Final Evaluation Report

Your Details	
Full Name	ZUBARIA WAQAR
Project Title	Genetic parameters of *Cariniana legalis* (Mart.) Kuntze (Jequitibá-rosa) to restore and conserve the Southern Bahia Atlantic Rainforest.
Application ID	37431-1
Date of this Report	23-10-2024

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
(I) comprehend how genetic parameters are related to forested landscape by using one Atlantic Forest native species and studying its gene flow in four different land-uses, called from now on as treatment (i)conserved Atlantic Forest fragments (remnants), (ii) passive forest restored areas, (iii) active forest restored areas, and (iv) Cabruca (cocoa agroforest plantation).		x		Due to limited number of trees in restored areas we did not investigate these parameters in that area, and only focused on cabrucas and native forest.
(II) Are restoration areas and		X		We only focused our research on cabruca useful fore ecological

"cabrucas" useful as ecological corridors to landscapes?				corridors to landscape.
(III) How landscape connectivity and permeability are efficient in maintaining the genetic variability of *Cariniana legalis*? Variegated landscapes are useful to amplify genetic variability of a wind pollinated tree species?			X	We changed our species for *Cariniana legalis* to *Plathymenia reticulata* due to unavailability of number of trees required to do genetic analysis.

2. Describe the three most important outcomes of your project.

Thankfully, we were able to find some interesting conservation-related findings thanks to the hard work of the entire team. As there hasn't been much time since our research was completed, I will outline the key outputs and a few intermediate findings, showing how they are affecting the stakeholders.

a). Our research reveals that *Plathymenia reticulata* cultivated in the cabruca agroforest system maintains a high level of genetic diversity, comparable to or even exceeding that of natural forest populations. Despite the anthropogenic influence, cabruca provides an effective habitat for the conservation of genetic diversity. The high genetic diversity observed in cabruca populations, including indices like the mean number of alleles, effective number of alleles, and Shannon Index, suggests that the agroforest system can play a critical role in biodiversity conservation, especially in fragmented landscapes. This finding emphasizes the potential of well-managed agroforestry systems to support conservation efforts for threatened species like *P. reticulata***.**

b). Other genetic diversity metrics reveal a significant genetic differentiation between cabruca and forest populations of *P. reticulata*. Environmental conditions and management practices in cabruca influence the genetic structure of populations, leading to distinct genetic profiles between forest and cabruca populations. The results suggest that while cabruca is effective in conserving genetic diversity, gene flow within and between cabruca populations is restricted, potentially leading to inbreeding. The natural forest, in contrast, shows moderate genetic differentiation with better genetic health and greater gene flow between populations.

c). We also did paternity analysis demonstrated that gene flow in cabruca populations occurs primarily over small distances, with juveniles mostly descending from parents within the same cabruca. This suggests that fragmentation and

isolation due to human activities in agroforestry systems limit gene flow, which could increase inbreeding over time. However, the presence of a small number of juveniles with parents from distant populations indicates that long-distance gene flow can still occur, potentially facilitated by animal seed dispersers. This highlights the need to improve landscape connectivity to ensure better gene flow and reduce the risks associated with inbreeding and genetic drift in isolated populations.

These findings underscore the importance of cabruca in biodiversity conservation, but also point to the need for sustainable management practices, enhanced connectivity with forest remnants, and the mitigation of human-induced fragmentation to preserve genetic diversity and ecosystem resilience.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

A major setback we encountered was the limited number of *Cariniana legalis* individuals required for genetic analysis. After visiting around 20 cabruca agroforests, we found that the number of trees was insufficient for our study. Since cabruca is a central part of our research, this presented a significant challenge. Consequently, we decided to shift our focus to *Plathymenia reticulata*, a species that, although threatened, is more common in the region. This change allows us to continue our study while still addressing important conservation issues related to native tree species in cabruca agroforestry systems.

Another setback we faced was related to the restored areas. During the analysis, our genotyping machine (ABI3500) malfunctioned. Due to the project's time constraints and other factors, we had to exclude the restored areas from our study and focus solely on the cabruca agroforest and natural forest. Despite these challenges, I believe we addressed the situation with a more practical approach, prioritizing the most critical areas of the research to ensure the project remained on track.

4. Describe the involvement of local communities and how they have benefitted from the project.

Our research had multiple benefits for local communities. First, our study focused on natural forests and cabruca agroforestry systems, which provided important insights into the protection of threatened species *like Plathymenia reticulata*. This promoted initiatives to conserve biodiversity and helped communities recognize the ecological significance of these trees

Brazil is an agricultural country, and agroforestry is widely practiced here. In Bahia, smallholder farmers manage historic cocoa plantations, known as cabruca, where cacao trees are grown under the shade of native Atlantic Forest trees. Cabrucas play a crucial role in the conservation of biodiversity and native species. The goal of our investigation was to investigate these systems, and we came to the conclusion that cabrucas can be useful restoration sites for native species conservation. In

addition to promoting biodiversity, the conservation of native trees in the cabrucas aids in regional ecological restoration initiatives. The preservation of the Atlantic Forest ecology and sustainable agriculture both depend on this agroforestry system.

5. Are there any plans to continue this work?

During the execution of this project, we identified a strong potential to expand the work, given the limited knowledge in this area within our region and the high level of interest from stakeholders. As a result, this project laid the foundation for a larger initiative focusing on the restoration of three Atlantic Forest species. The topic of genetic restoration has since been integrated into our research group (Genética da Conservação UESC - https://gaiotto2.wixsite.com/geneticaconservacao). Also, I am planning to write another project related to this project to work as Post-Doctoral researcher.

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

We are already working on it. We are planning to publish our paper in renowned journal. Also, during my PhD I did internship with Ello Ambiental Consultoria is a company specialized in studies and environmental management of enterprise. made a booklet for farm managers to explain importance of genetic analysis.

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

The next crucial step is to monitor the implementation of our recommendations. It is essential to increase awareness among farmers, encouraging them to adopt the practical guidelines developed by our partners. This will allow us to evaluate whether our results lead to the desired goal of establishing genetically viable conserved populations. Since other institutions are already investigating restoration genetics, we are confident that this objective can be achieved in the coming years.

8. 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, I used Rufford logo in seminars inside my university. I also used The Rufford Foundation logo in my project presentation to acquire my PhD title.

9. Provide a full list of all the members of your team and their role in the project.

Fernanda Amato Gaiotto – provided assistance in project elaboration, field activities, lab analysis and all steeps of this project.
Ane Karoline Campos Fernandes- she was a very helpful colleague that assisted in field and identified the areas where *Plathymenia reticulata* can be found.
Sampling. Also, she helped with lab analysis.

Taise Conceição de Almeida – she was a very helpful colleague that assisted in field Sampling.
Deborah Lima Santos- She was very helpful and assisted in the field samplying
Marcos Penna – he was our financial management that helped me with the project budget and expenditure.
Lukas Halla Daneu- Our driver and field assistant.

10. Any other comments?

Also, I am sending some photos of the studied species and field work.

Photograph 1. The studied species –*Plathymenia reticulata*, a threatened native tree of the Atlantic Forest in Brazil. Credits: Zubaria Waqar

Photograph 2. Tree in Cacao Agroforest located in southern Bahia. Credits: Ane Karoline Campos Fernandes

Photograph 3. A native natural forest. Credits: Zubaria Waqar

Photograph 4. Zubaria and Deborah in Collection area in Cacao Agroforest. Credits: Ane Karoline Campos Fernandes

Photograph 5. Zubaria using slingshot to collect leaves from adult trees Credits: Ane Karoline Campos Fernandes

Photograph 6. Part of the project team in one of the field trips. From the left to the right, Zubaria and Taise C. Almeida. Credits: Alaya Keane

Photograph 7. Juvenile of *Plathymenia reticulata*. Credits: Taise C. Almeida

Photograph 8: Our Team trying to find trees in Cacao Agroforest. Credits: Taise C. Almeida

Photography 9: Ane Karoline in front of adult tree in Natural Forest. Credits: Taise C. Almeida