage to sustain soil and crop health	• Organic soil amendments and composting improve water retention, maintaining yields during droughts • Reduced reliance on synthetic fertilizers, which supports long-term resilience to floods and storms	• Rodale Drought Resilience Summary • FAO Soil Fertility Guide
7	**Efficient Water Use**	Practices include rainwater harvesting, improved irrigation management, and water recycling in processing	• Water use efficiency supports yield stability during drought by up to 20-30% • Reduced dependence on external water sources helps mitigate impact during water scarcity due to storms	• Agricultural Water Management Study (2021) • FAO Water Management Report
8	**Wastewater Management**	Treating residual water from coffee processing to reduce pollution and carbon emissions	• Prevents contamination of surrounding land and water bodies during floods, protecting soil health • Supports ecosystem stability, reducing post-storm environmental damage	• USDA Environmental Impact Case • FAO Wastewater Management Study
9	**Waterbody Protection**	Using riparian buffers to prevent contamination of nearby water sources	• Protects water sources from contamination during storms and floods • Maintains biodiversity in buffer zones, which provides natural resilience to flood and storm impacts	• FAO Riparian Buffers Study • USDA Waterbody Conservation Guide
10	**Waste Valorization and Production of Organic Inputs**	Recycling coffee byproducts and organic waste into inputs like compost and biochar	• Composting improves soil structure, aiding resilience to drought and reducing erosion in flood-prone areas • Decreased reliance on external inputs supports economic stability post-storms	• Rodale Compost and Soil Study • FAO Composting Guide

Scale of investment and benefits varies across regions based on existing coffee cultivation practices

Origin	Investment ($M)[1]	Coffee Farms ('000s)[2]	Coffee Area ('000s ha)[3]	Incremental Exports ($M, % change)[4]		Incremental Farm Income ($M, % change)[5]		GHG Emissions Reduction (MT CO_2e, % change)[6]	
Colombia (A)	1,218	275	385	432	14%	128	42%	333	(23%)
Peru (A)	224	65	150	206	20%	130	105%	27	(11%)
Honduras (A)	156	48	106	351	23%	164	84%	245	(31%)
Ethiopia (A)	520	1,100	440	669	39%	679	88%	3	NA[6]
Uganda (R)	100	650	322	315	52%	150	101%	(101)[6]	NA[6]
Kenya (A)	53	225	36	85	32%	91	196%	74	(66%)
Indonesia (R)	270	464	371	302	49%	404	166%	654	(52%)
Brazil (R)	229	20	98	13	1%	21	13%	158	(18%)
Brazil (A)	1,084	96	478	16	0%	64	10%	1,676	(46%)
Vietnam (R)	75	300	312	181	6%	312	36%	387	(15%)
Total	**3,928**	**3,243**	**2,699**	**2,571**	**30%[4]**	**2,143**	**62%**	**3,457**	**(38%)**

(A) Arabica
(R) Robusta

[1]Sum of investments needed over a 7-year transition period. [2] Assumes 50% adoption of regenerative practices among the 6.5 million smallholder farms within selected origins and archetypes [3]Assumes farmers apply practices across all coffee area. [4]Assumes all incremental production is absorbed by export markets. Total 30% excludes Brazil and Vietnam, where projected gains from regenerative practices are minimal relative to their large production share. [5]Farmer net income at steady state versus baseline for farms that adopt selected regenerative practices [6]Variance in GHG emissions for coffee produced on adopting farms, based on Cool Farm Platform. See appendix for detailed calculation inputs and assumptions. Uganda: from 0.02 to 0.3 Kg CO_2e/Kg GBE due to optimization of organic and synthetic fertilizer application. Ethiopia: from 0.0 to-0.01 Kg CO_2e/Kg GBE.

While market prices fluctuate, we used recent figures that reflect local prices received by farmers according to relevant actors

Origin	Farmgate Price ($/ kg GBE)	Source	Time period
Colombia (A)	3.85	Industry partners	2023
Peru (A)	3.58	TNS	2023
Honduras (A)	3.53	TNS	2023
Ethiopia (A)	4.14	TNS	2019-2023
Uganda (R)	1.46	Industry partners	2022-2023
Kenya (A)	4.13	TNS	2020-2024
Indonesia (R)	1.38	Industry partners	2023
Brazil (R)	2.14	Industry partners	2023
Brazil (A)	2.96	Educampo	Biennium 2021/23
Vietnam (R)	1.95	Industry partners	2023

Time Periods:

- While the target year of 2023 is used for many origins for consistency and to reflect the most recent reality, variations exist due to data availability
- Averaging over several years (Ethiopia 2019-2023, Kenya 2020-2024) helped to smooth out short-term price volatility and provides a more stable representation
- Using a biennium (Brazil) to capture price trends over a slightly longer term given variability within one year

Data Sources:

- Data from industry partners represent direct information from within the coffee trade for specific origins
- TechnoServe data comes from its implementation programs in various origins

Significantly lower prices would put smallholder farmers in Colombia and Brazil in a critical situation

Origin	Baseline Profit Margin	Endline Profit Margin (post-transition to Regenerative practices)		
Farmgate price scenarios	**Baseline[1]**	**Same price as baseline**	**+25% higher prices**	**-25% lower prices**
Colombia (A)	21%	25%	40%	2%
Peru (A)	32%	39%	51%	19%
Honduras (A)	49%	54%	63%	39%
Ethiopia (A)	92%	94%	95%	92%
Uganda (R)	75%	75%	80%	67%
Kenya (A)	58%	85%	88%	81%
Indonesia (R)	55%	82%	84%	78%
Brazil (R)	23%	25%	40%	0%
Brazil (A)	27%	29%	43%	5%
Vietnam (R)	56%	67%	73%	56%

- Cost structures drive lower baseline profit margins in Colombia and Brazil compared to Ethiopia and Uganda
- Profit margins in Colombia, Honduras, Peru and Brazil are more sensitive to price changes than Ethiopia, Kenya, Uganda, Indonesia and Vietnam
- Brazil and Colombia are particularly sensitive to price decreases, potentially reaching near-zero profit margins
- Ethiopia and Uganda show very little change in their already high profit margin, suggesting robust profitability even with price fluctuations

[1] See previous page for farm-gate price baseline assumption

GHG emissions were obtained for each country archetype, using the online-based calculating tool Cool Farm Platform

Methodology

- **Data collection:** Data was collected from TNS farm field surveys, partners' farmer data, public research, and expert interviews. All data has been anonymized for confidentiality purposes

- **Data analysis technique:** Raw datasets received were aggregated and filtered to include only those farms that fit the selected archetype dimensions.

- **Calculating tool (and methodology):** GHG emissions were obtained by manually uploading data into Cool Farm Platform's (CFP) GHG module, version Methods 2.2.0 - CFP 2.XX. The pathway used was "perennials", and the typology selected was "Coffee – shaded" for all archetypes except for Brazil Arabica and Brazil Robusta, for which "Coffee – monocrop" was selected

- **Global Warming Potential (GWP):** IPCC AR6

- **Operational boundary:** GHG emissions assessment limited to on-farm emissions from activities that farmers have direct control over and could be mitigated with implementation of regenerative practices. Explanations of emissions sources/sinks excluded are found in upcoming slides. This study assesses the potential variance in GHG emissions from adopting certain regenerative practices, rather than coffee's carbon footprint. A complete carbon footprint would require a life-cycle assessment, either cradle-to-gate or cradle-to-grave, which exceeds the purposes of this study

Emissions sources/sinks considered:

Included in all analyses:
- Crop details
- Crop residues
- Pesticide
- Fertilizers
- Non-crop estimates

Included in some analyses:
- Wastewater[1]
- Fuel and energy[2]
- Irrigation energy[3]

Excluded from all analyses:
- Transport
- Re/deforestation
- Soil carbon changes
- Machinery operations

[1] Only included if farmer archetype irrigates and/or wet process on-farm; 2Only included if farmer archetype is highly mechanized; 3Only included if farmer archetype irrigates

Certain emission sources and sinks were excluded from the study as they were out-of-scope, not applicable to the farmer archetype, or redundant

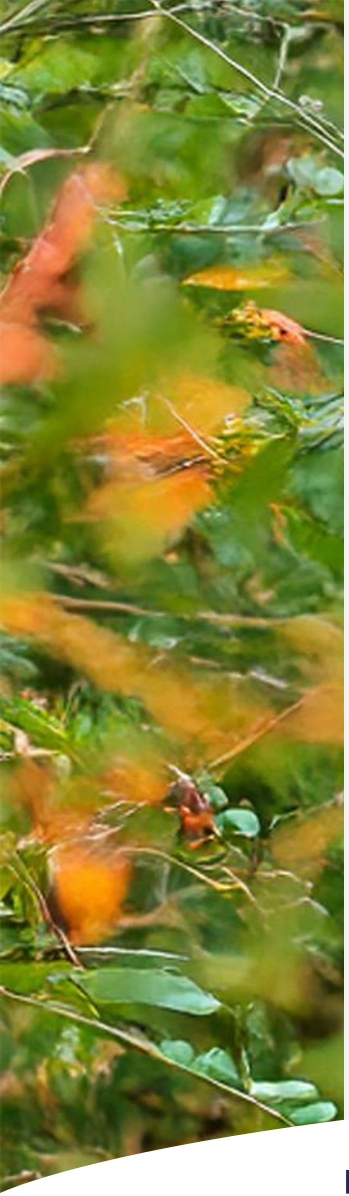
Emission sources/sinks excluded

Source/Sink	Archetype	Reason for exclusion
Inbound transportation	All archetypes	Assessment focuses only on on-farm emissions that could be mitigated with implementation of regenerative practices. All upstream emissions, except for fertilizer and phytosanitary input manufacturing, are out-of-scope
Outbound transportation	All archetypes	Assessment focuses only on on-farm emissions that could be mitigated with implementation of regenerative practices.. All downstream emissions beyond the farm-gate are out-of-scope
Land-use change (LUC)	All archetypes	Assessment focuses only on on-farm emissions that could be mitigated with implementation of regenerative practices.. Emissions from any land use change that may have occurred prior to intervention cannot be changed with regenerative transition and are therefore out-of-scope
Soil organic carbon (SOC)	All archetypes	Land management practices such as carbon inputs or tillage are considered irrelevant in the tier 1 SOC model for perennial systems, as indicated by IPCC [2019] (Volume 4, Figure 5.1). Consequently, only LUC impacts the SOC model at present
De/Reforestation	All archetypes	Assessment focuses only on on-farm emissions that could be mitigated with implementation of regenerative practices. Emissions from any deforestation that may have occurred prior to intervention cannot be changed with regenerative transition and are therefore out-of-scope
Machinery operations	All archetypes	Fallback for when accurate energy usage is not available. Given availability of primary energy usage data, machinery operations excluded.
Wastewater	Only if archetype doesn't wash coffee on farm	Not applicable for farmer archetypes that do not wash coffee on-farm
Energy for irrigation	Only if archetype doesn't use artificial irrigation	Not applicable for farmer archetypes that do not artificially irrigate their fields
Fuel and energy use	Only if archetype isn't highly mechanized	Not applicable for farmer archetypes that are not mechanized, and heavily rely on manual labor

Workarounds were implemented to address current limitations within the Cool Farm Platform, which is still in development

Tool & methodology limitations

Source/Sink affected	Limitation	Analysis workaround
Organic fertilizers	Only a few options are available for organic fertilizers. Although CFP allows to enter a fertilizer's NPK composition to estimate manufacturing emissions of products that are not already mapped, it can only be used for synthetic inputs	Organic fertilizers included in calculations only if suitable match based on carbon sequestration potential input from CFP options available
Non-NPK fertilizers (micronutrients)	If a non-NPK fertilizers is not already mapped in CFP, it cannot be assessed through the option "compose your own NPK"	Excluded from carbon footprint analysis
Bio-pesticides	Although there are emissions associated to the manufacturing of bio-pesticides, CFP is not built to consider them	Excluded from carbon footprint analysis
Inputs' density (liters/kilograms)	Emission factors for fertilizers and pesticides are defined per kilogram of product used. There are no emission factors defined per liters of product used	In cases where quantity of input used was provided in liters, density liters/kilograms was assumed to be equal to 1. This is in line with CFP's approach
Crop residues	Emissions factors for management options are still in development (e.g., "residues left on soil" mgmt. option is not yet modelled); Refined emissions factors will be part of the *L*SOC-N2O model coming in 2025	Calculated using Cool Farm Tool (with 0% waste fruit included due to negligible amounts of coffee cherries left on farm and pulp residues included only for archetypes with dry hulling or wet milling)
Soil organic carbon (SOC)	Land management practices such as carbon inputs or tillage are considered irrelevant in the tier 1 SOC model for perennial systems, as indicated by IPCC [2019] (Volume 4, Figure 5.1). Consequently, these type of practices do not impact CFP's SOC model at present	Excluded from carbon footprint analysis
Intercrops, shade-trees and hedges	CFP assess carbon sequestration from these type of biomass based on the plant's specie. However, it offers a limited number of species to choose from, oftentimes, not in line with region or farmer context	• Shade trees included in calculations only if suitable match based on carbon sequestration potential input from CFP options available (incl. tropical shade tree in dry areas, tropical shade trees in wet areas – canopy trees, tropical shade trees in wet areas – understory, temperate conifers, temperate broadleaf trees, temperate shrubs) • Intercrops included in calculations only if suitable match based on carbon sequestration potential input from CFP options available (incl. avocado, cashew, jackfruit, rubber durian)



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