Financing Smallholder Cocoa Rehabilitation in Ghana

PRIVATE INVESTMENT IN ENHANCED RESILIENCE (PIER) PROJECT

WINROCK INTERNATIONAL

Private Investment in Resilience

FINANCING SMALLHOLDER COCOA REHABILITATION IN GHANA

Date: September 2020

PROJECT:

Private Investment for Enhanced Resilience (PIER)

AUTHORS:

Robert O'Sullivan, independent consultant

Anmol Vanamali, Private Sector Partnerships Lead (PIER)

FUNDER:

United States Department of State, Bureau of Oceans and International Environmental and Scientific Affairs

COOPERATIVE AGREEMENT:

S-LMAQM-17-CA-2032-M001

COVER PHOTO:

Young Cocoa Trees, Robert O'Sullivan

SUGGESTED CITATION:

O'Sullivan R., and Vanamali A., (2020). *Financing Smallholder Cocoa Rehabilitation in Ghana.* Winrock International, Washington, D.C.

CONTACT:

Michael Cote, PIER Project Director, Michael.Cote@Winrock.org

2101 Riverfront Drive
Little Rock, AR 72202
501-280-3000

2451 Crystal Drive, Suite 700
Arlington, VA 22202
701-302-6500

winrock.org

Table of Contents

Executive Summary

The Private Investment for Enhanced Resilience (PIER) project was designed to help bridge the finance gap between public funds and on-the-ground needs to adapt to climate change. In Ghana, PIER and cocoa trading company ECOM Agroindustrial Corporation (ECOM) are collaborating on developing a sustainable service delivery model for cocoa farm rehabilitation services. These services aim to rehabilitate old and diseased cocoa farms to more resilient agroforestry systems that deliver multiple benefits.

Results from our efforts show that commercially viable farm rehabilitation services are possible, with increased livelihoods benefits from diversified cash crops. Blended finance solutions are suggested to help address underlying cash crop production risks, value chain development, and land and tree tenure, and leverage significant private investment needed to finance rehabilitation at scale.

Significant investment by multiple parties is required to rehabilitate Ghana's cocoa farms.

At an average cost of $14,000 per hectare – approximately $1.9 billion of public investment is needed to leverage $7.8 billion of private investment to rehabilitate 700,000 hectares.

This investment would have a significant impact to improve the livelihoods and resilience of over 130,000 cocoa growing households across Ghana, with positive ripple effects throughout the cocoa sector, economy, and development objectives. The PIER project demonstrates a viable finance strategy for climate smart farm rehabilitation services that delivers multiple environmental and social benefits to investors and farmers.

In addition to substantial economic and resilience benefits to Ghana, cocoa rehabilitation contributes to multiple Sustainable Development Goals including: Goal 1. *No Poverty*, Goal 2. *Zero Hunger*, Goal 8. *Decent Work and Economic Growth*, Goal 13. *Climate Action*, Goal 15. *Life on Land*, and Goal 17. *Partnerships*.

We propose that donors and multi-lateral banks collaborate to design a technical assistance project in support of blended finance solutions for resilient cocoa in West Africa. Three design options are explored in Section 6 – a Blended Finance Facility, an SME Loan Fund, and Resilience Bond. The PIER project is exploring development of a formal concept note for consideration by the U.S. Department of State and other donors for future consideration.

Challenges and solutions to Ghana's cocoa sector

Ghana is the second largest producer of cocoa globally and cocoa is economically significant. Cocoa farming employs over 2 million people directly, with 6.3 million (or 26 percent of Ghana's total population) dependent on the sector. However, cocoa farms are in decline across Ghana with low yields due to a combination of age, poor maintenance, pests and disease, low soil fertility, poor shade, and inadequate inputs. Many cocoa farmers are highly dependent on cocoa as their primary source of income, and the combination of low cocoa prices and low yields have left many Ghanaian cocoa farmers facing poverty, seasonal food security issues, trapped in debt cycles, and unable to earn a living income from cocoa.

Up to 40 percent of cocoa farms (700,000 hectares) need to be replanted to address current productivity challenges and over half of Ghana's cocoa is produced in areas that require systematic adaptation to address future climate risks. Without systematic adaptation, the estimated mean cost of climate change on Ghana's cocoa sector is estimated to be between \$270 – \$660 million per year by 2050 (0.7 - 1.6 percent of GDP).

Cocoa farm rehabilitation

The solution to these challenges is wide scale rehabilitation and replanting of cocoa and the appropriate number and species of shade trees. Cocoa takes up to 5 years to mature and produce pods, and several barriers make it difficult for cocoa farmers to rehabilitate their cocoa farms on their own using best practices. The barriers most relevant to Ghana are: i) financial, ii) technical and social, and iii) land and tree tenure barriers.

The most significant financial barrier is lost income from cocoa once a farm is replanted. Some programs have tested combinations of cash crops and rotational clearing to try and reduce this risk, but negative cash flows have traditionally persisted during the early years. Technical and social barriers include access to planting materials, labor, inputs, and rehabilitation techniques along with perceptions of cocoa's future. Insecure land tenure is most relevant for farmers that hold customary *abunu* title to land, as these farmers often require approval from the landowner before they can rehabilitate an old farm. Tree tenure is relevant for all farmers across Ghana as the government claims ownership of all naturally occurring trees, which extends to shade and timber trees on cocoa farms. This state ownership of naturally occurring trees is widely considered a strong disincentive for landowners and smallholders to plant or nurture trees on their cocoa farms - regardless of land tenure.

The government of Ghana provides some rehabilitation services funded by a \$600 million loan from the African Development Bank. In this model farmers are compensated when their farms are rehabilitated to cover lost income, but the government program is only expected to cover up to 160,000 hectares if fully implemented as planned. Evaluations of an earlier government sponsored rehabilitation program to rehabilitate 17,300 hectares also funded by the African Development Bank found the program only rehabilitated between 22 and 36 percent of the area initially planned.

ECOM's service delivery model for resilient cocoa farm rehabilitation

ECOM's service delivery model (SDM) aims to address barriers to rehabilitate old or diseased cocoa farms using a climate resilient agroforestry model and generate a return over the first four years. Under the model, ECOM clears old or diseased cocoa farms and replants 2/3 with cocoa trees and a few shade trees based on projected climate impacts. Cash crops are intercropped in the early years as the cocoa and shade trees mature. The other 1/3 of the farm is cleared and planted with annual cash crops only. The sale of cash crops across the entire rehabilitated farm is used to ensure farmers' earn income and to repay ECOM's investment within the first 4 years – i.e. before the cocoa starts to produce pods.

Field tests of cash crops over the 2019 – 2020 growing season were used to generate three farm rehabilitation service delivery model scenarios to test the return from different combinations of cash crops on the 1/3 extra plot set aside for cash crops (see table below). Two options were also developed to analysis the impacts of keeping this extra plot for annual cash crops or converting it into cocoa in year five. The model shows significant long-term improvement in farmer income in all scenarios. Given the model targets rehabilitation of old or diseased cocoa farms with low yields, an increase in income is to be expected. This can be seen in net present value of all six scenarios, which shows greater long-term value.

Net Present Value for all Scenarios (GH¢)

Discount rate: 28 percent	**Net present value (GH¢)**			
	2/3 rehabilitated to cocoa; 1/3 retained as cash crop		Full rehabilitation to 100% cocoa over time	
	4 year	**25 year**	**4 year**	**25 year**
Scenario 1 (chili pepper, cabbage)	27,005	56,051	24,717	28,609
Scenario 2 (maize, garden eggs, okra)	-2,363	10,411	-1,263	2,629
Scenario 3 (turmeric)	3,993	32,223	-3,155	737

Actual returns for ECOM and the farmers and viability of the model will be affected by several risks, some of which are not fully captured in the model. The key risks include crop prices, production quality, production yield, and side selling of cash crops by farmers.

The model demonstrates that keeping some land set aside for annual cash crops is better for farmers' long-term income across all scenarios, which will benefit livelihoods and help improve overall economic resilience. However, without ongoing or additional support it is difficult for some farmers to pursue long-term diversification away from cocoa for several reasons, including higher annual capital needs for cash crops, access to markets for non-cocoa cash crops at scale, labor constraints as annual cash crops are more labor intensive, cultural preferences for cocoa, and customary tenurial barriers for *abunu* farms whose land tenure is tied to keeping land under cocoa.

National implications and recommendations for blended finance solutions

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 hectare over four years, +/- $1,000 depending on the cash crop. When applied to the 368,000 – 700,000 hectares of cocoa farm that are estimated to need to be rehabilitated the total cost of rehabilitating all of Ghana's cocoa is between $4.8 billion and $5.5 billion to completely replant 368,000 hectares, and between $9.2 and $10.4 billion to replant 700,000 hectares depending on the scenario.

Blended finance combines private capital with grants or subsidized finance from development institutions or donors to achieve common goals. Blended finance solutions could help mitigate some key risks to private sector entities like ECOM, and drive benefits for cocoa farmers and support Ghana's Journey to Self-Reliance. Three key risks were identified for development finance support: cash crop production risk, challenges establishing new value chains at scale, and land and tree tenure. Three options to structure blended to address these risks are proposed in Section 6.

Figure 1 Cocoa seedlings in nutrient pots, nearly ready for transportation to farms. It takes 3-5 years for a new cocoa plant to produce fruit. Photo: Robert O’Sullivan

Figure 2 Cocoa farm being rehabilitated. Old trees are felled, and land cleared. Several healthy shade trees remain to provide cover and microclimate for new cocoa trees. Photo: Robert O'Sullivan

1. Introduction

1.1. PIER PROJECT AND COLLABORATION WITH ECOM

The Private Investment for Enhanced Resilience (PIER) project was designed to help bridge the finance gap between public funds and on-the-ground needs to adapt to climate change. National development programs, such as National Adaptation Plans (NAPs) and "green growth" strategies, envisage that adaptation actions that are not yet financed by government will attract finance from development partners and the private sector. The private sector is critically important to build resilience to climate change through investment and technical capability in climate risk-reducing products, services, and infrastructure. However, aside from social-impact investors and a few large corporations that have made a commitment to sustainability, the private sector is not fully considering risks-to-profit due to climate change.

PIER supports the idea that private capital and the business sector are key to promote global growth and reduce investment risk through enhancing resilience. PIER supports activities that aim to mobilize private investment for resilience in Ghana, Vietnam, Peru, and Indonesia. In Ghana, PIER and ECOM Agroindustrial Corp. Ltd (ECOM) are collaborating to develop a sustainable service delivery model for cocoa farm rehabilitation. ECOM is a global commodity merchant and sustainable supply chain management company and leading cocoa purchasing company in Ghana that supplies cocoa to many US and international chocolate brands such as Hershey's and Mars.

The collaboration between PIER and ECOM is important as Ghana is the second largest producer of cocoa globally, but cocoa production in Ghana faces a series of threats. Up to 40 percent of cocoa farms (700,000 hectares) need to be replanted to address current productivity challenges and over half of Ghana's cocoa is produced in areas that require systematic adaptation to address future climate risks. The solution to both these challenges is wide scale rehabilitation and replanting of cocoa and the correct number and species of shade trees. This is challenging for cocoa farmers as cocoa takes up to 5 years to mature and produce pods, and many farmers lack access to sufficient finance, inputs, labor, or know-how on good agricultural practices for climate smart cocoa. ECOM is familiar with these challenges and in 2016 saw a potential business opportunity that could generate multiple benefits: If a commercially viable farm rehabilitation service could be developed that addressed these barriers, the service could help thousands of farmers rehabilitate their farms, improve livelihoods, restore cocoa yields, and grow ECOMs service offerings. However, for it to work it needs to make business sense.

In 2016 the United States Agency for International Development (USAID) was increasingly interested in supporting deforestation free commodity production. USAID recognized the links between insecure farmer tenure, low cocoa yields, and deforestation in Ghana. At the same time Hershey's was also increasingly aware of the connections between cocoa production, low yields, deforestation and land tenure. In 2016 USAID began to collaborate on the aligned interests of Hershey's and ECOM under the USAID-funded Tenure and Global Climate Change (TGCC) Program to address land and tree tenure constraints that inhibit cocoa productivity and contribute to deforestation around smallholder cocoa farming in Ghana.[1]

One of the components of TGCC helped support ECOM's initial work to develop a new, sustainable, service delivery model for cocoa farm rehabilitation. Under this model ECOM clears old or diseased cocoa farms and replants 2/3 with cocoa and the correct number and species of shade trees based on projected climate impacts. Cash crops are intercropped in the early years as the cocoa and shade trees mature. The other 1/3 of the farm is cleared and planted with annual cash crops only. The sale of cash crops across the entire rehabilitated farm is used to ensure farmers earn income and ECOM's investment is repaid within the first 4 years – i.e. before the cocoa starts to produce pods. The collaboration between ECOM and PIER focused on the following refinements to the model:

- Identifying the correct shade tree species and density for rehabilitated farms to increase farm resilience to future climate impacts.
- Modeling different combinations of cash crops across the rehabilitated farm to increase the financial viability of farm rehabilitation as a commercially viable service.

The approach will help Ghana on its journey to self-reliance by reducing deforestation, increasing cocoa farm resilience and productivity, diversifying farmer incomes, and improving livelihoods.

In parallel to the collaboration with ECOM, PIER also works with Ghana's Environmental Protection Agency to build capacity and engage the private sector to implement adaptation opportunities within Ghana's Private Sector Engagement Strategy. The results of this collaboration will be captured in a separate report.

1.2. REPORT OBJECTIVES

The objective of this report is to provide information, lessons learnt, and recommended next steps on the farm rehabilitation service delivery model. The updated model and this report include data collected from a selection of pilot crops grown during the 2019 – 2020 growing season.

2. Background: Ghanaian Cocoa Sector

2.1. ECONOMY AND ENVIRONMENT

Ghana is the world's second largest cocoa producer and cocoa exporter (FAO STAT, 2018; Fountain and Hütz-Adams, 2018). In 2010, cocoa accounted for eight percent of Ghana's gross domestic product,

[1] TGCC ran through early 2018 and included initial development and piloting a cocoa farm rehabilitation service delivery model led by ECOM on 50 hectares spread across 71 farms. The collaboration between the partners was captured in TGCC's work plan for Ghana that was co-developed with the private sector partners. ECOM continued to collaborate with Hershey's and USAID on deforestation free cocoa production in 2018 under the TGCC follow on - the Integrated Land and Resource Governance (ILRG) task order under the Strengthening Tenure and Resource Rights II Indefinite Delivery/Indefinite Quantity contract. The collaboration between PIER and ECOM is integrated into ILRG's work plan to ensure the two programs are coordinated. For more details on TGCC see Roth et al, (2018). For more details on ILRG see: O'Sullivan et al, (2019); O'Sullivan & Antwi, (2019).

between 30 to 40 percent of total export earnings, and around 25 percent of the country's foreign exchange. Cocoa is part of Ghana's culture, particularly in rural areas where cocoa farming is estimated to employ over 2 million people directly, with around 6.3 million (or 26 percent of Ghana's total population) dependent on the sector (Ghana Cocoa Board, 2018; Peprah, 2015).

Since cocoa was first introduced into Ghana in the late 1800s[2] smallholder cocoa farmers cleared primary forests to establish their farms. This involved removing the forest understory to plant cocoa trees and thinning the forest canopy to create room for cocoa and let in some light. Starting in the late 1950's the government of Ghana claimed ownership of the "naturally occurring" trees on cocoa farms and across Ghana. The Forestry Commission granted timber licenses to private operators that felled many of the large shade trees found on cocoa farms. In the 1980's the Ghana Cocoa Board (Cocobod's) extension service agents also encouraged farmers to abandon the traditional shade cocoa agroforestry system in favor of zero shade or full sun cocoa production to boost yields. The new cocoa board policy produced short term yield gains, but also increased susceptibility to diseases and shortened cocoa trees' productive life (Fischer et al, 2020).

The combined pressures from forestry and cocoa led to deforestation and fragmentation of forest landscape in Ghana's high forest zone and widespread removal of shade trees from cocoa farms. An average of 138,000 hectares of forest was lost per year from 2000 to 2015 (Republic of Ghana, 2014; Republic of Ghana, 2017) and by 2007, 72 per cent of cocoa farms across Ghana were characterized as having "no to light" levels of shade (Kolavalli & Vigneri 2011). Today there is little forest outside the forest reserves, and the remaining forest reserves are also facing encroachment pressures.

2.2. COCOA FARMING CHALLENGES

Low yields and poverty

Cocoa has been credited with helping poverty alleviation in Ghana in the past (World Bank, 2007; Monastyrnaya et al, 2016; Vigneri & Kolavalli, 2018), but this is no longer the case. Ghana's cocoa sector has been governed with a focus almost entirely on short-term production and sales (Fischer et al, 2020), and environmental objectives, the interests of cocoa farmers, and the long-term survival of the sector have not been adequately considered (Tropenbos International-Ghana, 2018). Cocoa farms are in decline across Ghana with yields around 300-400 kilograms (kg)/ha. This is about 56 percent lower than the average yields in Côte d'Ivoire (800 kg/ha)[3] and 79 percent lower than the average yields in Malaysia (1,700 kg/ha). The low yields in Ghana are due to a combination of age, poor maintenance, pests and disease, low soil fertility, poor shade, and inadequate inputs (Roth et al., 2017; Enriquez et al, 2020).

[2] Ghana Cocoa Board reports 1879 as the date it was introduced (Ghana Cocoa Board, 2018), whereas Kolavalli & Vigneri (2011) report it was introduced in 1888.

[3] The higher yields in Cote d'Ivoire may also decline in coming years, as some of the differences in yields between the neighboring countries can be explained by the more recent expansion of cocoa in Cote d'Ivoire, and soil exhaustion and diseases have not yet caught up to farmers there. See Roth et al, 2017 at 8.

Many cocoa farmers are highly dependent on cocoa as their primary source of income, and the combination of low cocoa prices and low yields have left many Ghanaian cocoa farmers[4] facing poverty, seasonal food security issues, trapped in debt cycles, and unable to earn a living income from cocoa (Bymolt et al, 2018; Fountain and Hütz-Adams, 2018; Roth et al, 2018; Jiekak & Freudenberger, 2019; Persha et al, 2020; VOICE Network 2020). Land degradation has also been linked to poverty in Ghana's cocoa farmers (Peprah, 2014).

Future climate impacts

Climate change is expected to exacerbate the plight of cocoa farmers further, with drought and rising temperatures negatively effecting cocoa suitability (Bunn et al, 2018 citing several other papers). A recent literature review of climate smart cocoa production (Enriquez et al, 2020) identified a handful of studies that estimated the impacts of climate change on cocoa production in West Africa. While cocoa is still expected to be viable in some areas, all studies identified future impacts of climate change on cocoa production. Bunn et al (2018) analyzed climate impacts on the suitability of cocoa in Ghana and Cote d'Ivoire using 19 different climate scenarios from the Representative Concentration Pathways 6.0 emissions trajectory.[5]

Table 1. Adaptation zones and impact on income (adapted from Bunn et al, 2018)

Adaptation zone	Impact on income, based on low, moderate, or high climate impact
Incremental adaptation	10%, 15% or 20% loss without adaptation
Systemic adaptation	30%, 40%, or 50% loss without adaptation
Transformation	60%, 80%, 100% loss without adaptation
Opportunity	10%, 15%, 20% gain with planned adaptation

They used this analysis to create a map of climate impacts and adaptation responses for cocoa using 19 bioclimatic variables used to model crop suitability (see Figure 1, next page). The impact map was arranged into four spatially explicit zones. Each zone had three possible levels of economic impact depending on either low, moderate, or high climate impacts (see Table 1, previous page).

The analysis by Bunn et al (2018) shows a stark future for Ghanaian cocoa farmers and the economy unless steps are taken. They projected more than half of current cocoa production (470,000 tons per

[4] It should be noted that Bymolt et al (2018) also compared cocoa farmer poverty to other rural households to examine if poverty was cocoa specific. They concluded that cocoa households face similar levels of poverty as other rural and smallholder households and that poverty levels were less severe than reported by other researchers.

[5] There are four main Representative Concentration Pathways (RCPs) of possible GHG emissions (RCP2.6, RCP4.5, RCP6.0 and RCP8.5). RCP2.6 assumes the steepest emission reductions, with radiative forcing from GHG emissions peaking mid-century to produce future temperature increases of 0.9 – 2.3°C by 2100. RCP6.0 assumes peaking after 2100 with future temperature increases of 2.0 – 3.7°C by 2100 and RCP8.5 assumes little effort to reduce emissions by 2100 which would result in 3.2 – 5.4°C of warming by 2100 (Australian Government n.d.; RCP Database, 2009). The Paris Agreement aims to keep temperature increases to "well below" 2°C with the goal of 1.5°C warming. Current Paris Agreement commitments are projected to result in 2.8 – 3.2°C warming, but these commitments are not being met (Geigas et al, 2019; Climate Action Tracker, 2019). Recent analysis finds current emissions are more consistent with RCP8.5 than other scenarios (Schwalm et al, 2020).

year) is in zones that will require systemic adaptation, with insignificant gains from climate change elsewhere unable to offset these losses. Without systematic adaptation, the estimated mean cost of climate change was $410 million per year by 2050 (equivalent to 1 percent of GDP at 2010 base year prices). They reported considerable uncertainty on this figure due to uncertain climate impacts but the 90 percent confidence interval for cost estimates shows an impact range of between $270 – $660 million per year by 2050 (0.7 - 1.6 percent of GDP). Cote d'Ivoire produces more cocoa and the cost of inaction was higher, with an estimated mean cost of $1.12 billion per year by 2050 (3.9 percent of GDP).

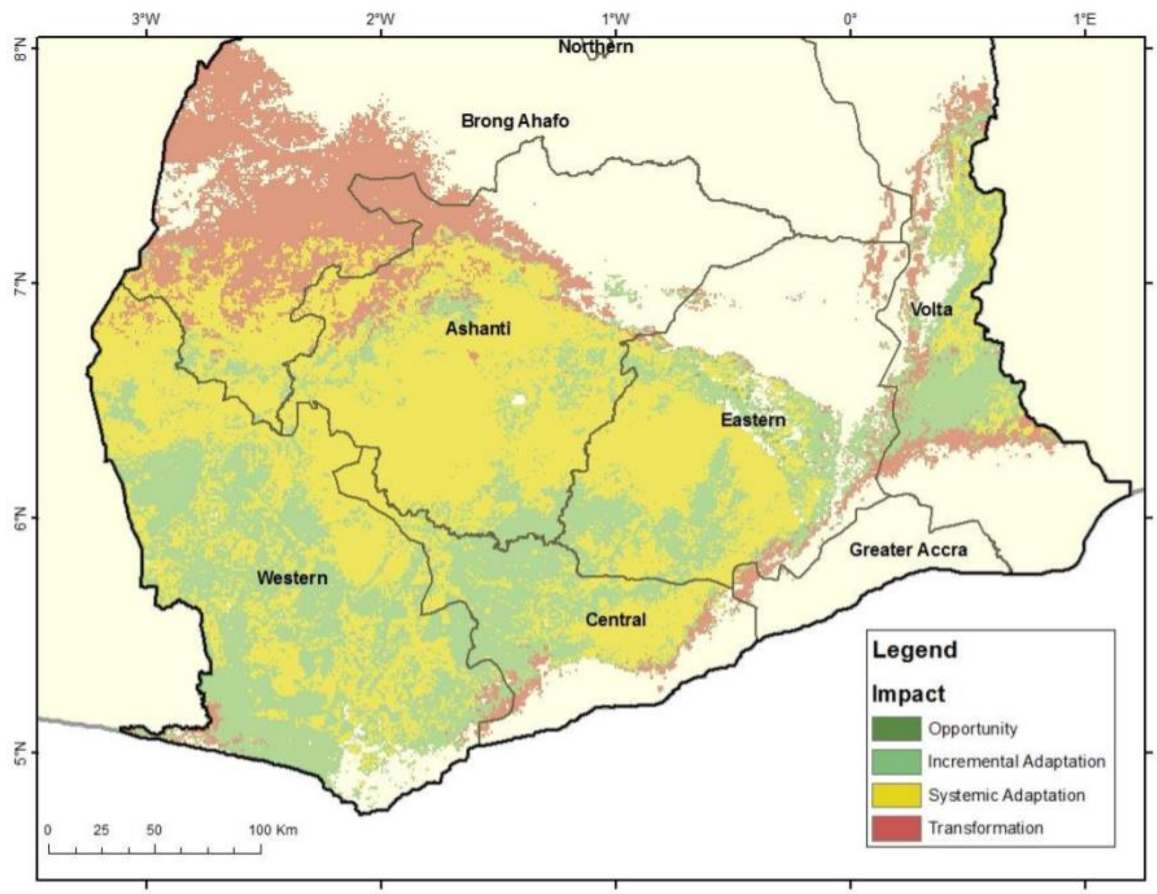

Figure 3. Zones of most likely climate impact on cocoa suitability by 2050 relative to 1950 - 2000 in Ghana. Only a small number of "opportunity" pixels were identified for Ghana. This zone was so infrequent that it is not visible on the map (Bunn et al, 2018 at 16)

3. Cocoa farm rehabilitation

3.1. FARM REHABILITATION TO ADDRESS CURRENT LOW YIELDS

Ghana's cocoa farms need help to address current yield and income challenges and adapt to future climate impacts. A range of techniques can increase productivity of old or diseased cocoa trees and farms and the scale of rehabilitation needs is significant (see Box 1). Cocobod and other guidance on good agricultural practices for cocoa (Asare, 2017; Ghana Cocoa Board, 2018) describe a range of rehabilitation activities as follows:

- *Under-planting:* Removing some cocoa trees in an existing farm and planting new cocoa trees.
- *Gradual replanting:* Removing all cocoa trees in a section or block of an existing farm and planting new cocoa trees in that section.
- *Rejuvenation / coppicing*: This involves cutting back old trees to stimulate regrowth and may be combined with grafting.
- *Complete replanting (re-establishment)*: Removing all cocoa trees and completely replanting the whole farm.

The choice of activity depends on the age of the cocoa trees and presence of diseases including cocoa swollen shoot virus disease (CSSVD), which can only be treated by removing and destroying infected trees and leaving the land fallow for at least 1 year before replanting.

Other authors that focus on the finance and economics of tree crops differentiate between "renovation" and "rehabilitation" activities to increase farm productivity. In this context "renovation" refers to practices that remove and replant cocoa trees and "rehabilitation" to practices that focus on management of existing trees such as pruning, coppicing, and grafting (e.g. Dalberg 2015; Kroeger et al, 2017). This distinction is not found in the agricultural practice manuals cited above but can be useful when estimating the costs of interventions and their pay-back period. Newly planted cocoa seedlings can take 3-5 years before they start producing pods, whereas grafting can produce faster results. This is discussed further in Section 4.1 below.

Box 1: Scale of rehabilitation needs

Cocoa yields on healthy farms tend to decline after 25 years. Some estimates find 23 percent (368,000 hectares) of Ghana's cocoa farms are over 30 years old and at least 17 percent (272,000 hectares) are affected by CSSVD (Kroeger et al, 2017). Separate estimates find 25-40, 35, or 40 percent of Ghana's cocoa farms (up to 700,000 ha) need to be replanted to address current productivity challenges from a combination of cocoa tree age and disease (Roth et al, 2017; Convergence, 2018; Ghana Cocoa Board, 2018).

To address future climate risks, over half of Ghana's cocoa is produced in areas that required systematic adaptation and one third requires minor adaptation (Bunn et al, 2018).

For simplicity, unless otherwise specified, this report uses rehabilitation broadly to refer to the range of agricultural practices listed above that can increase yields, noting ECOM's farm rehabilitation model is based on complete replanting.

3.2. HOW TO INCREASE COCOA FARM RESILIENCE

Many of the adaptation measures needed to safeguard future yields are "no regrets" good agricultural practices that will also help increase productivity under current climate conditions. These include better pest and disease control, use of drought tolerant cocoa varieties, soil management, and ensuring there is optional shade (Hutchins et al, 2015; Schroth et al, 2017; Bunn et al, 2018; Asare 2019; Maguire-Rajpaul et al, 2020).

Shifting to a cocoa agroforestry system also increases Ghana's resilience to a changing climate (Asare et al., 2019; Hirons et al., 2018a). Diversified shade cocoa farms and multi-strata agroforestry cocoa production systems that contain crops, native forest, and fruit trees are more sustainable and more valuable as they offer smallholders a range of agronomic, economic, cultural, and ecological benefits which extend well beyond the farm. When the full ecosystem services of agroforests are included, they are the most profitable form of cocoa farming and more profitable than oil palm or rice (Asare et al 2014), with more recent research finding cocoa farms yield can double when moving from zero to approximately 30 percent shade cover (Asare et al 2019). Recent analysis of optimal shade tree cover and species composition for each zone commissioned by PIER recommends optimal shade of between 30 – 50 percent depending on the zone (see Table 2)[6]. This corresponds to between 15 – 50 trees per hectare depending on the species, age and canopy area (Asare, 2019).

Table 2. Shade trees needs across cocoa adaptation zones in Ghana (Asare, 2019)

Zone	Percent shade cover needed	Number of shade trees per hectare
Cope	30 – 40%	15 – 25
Adjust	40 – 50%	20 – 45
Transform	50 – 70%	25 – 50

Irrigation is another possible adaptation measure (Hutchins et al, 2015; Asare 2019; Maguire-Rajpaul et al, 2020), but irrigation can be challenging for smallholder farmers due to a combination of economic, technical and social challenges which make it impractical in Ghana (Maguire-Rajpaul et al, 2020). In areas that will become unsuitable for cocoa, adaptation should focus on diversification away from cocoa to other crops (Schroth et al, 2017; Bunn et al, 2018).

[6] Note, Asare, 2019 described three adaptation zones based on work by Brunn et al, 2016, and referenced Brunn et al, 2018. The adaptation zones used by Asare, 2019 and Brunn, et al 2016 are similar to the zones in Brunn et al, 2018, but Asare, 2019 describes them more simply as "cope and opportunity, adjust, and transform" rather than "incremental adaptation, systemic adaptation, and transform".

4. Barriers to rehabilitation

Large scale efforts are needed to increase and maintain Ghana's cocoa yields (see Box 1), but several barriers make large scale rehabilitation challenging (see Table 3).

Table 3. Barriers to rehabilitation of cocoa and other tree crops

Source	Barriers to rehabilitation	Scope
Dalberg, 2015	• Cost effective availability of core components including planting materials, training, inputs, and finance. • Ensuring rehabilitation and renovation is attractive and feasible for smallholder farmers. This includes the scale of upfront investment. • Aggregation of smallholder farmers to make services cost effective. • Ensuring renovation and rehabilitation finance is attractive and feasible for investors. • Side selling, i.e. farmers selling crops on the side that are meant to be used to repay investments. • Successful adoption and implementation of renovation and rehabilitation practices.	Tree crop (coffee, cocoa, palm oil and tea) renovation and rehabilitation globally.
Kroeger et al, 2017	• Lack of technical expertise. • Insufficient planting materials and inputs. • Limited access to finance.	Cocoa renovation and rehabilitation in Ghana and Cote d'Ivoire.
ECOM and USAID: Roth et al, 2017; TGCC, 2017a; Roth et al, 2018	• Access to finance, labor, planting materials and inputs. • Lack of expertise on farm rehabilitation techniques. • Overcoming farmer income gaps during rehabilitation. • Tenure (land and tree).	Cocoa rehabilitation via cutting and replanting farms in Ghana.
Convergence, 2018	• Scale of upfront investment. • Income gap as cocoa farm matures. • Limited access to seeds, inputs, and input finance. • Limited access to Cocobod's rehabilitation programs. • Market distortions and lack of incentives to produce high quality cocoa. • Challenges mobilizing international private investment into value-chain specific solutions.	Cocoa rehabilitation, renovation, and climate smart production in Ghana.

The barriers identified in Table 3 are discussed further in three broad categories most relevant to Ghana: i) financial, ii) technical and social, and iii) tenurial barriers.

4.1. FINANCIAL BARRIERS

Given the financial implications of different rehabilitation practices and how this is discussed in the literature, the discussion of financial barriers splits rehabilitation practices into "renovation" to describe cutting and replanting and "rehabilitation" to describe other activities to boost tree productivity (see Section 3.1 above for more details). Together they are abbreviated as "R&R".

There is no standardized approach to estimating the costs and returns of different R&R techniques (Kroeger et al, 2017), but the cost of meeting global demand for cocoa R&R has been estimated to be $52.7 billion over 25 years (Dalberg, 2015). In general, farm renovation has a higher upfront investment cost that renovation, and a renovated farm can take longer to produce cocoa pods than one that has been rehabilitated. This gap between R&R investment and income from cocoa can have a significant impact on financing. Dalberg (2015) describes a period of negative cash flow between investment outlay and income generation from tree crops as a "valley of death" for smallholders and investors, with a shorter and shallower valley for rehabilitation compared to renovation. However, rehabilitation efforts are not suited to some farms – such as those infected by CSSVD – and Dalberg (2015) notes the long-term return for renovation is generally higher than rehabilitation.

Financial barriers can be broken down further into:

- Cost of initial R&R activities. This includes labor, planting material and inputs.
- Cost of ongoing cocoa farm maintenance as cocoa matures. This includes additional inputs, weeding and pest control.
- Lost income between R&R activity and cocoa yielding pods.

There is no clear path for smallholder farmers to address all these financial barriers themselves. Smallholder farmers in Ghana have some access to credit including loans and input finance, but farmers are generally averse to taking on debt (Bymolt et al, 2018; Persha et al, 2020). Loans are also typically small and short term with high interest rates and therefore not suitable for R&R (Kroeger et al, 2017). This is supported by a survey of 714 cocoa households across 12 villages in Wassa Amenfi West that reported approximately 45 percent of households took a loan over the prior year, with an average loan amount of approximately $560. Loans from banks were most common, followed by cocoa companies and then family or friends. Most did not require collateral and approximately 17 percent where not repaid on time. The most common use of the loan was to purchase agricultural inputs followed by meeting basic household needs such as food, transport, clothing, and school fees (Persha et al, 2020). Other research across Ghana by Bymolt et al reported similar findings, though average loan size was $290 (range of $100 - $400) with chocolate companies the most common provider of credit followed by family and then banks, and 10 percent of borrowers not repaying loans on time (Bymolt et al, 2018). This type of existing finance could in theory be accessed to cover some of the R&R costs, but given limited literature estimates of R&R costs range between $333 to $5,000 per hectare per year for several years (Kroeger et al, 2017), and most cocoa farmers in Ghana have on average 2.8 hectares, existing smallholder finance solutions are not adequate.

Cash crops have been identified as a possible source of replacement income, but periods of negative cash flow are still reported for R&R (Dalberg, 2015; Kroeger et al, 2017; Convergence, 2018). Staggered or rotating R&R across a farm can also help lessen the financial impact but does not eliminate a period of negative cash flow (Dalberg, 2015; Roy & Macek, 2018).

4.2. TECHNICAL AND SOCIAL BARRIERS

Technical and social barriers include access to planting materials, labor, inputs and rehabilitation techniques along with perceptions of cocoa's future.

Planting materials

Cocobod controls most cocoa seedling production and distribution in Ghana. Cocobod set a goal of providing 60 million free cocoa seedlings to farmers but has struggled to meet existing demand. Even if Cocobod were able to successfully produce 60 million seedlings per year, it would take 16 years to produce enough seedlings to meet its rehabilitation targets. Cocobod seedlings also have high mortality rate, which creates further challenges to rehabilitation (Kroeger et al, 2017). For example, ECOM's earlier rehabilitation pilot that was part of TGCC reported a 20 percent seedling survival rate for Cocobod's free seedlings after 6 months compared to a 70 percent survival rate for seedlings purchased from a commercial supplier. ECOM needed to replant dead seedlings which increased rehabilitation costs but replanting large numbers of dead cocoa seedlings may not be as easy for a smallholder farmer.

Other planting materials such as plantain suckers and shade trees can usually be sourced locally in small quantities, but it can be hard to determine plantain varieties and shade tree seedling quality.

Labor

Clearing an old or diseased cocoa farm is labor intensive. All the existing cocoa trees need to be cut and then removed from the farm. Finding sufficient labor to complete this can be challenging irrespective of the cocoa farmer's age or household size.[7]

Inputs

Farmers face many challenges regarding agricultural inputs that carry over as additional barriers to rehabilitation (Monastyrnaya et al, 2016; Kroeger et al, 2017; Bymolt et al, 2018; Maguire-Rajpaul et al, 2020):

---

[7] The age of cocoa farmers has been reported as a barrier to rehabilitation (TGCC, 2017b), and several papers have cited an increasing age of cocoa farmers as a threat to cocoa farming more broadly (Bymolt et al, 2018, citing other studies). However, while Bymolt et al (2018) found the mean age of cocoa households to be on average 5.5 years older than non-cocoa households (50.69 vs. 45.04), they did not find evidence that the mean age was increasing and hypothesized younger farmers were still engaging in cocoa farming. Persha et al (2020), on the other hand found the mean age of household head in their study to be 45.56 – only slightly higher than the mean age of non-cocoa farmers in Bymolt et al (2018). TGCC's research in communities surveyed by Persha et al (2020) also reports challenges engaging youth in cocoa given the heavy labor requirements and other employment opportunities in cities (Roth et al, 2018) with anecdotal evidence of older and sometimes widowed farmer's not being able to rehabilitate their farms themselves with most family members migrating to towns and cities in search of other work (personal communications of the author with cocoa farmers in Wassa Amenfi West).

- Cocobod is meant to provide free advice from extension agents, free fungicide and pesticide spraying and free fertilizer. However, it does not meet demand or distribute services effectively or evenly across cocoa growing regions.
- Most farmers do not test the soil conditions of their farms to know what types of inputs are needed for optimal cocoa growth. Cocobod also promotes a single cocoa fertilizer that does not take account of specific farm characteristics.
- High quality inputs are not always available and counterfeit or sub-standard inputs are common.
- Farmers are not always trained in correct application of inputs, particularly for rehabilitation (see below).

Rehabilitation techniques

Farmers lack training in good rehabilitation techniques. This includes correct spacing between cocoa trees, correct selection and spacing of shade trees, and farm management. For example:

- Traditional rehabilitation practices can involve overcrowded planting of cocoa seedlings that are not arranged in rows. This can make pruning and management harder as farms mature.
- Old cut trees need to be removed from a farm to prevent termites from infecting a farm which can kill cocoa and shade tree seedlings.
- Incorrect use of glyphosate for weed management around cocoa seedlings can damage cocoa yields several years later when the cocoa tree matures and starts to produce pods (Konlan et al, 2019).
- Farm soils may need amendments when a farm is rehabilitated. This requires equipment to test the soil and determine amendment needs, and then sourcing the inputs.
- Farms infected with CSSVD need to wait at least 12 months before cocoa is replanted to prevent reinfection.
- If grafting is used, farmers need to be trained in grafting techniques and have access to grafting stock.

Perceptions of cocoa's future

Cocoa is not a lucrative business for most smallholder farmers. As noted in Section 2.2 many cocoa farmers in Ghana live in poverty and do not earn a living wage. Cocoa farmer poverty has been identified as a threat to future supply as it acts as a disincentive for farmers to reinvest in their farms and discourages younger generations from cocoa farming. (Bymolt et al, 2018, Kroeger et al, 2017; Roth et al, 2017). For cocoa rehabilitation to be attractive it needs to boost and diversify farmers' income and show a more positive future for farmers.

4.3. TENURIAL BARRIERS

Land tenure

Cocoa farming is dominated by smallholder farmers who work their farms under one or more customary tenure arrangements (see Annex 1) that are often not documented (Peprah, 2015; Asamoah & Owusu-

Ansah, 2017; Roth et al., 2017; Fischer et al, 2020). While land tenure insecurity in general has been identified as a barrier to adopting adaptation strategies (Antwi-Agyei et al, 2015; Maguire-Rajpaul et al, 2020) connections between tenure and land management practices are multi-faceted. Cocoa farmers perceive many forms of customary land tenure as secure, and many non-tenure factors such as access to credit, inputs, technical advice, and markets also impact land management decisions (Jiekak and Freudenberger, 2019; Asaaga et al, 2020; Fisher et al, 2020; Persha et al, 2020). Certain types of customary tenure have, however, been clearly identified as a barrier to cocoa farm rehabilitation (Roth, 2017; TGCC, 2017b; Roth, 2018).

Box 2: Tenurial barriers to rehabilitation in Wassa Amenfi West

A USAID funded survey in Wassa Amenfi West in Ghana's cocoa belt reported 32% of all households did not have the right to cut and replant cocoa trees, and 14% of households reported a risk of losing their farm if they attempted to cut and replant their cocoa farm. When specific types of tenure are analyzed, 38% of farms were acquired through *abunu* and 4% as *abusa*, and 53% of *abunu* farmers and 90% of *abusa* farmers said they did not have the right to cut and replant their cocoa farm (Persha et al, 2020).

Abunu is one form of customary tenure arrangement whereby a stranger or migrant or (in rare occasions) an indigene acquires land for farming. An *abunu* farmer's land rights continue in perpetuity if the land is maintained as a cocoa farm. However, the farmer often requires the consent of the landowner to cut and replant a cocoa farm, though this is not universally required across Ghana (Fisher et al, 2020). The requirement to obtain a landlord's consent to cut and replant cocoa farms can become a barrier to rehabilitation, particularly where there is increased land pressure and landlords can use consent as an opportunity to evict, restrict, or extract additional payments from *abunu* farmers (Roth et al, 2017; Roth et al, 2018; Jiekak and Freudenberger, 2019). The prevalence of *abunu* will vary from region to region, and one survey across seven cocoa regions estimated 22.7 percent of cocoa farms were managed as *abunu* (Asamoah & Owusu-Ansah, 2017). Another survey of Wassa Amenfi West found a higher local prevalence of *abunu*, along with customary restrictions on cutting and replanting cocoa for *abunu* and *abusa*[8] (Box 2).

Tree tenure

The government of Ghana claims state ownership of all "naturally occurring" trees, including on land privately held under customary title. As noted above, shade trees are an important adaptation strategy that need to be part of farm rehabilitation efforts, but the current tree tenure laws disincentivize planting more shade trees (Fischer et al, 2020; Maguire-Rajpaul et al, 2020).

Fischer et al (2020) provides a detailed review of tree tenure in Ghana and the need for reform. They report that state ownership of naturally occurring trees is widely considered a strong disincentive for landowners and smallholders to plant and nurture trees on their cocoa farms - regardless of land tenure. In part this is because the benefits of harvesting naturally occurring trees are shared between loggers,

[8] *Abusa* is a type of customary caretaker or sharecropping arrangement that does not amount to a tenurial claim to the land. See Annex 1 for more details on customary tenure.

traditional authorities, and the government, while landowners are excluded. Numerous government policy documents over the last decade have advocated for vesting title to naturally occurring trees with communities and farmers that cultivate and tend these trees.

However, years, even decades, of tweaking and modifying the legal and policy frameworks to address illegal logging and destruction of forest resources on cocoa farms have been ineffective due to divergent and competing interests and unequal power relations between the state and smallholder cocoa producers. This applies to current reform that proposes establishing a tree registry to allow farmers claim rights by registering trees on their land. Forest resources in Ghana represent an important source of revenue for the government, so reforms that limit or remove the state's control over the resource base have met strong resistance by the Forestry Commission and customary powerholders, including the stool and chiefs. As a result, the focus of policy reform has been on enforcing and adjusting an inherently unenforceable and unfair legislative framework rather than tackling the core policy issues (Fischer et al, 2020).

5. Farm rehabilitation models

5.1. CURRENT MODELS OF FARM REHABILITATION

Cocoa farmers would traditionally clear new forest to establish new farms as existing farms aged, or gradually cut and replace cocoa trees over time. Gradual replanting does not work for farms affected by CSSVD, and the overall progress of farm rehabilitation has been too slow to date. This is evidenced by the current scale of rehabilitation needs (see Box 1).

Dalberg (2015) identifies three general models to deliver renovation and rehabilitation for four tree crops (cocoa, coffee, tea, palm oil): i) co-operative R&R service delivery; ii) commercial R&R service delivery; and iii) integrated direct-to-farmer models. Models of cocoa R&R in Ghana and West Africa are not well documented, but governments, cocoa companies, and civil society have used different approaches to try and scale up efforts to rehabilitate old and diseased farms.

Cocobod's model

Cocobod has had several programs to clear and replant diseased or overaged farms. In the 1990's Cocobod financed a large-scale CSSVD control program via a loan from the African Development Bank. The program aimed to clear 17,900 hectares of diseased farms and replant 17,300 (African Development Bank, 1999). Under the program Cocobod compensated farmers for an estimate of four years of production loss as their farms were being rehabilitated (Table 2). African Development Bank reports on the project's impact are inconsistent. The project completion report found Cocobod had cleared 16,537 hectares and replanted 3,810 hectares by 1997 (African Development Bank, 1999) while a later project performance evaluation found a total of 13,050 hectares were cleared and 6,258 hectares were replanted (African Development Bank, 2002).

In 2019 Cocobod secured a syndicated $600 million, seven-year loan from the African Development Bank and others to boost cocoa production (African Development Bank, 2019a; African Development Bank 2019b). The loan includes a farm rehabilitation component that aims to rehabilitate almost 160,000 hectares of diseased and overage farms over 5 years (Cocoa Post, 2020a). It will follow a similar compensation model to the earlier program, but this time will pay both farmers and landlords (see Table 4). Assuming 50 percent of farms require compensation payments to both farmer and landlord, the total compensation payment budget for the current program is approximately USD $42 million, with a substantially larger budget needed to pay for the rehabilitation.

Table 4. Historic and current Cocobod farm clearing and rehabilitation incentive payments

Time period[9]	Incentive payment per hectare (Ghana Cedi)[9]	FX rate (date)[10]	Incentive payment per hectare (USD)[11]
1991 – 1994	120,000 to farmers	745 (Dec 31, 1993)	$161.07
1994/1995	336,000 to farmers	1,028 (Dec 31, 1994)	$326.85
1995/1996	403,000 to farmers	1,395 (Dec 31, 1995)	$288.89
1996/1997	576,000 to farmers	1,710 (Dec 31, 1996)	$336.84
2020	1,000 each to farmers and landowners	5.72 (June 30, 2020)	$174.83 (each)

Cocoa companies and civil society models

Cocoa companies and civil society have also worked with farmers to support farm rehabilitation in Ghana. These efforts are not well documented or studied. Anecdotal evidence from people involved in these programs indicates extension services offered by cocoa trading companies that educated local farmers using a “model farm” approach have had mixed results. This is because farmers were not able to implement the model farm best practices due to underlying barriers.

Some civil society rehabilitation efforts have used a combination of donor and farmer finance (50:50 split) to rehabilitate cocoa farms (TGCC, 2017b) and there are also indications of some loan-based rehabilitation pilots to understand the financial return from rehabilitation in Cote d’Ivoire and Ghana (Buckles & Roy, 2013; Convergence, 2018; Roy and Macek, 2018).

Cocoa trading companies are testing different agronomic approaches to rehabilitation in Ghana and West Africa, with some such as Mars and Barry Callebaut testing grafting (IDH n.d.; Barry Callebaut, 2012) while others such as ECOM’s discussed in this paper focus on cutting and replanting.

[9] Historic rates from 1991 – 1997 are reported in African Development Bank, 1999; 2020 rates reported in GhanaWeb, 2020 and Cocoa Post 2020b.
[10] FX rate reported by US Department of the Treasury Financial Management Service, *Treasury Reporting Rates of Exchange* for 1993, 1994, 1995, 1996 and 2020. Note in 2007 Ghana re-denominated the Cedi with an exchange rate of 10,000 old Cedi for 1 new Cedi.
[11] Note the historic payments are not inflation adjusted.

5.2. ECOM'S SERVICE DELIVERY MODEL FOR RESILIENT FARM REHABILITATION

In 2016, ECOM started to collaborate with USAID on a commercially viable service delivery model to rehabilitate old cocoa farms through complete replanting (O'Sullivan et al, 2018; Roth et al, 2018). The new model attempts to repay the cost of rehabilitation within the first three – four years using cash crops. The focus on cash crops also overcomes the short-term loss of cocoa income when old trees are cut, and before the replanted cocoa trees mature. This also helps diversify farmer income, which has been advocated to reduce poverty and increase resilience if viable alternatives that can compete with cocoa are identified (Monastyrnaya et al, 2016; Bymolt et al, 2018).

ECOM's service delivery model works as follows:

ECOM advertises the service and selects eligible farmers based on pre-set criteria (see box 3). Three acres of old cocoa trees are cleared. Existing shade trees are retained where possible, but some may need to be cleared if not suitable for the farm. Two of the three acres are replanted with cocoa, new shade trees as needed, plantain, and other cash crops, and the third acre is planted with cash crops only. The 2:1 ratio is important because the cost of cocoa farm rehabilitation on the extra plot is delayed at the same time income from this plot is boosted by focusing on cash crops. This shift in cost and income on the extra plot helps make the rehabilitation model financially viable.

The farms that are initially rehabilitated for cocoa may need to delay replanting cocoa for at least 1 year to ensure no CSSVD is present in the soil and adequate shade has been established. During this period cash crops and shade trees can be planted. Depending on the crop, cash crops can be intercropped with cocoa for up to three years, after which point there is typically too much shade in a farm for food crops. Cash crops can be maintained on the extra plot indefinitely, or this extra plot can be converted to cocoa once the rehabilitated cocoa farm starts producing cocoa pods (see Figure 2, next page).

Box 3: ECOM farm selection criteria

1. Farmers should have gone through at least one year of ECOM training
2. Site slope should not be above three percent
3. Farmers should be prepared to cut cocoa for complete rehabilitation
4. Farmers should have the capacity to repay the investment and be willing to pay it off with proceeds from the farm
5. The site cannot be swampy or water-logged
6. Farmers with multiple farms shall be considered as an added advantage
7. Farms should be over 25 years old with a focus on highly unproductive farms (i.e., farms producing below 200 kg/ha)
8. The plot/site should not be in the middle of a forest and should be at least 30m away from any natural reserves
9. The farmer has the right to cut and replant the cocoa farm

Source: O'Sullivan et al, 2019

ECOM carries out the cocoa rehabilitation and manages all farm activities and crop sales over four years. This includes investing in farm activities throughout the year (planting, transportation, labor, inputs, supporting logistics) using its own staff or hired labor, though the farmer may also be hired to save costs. The farmer works alongside ECOM staff and gains hands-on experience on farm rehabilitation techniques and farm management.

Initial pilots in 2017/2018 focused on maize and plantain as the primary cash crops. These two crops were recommended by local agronomist experts and many farmers were already familiar with them, especially plantain which is traditionally used as temporary shade for cocoa seedlings when a farm is established. The first year did not produce viable results – costs were higher than expected due to high seedling mortality amongst other factors, and income from cash crops was lower than projected.

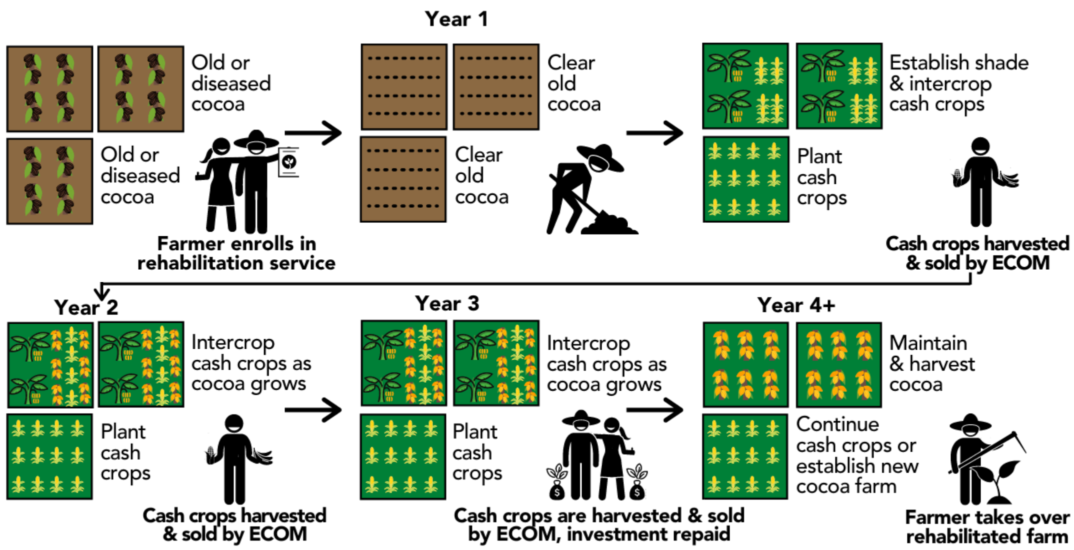

Figure 4. Diagram of farm rehabilitation model showing 2:1 ratio and plot progression.

In 2018 ECOM and PIER started to collaborate to refine the service delivery model. This involved market research on a series of cash crops for domestic and international markets, further refinements to the financial model to include multiple cash crops and scenarios, and additional research on shade tree species and density (Asare, 2019) for each adaptation zone developed by Bunn et al, 2018. ECOM and USAID also continued collaboration on the farm rehabilitation service under ILRG. This included using new technology to rapidly test soil conditions and amendment needs and testing new techniques in cocoa nurseries to address cocoa seedling mortality observed in earlier trials.

Importance of crop diversity

Climate change has already affected food security due to warming, changing precipitation patterns, and greater frequency of some extreme events, and the tropics and subtropics are projected to be most vulnerable to crop yield decline due to climate change (IPCC, 2019). A diverse selection of cash crops is therefore important to mitigate against seasonal weather fluctuations and pests that are expected to worsen with climate change. It also helps mitigate risks in fluctuating market prices of individual crops. Crop diversity helps farmers and ECOM, both of whom rely on proceeds from the sale of cash crops to repay the farm rehabilitation investment.

There is, however, increased complexity and costs associated with diversification. Multiple types of seeds or stock need to be procured, germinated, and planted at the correct time. Some crops can be sold in local markets, but local markets may become flooded. Several crops are best monetized via sales at pre-arranged prices in markets in Accra or internationally, but each value chain takes time and effort to establish, and vendors may change over time.

To help identify the optimum combination of cash crops the updated service delivery financial model included options to combine multiple crops on different farm plot arrangements. This allowed ECOM to analyze the most financially viable cash crop portfolio for each farm and discuss crop selection with farmers.

Importance of shade tree diversity

Shade trees can further diversify cocoa farmers short- and long-term income. Intercropping fruit trees can generate additional income alongside cocoa, and high value timber species can serve as a retirement account for cocoa farmers. Certain species of trees can also help fix nitrogen in soils, a further benefit for cocoa and other trees. As shade trees are expected to remain on a farm for decades, species selection needs to consider future climate change impacts along with current weather patterns. There are different views as to the ideal composition of a mosaic cocoa agroforestry production system in Ghana, including the number and species of trees that should be grown on the cocoa farm (Ruf, 2011; Asare, 2013; Asare et al., 2019). The shade tree and food crop recommendations that take into account the cocoa adaptation zones produced in Asare 2019 is included in Annex 2, but the income from these are not included in the financial model.

5.3. 2019 – 2020 FIELD TESTS AND DATA COLLECTION

In 2019 ECOM enrolled 29 cocoa farmers with 87 acres (35.2 ha) in its farm rehabilitation services. All 87 acres were cleared in 2019 and planted with plantain suckers. These take more than 14 months to produce plantains but need to be planted first to establish shade before the cocoa seedlings can be planted.

To collect data and experience with diverse food crops and inform the service delivery model ECOM planted a diverse range of cash crops. In 2019 a combination of chili pepper, garden eggs, okra and turmeric were planted on the extra plots to help generate data for the financial model. The soil of each farm was also tested in three separate locations using new soil scanning technology. The scanners rapidly identify deficiencies in soil pH, organic carbon content, nitrogen, phosphorus, potassium, and cation exchange capacity.

Crop	Acres planted	Yield (percent of forecast)
Chili pepper	1.3	10%
Garden eggs	0.5	26%
Okra	1.3	29%
Turmeric	1.8	66%

Table 5. Cash crop field trial results

The 2019 – 2020 yields of all crops were lower than initially forecasted, and actual yields varied between 10 and 66 percent of the initial projections based on data from the Ministry of Food and Agriculture (MOFA) (see Table 5). The low yields were due to a combination of factors:

- Soil analyses showed that 82 percent of the farms were low in cation exchange capacity, a soil characteristic that determines the ability of the soil to absorb water and key nutrients that affected yields across all crops. Because the soil analysis occurred after cash crop trials had started, amendments could not be carried out until after the trial crops were harvested.

- Some farmers harvested the crops for their own consumption or side sales, which decreased the amounts ECOM could harvest and sell. This was an issue across all crops except for turmeric, which is not consumed locally and does not have a local market.
- Only 68 percent of the chili peppers germinated, and when combined with the factors above chili had the lowest yields.
- The maize crops were infested by fall armyworm, and only 40 percent of the farms could be salvaged.

To correct the soil deficiencies ECOM applied compost and agricultural lime to the farms. This should improve yields for grains, beans, and vegetables in subsequent seasons, but also increases the cost of the farm rehabilitation model by at least 2.9 percent.

To further inform the model PIER collected local and regional market price data on a selection of crops. ECOM also worked to identify and establish value chains to allow bulk sales of cash crops in Accra and international markets to avoid any risk of their sales effecting local market prices. The model also uses 2019 – 2020 farm gate cocoa price of 515 Cedi per cocoa bag, which is less than the recently announced 625 Cedi per bag for the 2020 – 2021 season (Dentoh, 2020).

In the 2020 – 2021 growing season ECOM is piloting additional cash crop combinations and will plant 16 acres with cabbage, chili, turmeric, and watermelon. These crops are planted on farms after the soil has been amended, and the results will help create additional scenarios and further refine the model.

6. Model results and analysis

The 2019 – 2020 field trial results were used to refine the service delivery model's cost, yield, and income estimates. This included making reductions to yield estimates compared to earlier versions of the model. Some yield estimates are forecasted to be above the trials yields to account for the improvements from soil amendments and better agricultural practices such as improved chili pepper germination. Cost and income estimates were also updated.

6.1. SERVICE DELIVERY MODEL RESULTS

The field results were used to generate three farm rehabilitation service delivery model scenarios to test the return from different combinations of cash crops on the 1/3 extra plot set aside for cash crops (see Table 6). The model also contained two options for what the farmer does with the 1/3 of the farm area used for cash crops in years 1 to 4: either i) keep it for annual cash crops, or ii) convert it into cocoa. In all scenarios the model assumed the same combination of maize, plantain, and cowpeas are intercropped on the 2/3 of the farm being

	Scenario 1	Scenario 2	Scenario 3
Crop	Chili pepper	Maize	Turmeric
	Cabbage	Garden egg	
		Okra	

Table 6. Cash crops across three scenarios

rehabilitated for cocoa. Reduced volumes of cowpea are maintained permanently after the other cash crops are phased out to help maintain nitrogen in the soil. The feasibility of this is based on recent unpublished research by the Cocoa Research Institute of Ghana and is still to be tested by ECOM.

Annual revenue, cost, and cash flow for full rehabilitation are shown in Figures 3 – 5. If annual costs exceed annual income, the results show as a negative cash flow to the farmer for that year and it assumes the farmer covers this cost from other sources. In all scenarios ECOM's investment cost for the rehabilitation is paid back over the first four years. The total per hectare rehabilitation investment over the first 4 years for each scenario is GH¢ 116,836 (Scenario 1), 120,870 (Scenario 2) and 135,749 (Scenario 3).

The model projects the net cash flow to the farmer for both rehabilitation options and all three scenarios for 25 years. This is compared to a baseline cash flow for cocoa farmers in Asankrangwa collected by Persha et al 2020 (Figure 6).

The current version of the model does not include possible income from carbon sequestration, intercropping fruit trees, or the long term income from high value timber species that may be planted as shade trees. Including these should have a positive effect on longer-term value to farmers.

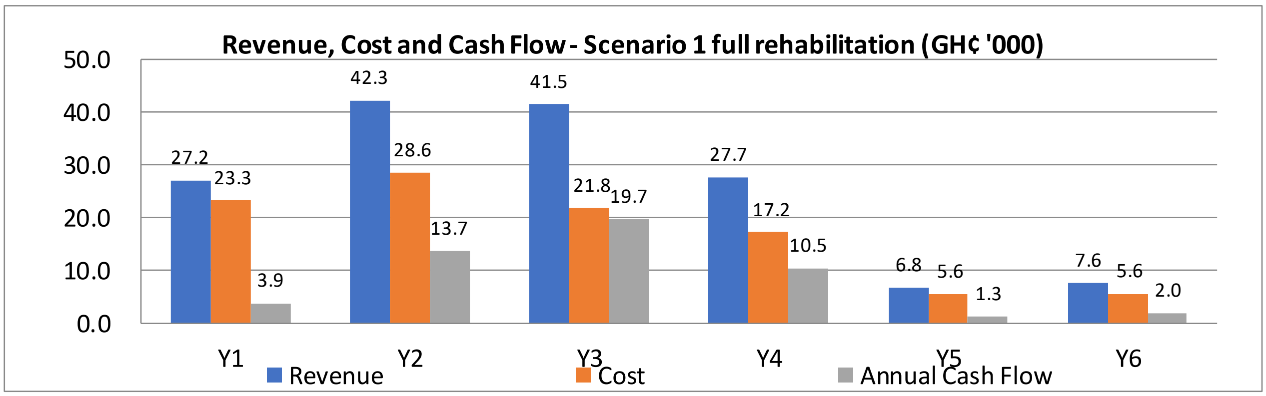

Figure 6. Revenue, Cost and Cash Flow - Scenario 1 full rehabilitation (GH¢ '000)

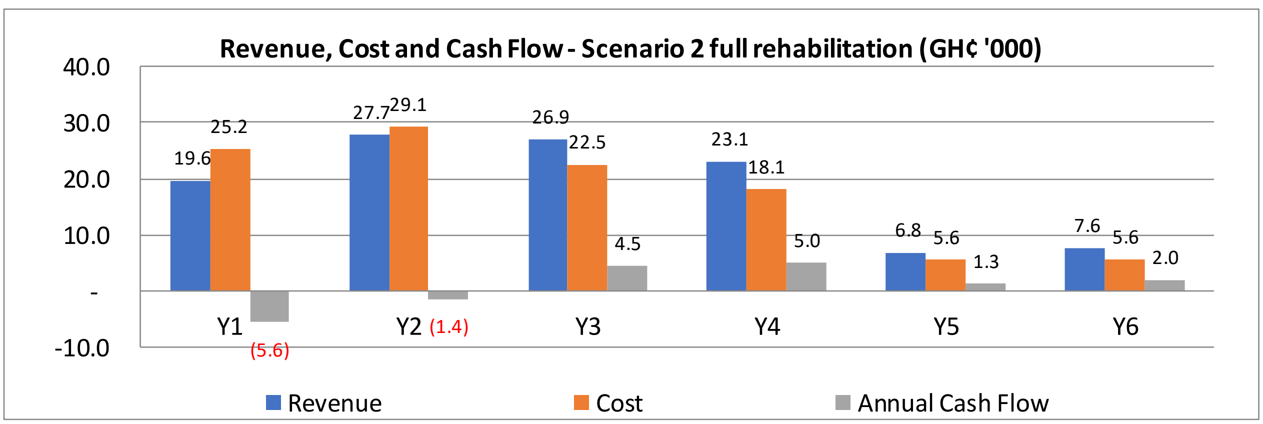

Figure 5. Revenue, Cost and Cash Flow - Scenario 2 full rehabilitation (GH¢ '000)

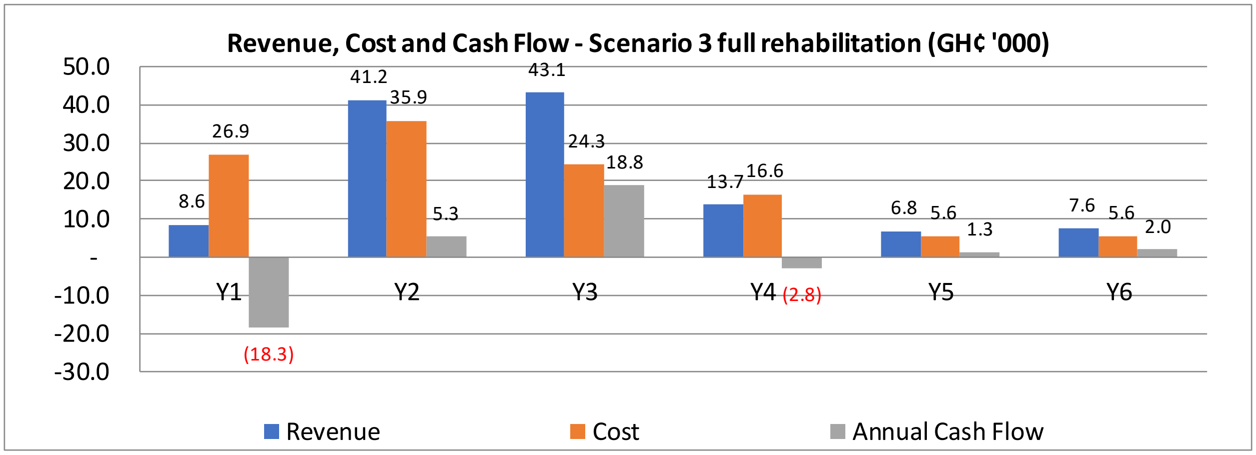

Figure 8. Revenue, Cost and Cash Flow - Scenario 3 full rehabilitation (GH¢ '000)

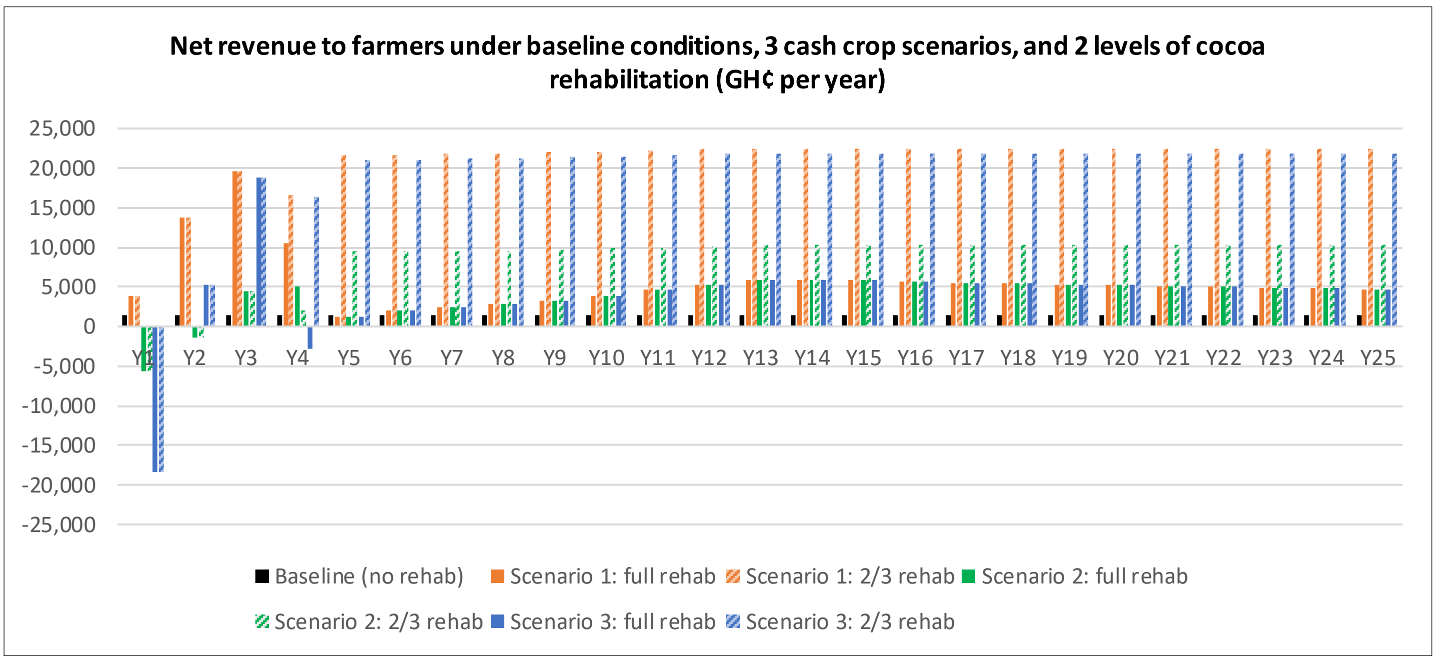

Figure 7. Net Revenue to Farmers Under all Scenarios (GH¢)

6.2. INTERPETATION OF RESULTS

The model shows significant long-term improvement in farmer income in all scenarios. Given the model targets rehabilitation of old or diseased cocoa farms with low yields, an increase in income is to be expected. This can be seen in net present value of all six scenarios, which shows greater long-term value (Table 7, next page).

Table 7. Net Present Value for all Scenarios (GH¢)

Discount rate: 28 percent	**Net present value (GH¢)**			
	2/3 rehabilitated to cocoa; 1/3 retained as cash crop		Full rehabilitation to 100% cocoa over time	
	4 year	25 year	4 year	25 year
Scenario 1 (chili pepper, cabbage)	27,005	56,051	24,717	28,609
Scenario 2 (maize, garden eggs, okra)	-2,363	10,411	-1,263	2,629
Scenario 3 (turmeric)	3,993	32,223	-3,155	737

All scenarios showed a greater net present value over a longer time frame than the 4-year investment recovery window of ECOM's service delivery model. This shows the clear long-term benefit to rehabilitating old farms. For the service delivery model to work ECOM needs an appropriate risk-adjusted return over the first 4 years.

The lower returns in the first year across scenarios is due to the higher costs in year 1 associated with clearing and establishing the farm. The significantly negative revenue from turmeric in year 1 is because turmeric is an annual crop, and the first harvest only occurs in year 2. The other cash crops generate income in year 1. The lack of income as farmers transition from turmeric to cocoa on the extra plot in year 4 and 5 also affects the four- and 25-year net present value of turmeric as a cash crop in the full rehabilitation scenario. Mixing some chili peppers into Scenario 3 may help improve the returns of this scenario.

The combination of chili peppers and cabbage showed better returns than the other options. Field trials are planned for cabbage in 2020 - 2021, but the chili peppers appear more profitable than cabbages and may be a better model than the combined crop under current assumptions. Turmeric is the next most profitable crop after peppers and once established is very closely competitive with chili peppers and cabbage but has other advantages over these crops (see Section 6.3).

Yield and price assumptions affect the returns for each scenario. For example, Scenario 1 assumed chili yields were 50 percent of maximum and Scenario 3 assumed turmeric yields were 42 percent of maximum. If chili yields are reduced to 35 percent of maximum yields and turmeric is increased to 60 percent then the profitability of these scenarios' reverses, with Scenario 3 the most profitable generating over 30,000 GH¢ per year from year five if the extra plot is maintained for turmeric.

All the scenarios that involve rehabilitating the remaining 1/3 of the farm from cash crops to cocoa show a substantial dip in farmer income. This is due to a combination of factors:

- There is an initial loss of income from cash crops for a couple of years when then extra plot is converted to cocoa. This is because there is a period when it too shaded for cash crops and the cocoa on these plots is not yet at its peak (years 5 and 6 in Figures 3, 4 and 5).

- There is a longer-term income loss as cash crops are more profitable per acre than cocoa across all scenarios. Converting the cash crop portion of the farm to cocoa therefore reduces overall profitability of the farm and net present value of rehabilitation (Table 7).

National implications

The cost of fully rehabilitating a cocoa farm ranges from between $13,000 and $15,000 per hectare over four years depending on the cash crop. This is comparable to estimates reported by Kroger et al (2017) of between $333 to $5,000 per hectare per year for R&R (i.e. including cheaper options that do not involve clearing and replanting). ECOM's estimated per hectare rehabilitation costs can be applied to the 368,000 – 700,000 hectares of cocoa farm that are estimated to need to be rehabilitated (see Box 1 in Section 3.1). The average cost is estimated to be approximately $1.4 billion per 100,000 hectares over four years, with a total cost estimates of between $4.8 billion and $5.5 billion to completely replant 368,000 hectares, and between $9.2 and $10.4 billion to replant 700,000 hectares depending on the scenario. As some farms may not need complete replanting, actual costs may be lower. These estimates should therefore be considered a rough order of magnitude estimate of funding needed to comprehensively rehabilitate Ghana's cocoa sector.

6.3. STRENGTHS, CHALLENGES, AND OPTIONS TO MITIGATE RISK

Crop selection and production

The model allows ECOM and farmers to analyze the theoretical returns of different crops, highlights which crops are most profitable, and demonstrates the short and long-term returns from farm rehabilitation. However, actual returns for ECOM and the farmers and viability of the model will be affected by several risks, some of which are not fully captured in the model:

- *Price risks:* Conservative market prices are used, but prices for all crops will fluctuate over time that may have a positive or negative affect on the model. ECOM can mitigate some price risks for non-cocoa cash crops through pre-negotiated sales with larger buyers in Accra or internationally, but these contracts take time to finalize for each crop and do not yet extend for multiple years. Cocoa is also purchased annually without long-term contracts, but prices are fixed in advance for a growing season by Cocobod.
- *Production quality:* Long term buyers of vegetable cash crops require larger volumes and quality assurances. Volume needs to be aggregated across farms, and farmers may require additional training. ECOM will also need to work through the logistics of crop handling and transportation to bring products to market. ECOM and other cocoa companies are familiar with cocoa production and transportation, but less familiar with vegetable crops.
- *Production yield:* Yield assumptions have a significant impact on the model. Yields are impacted by a range of factors including weather, pests, disease, and soil quality. ECOM can correct soil, but this adds costs. Similarly, pests and disease can be controlled with spraying, but this comes with costs, risks, and is not always effective. For example, 60 percent of the maize crops in the pilot were unable to be salvaged from fall armyworm infestations, even with spraying. It is also difficult to protect vegetable crops against drought as irrigation is expensive. The best mitigation option may be

to plant turmeric which is estimated to only have a 20 percent reduction in yield in drought conditions compared to 80 percent reductions for vegetable crops.

- *Side selling:* The model contains some yield discounts, but side selling by farmers remains an ongoing risk for all crops other than turmeric. ECOM can partially mitigate this risk for vegetable crops by careful screening of farmers and close monitoring of fields, but narrow eligibility limits participation and increased monitoring increases cost.

Crop insurance can theoretically mitigate many of the production risks identified above. However, crop insurance in practice is not readily available in Ghana and the cost effectiveness of the premiums is unknown. There is also a risk that demonstrating the higher value of cash crops may lead to increase pressure to clear forests for cash crops rather than cocoa farms. This pressure already exists from cocoa and gold mining, and the same efforts to protect forest reserves from these pressures would also need to address potential pressure from cash crops.

Income diversification with cash crops

The model clearly demonstrates that keeping some land set aside for annual cash crops is better for farmers long-term income across all scenarios, and further increases in higher value cash crops will continue to increase farmer income. This is clearly beneficial for farmer's livelihoods, and income diversification will help improve overall economic resilience. However, without ongoing or additional support it may be hard for some farmers to pursue long-term diversification away from cocoa for several reasons:

- *Capital needs:* Annual cash crops are more capital intensive and require annual investments to purchase seeds and inputs. Once a cocoa farm is established a farmer only needs to purchase inputs, and a farm may still produce some pods with minimal or no inputs. For example, capital needs to purchase all inputs and materials to farm one acre of chili is over GH¢1,300 per year, whereas cocoa is approximately GH¢350 per year after it is established.
- *Access to markets:* The cocoa value chain is well established in rural Ghana. There are some local markets for locally consumed food crops, but these could not support a wide-scale shift in rural agricultural production. Value chains that bring rural crops to larger markets in Kumasi, Accra, or international markets need access to consistent produce at scale. Farmers need support from a third-party aggregator to access these markets.
- *Labor:* A fully established cocoa farm requires less labor per acre than annual cash crops. It is unclear if cocoa farmers can provide or pay for the additional labor required to farm larger areas of land for cash crops. See the discussion on labor as a barrier to rehabilitation in Section 4.2 above.
- *Cultural:* There is a strong social attachment to cocoa in many parts of rural Ghana, with higher social status associated with larger cocoa farms. However, there is also some pessimism over the profitability of cocoa long-term (see Section 4.2 above), so it is unclear how these social dynamics may play out in practice over time.
- *Tenure:* Cocoa farms help some farmers establish tenure over the land. Cocoa farmers with *abunu* tenure could not switch from cocoa to annual cash crops without changes to customary tenure arrangements. See the discussion on tenure as a barrier to rehabilitation in Section 4.3 above.

If ECOM remains engaged and supports vegetable farming on the extra plot as an alternative to cocoa many of barriers to vegetable farming could be addressed. This include ECOM helping with inputs and continuing to offtake cash crops for sale in larger non-local markets. ECOM will not, however, be able to address underlying tenure barriers to switching from cocoa farming to vegetable crops.

Risk of negative returns

The model currently assumes farmers make up payments in any year that income does not cover costs. This is not realistic and would act as a disincentive for farmers to participate. Debt could be carried through and repaid in later years, but interest rates in Ghana are 28 percent or more which increases the overall cost to farmers. The model could be restructured to show how to finance this debt, but this would not change the underlying economics of the different scenarios and crop selection objectives of the model. This highlights the challenge smallholders face to overcome the financial "valley of death" of tree crop rehabilitation (see Section 4.1).

Tenure risks

Two tenure risks may affect wide scale adoption of agroforestry rehabilitation:

- *Land tenure risks*: This is associated with *abunu* farmers and their right to cut and replant either cocoa or a combination of cocoa and cash crops. This will affect uptake by an unknown number of farmers and will need to be addressed through on-the-ground dialogue and dispute resolution between farmers and landlords.
- *Tree tenure risks*: This is relevant to all farmers as it significantly discourages agroforestry models. As advocated in Fischer et al (2020), tree tenure reform is needed to eliminate the distinction between naturally occurring and planted trees to devolve all rights to all trees to individuals or families that hold customary tenure over that land.

Competition with Cocobod

Any commercial service delivery model will need to compete with Cocobod's rehabilitation offering that aims to compensate farmers and landlords directly (see Section 5.1). The scope of Cocobod's rehabilitation plans will not meet needs and many farmers acknowledge that they will likely never receive Cocobod's services. However, the widespread marketing of the service creates a counter-point example that any service delivery model must compete with. The greater the financial risk farmers perceive, the less likely they are to enroll in rehabilitation services – particularly if there is the potential for a "free" or "paid" option in the future.

A better solution is for Cocobod to partner with ECOM or other service delivery providers and use the loan from African Development Bank to support a blended finance option to support commercial rehabilitation.

6.4. FINANCIAL STRUCTURE OPTIONS

The farm rehabilitation scenarios discussed above show positive rates of return for a service delivery model are possible. However, as noted in 6.2 there are still challenges that need to be addressed. These make the model insufficient by itself to mobilize private sector investment at the scale required for the following reasons:

- *Risk of key assumptions:* The model has several assumptions related to revenues, costs, and yields that may differ during implementation. As noted above these are due to various factors out of the farmer or ECOM's control such as climate variability, market demand etc. Investors or lenders would either i) price in these risks which leads to higher cost of capital; ii) add additional security requirements on the finance to backstop these assumptions and protect investors against losses.
- *Execution risk:* The ability of ECOM or a similar private sector entity to consistently deliver and execute the farm rehabilitation services has not been fully proven. The lack of an implementation track record – particularly at scale – will be a barrier to mobilizing large scale finance.
- *Adoption risk:* The mobilization of large-scale finance is predicated on farmers enrolling in the service along with multiple private sector actors to provide farm rehabilitation services. Farmers can be reluctant to take on debt or allow their farm to be cleared, and the number of additional firms beyond ECOM that could provide these services is unclear. Additional incentives may be needed to stimulate wide-scale adoption.
- *Capacity constraints.* ECOM has been experimenting and increasing its capacity to deliver farm rehabilitation services for almost 5 years, but its experience and capacity is still nascent. ECOM also cannot be expected to meet the estimated demand for these services across Ghana. To rehabilitate up to 700,000 hectares significant capacity-building effort will be needed, which may require technical assistance funding to support private sector capacity to deliver these services.

Blended finance solutions

Blended finance combines private capital with grants or subsidized finance from development institutions or donors to achieve common goals. Blended finance could therefore be a solution to address the challenges outlined above.

Convergence (2019) tracks global trends in blended finance valued at around $140 billion. They report blended finance deal sizes range from $110,000 to $8 billion, with a median deal size in 2018 of $50 million and average of $300 million. Sub-Saharan Africa was the most targeted region, with Ghana the third most frequently target country globally behind India and Kenya. Between 2016-2018 agriculture was the third most common sector targeted globally (21 percent) behind energy (44 percent) and financial services (28 percent). During this same period, the most common blended finance structures were concessional debt or equity (67 percent) followed by guarantees or risk insurance (38 percent). Guarantees were found to be used most frequently for blended finance transactions between $100 - $250 million in size, and Convergence cites other research by Benn et al (2017) that has associated guarantees with mobilizing the greatest volume of private sector capital. Benn et al (2017) also found that 26 percent of the funding mobilized by the private sector targeted climate mitigation and/or adaptation, with 21 percent focused on mitigation only, 1 percent on adaptation only, and 4 percent on both.

Using blended finance to support rehabilitation is supported by several papers on financing R&R (Dalberg, 2015; Root Capital, 2016; Kroeger et al, 2017; Convergence, 2018). Dalberg, (2015) notes the diverse benefits of R&R makes it appealing to diverse stakeholders including donors and investors, but also notes aligning diverse incentives can be challenging and blended finance solutions can be complex. Root Capital, (2016) focuses on renovation of smallholder coffee farms, and advocates for blended finance solutions for aggregators that includes targeted subsidies and technical assistance. Convergence (2018) also concluded blended finance directed towards cocoa smallholders in Ghana was difficult to structure and implement and suggested blended finance solutions could focus on aggregators who could on-lend to smallholders. However, they also noted value-chain specific solutions in a single country are unlikely to catalyze private investment. Kroeger, (2017) proposes developing a new blended finance fund for cocoa R&R that combines public and private funding via grants, commercial finance, concessional finance, and in-kind delivery from donors, development finance institutions, producer country governments, international financial institutions, and impact funds to support R&R at scale.

These types of blended finance solutions could help mitigate some key risks, drive key benefits for cocoa farmers and support Ghana's Journey to Self-Reliance. The analysis of challenges above identifies the following entry points for development finance support:

- ***Reduce cash crop production risk****:* A loss of yield due to drought, disease or pest is the most significant production risk that is outside ECOM and farmer's control. Development finance could help reduce this risk through a loan guarantee or grant facility that ECOM could draw upon if yields are significantly affected by an agreed trigger. There are many ways of structuring this that could ensure baseline income is delivered to farmers from the sale of cash crops along with some risk-sharing with ECOM's efforts to recoup its rehabilitation investment. This could be combined with one or more forms of crop insurance, but as noted above crop insurance in practice is not readily available in Ghana and the cost effectiveness of the premiums is unknown.
- ***Support vegetable crop farming****:* Diversifying cocoa farmers away from cocoa will increase overall household income and make farmers more resilient. ECOM can help farmers realize the economic value of vegetable farming, but ECOM is primarily a cocoa trading company. Additional support to establish value chains and integrate good agricultural practices for diverse crops into extension agent's training would help ECOM diversify the value chains it works in. This will help both the short-term returns and viability of rehabilitation and create a longer-term financial incentive for both the farmers and ECOM to keep a portion of cocoa farms diversified.
- ***Land and tree tenure support****:* Development assistance can help meditate and address land tenure conflicts that may arise for *abunu* farmers who need to rehabilitate their farms. Development institutions should also support comprehensive tree tenure reform to eliminate the distinction between naturally occurring and planted trees

Convergence (2019) reports the average leverage ratio for blended finance funds with concessional capital has been 4x, with a range of 0.3x to 22x and median of 2.7x. The 4x leverage ratio can be applied to the average extrapolated cost estimates to rehabilitate Ghana's cocoa sector discussed in Section 6.2. At an average cost of around $14,000 per hectare, this translates into approximately $1 billion in public funding needed to leverage over $4 billion in private investment to rehabilitate 368,000 hectares, or $1.9 billion of public investment needed to leverage $7.8 billion of private investment to rehabilitate 700,000 hectares.

Three blended finance structures

Several factors need to be considered to design a financial structure that could deliver the large-scale finance needed to restore Ghana's cocoa sector. The ideal financial structure should deliver micro-finance or small and medium enterprise (SME) finance and be scalable to potentially mobilize billions in investment.

The financial structure most likely to meet the desired outcomes at scale is a blended finance approach that combines commercial capital, concessional funding, and grants. Table 8 illustrates three possible financial structures.

Table 8. Thee blended finance structures

Structure	Explanation
ECOM Blended Finance Facility	An entry point to test the bankability of scaling the farm rehabilitation service delivery model is to capitalize a \$10 - \$50 million blended finance facility ("Facility") to support ECOM expand its services after the 2020-2021 growing season. The Facility could comprise of a loan fund, a loan reserve, and a technical assistance facility. The loan fund could be managed by an independent loan fund manager who could underwrite ECOM's pipeline. As collateral for the financing, ECOM could pledge the rehabilitation contracts with farmers and supplier contracts with cash crop off-takers. The loan reserve could comprise of two parts – one for delayed payments and another for defaults. The delayed payments would be backstopped in full while the loan defaults would be compensated at a certain risk-sharing ratio (for e.g. 50/50). Certain amount of risk sharing in case of loan losses with the loan fund manager as opposed to covering 100% of loan losses would be recommended to avoid moral hazard. The technical assistance portion of the Facility would be managed by a combination of ECOM's agronomists, land tenure experts and monitoring and evaluation (M&E) expert such as Winrock. ECOM's agronomists would ensure that the farmers that enroll in the rehabilitation services are fully aware of the rehabilitation plans and are trained in future upkeep of the farm in post-contractual phases. Land tenure experts would assist farmers to resolve any possible disputes between landlords and *abunu* farmers who want to rehabilitate their farms. Winrock as the M&E expert would verify ECOM's performance and adherence to rehabilitation agreements and various environmental and social safeguards, evaluate loan fund performance and loan reserve invocations and generate periodical reports for funders and other stakeholders as agreed to at inception and as modified thereon.

SME Loan Fund + Crop Insurance + Technical Assistance & Seed Fund	An SME Loan Fund could finance enterprises that act in the capacity of ECOM's role. An enterprise that enrolls a minimum of acres in a rehabilitation program would have access to financing from the fund. The fund will provide for a flexible loan structure which will fulfill working capital needs (repaid within 12 months) as well as a term loan that would be repaid over a period of 4-5 years (in time for the renovated cocoa farms to reach maturation). As part of the financing terms, the SME loan fund would either require collateral from the enterprise or require them to purchase an acceptable insurance policy with the Loan Fund being a beneficiary of any pay outs. The SME Loan Fund could serve as a prototype housed within a national or supra-national entity (African Development Bank), with the eventual aim of phasing out as private financial institutions offer similar products or through privatization. The fund would be supported by: A crop insurance product to protect crop yields from climate and other environmental factors. This could be developed by other entities to support this financing structure if affordable and accessible products are not currently available. A technical assistance (TA) fund that trains private sector enterprises would support this initiative. The TA fund could i) train and certify delivery partners before they seek loan funds, ii) provide seed funding for enterprises that successfully complete training to undertake demonstration plots and sign up interested farmers and iii) resolve any possible disputes between landlords and *abunu* farmers who want to rehabilitate their farms. The certification process mentioned under i) would also provide quality assurance to farmers looking for such services from third parties.
Resilience Bond + Pay for Success Program + Technical Assistance Fund	A resilience bond issued by Ghana and/or a development finance institution through international finance markets could be used to capitalize a pay-for-success (PfS) program implemented by private sector entities or contractors. The contractors that manage the PfS programs would use a combination of: i) training and certifications, ii) incentive mechanisms, iii) debt financing to spur locally based private sector enterprises (such as ECOM) to provide farm rehabilitation services, and iv) land tenure services to help resolve disputes for interested farmers. The PfS contract could be structured to provide contractors with set performance benchmarks that i) penalizes them for underperformance, ii) provides cost-recovery for meeting minimum performance, and iii) provides a sliding scale of performance bonuses for overperformance.

	Encouraging multiple contractors to manage PfS programs creates an element of competition. This can lead to further innovation in terms of incentive design and financing mechanisms that could be used to design better PfS programs, or national policy initiatives as well inform international initiatives aimed at undertaking large scale smallholder farmer resilience. The resilience bond would be repaid through finance repayments and earmarks from Ghana's existing cocoa subsidy programs and from increased tax collections from profits earned by the contractors and enterprises involved in the implementation of the PfS program. The ability for an entity like the US Development Finance Corporation or the African Development Bank to provide insurance to cover such an issuance, and hence investors, against a variety of risks such as political risks, climate risks, exchange risks (if issuance is in foreign currency denomination) will allow for cheaper borrowing costs and increased marketability.

The three options in Table 8 could also be supported by broader support to reform tree tenure laws in Ghana. This reform should eliminate the distinction between naturally occurring and planted trees and devolve ownership of all trees outside reserves to holders of customary tenure. It may be possible to register all trees on rehabilitated land without this reform, but this would add time and cost to the farm rehabilitation model.

The three options are also not mutually exclusive, and other structures can be developed. For example, the first option to develop an ECOM Blended Finance Facility will likely be smaller and faster to initiate than the other options. It could help further demonstrate proof of concept at a modest scale, which could make it easier to develop the other options or be rolled into a larger Loan Fund. A company specific Blended Finance Facility could also operate alongside a PfS mechanism, and companies with such a Facility may not need the support of the PfS Technical Assistance Facility.

7. Conclusions and Recommendations

Large scale rehabilitation of cocoa farms across Ghana and West Africa is needed to address current production challenges and increase farmer's resilience to the impacts of climate change. Without systematic adaptation, the estimated mean cost of climate change on Ghana's cocoa sector is estimated to be between \$270 – \$660 million per year by 2050 (0.7 - 1.6 percent of GDP). A rehabilitation service delivery model that creates a business case for rehabilitation has the potential to drive climate resilient rehabilitation at scale.

The financial model developed by ECOM and PIER, as part of the joint efforts to design a sustainable service delivery model, is a useful tool to analyze the financial viability of farm rehabilitation services and long-term farm profitability based on different combinations of cash crops. The analysis shows two cash crop scenarios that generate a positive net present value after 4 years, although turmeric only has a positive four-year net present value if turmeric is kept as a cash crop in year 4. Additional testing of additional crops at larger scale, and with improved soil and agricultural practices will help to further refine the model over the 2020 – 2021 growing season. When the value of rehabilitation is analyzed over the 25-year life of a cocoa farm farmers see substantially greater benefits. The long-term benefit increases substantially if a portion of the farm is kept for annual cash crops. The impacts of ECOM's approach can contribute to multiple Sustainable Development Goals including; Goal 1 (No Poverty), Goal 2 (Zero Hunger), Goal 8 (Decent Work and Economic Growth), Goal 13 (Climate Action), Goal 15 (Life on Land) and Goal 17 (Partnerships).

The analyses performed to understand the viability of the farm rehabilitation service delivery model provides insights to understand investment needs at scale. If the costs of ECOM's service delivery model are applied across Ghana, the cost – and investment opportunity - for systematic replanting of all farms that need it is estimated at between $4.8 and $10.4 billion depending on the number of hectares rehabilitated and the cost per hectare. This demonstrates that there is a large-scale business case for climate smart farm rehabilitation services that delivers multiple environmental and social benefits to investors and farmers.

The total investment needs are too large for any single cocoa company, and several key risks make it challenging for ECOM to scale up the services. Blended finance solutions that combine donor finance with private finance are therefore recommended to address three key challenges in the rehabilitation model: cash crop production risk, challenges establishing new value chains at scale, and land and tree tenure. Several options to structure blended finance to address these risks are possible. If a 4x leverage ratio is used, approximately $1 billion in public funding directed towards addressing these challenges could leverage over $4 billion in private investment and rehabilitate 368,000 hectares of cocoa. This would have a significant impact to improve the livelihoods and resilience of over 130,000 cocoa growing households across Ghana, with further positive ripple effects throughout the cocoa sector and economy.

Annex 1: Customary Land Tenure Arrangements in Ghana's Cocoa Production System

The key land rights affecting the cocoa production system are summarized below in hierarchical order:

Allodial title. The highest form of customary interest in land held commonly by indigene landowning groups. Only indigene landowning groups can hold allodial title to land. The allodial title may enter into customary tenure agreements with non-indigene "strangers" or immigrants, but not as usufruct title. While the stool still owns the allodial tile, possession and all rights of economic utilization are passed down to usufruct and *asideɛ*, which in turn can pass this down further to *abunu*. Given all the land under cocoa cultivation has been passed out in this way, the allodial title is essentially ceremonial without economic interest in the land. However, the allodial stool is referred to for dispute resolution and collects *afashyɛtoɔ* (fees) from strangers, as well as benefitting from land rents collected by the Office of Administrator of Stool Lands.

Usufruct (customary freehold). The usufruct is created through customary rules that entitle every indigene or sub-group of an allodial community the right to work any common forests. Lands, once worked and converted to usufruct, remain private within the usufruct family or clan and may be left fallow for years without loss of usufruct rights. The holder of allodial land has strong incentives to limit the rights of usufruct by, for example, allocating lands for cocoa production only to non-indigenes who cannot gain usufruct rights. Usufruct rights are perpetual and usufruct rights holders may enter into customary tenure arrangements with strangers/immigrants without involvement or interference of the allodial titleholder.

Stranger landowner (asideɛ). This is a variation of usufruct that is established when strangers migrate to a community and acquire land directly from the allodial. In Wassa Amenfi West this occurred roughly 50 to 60 years ago when land was in abundance. *Asideɛ* landowners have perpetual rights. They can sell the land with consent of the allodial at a fee, grant *abunu,* and bequeath the land.

"Tenant" farmer (abunu). Land rights are gained through a land agreement whereby a stranger or migrant or (in rare occasions) an indigene, acquires land for farming. The landlord provides uncultivated land to the farmer to clear and grow agreed upon cash crops (generally cocoa). The *abunu* farmer clears the land and establishes a cocoa farm. Once the cocoa matures sufficiently (five to seven years), the farm is split into two and the landlord keeps half and the *abunu* farmer keeps the other half. An *abunu* farmer can bequeath or sell the land and rehabilitate their farm (cut and replant cocoa). This often requires the consent of the landowner, but landlord consent is not universally required across Ghana. So long as the land is maintained as a cocoa farm, *abunu* tenure rights continue in perpetuity. *Abunu* farmers may also be expected to pay an annual flat fee (*afahyɛtoɔ*) to the allodial, but they do not pay rent to landlords. *Abunu* is often described as tenancy as the closest English equivalent but *abunu* rights are different froma common law tenant.

Caretaker (abusa). Under *abusa,* the landowner establishes a farm and a sharecropper or caretaker is hired to maintain the farm. In return for their labor the *abusa* farmer receives one-third of the cocoa yield. There is flexibility on how the remaining two-thirds is divided – this may all go to the landowner who is responsible for inputs, or one-third may go to the landowner and one-third be allocated to purchase inputs. The caretaker may be fired on short notice and does not have any rights to the land being farmed.

Source: Extracted from Fischer et al, 2020, citing Roth et al, 2017; Asamoah & Owusu-Ansah, 2017; Roth et al, 2018

Annex 2: Predominant agroforestry tree species for the climatic impact zones (Asare, 2019)

Zone	Food crops (common or local name)	Fruit trees (common or local name)	Timber and non-timber trees (local name)
Coping zone	*Musa spp.* (Plantain)	*Citrus spp.* (Orange)	*Ricinodendron heudelotti* (Wama)
	Zea mays (Maize)	*Mangifera indica* (Mango)	*Rauvolfia vomitoria* (Kakapenpen)
	Manihot esculenta (Cassava)	*Persea Americana* (Avocado)	*Khaya ivorensis* (Mahogany)
	Arachis hypogea (Groundnut)	*Elaies guinensis* (Oil palm)	*Milicia excelsa* (Odum)
	Vigna unguiculata (Cowpea)	*Carica papaya* (Pawpaw)	*Tiegmella heckelii* (Baku)
	Piper nigrum (Black pepper)	*Cocos nucifera* (Coconut)	*Khaya ivorensis* (Mahogany)
	Colocasia esculenta (Taro)	*Psidium guajava* (Guava)	*Entandrophragma angolense* (Edinam)
	Vegetables (Garden eggs, okra, etc.)	*Cola nitida* (Cola)	*Heritiera utilis* (Nyankom)
	Dioscorea spp. (Yam)	*Garcinia kola* (Bitter kola)	*Ficus exasperate* (Nyankyerene)
		Alanblakia spp. (Sonji)	*Ceiba pentandra* (Ceiba)
Adjustment zone	*Musa spp.* (Plantain)	*Citrus spp.* (Orange)	*Terminalia ivorensis* (Emere)
	Zea mays (Maize)	*Mangifera indica* (Mango)	*Terminalia superba* (Ofram)
	Manihot esculenta (Cassava)	*Persea Americana* (Avocado)	*Alstonia boonei* (Nyame dua)
	Xanthosoma sagittifolium (Cocoyam)	*Elaies guinensis* (Oil palm)	*Mansonia alttissima* (Prono)
	Yam (*Dioscorea* spp.)	*Carica papaya* (Pawpaw)	*Spathodea campanulata* (Akuokuoninsuo)
	Zingeber officinaleies (Ginger)	*Cocos nucifera* (Coconut)	*Newbouldia laevis* (Sesemasa)
	Ipomoea batatas (Sweet potato)	*Psidium guajava* (Guava)	*Pycnanthus angolensis* (Otie)
	Vegetable (pepper, tomatoes, okra etc.)	*Cola nitida* (Cola)	*Albizia zygia* (Okoro)
			Funtumia elastica (Fruntum)
			Aningeria robusta (ASamfena)

Transformation zone	*Musa spp.* (Plantain)	*Citrus spp.* (Orange)	*Khaya ivorensis* (Mahogany)
	Manihot esculenta (Cassava)	*Vitellaria paradoxa* (Shea)	*Albizia ferruginea****
	Dioscorea spp. (Yam)	*Parkia biglobosa* (Dawadawa)	*Antiaris toxicaria* (Kakapenpen)
	Zea mays (Maize)	*Mangifera indica* (Mango)	*Triplochiton scleroxylon* (Wawa)
	Arachis hypogea (Groundnut)	*Elaies guinensis* (Oil palm)	*Millicia excelsa* (Odum)
	Vigna unguiculata (Cowpea)	*Carica papaya* (Pawpaw)	*Spathodea campanulata* (Akuokuoninsuo)
	Vegetables (Tomatoes)	*Cola acuminate* (Cola)	*Albizia coriaria* (Awiemfo samina)
		Anacardium occidentale (Cashew)	*Entandrophragma angolense* (Edinam)
			Alstonia boonei (Nyame dua)
			Terminalia superba (Ofram)
			Terminalia ivorensis (Emere)
			Albizia adianthifolia (Pampena)
			Tetrapleura tetraptera (Prekese)
			*Gliricidia sepium****
			*Pterocarpus mildraedii****
			*Piptadeniastrum africanum** (Dahoma)

****leguminous species; *leguminous Cover crop*

References

Acheampong, E., Dawoe, E., Bosu, P. & Asante, W. (2014). *Moving Forward with REDD+ in Ghana: Shade Systems, Crown Cover, Carbon Stocks and Socio-Economic Dynamics of Smallholder Cocoa Agroforestry Systems*. Accra: REDD+ Energy and Agriculture Programme.

African Development Bank African Development Fund (1999). *Republic of Ghana Cocoa Rehabilitation Project Project Completion Report*, OCDW West Region

African Development Bank African Development Fund (2002). *Government of Ghana Cocoa Rehabilitation Project Project Performance Evaluation Report*, Operations and Evaluations Department, ADB/ADF/OPEV/02/10

African Development Bank, (2019a) *African Development Bank, Credit Suisse, Industrial and Commercial Bank of China and Ghana Cocoa Board ink $600 million loan agreement to boost cocoa production*, November 12, 2019. Retrieved August 17, 2020 from: https://www.afdb.org/en/news-and-events/press-releases/african-development-bank-credit-suisse-industrial-and-commercial-bank-china-and-ghana-cocoa-board-ink-600-million-loan-agreement-boost-cocoa-production-32628

African Development Bank, (2019b) *Project Summary Note Ghana Cocoa Board, Ghana*, September 2019. Retrieved August 18, 2020 from: https://www.afdb.org/en/documents/ghana-ghana-cocoa-board-project-summary-note

Antwi-Agyei, P., Dougill, A., Stringer L., (2015). "Impacts of land tenure arrangements on the adaptive capacity of marginalized groups: The case of Ghana's Ejura Sekyedumase and Bongo districts", *Land Use Policy* 49 (2015) 203–212. https://doi.org/10.1016/j.landusepol.2015.08.007

Asaaga, F., Hirons M., Malhi, Y., (2020). "Questioning the link between tenure security and sustainable land management in cocoa landscapes in Ghana". *World Development* 130 (2020) 104913. https://doi.org/10.1016/j.worlddev.2020.104913

Asamoah, M., & Owusu-Ansah, F. (2017). *Report on land tenure & cocoa production in Ghana: A CRIG/WCF collaborative survey*. Accra: USAID, CRIG, and WCF.

Asare, R., (2017). *Good agricultural practices for sustainable cocoa production: a manual for participatory farmer training on cocoa agroforestry*. Prepared for USAID Tenure and Global Climate Change Program (on file with the author and USAID); based on Asare, R. and David. S. (2011). *Good agricultural practices for sustainable cocoa production: a guide for farmer training. Manual no. 1: Planting, replanting and tree diversification in cocoa systems*, Sustainable tree crops programme, International Institute of Tropical Agriculture, Accra, Ghana.

Asare, R. (2019) *Species–Specific Agroforestry Models for Specific Climatic Zones of Cocoa Production*, unpublished report commissioned by the US Department of State funded Private Investment for Enhanced Resilience project.

Australian Government Department of the Environment, (n.d.) *Representative Concentration Pathways (RCPs) Fact Sheet,* retrieved August 6, 2020 from: https://environment.gov.au/system/files/resources/492978e6-d26b-4202-ae51-5eba10c0b51a/files/wa-rcp-fact-sheet.pdf

Barry Callebaut, (2012). *Barry Callebaut breaks ground at its first Center of Cocoa Excellence in West Africa,* June 29, 2012. Accessed August 18, 2020 from: https://www.barry-callebaut.com/en/group/media/news-stories/barry-callebaut-breaks-ground-its-first-center-cocoa-excellence-west

Benn, J., Sangaré, C., and Hos, T. (2017). "Amounts Mobilised from the Private Sector by Official Development Finance Interventions: Guarantees, syndicated loans, shares in collective investment vehicles, direct investment in companies, credit lines", *OECD Development Co-operation Working Papers*, No. 36, OECD Publishing, Paris, https://doi.org/10.1787/8135abde-en.

Buckles, M., and Roy, H., (2013). *Investing in Sustainability and Productivity Improvements to Transform Cocoa Production and Livelihoods in Côte d'Ivoire, Phase 1 Feasibility Study Results*. Rainforest Alliance. Retrieved August 18, 2020 from: https://www.rainforest-alliance.org/sites/default/files/2016-08/sustainablity-cocoa-production-cote-divoire.pdf

Bunn C, Lundy M, Castro F., (2016). *Climate-smart Cocoa: Adaptation Practices for Smallholder Systems in Ghana*. Presented at the kick-off workshop held in May 2015. International Center for Tropical Agriculture (CIAT). Retrieved August 18, 2020 from: https://hdl.handle.net/10568/79803

Bunn, C., Castro-Llanos F., and Schreyer F., (2018). *The Economic Case for Climate Action in West African Cocoa Production*. Cali, Colombia: CGIAR Research Program on Climate Change, Agriculture and Food Security. https://hdl.handle.net/10568/97166.

Bymolt, R., Laven, A., and Tyszler, M., (2018). *Demystifying the Cocoa Sector in Ghana and Côte d'Ivoire.* The Royal Tropical Institute (KIT), Amsterdam, The Netherlands.

Climate Action Tracker Global Temperatures (2019) retrieved August 6, 2020 from Climate Action Tracker website https://climateactiontracker.org/global/temperatures/

Cocoa Post, (2020a). *Ghana's $230-Million Cocoa Farm Rehabilitation Programme Takes Off*, February 19, 2020. Retrieved August 17, 2020 from https://thecocoapost.com/cocoa-farm-rehabilitation-programme/

Cocoa Post, (2020b). *COCOBOD Steps Up Cocoa Farm Rehabilitation Programme In Western North*, August 12, 2020. Retrieved August 17, 2020 from https://thecocoapost.com/rehabilitation-programme-cocoa/

Convergence, (2018) *Conducting a feasibility study for a financing facility for cocoa smallholders in Ghana*, Design Grant Summary, May 2018. Retrieved August 17, 2020 from: https://assets.ctfassets.net/4cgqlwde6qy0/2LI2PUCUrKg2ouQCWWgSUg/ffaf31c2ee39469a8577fc09a6515cc3/Convergence__Conducting_a_Feasibility_Study_for_a_Financing_Facility_for_Cocoa_Smallholders_in_Ghana_Design__Grant_Summary___2.pdf

Convergence, (2019) *The State of Blended Finance 2019*, September 24, 2019. Convergence Toronto, Canada and Nairobi, Kenya. Retrieved October 13, 2020 from: https://www.convergence.finance/resource/13VZmRUtiK96hqAvUPk4rt/view

Dalberg. (2015). *Smallholder tree crop renovation and rehabilitation (R&R), A Review of the State of the Emerging R&R Market and Opportunities to Scale Investment*. Commissioned by IDH, the Sustainable Trade Initiative.

Dentoh, E. (2020, September 13). Ghana Raises Cocoa Farmers' Pay by 21% After Premium Surcharge. *Bloomberg.* Retrieved September 14th from: https://www.bloomberg.com/news/articles/2020-09-13/ghana-raises-cocoa-farmers-pay-by-21-after-premium-surcharge

Enriquez, S., Hyman E., O'Mealy M., Cooley D., and Sraha T., (2020). *The Value of Climate-Smart Cacao Production: A Literature Review*. Washington, DC: Crown Agents-USA Ltd. and Abt Associates, Prepared for USAID.

FAO STAT, FAO Statistical Division agriculture data for 2018. Retrieved August 5th 2020 from http://www.fao.org/faostat/en/#home

Fischer, J. E., O'Sullivan, R., Antwi, Y. A., & Freudenberger, M., (2020). *Rooted in the ground: Reforming Ghana's forest laws to incentivize cocoa-based agroforestry.* Washington, DC: USAID Integrated Land and Resource Governance Task Order under the Strengthening Tenure and Resource Rights II (STARR II) IDIQ.

Fountain, A. and Hütz-Adams F., (2018). *Cocoa Barometer 2018*. Ede, Netherlands: Voice Network.

Geiges, A. Parra, P., Fyson, C., Günther, A., Hare, B., Schaeffer, M., Hutfilter, U., (2019) *How can Paris Agreement commitments be improved now to close the gap to 1.5°C*, Climate Analytics, Berlin Germany.

Ghana Cocoa Board, (2018). *Manual for cocoa extension in Ghana*. CCAFS manual. Ghana Cocoa Board (COCOBOD).

GhanaWeb Business News, (2020). *COCOBOD embarks upon massive rehabilitation of Moribund Cocoa farms*. August 11, 2020. Retrieved August 17, 2020 from: https://www.ghanaweb.com/GhanaHomePage/business/COCOBOD-embarks-upon-massive-rehabilitation-of-Moribund-Cocoa-farms-1031356

Hutchins, A., Tamargo, A., Bailey, C., and Kim, Y., (2015). *Assessment of Climate Change Impacts on Cocoa Production and Approaches to Adaptation and Mitigation: A Contextual View of Ghana and Costa Rica*, Capstone Report for World Cocoa Foundation

IDH, (n.d.). *Mars, Inc.: caring for the future of cocoa*. IDH the Sustainable Trade Initiative. Accessed August 18, 2020 from: https://www.idhsustainabletrade.com/publication/flourish/mars/

IPCC, (2019). "Summary for Policymakers". In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.- O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

Jiekak, S., & Freudenberger, M. (2019). *Supporting Deforestation-Free Cocoa in Ghana Initiative: Land Use Planning Diagnostic Report*. Washington, DC: USAID Integrated Land and Resource Governance Task Order under the Strengthening Tenure and Resource Rights II (STARR II) IDIQ.

Kolavalli, S. & Vigneri, M. (2011). Cocoa in Ghana: shaping the success of an economy. In *Yes, Africa can: success stories from a dynamic continent*. Washington, DC: World Bank.

Konlan, S., Quaye, A. K., Pobee, P., Amon-Armah, F., Dogbatse, J. A., Arthur, A., Fiakpornu, R. and Dogbadzi, R. (2019) "Effect of weed management with glyphosate on growth and early yield of young cocoa (Theobroma cacao L.) in Ghana". *African Journal of Agricultural Research,* Vol. 14(28), pp. 1229-1238, DOI: 10.5897/AJAR2018.13555

Kroeger, A., Koenig, S., Thomson, A., Streck, C., (2017). *Forest- and Climate-Smart Cocoa in Côte d'Ivoire and Ghana, Aligning Stakeholders to Support Smallholders in Deforestation-Free Cocoa*. World Bank, Washington, DC., https://elibrary.worldbank.org/doi/abs/10.1596/29014

Maguire-Rajpaul VA, Khatun K and Hirons MA (2020) “Agricultural Information’s Impact on the Adaptive Capacity of Ghana’s Smallholder Cocoa Farmers”. *Front. Sustain. Food Syst*. 4:28. doi:10.3389/fsufs.2020.00028

Monastyrnaya, E., Joerin, J., Dawoe, E. and Six J., (2016). *Assessing the resilience of the cocoa value chain in Ghana*. Case Study Report, Swiss Federal Institute of Technology, Zurich, Switzerland

Vigneri M., and Kolavalli S., (2018). *Growth through pricing policy: The case of cocoa in Ghana*, Food and Agriculture Organization of the United Nations, Rome

Peprah K., (2015), “Sustainability of cocoa farmers’ livelihoods: A case study of Asunafo District, Ghana”, *Sustainable Production and Consumption*, Volume 4, October 2015, Pages 2-15
http://dx.doi.org/10.1016/j.spc.2015.09.001

O’Sullivan, R., Roth, M., Antwi, Y., Ramirez, P., Sommerville M., (2018) “Land and tree tenure innovations for financing smallholder cocoa rehabilitation in Ghana”. Paper prepared for the *2018 World Bank conference on land and poverty*. The World Bank - Washington DC, March 19-23, 2018,

O’Sullivan, R., Freudenberger, M., Herrera, A., Moulianitaki, B., & Vaassen, T. (2019). *Supporting Deforestation-Free Cocoa in Ghana: Implementation Plan*. Washington, DC: USAID Integrated Land and Resource Governance Task Order under the Strengthening Tenure and Resource Rights II (STARR II) IDIQ.

O’Sullivan, R. & Antwi, Y. (2019). *Supporting Deforestation-Free Cocoa in Ghana: Implementation Plan - Addendum*. Washington, DC: USAID Integrated Land and Resource Governance Task Order under the Strengthening Tenure and Resource Rights II (STARR II) IDIQ.

Peprah, K., (2014). “Poverty and Land Degradation Nexus: The Case of Asunafo, Ghana”, *International Journal of Science and Research,* vol 3 issue 4, May 2014

Persha, L., Haugan, G., Mittelberg, T., Wendt, R., and Protik, A. (2020) *Evaluation of the ‘Supporting Deforestation-Free Cocoa in Ghana’ Project Bridge Phase: Baseline Report*. Washington, DC: USAID Communications, Evidence and Learning (CEL) Project.

RCP Database Version 2.0.5 (2009), retrieved August 6, 2020 from
http://tntcat.iiasa.ac.at:8787/RcpDb/dsd?Action=htmlpage&page=about

Republic of Ghana. (2014). *Emission reductions program idea note (ER-PIN). Ghana’s emission reductions program for the cocoa forest mosaic landscape*. Accra: Forest Carbon Partnership Facility (FCPF) Carbon Fund.

Republic of Ghana. (2017). *Ghana Cocoa Forest REDD+ Programme. Emission Reductions Program Document* (ER-PD). Prepared for the Forest Carbon Partnership Facility Carbon Fund. Accra: Government of Ghana.

Root Capital. (2016). *Financing Farm Renovation: How to Build Resilience Using a Blend of Capital*. Learning Report: The Coffee Farmer Resilience Initiative. Retrieved August 19, 2020 from:
https://rootcapital.org/resources/financing-farm-renovation-how-to-build-resilience-using-a-blend-of-capital/

Roth, M., Antwi, Y., & O’Sullivan, R. (2017). *Land and natural resource governance and tenure for enabling sustainable cocoa cultivation in Ghana.* Washington, DC: USAID Tenure and Global Climate Change Program.
https://www.land-links.org/wp-content/uploads/2017/02/TGCC-Cocoa-tenure-deforestation-assessment_Feb-2019.pdf

Roth, M., Antwi, Y., O'Sullivan, R., & Sommerville, M. (2018). *Improving tenure security to support sustainable cocoa – Final report & lessons learned*. Washington, DC: USAID Tenure and Global Climate Change Program.

Roy, H., and Macek, P. (2018). *Investing in Small Farm Renovation: The Business Case*. World Cocoa Foundation blog, December 11, 2018. Retrieved August 17, 2020 from: https://www.worldcocoafoundation.org/blog/investing-in-small-farm-renovation-the-business-case/

Schroth, G., Läderach, P., Martinez-Valle, A.I., & Bunn, C., (2017). "From site-level to regional adaptation planning for tropical commodities: Cocoa in West Africa". *Mitigation and Adaptation Strategies for Global Change*, 22 (6): 903–927. doi:10.1007/s11027-016-9707-y. https://link.springer.com/article/10.1007/s11027-016-9707-y

Schwalma, C., Glendona, S., and Duffya, P., (2020) "RCP8.5 tracks cumulative CO2 emissions", *PNAS,* August 3rd 2020, https://doi.org/10.1073/pnas.2007117117

Tenure and Global Climate Change Program (TGCC), (2017a). *A Financial Model for Cocoa Farm Rehabilitation and Income Diversification*. TGCC brief, Improving Tenure Security to Support Sustainable Cocoa Pilot. Retrieved August 18, 2020 from https://www.land-links.org/document/a-financial-model-for-cocoa-farm-rehabilitation-and-income-diversification/

Tenure and Global Climate Change Program (TGCC), (2017b). *Improving Tenure Security to Support Sustainable Cocoa: Current Lessons and Looking Forward*. Workshop Proceedings Wednesday, 6 December, 2017 (on file with the author)

Tropenbos International-Ghana. (2018). *Learning Lessons from FLEGT-VPA to promote governance reform in Ghana's cocoa sector.* Briefing Paper. Tropenbos International.

VOICE Network, (2020), *Position paper on Living Income Farm Gate Prices*, Cocoa Barometer, January 2020, available at: https://www.voicenetwork.eu/cocoa-barometer/

World Bank. (2007). *Ghana: Meeting the Challenge of Accelerated and Shared Growth*, Country Economic Memorandum, World Bank, Washington, DC.

2101 Riverfront Drive
Little Rock, AR 72202
501-280-3000

2451 Crystal Drive, Suite 700
Arlington, VA 22202
701-302-6500

winrock.org