Sustainable financing ecosystem for cocoa irrigation in Ghana: A literature review

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Abstract: Based on a systematic literature review using scientific database search engines and an opportunistic review of published and unpublished government, international and non-governmental organization reports on cocoa from the internet, the paper explores sustainable irrigation financing feasibility and the potential for different cocoa systems. We design a conceptual framework and propose a sustainable financing ecosystem for supplemental irrigated cocoa farming in Ghana and a qualitative data collection tool based on the conceptual framework and insights from the literature review.

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Executive Summary

Cocoa has a major stake in the performance of the Ghanaian economy, and increasing its yields within a sustainable forest ecosystem is a government focus through several interventions. Public, private and non-governmental initiatives aim to increase the sustainability and productivity of Ghana's cocoa sector. The Government of Ghana increased investment in targeted extension services, drought and disease research, and access to fertilizers and insecticides and partially privatized some roles, such as crop transportation in the cocoa sector, to achieve cocoa intensification.

However, regional climate change and microscale weather patterns are impacting production and present risks to cocoa's future in West Africa, including Ghana. Most production areas in Ghana have inadequate rainfall to meet crop water requirements, especially for seedlings needed to replant farms. Higher temperatures, increased rainfall variability and prolonged drought– all associated with climate variability and change - are expected to increase by 2050 with negative effects on cocoa production.

Water is at the center of urgently needed reforms to rehabilitate farms, improve productivity across multiple production seasons, and mitigate the threats associated with climate change. The need to improve agricultural water management for farm rehabilitation and productivity across all growing seasons has increased. Some stakeholders are exploring irrigation use and different cocoa systems. Drought-tolerant varieties, improved in-situ soil and water conservation, and, more recently, supplemental irrigation, especially in the northern and eastern parts of the cocoa belt, have been put forward as options to mitigate the negative impacts of weather-related factors.

Reforms continue to progress in the cocoa sector, including initiatives supported through international and bi-lateral development partners. Public and private capital is readily available, and the private sector is eager to find attractive investment opportunities that help advance cocoa farm renovation and rehabilitation.

The review follows a systematic literature review using scientific database search engines and an opportunistic review of published and unpublished government, international and non-governmental organization reports on cocoa from the internet to explore sustainable irrigation financing feasibility and the potential for different cocoa systems. We design a conceptual framework and propose a sustainable financing ecosystem for supplemental irrigated cocoa farming and a qualitative data collection tool based on the conceptual framework and insights from the literature review. The specific objectives were (i) analyzing the financing ecosystem of the agricultural sector in Ghana and identifying gaps and opportunities for financing irrigated cocoa production in Ghana and (ii) designing data collection tools to identify/design actionable strategies/pathways to accelerate sustainable financing of cocoa irrigation investments.

The review links the concept of supplemental cocoa irrigation through maintaining cocoa ecosystem biodiversity and forest ecosystem services at the national level. We analyze the existing forest ecosystem financing and management issues, agricultural-related funding sources and the need to situate cocoa ecosystems challenges, needs and funding, particularly supplemental irrigation of cocoa farms, within the context of forest ecosystem services and the general funding environments for forest management and agricultural food crops using the conceptual framework developed. The review also describes Ghana's different segments of cocoa systems (cocoa

segmentation by climatic changes). It focuses on financing demands for irrigated cocoa production systems, and the gaps and opportunities for financing irrigated cocoa production in Ghana.

The review suggests and proposes that enhancing cocoa biodiversity through cocoa farm supplemental irrigation financing could increase farm productivity and support the provision of other services and hence, needs to be factored into sustainable financing arrangements under forest (Ministry of Lands and Natural Resources) and agricultural policy funding trajectories (Ministry of Agriculture and COCOBOD) to protect sustainable use of resources in the cocoa farming sector. This literature review contributes to developing actionable strategies and pathways to accelerate sustainable financing for cocoa supplemental irrigation investments.

The key summaries from the literature review are:

Financing the forest and agricultural sector in Ghana to restore forest cover

Funding mechanisms exist within the agricultural (forest and crop sub-sectors) sector, which have been assessed to implement forest ecosystem management and enhance agricultural intensification. Forest reserve funding mechanisms and forest-based strategies to improve the livelihoods of forest communities, restore the degraded forest cover and sustain agricultural intensification are relevant for cocoa ecosystems management in addressing important supplemental water needs through irrigation for maintaining cocoa trees to add to the reforested areas and sustain rural cocoa communities' livelihoods. The Modified Tuangya System could be tailored to meet such objectives. These financing arrangements are long-term investments. The REDD+ Program recognizes agricultural lands within forest zones as "Agro-forestlands" and has provisions to incentivize cocoa farm owners to adopt climate-smart farming practices such as agroforestry.

On the other hand, financing interventions to help improve the crop sector by accessing agricultural inputs and business advisory services are short-term financing products. These financing arrangements provide different opportunities for farmers to access funds. They are three options and/or combinations: loans, subsidies and input-credits, all on different repayment terms.

The literature review points to some synergies between forest sector funding mechanisms, food crop funding modules and cocoa sector funding in the light of the need for carbon sequestration and impacts on the cocoa tree agroforestry system and cocoa farmer livelihoods. Perhaps partnerships in the Climate Cocoa Partnership for REDD+ Preparation project (Hutchins et al. 2015) that has Olam and Rainforest Alliance, in collaboration with the Forestry Commission, could sustain financing the forest and the cocoa sector to help cocoa trees become more resilient to moisture and temperature changes due to climate change and contribute to REDD+ carbon finance options through their increased carbon stocks on the farms. While the existing studies find climate change effects unfavourable to cocoa farmers unless farmers adapt, access to financing mechanisms to mitigate rainfall variability in restoring cocoa forest cover would require a combination of short- and long-term financing instruments.

Financing demands for supplemental small-scale cocoa farm irrigation investments

Focusing on the financing demand for cocoa farm irrigation services, the literature review found no studies in Ghana (and elsewhere) that directly ask cocoa farmers about these services. However, many studies find that when asked about constraints to cocoa production, farmers mentioned declining soil fertility, high incidence of pests and diseases, high exposure to droughts and temperature extremes, poor agronomic practices, and inadequate farm maintenance. From the review, it is acknowledged that productivity on cocoa farms could be raised through a combination of agronomic practices and cocoa farmers' demand for technology and input packages, including soil testing, improved seedlings and fertilizers, and improved farm management practices. In light of climatic changes, the quest to adopt farm-level technologies to sustain cocoa farm intensification through supplementary cocoa farm irrigation will increase with COCOBOD's pioneered pilot cocoa farm supplementary irrigation programme. It is anticipated that with increasing climatic challenges, the profitability of cocoa farm enterprises on a commercial-oriented cocoa farm may demand the financing of supplemental irrigation and farm-related activities. However, access and purchasing of such equipment will depend on costs, accessibility and availability (such that no farmer is disadvantaged, including women, youth, and migrants) of the irrigation equipment at the local level and the demonstrable technical sustainability of the technology.

Gaps, opportunities and risks

There exist gaps, opportunities, and risks in the push for supplemental irrigation of cocoa farms under threat from climate change effects in Ghana. The review of the relevant literature suggests gaps such as the lack of appropriate data and research on cocoa farmers' demand for cocoa farm irrigation services; funding sources for sustaining cocoa ecosystem functioning limited to the general forest ecosystem and to cocoa (the focus seems more on rehabilitation and replanting of the cocoa tree, whilst the cocoa ecosystem faces both biophysical and socio-economic challenges); and only the COCOBOD is championing the institutional/stakeholder collaboration in delivering efficient agricultural water management to cocoa farms through irrigation is whilst other partners, and stakeholders pursue alternative cocoa crop productivity arrangements.

Nonetheless, there are opportunities in harnessing the existing environment in the push for supplemental irrigation of cocoa farms that includes the expansion of small-scale private irrigation in many SSA countries, driven by farmers' initiatives and investments and coupled with COCOBOD efforts in providing smallholder cocoa farmers with irrigated facilities. In addition, the demand for cocoa farm irrigation and its financing mechanisms are emerging, and cocoa farmers' awareness about climate change drivers has been raised through several interventional projects and training on adaptation and mitigation strategies. Besides, business models for farmers' on-farm irrigation exist, and the government is interested, and there are potential private funding sources for financing supplemental irrigated cocoa production.

However, perceived risks exist in terms of smallholder farmers being considered too risky and costly to finance; the under-developed demand and supply market for irrigation equipment, particularly for cocoa irrigation; poor farmer financial support in agricultural financing, especially farm irrigation infrastructure needs; and high interest on financial support from financial institutions.

The identified gaps, opportunities and risks provide for financing cocoa farm irrigation equipment and the effective demand for this equipment. It requires COCOBOD and the relevant stakeholders to provide the supportive environment needed to develop an effective business-case that can encourage private firms to engage in these technology transfers to the farm level.

Need for a sustainable financing ecosystem for irrigated cocoa production

The financing arrangement with farmers to provide cocoa farm irrigation is not yet developed. One suggestion is for water management on cocoa farms using drip irrigation, although the costs outweigh the benefits, with a high upfront investment for irrigation. With climatic effects threatening agriculture, the argument is that finance is only one element of constraints on adopting farm technologies, suggesting that solutions need to be integrated.

The proposed sustainable financing ecosystem for irrigated cocoa production will be a special purpose vehicle (SPV)[1] that mobilizes funds from private and public (blended finance) for long-term investment purposes and will be spearheaded by COCOBOD given her role in the oversight of the cocoa industry and the pioneering role in the supplemental cocoa farm irrigation project. Most financing programs for smallholder farmers offer relatively small loans for short periods and often at high real interest rates. This financing arrangement does not advocate short-term loans to purchase a relatively expensive irrigation system for cocoa farming.

The SPV will grant loans and financial advances to the cocoa farmers, individually or in groups, and accept repayments and deposits. A financing mechanism based on an arrangement with the private sector that spreads out payments and enables cocoa farmers to benefit could minimize risks to the financing scheme.

For sustainability, in terms of technical and institutional, stakeholders would include financial institutions, actors in the cocoa landscape, NGOs, licensed cocoa buying entities, commercial cocoa farmers and Cocoa Farmer Cooperatives, guided by clear policies and regulatory frameworks to facilitate the institutional financing arrangements.

The proposed financing system would link critical actors, their roles and functions, to sustaining the cocoa farmer's farm irrigation efforts. These actors include government ministries and agencies, research institutions (CRIG, WRI, GIDA, etc.), cocoa farmer associations, private entities providing smallholder farm services (farm irrigation equipment, other farm inputs), NGOs and licensed cocoa buying agencies, the financial institutions and traditional authorities. How these actors relate to each other in a coordinated and strategic linkage to the smallholder cocoa farmer and the financing structure will be important for achieving the cocoa farm supplemental irrigation and intensification objective. The specific roles and functions of the critical actors are envisioned as follows:

The proposed financing aims to develop the rural economy and the livelihoods of cocoa farmers sustainably by providing short-term and long-term credit to adapt to climatic changes in cocoa agriculture intensification. Achieving this objective requires solutions for cocoa farmers and close collaboration among the stakeholder actors, including the government actors, the private sector and the non-governmental organizations (NGOs) in the cocoa landscape and key to sustaining

[1] https://www.tradefinanceglobal.com/legal/spv-financing/

farmer commitment and continued investments, particularly in financial, social and environmental sustainability, that ensures the farmer achieve returns on investments.

The review also proposes a primary data collection tool for identifying and designing actionable strategies/pathways for accelerating sustainable financing for cocoa irrigation investments (included in the appendices). We used the reviewed literature to design data collection tools to address the proposed sustainable financing of cocoa farm irrigation, which provides social, environmental, and economic benefits to the smallholder farmer and the economy.

There are three modules of seven categories, where three modules are (a) interview guides that are geared to officials of COCOBOD, MoFA, Forestry Commission, NGOs in the cocoa production space, farmer key informants such as executives of farmer-based organizations (FBOs); (b) structured questionnaires to sampled cocoa farmers; and (c) interview guides for focus group discussions (FGDs). The underlying objectives of the various modules are:

(a) COCOBOD/MoFA/Researchers

The main outcome of this interview guide will be to understand the rationale for the cocoa irrigation pilots and their up-scaling mechanisms. It will also solicit an understanding of the financing mechanisms (free, subsidized, outright payment, etc.), the sustainability of the funding and irrigation systems, and farmer feedback.

(b) Forestry Commission (FC)

The Forestry Commission (FC) has funding mechanisms for forest ecosystem management under REDD+, including cocoa landscapes. The main outcome of interview guides will be to understand the forest management's scale (on/off forest reserves) and the funding mechanisms relative to cocoa ecosystem restorations. It also solicits information on possible funding rationale for supplemental irrigation in the cocoa landscape and the collaboration with COCOBOD on funding arrangements.

(c) LBCs/NGOs in the cocoa production space

Several cocoa licensed buying agencies (LBCs), and NGOs operate in the cocoa space as buying organizations and/or as cocoa production sustainability champions. The interview guide will address the relevance of supplemental irrigation and the cocoa sector's ongoing renovation and rehabilitation efforts. In addition, funding arrangements in the rehabilitation process and its possible financing of irrigation in cocoa will be solicited. Farmer responses to irrigation demand will also be solicited.

(d) Farmer Key Informants

Farmer key informants *(KI's)* include FBO executives, chief cocoa farmers and input distributors. Information sought from the informants will include the COCOBOD irrigation pilots and up-scaling rationale, farmer demand for farm irrigation and other farm services in light of the changing climate, and the preferred funding mechanisms. The key question will be who funds the initiative and the farmers' contribution.

(e) Structured Farmer Questionnaires

The focus of this structured questionnaire will be to *understand the capacity of the cocoa farmer* to engage in the sustainable cocoa irrigation financing scheme, their ability to participate and pay for the irrigation scheme and their preferred funding arrangements.

(f) FGDs interview guides

Focus group discussions will be structured around interactions with 9-10 male, female and youth cocoa farmers (≤35 years) in selected communities. Like the KIs, the information sought will include the COCOBOD irrigation pilots, up-scaling rationale, farmer demand for farm irrigation and other farm services, and the preferred funding mechanisms. The key question will be who funds the initiative and the farmers' contribution.

(g) Financial Institutions

Financial institutions *(FI)* will play key roles in intermediating between the funding institutions and the farmers. The interview guide will seek to understand financial institutions' various products, specifically for smallholder farmers' cocoa financing. It will also solicit FI's opinions in participating in the proposed sustainable financing of cocoa farmers' irrigation, the benefits and the risks, among others.

1.0 Introduction and objectives of this review

Ghana is the second largest cocoa bean producer globally, after the Ivory Coast, and represents about 20% of global production. Cocoa is cultivated mainly in the Ashanti, Brong-Ahafo, Volta, Central, Eastern and Western regions, generating US$2 billion in foreign exchange annually and accounting for 30% of Ghana's total export revenue. About 3.2 million cocoa workers represent 60% of Ghana's agricultural labor force. Companies that purchase cocoa and cocoa products in West Africa include Ecom, Nestle, Barry Callebaut, Glander Yayra Glover, Cadbury, Cargill, Unilever, Fairafric and Lindt, and many other global and niche companies.

Cocoa is the backbone of Ghana's agricultural economy and holds historical, cultural, and political significance. However, regional climate change and microscale weather patterns are impacting production and present risks to the future of cocoa in West Africa. Larger-scale climate change and extreme weather events threaten the sector's future in Ghana. Most production areas have inadequate rainfall to meet crop water requirements, especially for replanting farm seedlings. Higher temperatures, increased rainfall variability and prolonged drought – all associated with climate variability and change - are expected to increase by 2050 with negative effects on cocoa production. Water is at the center of urgently needed reforms to rehabilitate farms, improve productivity across multiple production seasons, and mitigate the threats associated with climate change. Cocoa producers, researchers, extension agents and buyers have all expressed the need to improve agricultural water management for farm rehabilitation and productivity across all growing seasons. Some stakeholders are exploring irrigation feasibility and the potential for different cocoa systems. Drought-tolerant varieties, improved in-situ soil and water conservation, and, more recently, supplemental irrigation, especially in the northern and eastern parts of the cocoa belt, have been put forward as options to mitigate the negative impacts of weather-related factors. National and international researchers are also analyzing climate change impacts in relation to cocoa production.

1.1 Cocoa and the Ghanaian economy

Cocoa is the mainstay of the Ghanaian economy as it generates more than USD 2.2 billion annually in foreign earnings. Ghana is the world's number one producer of premium quality cocoa and the second-largest producer in volume (COCOBOD, 2021), offering employment for millions and providing a livelihood for nearly 800,000 to 1 million smallholder farmers (COCOBOD, 2012).

Cocoa in Ghana is grown by smallholder farmers who farm on ~2 hectares or less of land. Cocoa cultivation is mainly in eight regions of Ghana's current 16 regions: Ashanti, Ahafo, Bono, Central, Eastern, Volta, Western and Western North regions (old six regions of Ghana's ten regions: Ashanti, Brong Ahafo, Central, Eastern, Volta and Western regions). The cocoa sector in Ghana is under the Government of Ghana, whose institution, the COCOBOD, operates a monopoly over producing and exporting cocoa beans. Currently, the COCOBOD is under the Ministry of Food and Agriculture. The COCOBOD oversees cocoa beans' export and internal marketing, cocoa research and extension services to farmers, and cocoa bean quality control. The internal purchasing of cocoa beans is done through private sector companies registered and licensed with COCOBOD.

Cocoa produced by the Western Region (Western and Western North regions) accounts for ~60% of production due to the shift into new forest land from the old cocoa-growing regions of the Eastern, Ashanti, Central, and Volta regions due to the upsurge of swollen shoot virus disease. This shift to the forest regions highlights a sustainability concern due to land use change driven by cocoa production.

After emerging as the world's leading cocoa producer in the 1960s, the sector declined in the early 1980s due to several problems, including price disincentives. The 1990s saw a revitalization of the cocoa sector. From Figure 1.1 for total cocoa purchases for Ghana, cocoa production at the end of 2010/2011 attained over one million tonnes, and showed a positive trend for production volumes from 1947/48 to 2019/2020. Regarding regional cocoa production trends, between 1947/48 and 2019/2020, cocoa production volumes have fallen for the Brong Ahafo, Ashanti and Volta regions, with a stagnant trend in the Eastern Region with a slight decrease, whilst strong cocoa production output trends are observed for the Central and Western Regions. Whilst the aging farmer population and a general lack of agrochemicals and incentives for farm work persist in all production regions, diseases and climatic factors have tended to impact more negatively of cocoa production more in the Brong Ahafo, Ashanti and the Volta Regions (Okyere & Mensah, 2016).

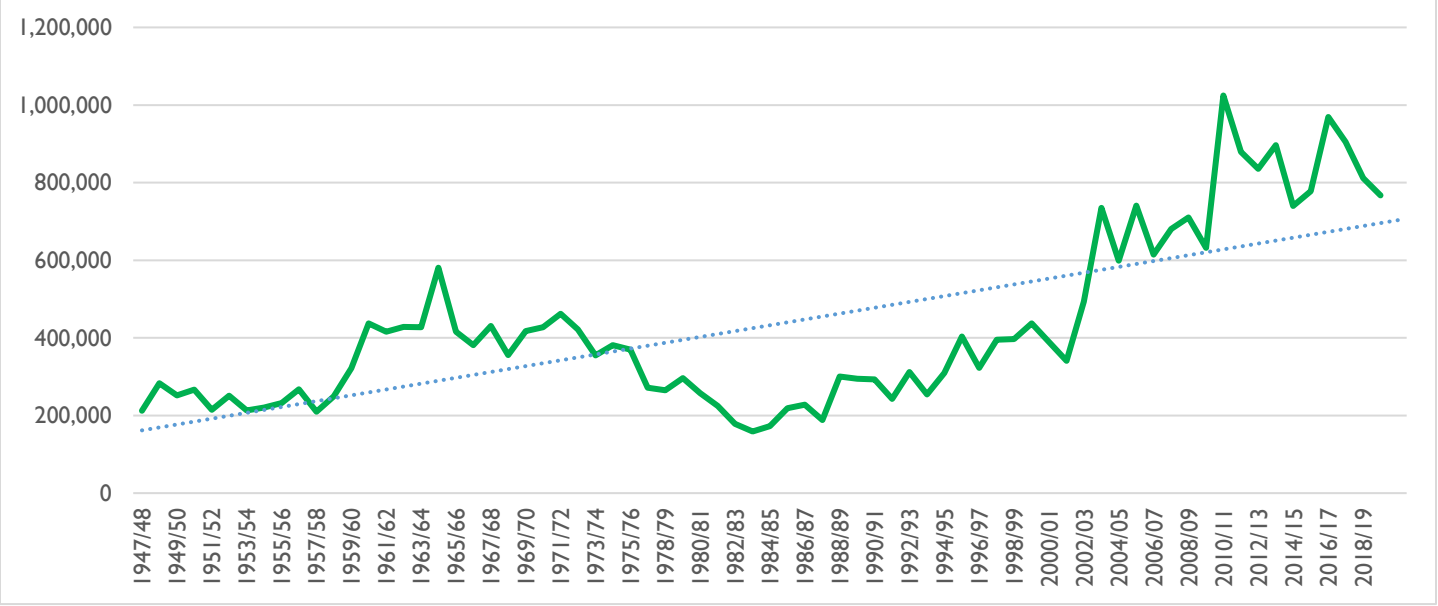


Figure 1.1: Purchases of Cocoa beans, Ghana 1947/48-2019/2020

Source: COCOBOD 2021

Solidaridad Ghana (2013) provides estimated yield levels associated with the different cocoa farming systems regarding technology adoption. Ghana's average annual cocoa yield was 400 kg/ha under the low-input, low-output extensive farming system, consisting of about 50 to 65% of output, which compares unfavorably to the Ivory Coast (580 kg/ha) and Indonesia (800 kg/ha) as

at 2013. Akrofi-Atitianti et al. (2018) also assert that on average, Ghana's cocoa productivity is 330kg/ha; Cote D'Ivoire, Indonesia and Malaysia, on the other hand, produce 580kg/ha, 770kg/ha and 1,700kg/ha on average respectively. However, under sustainable agricultural intensive cocoa farming, yields between 1.4-2.0MT/ha output could be achieved in Ghana.

Besides the socio-economic factors (ageing cocoa farmers, low farmer access to credit) that hamper increased farm yields, several biophysical factors (pests and diseases: Black pod disease, Mirids/capsids and the Swollen shoot) also undermine the production of cocoa in Ghana. Besides the sustainability issues in cocoa farming, there are the threatening effects of climate change and the declining interest of the youth to take agriculture.

Over the last decade (2005-2020), to reduce the impact of these sustainability-threatening variables and to enhance cocoa productivity, there have been efforts to increase the adoption of intensification practices in the cocoa sector in Ghana through the COCOBOD Hi-Tech programme, investments in Disease and Pest Control CSSVD (Mass Spraying) and the access to free cocoa seedlings to farmers, which itself, from a sustainability perspective, increases farmers' costs, and creates other environmental challenges associated with (over) use of pesticides. Under a Productivity Enhancement Programmes (PEPs), COCOBOD has invested in programmes aimed at stimulating higher productivity among farmers, including (a) an enhancement of the National Cocoa Rehabilitation Programme, (b) the National Pruning Exercise, (c) Hand Pollination Programme (d) Re-launch of the Cocoa Disease and Pest Control Program (e) Cocoa Roads Project, and (f) Cocoa Farm Irrigation Programme (COCOBOD, 2018, 2021).

Several other innovations have also been introduced in the cocoa sector to enhance productivity: (a) the Cocoa Management System (CMS), among others, to ensure a census of all cocoa farmers in Ghana as well as mapping of all farms with regards to implementation and the delivery of major interventions in the cocoa sector and collect data on every transaction within the industry about cocoa purchases, input sales, the delivery of subsidies to farmers and the clocking of all extension officers for all-farm visits; (b) the Cocoa Farmers Pension Scheme to guarantee a decent pension for cocoa farmers in Ghana that is open to all cocoa farmers in Ghana via voluntary contributions towards their retirement while COCOBOD makes a supplementary contribution for the farmers; (c) the implemented Living Income Differential (LID), where buyers are supposed to pay an extra US$400 in addition to the prevailing world market price of every tonne of cocoa beans purchased.

1.2 Justification for the literature review

Cocoa farming as part of the forest ecosystem provides global biodiversity conservation, genetic resources and non-timber forest products (NTFP), hence a need to maintain cocoa ecosystem capacity to maintain these benefits in the future, which is potentially threatened by anthropogenic impacts such as climate change, land use and unsustainable management practices. With cocoa as a major stake in the performance of the Ghanaian economy, increasing yields within a sustainable forest ecosystem is a government focus through several interventions. Public, private and non-governmental initiatives aim to increase the sustainability and productivity of Ghana's cocoa sector. For example, the Cocoa and Forests Initiative Agreement between the governments of Ivory Coast and Ghana and over 37 major cocoa and chocolate companies, announced at the UN Climate Change Conference in November 2017, seeks to end deforestation and replenish the trees and forests destroyed as a result of the cocoa production push into forested regions, particularly in Ghana. Recently, the Government of Ghana increased investment in targeted

extension services, drought and disease research, access to fertilizers and insecticides, and partially privatized roles, such as crop transportation. Local processing has also increased compared to earlier periods. Reforms continue to progress in the sector, including initiatives supported through international and bi-lateral development partners.

Public and private capital is readily available, and the private sector is eager to find attractive investment opportunities that help advance cocoa farm restructuring. This report, therefore, identifies relevant literature and a conceptual framework and proposes a sustainable financing ecosystem for supplemental irrigated cocoa farming and a qualitative data collection tool based on the conceptual framework and insights from the literature review. The specific objectives include (i) analyzing the financing ecosystem for the agricultural sector in Ghana and identifying gaps and opportunities for financing irrigated cocoa production in Ghana and (ii) designing data collection tools to identity/design actionable strategies/pathways to accelerate sustainable financing for cocoa irrigation investments.

The structure of this review is as follows. The next section outlines the conceptual framework and the methodology used for the literature review on the sustainable financing ecosystem for the irrigated cocoa system. This review links the concept of supplemental cocoa irrigation through maintaining cocoa ecosystem biodiversity and forest ecosystem services at the national level. Using the conceptual framework developed, we first analyzed the existing forest ecosystem financing and management issues, agricultural-related funding sources and the need to situate cocoa ecosystems challenges, needs and funding, particularly supplemental irrigation of cocoa farms, within the context of forest ecosystem services and the general funding environments for forest management and agricultural food crops. The review also describes Ghana's different segments of cocoa systems (cocoa segmentation). It focuses on financing demands for irrigated cocoa production systems, and the gaps and opportunities for financing irrigated cocoa production. The review suggests and proposes that enhancing cocoa biodiversity through cocoa farm supplemental irrigation could increase farm productivity and support the provision of other services and hence, needs to be factored into sustainable financing arrangements under forest (Ministry of Lands and Natural Resources) and agricultural policy funding trajectories (Ministry of Agriculture and COCOBOD) to protect sustainable use of resources in the cocoa farming sector. This literature review contributes to developing actionable strategies and pathways to accelerate sustainable financing for cocoa supplemental irrigation investments.

The review also proposes a primary data collection tool for identifying and designing actionable strategies/pathways for accelerating sustainable financing for cocoa irrigation investments.

2.0 Conceptual framework

The conceptual framework for reviewing the financing ecosystem for Ghana's agricultural sector and the gaps, opportunities and risks for financing irrigated cocoa farm systems are presented in Figure 1.2. The conceptual framework for this literature review increases our understanding of the linkages envisaged in the sustainable financing ecosystem for irrigated cocoa farming. It explores dynamic systems with feedback loops. The conceptual framework consists of four main dimensions to identify the links between the key priority needs and current gaps, opportunities and risks. Some of the underlying assumptions for sustainable models for financing supplemental irrigated cocoa farming that helps to further propose a framework for the financing ecosystem's

structure (actor(s), their networks and relationships, institutions, infrastructure, etc.), function (activities and functions, boundary and enabling environment) and sustainability:

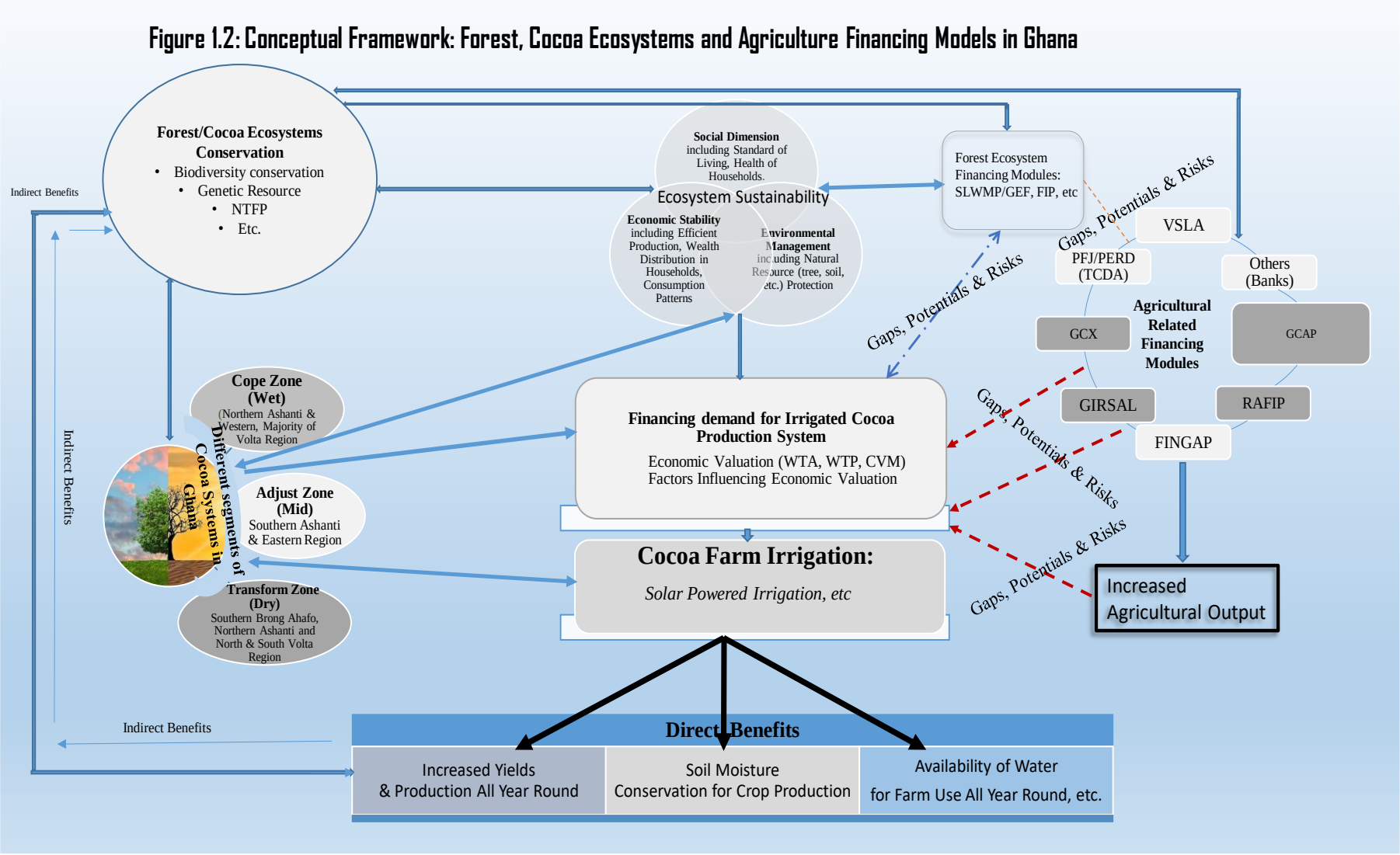
- Forest/Cocoa ecosystem conservation need/sustainability issues/forest ecosystem financing modules
- Agricultural-related financing and modules
- Segmentation of cocoa systems in Ghana and the finance demand for irrigated cocoa production inclusivity (youth, gender, etc.)
- Gaps, opportunities and risks for financing sustainable irrigated cocoa production systems and for sustainably increasing cocoa yields

We situate the cocoa ecosystem (cocoa tree crop production and agroforestry) within the general sustainable forest, biodiversity, and genetic resources conservation that impacts farmers' social, economic, and environmental well-being. Existing ecosystem financing models under the Ghana Forestry Commission (under the Ministry of Lands and Natural Resources), such as the Sustainable Land and Water Management Project (SLWMP) under the Global Environment Facility (GEF), Forest Investment Programme (FIP), etc. that support forest ecosystem sustainability were considered as a pathway for cocoa ecosystems development for Ghana with livelihood objectives for the smallholder cocoa farmer.

There are also agricultural-related financing models in Ghana to strengthen agribusinesses to increase actors' incomes along selected value chains. However, these models mainly support food crops in rural and peri-urban areas. Still, they do not transform access to finance, share risks to tree crops in the agricultural sector, and highlight an emphasis on food security, which is typical across most African countries. Agricultural policies tend to favour food crops over fibre/industrial crops. The differentiated segmentation of cocoa production in Ghana based on climate change effects (dry/wet zones) suggests preserving the cocoa forest ecosystem for sustainable agricultural intensification.

Existing business models on solar-powered irrigation can support cocoa farm irrigation by providing direct benefits of increased yields and all-year-round production, enhanced soil water conservation for crop production and all-year water availability for farm use, and an analysis of a sustainable financing scheme and a financing demand through cocoa farmer consultations for irrigated cocoa systems are germane.

Figure 1.2: Conceptual Framework: Forest, Cocoa Ecosystems and Agriculture Financing Models in Ghana

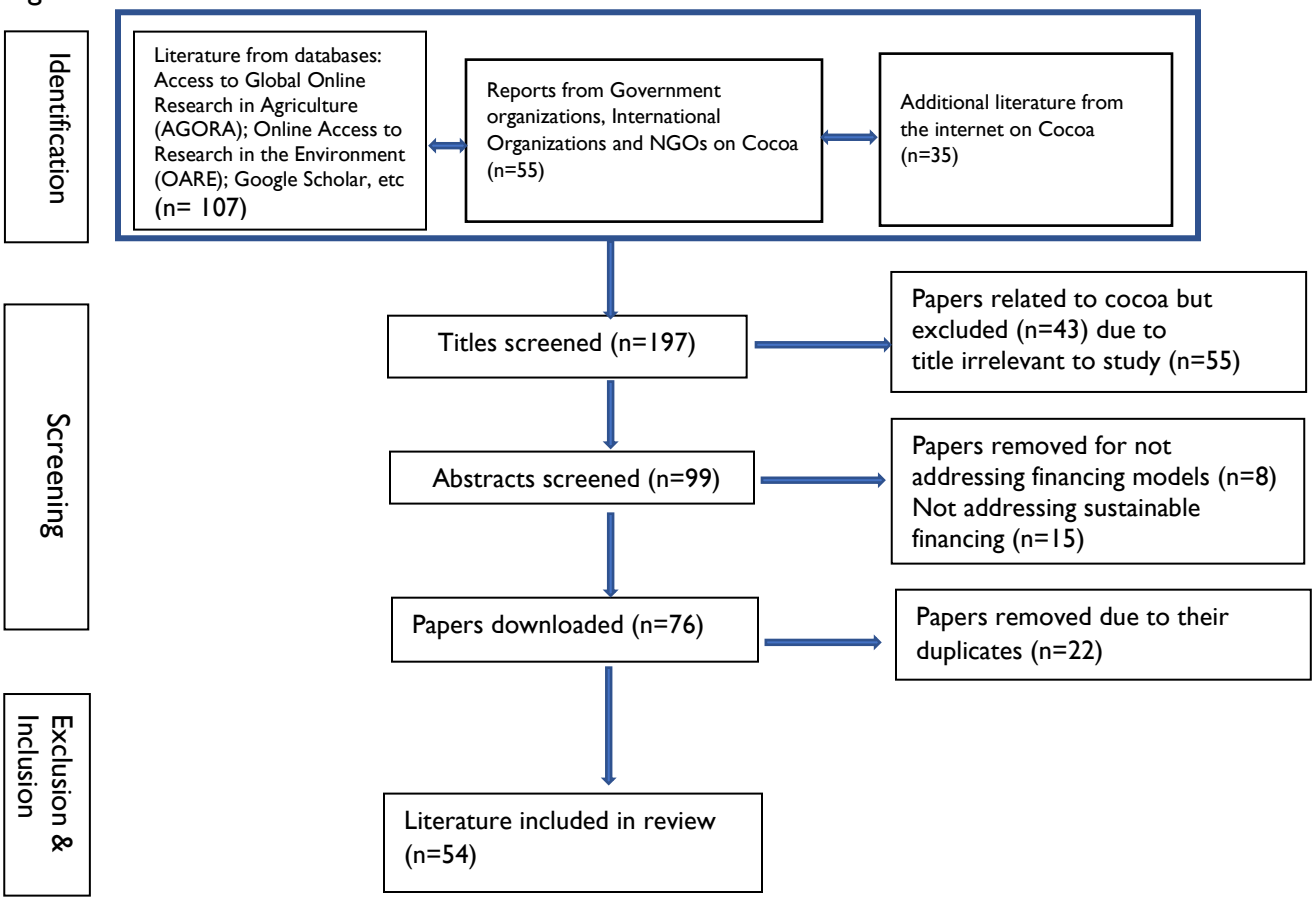


Source: Author

3.0 Methodology of the literature review

A systematic literature review search from scientific databases (Access to Global Online Research in Agriculture (AGORA); Online Access to Research in the Environment (OARE); Google Scholar) and an eclectic (opportunistic review of both published and unpublished reports) data search on government, international and non-governmental organization reports from the internet was followed to respond to the outlined conceptual framework (Figure 1.2). The aim was to understand the context of proposing a sustainable financing mechanism for cocoa farm supplemental irrigation under climate vulnerability for cocoa farmers in Ghana.

Figure 1.3: Schematic Flow for the Literature Search



Source: Authors

The Boolean and string combinations used in searching for relevant articles primarily focus on "*cocoa*", "*sustainable financing*", "*farmers' adaptation to climate change*", "*forest ecosystem*", "*tree crop financing*", "*ecosystem financing in agriculture*", "*cocoa AND climate change*", "*irrigation AND cocoa farming*", "*irrigation AND climate change adaptation*" and "*cocoa irrigation financing*". The identified, screened and included (excluded) literature volumes with emphasis on Ghana are presented in Figure 1.3. Through the literature review process, it was imperative to search for literature by categorising relevant studies, which increased the chances of designing a relevant framework based on peer-reviewed and credible reports. Relevant articles located were further mined for

additional citations. We examined references of key articles for relevant citations that could be traced and included by checking on the coverage relevance of the articles. When references were selected for the review, we focused on those that illustrated the core background and theoretical and methodological concepts related to the topic of the review, as well as recent relevant studies. This was done by paying attention to the relevant articles and documents' abstracts. Using a citation manager, Mendeley, helped store citations used to generate the references.

4.0 The existing financing models for the forest and agricultural sector in Ghana: a review

4.1 Forest ecosystem conservation in Ghana

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4.1.1 Managing Sustainable Forest Systems in Ghana

Most of Ghana's forests lie in the high forest zone and are categorized into forest reserves and off-reserve areas. Forest reserves are managed for timber production and biodiversity conservation and have several areas severely degraded or deforested due to overexploitation. Off-reserve areas, mostly converted to agriculture land-use, and partly dominated by perennial crops like cocoa and oil-palm, have little remaining closed canopy forests (Oduro, Mohren, Affum-Baffoe & Kyere, 2014) and are also exploited for remaining timber products. In 2005, Reducing Emissions Deforestation in Developing Countries (REDD): Approaches to Stimulate action[2] discussed measures for tackling emissions due to deforestation and land degradation in natural forests. In 2009 the REDD+: "reducing emissions from deforestation and forest degradation in developing countries on the one hand, and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries on the other", were discussed[3]. For the singular purpose of combating the threat of deforestation through comprehensive reforestation and sustainable forest plantation development, and a carbon sequestration plan, Ghana signed up for the REDD+ Program in 2010.

Ghana joined the REDD+ with the principal goal of reclaiming 40% of its degraded forest lands and supporting green carbon forest Plantation Development; while fulfilling the REDD+ safeguards by promoting climate-smart agrarian activities in cocoa-growing communities, especially in communities within the Land use, Land-use Change and Forestry (LULUCF) of the country's High Forest Zone (World Bank, 2015). Three such programs have been launched, including (a) an emission reduction programme for the Cocoa Forest Mosaic landscape within the high forest zone, (b) an emission reduction programme for the shea landscape within the savanna forest zone, and (c) tree tenure and Carbon Rights Policy and legislative reforms for enhanced benefit sharing regime. Between 2021 and 2036, REDD+ Program Implementation in Ghana is expected to remove 255.0 $MtCO^2e$ from Ghana's atmosphere (United Nations, 2018). Climate Smart Cocoa (CSC) is not only about avoiding future losses but also about mitigating greenhouse gas (GHG) emissions and improving the livelihoods of farmers by increasing the productivity and resilience of their farms (Bunn et al., 2019).

[2] At the 11th session of the Conference of the Parties (COP) of the UNFCCC, Papua New Guinea and Cost Rica, on behalf of the Coalition for Rainforest Nations (CfRN).

[3] 15th session of the COP's convention in Copenhagen in 2009

Ghana's development agenda, from Vision 2020, Ghana Poverty Reduction Strategies (GPRS I & II) to the Ghana Shared Growth, and Development Agenda (GSGDA), has always prioritized forest conservation as part of the country's commitment to the global sustainable development agenda. Following the 2015 replacement of the Millennium Development Goals (MDGs) with the seventeen (17) Sustainable Development Goals (SDGs), in which goal 15 entreats UN member countries to take steps to conserve and restore ecosystems, halt biodiversity loss, deforestation and land degradation in combating climate change, with target 2 of SDG 15 advocating doing so in a sustainable way, Ghana has intensified its commitment towards the global SDGs agenda, especially with the coming on board of several international funding windows to support member states in that regard (United Nations, 2018).

Before the global MDGs and SDGs, several policies were in place in Ghana for enhancing sustainable forest governance: the Forest Commission Act of 1960 (amended in 1999); the Forest Concession Act of 1962 (amended in 1999—Act 571); the Land Administration Act of 1984; the Control and Prevention of Bushfires Law of 1990, Forest and Wildlife Policy of 1994 (amended in 2001), the Forest and Plantation Development Act of 2000 (Act 583 - that gave private commercial timber producers financial assistance to carry out their forest plantation and harvesting activities) and the Forest Protection Act, 2002 (Act 624); the Timber Resources Management Act of 1997, amended in 2002 and 2003 (an amendment of the 1999 Forest Commission Act that established the Timber Utilization Contracts (TUCs) to ensure that landowners and local farmers from whose forestlands trees are harvested, benefit from harvest proceeds. The amendment also banned chainsaw operations in commercial tree harvesting and introduced competitive bidding for timber harvesting grants for private sector players. Finally, the Timber Resources Management Act policy gave the Forestry Commission absolute power to disqualify the harvesting rights of persons who engage in illegal chainsaw operations (Ministry of Lands and Natural Resources, 2014).

A Forest Law Enforcement Governance and Trade (FLEGT) Voluntary Partnership Agreement (VPA) between Ghana and the European Union of 2008 ensured that only legally produced timber from Ghana was licensed for the EU market. Watts et al. (2018) state that even though the VPA has helped in removing the restriction in the allocation procedure of timber rights and now makes it open to all citizens, the bidding process is too expensive, hence restrictive; but has the Community Resource Management Areas (CREMAs) that get local actors involved in the forest governance decision making (Watts et al., 2018).

4.1.2 Funding Mechanisms for Forest Ecosystems Management in Ghana

Various funding mechanisms have been assessed for implementing forest ecosystem management (on/off reserves) in the country (Table 1.1). Some of them include the Modified Tuangya System (MTS) and Forest Investment Program (FIP), which received multilateral funding from the World Bank's Strategic Climate Fund (US$30m), African Development Bank (US$15.33m) and the International Finance Corporation (US$10m)

Table 1.1: National Afforestation-Re-afforestation Programme: Ecosystem Financing Models

Module	Funding Source	Year	Comments
Youth in Afforestation/Reforestation Project (YAP)	Government	2018	Involves the youth in undertaking restoration of degraded and deforested landscapes nationwide.
Modified Taungya System (MTS)	Government	2001	Farmers provide labour in establishing forest plantations. Food crops are cultivated alongside the tree within a given period.; In addition, farmers enjoy a share of the tree value.
REDD+ Project	Government with Mondelez International	2016	Aimed to reverse forest loss & reduce GHG emissions to mitigate climate change.
Sustainable Land and Water Management Project (SLWMP)	Government with GEF	2018	Directed towards improving degraded land conditions through land management of selected micro-watershed.
Reforestation Offset Project	Private (Golden Star limited)		Abating the impact of mining activities on surrounding land conditions in the Minta Forest Reserve
Youth in Forest Plantation Enterprise Project (YFPEP)	Government	2019	Provides opportunities for the youth to engage in commercial forest plantation development.
Forest Investment Programme (FIP)	Government	2015	Aimed at addressing deforestation and declining forest conditions by promoting agroforestry practices and forest rehabilitation.
Forestry Commission/ Timber Industry Plantation Development Fund	Government	2010	To increase the volume of timber plantations through the establishment and maintenance
Forest Landscape Restoration Through a Sustainable Wood Energy Value Chain Project	Government	2019	This project aims at restoring forest landscapes conjointly with landowners and smallholder farmers in Ghana
Private Plantation Developers On-Reserve (PPD)	Private Sector-Led with Government	2002	Degraded forest areas are designated to private entities and monitored to ensure compliance with afforestation plans.
Public-Private Partnership (PPP)	Private Sector-Led with Government	2013	In this model, designated plots in bad condition are assigned to private entities. However, the Forestry Commission monitors the land and oversees the benefit-sharing agreements.

Source: Ghana Forest Plantation Strategy. Annual Report 2020. Forest Services Division of the Forestry Commission

Other forest financing mechanisms have been (a) the Forest Preservation Program, which received funding from the Japanese Government, (b) the Forest Carbon Partnership Fund of the World Bank [that supported Ghana's REDD+ Readiness Preparation Phase (R-PP)], (c) the Dedicated Grant Mechanism for indigenous peoples and local communities (DGM) (which is an annex of the Climate Investment Fund with support from the Multilateral Development Banks (MDBs). The International Finance Corporation and the Dedicated Grant Mechanism are funding windows engaging the private sector-led Carbon Forestry Development Program whose purview this study falls within.

The Modified Tuangya System (MTS), for instance, is a forest reserve funding mechanism and a forest-based strategy to improve the livelihoods of forest communities, restore the degraded forest cover and address timber deficits (Acheampong, Insaidoo & Ros-Tonen, 2016). Under the MTS, farmers are given access to degraded forest reserve areas for tree planting with the integration of food crops until tree canopy closure under a financing and sharing arrangement between the individual farmers, Forestry Commission and forest edge communities, who all become shareholders in the harvested planted trees (Abugre, Asare & Anaba, 2010). The MTS model could be relevant for cocoa ecosystem management in addressing important supplemental water needs through irrigation for maintaining cocoa trees to add to the reforested areas and sustain rural cocoa communities' livelihoods through sustainable agricultural intensification.

Ghana's REDD+ program, which focuses on enhancing the carbon sequestration portfolio of the country, unfolds in two phases: Phase One deals with restructuring and strengthening Institutions directly linked with the country's forest management system and drawing up forest policy reforms. Phase Two is a multi-dimensional strategy with three principal forest Investment Projects, including tree security and enhancement in cocoa growing and agroforestry areas within Bono, Bono East, Ahafo, Western and Western North Regions' High Forest Zones and the provision of incentives for climate-smart cocoa farming (Forestry Commission, 2015). The REDD+ Program recognizes agricultural lands within forest zones as "Agro-forestlands" and provisions to incentivize cocoa farm owners to adopt climate-smart farming practices such as agroforestry.

4.2 Cocoa forest ecosystem: the case for conservation and financing

According to Sunderlin et al. (2014) and Lyons & Westoby (2014), the main purpose of the REDD+ Programme is to incorporate the livelihoods of rural farmers who depend on anthropogenic activities in the forests for their sustenance into the funding mechanism of the Forest Investment Programme (FIP) in the Climate Investment Fund (CIF). Thus, climate mitigation, security of agricultural livelihoods, and possible financial benefits to smallholder farmers were among the benchmarks on which the REDD+ action would be assessed after implementation (Chhatre et al., 2012).

The Forest Investment Program (FIP) ensures the advancement of REDD+ programs by providing the necessary funds in the form of loans and grants to achieve the synergies of conserving biodiversity, enhancing high carbon sequestration portfolios in the forests, maintaining sustainable economic returns on investment by private sector players in the green carbon forestry industry, while ensuring that the livelihoods of rural households who depend on these forests for their sustenance are not compromised (World Bank, 2015).

Hutchins et al. (2015) indicate that through the "Climate Cocoa Partnership for REDD+ Preparation" project, Olam and Rainforest Alliance, in collaboration with the Forestry Commission, are working to build cocoa-producing areas in degraded lands in ecological corridors, helping cocoa trees become more resilient to moisture and temperature changes due to climate change. The project contributes to Ghana's National REDD+ platform by identifying REDD+ locations and preparing farmers for REDD+ carbon finance options through increased carbon stocks on their farms.

Cocoa is foremost a "tree" whose preservation reduces deforestation, land degradation and emission within a landscape in the high forest zone. However, its economic value as an industrial crop has been the focus of governments. Ghana's cocoa production frontier accounts for 50% of agricultural deforestation in Ghana (Akrofi-Atitianti et al., 2018). Several concerted efforts were made to seek environmentally and socially sustainable ways of exploiting Ghana's common forest resources (IDH, 2020). The mission of the Joint Framework for Action, established in 2017, with partnership from the private sector [i.e. World Cocoa Foundation, IDH (Sustainable Trade Initiative) and 35 leading cocoa and chocolate companies – 855 of global cocoa usage], is to conserve, restore and rehabilitate the country's 21 wildlife protected areas and end deforestation and forest degradation in cocoa-growing landscapes through community engagement and social inclusion, to ensure that cocoa productivity is no longer at the mercy of trading off the country's old-growth forest for cocoa (IDH, 2020).

Conserving cocoa ecosystems through sustainable agricultural intensification is expected to remove pressure from the remaining natural cocoa forests to preserve them. Mars's (2020) report outlines their commitment to act to help preserve the world's forests toward a deforestation-free cocoa supply chain by helping farmers grow more cocoa on existing farmland without encroaching on forests.

4.3 Agricultural-related financing modules in Ghana

4.3.1 Agricultural financing ecosystem in Ghana

Whilst agricultural finance is highly important, access to finance is a major hurdle for agricultural development (IFAD, 2019). In Ghana, where smallholder farmers do most agriculture-related activities, financing services are critical for investment in improving farm productivity and rehabilitation, post-harvest conditions, market access and cash flow (Bonnieux, 2019, Alliance for Financial Inclusion, 2018). Ghana's financial system is categorized into formal, semi-formal and informal (Quartey et al., 2012). The formal financial institutions are licensed to provide financial services under the Bank of Ghana regulations. Commercial banks are dominated by a few major banks, which have been growing rapidly since 2010 (World Bank, 2019). The semi-formal financial sector includes Credit Unions, Savings and Credit Co-operatives, and many NGOs. Several semi-formal financial agents have implemented innovations in recent times due to financial constraints in agriculture. These include microfinance, community banking, modern communication technology to enhance payment systems (mobile money) and merging financial services with non-financial services to improve access to agriculture financing (ISSER, 2010). The most prevalent of these is microfinance, which involves providing financial services to low-income customers who are normally excluded from the commercial banking sector (Kamara, 2011). These include credits, savings and increasing micro-insurance and serve as a risk management tool (Quartey et al., 2012).

The informal financial agents include moneylenders; *susu* collectors (savings mobilizers); traders, agricultural processors and input distributors; *susu* groups/ROSCAs (Rotating Savings and Credit Associations); and friends and relatives (Jones et al., 2000) and the VLSA's. The money-lending business for financing agriculture involves giving out small loans and can also take the form of loans in kind, including fertilizer and agro-chemicals (Quartey et al., 2012).

In rural areas, access to financial services doubled between 2011 and 2017, but is still considered low (World Bank, 2019). This is due to several constraints, including the absence of lending

products tailored to satisfy the needs of smallholder farmers (long-term loan repayment structure), high-interest rates and harsh terms for agricultural loan repayments, lack of credit guarantee mechanisms and crop insurance and high operational costs for financial institutions (Martin & Hurley, 2019). Others include dispersed and remote locations of agricultural households, making it challenging for financial institutions to provide cost-efficient and affordable services in supporting smallholder farmers across Africa with the solution of encouraging farmer cooperatives to create the necessary scale to easily support smallholder farmers access inputs, including credit and marketing (Staatz, 1987; Valentinov, 2007; Alho, 2015). Farmers' over-dependence on rainfall for agricultural activities makes it difficult for financial service institutions to mitigate risks or operate profitable insurance ventures (Quartey et al., 2012).

The lack of education on how modern banking institutions work and finance service providers' lack of knowledge of agriculture to model profitable financial products make it challenging for rural and smallholder farmers to access agricultural finance (Quartey et al., 2012). These have led to formal financial institutions losing interest in agriculture financing over the years (IFPRI, 2010) and was evident in the share of domestic money banks issue as a credit to agriculture, which declined consistently between 1998 to 2008, except for the increase in trend in 2009, which was only marginal (ISSER, 2010) and has a share of around 4.0% between 2010-2019 (Table 1.2).

Table 1. 2: Outstanding Credit to Private Sector and Agricultural Sector by Formal Banks

Years	Total Outstanding credit to Private Sector (GHS'b)	Credit Allocation to Agriculture, Forestry & Fisheries (GHS'm)	Percentage of Total Credit Allocation	Percentage Change from the Previous Year
2010	6,776.6	456.2	6.7%	49.3%
2011	8,560.9	505.1	5.9%	10.72%
2012	11,477.4	539.4	4.7%	6.8%
2013	14,757.2	535.9	3.6%	-1.1%
2014	21,006.5	890.1	4.2%	66.1%
2015	26,237.4	1,020.7	3.9%	14.7%
2016	29,983.5	1,130.6	3.7%	10.8%
2017	33,819.3	1,343.5	4.0%	18.8%
2018	37,593.17	1,428.21	3.8%	6.29%
2019	44,485.25	2,231.22	5%	56.22%

Source: Extracts from Bank of Ghana Annual Reports

4.3.2 Agriculture crop-related financing models in Ghana

The Government of Ghana has made policy strategies and interventions to help improve the agricultural sector through access to finance (Table 1.3). Some of these interventions include the Ghana Incentive Risk Sharing Agricultural Lending (GIRSAL) and several Value Chain Financing (VCF) arrangements (Warehouse Receipt System (WRS), Ghana Commodity Exchange (GCX)), which positively influence the adoption of productivity-enhancing technologies, including irrigation (AGRA, 2017), and the Planting for Food and Jobs (PFJ). The Affordable Agricultural Financing for Resilient Rural Development (AAFORD) is one public project to improve access to rural finance. It is complemented with access to agricultural inputs, market access, business advisory services and products well suited for the agricultural community (Martin & Hurley, 2019). These financing arrangements provide different financial access by farmers and are basically

of three options and/or their combinations: loans, subsidies and input credits on different farmer repayment terms, mostly short-term.

Table 1.3: Agricultural Finance Modules in Ghana (2008-2020)

Finance Model	Source	Year	Finance Type	Comments
The Rural and Agricultural Financing Program (RAFIP)	International Fund for Agricultural Development, DANIDA and Italy	2008	Agricultural Value Chain	The aim is to connect farmers with rural financing institutions to support and enhance the livelihood sustainability of the most vulnerable rural population.
The Financing Ghanaian Agriculture Project (FINGAP)	Private (USAID)	2013	Maize, Rice and Soy Value Chain	This model's beneficiaries are farmers, processors, and input dealers.
The Out-Grower Scheme	Private		Agricultural Value Chain	It involves high-value chain actors providing financial support to lower-value chain actors (producers and farmers)
Warehouse Receipt System (WRS)	Government	2017	Maize, Cocoa	This project seeks to improve the financial inclusion of farmers and provide a solution towards marketing crops from Ghana's PFJ initiative
Ghana Incentive-Based Risk-Sharing System for Agricultural Lending (GIRSAL)	Government	2014	Agricultural Value Chain	It aims to gradually eliminate the risk of financial lending to agriculture through agricultural credit guarantee instruments.
Planting for Food and Jobs (PFJ)	Government	2017	Food Crops	Through the PFJ initiative, farmers are exposed to credit institutions like ADB to achieve national food security and improved employment opportunities.
PERD (TCDA)	Government	2020	Tree Crops	A module under PFJ to develop the tree crops sector to open up new revenue streams.
Ghana Commodity Exchange (GCX)	Government and Apex Bank	2019	Food crops	Makes provision for loans for farmers in the agricultural value chain to sustain their agricultural-related activities between harvesting seasons to improve their purchasing power for farm inputs.
EXIM Bank	Government	2017	Agricultural Produce	Supports agricultural finance initiatives to improve the country's international trade and enhance the country's competitiveness
Rural Enterprise Programme (REP)	Government & IFAD	1990	Agricultural Produce	The REP facilitates the provision of low-interest funds from lending institutions to improve farmers' financial participation
Affordable Agricultural Financing for Resilient Rural Development (AAFORD)	Government /IFAD/AGRA /Agribusiness Capital Fund/AfDB/ Beneficiaries	2019	Rural Finance	Improve access to rural finance, and it is complemented with access to agricultural inputs, market access, business advisory services and products

Source: Alliance for Financial Inclusion (2018); Ministry of Food and Agriculture, Various sources

At the regional level, Ghana's subscription to the Comprehensive Africa Agriculture Development Programme (CAADP) to increase the public share of spending towards the agricultural sector (ODI, 2020) and Invest for Food and Jobs, which is a medium-term development plan aims at investing at least 10% of the national budget in the agricultural sector (AGRA, 2017) in influencing agricultural sector growth rate of at least 6% annually (ODI, 2020), are to enable Ghana's attainment of certain set objectives for sub-Saharan African countries under the Malabo Declaration (Government of Ghana, 2017).

4.4 *Modalities and factors determining sustainability and social, youth and gender inclusivity in Agricultural financing modules*

Although the state of financial inclusion in Ghana, that is, access to formal financial services, increased significantly from 41% to 58% between 2010 and 2015, certain groups, including the poorest regions of Upper West, Northern, Volta, Upper East, and Brong Ahafo, rural residents, women, the poorest quantile of the population (the resource-poor including farmers), and youth have even less access than their counterparts (Republic of Ghana, 2018).

Improving access to financial products and services can be important in improving women's lives (Njuki et al., 2019; Sekyi, Abu & Nkegbe, 2017; FAO, 2011), the marginalized and the resource-poor. However, conditions of limited financial services in rural areas and the exclusion of women, the marginalized, and the resource-poor benefiting from financial services prevail (Taylor & Boubakri, 2013; Feed the Future, 2020). Akudugu, Egyir & Mensah-Bonsu (2009) highlighted that rural women were more restricted in their access to formal financial services, that the preventive measures that lenders adopt to minimize the risks of defaults tend to exclude people who are engaged in small-scale production, such as women farmers. Group-based lending is recommended to circumvent the problems of moral hazards and adverse selection, making those not in groups not to access finance.

ACET (2019) and Rutten & Fanou (2015), among others, indicate poor youth financial inclusion as a result of a lack of regular stable income, negative perception of youths' financial discipline and financial competence, lofty transaction costs and ownership costs of mobile devices, deficit in finance innovation and policy and regulatory ecosystem that limit youth's financial inclusion.

However, several agricultural-related financing models support women and youth inclusion. For instance, Village Savings and Loans Association (VSLA)adjusted to include women and youth accessing financial services as members of the VSLA. Regular and joint contributions are made to fund women in rural areas where agriculture is dominant and access to finance from public or government institutions and private financial services is limited (FAO, 2020). The Credit Union Cooperatives also consist of organized women and youth in agribusiness and other production sectors that make financial services available to themselves (FAO, 2020). These are microcredit and, as a financial model, improve women's income generation (Alhassan & Akudugu, 2012). However, Ganle, Afriyie, & Segbefia (2015) report mixed effects of microcredits on rural women empowerment in the Upper West Region of Ghana. Some women benefited whiles others did not due to their husbands' control over the loan use.

5.0 Segmentation of cocoa production systems in Ghana by Climatic Effects

5.1 The segmentation of cocoa systems in Ghana by climate change effects

Ghana's current cocoa output is distributed across a climate gradient, with annual rainfall regimes being the most important factor. Low yields are already visible in Ghana's cocoa belt fringe districts (Abdulai et al., 2018). Whilst the impacts of climate change on the agricultural sector are crop and site-specific (Murken et al. 2019), crops are predominantly rainfed. They are susceptible to drought as crop yields depend on water availability. Figures 1.4 and 1.5 present the cocoa growing areas and their respective agro-ecological zones and their suitability for cocoa production under climate change as depicted by the International Centre for Tropical Agriculture (CIAT), the International Institute for Tropical Agriculture (IITA) and in collaboration with the Cocoa Research Institute of Ghana (CRIG).

Cocoa is grown in the deciduous forest zone (Ashanti Region; Eastern Region), Rain Forest zone (Western Region/Western North; Central Region) and the Forest savanna Transition Zone (Brong Ahafo (Ahafo and Bono Regions)). Laderach et al. (2013) predict several changes in climate conditions (reduction in rainfall volumes, precipitation decreases, and increases in the mean annual temperatures) in the cocoa belts of Ghana by 2050. By 2030, while most areas in Ghana would show a slight decrease in suitability for growing cocoa, the Western and South of the Brong Ahafo Regions of Ghana will show greater decreases in the suitability of cocoa (Laderach et al., 2013; Schroth et al., 2017).

A climate typology report by Abdulai et al. (2018) indicates the Ashanti Region has mid temperatures, the Forest zone has wet temperatures, and the Brong Ahafo Region has dry temperatures.

Figure 1.4: Distribution of cocoa growing agro-zones

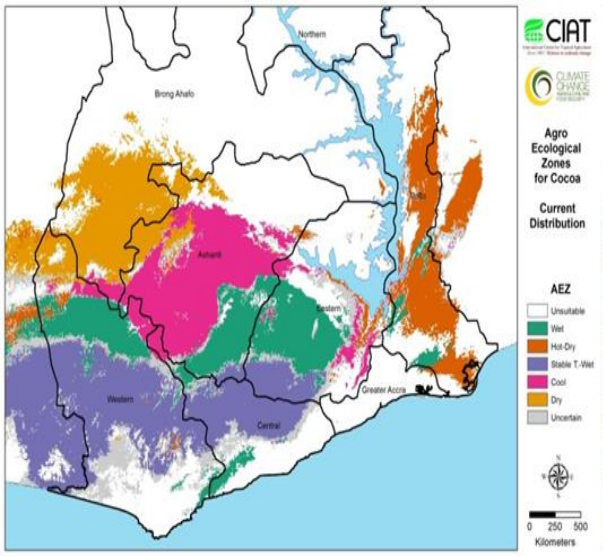
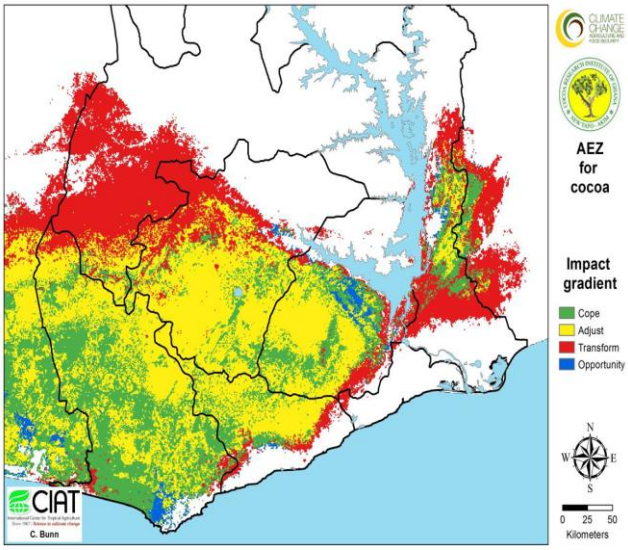


Figure 1.5: Decision Map for Cocoa ecological farmers for future climate



Sources: CIAT, IITA

The wet-mid-dry cocoa climate typology has various effects on cocoa production areas in Ghana. It is classified into three zones: Zones to Transform, Cope, and Adjust (Dalaa and Asare, 2019) (see Table 1.4).

Table 1.4: Decision Outcomes for farmers in future climatic change for cocoa production

ZONE	Description of Key climatic hazards	Suitability for Cocoa Cultivation
Coping + Risk Zone	Less significant or unpredictable climate impact trajectories. Basic Management Practice will focus on general Good Agricultural Practices and no–regret solutions to build stronger systems to enhance adaptive capacity.	Most Suitable
Adjustment Zone	Higher annual average temperature; weak, dry season (short, with comparatively higher precipitation in the driest quarter); higher annual precipitation.	Suitable but Needs Adjustment To Management Practices
Transformation Zone	Hot and dry temperature	Not Suitable Going Forward

Source: Dalaa and Asare, 2019 (IITA, Ghana)

According to the gradient, Southern Brong Ahafo, northern Ashanti, and the north and south of Volta will all become transformation zones (Table 1.4). Higher temperatures, less rainfall, a longer dry season, and drought are projected in these places (Bunn et al., 2019). This type of zone is appropriate for developing alternative value chains or unique cocoa systems that are viable under conditions previously considered unfriendly to cocoa (Bunn, 2018; Bunn, Fernandez-Kolb, Asare, & Lundy, 2019).

Climate conditions in the Cope Zone are expected to be relatively favorable for cocoa production, with little change in cocoa suitability. The Cope Zone encompasses the northern half of the central cocoa production zone, including northern Ashanti, the western region, and the Volta area. For this zone, global climate models don't exhibit the necessary degree of agreement to support specific technological packages, and emphasis should be put on increasing producers' resilience (Bunn, Fernandez-Kolb, Asare, & Lundy, 2019).

In the Adjust Zone, higher annual average temperature, shorter and weaker dry season with higher rainfall in the driest quarter and higher annual rainfall is expected. Southern Ashanti, the Eastern region, and the southern margin will require systemic change because a change from one climate zone to another was projected (Bunn, Fernandez-Kolb, Asare, & Lundy, 2019). They reported that the climate change signal was less significant in the other parts of the country, and the southern production zone is projected to remain in the same climate zone so that no significant changes in agronomic practice are needed.

5.2 *Supplemental Irrigation of Cocoa farms in Ghana and COCOBOD Responses*

Climate change presents challenges to Ghana's development, impacting all sectors of the economy, and is manifested through (i) rising temperatures, (ii) declining rainfall totals and variability, (iii) rising sea levels and (iv) weather extremes (GoG, 2012, 2013). These climate change challenges present two primary risks to smallholder farmers: rising temperature and declining water availability for crop and livestock production. These risks impact shifts in crop

suitability, increasing water scarcity. Smallholder farmers who lack access to credit and other means to adapt to these climatic changes are the most vulnerable. Smallholder farmers must manage water resources to enhance farm productivity and livelihoods and minimize climate change impacts through agricultural diversification. Several institutions (World Bank, USAID, and the African Development Bank) are helping expand irrigation in Ghana to support sustainable agricultural intensification (FAO, 2014).

In the cocoa sector, climate change, among other drivers militating against cocoa production and productivity (aging farmers' population, inadequate extension officers and farmers' failure to adhere to good agronomic practices as some common challenges), has negatively impacted cocoa production and output in Ghana to varying degrees. The negative impacts of climate change on cocoa would have repercussions for the Ghanaian economy, especially for rural development (Bunn et al., 2019). Cocoa farmers are increasingly aware of the impacts of the climate on their production and the possible adaptation measure needed against climatic extremes. Rainfall is seen as the most significant climatic parameter. Long dry periods, unpredictable rainfall patterns and high sunshine/temperatures are among the noticeable climate changes (Buxton et al. (2018), and cocoa farmers believe that these weather changes negatively affect their cocoa production: decreased yields, plants dying and hard to-know when to spray for pests and diseases because of the unpredictability of rains (Hutchins et al. (2015).

According to Alvarez et al. (2014), understanding the existing characteristics of cocoa production, perceived climate change and drought effects, income diversification, and management of shade trees in cocoa-growing systems in different climatic regions within the cocoa belt is the first step in designing a sustainable adaptation pathway. Current cocoa replanting and rehabilitation efforts will require supplemental water/irrigation for raising the young seedlings. In addition to the food crops and shade trees that provide cover for the young, transplanted seedlings in areas of deficit rainfall, supplemental water provision will be required. Cocoa plants need water during flowering; insufficient water unavailability aborts flowers and decreases pod formation.

An important change in approach will require a total adaptation strategy which includes using more shade trees or irrigation systems or a change in the cocoa variety cultivated (Merrey & Lefore, 2019; Bunn et al., 2019). Adopting [supplemental] irrigation under agriculture is largely more productive, economically viable and less risky than rainfed agriculture when a vibrant output market exists (Merrey & Lefore, 2019). In all these adaptation measures, sustainable financing is key.

The southern Brong Ahafo, northern Ashanti, and the north and south of Volta regions, described under future climatic scenarios for cocoa production as transformation zones, according to Laderach et al. (2013) and Schroth et al. (2017), would be less suitable for cocoa production in the future during the dry season and can be a major cause to the projected loss of suitability across the cocoa belt. Supplemental water provision for farms to mitigate water deficits during the dry seasons (irrigating cocoa farms) will therefore be critical in sustaining cocoa farming.

Under COCOBOD Productivity Enhancement Programmes (PEPs), and to assist cocoa farmers in minimizing the damaging effects of the dry weather and illegal mining activities that have destroyed water bodies on cocoa production, the programme envisages irrigating 200 farmer's farms and 44 COCOBOD farm sites as demonstration farms. COCOBOD (2018) plan is to make cocoa production (in all cocoa growing areas in the country) all year round with the inauguration

of solar-powered irrigation schemes, expecting a 1-ha farm, which currently yields about 1.1MT of cocoa to yield about 4.8MT/ha a year.

In this effort, COCOBOD has piloted an irrigation system (solar-powered and serves 1 ha of the various farms it is being piloted) in the Bono, Bono East and Ahafo Regions. The pilot cocoa districts include Techiman, Goaso, Sankore and Nkrankwanta and are expected to expand the irrigation system to cover more farms after environmental assessments (COCOBOD 2018).

COCOBOD is looking into the future with changing climatic effects on cocoa production. The COCOBOD's syndicated $600 million, seven-year loan in 2019 (PEPs) from the African Development Bank and others to boost cocoa production (African Development Bank, 2019). The loan includes financial interventions to sustainably increase cocoa plant fertility, improve irrigation systems, rehabilitate aged and disease-infected farms and help increase warehouse capacity, and support local cocoa-processing companies.

As more regions of intensive production become marginalized due to increasingly difficult environmental constraints and protracted dry spells, the necessity for [supplemental] irrigation in cocoa production has increased (World Cocoa Foundation, 2018). The occurrences of climate change have created a natural hazard and negatively impacted smallholder farmers' livelihoods (Akudugu, Dittoh, & Mahama, 2012) because it affects yield. This is confirmed by Satheesh's (2014) study that climate warming in most tropical regions will negatively affect the yield of cocoa. Areas known for cocoa production in Ghana have been plagued with environmental-associated problems such as declining soil fertility, high exposure to droughts, and extreme temperature conditions (Akrofi-Atitianti, Ifejika Speranza, Bockel, & Asare, 2018).

Besides calling for cocoa farmers to adopt intensification strategies to increase livelihood outcomes, the need to take intensification decisions that would make farm production resilient to the changing climatic conditions is germane. Therefore, there is a need to include supplemental irrigation to curb the problems of cocoa productivity associated with these ecological constraints. An instance is the extension of the growing season as a result of the all-round availability of water supply due to the expansion of irrigation technologies and the decrease in dependence on rain-fed agriculture, especially in areas where rainfall is inadequate (Lipton & Litchfield, 2003).

5.3 Financing demand for supplemental irrigated cocoa production systems in Ghana

The Ghanaian cocoa farmer faces declining soil fertility, high incidence of pests and diseases, high exposure to droughts and temperature extremes, poor agronomic practices, and inadequate farm maintenance by characteristically aged farmers (Dormon et al. 2004). Several researchers acknowledge that productivity on cocoa farms could be raised through a combination of agronomic practices such as effective weed, pests and diseases control, pruning and shade management (O'Sullivan and Vanamali, 2020; COCOBOD, 2018; Baah, Anchirinah & Amon-Armah, 2011). Cocoa farmers demand technology input packages for soil testing, improved seedlings and fertilizers, as well as improved farm management practices, namely control of capsid and black pod disease, fertilizer application and pruning, crop protection products and how to properly apply them (Anchirinah & Amon-Armah, 2011; O'Sullivan and Vanamali, 2020) in the quest to sustain cocoa farm intensification. Although COCOBOD has pioneered a pilot cocoa farm supplementary irrigation programme, there seems to be no study on cocoa farmers' demand for cocoa farm irrigation services in Ghana.

It is anticipated that with increasing climate challenges and profitability of cocoa farm enterprises, commercial-oriented cocoa farmers may demand the financing of supplemental irrigation farm-related activities (Nieburg, 2015; Akrofi-Atitianti, Ifejika Speranza, Bockel, & Asare, 2018). The financing arrangement with farmers, however, is not yet known. Although Bunn et al. (2019) suggest water management using drip irrigation can increase yields on cocoa farms, the costs outweigh the benefits of high upfront investment for irrigation.

There are existing financing model interventions like the Ghana Commercial Agricultural Project (GCAP) and its financing support to Farmer-Led Irrigation Development (FLID). However, it does not fully extend to all smallholder irrigators to address their financing problems. Credit access is a difficult alternative for increasing productivity if farmers are not organized into well-functioning irrigation farmer-based organizations (Dittoh, 2020). Irrigation adoption as a possible adaptation measure in cocoa production against climatic extremes, according to Maguire-Rajpaul et al. (2020), can be challenging for smallholder farmers due to a combination of economic, technical and social challenges. Whilst over half of Ghana's cocoa farm landscape requires systematic adaptation to address future climate risks, O'Sullivan and Vanamali (2020) allude to the possible irrigation need and present the strategic case for financing climate-smart farm cocoa through services that deliver multiple environmental and social benefits to investors and farmers through upscaling rehabilitation and replanting of cocoa, with the correct number and species of shade trees. Perhaps under the climatic segmented "zones", the "dry" communities are better-off without cocoa, so one should not expect to see more pronounced changes to adopting irrigation on cocoa farms. COCOBOD (2018) and AfDB (2019), however, emphasise pursuing the supplemental irrigation option alongside the replanting and rehabilitation of cocoa farms.

6.0 A proposal for a sustainable financing system for irrigated cocoa systems

Following the literature reviewed, a sustainable financing arrangement for irrigated cocoa system is proposed by drawing on the synergy between private and public funds that exist and could be mobilized in optimizing cocoa farmlands, sustainable agricultural intensification and reducing emissions within Ghana's cocoa forest landscape.

Figure 1.6 presents the proposed mobilization of funds and financing structure, the actors and their function and the enabling environment for the cocoa farmer. The proposed structure would require the government of Ghana (Ministry of Finance, COCOBOD, Ministry of Lands and Natural Resources, etc.) mobilizing funds from private and public (blended finance), guarantee the participation of the key stakeholders and be able to address the specific/targeted problems of rainfall variability due to climatic conditions and faced by small-scale cocoa farmers on their farms in meeting their sustainable livelihood aspirations.

The assumption is that cocoa farmers who uptake the cocoa farm irrigation technology could be facilitated to access reasonably priced credit. We envisage that a successful model must connect smallholder cocoa farmers to credit, inputs, and the functioning of farmer-based organizations. The proposed financing structure must also offer short-term credit for seasonal inputs, such as seeds and fertilizer, and longer-term credit for purchasing the farm irrigation capital equipment.

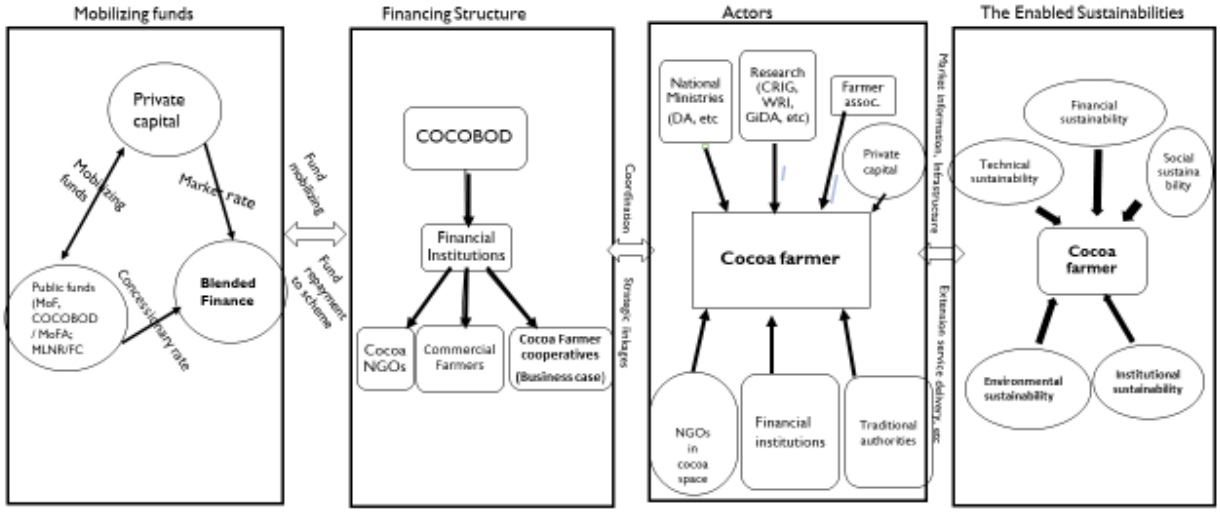


Fig. 1.6: Proposed framework for Sustainable Financing Mechanism for Supplemental Irrigation in Cocoa farms

- ***The proposed financing ecosystem structure***

The structure envisages that mobilized funds will be lodged in a financing governance structure (Special Purpose Vehicle) spearheaded by COCOBOD, given her role in the oversight of the cocoa industry and the pioneering role in the supplemental cocoa farm irrigation project. COCOBOD, a government entity, can uniquely raise funds from commercial financial institutions to financially support the sustainable growth of farmers' cocoa production. For sustainability, in terms of technical and institutional (appropriateness and acceptance of the technology and the continued investments and who takes the lead in the structural arrangement over the long-term as well as roles and responsibilities of the different actors working together, etc.), stakeholders in the structure should include financial institutions (formal banks that lend to agriculture). Actors in the cocoa landscape include NGOs, licensed cocoa-buying entities, commercial cocoa farmers and Cocoa Farmer Cooperatives. These would be guided by clear policy and regulatory frameworks to facilitate the institutional financing arrangements. The arrangements would include granting loans and advances to the cocoa farmer, whether individually or in groups, and accepting repayments and deposits. A financing mechanism based on an arrangement with the private sector that spreads out payments and enables cocoa farmers to benefit could minimize risks to the financing scheme.

- ***Actors in the sustainable financing system and envisaged functions and activities***

The proposed financing system will link critical actors, roles, and functions to sustaining the cocoa farmer's irrigation efforts. These actors include government ministries and agencies, research institutions (CRIG, WRI, GIDA, etc.), cocoa farmer associations, private entities in the smallholder farm service provision space (farm irrigation equipment, other farm inputs), NGOs and licensed cocoa buying agencies, the financial institutions and traditional authorities.

How these actors relate to each other in a coordinated and strategic linkage to the smallholder cocoa farmer and the financing structure will be important for achieving the cocoa farm

supplemental irrigation objective for the cocoa farm intensification programme. The specific roles and functions of the critical actors are envisioned as follows:

Government Ministries and Agencies

In Ghana, COCOBOD is currently under the Ministry of Food and Agriculture (MoFA). Government agencies, spearheaded by the District Assemblies with the decentralized MoFA directorates, must prioritize agriculture and cocoa production in light of climatic changes. Therefore, MoFA's relationship with the relevant actors in allocating resources for the cocoa farm sector], especially the public institutions, will have to be harmonized, especially with COCOBOD Community Extension Agents.

Research Institutions (CRIG, WRI, GIDA, etc.)

Research institutions play critical roles in the agricultural sector. The Cocoa Research Institute of Ghana (CRIG) functions as the research unit of the COCOBOD, and its role will continue to research new cocoa planting materials, diseases and pests militating against cocoa production. CRIG plays the lead role in providing Science and Technology inputs for the cocoa industry. The Water Research Institute (WRI) of the Centre for Scientific and Industrial Research (CSIR) in Ghana is mandated to undertake research into water bodies and related issues. In collaboration with other regulatory agencies (Environmental Protection Agency (EPA), etc.), her role will be critical in determining the quality, suitability and environmental sustainability of the waterbodies to be accessed for the cocoa farm irrigation. The Ghana Irrigation Development Authority's (GIDA) role will ensure the suitability of the various recommended irrigation equipment for the cocoa farmer.

Cocoa Farmer Associations

Organized Cocoa Farmer Associations (CFOs) serve as distribution channels for farmer training, inputs or planting material while at the same time strengthening farmer integration in the value chain and providing them with increased negotiating power. Private and public agricultural extension agents (AEAs) are important in establishing FBOs, especially those set up through government projects. Many cocoa farmers have been enabled through such associations. Organized cocoa farmer associations, whether at the village or national level, provide a strong lobby group for getting important policy decisions made and adopted by the farmers. There is the Ghana Cocoa, Coffee and Shea Nut Farmers Association (GCCSFA) to which many cocoa farmers belong and many other organized cocoa farmer associations. The farmer associations' role, among the others, will be to bring all the cocoa farmers (caretakers, landowners and the migrant, youth and women) together to build resource-synergies to benefit from the proposed financing of irrigation schemes.

Private entities in the smallholder farm service provision space (farm irrigation equipment, other farm inputs dealers)

Private farm irrigation equipment dealers and other farm input dealers, such as for fertilizers and pesticides, address specific challenges that cocoa farmers face. As the demand for infrastructure, such as the cocoa farm irrigation system and other farm development, expectations will grow for direct private-sector investment in the provision of services and equipment. In light of cocoa farm intensifications, new plantings, increasing existing cocoa tree productivity and applying improved agricultural practices and intensifying the use of key inputs, including fertilizer and pesticides, may emerge. Some of these actors, particularly farm irrigation equipment suppliers, would have to

participate at the local level, reflecting a new orientated business focus which could have various risks and financial needs. Participating in the sustainable financing scheme provides the private companies participating in the business case sustainability as they may be unwilling to invest in the remote communities without some security to recoup their investments.

NGOs and Licensed Cocoa Buying Agencies

Several profit/not-for-profit, non-governmental organizations, including licensed buying agencies in Ghana, help cocoa farmers in cocoa production intensification. These entities are helping small-scale farmers revitalize existing plantations through cocoa farm renovations/rehabilitations and in ecologically sustainable production through training workshops, farm extension, micro-loans and farm resource management, including in the organization of farmers to make the delivery of services and funding feasible. Some NGOs in the cocoa space emphasize social responsibility, including the issue of child labour and child rights. These entities also build capacity within the cocoa sector to implement various cocoa market standards with groups of cocoa farmers. These entities' role would be to continue engaging the cocoa farmer even as they add on additional investments in cocoa farm irrigation.

Financial Institutions

The financial institution's role, particularly of the rural and community banks, in promoting sustainable cocoa farming in Ghana through liquidity mobilization and providing institutional credit to farmers for various agricultural-related activities needs strengthening. The farmers face many problems, such as lack of credit, farm inputs, machinery, and uncertain weather patterns. With a lack of financial capacity, the envisaged access to agricultural credit would play an important role in increasing cocoa farm productivity.

Traditional Authorities in the cocoa landscape

The traditional systems of sharing benefits from cocoa farmlands (arrangements between farmer caretaker, short or long-term migrant) and landowners are said to offer unique opportunities for farmer scaling-up since they enable farmers to undertake responsible actions of tree planting and preservation on their farms. However, tree tenure – the ownership and benefit sharing in planted and naturally growing trees on farms - continues to be one of the thorny issues facing landowners and cocoa tenants and thus hamper long-term farm investments. Security of tenure is needed to ensure that farmers benefit from long-term investments in maintaining cocoa trees and investing in improvements that enhance the value and sustainability of trees. The role of traditional rulers in the cocoa production landscape's socio-economic development, who are the custodians of ancestral and community land, must protect the smallholder cocoa farmers undertaking long-term investments such as in the cocoa irrigation system.

- ***Enabling the environment and sustainability***

The proposed financing of cocoa farm irrigation aims to sustainably develop the rural economy and the livelihoods of cocoa farmers by providing short-term and long-term credit to adapt to climatic changes in cocoa agriculture intensification. Achieving this objective requires cocoa farmer solutions and close collaboration among the stakeholders, including the government actors, the private sector and the non-governmental organizations (NGOs) in the cocoa landscape.

Key to sustaining farmer commitment and continued investments are particularly the financial, social and environmental sustainability that ensures farmers achieve investment returns. While investments in small-scale irrigation technologies can benefit the cocoa farmer in the face of rainfall variability, an unregulated spread of the technologies can have environmental and social consequences. Hence, the system must address the appropriateness and acceptance of the farm technology and its continued investment, operations and maintenance (technical sustainability). Social sustainability must ensure that the youth, women, and migrant cocoa farmers are included in the financing arrangement and participate in supporting their social wellbeing. Critical also is the environmental sustainability implications of the scale of water availability and its sustainability as well as withdrawal impacts on the farm environment and household activities while ensuring that cocoa farmers within the cocoa production forests contribute to the REDD+ objectives.

The intensification of market information, availability of improved physical community infrastructure (markets, roads, access to mobile networks), and extension service delivery to remote cocoa farmers will benefit all stakeholders in the long run, particularly the cocoa farmer. The private sector and the NGOs in the cocoa production space have crucial roles. Still, stakeholders must also work to sustainably preserve the cocoa farm sector's livelihoods.

6.1 Gaps, opportunities and risks for financing sustainable irrigated cocoa production system for increased cocoa intensification

Ghana's REDD+ program enhances carbon sequestration directly linked with the country's forest management system. The REDD+ Program recognizes agricultural lands within forest zones as "Agro-forestlands" and even makes provision to incentivize cocoa farm owners to adopt climate-smart farming practices such as agroforestry. This implies that safeguards exist under REDD+ to enhance cocoa ecosystems and benefit rural farmers. Cocoa is naturally an understory specie plant that thrives well in humid forest ecosystems.

Financing Ghana's forest ecosystems have included cocoa forests, but restoring degraded cocoa farm lands has not involved irrigated options. The agricultural dividend that could result from using forest ecosystem financing cocoa farm irrigation is supplanted by timber production considerations within the forest off-reserves. With increasing debilitating climate change effects across several cocoa-producing areas impacting cocoa outputs, enhancing a sustainable investment and financing of sustainable cocoa production will be increasing in the face of climate change.

The importance of efficient agricultural water management as it affects every agricultural value chain, including cocoa production in the "transform" zones of the segmented cocoa production systems, demands appropriate tools and data, acknowledging that there is no "one-size-fits-all" solution to scale up appropriate financing models for cocoa farm re-tooling.

There exist gaps, opportunities, and risks in the push for supplemental irrigation of cocoa farms in Ghana under threat from climate change effects. Based on the literature review, gaps, benefits and associated risks in crafting the sustainable financing model to assist in providing supplemental irrigation to cocoa farms for cocoa farmers to adapt to the impacts of climate change were identified.

A. *Identified GAPS:*

1. *Appropriate data and research work* on cocoa farmer demand for farm irrigation services are virtually non-existent. Although studies on the effects of climate change on cocoa production have made recommendations for cocoa farm transformation, no data has been reported on cocoa farmer expressions for farm irrigation. The few existing studies that factor in cocoa farms' supplemental irrigation report high initial investment costs. More studies are needed to position cocoa farmers to the alternative climate-adapted scenarios for farm transformation.
2. *Funding sources for sustaining cocoa ecosystem* functioning are limited to the general forest ecosystem, and to cocoa, the focus seems more on rehabilitation and replanting of cocoa trees. Making supplemental water available all year is part of restoring the cocoa forest ecosystem in the "dry" cocoa production belts and enhancing smallholder farmer livelihoods.
3. *The cocoa ecosystem faces both biophysical and socio-economic challenges*. The weakness is usually to focus on the two categories separately, which creates unsustainability. Sustainable funding models should therefore be able to consider both categories equally to identify and mitigate risks/tradeoffs that could arise and create synergistic opportunities for accelerated farmer investments in sustainable agricultural investments
4. *Institutional/stakeholder collaboration* in delivering efficient agricultural water management to cocoa farms, such as irrigation, appears championed only by the COCOBOD, whilst other partners and stakeholders pursue alternative cocoa crop productivity arrangements

B. *Identified Opportunities*

1. *Small-scale private irrigation is expanding* in many SSA countries, apparently driven by farmers' own initiatives and investments (Burney, Naylor, & Postel, 2013; Giordano, de Fraiture, Weight, & van der Bliek, 2012). With the Ghanaian cocoa landscape plagued with ecological problems, including declining soil fertility and high exposure to droughts and temperature extremes (Akrofi-Atitianti, Ifejika Speranza, Bockel, & Asare, 2018) and coupled with COCOBOD efforts in providing smallholder cocoa farmers with irrigated facilities, the demand for cocoa farm irrigation and its financing mechanisms are emerging.
2. *Through several interventional projects and training on adaptation and mitigation strategies, cocoa farmers' awareness about climate change drivers has been raised*. Cocoa farmers understand agricultural water needs for cocoa productivity and how to mitigate the overall climate change phenomena and adapt to the effects by adopting innovative water-harvesting technologies. The existence of cocoa FBOs creates synergies for the innovativeness of cocoa farmers.
3. *Business models for farmers for on-farm irrigation exist*. Solar Powered Irrigation Systems for crop production in Ghana and elsewhere have been developed to serve the needs of small-scale farmers. New irrigation systems, including groundwater and sun-surface-based irrigation type systems (Namara et al., 2011), are in existence. Thus, a well-developed distribution network can potentially boost farmers' demand and subsequent purchase of irrigation equipment. Table 1.5 summarizes two business models adapted to small-scale farmers.

Table 1.5: Business models on Solar Powered Irrigation Systems for crop production

Technology	Business Model	Target Market	Comments	Source
Automated Solar-PV Drip Irrigation System (ASPDI)	Three main parts: value creation and delivery, capture and value proposition for financial, economic and environmental assessment of the CB of the project	Vegetable farmers	To irrigate a 500m^2 area using a 12-volt DC pump submerged in a water source powered by a 50-watt solar PV plate.	Bolwig, Baidoo, Danso, Rosati, Ninson, Hornum, & Sarpong (2020).
Pumptech-LORENTZ PS2 solar irrigation pumps	Pay-Own financing scheme	Farmers in a remote location with sun intensity and demand for irrigation	The PS2-100 system provides over 20,000 litres of water daily and pumps up to 40-meter heads. This serves a wide range of opportunities in providing water for irrigation	Minh, T.T. and Ofosu, A (2021)

4. *Government interests and funding sources*. There are observable potentials for financing supplemental irrigated cocoa production, given the interest of government and stakeholders in sustainable agricultural intensification, including investments in irrigation infrastructure such as the One Village-One Dam programme initiated to harness the potential of upscaling irrigated agriculture, which includes cocoa production (Okyere & Usman, 2021). In addition, the forest ecosystem funding arrangements of the Ghana Forestry Commission under the REDD+ and the COCOBOD financing schemes exist to create synergies for supplemental irrigation financing for cocoa farms.
5. *Private Funding sources*. The ICCO, for instance, commissioned a study to explore the options for a Cocoa Sustainability Fund, which would address the problems faced by small-scale cocoa farmers in their cocoa production (ICCO, 2016; Hütz-Adams et al., 2016). The Cocoa Sustainability Fund would mobilize funds, guarantee the participation of the key stakeholders, and be able to address the most urgent problems faced by small-scale cocoa farmers. Additionally, many companies have set up their projects supporting farmers along the value chain.

C Identified Risks

1. *Smallholder farmers are considered too risky and costly to finance*. Investment models for water use and management in agriculture (irrigation) benefit projects, but these may be costly for cocoa farmers. Bunn, Fernandez-Kolb, Asare, & Lundy (2019) indicate a negative internal rate of returns (IRR) and net present values (NPV) on cocoa farm irrigation relative to current farmer practices because of high upfront investment requirements. More empirical analyses may need to drive a sustainable cocoa supplemental irrigation financing ecosystem within smallholder farmers.
2. *Farmer-level irrigation demand and supply of equipment*. There is an under-developed demand and supply market for irrigation equipment, particularly cocoa irrigation. Irrigation suppliers are concentrated in Accra (Mendes, Paglietti & Jackson, 2014), which presents a wide gap in irrigation supply to rural smallholder farmers.

3. *Irrigation infrastructure needs and farmer financial support*. Poor infrastructure hinders finance outreach to rural people (IFPRI, 2010), including financial investment gaps for cocoa and other agricultural crop-related projects.
4. Interest rates on financial support from financial institutions are too high for farmers interested in irrigation to even consider credits from such sources (Dittoh, 2020). Although there are some existing financing models, interventions like the Ghana Commercial Agricultural Project (GCAP) and its financing support to Farmer-Led Irrigation Development (FLID), it does not fully extend to all smallholder irrigators by addressing their financing problems, and this will continue to make credit access a difficult alternative for increasing productivity if farmers are not organized into well-functioning irrigation farmer-based organizations(FBOs) (Dittoh, 2020).

7.0 Proposed primary data collection tools to identify/design actionable strategies/pathways to accelerate sustainable financing for cocoa irrigation investment

We used the reviewed literature to design data collection tools to address the proposed sustainable financing for cocoa farm irrigation, which provides social, environmental, and economic benefits to the smallholder farmers and the economy. Key informant interviews with COCOBOD, MoFA and the Forestry Commission; the private sector; NGOs in the cocoa landscape; and financial institutions are envisaged.

The proposed data collection tools are attached as APPENDICES. There are three modules of seven categories. The three modules are (a) interview guides that are geared to officials of COCOBOD, MoFA, Forestry Commission, NGOs in the cocoa production space, and farmer key informants such as executives of FBOs; (b) structured questionnaires to sampled cocoa farmers; and (c) interview guides for Focus Group Discussions (FGDs).

(h) COCOBOD/MoFA/Researchers

The main outcome of this interview guide will be an understanding of the rationale for the cocoa irrigation pilots and their upscaling mechanisms. It will also solicit an understanding of the financing mechanisms (free, subsidized, outright payment, etc.) followed, the sustainability of the funding and irrigation systems, and farmer feedback.

(i) Forestry Commission

The FC has funding mechanisms for forest ecosystem management under REDD+, which includes cocoa landscapes. The main outcome of this interview guide will be to understand the scale (on/off forest reserves) of forest management and the funding mechanisms relative to cocoa ecosystem restorations. It also solicits information on possible funding rationale for supplemental irrigation in the cocoa landscape and collaboration with COCOBOD on funding arrangements

(j) NGOs in the cocoa production space

Several NGOs are operating in the cocoa space as buying organizations and/or sustainability champions in cocoa production. The interview guide addresses the relevance of supplemental irrigation in addition to the on-going renovation and rehabilitation efforts in the cocoa sector. In addition, funding arrangements in the rehabilitation process and its possible financing of irrigation in cocoa will be solicited. Farmer feedback in terms of irrigation demand will also be solicited

(k) Farmer Key Informants

Farmer key informants include FBO executives, chief cocoa farmers and input distributors. Information sought to include the COCOBOD irrigation pilots and upscaling rationale, farmer demand for the product (farm irrigation) in addition to other farm services in the light of the changing climate, and the preferred funding mechanisms. The key question will be who funds the initiative and the farmers' contribution.

(l) Structured Farmer Questionnaires

The focus of this structured questionnaire will be to *understand the capacity of the cocoa farmer* to engage in the sustainable cocoa irrigation financing scheme, their ability to participate and pay for the irrigation scheme and their preferred funding arrangements.

(m) FGDs interview Guides

Focus Group Discussions will be structured around interactions with 9-10 male-only, female-only, and youth cocoa farmers (≤35 years) separately in selected communities. Like the KIs, the information sought includes the COCOBOD irrigation pilots and upscaling rationale, farmer demand for the product (farm irrigation) in addition to other farm services in light of the changing climate, and the preferred funding mechanisms. The key question will be who funds the initiative and the farmers' contribution.

(n) Financial Institutions

Financial institutions will play key roles in intermediating between the funding institutions and the farmers. The interview guide will seek to understand financial institutions' various products, specifically for smallholder farmers' cocoa financing. It will also solicit FI's opinions in participating in the proposed sustainable financing of irrigation for cocoa farmers, the benefits and the risks, among others.

8.0 Conclusions

This section concludes with a review of the literature and the lessons learned from the proposed sustainable financing framework of providing financial support for smallholder cocoa farmers' irrigation equipment purchases.

8.1 Financing the forest and agricultural sector in Ghana to restore forest cover

Funding mechanisms exist within the agricultural (forest and crop sub-sectors) sector, which have been assessed to implement forest ecosystem management and enhance agricultural intensification. Forest reserve funding mechanisms and forest-based strategies to improve the livelihoods of forest communities, restore the degraded forest cover and sustain agricultural intensification are relevant for cocoa ecosystems management in addressing important supplemental water needs through irrigation for maintaining cocoa trees to add to the reforested areas and sustain rural cocoa communities' livelihoods. The Modified Tuangya System could be tailored to meet such objectives. These financing arrangements are long-term investments. The REDD+ Program recognizes agricultural lands within forest zones as "Agro-forestlands" and provisions to incentivize cocoa farm owners to adopt climate-smart farming practices such as agroforestry. On the other hand, financing interventions to help improve the crop sector by accessing agricultural inputs and business advisory services are short-term financing products.

These financing arrangements provide different access to funds by farmers and are basically of three options and/or their combinations: loans, subsidies and input-credits and on different farmer repayment terms.

The literature review points to some synergies between the forest sector funding mechanisms, food crop funding modules and cocoa sector funding in the light of mitigating carbon sequestration and impacts on the cocoa tree agroforestry system and cocoa farmer livelihoods. Perhaps partnerships in the Climate Cocoa Partnership for REDD+ Preparation project (Hutchins et al. 2015) that included Olam and Rainforest Alliance, in collaboration with the Forestry Commission, could sustain financing the forest and the cocoa sector to help cocoa trees become more resilient to moisture and temperature changes due to climate change and contribute to REDD+ carbon finance options through their increased carbon stocks on their farms. While the existing studies find climate change effects inimical to cocoa farmers unless farmers adapt, access to financing mechanisms to mitigate rainfall variability in restoring cocoa forest cover would require that combination of short- and long-term financing instruments.

8.2 Financing demands for supplemental small-scale cocoa farm Irrigation Investments

Focusing on the financing demand for cocoa farm irrigation services, the literature review found no studies in Ghana (and elsewhere) that directly asks cocoa farmers for these services. However, many studies find that when asked about constraints to cocoa production, declining soil fertility, high incidence of pests and diseases, high exposure to droughts and temperature extremes, poor agronomic practices, and inadequate farm maintenance are raised. From the review, it is acknowledged that productivity on cocoa farms could be raised through a combination of agronomic practices and cocoa farmers' demand for technology input packages, including soil testing, improved seedlings and fertilizers, as well as improved farm management practices, in the light of climatic changes, the quest to adopt farm level technologies to sustain cocoa farm intensification through supplementary cocoa farm irrigation will increase with COCOBOD pioneered pilot cocoa farm supplementary irrigation programme and her vision into the future in the light of climatic changes and cocoa production. It is anticipated that with increasing climatic challenges but the profitability of cocoa farm enterprises, commercial-oriented cocoa farmers may demand the financing of supplemental irrigation farm-related activities. However, accessing and purchasing such equipment will depend on costs, accessibility and availability (such that no farmer is disadvantaged: women, youth, migrants) of the irrigation equipment at the local level and the demonstrable technical sustainability of the technology.

8.3 Gaps, opportunities and risks

There exist gaps, opportunities, and risks in the push for supplemental irrigation of cocoa farms in Ghana under threat from climate change effects. The review of the relevant literature suggests gaps, the lack of appropriate data and research work on cocoa farmer demand for cocoa farm irrigation services; funding sources for sustaining cocoa ecosystem functioning that are limited to the general forest ecosystem, and to cocoa, the focus seems more on rehabilitation and replanting of the cocoa tree, whilst the cocoa ecosystem faces both biophysical and socio-economic challenges; and institutional/stakeholder collaboration in delivering efficient agricultural water management to cocoa farms through irrigation that appears championed only by the COCOBOD whilst other partners and stakeholders pursue alternative cocoa crop productivity arrangements.

Nonetheless, there are opportunities in harnessing the existing environment in the push for supplemental irrigation of cocoa farms that includes the expansion, currently, of small-scale private irrigation in many SSA countries, apparently driven by farmers' initiatives and investments and coupled with COCOBOD efforts in providing smallholder cocoa farmers with irrigated facilities, the demand for cocoa farm irrigation and its financing mechanisms are emerging; cocoa farmers' awareness about climate change drivers have been raised through several interventional projects and training on adaptation and mitigation strategies; business models for farmers for on-farm irrigation that exist and government interests and private funding sources potentially for financing supplemental irrigated cocoa production.

However, perceived risks exist concerning smallholder farmers who are considered too risky and costly to finance; the under-developed demand and supply market for irrigation equipment, particularly for cocoa irrigation; poor farmer financial support in agricultural financing, especially farm irrigation infrastructure needs and high interest on financial support from financial institutions.

The identified gaps, opportunities and risks provide for financing cocoa farm irrigation equipment and the effective demand for this equipment. It requires COCOBOD and the relevant stakeholders to provide the enabling supportive environment needed to develop an effective business-case as to encourage private firms to engage in these technology transfers to the farm level.

8.4 Need for a sustainable financing ecosystem for irrigated cocoa production

The financing arrangement with farmers for cocoa farm irrigation is not yet known. There is a suggestion for water management on cocoa farms using drip irrigation that can increase yields, although costs outweigh the benefits with high upfront investment for irrigation. With climatic effects threatening agriculture, the argument is that finance is only one element of constraints on adopting farm technologies, suggesting that solutions need to be integrated. There is a need for a comprehensive study on financing infrastructure to support cocoa farming.

The proposed sustainable financing ecosystem for irrigated cocoa production will be an SPV that mobilizes funds from private and public (blended finance) for long-term investment purposes and will be spearheaded by COCOBOD given her role in the oversight of the cocoa industry and the pioneering role in the supplemental cocoa farm irrigation project. Most financing programs for smallholder farmers offer relatively small loans for short periods and often at high real interest rates. This financing arrangement does not envisage short-term loans to purchase relatively expensive irrigation systems for cocoa farming.

The SPV will grant loans and advances to the cocoa farmer, individually or in groups, and accept repayments and deposits. A financing mechanism based on an arrangement with the private sector that spreads out payments and enables cocoa farmers to benefit could minimize risks to the financing scheme. Thus three key interventions are needed (a) sustainably sourced funding, (b) a simplified financing institutional structure, and (c) enabling actors to support the cocoa farmer.

For sustainability, in terms of technical and institutional, stakeholders would include financial institutions, actors in the cocoa landscape, including NGOs, licensed cocoa buying entities, commercial cocoa farmers and Cocoa Farmer Cooperatives, guided by the existence of the clear policy and regulatory frameworks to facilitate the institutional financing arrangements.

Enhancing cocoa biodiversity through financing cocoa farm supplemental irrigation could increase farm productivity and support the provision of other services and hence needs to be factored into sustainable financing arrangements under forest (Ministry of Lands and Natural Resources) and agricultural policy funding trajectories (Ministry of Agriculture and COCOBOD) to protect sustainable use of resources in the cocoa farming sector. There are business models, opportunities in developing solutions to cocoa farm irrigation services, and policy efforts could be directed at providing such models for cocoa farm irrigation.

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APPENDICES

Proposed primary data collection tools to design actionable pathways to accelerate sustainable financing for cocoa irrigation investment

QUESTIONNAIRE

International Water Management Institute

An analysis of the Sustainable financing ecosystem for Cocoa Irrigation in Ghana
PROPOSED FARMER QUESTIONNAIRE (to be verified by the institutional Ethical Review Boad)

Survey Instrument

The focus of this structured questionnaire will be to *understand the capacity of the cocoa farmer* to engage in the sustainable cocoa irrigation financing scheme, their ability to participate and pay for the irrigation scheme and their preferred funding arrangements.

[READ TO THE FARMER IN THE LANGUAGE THEY UNDERSTAND]

Thank you for your interest in this interview. We seek information on your current household crop production levels, revenue and assets, access to and use of agricultural/financial services and a description of your farm business. The International Water Management Institute is carrying out this study. Please be assured that everything you tell us will be kept confidential by the research team and will not be used for any other purpose than research consistent with the Data Protection Act. The information we collect about you, your household and your farm enterprise will be mixed with information about many other farmers in other parts of the country. There will be no personal reports about you but only about farming in the area or Ghana. The study team is **not** related by business ties or employment to any farmer group. The interview is voluntary and you do not have to answer all questions. Do I have your permission to continue with the interview? **YES NO (If NO, terminate)**

GENERAL INFORMATION

Date of Interview……

Time of Interview……

1. Questionnaire No. ……

2. Enumerator Name/No……..

3. COCOA REGION	4. COCOA District	5. Village/ Community (to be given numbers)

A. RESPONDENTS' HOUSEHOLD CHARACTERISTICS (SOCIO-ECONOMIC INFORMATION)

A1. Name of Respondent (as in NHIS card/Voter Card/Ghana Card etc.) – official (only if needed, better leave it anonymous)……

A1a.Name of Respondent - Common Name in the village/community …(only if needed, better leave it anonymous) …….

A2. Age of Farmer ……..years

A3. Gender of Respondent. 1 = Male 0 = Female

A4. Marital Status: 1= Married 2 = Widowed 3 = Single 4= Separated 5 = Divorced

A5. What is the residential status of the farmer respondent? 0. Indigene/Native 1. Migrant

A6. What is your household size, and how many are available for farm work regularly? (***should include respondent***)

Category of a household member	A5aNumber	A5b. Number Available for farm Work	
		≤ 2 days/Wk	> 2 days/Wk
Male adults (eighteen years and above)			
Female adults (eighteen years and above)			
Children between 6 years and 18 years			
Children under 6 years			
Total household size			

A7. What is your principal occupation?

1 = Farmer 2 = Self-employed artisan/Skilled Craftsman 3 = Salaried employee 4 = Food processor

5 = Trader 6 = Hired labourer on farm 7 = Other Agro-processing (other than food, e.g. Soap making from the cocoa husk, etc.) 8= Other (specify) …….

A8a. Are you a member of FBO? 1=Yes 0=No

A8b. Are you a member of a Cocoa cooperative in your community? 1=Yes 0=No

A9. What is your educational Status?

0. None 1. Uncompleted primary 1. Primary completed 2. Middle/JSS 3. Secondary/SHS/SSS
4. Higher than Secondary/SHS/SSS 5. Arabic education 6. Non-formal education
7. Other (specify): ……..

B. Agricultural Production (Plots, Crops, outputs, inputs, cost and revenue)
[Read to the farmer: I am going to ask you several questions that relate to cocoa and other crop production]

B.0 Indicate the *Number* of plots (under cocoa production) **……**

Cocoa production							
B.01	For each plot of the cocoa farm, please indicate the type of landholding arrangement and characteristics of the farm						
			Cocoa farm holding or plot number				
			Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
	B.01a	1=Farm owner 2=Caretaker 3=Sharecropper					
	B.01b	Landholding type (1=Owned 2=Family land 3=Rented 4=Others					
	D.01c	State size of farm (area planted on this plot)	|……|	|……|	|……|	|……|	|……|
	D.01d	Farm size unit (1=poles, 2=Acres, 3=Ha, 4=ropes)	|……|	|……|	|……|	|……|	|……|
	D.01e	Is this a cocoa farm/plot bearing fruits? 1=Yes 0=No	|……|	|……|	|……|	|……|	|……|
B.02	What was your **output of dried cocoa beans** from the different plots for the 2020-2021 cocoa season (major & minor seasons)						
			Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
	D.03a	Major season output in bags (Sept 2020 – Jan 2021)	|……|	|……|	|……|	|……|	|……|
	D.03b	Minor season output in bags (May 2021 – Aug 2021)	|……|	|……|	|……|	|……|	|……|
Other cash crops							
B.03	What type(s) of cash crops other than cocoa are you engaged in?		Oil Palm		Orange	Mango	Others

	Indicate the area planted for these cash crops	|……|	|……|	|……|	|……|
	Farm size unit (1=poles, 2=Acres, 3=Ha, 4=ropes)	|……|	|……|	|……|	|……|
	What was your output for the year 2020 (in kilos)	|……|kg	|……|kg	|….|kg	|……|kg

Food crops

B.04		Maize	Cassava	Plantain	Yam	Vegetables (pepper, tomato, garden eggs, etc.)	Others
	Did you cultivate these food crops last season? 1=Yes 0=No	|……|	|……|	|……|	|……|	|……|	|……|
	area planted to crops last season (1=poles, 2=Acres, 3=Ha, 4=ropes)	|……|	|……|	|……|	|……|	|……|	|……|
	What was your output from the mentioned crops last season?	|……|kg	|……|kg	|……|kg	|……|kg	|……|kg	|……|kg
	What proportion of crops output harvested has been damaged/lost?	|……|%	|……|%	|……|%	|……|%	|……|%	|……|%
	What quantities of the crops did you sell?	|……|kg	|……|kg	|……|kg	|……|kg	|……|kg	|……|kg

Livestock

B.05		Cattle	Sheep	Goats	Poultry	Others
	How many of these animals do you currently own?	|……|	|……|	|……|	|……|	|……|

Inputs		Quantity	Price/unit (GHC)	Total (GHC)
Fertilizer				
B.06	Asaase Wura			
B.07	Cocofeed			
B.08	Sidalco			
B.09	Confidor			
B.10	Organic			
B.11	Others			
Pesticides				
B.12	Akate Master			
B.13	Actara			
B.14	Others			

Fungicides				
B.15	Ridomil Gold			
B.16	Funguran-OH			
B.17	Kocide 2000			
B.18	Nordox 75 WG			
B.19	Champion			
B.20	Others			
Herbicides				
B.21	Round up			
B.22	Gramoxone			
B.23	Others			
Labour (Paid)				
B.24	Clearing /weeding			
B.25	Pruning (including mistletoe)			
B.26	Spraying: Fungicides			
B.27	Spraying: pesticides			
B.28	Spraying: Herbicides			
B.29	Fertilizer Application			
B.30	harvesting			
B.31	Transport of beans			
Other Labour Cost				

Expenditures over the last year (2020/2021) cocoa season			
Please indicate your expenditure on the following items in Ghana cedis for 2020/2021		**Frequency of expenditure** [1=Daily 2=Weekly 3=Monthly 4=Quarterly 5=Yearly]	**Expenditure per period (GHC)**
B.32	Food purchase	|……|	|……| GHS
B.33	Water	|……|	|……| GHS
B.34	Public toilet	|……|	|……| GHS
B.35	Sanitation – waste disposal	|……|	|……| GHS
B.36	Education for children (mainly uniforms, books, school fees & transport)	|……|	|……| GHS
B.37	Health/NHIS	|……|	|……| GHS
B.38	Rent	|……|	|……| GHS

	B.39	Travels	|……|	|……| GHS
	B.40	Funerals/social	|……|	|……| GHS
	B.41	Firewood/Charcoal	|……|	|……| GHS
	B.42	Electricity	|……|	|……| GHS
	B.43	Gas	|……|	|……| GHS
	B.44	Kerosene	|……|	|……| GHS
	B.45	Remittance	|……|	|……| GHS
	B.46	Others (specify)	|……|	|……| GHS

Cocoa income for 2020/2021 Cocoa Season				
B.47	Please state the income from cocoa for the major and minor seasons			
	B.47a	Major season income (Sept 2020 – Jan 2021)	|……| Ghana cedis	
	B.47b	Minor season income (May 2021 – Aug 2021)	|……| Ghana cedis	
Other sources of income for the 2020/2021 Cocoa Season				
B.48	What are your other sources of income for the last year, 2020/2021 and how much money did you receive per period?			
			Regularity of income flow [1=daily, 2=weekly, 3=monthly, 4=quarterly, 5=yearly]	Income from the activity for 2017/2018
	a. Sale of food crops		|……|	|……| GHS
	b. Other cash (tree) crops than cocoa (Oil palm, orange, mango, etc.)		|……|	|……| GHS
	c. Sale of animals		|……|	|……| GHS
	d. Agricultural wage labour (employed for farm work)		|……|	|……| GHS
	e. Non-agricultural labour (employed for off-farm work, e.g. store guard, waiter, domestic worker)		|……|	|……| GHS
	f. Petty trading		|……|	|……| GHS
	g. Transport business		|……|	|……| GHS
	h. Artisan (handicraft, mason, construction work)		|……|	|……| GHS
	i. Salaried worker/pension/social security fund		|……|	|……| GHS
	j. Fishing/hunting		|……|	|……| GHS
	k. Remittances		|……|	|……| GHS
	l. Others (e.g. gifts, LEAP, etc.)		|……|	|……| GHS
B.49	Has your income changed in the past 12 months? 1=No change 2=Decrease 3=Increased		|……|	
B.50	By how much has it changed, decreased or increased?		|……|%	

C. FINANCIAL OPPORTUNITIES: PROVISION OF CREDIT, SAVINGS, INSURANCE & INVESTMENT

Credit Facility

C.1 Did you apply for credit (money/a loan: cash or in kind/input supply credit) in the 2020/21 season for your production (from any source, including formal and non-formal institutions)? 1= Yes **(skip to C3)** 0= No

C.2 If No, why did you not apply for credit? (Provide possible responses). (***Skip to B5***)

(1) Don't have access to a Financial Institution (FI)—Financial Institution too far
(2) No collateral
(3) Cannot meet the loan repayment schedule
(4) Don't need money from the FI
(5) Relatives/Friends, etc., always help me financially
(6) Complicated loan processing procedure
(7) Never made any attempt
(8) Don't know how to access a loan from FI
(9) No savings at FI to access loans
(10) Others (specify)

C.3 If yes, were you given the credit/loan? 1 = Yes 0 = No (***Skip to C4***)

Source	C3a. If yes, from which source 1 = Yes 0 = No	C3b. Amount Loan requested (GHS)	C3c. Amount of loan received (GHS)	C3d. What was the interest rate charge? (%)	C3e. What were the lending terms for the loan received? Code	C3f. What costs were incurred before the loan was granted? (GHS)	C3g. What was the credit obtained used for? (**see code**)
Rural Bank /Community Bank							
Agricultural Development Bank							
Ghana Commercial Bank							
Other Universal/Commercial Banks							
Savings and loans company/MFI							
Credit Unions							
Fintechs							
Moneylender							

VSLA or Rotation Saving and Credit Association = susu group							
Family/friends							
Purchasing Clerk							
Others							

What was the credit obtained used for? Code: 1. Farm input purchases (chemicals + labour) 2. Household obligations/expenditures 3. To pay for previous loans, 4. To pay for association dues, etc. 5. Other (specify…)

C.4 . If you requested credit but did not get what was the reason for not getting it?

1 = No collateral 2 = Had outstanding loan 3 = Don't Know 4 = Other, specify_____

Savings and Investment

C.5 Do you save with a financial institution towards your farm business investments?

1= Yes (***Skip to C7***) 0= No

C.6 If **No**, state the reasons for not saving. (***Multiple responses possible***).

1. Don't have access to the financial institution –located too far
2. From experience, financial institutions will not honour their promises
3. Do not know that there are financial institutions that mobilize savings from farmers
4. Do not need to save with any financial institution
5. Relatives/Friends advised me against it
6. Never made any attempt to save
7. Do not know how to access savings services of financial institutions
8. No excess money to set aside as savings
9. Others (specify)

C.7 Do you have insurance to protect your farm business investments?

1= Yes (***Skip to C9***) 0= No

C.8 If **No,** state the reasons for not operating any insurance.

(i) Don't have access to an operating company
(ii) From experience, the insurance company will not honour its promises
(iii) Don't know that there are insurance companies for farmers
(iv) I don't need to insure my farm investments
(v) Relatives/Friends will help when there is a problem on my farm
(vi) Never made any attempt
(vii) Don't know how to access the services of the insurance companies
(viii) No money to pay the insurance premium

(ix) Others (specify)

C.9 If **Yes to C7**, specify who insured you, when you began, how much premium you paid, and any benefit gained

	C9a	**C9b**	**C9c**	**C9d**	**C9e**	**C9f**
Insurance on cocoa farm investments	Who insured? 1 = Yes 0 = No	What insurance covers? 1=Fire 2=Flooding 3=low yield 4=wind storm 5=Other……..	When begun (year)	How much premium per month (GH¢) is paid currently or when you last paid?	Any benefit gained? 1=Yes 0= No	If yes, specify the benefit
With the insurance person/agent						
Savings and loans company						
Rural bank						
Universal/Commercial bank						
Insurance company						

INVESTMENT

C.10 List, if any, your capital investment for the production of your produce/product in the last five years (2016-2021)

Production Capital Item	When purchased/acquired	Value of Capital Item (GHS)	The current condition of Item

C.11 List, if any, your capital investment for post-production management of your produce/product in the last five years (2017-2021).

Capital Item for post-production management	When purchased/acquired	Value of Capital Item (GHS)	The current condition of Item

C.12 List your working capital investment for production and post-production management of your produce/product in the last five years (2017-2021).

Working Capital Item for production management	Working Capital Item for post-production management	When purchased/acquired	Value of Capital Item (GHS)	The current condition of Item

C.13 What are the current investment needs for the growth of your agribusiness?

Investment Item	Number/Quantity	Estimated/Current Value of Capital Item (GHS)	How do you plan to obtain it?

D. AWARENESS AND USE OF ON-FARM COCOA IRRIGATION

D.01 Do you use irrigation in your farming activities? 1= Yes (***Skip to D3***) 0= No

D.02 If No, why? 1= High cost of installation and maintenance 2= Unavailability of water source 3= Drainage problem 4= Lack of Technical Know-How 5. Lack of Access to Irrigation Facility (services, financial support, etc.)

D.03 If Yes to D.01, which area of your farming activities do you use irrigation? 1= Nursery 2= Transplanting 3= Vegetables farm 4= Food crop 5= Tree crops (cocoa) 6= other(s) Specify: ……..

D.04 Are you aware of the use of irrigation in cocoa production? 1= Yes 0= No (***Skip to E***)

D.05 How did you know about the use of irrigation in cocoa production? 1= Visits by irrigation companies/Ghana Irrigation Authority 2= Cooperatives training and awareness creation with members 3= Cocoa Board representatives/extension officers 4= Media (radio, tv, social media 5= Project/NGO other than cocoa board project 6= Other(s) Specify: ……..

D.06 Do you use irrigation in your cocoa production activities? 1= Yes 0= No (***Skip to E***)

D.07 If Yes to D.06, which areas of the cocoa production do you use for irrigation? 1= Nursery 2= Transplanting 3= Young Farm (1 to 5 years) 4= Mature Farm (6 years and above) 6= Other(s) Specify: ……

E. WILLINGNESS TO ADOPT AND PAY FOR COCOA FARM SUPPLEMENTAL IRRIGATION

Supplemental irrigation will help to grow your cocoa tree crop for increased yields, **maintain landscapes**, and revegetate disturbed soils in dry areas and during periods of less-than-average rainfall. Supplemental irrigation has other uses in cocoa production, including preventing soil compaction.

E.01 Are you willing to adopt supplemental irrigation in your cocoa production? 1= Yes 0= No (If NO, move to F)

E.02 If Yes, which type of irrigating system are you willing to use? 1. Solar Powered 2= Fuel Powered 3= Manual

E.03 Which areas in your cocoa production activities are you willing to use irrigation? 1= Nursery 2= Transplanting

3= Young Farm (1 to 5 years) 4= Mature Farm (6 years and above) 6= Other(s) Specify: ……

E.04 Please indicate when you are willing to use irrigation in cocoa production activities. 1= In less than a year 2= 1 to 5 years 3= 6 years and above

E.05 Are you willing to pay for the cost of irrigation plant installation and maintenance? 1= Yes 0= No (If NO, move to F)

E.06 If YES, how much are you willing to pay for the irrigation plant installation? GHs ……..

E.07 If YES, how do you want to pay for such services or expenses (**payment system/model)**?

Please choose the option that you consider most suitable for you in the payment for your irrigated farm. Imagine that these three options are the only options available to get support through a financing scheme for supplemental irrigation on your farm. Please consider each question independently from the other choice questions.
Tick your one preferred option.

	Alternative 1	**Alternative 2**	**Alternative 3**	
Type of Funding	Reward	Blended	Donation	
The proportion of the on-farm irrigation financed through Financial Institution (FI)	30% financed through Bank	70% financed through Bank	100% financed through Grant	
Source of additional funding (in addition to FI)	70% financed through own capital	30% financed through own capital	No additional funding source	
Collaborating with other cocoa farmers in the financing of farm irrigation	Yes	No	No	**None of these alternatives**
I prefer →	☐	☐	☐	☐

F. ASSETS OF THE HOUSEHOLD [INCLUDE ITEMS ONLY IF THEY ARE IN WORKING CONDITION]

F.01 Do you currently (in 2021) own any of the following assets in working condition?

Assets	F.01 Own any of the following assets? 1 = Yes 0 = No	F.02 If YES, indicate the number or size of assets where applicable for 2021.	F.03 Does a **female** member of the household own any of these assets? 1 = Yes 0 = No	F.04 If YES, indicate the number or size of assets where applicable for 2021.
1. Motor car				
2. Motorbike				
3. Bicycle				
4. Truck				
5. Tractor				
6. Furniture				
7. Sewing machine				
8. Refrigerator/Freezer				
9. Radio (Small size, no cassette)				
10. Radio cassette				
11. Television				
12. Video recorder				
13. Electric/Gas Stove				
14. Electric Iron				
15. Electric Fan				
16. Utensils				
17. Mobile Telephone				
18. Canoe				
19. House				
20. Land for farming				
21. Other lands				
22. Account with a financial institution				
23. Shares in a company				
24. Jewellery				
25. Cloth: Dumas, Lace etc				
26. Cattle				
27. Sheep/Goats				
28. Chickens				
29. Non-farm business enterprise				
30. Donkeys				
31. Treasury Bills				
32. Fixed line phone				
33. Farm tools				
34. Cart				
35. Corn Mill				
36. Air conditioner				
37. Other				

THANK YOU **END TIME**_____

SUPERVISOR CHECK TIME/DATE_____ **SUPERVISOR NAME**_____

Key informant interview Guides

FINANCIAL INSTITUTIONS (FI)

Financial institutions will play key roles in intermediating between the funding institutions and the farmers. The interview guide will seek to understand financial institutions' various products, specifically for smallholder farmers' cocoa financing. It will also solicit FI's opinions in participating in the proposed sustainable financing of irrigation for cocoa farmers, the benefits and the risks, among others.

After Informed Consent, the discussion will focus on the following topics:

- Perception about climate change and cocoa production
- Feedback from farmers (farmer demand) on the need for cocoa farm irrigation
- Is there a need for cocoa irrigation (Yes/No, explain)?
- Type of irrigation needed
- Specific loan or financing products targeting /smallholder farmers and/or tree crops, especially cocoa irrigation
- Lending terms for general lending and agricultural lending, in particular, e.g. Tree crops if any
- Financial arrangement/payment module
- Willingness to participate in proposed sustainable financing of irrigation for cocoa farmers
- Ways your institution will be willing to participate in sustainable financing of irrigation for cocoa farmers

COCOBOD (CHED, CRIG, SPED)/MoFA/Researchers)

These interview guides' main outcome will be to understand the cocoa irrigation pilots' rationale and scale-up mechanisms. It will also solicit an understanding of the financing mechanisms (free, subsidized, outright payment etc.) followed, the sustainability of the funding and irrigation systems, and farmer feedback.

After Informed Consent, key informant discussion will focus on the following topics:

- Status of the cocoa irrigation project, scaling up plan
- Type of cocoa farm irrigation providing
- Feedback from farmers (farmer demand) on the cocoa farm irrigation projected/main evaluation outcomes
- Current payment arrangement/Financing arrangement for cocoa irrigation (free, subsidized, outright farmer payment at cost, etc.)
- Future payment arrangement/financing arrangement for cocoa irrigation (free, subsidized through a bank loan, bank loan arrangements, farmer outright payment, etc.)
- Available funding opportunities/technical support services for cocoa farmers for cocoa farm irrigations
- Relationship between COCOBOD/MoFA and Financial Institutions in soliciting funding for cocoa farmers
- From your field experience, are financial institutions willing to lend to cocoa farming and for cocoa farm irrigation? Reasons?
- Relationship between COCOBOD/MoFA and Forestry Commission on REDD+ in meeting cocoa farmers' needs
- Has COCOBOD implemented a sustainable financing scheme (LT) for cocoa farm irrigation? What form/structure is this? Does it permit PPP arrangements?

Ministry of Lands and Natural Resources/Forestry Commission

The Forestry Commission (FC) has funding mechanisms for forest ecosystem management under REDD+, including cocoa landscapes. The main outcome of this interview guide will be to understand the scale (on/off forest reserves) of forest management and the funding mechanisms relative to cocoa ecosystem restorations. It also solicits information on possible funding rationale for supplemental irrigation in the cocoa landscape and the collaboration with COCOBOD on funding arrangements

After Informed Consent, key informant discussion will focus on the following topics:

- Perception about climate change and cocoa production
- Feedback from farmers (farmer demand) on the need for cocoa farm irrigation
- Is there a need for cocoa irrigation (Yes/No, explain)?
- If Yes, what type of irrigation needed
- Relationship between COCOBOD/MoFA and Forestry Commission on REDD+ in meeting cocoa farmers' needs
- Funding arrangements in the rehabilitation process/possible financing of irrigation in cocoa
- Available funding opportunities/technical support services for tree crops/ cocoa ecosystem restoration/agroforestry/ rehabilitation
- Willingness to participate in proposed sustainable financing of irrigation for cocoa farmers
- Ways your institution be willing to participate in sustainable financing of irrigation for cocoa farmers

NGOs in the cocoa production space

Several NGOs are operating in the cocoa space as buying organisations or sustainability champions in cocoa production. The interview guide would address the relevance of supplemental irrigation and the cocoa sector's ongoing renovation and rehabilitation efforts. In addition, funding arrangements in the rehabilitation process and its possible financing of irrigation in cocoa will be solicited. Farmer feedback in terms of irrigation demand will also be solicited

After Informed Consent, the key discussion will focus on the following topics:

- Perception about climate change and cocoa production
- Current efforts on cocoa farmer farm rehabilitation/renovations outcomes
- Feedback from farmers (farmer demand) on cocoa farm irrigation
- Is there a need for cocoa farm irrigation (Yes/No, explain)?
- If Yes, what type of irrigation needed
- Available funding opportunities/technical support services for tree crops/ cocoa ecosystem restoration/agroforestry
- Preferred payment arrangement/Financing arrangement for cocoa irrigation (free, subsidized, outright payment etc.)
-
- Willingness to participate in proposed sustainable financing of irrigation for cocoa farmers
- Ways your institution be willing to participate in sustainable financing of irrigation for cocoa farmers

Farmer Key Informants (KIs)

Farmer key informants include FBO Executives, Chief Cocoa farmers, Input Distributors, etc. Information sought to include the COCOBOD irrigation pilots and scale-up rationale, farmer demand for the product (farm irrigation) and other farm services in the light of the changing climate, and the preferred funding mechanisms. The key question will be who funds the initiative and the farmers' contribution.

After Informed Consent, the discussion will focus on the following topics:

- Perception about climate change and cocoa production
- Current efforts on cocoa farm rehabilitation/renovations outcomes
- Feedback from farmers (farmer demand) on the need for cocoa farm irrigation
- Is there a need for cocoa irrigation (farmer's perspective)? Yes/No, explain
- Status of cocoa irrigation pilot project, scaling up plan by COCOBOD
- Feedback from farmers (farmer demand) on the cocoa irrigation projected/main evaluation outcomes
- Who will pay for the cocoa farm irrigation? COCOBOD? Farmer?
- Preferred payment arrangement/Financing arrangement for cocoa irrigation (free, subsidized, outright farmer payment? etc.)
- Are farmers willing to participate in sustainable financing of an irrigation scheme for cocoa farmers
- Ways your institution/personnel be willing to participate in sustainable irrigation for cocoa farmers

FGDs interview Guides

Focus Group Discussions will be structured around interactions with 9-10 male-only, female-only, and youth cocoa farmers (≤35 years) separately in selected communities. Like the KIs, the information sought includes the COCOBOD irrigation pilots and scale-up rationale, farmer demand for the product (farm irrigation) in addition to other farm services in the light of the changing climate, and the preferred funding mechanisms. The key question will be who funds the initiative and the farmers' contribution.

After Informed Consent, the discussion will focus on the following topics:

- Perception about climate change and cocoa production
- Current efforts on cocoa farm rehabilitation/renovations outcomes
- Feedback from farmers (farmer demand) on the need for cocoa farm irrigation
- Is there a need for cocoa irrigation (farmer's perspective)? Yes/No, explain
- Status of cocoa irrigation pilot project, scaling up plan by COCOBOD
- Feedback from farmers (farmer demand) on the cocoa irrigation projected/main evaluation outcomes
- Who will pay for the cocoa farm irrigation? COCOBOD? Farmer?
- Preferred payment arrangement/Financing arrangement for cocoa irrigation (free, subsidized, outright farmer payment? etc.)
- Are farmers' willingness to participate in sustainable financing of an irrigation scheme for cocoa farmers