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PRELIMINARY IMPACT APPRAISAL

COCOA VALUE CHAIN REHABILITATION IN GHANA: 2018–2028

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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AND
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Executive summary

Initiated jointly by FAO Regional Office of Africa (RAF) and COCOBOD, the study is the first output of a wider work on cocoa value chain policies covering both Ghana and Ivory Coast. The main experts involved in the study are Eric S. Bani, COCOBOD Deputy Technical Manager, Louis Bockel, FAO-RAF Policy Officer and Padmini Gopal, FAO RAF Consultant. Koffi Amegbetto from the RAF Policy Unit provided the technical backstopping.

The Governments of Ghana and Cote d'Ivoire (both of which account for 60 percent of the world's cocoa output) signed the "Declaration of Abidjan" in March 2018 to collectively develop a common strategy that sustainably improves prices for cocoa producers. In view of this policy, the Ghana Cocoa Board (COCOBOD), a state-run board that serves as the marketing intermediary between primary producers and processors of cocoa beans in Ghana (COCOBOD, 2015), is conducting an impact appraisal study of the Ghanaian cocoa value chain in partnership with the Food and Agriculture Organisation (FAO). A similar study is currently being conducted for Cote d'Ivoire with FAO support (TCP).

Both studies will be used to develop united policies for the two countries and improve the synergy between different national cocoa policy measures, especially in terms of farm gate cocoa prices, incentives for cocoa agro-forestry system uptake, and support to value chain downstream agents. This appraisal study uses the EX-ACT Value Chain tool (EX-ACT VC), developed in 2016 by the FAO, to assess the value chain's contribution to climate mitigation, climate resilience, and socio-economic impact (i.e. value added, employment generated, economic return). The tool assesses the impact of the cocoa agroforestry value chain for 2018 and under an upgraded/growth scenario for 2028.

In Ghana, cocoa is an essential contributor to the economy and an important source of rural employment, supporting more than 800 000 smallholder farmers and contributing to 70 percent - 100 percent of their income (Kolavalli, S, Vigneri, & M, 2010). Cocoa agroforestry is described as 'a complex shade grown cocoa system in which forest tree species and food crops are integrated with cocoa for their economic, social and environmental benefits'. Currently, reduced yield in cocoa plantations is primarily attributed to the problem of virus affected or old cocoa plantations, which is why, COCOBOD has instituted a renovation and rehabilitation (R&R) programme for 2018–2028 to replant low yielding cocoa plantations through improved agroforestry measures.

The upgraded interventions that this programme seeks to implement are-

- improving the management of existing trees (rehabilitation) – approx. 720,000 ha.,
- planting new trees in existing farms (renovation) – approx. 58,909 ha., and
- implementing other CSA practices such as agroforestry, appropriate fertilizer and pesticide application, and use of improved seedlings.

Preliminary assessments of the cocoa value chain show that the cocoa value chain has a significant potential to improve farmer incomes while mitigating climate change. With an R&R strategy of implementing cocoa shadow agroforestry in low-yielding old plantation areas**,** the mitigation impact of the value chain reaches approximately 146 million tCO_2e in the next 20 years. This translates to a carbon footprint of – 5.6 tCO_2e for every ton of cocoa produced.

Additionally, the gross income per farmer increases by almost 38 percent - up to USD 10.46 per working day by 2028. Most of the value added coming from the upgraded scenario stems can be attributed to the producer – more than USD 1 billion in an aggregate value added of over USD 1.6 billion by 2028. Moreover, the cocoa value chain will create an additional 277 669 jobs, and increase the climate resiliency of almost 1.85 million hectares of landscape in Ghana.

Such performances confirm the relevance of the cocoa value chain as a key Pro-Poor Carbon-Fixing Engine in Ghana, and well complement the objectives of the Abidjan Declaration.

1 Background

1.1 Cocoa - a key sector in Ghana

Ghana is recognised globally for its cocoa cultivation and export worldwide. Cocoa is an essential contributor to Ghana's economy and an indirect contributor to Ghana's food security owing to its function in supporting the livelihoods of people engaged in the cocoa sector. Being primarily a cash crop, cocoa does not contribute much to the nutritional aspects of food security. Being an important source of rural employment, cocoa production supports more than 800 000 of smallholder farmers and contributes to 70 percent - 100 percent of their income (Kolavalli, S, Vigneri, & M, 2010).

Ghana's cocoa processing is expanding at an impressive rate - increasing by 69.1 percent up to 225 000 tonnes between 2012 and 2017. Although Ghana accounts for 20 percent of the USD 9 billion global cocoa bean market, it is estimated that less than 30 percent of the cocoa beans grown in the country are locally processed. This means that Ghana captures only 5 percent of the USD 28 billion global intermediate cocoa processing industry and only a minute share of the global final consumer market of USD 87 billion. Moreover, while the global chocolate industry alone is valued at an estimated USD 110 billion dollars, Ghana exports over 80 percent of cocoa only in its raw state (AMC & Goodman, 2017).

1.2 Ghana Cocoa Board

The Ghana Cocoa Board, established in 1947, has had a long history of overseeing the cocoa sector of Ghana. COCOBOD is a state-run board that serves as the exclusive marketing intermediary between primary producers and processors of cocoa beans in Ghana (COCOBOD, 2015). Since Ghana's cocoa industry became established, COCOBOD has undergone various transformations. Its modern constitution and mandate reflects the current trends in the industry, especially Ghana's socio-economic and political aspirations. Reforms carried out between the 1980s until date have restructured COCOBOD significantly. The Cocoa Sector Rehabilitation Project funded by the World Bank included reducing COCOBOD in size by restructuring and re-organising some of the subsidiaries to enhance the farmers' share of earnings from cocoa exports (Essegbey & Ofori-Gyamfi, 2012).

Cocoa has and continues to play a central role in the economy of Ghana, which is now the second largest producer of cocoa beans in the world. The key to this success is anchored to specific strategies put in place and managed by COCOBOD. An important strategy was to pass on an increasing share of export prices to producers, as a result of which, growing global prices in the 2000's gave producers higher real prices. Two major government programmes – also initiated in early 2000's – offered farmers improved varieties, subsidized fertilizers, and free pest and disease control (Vigneri, M, Kolavalli, & S, 2018). One of the main causes for the recent declines in cocoa production has been either virus affected or old cocoa plantations. Thus, COCOBOD has instituted a renovation and rehabilitation (R&R) programme starting in 2018 to replant low yielding cocoa plantations.

1.3 A poverty reduction success story

In the last ten years, Ghana has performed remarkably in terms of achieving poverty reduction. Studies conducted using the Ghana Living Standards survey show how the country has achieved significant reduction in poverty rates, with a near halving of rural poverty between 1991/92 (from 64 percent) and 2004/05 (to 39 percent) (Coulombe, and, Mckay, & A., 2003). The national representative data also presents evidence showing the cocoa producing households playing a major role in these achievements; their poverty headcount dropped to 23.9 percent in 2005, from 60.1 percent at the beginning of the 1990s. These changes in production and poverty reduction data unequivocally reflect the significance of cocoa's contribution in improving households' livelihoods - the upward trend in quantity produced and portion of sector revenues going to growers cocoa (derived from COCOBOD data) matches the downward trend in the incidence of poverty among households reporting cultivating cocoa as one of the main sources of income (data from the Ghana Statistical Service's Living Standards Survey - measured in cocoa growing regions only). Between 1991 and 2005, cocoa production tripled and revenues going to the population as a whole increased by a factor of 3.8 (UNCTAD-FAO, 2017).

The governments of Ghana and Cote d'Ivoire, and private companies have agreed through the Frameworks for Action to accelerate investment in long-term sustainable production of cocoa, with an emphasis on "growing more cocoa on less land" (The sustainable trade initiative, 2017). Key actions include providing improved planting materials, training in sustainable agricultural practices, and development and capacity building of farmers' organizations.

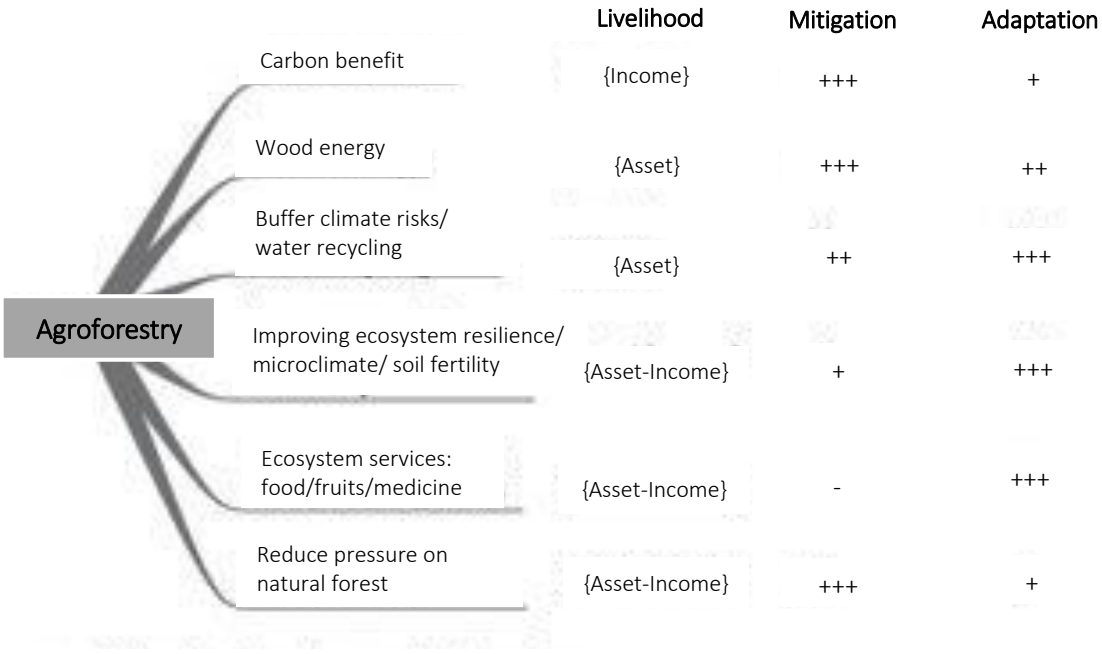
1.4 Cocoa – a key agroforestry system in climate mitigation and adaptation

In Africa, it has been shown that agroforestry systems are one of the most conspicuous land use systems across landscapes and agro ecological zones and constitute the third largest carbon sink after primary forests and long-term fallows. In addition, Zomer *et al*. show that the area suitable for agroforestry worldwide is much larger with substantially greater potential than existing systems (Zomer, Trabucco, Coe, & Place, 2009). In Africa, 1 550 million ha of land are suitable for some type of agroforestry (Unruh, Houghton, & Lefebvre, 1993).

With food shortages and increased threats of climate change, there is an increased interest in agroforestry's potential to address various on-farm adaptation needs and fulfil many roles in Agriculture Forest and Other Land Use (AFOLU) related mitigation pathways. Agroforestry provides assets and income from carbon, wood energy, improved soil fertility and enhancement of local climate conditions; it provides ecosystem services and reduces human impacts on natural forests (Mbow, Smith, Skole, Duguma, & Bustamante, 2014).

Cocoa agroforestry is described as a complex shade grown cocoa system in which forest tree species and food crops are appropriately integrated with cocoa for their economic, social and environmental benefits. With the right mix of trees to mimic the natural ecosystem, cocoa agroforests can also deliver environmental benefits in landscapes already degraded and fragmented by expansive monoculture cocoa cultivation.

Figure 1: Impacts of implementing agroforestry



+++: high positive impact; ++: positive impact;
+limited positive impact; -: zero positive or potential negative impact

Source: (Mbow, Smith, Skole, Duguma, & Bustamante, 2014)

1.5 Sustainability of shaded cocoa farming systems

Historically, cocoa used to be grown under the shade of forest trees in West Africa, however with hybrid, higher yielding cocoa varieties gaining popularity over the years, the shaded cocoa agroforestry practice was replaced over time. Currently, there is a burgeoning revival of growing cocoa beneath the canopy of forest trees (Acheampong, Dawo, Bosu, & Asante, 2014).

Studies have shown that multi-strata cocoa plantations contain higher carbon stocks than other agricultural land-uses and have considerable potential in mitigating climate change and storing carbon under the forest canopy (Acheampong, Dawo, Bosu, & Asante, 2014). Growing cocoa under this shade can not only mitigate emissions and store carbon in the soil, it can help protect cocoa from the harsh sun, regulate temperature and humidity, and create a habitat for wildlife (Blaser, *et al*., 2018; Haynes, Cubbage, Mercer, & Sills, 2012). A study by Anders *et al*. 2018 has also found that growing cocoa within an agroforestry system can mitigate and reduce the severity of the cocoa swollen shoot virus (CSSV)(a disease that significantly affects cocoa monoculture plantations) and lowers its resulting yield reducing effect (Andres, *et al*., 2018). Therefore, cocoa agroforests have the capacity to reduce household vulnerability to climate stress, pests and diseases and food insecurity (Asare, Afari-Sefa, Osei-Owusu, & Pabi, 2014).

Establishing sustainable, fair-trade systems can create an opportunity for cocoa producers to sell their products and ecosystem services at premium prices and increase their incomes (Asare, Afari-Sefa, Osei-Owusu, & Pabi, 2014). Farmers can also sell carbon credits based on the mitigation potential of their cocoa agroforestry practice, effectively improving their economic wellbeing (Nadège, Zapfack, Cédric, & Banoho, 2019).

2 Methodology and tools used

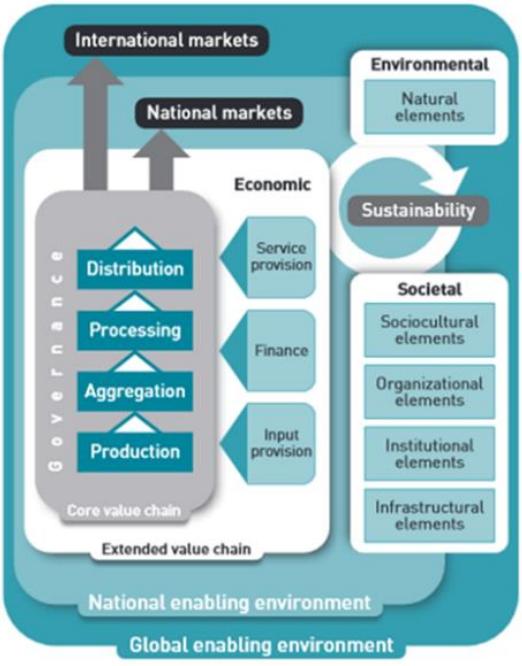
2.1 Approach: sustainable food value chain framework

A sustainable food value chain is defined as the full range of farms, micro-agents, firms and their successive coordinated value-adding activities that produce and transform raw agricultural materials into food products that are sold to final consumers and disposed of after use – all in a manner that is profitable throughout, has broad-based benefits for society, and does not permanently deplete natural resources.

Unlike the related concepts of "filière", "commodity chain" and "supply chain", the sustainable food value chain concept stresses the importance of three elements: (i) a "value chain" is a broadly defined concept and may be applied to any product subsectors (e.g. beef, maize, cocoa or shea), (ii) value chains are dynamic, market-driven systems governed and regulated through vertical coordination; and (iii) sustainability and the value added are explicit and multidimensional performance measures are assessed at an aggregate level (FAO, 2014).

The climate-smart agriculture (CSA) concept, launched by FAO in 2010, encompasses agriculture that targets food security and development goals through sustainable practices (FAO, 2013). CSA has three main objectives: (i) to increase food security while boosting productivity and income generation; (ii) to enhance the resilience of agricultural systems and rural populations to climate change; and (iii) to reduce GHG emissions in agriculture (mitigation). Thus, CSA is neither a new agricultural model, nor a new set of practices, but rather a framework for developing more productive and sustainable food value chains. This framework involves (i) climate change mitigation and adaptation options through ecosystem management in order to (ii) preserve existing carbon stocks and decrease existing carbon sources, and (iii) improve smallholder livelihoods to reduce their vulnerability to climate change.
The sustainable food value chain framework acts as a guidance for structuring the analysis of the food chain performance by addressing climate-change related strategies of mitigation, adaptation and resilience of the value chain, and stressing the importance of CSA, agro-ecological and socio-economic practices in the analysis of food value chains. This framework involves the value chain actors, i.e. those

Figure 4: The sustainable food value chain framework



who produce a good or a service, who add value to the product, sell it, transfer it to the next level or export it. In this framework, shown in Figure 2, four core functions of the value chain are identified: (i) production (agriculture, livestock, and fishing), (ii) aggregation, (iii) processing and (iv) distribution (wholesale and retail) at local, national and international levels (FAO, 2014).

This framework enables to identify criteria that can serve as growth engines, to assess the poverty reduction potential of an activity, and to facilitate the adoption of agricultural strategies with appropriate policy measures.

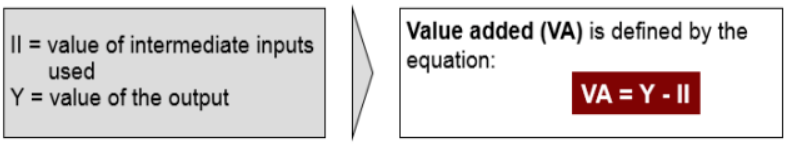
2.2 Value Chain Analysis (VCA)

One of the most critical concepts in value chain analysis (VCA) is the "value added" in the entire production process. The "value added" (VA) measures the accumulation of wealth and the contribution of the production process to economic growth, and is one of the key concepts identified by Porter (Porter, 1985) and FAO (FAO, 2014).
It is defined as the difference between the gross production value (incorporating the value of all factors that contribute to production) and the wealth consumed in the production process (Bockel & Tallec, 2005). In other words, the VA is the value that each agent, at each stage of the value chain, adds to the value of inputs during the accounting period of the food production process. The VA generated during the production process, from producers to retailers, plays a major role in the performance of food value chains as it directly impacts poverty and hunger.

VA can be calculated for each intermediate agri-food product and at every stage of the value chain (i.e. storage, conditioning, transport, processing, etc.). It can also increase or decrease over space and time (FAO, 2014). Calculating the VA enables to analyse the redistribution of wealth generated at each level of the chain.
The VA is calculated as the difference between the intermediate inputs used (II) and the value of the output in the post-production phase (Y). VA has five major components: (i) the salaries of workers, (ii) tax revenues to the government, (iii) returns to assets (profits), (iv) a better food supply to consumers (consumer surplus) and (v) environmental impact (FAO, 2014). Redistribution is thus measured amongst different economic agents: households (returns of labour), financial institutions (interest charges), government (taxes), and non-financial enterprises (gross income).

The impact of upgrading a value chain can be analysed at a socio-economic level by assessing the increase or decrease of the VA at every stage of the production process. An increase in the VA implies an increase in the ability of its components to better target poverty reduction and food security.

Figure 7: The concept of value added



2.3 EX-ACT tool

The Ex-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing ex-ante estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. The carbon-balance is defined as the net balance from all greenhouse gases (GHGs) (expressed in carbon dioxide (CO_2) equivalents) that are emitted or sequestered due to project implementation as compared to a business-as-usual scenario.

EX-ACT is a land-based accounting system that estimates carbon (C) stock changes (i.e. emissions or sinks of CO_2) and GHG emissions per unit of land, expressed in equivalent tonnes of CO_2 per hectare and year. The tool helps project designers to estimate and prioritize project activities with high benefits in economic and climate change mitigation terms. The amount of GHG mitigation can also be used as part of an economic analysis to facilitate funding applications for additional project components.

EX-ACT has been developed by primarily using the Intergovernmental Panel on Climate Change 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) that furnishes EX-ACT with recognized default values for emission factors and carbon values - the Tier 1 level of precision. Additionally, EX-ACT is based on chapter 8 of the Fourth Assessment Report from working group III of the IPCC (IPCC, 2007) for specific mitigation options not covered in the IPCC (2006). Other required coefficients are obtained from published reviews or international databases. For instance, embodied GHG emissions for farm operations, transportation of inputs, and irrigation systems implementation are sourced from Lal (Lal & R, 2004), and electricity emission factors are based on data from the International Energy Agency (IEA, 2013).

2.4 EX-ACT Value Chain tool (EX-ACT VC)

EX-ACT Value Chain (EX-ACT VC) is a tool, developed by FAO in 2016, that is derived from EX-ACT (EX-Ante Carbon-balance Tool). EX-ACT VC is an AFOLU, and processing and transportation framework of 8 Excel modules that provides co-benefits appraisal of crop-based value chain in developing countries on GHGs emissions, climate resilience and income.

EX-ACT VC methodology provides both a quantified socio-economic appraisal (at both the micro- and at the meso-levels (i.e. by agent, by stage and by sector), and an environmental carbon-balance appraisal (climate mitigation, adaptation and resilience). The tool facilitates project design of sustainable value chains by providing performance assessments for value chains in the following areas:

- The impact on climate mitigation is reflected through quantitative indicators, derived directly from the EX-ACT tool. These indicators are used to obtain and analyse the mitigation impacts in terms of tCO_2-e of the project. The carbon footprint of the product is calculated for the whole value chain and at different needed stage, aiming at analysing the environmental performance of the chain. The equivalent economic return is also determined and could be an important aspect to be considered when attempting, for example, to access to payments for environmental services.
- Value chain resilience is assessed using simple quantitative but also qualitative indicators. Adaptation indicators measure the reduction of vulnerability of people, livelihoods and ecosystems to CC.
- Socio-economic impact of the value chain is assessed in terms of value added, income and job generated using a socio-economic appraisal of the value chain.

2.5 Marginal Abatement Cost (MAC)

A Marginal Abatement Cost Curve (MAC curve or MACC) is a succinct and straightforward tool for presenting carbon emissions abatement options relative to a baseline (typically a business-as-usual pathway). A MAC curve permits an easy to read visualization of various mitigation options or measures, organized by a single, understandable metric - the economic cost of emissions abatement. MAC curves are useful for framing carbon emissions abatement options, providing a neat and accessible tool that orders measures on a simple economic metric (USD/tCO_2e). It will be used in the cocoa value chain to compare COCOBOD investment business options in terms of public and private cost per tCO_2e fixed.

In recent years, MACC has become very popular with policy makers, especially with the McKinsey and Company report (MacLeod, *et al*., 2010), analysing the global GHG abatement cost curves for different sectors, including agriculture. Policy-makers use MAC-curves in order to demonstrate how much abatement an economy can afford and the area of focus, with respect to policies so as to achieve the emission reductions (Bockel, Sutter, Touchemoulin, & Jonsson).

The OECD study on *Climate Change in Agriculture – Impacts, Adaptation and Mitigation has* identified the development of marginal abatement cost modelling as one of the five areas of research and policy advocacy relevant for the OECD in relation to furthering the economics of climate change in agriculture (Wreford, Adge, & Moran, 2010).

3 Current and expected government support for cocoa (2018–2028)

Increasing cocoa production through climate-smart practices could enhance the climate resilience of smallholders while boosting their incomes and protecting forests and surrounding ecosystems. An important element of such practices is the renovation and rehabilitation (R&R) of cocoa farms to halt and reverse the decreasing productivity of cocoa trees. This intervention entails improving the management of existing trees (rehabilitation) and/or replanting farms with new trees (renovation). Paired with other CSA practices such as agroforestry, appropriate fertilizer and pesticide application, and use of improved seedlings, R&R will increase productivity while sparing forested land from further destruction.

3.1 Cocoa plantation renovation and rehabilitation programme 2018–2028

The ongoing renovation and rehabilitation programme includes a series of actions. For 2018, the replanting of 58 909 ha of cocoa trees on farmland (mix of land used as annual crops and set aside lands) was planned. Furthermore, a large renovation of existing plantations has been planned that would replace 320 000 ha of diseased trees and 400 000 ha of old trees. Additionally, given the significant challenge cocoa farmers face in periods of drought, COCOBOD has planned an irrigation project for cocoa farmers that would irrigate over 200 000 ha of cocoa farms.

This rehabilitation scenario started in 2018 (budget estimated at USD 600 million) and will have a 10 year life span that will impact the entire cocoa sector. The currency rate used in the analysis during the 10 year project is USD 1 = GHc 4.7 (Ghana Cedi).

3.2 COCOBOD investments and incentives to farmers

Public investment: Based on the current budget established by COCOBOD for controlling the Cocoa Swollen Shoot Virus Disease (CSSVD) and cocoa plantation rehabilitation, every hectare treated for the virus and replanted represents GHc 6 975 or USD 1 450, while plantation rehabilitation (replacing old trees with new trees) costs GHc 5 643, around USD 1 100 per ha.

Incentives to farmers: COCOBOD currently provides financial compensation to farmers as a way of providing a grant or incentive to treat their plantations against the virus and replant them. For every hectare treated against the virus, the farmer receives GHc 552, and for every hectare replanted GHc 1 291 is offered (3news, 2018). Owners are also compensated with GHc 1 000 per ha as trees are destroyed to avoid virus expansion and there is reduced income due to replanting while trees are growing.

3.3 Farm gate market price support

In end of 2017, the President of Ghana, Nana Akufo-Addo, assured Ghanaian cocoa farmers that the government will maintain the current producer price for cocoa purchased from them during the 2017/2018 crop season, despite more than a 40 percent drop in the world market price for the commodity (Ghanaweb, 2017). The world market price for cocoa, which amounted to USD 3 000 at the beginning of the 2016/2017 season, has fallen below USD 2 000, owing to expectations that Ghana and Cote d'Ivoire (that together account for 60 percent of total global output) would slash their farm-gate prices. "Indeed, (the) government will make sure that producer prices paid to Ghanaian cocoa farmers remain unchanged, and will be in sync with those of Ivorian farmers. (The) Government is also working on the cocoa pension scheme for cocoa farmers, the first of its kind in our history," President Akufo-Addo announced. (Ghanaweb, Government to maintain cocoa producer prices for 2017/2018 season, 2017). The country pays GHc 7 600 to local farmers per ton of cocoa purchased. In the cocoa sector, the Government of Ghana and Cote d'Ivoire are expected to strengthen their partnership to further influence the pricing process on the London Stock Exchange.

4 Landscape and micro level database used in the analysis

4.1 Land use implications of rehabilitation

Table 1: Non- forest land use change under the upgrading scenario

Fill with your description	Initial land use	Final land use	Fire Use (y/n)	Area transformed (ha)	
				Current	Upgrading
Newly planted on set aside	Set Aside	Perennial/Tree Crop	NO	0	29 454.5
Newly planted on annual land	Annual Crop	Perennial/Tree Crop	NO	0	29 454.5

Source: EX-ACT VC tool, 2020

- *Converting farm land in new cocoa plantations*

Currently, 58 909 ha of previously set aside lands (50 percent) and annual crops (50 percent) will be replanted in cocoa plantations with shadow trees. This is considered in the non-forest land use changes module of the EX-ACT VC tool as shown below.

- *Renovation of 400 000 ha of old plantations and replacement of 320 000 ha of CSSV -affected trees*

These degraded cocoa areas produce low yields (300 kg per ha) and will be cleaned and replanted with appropriate selected seedlings that would progressively reach a yield of 1 000 kg per ha. In terms of carbon mitigation, the biomass growth generated by renovated plantations is estimated at 1.82 tC per ha per year for above ground biomass and 0.44 tC per ha per year for below ground biomass (Cardinael, R, et, & al, 2018) as shown in table 2.

- *Improved agroecological practices on remaining planted areas (1 080 000 ha) with targeted irrigation support (200 000 ha)*

These improved actions should increase yield from 600 kg/ ha to 700 kg / ha, while additional irrigation support should increase the yield by a factor of 2.5 (1 500 kg/ha).

These elements are critical data points in describing the dimension of the rehabilitation process (total of 720 000 ha) and the targeted improvement of practices on other existing plantations. These elements are also taken into consideration under the perennial systems module with specific yields (yellow column), distinguishing the current situation and the upgrading scenario (see table 2).

Table 2: Perennial systems remaining as perennials

Perennial systems from other LU	Residue/ biomass burning	Yield (t/ha/yr)	*Area concerned (ha)*		Tier 2 ABG Biomass growth (tC/ha/yr)	*Default value*	Tier 2 BLG Biomass growth (tC/ha/yr)	*Default value*	Tier 2 SOC growth (tC/ha/yr)	*Default value*
			Current	*Upgrading*						
Perennial after Deforestation	NO		0	0		2.6		0		0.7
Perennial after non-forest LU	NO	1.00	0	58 909		2.6		0	1.21	0.7
Perennials staying as perennials:										
CSSA virus and old plantations	YES	0.30	720 000	0		0		0		0.7
Rehabilitated cocoa plantations	NO	1.00	0	720 000	1.82	0	0.44	0	0.61	0.7
Other cocoa plantations	NO	0.60	1 080 000	0		0		0		0.7
Other cocoa plantations with CSA	NO	0.70	0	880 000		0		0	0.61	0.7
Irrigated cocoa plantations	NO	1.50	0	200 000	1.82	0	0.44	0	0.61	0.7
		Total area	1 800 000	1 800 000						

Source: EX-ACT VC tool, 2020

4.2 Input and labour use data in both current and upgrading scenario

The main inputs for cocoa production are cocoa seedlings, fertilizers, pesticides, fungicides as well as farming equipment, such as harvesting hooks (locally known as "go-to-hell"), cutlasses (large knives to break pods), pruners and spraying machines.[1] Pesticides and fungicides are widely used against common threats of cocoa production, such as the black pod disease, CSSV and capsids (mirids), whereas fertilizers help to revive soils and increase yields (World Bank, 2013). COCOBOD retains an active role in the distribution of improved planting material and agro-inputs (Monastyrnaya, Joerin, Dawoe, & Six, 2016).

It is considered that 90 percent of the cocoa areas (1 620 000 ha) are currently fertilized with an average of 111 kg of NPK 15-15-15 and 2 kg of insecticide per ha (Cobbina & J, 2014). Fertilizer use will progressively increase to 176 kg/ ha, while use of insecticide will increase to 3 liters. On 30 percent of cocoa areas, farmers use compost (1000 kg per ha per year); the practice will progressively be extended to 60 percent of areas. All these crop-based inputs are considered on the EX-ACT value chain tool in table 3.

[1] Based on farmer interviews.

Table 3: Crop-based input under different scenarios

4.2.1 - Fertilizer consumption at production level :							
Please fill this part both for crop or feed crop (livestock)							
	Specify NPK parts (%)			Amount introduced and corresponding areas			
				Current		Upgrading	
List of specific fertilizers	N	P	K	Qty (Kg/ha/yr)	Area (ha)	Qty (kg/ha/yr)	Area (ha)
Lime				0	0	0	0
Urea	47%			0	0	0	0
Other N-fertilizer	40%			0	0	0	0
N fertilizer in irrigated rice	38%			0	0	0	0
Sewage	5%			0	0	0	0
Compost	4%	1.5%	1.2%	500	540 000	800	1 115 345.4
Phosphorus synthetic fertilizer (P2O5)		10%		0	0	0	0
Potassium synthetic fertilizer (K2O)			10%	0	0	0	0
Please enter your specific NPK synthetic fertilizer (N other than urea and not for irrgated rice):							
NPK 15-15-15	15%	15%	15%	111	1 620 000	176	1 673 018.1
Description#2	0%	0%	0%	0	0	0	0
Description#3	0%	0%	0%	0	0	0	0
Description#4	0%	0%	0%	0	0	0	0
Description#5	0%	0%	0%	0	0	0	0

4.2.1 - Pesticides consumption at production level :				
	Amount introduced and corresponding areas			
	Current		Upgrading	
Type of pesticides	Qty (kg/ha/yr)	Area (ha)	Qty (kg/ha/yr)	Area (ha)
Herbicides (kg of active ingredient per year)	0	0	0	0
Insecticides (kg of active ingredient per year)	2	1 620 000	3	1 673 018.1
Fungicides (kg of active ingredient per year)	0	0	0	0

Source: EX-ACT VC tool, 2020

Table 4: Production loss and water management at the farm level

	Current	Upgrading
Percentage of wasted production or mortality rate (%)	5%	3%

Table 5: Man-days spent per hectare

Man -days	Current MD/ ha	Foreseen MD/ ha
Land preparation-tillage	8	10
Seeding- input procurement	4	8
Weeding - treatment	10	15
Manure- compost delivery	5	6
Harvesting- farm transport	20	25
Pruning, cleaning	6	8
fruit breaking, fermentation- drying	6	12
Total man-days per ha	**59**	**94**

Better tree management and improved harvest conditions will also help reduce harvest loss from 5 percent to 3 percent. Cocoa is harvested by cutting the ripe pods from the trees, breaking them open and extracting the beans. The beans are fermented for 6 or 7 days with 2 or 3 turnings before drying for another 7 days in the sun. The beans are then bagged, graded and sealed for export. The labour data is entered in the EX-ACT economic analysis are presented in table 6 and 7.

Table 6: Family labour spent - current scenario

Crop production (man-days/ha)	
% of family labour	80%
Land preparation-tillage	8
Seeding- input procurement	4
Weeding - treatment	10
Manure- compost delivery	5
Harvesting- farm transport	20
Pruning and cleaning	6
Fruit breaking, fermentation- drying	6
Total man-days per ha	**59**

Source: EX-ACT VC tool, 2020

Table 7: Family labour spent - rehabilitation scenario

Crop production (man-days/ha)	
% of family labour	60%
Land preparation-tillage	10
Seeding- input procurement	8
Weeding - treatment	15
Manure- compost delivery	6
Harvesting- farm transport	35
Pruning and cleaning	8
Fruit breaking, fermentation-drying	12
Total man-days per ha	**94**

Source: EX-ACT VC tool, 2020

***Post-harvest cracking, fermentation and drying process**: The harvested pods are collected together, the pods cracked open with a wooden baton and the wet beans removed by hand. The wet beans are fermented for some days to ensure the chocolate flavor is developed upon roasting in the factories. Fermentation is done by heaping of 90-250 kg of wet cocoa beans on plantain leaves, and then covered again with more plantain leaves. This should be done away from full sunlight and that is why it is done at the farm and must be turned after three days to ensure even condition in the heap. The corrosive liquid from the wet beans starts flowing after the second day of the fermentation process. When the fermentation process is completed, the beans are sent to the villages to be dried on raised bamboo mats for 7-10 days or longer depending on the weather condition because the beans normally take a longer time to dry during the raining season. The drying should be a gradual process for the beans to attain the best quality of cocoa as possible with no defective beans. When the beans crack in the hand when rubbed together then they are said to have achieved the desired level of dryness and 7.5 percent moisture content left. They are then cooled for one more day and ready to be sold*

Source: (Nbabuine, 2012)

Most of the information given in the previous EX-ACT VC modules are automatically considered in the economic analysis module, where only information on costs have to be addressed where needed. All prices are entered in the local currency and converted in USD according to the currency exchange rate assumed in this study.

4.3 Input, energy and labour costs used

The current farm gate price supported by the Government for 2017-18, is at GHc 7 600 per ton. The NPK price per bag of 25 kg, is at GHc 108 (subsidized at 50 percent by the government). The price of compost is currently estimated at 600 GHc/ton. The price per liter of insecticide is assumed to be at 40 GHc and premix fuel to be at 5.7 GHc/liter. The wages per day of work in agriculture is estimated at 8 GHc/day. The part of hired labour in cocoa is currently estimated to be around 55 percent of labour used, and could reduce to 40 percent in a labour intensive rehabilitation scenario. Higher wages are used downstream for workers and truck drivers.

4.4 Cocoa transport from farm

There are different sequences of transport by truck and is as follows - first, the cocoa is transported from farms to primary collectors with smaller vehicles (distance covered by tricycle-transporter to village is around 5 km), then with 6-7 ton trucks to Licence Buying Company (LBC) wholesalers (20 km), finally followed by bigger trucks to processors (300 km) and exports (15 km to harbour).

Cocoa beans are packaged in jute sacks to maintain the 7 percent moisture required. The sack is perforated to allow air circulation during transportation and is thick enough to absorb excess moisture when they are being shipped in containers. The haulage of the beans from the farmers to the ports has been outsourced to private transportation companies. These are transportation companies that have registered their company names with COCOBOD. The haulage companies are close to a point where cocoa beans need to be evacuated to the takeover or shipping port are notified. The companies send their waybill to COCOBOD who intend arrange for it to be paid (A Step-by-Step Explanation of Cacao Harvesting & Processing, 2018).

Table 9 shows how the cost is computed for upstream transport, assuming it is done with trucks transporting 7 tons over 400 km to the LBC, acting as wholesalers for COCOBOD. Trucks are mostly service providers, although there are some that directly work with LBCs. The cocoa value chain engages over 990 trucks that are managed by 330 operators (assuming 3 trucks per operator). A series of other annual costs per transport operator is considered (over USD 2 700) in addition to the staff and fuel costs.

Table 8: Transport used at different stages of value chain

Place of departure	Type of transport	Type of conditioning	Nb of km	% of loss	
Farm	*Between 1 and 2*			current	upgrading
	Truck in country	Please select	5	0%	0%
Collectors	*Between 2 and 3*				
	Truck in country	Please select	40	0%	0%
Wholesaler					
	Truck in country	Please select	400	0%	0%
Processing/storage					
	Truck in country	Please select	15	0%	0%
Harbour initial					

Source: EX-ACT VC tool, 2020

Pederson shows that rural transportation, which accounts for only 4 percent of the total transport distance, contributes to almost half of total transport costs from Ghana to Europe and is almost 500 times more expensive than maritime transport in USD tonne-km (Pedersen, 2001).

Table 9: Upstream transportation costs

Upstream transportation cost

Option#1:				
			Local currency	USD
Transportation cost (per tonne), i.e. without considering wage for driver and co.			0	-
Option#2:				
Quantity in tonne transported / truck			0	
Nb of litre consumed / truck per 100 km			0	
Nb of operators			0	
Assumption: 1 operator = 1 truck x 100 truckloads / year*			0	tonne collected
				Tier 2
Truck load* to be changed at tier 2 if different:			100	
Number of truck			1	
Upstream transportation	km		price of fuel	USD per tonne
	5		0	0.00
Upstream transportation labor			Wage per day	salary USD per tonne
Nb of driver-eq	0		0	0.00
Nb of driver assistants-eq	0		0	0.00
Assumptions: 2 assistants per driver, if not pls change:				
Transportation cost per tonne of product				USD
Salary / tonne transported				0.00
			litre	USD
Fuel consumed round trip farm-processor			0.00	0.00
Other costs at transportation level per tonne transported				USD per tonne
Food, …			0	0
Various			0	0
Other cost per unit of processing			Cost per operator	USD per operator
Maintenance of processing equipment +oil			100 000	18 587
Maintenance and reparation of truck			5 000	929
Renewed equipment (including bags, boxes…)			40 000	7 435
Building renting			120 000	22 305
Stocking chemicals			20 000	3 717
Capital amortization per year			130 000	24 164
Credit costs			50 000	9 294
Total cost per tonne of product				**USD 1 644**

Source: EX-ACT VC tool, 2020

4.5 Downstream operators: wholesalers – Licence Buying Companies (LBC)

There are 20-30 LBCs working as wholesalers under the control of COCOBOD that are mastering the export process. In the case of COCOBOD, warehousing starts from the shed of the LBC until the time the beans are evacuated to the takeover centres of Tema, Takoradi and Kumasi. Upon reaching these centers, the beans are received by warehouse managers into the warehouse sheds and are counted to check if the quantities match those on the waybill. The received beans are then stacked in the warehouse and fumigated for a fortnight, after which they are ready for shipment (Nbabuine, 2012).

4.6 Exports

All the cocoa exports are delivered to a subsidiary of COCOBOD – the Cocoa Marketing Company (CMC), which stores cocoa in three take-over centres (Tema, Takoradi and Kaase) prior to shipment (World Bank, 2013). CMC has exclusive rights to the marketing and exports of cocoa beans to local and foreign buyers. In addition, CMC manages pre-harvest forward sales and contracts at a fixed price with international merchants and cocoa processors to hedge against price volatility. Around 60 percent - 80 percent of cocoa is pre-sold (World Bank, 2013). In March 2018, COCOBOD pre sold cocoa at USD 2 200 per ton. According to the International Cocoa Organization (ICCO), the price of cocoa has dropped by about 18 percent from over USD 2 700 on May 1, 2018 to over USD 2 300 as of June 11, 2018.

5 Foreseen socio-economic and climate impact of cocoa sector rehabilitation

5.1 Socio-economic value chain impact

The current upper cocoa value chain (without downstream processing, retail and export) generates USD 1.17 billion of gross product and USD 800 million of value added. However, this result is yet to be completed with data from processing and export.

Table 10: Socio-economic performances of the value chain

Socio-economic performances of the value chain	Current	Upgrading	Balance	
Production level				
Nb of HH	0	800 000		
Nb of employement-eq	424 800	698 950	274 150	jobs
Gross production Value (GPV)	**1 171 700**	**2 346 409**	1 174 710	000 USD
Value Added (VA)	**800 438**	**1 827 199**	1 026 762	000 USD
Gross Income (GI)	**700 274**	**1 635 592**	935 318	000 USD
VA / tonne of product	**965**	**1 100**	135	USD
VA / ha	**445**	**983**	538	USD
Gross income / HH	**875**	**2 044**	1 169	USD
COLLECTORS AND LBC WHOLESALERS				
Nb of operator eq	60	0		
Nb of employement-eq	5 466	6 876	1 410	Jobs
Gross production value	**121 079**	**148 612**	27 533	000USD
Value added	**95 860**	**104 026**	8 167	000 USD
Gross income	**86 473**	**84 099**	-2 374	000 USD
VA / employee	**17 536**	**15 128**	-2 408	USD
Gross income / employee	**15 819**	**12 230**	-3 589	USD
DOWNSTREAM PROCESSING				
Nb of operator-eq	12	13		
Nb of employement-eq	2 001	4 006	2 006	Jobs
Gross processed production value (GPPV)	**159 597**	**319 604**	160 007	000 USD
Value added	**140 461**	**281 311**	140 850	000 USD
Gross income	**138 302**	**277 356**	139 055	000 USD
VA / tonne of product	**564**	**565**	0	USD
Gross income / operator	**11 525 137**	**21 335 097**	9 809 960	USD
COCOBOD EXPORT				
Nb of operator eq	1	1		
Nb of employement-eq	104	208	104	Jobs
Gross production value	**423 777**	**862 013**	438 236	000 USD
Value added	**423 492**	**861 463**	437 970	000 USD
Gross income	**420 004**	**859 475**	439 471	000 USD
VA / operator	**423 492 420**	**861 462 559**	437 970 139	USD
Gross income / operator	**420 004 354**	**859 475 182**	439 470 828	USD

Aggregated Socio-economic performances	Current	Upgrading	Balance	
Value added	**1 460 250**	**3 073 999**	**1 613 749**	000 USD
Gross production value	**1 876 152**	**3 676 638**	**1 800 486**	000 USD
Total job generated	**432 371**	**710 040**	**277 669**	Jobs created

Source: EX-ACT VC tool, 2020

At the production level, the rehabilitation scenario will augment the gross production value to USD 2.34 billion, while generating around 274 000 additional employments. The gross income per producer should increase from USD 875 to USD 2 044 over 8 years, indicating an increase in household income by a factor of 2.3 generated by cocoa at the farm level. Including downstream processing and export, the aggregate value added and gross production value is USD 1.6 billion and USD 1.8 billion respectively. Such performances reflect the high efficiency of the rehabilitation scenario in creating poverty reduction and improving producers' livelihoods.

5.2 Climate mitigation impact of the cocoa value chain

In the present analysis, we assumed no changes in energy and inputs used during the downstream phase and in the transport between the current situation and rehabilitation scenario. Therefore, GHG changes between the two scenarios are mostly due to changes in the management and upgrading of cocoa plantations and production practices (newly planted and restored 720 000 ha) and agricultural inputs.

Over the whole duration of the VC analysis, i.e. 20 years, the baseline scenario emits 1.1 million tCO_2e. With the implementation of the wide rehabilitation scenario, the carbon balance of the upgrading scenario demonstrates a high mitigation performance of above 7.3 million tCO_2-e fixed per year (over 146 million tCO_2-e over a period of 20 years). Every hectare of cocoa fixes on average 3.9 tCO_2 per year per ha. This co-benefit of the value chain represents an economic value of USD 118 per year per ha when using the social price of CO_2 (USD 30/ tCO_2)[2].

Table 11: Climate mitigation impact of the value chain

Climate mitigation dimension of the Value Chain	Current	Upgrading	Balance
GHG impact (tCO_2-e per year)	1 118 280	-6 193 355	
GHG impact (tCO_2-e per year per hectare)	0.6	-3.3	-3.9
Carbon footprint of production (tCO_2-e per tonne of product)	1.3	-4.3	-5.6
Annual tCO_2-e [emitted (+) / reduced or avoided (-)]		-7 311 635	
Annual tCO_2-e from renewable energy		0	
Equivalent project cost per tonne of $CO_{2\text{-}e}$ reduced or avoided (in USD on 20 years)		6	USD
Equivalent value of mitigation impact per year (USD 30/tCO_2-e)		219	USD million
Equivalent value of mitigation impact per year per ha (USD 30/tCO_2-e per year per ha)		118	USD
Carbon footprint at the different levels of the Value Chain	**tCO_2-e per tonne of product**		**Balance**
	Current	**Upgrading**	
PRODUCTION	1.32	-4.29	-5.60
PROCESSING	0.07	0.08	0.01
TRANSPORT	0.09	0.08	0.00
TOTAL	1.47	-4.13	-5.60

Source: EX-ACT VC tool, 2020

[2] World Bank recommended price in 2016 for the economic analysis of carbon mitigation impact.

This GHG impact highlights the potential of the cocoa value chain in being a main GHG fixing engine, especially since it fixes carbon at a very low public cost per ton. Considering the whole rehabilitation budget of USD 600 million is being spent by GOG (Government of Ghana) on sustaining pro-poor growth of the cocoa value chain, the resilience of the value chain, and on supporting climate mitigation, it would realistic to consider that the budget spent for GHG reduction would be a maximum of 20 percent. In such a case, the public cost per ton of CO_2 fixed would be of USD 1, making cocoa investment among the best in terms of GHG reduction performance per USD spent.

As no changes in energy and inputs consumption occur between the current and upgrading scenario at the processing and transport level, the carbon footprint is quite similar, both being around 0.08 tCO_2-e per tonne of cocoa product. From the present analysis, the cocoa carbon footprint from production to transport is therefore widely negative, but it does not yet include downstream processing in semi processed cocoa and chocolate. Such a significant negative carbon footprint demonstrates the highly green production process effected by cocoa rehabilitation.

5.3 Climate resilience impact

The rehabilitation scenario includes a series of improved practices that are going to increase the crop resilience to climate change, to viruses and diseases, and to market shocks. Moreover, it increases the producers' resilience in terms of poverty reduction.
The results in table 13 are based on a series of ratings made by project experts between 0 and 4 for every question asked in this module. It is a qualitative appraisal of the extent to which the upgrading scenario creates a buffer capacity for the value chain and households to natural shocks, to food security, resilience and the self-organization of households, market resilience and adaptation capacity for the value chain (see list of questions in annex 1).

Table 12: Climate resilience - quantitative results

Source: EX-ACT VC tool, 2020

Climate resilience dimension (s)	Upgrading	
Hectares of land managed under climate-resilient practices	**1 858 909**	ha
Hectares with improved tree and vegetal coverage (land slide, flood resilience)	**1 858 909**	ha
Number of hectares with increased soil carbon (drought and erosion resilience)	**1 858 909**	ha
Number of HH having become more climate resilient	**800 000**	HH

Table 13: Climate resilience - qualitative results

Resilience index of the value chain upgrading	**Upgrading**
Buffer capacity of watershed and landscape and project area	high
Buffer capacity of crop –livestock production	high
Buffer capacity of households in relation to food security	medium
Self-organisation of households	medium
Learning capacity of households	medium
Global climate resilience generated by Value chain	**medium**

Source: EX-ACT VC tool, 2020

5.4 Marginal Abatement Cost (MAC) analysis of COCOBOD business models

- *Towards low carbon business models in agricultural value chains*

Academic research and corporate practice are increasingly employing the business model as a unit of analysis, offering a systemic perspective on how to 'do business' with the aim of understanding how to improve the ability of companies to create financial value. Undoubtedly, sustainable development is not possible without the sustainable development of corporations and smaller companies. One of the options that combines economic, environmental and social issues are sustainable business models. Therefore, the thinking of business managers and policy makers should support the creation of such valuable solutions to cope with environmental and social challenges (Seroka-Stolka, *et al.*, 2017).

Sustainable business models are intended to create economic value while benefitting the environment and society. Sustainability is now a mainstream business concern, and leading companies around the world recognise the opportunity – and the imperative – of being part of the solution. They are positioning themselves to thrive in a new green economy by setting emissions reduction targets in line with what science says is required to prevent the deleterious effects of climate change.

- *COCOBOD business models*

In terms of investment weight, two main business models are derived from the Ghana cocoa rehabilitation strategy. These models are outlined below, with public investment support cost, subsidy- incentives to farmers and landowners, private costs and benefits generated, and positive externalities such as negative carbon footprint (high potential of mitigation) and climate resilience.

This cost-benefit analysis is based on detailed 2018 costs of COCOBOD's recent rehabilitation work plan that covered around 43 000 ha, and is also based on the first results of the FAO-COCOBOD value chain study. The CSSV control removal, replacement of virus affected trees (22 850 ha), and the rehabilitation of old cocoa tree plantations are based on an agroforestry approach using shadow trees, plantain suckers and hybrid cocoa seedlings –all of which are planted over two years. It is managed with a series of incentives to farmers (initial treatment grant, replanting grant) and land owners (land grant) to compensate the slot of years with low production. The replanting process is managed with strict controls (control assistants, disease spotters) and professional operators.

The COCOBOD investment plan targets to have over 170 000 ha of cocoa plantations rehabilitated over 4 years (USD 170 million), while the global target is to rehabilitate 720 000 ha (USD 937 million) over about 10 years. Such data demonstrates the need to mobilize donors.[3]

The below business models reflect the investment costs and benefits expected from such a large-scale operation, and what the returns are expected at the producer level (financial analysis), at the country level, and at the level of COCOBOD. The business model is built based on per ha rehabilitated, allowing for a quick switch to the cost of the whole strategy. The positive externalities or the GHG benefits realised per ha are accounted for 20 years.

[3] A donor roundtable showing these results may be organised in the future, if necessary.

- *Business Model 1: Replanting virus destroyed plantations (320 000 ha)*

Table 14: Business model 1- replanting virus destroyed plantations

Replanting virus destroyed plantations (CSVV) : investment public cost	USD *Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Year 6*	*Year 7*	*Year 8*
Equipment and material	80.89							
Cocoa and shadow tree seedlings	401.19							
Compost	132.00							
Staff	302.75							
Incentives- farmer grants	368.63							
Owner compensation	100.00							
Total	**1 385.46**							
Without project yield	0.20	0.15	0.1	0.1	0.1	0.1	0.1	0.1
With project yield	0	0	0.05	0.1	0.2	0.4	0.6	0.8
Incremental yield	-0.20	-0.15	-0.05	-	0.10	0.30	0.50	0.70

Most of the investment costs stem from purchasing cocoa and tree seedlings (USD 401/ ha), staff costs (USD 302/ ha) and providing incentives to farmers and owners (USD 368/ ha and USD 100/ ha). The payment for environment service (PES) incentive provided to the farmers (USD 368.63 in addition to the income they receive) would be 97 percent of their current gross income earned per ha (USD 378.45), which would effectively almost double their income. The resulting total public investment cost per ha is around USD 1 385.

The analysis provides a financial Net Present Value (NPV) of USD 4 166 per ha to farmers with a high Internal Rate of Return (IRR) due to the widely subsidized investment ensured by COCOBOD (USD 1 495 of investment per ha). The economic analysis using the COCOBOD export price (minus transport and value chain costs) provides an NPV of around USD 4 110/ ha for the whole country. The NPV moves up to USD 7 131 when GHG externalities are considered. As a mitigation option, the replanting of virus destroyed plantations generates a MAC public cost of USD 9.9 per ton of CO_2. When associated with the negative private cost (financial income of farmers), MAC is negative at - USD 19, meaning that the economy earns USD 19 per ton of CO_2 fixed.

At the country level, this business model could potentially fix over 46 million tCO_2 over 20 years with 320 000 ha rehabilitated. It would need USD 443 million of investment, which includes the USD 33 million that GOG already invested in 2018.

Table 15: Net Present Value and Internal Rate of Return for business model 1

Replanting virus destroyed plantations	NPV (USD)	IRR
NPV at financial price per ha	4 165.56	62 %
NPV at eco price per ha	4 110.18	25 %
NPV eco with carbon per ha	7 131.48	30 %
Public cost per ton of CO_2	9.90	-
Private cost per ton of CO_2	-28.79	-
Marginal abatement cost (public + private cost)	-18.90	-

Table 16: Economic benefits of business model 1 at country level

Target	320 000	Ha targeted

GHG/ha	7.23	tCO_2/ha/yr
GHG/yr	2 314 667	tCO_2/ yr
GHG total	46 293 333	tCO_2 over 20 years
Total	443	Million USD of investment
Total	2 282	Million of eco NPV with carbon

- *Business model 2: Rehabilitating old cocoa plantations (400 000 ha)*

Similar to the first business model, the investment costs primarily stem from purchasing cocoa and tree seedlings (USD 400/ ha), with reduced staff cost (USD 204/ ha) and reduced incentives to farmers (USD 258/ ha) – resulting in a total public investment cost that is lower than that of business model 1. The payment for environment service (PES) incentive provided to the farmers in this model (USD 258.04) would be 68 percent of their current gross income earned per ha (USD 378.45) – lesser than the resulting income earned by farmers in business model 2. This model is a bit less profitable since an old plantation that still produces cocoa is being replaced by a new plantation that takes 6-8 years to become productive. On year 8, the incremental yield provided by new plantations is still low at around 0.8 tonne/ha.

The NPV is at USD 3 671 with 41 percent of IRR for farmers, which is lower than that of business model 1. The economic return at the government level, considering public costs and economic price based on export price, is at an IRR of 24 percent, which increases to 30 percent when GHG externalities are accounted. Combining public and private costs, this option fixes every ton of CO_2 with a negative MAC cost of USD - 17.3 (high private benefit). The public MAC cost is of USD 8/ tonne of CO_2. At the country level, this model presents a critical GHG mitigation strategic option by fixing around 58 million tCO_2 in 20 years for a total cost USD 454 million. The total NPV with carbon is over USD 2.7 billion.

Table 17: Business model 2 - rehabilitating old cocoa plantations

Replanting old cocoa plantations (Rehab) : investment public cost	**USD** *Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Year 6*	*Year 7*	*Year 8*	*Year 9*	*Year 10*
Equipment and material	38.87									
Cocoa and shadow tree seedlings	400.88									
Compost	132.00									
Staff	204.65									
Incentives- farmer grants	258.04									
Owner compensation	100.00									
Total	**1 134.44**									
Without project yield	0.20	0.20	0.20	0.15	0.15	0.15	0.1	0.1	0.1	0.05
With project yield	0	0	0.05	0.1	0.2	0.4	0.6	0.8	0.9	1
Incremental yield	-0.20	-0.20	-0.15	0.05	0.05	0.25	0.50	0.70	0.80	0.95

Table 18: Net Present Value and Internal Rate of Return for business model 2

Replanting from old plantations	NPV (USD)	IRR

NPV at financial price per ha	3 671.48	41 %
NPV at eco price per ha	3 811.84	24 %
NPV eco with carbon per ha	6 833.13	30 %
Public cost per ton of CO_2	8.10	-
Private cost per ton of CO_2	-25.50	-
Marginal abatement cost (public + private cost)	-17.39	-

Table 19: Economic benefits of business model 2 at country level

Target	400 000	Ha targeted
GHG/ha	7.23	tCO_2/ha/yr
GHG/yr	2 893 333	tCO_2/ yr
GHG total	57 866 667	tCO_2 over 20 years
Total	454	Million USD of investment
Total	2 733	Million of eco NPV with carbon

6 Conclusion

Using the Ex-Ante Carbon Balance Value Chain Tool (EX-ACT VC), this paper assesses the current contribution of the cocoa value chain in Ghana towards climate mitigation, climate resilience and socio-economic impact, and its potential to significantly scale such impact through a rehabilitation and renovation (R&R) strategy by 2028.

The expansion strategy would involve improving the cocoa value chain through the following measures:

- improving the management of existing virus/ disease affected trees and old trees (rehabilitation) – approx. 720 000 ha.,
- planting new cocoa trees in existing farms (renovation) – approx. 58 909 ha., and
- implementing other CSA practices such as agroforestry, appropriate fertilizer and pesticide application, and use of improved seedlings.

Cocoa has an enormous potential to mitigate climate change in Ghana and through COCOBOD's R&R strategy can:

i. fix almost 7.3 million tons of CO_2e per year (i.e. 146 million tons of CO_2e over 20 years), resulting in 5.6 tons of CO_2e reduced per ton of cocoa produced,
ii. generate a 38 percent increase in income per working day for cocoa producers (from USD 7.54/day to USD 10.46/ day),
iii. increase employment, with approx. 277 000 additional jobs by 2028,
iv. create a gross production value of approx. USD 3.6 billion (increase of about 96 percent from 2018 to 2028) for the value chain, and
v. fix carbon with a negative marginal abatement cost between USD -17 and USD -18 per ton of CO_2 - this negative public and private cost results from private benefits that are much higher than public costs for both types of rehabilitation (virus affected trees and old trees). Public investments show an Internal Rate of Return of 30 percent each.

In the absence of detailed cost data from downstream operators, a few rough estimations were made for the purpose of this analysis. There was limited data available for the downstream part of the value chain, especially for business cost of wholesalers and transporters, functional cost of truck transportation (labour and diesel consumed per truck), distances of transport from collecting centers to wholesalers, and tax and capital costs for downstream operators etc. An assumption of no change in downstream prices between the current and the upgrading scenario has been made owing to the general volatility of prices downstream. The model results are rough estimate of value added and should not be used in any audit. These data gaps will be covered by complementary data collected by FAO in early 2020 on a combined study of Ghana and Ivory Coast cocoa value joined market.

Based on the preliminary results from the EX-ACT VC analysis, implementing the R&R strategy will make a marked impact in mitigating the effects of climate change and enhancing the climate resilience and livelihoods of those living in Ghana, thus making the cocoa value chain a key Pro-Poor Carbon-Fixing Engine for the region.

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Annex 1: Qualitative appraisal of climate resilience generated

7- Qualitative appraisal of climate resilience induced

Data entry for qualitative appraisal of climate resilience induced by project to be done in light blue cells

		Expert group assessment (0-4)	Indicator weighting (0-3)	
	Buffer capacity of watershed, landscape and project area			
1	To what extent does upgrading the value chain improve land cover? (e.g. agroforestry, cover crops etc.)	4	3	
2	To what extent does upgrading the value chain reduce soil erosion?	4	3	
3	To what extent does upgrading the value chain improve soil conditions (e.g. soil moisture, soil structure etc.)?	3	3	
4	To what extent does upgrading the value chain improve efficient use of water?	3	2	
5	To what extent does upgrading the value chain save water?	0	2	
6	To what extent the value chain area upgraded is protected from climate shocks ?	4	3	
7	To what extend the value chain infrastructure - building investments are climate-proof ?	3	2	
	Sub-Result	**57**	**high**	*36*
	Buffer capacity of systems production	**(0-4)**		
8	To what extent does upgrading the value chain reduce crop failure?	4	3	
9	To what extent does upgrading the value chain improve resistance of crops to pests and diseases?	4	3	
10	To what extent does upgrading the value chain improve resistance of livestock to pests and diseases? (e.g.	0	0	
11	To what extent does the project reduce post -harvest losses?	4	3	
12	To what extent does upgrading the value chain increase practice of mixed cropping/intercropping?	4	3	
13	To what extent does upgrading the value chain promote on-farm diversity (annuals/perennials, mixed cropping, mixed farm enterprise e.g. livestock-crop)?	1	3	
14	To what extent does upgrading the value chain reduce (crop/livestock) yield variability?	4	4	
	Sub-Result	**67**	**high**	*38*
	Buffer capacity of households in relation to food security	**(0-4)**		
15	To what extent does upgrading the value chain improve household food availability (e.g. through increased household food production or improved household access to food)?	2	3	
16	To what extent does upgrading the value chain improve household food storage ?	2	2	
17	To what extent does upgrading the value chain improve household income?	4	4	
18	To what extent does upgrading the value chain increase agricultural production physical assets?	4	3	
19	To what extent does upgrading the value chain improve access of households to agricultural inputs?	3	3	
20	To what extent does upgrading the value chain support (existing or new) farmer groups and networks?	3	2	
21	To what extent does upgrading the value chain increase agricultural skills?	3	3	
22	To what extent does upgrading the value chain improve access of households to climate-related social safety nets (e.g. climate-index agriculture insurance, cash, vouchers, warehouse receipt systems etc.)?	2	3	
	Sub-Result	**68**	**medium**	*46*
	Resilience and self-organisation of households	**(0-4)**		
23	To what extent does upgrading the value chain improve cooperation and networks of farmers (e.g. farmer groups, farmer field schools, farmer organisations etc.)?	3	3	
24	To what extent does the value chain upgraded collaborate with national/sub-national farmer/pastoralist organisations (capacity of farmers/pastoralists to influence decisions)?	1	2	
25	To what extent does upgrading the value chain support farmer-networks across scales (e.g. local farmer groups being connected to national farmer organisations; bridging/linking social capital)?	3	2	
26	To what extent are farmers actively participating in the upgrading project?	2	3	
27	To what extent does upgrading the value chain foster good governance (keeping of records; accounting for exclusion, elite capture and corruption) in farmer cooperation and networks?	2	3	
28	To what extent does upgrading the value chain improve farmer skills to manage groups?	1	1	
29	To what extent does upgrading the value chain link agriculture value chains?	1	2	
30	On-farm reliance: To what extent does upgrading the value chain build on local knowledge?	2	2	
	Sub-Result	**36**	**medium**	*36*
	Market resilience and adaptation capacity to value chain	**(0-4)**		
31	To what extent does upgrading the value chain improve farmer knowledge of threats and opportunities to agricultural production (e.g. climate specific awareness programmes)?	3	3	
32	To what extent does upgrading the value chain improve access to extension services?	4	3	
33	To what extent does upgrading the value chain improve farmer/pastoralist experimentation (e.g. through farmer/pastoralists field schools, climate field schools, exchange visits)?	2	3	
34	To what extent does upgrading the value chain improve access to climate information (e.g. seasonal forecasts adapted for agriculture, workshops)?	2	2	
35	To what extent does upgrading the value chain improve access to market information?	2	4	
36	To what extent does upgrading the value chain improve access to communication networks (e.g. mobile networking, radio programmes)?	2	2	
	Sub-Result	**43**	**medium**	*34*
	Total resilience index	**271**	**medium**	*190*

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