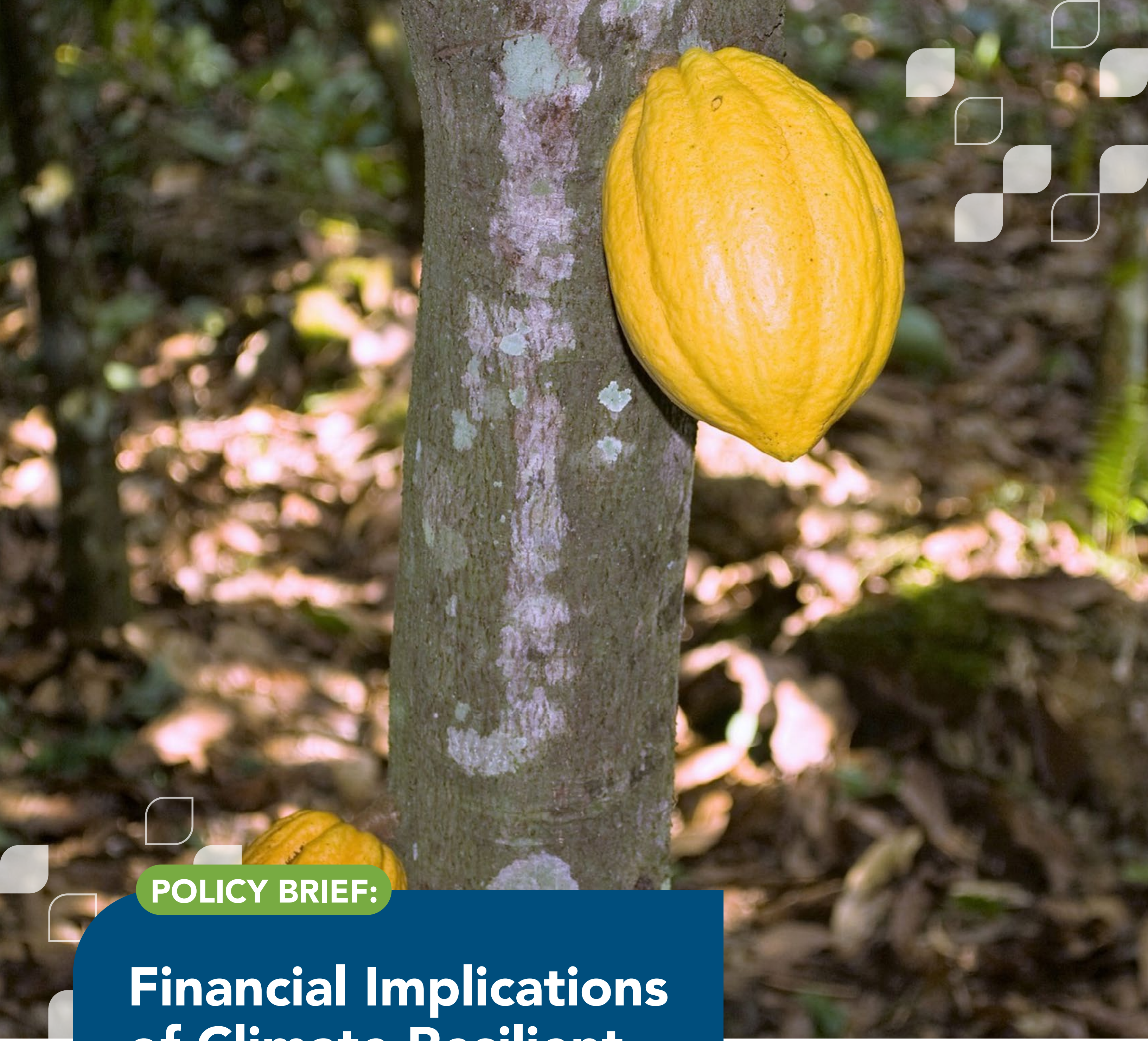

POLICY BRIEF:

Financial Implications of Climate-Resilient Coffee and Cocoa

CASE STUDIES FROM GHANA AND INDONESIA

WINROCK INTERNATIONAL

Private Investment for Enhanced Resilience project

Background

Coffee and cocoa are important global commodities, generating $17.9 billion for coffee-producing countries from October 2019–September 2020 (ICO 2021) and $9.6 billion for cocoa-producing countries in 2019 (OEC 2021). Approximately 70% of coffee (Alba 2019) and cocoa (IISD 2019) is produced by smallholder farmers (SHFs) who cultivate fewer than two hectares (ha) and who are highly dependent on income from these crops. Income from cocoa production, for example, accounts for between 60-90% of cocoa SHF's household income (IISD 2019).

Smallholder farmers face many production challenges. Crop productivity and product quality is dependent on multiple factors: sound management of trees, water, soil, pests, and disease; access to fertilizer and other inputs; and timely replacement of less productive old and diseased trees. To date, most on-farm assistance to SHFs primarily focused on addressing these issues. Coffee and cocoa yields are sensitive to climate variability and extreme weather events, which are increasing yearly. Climate change and increasing average temperatures are expected to reduce productivity. This will reduce yields and negatively affect livelihoods for both cocoa and coffee farmers, and could increase pressure to convert forests at cooler, higher elevations or other locations that were historically unsuitable for cultivation. Ensuring continued production of coffee and cocoa, as well as sustainable livelihoods for SHFs, will require climate-resilient practices and financing beyond public sector support.

The **Private Investment for Enhanced Resilience** (PIER) project, funded by the Bureau of Oceans and International Environmental and Scientific Affairs in the United States Department of State and implemented by Winrock International, assessed the potential for supporting climate-resilient production of cocoa in Ghana and coffee in Indonesia.

This policy brief describes two case studies that explore approaches to introduce climate-resilient management of smallholder farms, creating the capacity for increased productivity, income diversification, improved quality of cocoa/coffee value chains, and the potential to engage the private sector for financing. These examples provide insight into how climate-resilient coffee and cocoa agricultural approaches can be financially viable.

Case Studies of Financing Climate-Resilient Production

PIER partnered with ECOM Agroindustrial Corporation, Ltd. (a global company that sources cocoa, coffee, and other commodities from smallholder farms) to conduct financial analyses of cocoa in Ghana and coffee in Indonesia. These analyses explored various farming methods to identify approaches that are climate resilient while ensuring high yields and financial returns. In Ghana, PIER worked with ECOM to pilot cocoa rehabilitation combined with planting annual cash crops, and conducted an analysis of the expected financial returns of this approach. In Indonesia, PIER modeled the financial conditions of coffee farms in ECOM's supply chain using both current conditions and various resilience scenarios. These case studies are described here.

Ghana is the second largest exporter of cocoa beans ($2.5 billion in 2016). Approximately 2 million Ghanaians are employed to cultivate 1.7 million ha of cocoa trees and 6.3 million people (26% of the national population) are directly or indirectly involved in the cocoa value chain (IISD 2019).

Indonesia is the fourth largest coffee producer in the world and second largest in Asia behind Vietnam. An estimated 1.5–2 million people grow coffee in Indonesia (Hille 2016) and 96% of coffee farms cultivate coffee on less than 1 ha (Sustainable Coffee Program 2014).

Case Study: Cocoa in Ghana

Cocoa farms are in decline across Ghana, with low yields due to a combination of age, poor maintenance, pests and disease, low soil fertility, and inadequate shade and inputs. Climate change exacerbates these issues, primarily due to drought and its impacts on yield, pest, disease, and cocoa bean quality (Abdulai 2018). Low yields and low prices have resulted in many Ghanaian cocoa farmers facing poverty, seasonal food security issues, and debt cycles.

Significant investment by multiple parties is required to rehabilitate Ghana's cocoa farms. At an average cost of $14,000 per ha, approximately $1.9 billion of public investment is needed to leverage $7.8 billion of private investment to rehabilitate 700,000 ha. This level of investment would substantively improve the livelihoods and resilience of over 130,000 cocoa-growing households across Ghana, with positive ripple effects on the economy. Up to 40% of cocoa farms (700,000 ha) must be replanted to address current productivity challenges, and systematic adaptation is required to address future climate risks in over half of Ghana's cocoa-producing lands. Without systematic adaptation, Brunn *et al.* (2018) estimate the mean cost of climate change on Ghana's cocoa sector will be $270–$660 million per year by 2050 (74–180% of the cocoa sector's 2019 contribution to Ghana's Gross Domestic Product).

These challenges can be addressed with wide-scale rehabilitation and replanting of cocoa with the appropriate number and species of shade trees. However, cocoa takes up to five years to mature and produce pods, and several barriers make it difficult for cocoa farmers to rehabilitate cocoa farms on their own — including lost income during the first years after replanting, access to planting materials and labor, insecure land and tree tenure, and knowledge of rehabilitation techniques.

ECOM developed and tested a service delivery model for their SHF cocoa suppliers in Ghana to reduce barriers to rehabilitate old or diseased cocoa farms using a climate-resilient agroforestry model that generates a return for growers over the first four years, when cocoa trees are not yet productive. Under the model, ECOM clears old or diseased cocoa farms and replants two-thirds of the plantations with cocoa trees and shade trees based on projected climate impacts. Cash crops are intercropped in the early years as the cocoa and shade trees mature. The other one-third of the farm is cleared and planted with annual cash crops. Proceeds from sales of cash crops across the entire rehabilitated farm are first used to pay ECOM for its services, purchase of inputs, and interest accrued on the upfront investment by ECOM. All remaining surplus flows to the farmer as income.

The viability of this approach to yield returns to both ECOM and farmers is impacted by several factors. Key risks include crop prices, production quality and yield, and side-selling of cash crops by farmers. Significant investment by multiple parties is required to rehabilitate Ghana's cocoa farms. The average cost of fully rehabilitating a cocoa farm using ECOM's approach is approximately $14,000 per ha over four years (+/- $1,000 depending on the cash crop). When applied to the cocoa farms in need of rehabilitation, the total investment needed is between $4.8 and $5.5 billion to completely replant 368,000 ha, and between $9.2 and $10.4 billion to replant 700,000 ha.

In **Ghana**, PIER found that a limited subsidy scheme through blended finance structures could close the financial viability gap for smallholder cocoa farmers and reduce the current need for operational subsidies and concessional financing.

PIER worked with ECOM and two pilot groups of farmers over two years to assess the viability of this approach and to fully understand the risks. This work included training extension agents to introduce agroforestry methods and work with farmers, and a financial analysis.

Lessons learned during two-year pilot phase

Realistic value proposition. ECOM's approach aimed to offer a commercially viable (i.e., unsubsidized) pathway for farmers to adapt to a changing climate while improving livelihoods. While the results indicate viability is unlikely without additional financial support, a subsidy-light scheme is viable, using blended financing structures to reduce the need for operational subsidies and concessional financing. A limited subsidy would be a vast improvement over a 100% subsidy model for rehabilitation of cocoa farms.

Location selection. Viability of the rehabilitation model depends on factors including access to markets, soil conditions, and water supply (including irrigation). These should be considered when assessing where the model will be viable.

Appropriate suite of services. The pilot indicated that annual and semi-annual cash crops sometimes must be preserved to respond to market demand, as such demand may not exist at the time of harvesting. This indicates the need for a suite of services that includes post-production processing activities to fully realize the revenue potential of cash crops.

While ECOM ultimately determined that its approach was not financially viable as a stand-alone service, significant opportunity exists for an adjusted and/or subsidized approach to increase long-term income for farmers. This could improve livelihoods, increase economic resilience, and reduce shocks. The challenges ECOM faced when trying to establish a financially viable farm rehabilitation service are also faced by SHFs, who have less access to finance than ECOM. Without reliable finance, it is often difficult for farmers to diversify away from cocoa for several reasons, including higher annual capital needs for cash crops, access to markets for non-cocoa cash crops at scale, larrbor constraints given that annual cash crops are more labor intensive, cultural preferences for cocoa, and customary tenurial barriers. PIER's work in Ghana shows that it will be very difficult, if not impossible, for cocoa companies or SHFs to rehabilitate Ghana's cocoa farms without support. Financial assistance for rehabilitation of cocoa farms will be needed to avoid a potential social and economic collapse of the cocoa industry in Ghana over the coming decades.

Case Study: Coffee in Indonesia

Smallholder farmer productivity of coffee in Indonesia is very low, with an average of 500 kgs per ha produced annually.[1] This is due to a lack of farm inputs (e.g., fertilizers), suboptimal agricultural practices (e.g., monoculture and lack of shade trees), and mortality due to pestilence. Climate change poses additional challenges for arabica coffee cultivation in Indonesia and will further exacerbate the vulnerability of smallholder farms.

The impacts of climate change and climate variability are myriad in Indonesia. Rainfall is expected to become even more variable with frequently delayed monsoon rains, intermittent rain during the dry seasons, and more extreme weather events. Suboptimal temperatures will decrease the quantity and quality of coffee production and increase vulnerability to pests and diseases. Even with adaptive strategies to mitigate the effects of climate change in coffee production, land suitable for cultivation of arabica coffee is projected to decline by 33% by 2050 (Schroth 2015).[2]

In North Sumatra, Indonesia, ECOM procures arabica coffee from several thousand growers and supports their coffee-producing partners with technical assistance and training on good agricultural practices (GAP). To better understand the value of adaptation investments, the potential for uptake of climate smart practices, and the return on investment, PIER worked with ECOM to develop a financial model, train agronomists and farmers, and conduct a cost-benefit analysis.

Financial model

PIER's financial model compared the current financial conditions of a typical SHF in ECOM's supply chain with a variety of resilience scenarios that included adaptation investments. Modeled resilience scenarios ranged from 100% rehabilitation (better management of existing plant stock) to 100% renovation (replanting with climate-resilient plant stock).

Rehabilitation of smallholder coffee farms in Indonesia yields the highest short-term gains for farmers. With financial assistance, it may be possible to persuade farmers to adopt some combination of rehabilitation and renovation, which will provide larger gains in the long term as well as increased climate benefits.

1 This can be compared, for example, to Vietnam's production of 1,800 kg per hectare.

2 The authors assumed that higher-elevation land not currently suitable for coffee cultivation would be available for coffee production, indicating even deeper reduction in suitability of areas currently under cultivation.

The model estimated profits (Table 1) for a 1 ha farm for the periods 2021–2025 and 2026–2030 for the following scenarios:

- Baseline/current common practice
- 100% rehabilitation
- 50% each for rehabilitation and renovation
- 100% renovation

Table 1. Profits (in 2021 USD) for modeled scenarios for a one-hectare smallholder coffee farm in North Sumatra.

	Baseline Scenario	100% Rehab	50% Rehab/ 50% Reno	100% Reno
2021	844	1,612	(850)	(3,311)
2022	741	1,548	46	(1,456)
2023	639	1,484	1,125	766
2024	536	1,419	1,730	2,041
2025	433	1,355	2,609	3,862
5-year subtotal	3,193	7,418	4,659	1,901
2026	330	1,291	2,576	3,862
2027	227	1,226	2,544	3,862
2028	124	1,162	2,512	3,862
2029	21	1,098	2,480	3,862
2030	(81)	1,034	2,448	3,862
10-year total	3,814	13,229	17,220	21,211

Over a five-year timeframe modeled by PIER, the most profitable option is rehabilitation of the entire coffee plantation, followed by the rehabilitation/renovation (50% each) option and the baseline scenario, while the 100% renovation option is the least profitable. However, when modeled over a 10-year period, estimated profits for the two renovation options significantly exceed expected profits for the baseline scenario and rehabilitation options.

Trainings and uptake

Implementation of climate-resilient coffee production strategies such as rehabilitation and renovation are often capital intensive. For example, even the use of additional fertilizer inputs can be very costly for SHFs. Farmers will require financial assistance to develop the ability to implement climate-resilient practices that can help prevent future supply chain shocks in the global coffee market. Farmers will also require training on GAP, given that climate-resilient agriculture necessitates a new approach. Winrock collaborated with the Centre for Climate Risk and Opportunity Management — a research center at Bogor Agricultural University — to address capacity needs and train ECOM's agronomists on climate risks faced by the coffee sector in Indonesia. Training included discussion of various climate adaptation measures.

Training used the "training-of-trainers" model to build ECOM's capacity to spread awareness and technical know-how on climate adaptation among SHFs. ECOM agronomists trained SHFs from the Lake Toba region from July–September 2021 on climate risks faced by the coffee sector and on adaptation measures including pest control, input use, and pruning. In post-training surveys, participating farmers expressed willingness to invest $211 over a two-year period (on average), or approximately $106 per year on adaptation measures. Per our financial analysis, it costs the average smallholder farmer $200 per year to move to a 100% rehabilitation scenario, which implies that farmers may be willing to invest a little over half the amount required to adapt to climate change. The balance of 50% could be raised through a combination of government funding, supply chain incentives (i.e., higher prices for certified products), or financing. In the case of government funding, proof of the cost benefit of allocating government resources would be necessary, which is addressed below.

Cost-benefit analysis

PIER conducted a cost-benefit analysis (CBA) to supplement the findings of the financial model and assess whether the benefits of rehabilitation and renovation (along with other GAP procedures) are sustainable to justify the considerable investment and short-term production losses. The CBA was conducted for the Lake Toba region in North Sumatra, which has approximately 4,000 SHFs cultivating Arabica coffee on 0.5 ha (on average). Annual income of a SHF from coffee sales is approximately $285–$306 per year. Most trees in this region are over 20 years old, as the last large-scale replacement of old trees occurred in the 1990s.

The analysis assessed the benefits and costs of four scenarios:

- Training for SHFs on climate-smart agricultural practices (no financial assistance)
- Training and financial assistance for 100% renovation
- Training and financial assistance for 100% rehabilitation
- Training and financial assistance for 50% rehabilitation and 50% renovation

Each scenario assumes a linear trend of GAP uptake over a 20-year period, from 5–75%.

The expected benefits vary in magnitude by scenario, but in all cases include increased yields; decreased crop loss; and increased resilience to climate risks, pest infestations, and disease. Costs for all scenarios include training costs, opportunity costs for farmers to participate in training, and annual cultivation costs, as well as the costs of rehabilitation (additional labor costs for pruning and care of plants) and renovation (removal of old and diseased trees plus replanting costs).

Implementing 100% renovation in conjunction with GAP yielded the highest level of net benefits because the increased yields from renovation far exceed those from better practices alone, provided the period of analysis is long enough for trees to mature and sustain optimal productivity for several years. Table 2 includes GAP training, financial assistance, and resilience practices, and is expressed as net-present-value for a 20-year investment period. All scenarios assume GAP uptake.

Table 2. Results of cost-benefit analysis across Lake Toba region of North Sumatra province

Scenario	Net-Present-Value (2021)
Training only	$5,655,237
Training + financial assistance + 100% Renovation	$18,300,000
Training + financial assistance + 100% Rehabilitation	$14,860,260
Training + financial assistance + 50% Reno/50% Rehab	$17,259,080

Lessons learned

While the results from financial modeling and CBA show that renovation may be most profitable in the long run, renovation is likely to be a difficult option for SHFs to undertake for four primary reasons:

- Capital costs to replace trees require medium- to long-term financing, which is most typically available in the form of bank loans. SHFs face several barriers to accessing bank loans for long-term financing, including the lack of collateral or existing indebtedness. Even if a SHF were to overcome these barriers and qualify for a loan, they would in most cases be unable to repay it until the coffee plants have matured and they realize a profit.

- Where profits from coffee farming represent a significant share of household income, the farm family would require savings and/or the potential to earn off-farm income for three to four years while the coffee plants reach a productive age.

- SHFs are often risk-averse, and therefore unlikely to undertake renovation, especially considering input and market price volatility, climate variability, and threats to coffee yields due to pest infestations and disease.

- SHFs may be unwilling or unable to make investments which return profits over a 10-year timeframe, depending on the farmer's age and the family's long-term commitment to coffee cultivation.

When a new policy or assistance program is introduced — especially with limited historical information on how SHFs will respond — it is necessary to predict if SHFs will alter current management practices, and if so, which alternatives are most likely to be adopted. Smallholder coffee farmers are most likely to adopt rehabilitation practices, because they yield the highest short-term gains. With financial assistance, it may be possible to persuade SHFs to adopt some combination of rehabilitation and renovation.

Broader Implications

Coffee and cocoa growers increasingly need to adjust their growing practices to ensure that their farms and livelihoods are resilient to the impacts of climate change. Commodity companies, and coffee and chocolate brands, must safeguard their supply chains against climate shocks. PIER's case studies in Ghana and Indonesia demonstrate an overall positive return for farmers to adopt climate-smart practices, but barriers prevent uptake. The field work in Ghana also demonstrates that modeled benefits do not always hold during on-the-ground implementation. More work is needed to test practices in coffee in Indonesia to understand if the modeled benefits hold up. However, in both cases, PIER's work shows that there is a critical need for financing and at-scale technical assistance that can improve climate resilience to maintain or increase productivity for SHFs and allow for financial returns.

When developing approaches for resilient production, it is critical to consider all factors that could impact returns for SHFs. This includes financial analyses as well as factors not typically included in a standard financial analysis.

While a compelling economic argument exists for farmers to make management changes and invest in rehabilitation and renovation, a more robust understanding is needed regarding SHF decision-making and the barriers farmers experience and perceive in adopting these practices. This includes understanding attitudes toward climate and market risks, perceptions about information on the potential for investments to increase yields, and the options for increasing the rate of adoption of improved practices, including training, pilot cases, and demonstrations.

The PIER case studies demonstrate that farmers need support to navigate and address the range of factors that affect their livelihoods and which pose barriers to adopting resilience practices. Table 3 provides a list of decision-making factors that must be considered by SHFs and those who will provide assistance; Table 4 provides examples of both technical and financial assistance. These are meant to offer preliminary options to identify fully viable approaches to ensure uptake of climate-resilient agriculture.

Table 3. Decision-making factors for ensuring return to SHFs in development of climate-resilient agriculture

Production Issue	Decision-making Factor	Implications for SHF Profits
Production (yield and quality)	Performance of management options	Uncertainty about the impact of GAP on changes in yield and/or price results in uncertainty about future profits
	Climate variability	Extreme high and low temperatures, irregular rainfall, extreme heavy rains, drought, and high winds impact yield and quality and increase the risk of lower profits
	Pests and disease	Potential for pest infestations and diseases affecting yield, quality, and costs to address problems increases risk of low profits
Supply and commodity markets	Supply costs and input quality	Certainty regarding future supply costs reduces risk for low profits; availability of high-quality inputs reduces risk for diminished yield and quality
	Price volatility	Uncertainty regarding future prices received by SHFs increases risk of low profits
Financing	Ability/willingness to access credit	Access to credit increases SHFs' ability to make multi-year investments involving renovation of old and diseased trees
	Access to affordable credit	Affordable credit increases SHFs' ability to make multi-year investments involving renovation of old and diseased trees
Policy and socio-economic factors	Land and tree tenure	Established tenure decreases risk of multi-year investments involving renovation or planting of shade trees
	Family commitment to farming	Assured continuity is needed to engender willingness to make multi-year investments
	Share of income from cocoa or coffee production	Significant share of cocoa or coffee revenue in household income may limit ability or willingness to invest in renovation

Table 4. Potential assistance options for supporting smallholder farmers in adopting climate resilient practices

Technical Assistance	Training/technical assistance in developing and implementing good agricultural management practices, certification, and organic cultivation Shade tree planting/rehabilitation/renovation
	Research on agronomic practices, seed genetics, and climate effects on productivity
	Support for tree nurseries
	Support to create farmer associations and cooperatives and provide them with technical assistance and training
Financial Assistance	Soft loan terms (lower interest rates, grace periods)
	Forward pricing and offtake agreements
	Loan guarantees to overcome collateral constraints of SHFs
	Technical assistance and training in financial management
	Assistance to prepare financial application and select financier
	Indexed/catastrophic crop insurance

Conclusion

Adapting to climate change will be challenging for SHFs, and particularly difficult for those SHFs who rely on long-lived tree crops such as cocoa and coffee. While climate-smart practices should theoretically produce positive returns for farmers who adopt them, turning theory into practice will be difficult — if not impossible — without support, including to subsidize the cost of transitioning to climate-smart agricultural practices. Commodity companies, brands, and donors will need to tailor and modify their offerings of technical/finance assistance based on local circumstances and lessons learned from prior implementation.

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Private Investment for Enhanced Resilience

PIER is a 5-year (October 2017–May 2022) technical assistance project, funded by the United States DOS, that aims to address barriers the private sector faces to increasing investment in climate-resilience activities in 12 developing countries. The objective of PIER's technical assistance is to influence enabling environments for investments that reduce long-term environmental risks while increasing resilience in development sectors prioritized by counterpart communities.