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Falk Milan Georg Krumbé “The economic dependency of Ghana's cocoa sector on pollination services”, University of Hohenheim, 2022

Supervisors: Jun.-Prof. Dr. Arndt Feuerbacher

Problem statement

Global biodiversity integrity is at risk. This is highlighted by many reports across the globe with the IPBES report¹ being a very prominent example. The loss of biodiversity not only pertains to the intactness of ecosystems themselves but also to the ecosystem services associated with them. Among the many ecosystem services at risk, pollination services are crucial ones which are directly linked to ensuring crop production. The risk of deteriorating ecosystem services is even higher for crops like the cocoa tree which essentially depends on wild pollination services. Considering that cocoa is mostly grown by poor smallholder farmers, their income and consequently food security depend fundamentally on wild pollinators like the *Ceratopogonidae* midges. The loss of ecosystem services is therefore not a singular issue but rather a complex issue which is entangled with other global issues such as food security, poverty reduction and economic development. To inform policymakers of the importance of biodiversity and as a necessity for food security, new decision-making tools are needed which incorporate the value of ecosystem services. Economic thinking and models can provide these tools. The Dasgupta Review² gives a comprehensive overview of ways on how to adequately incorporate biodiversity into economic models. Studies on pollination services is a prominent example mentioned multiple times in the review, highlighting the importance of pollinators. Despite a multitude of studies estimating the economic value of pollination services, there has so far been no comprehensive evaluation of the value and relevance of cocoa pollinators. This thesis aim was to fill this gap by analyzing the importance of cocoa pollinators to the country of Ghana, a country whose economy and culture is closely interlinked with cocoa production, where cocoa provides income and food security to more than 800.000 smallholder farmers.

Objective

To assess the role of cocoa pollinators for food security and the economy of Ghana, this thesis' main tool of analysis was a computable general equilibrium (CGE) model. CGE models are often referred to as the workhorse models of policy analysis and are able to model policy changes or technological changes at the country level. The database of a CGE model is a Social

¹ IPBES. (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Version 1).

² Dasgupta, P. (2021), The Economics of Biodiversity: The Dasgupta Review. (London: HM Treasury).

Accounting Matrix (SAM), which follows the principles of national accounting. The idea of incorporating pollinators into national accounting systems is something that is even mentioned verbatim by the Dasgupta Review, where it says: “National asset management requires that pollinators enter projects with their accounting prices”.³ Building on that notion raised in the review, the goal was to model a change in cocoa pollinator populations in Ghana to see how these changes affect the economy of Ghana, the income of different household groups and the effects on food security. In contrast to previous studies, this thesis aim was to work with more realistic scenarios, as most economic valuation studies of pollination services simulate a complete loss of all pollinators. A detailed analysis of effects across different household groups (rural vs. urban & rich vs. poor) was conducted, to identify households whose income and food consumption are very sensitive to changing cocoa pollinator numbers. This is an aspect that has largely been ignored by most economic pollination studies.

Methodology

The thesis work can be split into three main parts: The first part consisted of the systematic literature review on cocoa pollination, which was conducted to identify the most relevant cocoa pollinators across the globe and in Ghana. The second part consisted of expert interviews in Ghana, which were conducted to analyze the importance of cocoa pollinators to cocoa farmers and assess the potential of the emerging technology of manual pollination. Lastly, the third part was the economic analysis. Here, necessary data needed to be gathered from various sources, which then needed to be adjusted. The model database, a SAM of Ghana for 2015, was provided by the Joint Research Centre (JRC) Seville, Spain. Afterwards the model code of the CGE model needed to be altered to fit the study design. Guided by the systematic literature review and expert interviews, shocks to the pollinator population were implemented into the model. The changes in cocoa pollinator populations were decreasing numbers of 10%, 30% and 50%, as well as an increase of pollinator numbers by 10%. The respective changes in cocoa pollinator numbers lead to changes of cocoa productivity of -9.5%, -28.5%, -47.5% and 9.5%.

Results

The systematic literature review revealed that *Ceratopogonidae* midges and especially members of the *Forcipomyia* genus are both globally and in Ghana specifically the most important cocoa pollinators. This information can guide decision makers to focus conservation efforts on insect species (e.g., the *Forcipomyia* midges), whose loss poses a large risk to the economy and income security. The economic analysis showed that the changes to macroeconomic indicators, like GDP, are across all four scenarios rather minor, which might seem surprising given the importance of cocoa to the Ghanaian economy. This rather minor shock can be explained by a currency depreciation of the Ghanaian Cedi following reduced cocoa exports which benefits other export-oriented sectors like the mining industry. The linkage between the cocoa industry to the mining sector is a crucial insight, as small-scale mining is a controversial topic in Ghana as it is associated with environmental degradation and negative effects on human health. The analysis also revealed that the effects of changing cocoa pollinator numbers on household income differ across households. Rural and poor households are for the largest part negatively affected by declining cocoa pollinator numbers, while urban and rich households even benefit to some extent from decreasing numbers. The effects on food consumption were mixed across the analyzed household groups, with rural and poor household groups in the Western region of Ghana, the major cocoa growing region, having to reduce their food consumption considerably if cocoa pollinators decline. Lastly, the expert interviews and

³ Dasgupta, P. (2021), The Economics of Biodiversity: The Dasgupta Review. London: HM Treasury).

the literature review showed that manual pollination is a very promising technology, but further implementation is constrained by limited fertilizer availability and labor shortages.

One caveat of the model, that is currently being adjusted, is the high flexibility it allows for factor reallocation. This gives cocoa farmers the option to shift their labor and capital to other agricultural activities like maize or cassava production, which leads to unintended positive side-effects such as increased food production. In reality labor and capital would not be as easily channeled into other occupations, with the income loss from cocoa production and the associated food expenditure being more severe.

In conclusion, the protection of cocoa pollinators can help improve the food security of poor and rural households of Ghana's cocoa-growing regions. Conservation can be achieved by intercropping cocoa with plantain, maintaining natural forest covers and promoting adequate use of pesticides. This thesis showed that CGE models allow for a comprehensive and complex analysis of the linkage between the economy, ecosystem services and food security. It is therefore recommended to encourage national agencies in Ghana to employ them hoping that improved national decision-making will lead to secured food security in the future.