EMPOWERING
AGRICULTURAL
DEVELOPMENT
INNOVATORS

Project Factsheet

Project duration: October 2020 – September 2022
Implementation partner: ETH Zurich & The University of Queensland (UQ)
Further partners: Kwame Nkrumah University of Science and Technology (KNUST), ECA/CABISCO Joint Cocoa Research Fund (JRF)
Direct and indirect beneficiaries: Actors involved in cocoa sustainability
Focus areas covered: increasing the understanding about the farmers and their environment

Methods for remotely estimating shade-tree cover and carbon stocks, and for developing spatially explicit recommendations for cocoa agroforests

Background
Over 60% of the global production of cocoa is grown on smallholder farms in Ghana and the Ivory Coast, providing the main source of income for approximately two million farming families. But as global demand for cocoa increases, production in these countries is threatened by unsustainable farming practices. Agroforestry – the deliberate inclusion of shade trees in cropping systems – can increase the sustainability of cocoa production by supporting high levels of biodiversity, buffering cocoa from contemporary climate changes, off-setting future climate change through carbon sequestration, and by encouraging agricultural intensification without deforestation. Because of these advantages, and in response to supply-chain and reputational risks, chocolate producing companies are increasingly engaging in efforts to implement cocoa agroforestry in major producing countries such as Ghana and the Ivory Coast. Importantly, however, this effort is currently hampered by: limited information on current levels of shade-tree cover and carbon stocks in individual farms and across entire regions; and the lack of an efficient, cost-effective tool to monitor progress on their agroforestry initiatives and commitments. Moreover, implementing agroforests in a way that does not compromise production requires recommendations for optimal levels of shade-tree cover across large geographic regions while accounting for locally varying growing conditions determined by climate and soils. Using available methods, developing such recommendations is not currently possible.

Project content
To meet these challenges, ETH Zurich, The University of Queensland and the Kwame Nkrumah University of Science and Technology (KNUST), are therefore implementing an innovative project across Ghana and the Ivory Coast that combines state-of-the-art Artificial Intelligence (i.e. Deep Neural Networks in Deep Learning) with traditional fieldwork, and a close collaboration between the cocoa industry and research institutes. The project is financially supported by the Lindt Cocoa Foundation (66%), ETH Zurich (18%), the ECA/CAOBISCO Joint Cocoa Research Fund (10%) and KNUST University (6%).

Over the course of two years (2020-2022), the project will develop methods for remotely estimating shade-tree cover and carbon stocks in cocoa farms and develop spatially explicit recommendations for the implementation of cocoa agroforests. In a first step, the research team will collect and curate industry estimates of cocoa yield, farm locations and information on farm management across thousands of individual cocoa farms. In a second step, these farms from across the entire study region will then be classified according to local climatic and soil conditions. Using state-of-the-art Artificial Intelligence, the project will then develop a Deep Learning approach to determine current shade-tee cover and carbon stocks in each of the cocoa farms obtained from industry partners (step 3). This Deep Learning approach will be calibrated and validate using reference data of shade tree cover and carbon stocks collected in ~500 farms during a six-months field campaign. In each farm drones will be used to capture high resolution aerial images to assess shade tree cover, carbon stocks and

About the Lindt Cocoa Foundation:
The Lindt Cocoa Foundation was founded in 2013 and has the declared purpose of working to achieve social and ecological sustainability in the cultivation, production and processing of cocoa and other raw materials used in chocolate production.

Learn more:
www.lindtcocoafoundation.org

shade-tree diversity will be assessed in 30 m radius subplot. The calibration and validation with ground truth data is an important and necessary step to ensure the accuracy of the estimates and conclusions drawn from this project. During the field campaign, the project team will also conduct household surveys with cocoa farmers to obtain data on cocoa yields, farm management and farmers demographic to create a high-quality dataset on cocoa yields and determinants of cocoa yields that can be linked directly to the on-farm measurements of shade tree cover and carbon stocks. Once calibrated and validated, the newly developed Deep Learning workflow for assessing shade-tree cover and carbon stocks will be turned into a monitoring tool, allowing repeated and remote assessment of shade-tree cover and carbon stocks to inform and monitor the implementation of cocoa agroforests.

The information on cocoa yields and estimates of shade tree cover and carbon stocks (steps 1-4) will then be combined to define the relationship between shade-tree cover and yield and also between shade-tree cover and carbon stocks, in each of the different climatic/edaphic zones across the study region (step 5). These relationships will then be used to identify the maximum level of cover that does not reduce cocoa yields and can be achieved in each climatic/edaphic environment covered by the dataset. These estimates will also account for the influence of important statistical covariates, such as farm age, farm management and cocoa variety where this data is available. The estimates of maximum level of shade-tree cover that does not reduce cocoa yields will form the basis to develop recommendations for optimal levels of shade-tree cover tailored to each climatic/edaphic growing area and will allow estimates of the existing and potential carbon-sequestration capacity of cocoa agroforestry across Ghana and the Ivory Coast.

Project objectives

The specific goals of this project are to:

1) Develop methods to rapidly assess shade-tree cover and carbon stocks in existing cocoa farms, across large scales, and repeatedly over time.
2) Develop an easy-to-use, cost-effective tool to measure changes in shade-tree cover in cocoa farms, and to monitor progress towards implementing agroforestry commitments.
3) Develop spatially explicit recommendations for optimal levels of shade-tree cover accounting for locally varying growing conditions.
4) Determine the carbon-sequestration potential of cocoa agroforestry across Ghana and Ivory Coast.

In achieving these goals, the project aims to generate project outcomes that allow the scientifically informed implementation of agroforests with targeted distribution of multipurpose trees and predictions of future carbon impact from on-farm tree planting across Ghana and the Ivory Coast. The methods developed in this project will further allow the remote and repeated assessment of shade-tree cover and carbon stocks in cocoa farms over time, which will be invaluable for the monitoring and evaluation of industry-led agroforestry initiatives.

Serving the mission of the Lindt Cocoa Foundation

The project touches upon the following focus area of the Lindt Cocoa Foundation:

1) Support research projects that aim at increasing the understanding about the farmers and their environment in order to improve the efficiency and effectiveness of projects.

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