



## Final Evaluation Report

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Your Details	
<b>Full Name</b>	Diogo F. Ferreira
<b>Project Title</b>	Putting a price on the menu: Evaluating bat ecosystem services in African cocoa plantations
<b>Application ID</b>	30078-1
<b>Grant Amount</b>	£5,980
<b>Email Address</b>	<a href="mailto:ferreiradfa@gmail.com">ferreiradfa@gmail.com</a>
<b>Date of this Report</b>	September 2021

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Select 8 farms and build 2 exclosures trees in each farm.				<p>We successfully built 16 exclosures in the eight different farms. Unfortunately, the fishing net was stolen from one on the exclosures, meaning that we end up the project with only 15 exclosures trees.</p> 
Monitoring the arthropod activity, tree productivity, herbivory, and pest evidence for 12 months.				<p>During the 12 months of monitoring, Alan Wandji was able to count 162,579 arthropods belonging to 17 orders: 77,384 from 17 orders in control trees and 85,195 from 16 orders in exclosure trees. He also counted a total of 15,154 flowers, 3,060 small fruits, 602 medium fruits and 1,042 big fruits. Finally, he recorded 2,157 events of pest feeding, 802 events of Cherelle Wilt and 717 events of Black Pod Disease. In total, we photographed and analysed the leaf damage on 575 leaves.</p>
Collect all cacao beans from the 16 exclosures and 16 controls (crop yield).				<p>We were able to collect 162 cacao pods from the control trees and 117 from the exclosures trees. In total, we had a yield of 11.4 kg (dry weight of cacao beans) and 8.4 kg in the control</p>

				and exclosures trees, respectively. Unfortunately, due to some problems during the harvesting season we were not able to collect all the pods and use this data in our statistical analysis.
Identify the bats species responsible for the pest consumption.				We were able to capture 158 bats from 17 species and show that six species preyed upon the main cacao pest in Africa.
Disseminate our results to farmers and public in our study area.				Due to the pandemic the workshops had to be postponed for a couple of months. Nevertheless, Melanie Tchoumbou was able to organise all the planned workshops and show our finding to 405 farmers.
				

**2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.**

The project started in February 2020 and 2 months after that the pandemic started. This created several problems, but most of them were addresses and solved. We had to create new protocols to guaranteed that our crew was always safe and reduced contact with farmers and other people to a minimum. Also, because I could not travel to Cameroon to capture bats, the August fieldwork was conducted by Patrick Jules Atagana and another technician. Unfortunately, due to the pandemic we could not travel always as planned, so sometimes the pods in the trees got rotten, meaning that we were able to count them but not harvest the cacao beans inside of the pods. Additionally, some pods were removed from the control trees without our permission, which did not allow us to use those trees for the analyses. To avoid having results that could not respond to the reality, we decided not to include the crop yield in our analyses and manuscript. Finally, as mentioned above one fish net was stolen in July 2020, right before the harvesting, and because of that we decided to exclude that tree from all analyses.

**3. Briefly describe the three most important outcomes of your project.**

We will publish in the next months a short communication in an indexed journals highlighting the results that we found from the analyse of the bat and bird faeces. The main aim of this publication will be to show what pests or potential pests are bats and birds eating in cacao plantations in Africa. This type of information is vital to address the reduction in yield cause by the main pest and other secondary pests.

The biggest outcome of this project will be a publication showing all the patterns and results found from the exclusion experiment (it will most likely be submitted to the Journal of Applied Ecology). I finished all the analyses last month and just finished writing the first draft of the manuscript. This publication will show the importance of bats (and birds) in regulating the populations of pests in cacao plantations and how that affects cacao production. With this paper we will show a proof of concept and recommend management actions to implement in cacao farms.

The workshops conducted during the last months allowed us to interact more with farmers and to pass them the information we obtain during this experiment about the role of bats (and birds) in their farms. Together with this, we also suggested management actions (although quite general because it is hard to know specific management actions without finishing our analyses and conduct more studies) that they could implement. In my opinion, the most important part of this was to demonstrate to farmers and public the ecological and economic benefits that bats can bring to the world and to show them that these animals are not the “bad guys”. This is especially important if we consider that we are facing a pandemic that is wrongly associated to bats. With this project we showed that if we live in balance with nature, we can create win-win scenarios for nature and humans.

**4. Briefly describe the involvement of local communities and how they have benefitted from the project.**

The team of this project was mostly composed by local people. During the duration of this project, we had four paid Cameroonian technicians. All of them were introduced to the concept of the project, taught on how to perform each task, and by the end of it all of them were totally independent. Besides, three of them are PhD students, meaning the two publications that will result from this project will help to improve their CVs and their capacity to compete with other researchers from across the world. Finally, farmers were also involved in our project. Eight farmers were responsible for maintaining the exclosures and all information that we learn from this experiment was shared with them and with other farmers (total of 405) during the workshops. Also, we compensated the farmers from our farms (eight farmers) for the work that they had to do to maintain the exclosures. Although not life changing, these compensations helped to mitigate a little the impacts that they were facing during these troubled times.

**5. Are there any plans to continue this work?**

Yes. Now that we identify the bats (and birds) responsible for eating the pests and showed that they can bring positive impacts to cacao plantations in Cameroon, we

plan to investigate how to attract these species to the farms and this way increase their role as pest suppressors. For that we are planning to apply to a booster grant to conduct telemetry and find the shade trees or other places where they are roosting, and then build bat and bird boxes to attract them to our farms.

#### **6. How do you plan to share the results of your work with others?**

The results of this project so far were already shared during the farmers workshops and presented in three international conferences:

- Ferreira DF, Wandji A, Jarrett C, Atagana PA, Maas B, Rebelo H and Powell LL (2021) "Putting a price on the menu: evaluating bat (and bird) ecosystem services in African cocoa plantations". European Bat Research Symposium. May 4-7, Turku, Finland (Online Conference).
- Ferreira DF, Jarrett C, Wandji A, Atagana PA, Maas B, Rebelo H and Powell LL (2021) "Putting a price on the menu: evaluating bat (and bird) ecosystem services in African cocoa plantations". ATBC. July 21-23 (Online Conference).
- Ferreira DF, Wandji A, Jarrett C, Atagana PA, Maas B, Rebelo H and Powell LL (2021) "Putting a price on the menu: evaluating bat (and bird) ecosystem services in African cocoa plantations". 2nd World Bat Twitter Conference 2021. May 26-28 (Online Conference) (most creative presentation award: <https://bit.ly/2YFhmu7>).

We also plan to share the results into two international scientific journals and do press releases about these two publications (e.g., Mongabay). Both publications will be share with the foundation as soon as they are accepted.

#### **7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?**

The project was supposed last from February 2020 to February 2021, however because the pandemic postponed the workshops it lasted from February 2020 to July 2021.

**8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.**

Item	Budgeted Amount	Actual Amount	Difference	Comments
Vehicle - Fuel	£1600	£1600		
Vehicle - Driver's per diem	£1380	£1380		
Lodging	£900	£900		
Food	£700	£700		
Farmer compensations	£800	£800		
Workshops	£540	£600	+60	Our workshops had more people that planned so we had to spend more than planned.
Divulcation material	£60		-60	We were able to print these at zero cost and so we used the extra money for the workshops.
<b>Total</b>	<b>£5980</b>	<b>£5980</b>		

**9. Looking ahead, what do you feel are the important next steps?**

The important next steps are to continue spreading our results to other farmers (in other areas of Cameroon), identify the shade trees and farm conditions that benefit the bats (and birds) that are eating the pests, and try different bats and bird boxes to see which one is better for our targeted bat/bird species.

**10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?**

Yes, during the conferences where I presented the results from this project, and in the flyers and other media that we produced for the farmers workshops.

**11. Please provide a full list of all the members of your team and briefly what was their role in the project.**

Diogo F. Ferreira	Project leader and responsible for sampling the bats, selecting the farms, helping to build the enclosures, analysing the data and writing the manuscripts.
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Alan Wandji	Entomologist responsible to build the exclosures and monitoring the trees every month for 12 months.
Crinan Jarrett	Ornithologist responsible for sampling the birds (although not part of this grant), selecting the farms, and helping to build the exclosures and analyse the data.
Patrick Jules Atagana	Bat biologist responsible for sampling the bats, build the exclosures and helping Alain when needed.
Sandjo Raoul	Master student responsible for helping sampling bats during the August field season.
Melanie Tchoumbou	Ornithologist responsible for sampling the birds (although not part of this grant) and conducting the farmers workshops.

**12. Any other comments?**

The support from The Rufford foundation was vital to the success of this project and I hope to collaborate again with this foundation. Thank you for the support!