Darwin Initiative Main & Extra: Final Report

To be completed with reference to the "Project Reporting Information Note": (https://www.darwininitiative.org.uk/resources/information-notes/).

It is expected that this report will be a **maximum of 20 pages** in length, excluding annexes.

Submission Deadline: no later than 3 months after agreed end date.

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Darwin Initiative Project Information

Scheme (Main or Extra)	Main
Project reference	29-030
Project title	Controlling invasive alien trees to support conservation and improve livelihoods
Country(ies)	Madagascar
Lead Organisation	Missouri Botanical Garden, Madagascar Research and Conservation Program
Project partner(s)	-Regional Directorate of Environment, and Sustainable Development (DREDD) -Regional Directorate of Industrialization, Trade and Consumer Affairs (DRICC) -Federation LOVASOA (LOVASOA)
Darwin Initiative grant value	£197 406
Start/end dates of project	01 July 2022 - 31 March 2025
Project Leader name	Adolphe Lehavana
Project website/blog/social media	http://mobot.mg/conservation/pointe-a-larree/
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1 Project Summary

Several invasive alien species pose serious threats to Madagascar's unique biodiversity and rural economy. At Pointe à Larrée, in central-eastern Madagascar, home to one of the largest remaining fragments of rare littoral forest, the invasive tree *Melaleuca quinquenervia* is outcompeting native plant species and degrading ecosystems. In response, our project supported local communities in tackling this invasive species within the protected area by converting the wood into charcoal, creating a new source of income for charcoal producers. This initiative not only helped restore degraded habitats with native species but also promoted sustainable livelihoods. The charcoal was sold through a local producers' cooperative, which received technical support from partners in the form of capacity building, infrastructure development, equipment provision, and the creation of a business and marketing strategy. This

project has emerged as a model for integrated conservation and community-based development within protected areas along Madagascar's east coast.

2 Project Partnerships

This project was collaboratively designed and implemented by four principal partners, all of whom recognized the ecological and socio-economic challenges posed by the invasion of *Melaleuca quinquenervia* within the Pointe à Larrée Protected Area (PA). At the project's outset, roles and responsibilities of each partner were formally defined through a Memorandum of Understanding (MoU) (Evidence Project Partnerships, Figure1), which also detailed operational procedures, particularly those related to financial management.

Two governmental technical services, representing the Ministry of the Environment and Sustainable Development and the Ministry of Commerce, provided technical guidance to ensure legal compliance and technical coherence of activities. The Lovasoa Federation acted as the intermediary between the project and the local communities, coordinating and supervising on-the-ground implementation. MBG assumed overall coordination responsibilities, including the distribution of financial and material resources, facilitation of communication between partners, and engagement with Darwin Initiative'administrator. All project activities received annual validation and approval from relevant local and regional authorities, including mayors, the Prefect, and the Governor, in alignment with national policy frameworks. To support the development of the Cooperative's business plan, four young professionals were recruited, two with expertise in accounting and two in commerce. The project's achievements were publicly presented during a booth exhibition organized by the British Embassy in Madagascar during the King's Birthday Celebration on 13 June 2024 (Evidence Project Partnerships, Figure2).

Throughout implementation, each partner fulfilled their agreed commitments. Bi-monthly coordination meetings were conducted to monitor progress, address emerging constraints, and apply adaptive management strategies through formally submitted Change Requests at DI level. Initial community resistance, a common challenge in novel initiatives, was gradually mitigated through targeted communication, inclusive dialogue, and the visible engagement of both partners and authorities, ultimately fostering local trust and participation.

To raise public awareness of the project's objectives and impacts, partners collectively participated in key regional and national events. Complementary outreach strategies included mass media campaigns, cultural festivals, and dissemination via social media platforms (e.g., Facebook, YouTube), which significantly enhanced consumer interest and product visibility. Despite early challenges in market acceptance, these awareness efforts contributed to the successful sale of all charcoal products.

Overall, partner collaboration was considered effective and productive, although some obstacles remain particularly regarding sustained awareness and engagement among Cooperative members.

3 Project Achievements

3.1 Outputs

Output1. ***Melaleuca*** **eliminated from high priority restoration zones within the PA thereby enhancing natural regeneration**

Output 1.1 By YR1 study published identifying high priority zones for restoration through the elimination of Melaleuca

A detailed map has been produced identifying heavily invaded areas within the Pointe à Larrée peninsula, including both within the core of the Protected Area (PA) and the surrounding peripheral zones (Evidence Output 1, Figure 3). In developing a restoration strategy, priority

was given to zones within the PA that harbor high concentrations of native biodiversity requiring urgent protection.

Given that *Melaleuca quinquenervia* is primarily an anemochorous species, with wind-dispersed seeds commonly travelling scores of meters, management efforts have also targeted satellite populations within a 200-meter buffer zone surrounding the PA. This buffer clearance aimed to minimize the risk of seed dispersal from adjacent invaded areas back into the protected area.

Output 1.2 By YR 1 adult stems of Melaleuca (stem dbh >5cm) eliminated over 10 hectare; by YR2 over 20 hectare and by YR3 over 30 hectare.

In Year 1 (YR1), a total of 5.7 hectares within the PA was cleared of *Melaleuca*, including individuals of all stem diameter classes, from saplings to mature trees. This area increased to 38.2 hectares in YR2, reaching a cumulative total of 60.5 hectares by YR3 (see Evidence Output 1.2, Table 3). These efforts targeted priority zones, resulting in the complete removal of *Melaleuca* over 31.9 hectares within the PA and 28.6 hectares in the adjacent peripheral zone. By the end of the project, the area cleared of *Melaleuca* invasions was double the initial target.

Given the species' strong coppicing ability, follow-up interventions were implemented to suppress regrowth of cut stems and seedlings were manually uprooted two to three times in previously cleared areas to prevent recolonization. By the end of the operations, only a few isolated seedlings were observed, indicating a significant reduction in regeneration potential of the species.

Output 1.3 By YR1, 50, by YR2 100 and by YR3 150 women involved in removal of Melaleuca

In YR1, 40 women participated in the removal of *Melaleuca quinquenervia*. This number increased to 80 in YR2 and to 251 in YR3. Due to the physical difficulty of uprooting large, mature trees, additional support from men was required, with a total of 189 men contributed to the effort from YR1 to YR3 (see Evidence Output 1.3, Table4). Overall, women were more actively involved in *Melaleuca* control activities, representing 57% of participants, compared to 43% for men.

Output 2. Melaleuca charcoal produced preferentially by local people and accesses lucrative markets with livelihood benefits for locals

Output 2.1. By YR1 protocol demonstrated in "real world" conditions that enables charcoal to be produced from *Melaleuca* with no more than 15% loss of efficiency compared to charcoal produced from native trees (some loss of efficiency must be expected and this will be compensated by greater sale's price)

Following the initial production of *green* charcoal of Melaleuca, informal surveys were conducted with six charcoal producers across three target villages. The objective was to assess the profitability and labor efficiency of converting *Melaleuca* into green charcoal. Respondents provided largely consistent responses. Compared to the use of native tree species, processing *Melaleuca* requires approximately 23% more labor, primarily due to the need for bark removal. However, it was noted that the wood of native species currently used for charcoal production in the area is extracted from deeply buried marshland. This practice entails a 26% higher labor cost than using *Melaleuca*, making *Melaleuca* a more labor-efficient alternative in terms of wood preparation.

The true economic performance of Melaleuca's green charcoal production system is driven by three key factors:

1. Improved technologies: The adoption of two "modern" carbonization techniques significantly enhances productivity. The MATI kiln (Meule à Tirage Inversé) is twice as efficient as traditional methods, while the Casamance kiln, introduced from Benin, produces 2.8 times more charcoal than conventional kilns (Output 2.1 Figure 4).
2. Market Competitiveness: Green charcoal commands a higher market price than charcoal made from native species, due to its superior quality (especially its resitence to fragementing during transport), which better meets consumer demands. Currently, the

cooperative pays charcoal producers members at MGA 8,000 per bag of Melaleuca charcoal (approximately £1.35), which compares to MGA 7,020 per bag (approximately £1.18) that the other charcoal members outside of Cooperative (Evidence Output 2.1 Table 5).

3. Producer Incentives**:** At the end of the financial year, cooperative members received bonuses of MGA 2,662 (£0.45) per bag from the cooperative's sales profits. This additional income served as a strong incentive, motivating members to maintain and expand their production efforts (Evidence evidence Output 2.1 Figure 5).

A key operational challenge associated with producing green charcoal using the two recommended improved carbonization techniques is the required drying period: *Melaleuca* wood must be air-dried for approximately one month before it can be processed in kilns. This delay poses difficulties for charcoal producers who depend on continuous production for income. To address this constraint, the project's startup fund enabled the cooperative to provide financial advances to committed producers, ensuring continuity in production despite the drying time.

Output 2.2 In YR1, YR2 and YR3 respectively, 30, 60 and 100 charcoal producers obtained 25% increase in household income from charcoal (currently zero *Melaleuca* charcoal as baseline)

By the end of the project, 28 cooperative members were actively involved in green charcoal production, with an additional member joining in May 2025 (Evidence Output 2.2 Table 6). Although this number appears low compared to initial targets, it reflects a gradual adoption process. At the project's outset, community members were hesitant to comply with the cooperative's strict operational rules resulting in no active participation in YR 1 and only four members in YR 2. However, participation grew to 28 in YR3, and new enrollments toward the end of the project brought total cooperative membership to 62.

Assessing income improvements was challenging because most members had ceased charcoal production for over three years following the establishment of Pointe à Larrée protected area in 2015. Consequently, baseline income data was collected through interviews with non-cooperative charcoal producers. These producers reported an average annual income of approximately MGA 1,891,890 (≈£317.87) (Evidence Output 2.1 Table 5).

To ensure data reliability, we compared the earnings from green charcoal with those from native species charcoal production during the same year. Charcoal made from native species sold for MGA 7,020 (≈£1.18) per bag, whereas green charcoal with premium fetched MGA 10,662 (≈£1.79) per bag (including bonus), representing a 51% increase in income per bag. Since the time required for harvesting Melaleuca (niaouli) and extracting buried wood in deepy marsh is roughly equivalent (see Output 2.1 Table 5), this price premium indicates that green charcoal is significantly more profitable.

Output 3. Melaleuca charcoal appreciated by urban populations and product sale strategy supported sustainably

Output 3.1 Permits obtained to provide a legal context for the project to exploit and sell charcoal from *Melaleuca* – including definition of mechanism to ensure that the charcoal being sold is really from *Melaleuca*

New operating permits were issued to each COBA on 16 September, 2024, with a validity of one year. These permits incorporate the results of product monitoring conducted by the forestry administration representative prior to the sale of green charcoal to distribution points ensuring that no charcoal from native trees were mixed with the green charcoal products (Evidence Output 3.1 Figure 6). Furthermore, to "label" this innovative project and to promote sustainable investment, the Ministry of Commerce and Industry has awarded a registered trademark certificate for « *Niaouli Green Charcoal »* to the Cooperative Samy Antsika. This trademark is officially recognized and valid for a period of 10 years, until 2034 (Evidence Output 3.1 Figure 7).

Output 3.2 Annually, 100% of charcoal produced by charcoal producers purchased by Cooperative and delivered to sale's point directly accessible to consumers

By the end of the project, 1,196 out of 1,500 bags of green charcoal had been sold to consumers, representing an 80% sales rate. Sales continued through June 2025, reaching a total of 1,254 bags sold out of 1,648 produced, equivalent to a 76% overall sales rate (Evidence Output 3.2 Table 7).

Output 3.3. By Y1, two sale's points installed and functional in Soanierana Ivongo and Sainte Marie

Due to rising fuel prices (to transport the production by boat), the planned point of sale on Sainte Marie Island was canceled. Instead, a new sales point was established at the MBG office in the regional capital, Fenerive-Est, where MBG oversees operations at the protected area. This location was chosen not only for logistical convenience but also because it offers a more profitable market. In Soanierana-Ivongo, the high cost of setting-up a sales point led to a partnership with local resellers to distribute the green charcoal (Evidence output 3.3 Figure 8).

Output 3.4. Volume of charcoal sold by Cooperative of Melaleuca charcoal producers increases annually from zero at T0 to 20 tons by Y1, 40 tons by Y2 and 60 tons by Y3.

In YR1, no sales were recorded, despite the production of 0.82 tons (1 bag= 15.5 kg). In YR 2, cumulative sales reached 1.13 tons out of a total 2.13 tons produced. By YR3, these cumulative figures increased significantly to 18.53 tons out of 23.25 tons. In YR4, cumulative sales rose to 19.43 tons out of a total production volume of 25.54 tons.

In summary, by the end of YR3 (the official project end), total sales amounted to 18.53 tons, representing 31% of the overall sales target of 60 tons, while production reached 39% of the planned target (See evidence output 3.2 Table 7).

Output 3.5. Y2, a business plan and a manual procedure elaborated showing the overall strategy of the cooperative for the sustainability investment including the extension of investment areas

A comprehensive five-year business plan (2023–2027) has been developed to guide the implementation of the green charcoal initiative. The plan outlines both the commercial and marketing strategies for green charcoal and currently serves as an operational reference for all cooperative activities. It includes detailed management guidelines and procedures for cooperative members. The document is accessible at the following link: https://mobot.mg/conservation/pointe-a-larree-site/di-melaleuca/.

Output 3.6. From YR1 to YR3, at least 10 Leaders of the cooperative trained on at least six themes relating to the management and governance of the cooperative

Twelve members of the Cooperative's leadership team received training in six core areas designed to enhance their entrepreneurial skills, member management, and business strategy. As a result, the leaders were able to independently conclude and implement two contracts with resellers (Evidence Output 3.3 Figure 8 and Output3.6 Figure 9).

However, due to their limited experience and low literacy levels, they continue to face challenges particularly in financial management, accounting, and implementing the procedures outlined in the business plan. Although the project has ended, we are committed to ongoing support in these areas and will continue to provide guidance.

Output 4. Promising model of a new relationship with IAS demonstrated to land managers (including PA managers) and public awareness on IAS (threats and opportunities) increased

4.1. In YR1, YR2, and YR3 interested parties informed of the project and its progress by means of one dedicated website and bi-monthly social media posts.

From the project's inception to its completion, at least six categories of local and regional stakeholders were engaged during the initial regional and local launch workshops including conservationists, landowners, policymakers, government officials, consumers and villagers, were reached through various dissemination efforts. This outreach was subsequently reinforced and updated through various channels, including mass media coverage, capitalisation workshops, social media, and organized field visits. At the local level, approximately 95% of villagers around Pointe à Larrée PA have been informed about the issues related to the species. What resonates most with them is the income-generating potential from developing the value chains (Evidence webpage operational : https://mobot.mg/conservation/pointe-a-larree-site/di-melaleuca/, 17 posts on Facebook, 4 broadcasts on national television, and one on YouTube).

Among consumers, although the price of green charcoal is higher compared to charcoal made from other tree species, the majority are conservation-minded (Evidence Output 3.2 Table7). They are aware that purchasing the Cooperative's product supports efforts to control the spread of the invasive species and are motivated by this cause. For authorities and decision-makers, promoting the exploitation of this species as a development opportunity is a key priority. They have shown strong support, including through direct consumption of the product (Evidence Output 3.2 Table7).

Output 4.2. In YR3 at least 10 land managers (including Protected Area Managers) visit Pointe-à-Larrée to evaluate project.

In March 2025, a total of 28 participants, including eight Protected Area Managers participated in a workshop to evaluate the project that included a field visit. Six protected areas affected by the *Melaleuca* invasion were represented. A majority of participants were regional authorities and technical department representatives, many of whom are key decision-makers (Evidence output 4.2: Figure10 and Figure 11).

The session provided an opportunity to present the project model and observe its implementation and impact at first-hand. This direct exposure to the project's impacts inspired participating the Protected Area Managers, strengthening their ambition to combat the spread of the species in their sites respectively. Following the workshop, two representatives of Protected Area manageers, whose sites are currently heavily affected by the species (Sainte Marie and Analalava PA), verbally expressed a strong interest in initiating similar efforts to combat the invasion.

Output 4.3. In YR3 one article describing and objectively evaluating the project will be published in a peer reviewed journal

To date, no peer-reviewed article has been published on the project; however, an abstract describing this work and its impact has been submitted and accepted for an oral presentation at the upcoming Association for the Taxonomic Study of the Flora of Tropical Africa (AETFAT) Congress, scheduled to take place in Ghana from 3 to 8 August 2025. The presentation is titled *"Integrated Management and Sustainable Utilization of Melaleuca quinquenervia (Cav.)* S.T. Blake, an Invasive Species at Pointe à Larrée, East-Central Madagascar*."* The authors: Dr. Adolphe Lehavana and Dr. Chris Birkinshaw (Evidence Output 4.3: Figure12).

Output 4.4. From Y2 to Y3, annually 20,000 people informed or sensitized of project results through four annual participations in local, regional, national celebration events, 24 annual radio broadcasts

During the course of the project, a range of communication strategies and awareness-raising activities were implemented to engage various target audiences at regional and national levels:

- Biodiversity Festival: Organized annually by the Missouri Botanical Garden (MBG) in collaboration with local partners, the biodiversity festival takes place in Pointe à Larrée and serves as a key outreach event. Over the three-year period, it is estimated that approximately 10,300 individuals attended the festival, where project activities and products were presented to the public (Evidence output 4.4 Figure 13).

- World Environment Day (June 5): Celebrations were held annually throughout the project, reaching an estimated total of 12,000 participants. The most recent event, held on Sainte Marie Island from 2 to 4 June 2025, just after the formal conclusion of the project, offered a valuable opportunity to further disseminate the project's outcomes and increase visibility among a broader audience (Evidence output 4.4, Figure 14).
- British Embassy Exhibition Stand (June 13, 2024): As part of the King's Birthday celebration hosted by the British Embassy in Madagascar, MBG participated in an exhibition aimed at engaging high-level stakeholders. Approximately 90 individuals visited the stand, including senior government officials and three Ministers. Samples of Melaleuca charcoal were distributed to interested visitors. This event was instrumental in raising awareness of the project's objectives among national authorities (Evidence 2.Project partenerships Figure 2**)**.
- Participation in Economic Fairs (2023 and 2024): MBG participated in regional and national economic fairs, which facilitated outreach to approximately 3,140 people. These events provided a platform to highlight the project's contributions to sustainable economic development and biodiversity conservation (Evidence output4.4 Figure 15).
- Digital and Mass Media Outreach: Social media and traditional media channels were extensively used throughout the project to diversify reach and impact. While the exact number of individuals reached through these platforms is difficult to quantify, the following outputs were achieved: 21 Facebook posts, 20 regional radio broadcasts, the launch of a functional project website, and four features on the national television channel. Based on estimated audience sizes, it is anticipated that these activities collectively reached at least 40,000 individuals (Evidence 4.4 Figure 16).

3.2 Outcome: A self-sustaining approach to the use of IAS is launched that demonstrably reduces the threat of Melaleuca at Pointe à Larrée PA while providing fuel-wood and income for local people

Outcome O.1 By YR 1 Melaleuca eliminated over 10 hectare of the PA; by YR2 over 20 hectare; and by YR3 over 30 hectare.

By the end of the project, *Melaleuca* populations were completely controlled within protected area covering 31.9 hectares, as well as from an additional 28.6 hectares in the surrounding buffer zone, resulting in a total cleared area of 60.5 hectares (Evidence Outcome O.1 Figure 17).

Outcome O.2 By YR3 the growth of native trees in restoration zones is at least 10% greater than in control areas where large Melaleuca stems have not been eliminated.

Following *Melaleuca* removal, a total of 16,253 seedlings of native trees were planted across 12.8 hectares using two endemic species: *Faguetia falcata* and *Syzygium emirnense*. These two species exhibit good adaptation to the conditions of this aquatic ecosystem, and further species will be either introduced or will establish naturally. Final inventories, conducted at the end of the project confirmed the absence of mature *Melaleuca* individuals in the treated areas, with only a few scattered seedlings (<20 cm tall) observed. No evidence of natural *Melaleuca* regeneration was detected. In contrast, the density of the two endemic planted species was significant, with *Faguetia falcata* reaching 2,033 individuals/ha and *Syzygium emirnense* 667 individuals/ha (Evidence see Output1.2 Table3 and Outcome O.2 Figure18). Monitoring conducted seven months after planting showed survival rates of 72.86% for *Faguetia falcata* and 88.8% for *Syzygium emirnense* (Outcome O.2 Table 8). These findings suggest a positive trajectory toward ecosystem restoration.

Spontaneous natural regeneration of herbaceous species (including the sedge *Lepironia articulata* that is valued for handicrafts) was also observed following the initial *Melaleuca* removal in marshy areas previously colonised and dried by the the Melaleuca. Of the 11 species recorded, three remain unidentified, while seven are native, collectively exhibiting a relative frequency of 143% and a total abundance of 304 stems/m². A single naturalized

species, *Imperata cylindrica,* was recorded, with a relative frequency of 9.93% and an abundance of 43 stems/m² (Evidence Outcome O.2 Table 9).

These results indicate that one year after invasive species control, ecosystem recovery has begun through the natural regeneration of native herbaceous species. This recovery process has been further supported by active restoration efforts involving the planting of endemic species well adapted to local environmental conditions (Evidence Outcome O.2 Figure19,a,b,c).

Outcome O.3 By YR3, with easy access to Melaleuca charcoal for local people, the number of infractions within the PA for exploiting native trees for charcoal has fallen by 50% compared to T0

The final recorded instance of charcoal production involving tree felling within the protected area occurred in April 2022 and involved the cutting of seven trees. No further tree harvesting for charcoal production was observed within the PA through the end of the project.

To effectively assess this indicator, instances of illegal logging were monitored both within the PA and the adjacent buffer zone. Prior to project implementation, the estimated annual number of native trees felled for charcoal production in the buffer zone was approximately 240 trees per year (Theresice, Ranger, pers. comm.). By the end of the project, this number had decreased to 84 trees, representing a 65% reduction (Evidence, Outcome O.3 Table 10).

Importantly, multiple inspections conducted by the forestry administration in the cooperative's charcoal warehouse found no traces of native tree species in the stored sacks of charcoal (Evidence, Outcome O.3 Figure 20). This suggests that illegal wood harvesting is being carried out by charcoal producers operating independently of the those associated with the cooperative.

Outcome O.4 Income from charcoal exploitation increased by 25% for 30 charcoal makers in Y1, 60 charcoal makers in Y2 and 100 in Y3 compared to zero as baseline

As noted in Output 2.2, establishing a baseline for charcoal producers' income at T0 is challenging, as production activities had ceased several years prior. Since operations were discontinued in 2015, many former charcoal producers shifted to alternative livelihoods such as fishing, agriculture, and livestock-rearing.

During the project period, a total of 1,500 bags of green charcoal were produced by the 28 active cooperative members over three years. With a premium price of MGA 10,662 per bag, this generated an average annual income of MGA 571,178 (approximately £260.37) per member. This income represents a new and additional revenue stream for the cooperative members (Evidence see output 2.2 Table 6).

Moreover, the introduction of the Casamance kiln enabled the recovery of wood vinegar as a valuable by-product. The market value of wood vinegar is estimated much higher than that of charcoal, a trend observed both in Benin where the Casamance technique was originally acquired and at the project site in Pointe à Larrée. For instance, during one production cycle in Pointe à Larrée, 18 bags of green charcoal with a total value of MGA 191,916 (£31.80) yielded 100 liters of wood vinegar, which were sold for MGA 2,000,000 (£331.43). However, establishing a stable and sustainable market for wood vinegar at this price point remains a significant challenge, and efforts to address this issue are planned for the coming years. It should be noted that wood vinegar is a product entirely unknown in Madagascar, in contrast to parts of Africa where it is well known and valued for an array of uses.

Outcome O.5. Consumption of Melaleuca charcoal by residents in two major conurbations close to PA (Soanierana Ivongo and Sainte Marie) increased from 0% in T0, to 10% in Y1, to 20% in YR2 and 30% in YR3 compared to charcoal of native species

At baseline (T0), the total annual charcoal consumption in three localities, including Pointe à Larrée, amounts to 282,615 bags. By YR3, annual production of green charcoal was 1,362 bags, representing only 0.5% of the consumptipn for the three locations (please see Evidence

Output 2.1, table 5). This outcome falls significantly short of the 30% target and has not contributed meaningfully to reversing the broader trend of charcoal production, particularly the shift toward the use of invasive species.

Currently, alien but widespread tree species such as *Grevillea banksii* and *Acacia mangium* are increasingly used to make charcoal, largely due to the scarcity of wood from native tree species. The original 30% target was clearly overly ambitious, in part due to the lack of accurate baseline data and contextual information at the start of the project (Evidence outcome O.5 Table 11)..

Despite this, the project marked a significant step forward from the baseline condition, in which no green charcoal was produced. It enabled the reintroduction of an alternative product that, while limited in quantity, partially met the needs of a niche market particularly environmentally conscious consumers such as conservationists and regional authorities, who constitute the primary customer base (Evidence output 3.2 Table7).

3.3 Monitoring of assumptions

Outcome: A self-sustaining approach to the use of IAS is launched that demonstrably reduces the threat of Melaleuca at Pointe à Larrée PA while providing fuel-wood and income for local people

Assumption 1: Focused and on-going exploitation of Melaleuca for charcoal followed by hand removal of young plants (unsuitable for charcoal production) will significantly reduce the abundance of this species with consequent rewetting of marsh habitats and increased growth of native swamp trees hitherto suppressed by dense stands of this species.

Comments: This assumption holds true because sufficient time and effort were invested in the complete removal of all *Melaleuca* stems. Field observations indicated that in areas where removal is conducted thoroughly, the recruitment of new individuals almost completely ceases. Within one year of *Melaleuca* removal, herbaceous marshy vegetation begins to re-establish, with native species comprising the majority of the regenerating flora. The out-planting of endemic tree species also accelerated ecosystem recovery, promoting a more natural state (Evidence outcome O.2 Figure 19,a, b,c versus d,e).

Assumption 2: While it is more time consuming to make charcoal from Melaleuca (because it is necessary to remove a thick layer of spongy bark) compared to native trees, this obstacle can be largely mitigated by providing access to bark-removing equipment and facilitating access to more lucrative markets for "green charcoal"

Comments: This assumption holds true only in part. Due to rising fuel costs, the project opted not to supply a mechanical bark-removal device. However, bark can still be removed effectively using manual tools such as an axe and a machete. To enhance the profitability of green charcoal production, two improved carbonization technologies, MATI and the *Meule Casamancaise* were introduced. These technologies increased charcoal yield by 2 times and 2.8 times, respectively, compared to traditional methods. Notably, these techniques had not been previously employed by charcoal producers in the region. Furthermore, the market price of green charcoal was set at 1.5 times higher than that of charcoal derived from native species, reflecting its superior quality and the awareness-raising efforts conducted as part of the project.

Output 1. *Melaleuca* eliminated from high priority restoration zones within the PA thereby enhancing natural regeneration

Assumption 3: It is possible to eliminate this species from defined areas of the PA by a combination of exploitation for charcoal followed by repeated cycles of compensated hand removal of young plants. Repeated removal of seedlings will be necessary because this species germinates freely from a soil seed bank.

Comments: Indeed, following a third removal of juvenile plants, regeneration was nearly eliminated, with only a few scattered seedlings observed. This suggests a staggered seed germination pattern for the species. Consequently, its continued removal is unlikely to pose a

significant threat to native vegetation, because seedlings can be selectively eliminated over time (Evidence oucome O.2 Figure 19,a,b,c)

Assumption 4: Single women are considered a vulnerable group, unemployed and if their security is assured in the forest, they can actively participate in the implementation of the project

Comments: Among the 251 female participants in the project, many were single mothers who reported feeling secure and comfortable when working in groups (Evidence Assumption 4, Figure 21).

Output 2. *Melaleuca* charcoal produced preferentially by local people and accesses lucrative markets with livelihood benefits for locals

Assumption 5: Appropriate sustainable technologies can be identified elsewhere in the World and introduced to Madagascar to effectively process *Melaleuca* trees despite its very thick spongy bark.

Comments: This assumption is invalid. Efforts to identify suitable technologies for the removal of *Melaleuca* bark through online searches and expert consultations have primarily yielded a basic method involving a wooden chisel and hammer. In practice, we have employed machetes for this task, which we consider to be the most effective method.

Assumption 6: Melaleuc*a* charcoal performs well in traditional and improved charcoal stoves and lucrative commercial markets can be identified and accessed for “green” charcoal by motivated business team.

Comments: The hypothesis was confirmed true. The implementation of two improved techniques for producing *Melaleuca* charcoal resulted in at least a twofold increase in yield. Additionally, these methods improved the quality of the green charcoal, leading to greater consumer satisfaction and giving it a competitive advantage in regional markets, where it can be sold at a highly profitable price (Evidence Assumption 6, Figure 22a,b).

Assumption 7: If Melaleuca charcoal is lucrative as we plan it to be, *Melaleuca* within the PA may become rare and uneconomical to exploit. While this is a good result for local biodiversity but be assumed that value chain associated with this activity can continue to operate by exploiting the large populations of this plant existing outside of the PA. In these zones, if seedlings are not removed, then the exploited populations will quickly regenerate.

Comments : this assumption is valid. By the second year of the project, we had nearly eliminated all usable *Melaleuca* trees within the PA. Consequently, we expanded removal efforts to peripheral zones at least 200 meters beyond the PA boundary to reduce the risk of *Melaleuca* recolonization.

At the conclusion of the project, our survey indicated that approximately 500 hectares on the peninsula remained invaded by *Melaleuca (*Evidence Output 1.1 Figure3*)*. Although the species is regenerating rapidly and continues to provide raw material for the cooperative’s charcoal production, the overarching goal remains the long-term control of *Melaleuca* across the entire peninsula. If this goal should be achieved then to sustain the cooperative’s operations alternative (but less troublesome) species such as *Acacia mangium* or *Grevillea banksii* could be considered as future sources of raw materials for charcoal production.

Output 3. Melaleuca charcoal appreciated by urban populations and product sale strategy supported sustainably

Assumption 8: While charcoal produced from certain native trees will likely be preferred by local people over Melaleuca charcoal (because they are familiar with using the former and also because has a greater energy production per unit volume), legal access to wood of native trees is now non-existent and therefore *Melaleuca* charcoal will become an acceptable alternative.

Comments: The initial assumption holds true: after multiple attempts at improvement, niaouli green charcoal has proven to be more popular than other species. It stands out for its durability, ease of ignition, and minimal ash production. Once consumers try it, they tend to remain loyal,

even when faced with somewhat higher prices (Evidence Assumption 6, Figure 22.c).The only drawback is its limited availability on the market.

Assumption 9: Poor governance and management of the cooperative could induce tension between members and compromise the sustainability of the project but such tensions can be effectively reduced by providing training cascades, and effectively applying the manual of procedure (with periodic supervision from the services concerned and the sanction measures in the case of non-compliance with internal rules)

Comments: This assumption is confirmed. According to the SWOT analysis, the Cooperative had remained only moderately active for a decade (2012 to 2022) due to limited technical support and administrative capacity. However, since our interventions, the situation has significantly improved. At the start of the project, the Cooperative had just 20 members. By the end, membership had grown to 62, with 28 actively engaged in green charcoal production.

Two key factors driving this progress are the equitable distribution of profits and transparency, both outlined in the Cooperative's manual of procedures. Members' benefits are directly tied to their individual contributions, particularly the time they invest in operations. This system has been effectively implemented through the annual presentation of operational results and the distribution of performance-based bonuses.

Assumption 10: The Pointe à Larrée area is a zone frequently impacted by cyclones could interrupt the supply of stocks to places of sale, a supply plan will thus be reinforced during the dry seasons to avoid product shortages during bad times.

Comments: This statement is no longer valid. The road to Pointe à Larrée has recently been resurfaced with tarmac, significantly improving access. With the exception of brief periods during cyclones, deliveries to sale's points in Soanierana Ivongo and Fenerive-Est are now possible throughout the year (Assumption 10, Figure 23).

Output 4. Promising model of a new relationship with IAS demonstrated to land managers (including PA managers) and public awareness on IAS (threats and opportunities) increased

Assumption 11 : High rates of illiteracy and conservatism (e.g use of charcoal from native species) may slow down behavioral change and diminish popular appreciation of "green" charcoal but, the importance of these factors will be diminished through a robust program of popular communication using simple key messages carefully crafted for each target group.

Comments: This assumption holds true. One of the key communication strategies that contributed to the successful marketing of green charcoal was the use of attractive packaging. Each package featured a clear, impactful message: *"I buy this product to contribute to environmental protection and local development,"* written in both Malagasy and French, the two most widely spoken languages in Madagascar (Evicence Assumption 11, Figure 24). This message resonates with literate consumers and reinforces the product's purpose. However, it is ultimately the high quality of the charcoal that ensures customer loyalty (Please see Assumption 6, Figure 22,c).

3.4 Impact:

The project proposal anticipated the following impact: " ***The ecosystems of the Pointe-à-Larrée PA are restored to a more natural condition while local people obtain needed fuel-wood and access improved livelihoods from "green" charcoal".***

- Biodiversity Conservation

Significant progress was achieved in reducing anthropogenic pressures on natural resources, particularly those associated with charcoal production. At baseline, an estimated 240 trees were felled annually for charcoal. By the end of the project, this figure had decreased by 67%, with only 84 trees felled in the buffer zone and none within the PA. Furthermore, regular Rangers' patrols documented the complete absence of *tavy* (slash-and-burn cultivation) throughout the implementation period (Evidence Outcome O.3 Table 10).

Since 2016, systematic monitoring of three diurnal lemur species has been conducted, and data collection continues to the present. Overall, population trends indicate an increase in the density of these animals. For the brown lemur, *Eulemur fulvus*, one of the PA's flagship species, statistical analysis demonstrates a strong positive correlation between population size and the quality of forest structure (Evidence Impacts Table 12 and Figure 25).

Post-removal of invasive *Melaleuca*, a notable reappearance of herbaceous marsh vegetation was observed, with a high prevalence of native species, indicating positive successional dynamics. In addition, the project enabled the planting of several thousand seedlings from two well-adapted native tree species, one of which (*Faguetia falcata*) is classified by the IUCN as Endangered (Evidence outcome O.2 Figure 18 and outcome O.2 Table 9).

- Reduction in Pressure on Native Forest Resources

To address community dependence on native woody species for fuelwood and construction materials, a series of alternative resource-use strategies were implemented. The production of green charcoal from *Melaleuca*, although limited in scale has contributed to reducing harvesting pressure on native biodiversity. Over the course of the project, approximately 1,500 bags of *Melaleuca*-based charcoal were produced, equating to the conservation of thousands of trees and shrubs within the PA.

Quantitative reductions in native wood extraction from the Peninsula by local communities were substantial. Harvest volumes declined from 37,409 tree stems in YR1 to 13,591 timber in YR2, and to 8,949 timbers in YR3 (Evidence Impacts Table12, at final row). These reductions are attributed to increased environmental awareness and adoption of alternative energy sources such as green charcoal.

- Livelihood and Socioeconomic Impacts

The project generated both direct and indirect economic benefits. A substantial proportion of the total expenses over three years (£53,177 out of £195,360), or 27%, was allocated to operating costs, supporting job creation for local community members, and funding the construction of facilities, equipment, and materials. In total, approximately 440 individuals secured temporary or recurring employment, 57% of whom were women

In terms of green charcoal production, 28 families adopted this activity as a new income-generating endeavor, with estimated annual earnings of £260.37 per household. Although this represents only 19% of the 147 charcoal producers in the area (across all types of charcoal production), it illustrates the potential of this sustainable model (Evidence output 2.1 Table5). The initiative has activated multiple segments of the value chain, including transportation, retail, and consumption.

During periods of charcoal shortages in major urban areas, including around Pointe-à-Larrée, green charcoal production has helped mitigate supply disruptions and reduce associated social tensions. Furthermore, the introduction of two improved carbonization techniques, along with the use of *Melaleuca* as a novel raw material, has doubled production yields, enhancing both efficiency and profitability.

- Institutional and Fiscal Contributions

The cooperative, revitalized through the project, has contributed not only to the well-being of local beneficiaries but also to the strengthening of national and local institutions. Annual tax payments have been made to the State Tax Center, the relevant Ministry, the commune, and the local resource management body (COBA) responsible for overseeing access to raw materials (Evidence Impacts Figure 26).

4 Contribution to Darwin Initiative Programme Objectives

4.1 Project support to the Conventions, Treaties or Agreements

NBSAP:

The project made significant contributions to Madagascar's National Biodiversity Strategy and Action Plan, specifically under:

Action 2 **: "***Development and implementation of a national strategy and programs to combat invasive species, with a focus on prevention, control, and community involvement".*
The project engaged key partners and mobilized 440 local community members in actively combating the spread of *Melaleuca quinquenervia* using an innovative approach. As a result, 60.5 hectares were successfully cleared (Evidence outcome O.1, Figure 17).

Action 4 : "*Promotion of research for the valorization of invasive species and the establishment of dissemination/extension programs".*
The project introduced to Madagascar two innovative techniques, MATI and the Casamance technique for converting *Melaleuca* wood into green charcoal and extracting wood vinegar. These sustainable uses of invasive biomass were shared through a broad outreach strategy, including social media, websites, mass media, YouTube, and participation in national and regional events.

CBD

This project contributed to the achievement of the main goal of the Convention on Biological Diversity, namely the conservation of biological diversity, by protecting both plant and animal species and their coastal forest habitats, particularly rare and threatened species. Updated inventories of the Pointe à Larrée protected area listed a remarkable 593 plant species, including 83 species classified by the IUCN as threatened with extinction. The area is also home to six lemur species (all threatened), at least 11 amphibian species (this group has been poorly inventoried), 23 reptile species, and 76 bird species (including the threatened *Ardeola idae***,** *Anas bernieri***,** *Anas melleri***,** and *Geobiastes squamigera*). Through the project, these species' habitats were freed from invasive pressures, thereby contributing to CBD Target 9: “Invasive Alien Species prevented and controlled.” This was achieved by managing populations of *Melaleuca quinquenervia*, an invasive species that degrades ecosystems and threatens the survival of native species (Evidence Convention, CBD Figure27).

RAMSAR CONVENTION ON WETLANDS

Goal 1 : "Addressing the Drivers of Wetland Loss and Degradation".
Of the 60.5 hectares cleared of *Melaleuca*, 46.6 hectares comprised aquatic ecosystems. *Melaleuca* is a water-loving, invasive species that significantly depletes water resources, leading to the degradation of wetland functions. Its removal contributes to reversing these negative impacts and supports the recovery of native biodiversity and ecosystem services in wetland habitats (Evidence Oucome O.2 Figure 19, a,b,c).

Target 2 : " Water use respects wetland ecosystem needs for them to fulfill their functions and provide services at the appropriate scale inter alia at the basin level or along a coastal zone". And Target 4 : “priority invasive alien species are controlled or eradicated”.

Pointe à Larrée is a coastal area where water availability is essential not only for local human populations but also for sustaining critical habitats, hosting rare and endemic Malagasy aquatic species such as the fish *Ptychochromis* sp. and *Paratilapia* sp., as well as endangered endemic birds including *Anas melleri* (EN) and *Ardea humbloti* (EN) (Evidence CDB Figure 27). The control of *Melaleuca* in these aquatic systems represents a key step toward ecosystem restoration and the maintenance of freshwater availability, both of which are essential for biodiversity conservation and human well-being in this ecologically sensitive coastal region.

UNFCCC

Madagascar has submitted its Nationally Determined Contributions (NDCs) under the Paris Agreement to address climate change (UNFCCC NDC Registry). This project directly supports both mitigation and adaptation measures, particularly within the forestry and energy sectors.

Forestry Sector : The project has contributed to climate change mitigation through forest restoration. A total 61,616 seedlings of 70 native species were planted covering 16,75Ha. These plantations play a role in enhancing carbon sequestration capacity, thereby contributing to greenhouse gas reduction targets and ecosystem resilience (Evidence UNFCCC, Figure 28 and Table 12).

Energy Sector : The project supports Strategic Priority 3 of the NDCs by promoting improved energy efficiency in charcoal production. The two advanced carbonization techniques have both demonstrating over 20% higher yields compared to traditional charcoal production. These techniques enhance the efficiency of the conversion of raw material conversion to fuel and thus reduces the pressure on forest resources.

SDGs

Goal 1 & goal 2 :"No Poverty and Zero Hunger". The project provided both temporary and permanent employment opportunities to 440 individuals, with average earnings of approximately £3.30 per day. Additionally, over a hundred families engaged in the green charcoal value chain (including 28 charcoal producers, local re-sellers, and transporters) and thus experienced improved household incomes. These beneficiaries typically live at or below the poverty line, earning approximately USD $1 per day. The supplemental income generated by the project significantly contributed to food security, particularly during the lean season from January to April.

Goal 5 "Gender Equality". The project promoted gender inclusion by creating employment opportunities for women in forest surveillance and uprooting *Melaleuca* seedlings. Special attention was given to vulnerable groups, including single women, who were organized into work groups to enhance safety when working in remote locations and promote equal access to economic opportunities (Evidence output1.3, table 4).

Goal 7 "Affordable and Clean Energy". The green charcoal, derived from locally abundant invasive species, provides a renewable and affordable energy source accessible to all. To meet the needs of diverse consumers, the charcoal is packaged in three sizes large, medium, and small, with prices scaled to match local purchasing power. This model promotes equitable access to clean cooking fuel in rural communities (Evidence output 4.4, Figure 14).

Goal 9 "Industry, Innovation, and Infrastructure". The project was implemented through a legally registered cooperative, representing a novel, locally-managed business model in Madagascar’s rural energy sector. Green charcoal production is a kind of pioneering innovation in the country (Evidence Output 3.1 Figure 7). Over three years, members have received continuous technical support and capacity building in business management and entrepreneurship and were equipped with essential infrastructure and tools including thee warehouses, a motor boat for transport, and a Kubota (very small tractor) to enhance the efficiency of production and distribution. Currently, membership has grown to 62 individuals, all of whom benefit from cooperative revenues and services.

Goal 13 "Climate Action". By reducing deforestation and promoting reforestation efforts, the project contributes to climate change mitigation through increased carbon sequestration. The use of invasive species for charcoal production also reduces pressure on native forests, further enhancing ecosystem resilience. The forest within the protected area shows robust regeneration while that in the surrounding landscape experienced a reduction of the number of trunks of native trees exploited.

4.2 Project support for multidimensional poverty reduction

The project was implemented in a coastal region of Madagascar that is regularly exposed to climatic hazards, particularly cyclones and severe flooding. These recurrent events intensify the

vulnerability of local populations whose livelihoods are predominantly based on subsistence agriculture and artisanal fishing. In response to these challenges, the project contributed to poverty reduction and human development through five key dimensions:

-Creation of sustainable employment: The project facilitated the creation of permanent jobs within a cooperative, which expanded from 28 members to 62 by the end of the intervention. The average additional income generated per household was estimated at £260.37 annually, representing over 70% of Madagascar's average annual income (US$510, or approximately £376.70; World Bank, 2022). This cooperative model, if well managed, offers strong potential for long-term financial stability and local economic resilience.

-Capacity building in technical and entrepreneurial skills: Thirty-five cooperative members received training in improved charcoal production technologies, while twelve group leaders were trained in business management and entrepreneurship. These capacity-building efforts are expected to enhance both individual agency and the collective efficiency of the cooperative, fostering long-term socio-economic empowerment.

-Institutional trengthening and ross-ectoral knowledge exchange: The project also supported institutional development through bi-monthly multi-stakeholder meetings, which promoted cross-sectoral learning. As a result, staff from the Ministry of Environment acquired knowledge in commercial strategy and marketing, while personnel from the Ministry of Trade gained familiarity with the challenges and opportunities posed by invasive plants. Two representatives, one from MBG and one from the Lovasoa Federation, participated in a knowledge exchange mission to Benin. During this mission, they received training not only in improved charcoal production techniques but also in various sustainable natural resource management systems. This immersive learning experience fostered mutual knowledge exchange with Beninese stakeholders, contributing to the transfer of practical know-how and locally adapted innovations. These exchanges enhanced institutional collaboration and expanded the technical capacities of the participating organizations (Evidence Poverty reduction, Figure 29).

-Professional integration of young graduates: Four recent university graduates were integrated into the project to assist in business planning for the cooperative, under the mentorship of technical professionals. This hands-on experience provided them with practical exposure to real-world business development processes. At the conclusion of their internships, all received official certificates of participation; one has since been employed as the MBG's accountant.

-Fiscal contributions to local and national development: The cooperative has consistently fulfilled its tax obligations to relevant administrative entities, including community-based organizations, municipal authorities, and national ministries. This fiscal compliance contributes to local revenue generation and the financing of public services, thereby reinforcing decentralized governance and supporting the national budget (Evidence Impacts, Figure 26).

4.3 Gender Equality and Social Inclusion (GESI)

GESI Scale	Description	Put X where you think your project is on the scale
Not yet sensitive	The GESI context may have been considered but the project isn't quite meeting the requirements of a 'sensitive' approach	
Sensitive	The GESI context has been considered and project activities take this into account in their design and implementation. The project addresses basic needs and vulnerabilities of women and marginalised groups and the project will not contribute to or create further inequalities.	

GESI Scale	Description	Put X where you think your project is on the scale
Empowering	The project has all the characteristics of a 'sensitive' approach whilst also increasing equal access to assets, resources and capabilities for women and marginalised groups	X
Transformative	The project has all the characteristics of an 'empowering' approach whilst also addressing unequal power relationships and seeking institutional and societal change	

In the region, the traditional division of domestic and professional tasks between men and women is relatively balanced. However, tasks requiring significant physical strength are typically assigned to men. From a societal consideration, single mothers are often perceived as particularly vulnerable. This vulnerability is largely due to their sole responsibility for childcare and their disadvantaged position in the labor market. When employed, their single status may also pose safety concerns, especially for activities carried out in remotve locations such as within the forest. To address these structural barriers and promote equitable participation of women, our strategy focused on providing targeted support to women, with particular emphasis on single mothers as follows:

-Control of Invasive Melaleuca ***:*** The removal of large *Melaleuca* trees for charcoal production, is physically demanding, and was consequently assigned to men. Conversely, the uprooting of seedlings, which requires less physical effort but greater meticulosity, was exclusively allocated to women. Women were paid at the same amount as men, ensuring wage equity. To enhance safety during forest-based activities, women were encouraged to work in groups. As a result of this inclusive approach, women were strongly represented in this activity: 251 women participated compared to 189 men, accounting for 57% female participation.

-Forest Patrols **:** In addition to professional ranger-led patrols, community patrols were also organized with the support of co-funding. Each patrol group consisted of four members, with at least two being women. Out of 201 participants in these forest patrols, 119 were women (59%) and 82 were men. This high level of female involvement in such work is exceptionally unusual in Madagascar (Evidence GESI, Table 14).

-Tree Planting and Forest Restoration **:** Reforestation activities, including the transporting and planting of fast-growing tree species (supported with cofunding) and forest ecosystem restoration were also made widely accessible to women. These tasks, traditionally familiar to women and less physically demanding, attracted strong female participation. Of the 379 individuals involved, 175 were women, representing 46% of total participants (Evidence GESI, Table 15).

-Support for single mothers **:** Acknowledging their heightened socioeconomic vulnerability, the project prioritized single mothers for female-targeted activities. They were systematically integrated into all-women work groups to ensure safety and foster mutual support and solidarity.

Given these considerations, and in our efforts to address structural barriers limiting women's participation, our approach has been classified under the "Empowerment" class within three GESI scale.

4.4 Transfer of knowledge

The project facilitated the transfer of two types of technologies, both within the Pointe à Larrée area and more broadly across Madagascar :

- The first case involves the Samy Antsika Cooperative, the sole enterprise in the Pointe à Larrée region established with the explicit aim of generating income as a small-scale business.

Although this cooperative was established over ten years ago, created by the enthusiasm of certain community members, it never became operational due, primarily, to a lack of leadership capacity in general management and entrepreneurial skills. To address this, the project adopted a strategy focused on capacity building by recruiting national consultants in various fields and leveraging support from technical partners to deliver tailored training and mentorship.

The second case relates to the charcoal production techniques used by local producers. Traditionally, charcoal makers relied on rudimentary methods with low yields, approximately 10% conversion. To improve this, the project introduced an improved carbonization technique known as MATI, developed nationally, which doubled the yield. Furthermore, the project initiated the exploration of the Casamance kiln technology from Benin, which has been adopted in several African countries but prior to our intervention was entirely unknownin Madagascar. A prototype was successfully tested, resulting in an increase in yield to a remarkable 28%**.**

Importantly, the Casamance kiln also enables the collection of wood vinegar, a by-product of the carbonization process. In Benin, wood vinegar has proven to be an effective natural pesticide against insect infestations of crops and to preserve timber. Independent from this project the truth of these claims is now being investigated by MBG scientists. If proven then this product opens promising new opportunities to enhance agricultural productivity and extending the lifespan of construction timber (Evidence Transfer of knowledge, Figure 30)**.**

4.5 Capacity building

The members of the cooperative were the primary beneficiaries of the project's capacity-building efforts. In addition to six thematic training modules, including group management, leadership and governance**,** product marketing**,** and good governance, they also received hands-on training over several months. This included the practical application of a business plan, which now serves as the foundational document for cooperative operations. In total, 12 members were trained**,** including one woman**.**

With regard to carbonization techniques, all cooperative members now fully master and actively use the MATI technique. New members are required to undergo specific training before engaging in the cooperative's activities, ensuring that the charcoal they produce meets required quality. This training is conducted annually to ensure compliance and technical consistency among all members.

As for the Casamance kiln technology, two individuals, one cooperative member and the MBG project manager, received specialized training in Benin. Upon their return, they provided a cascade training program for 35 cooperative members, including 10 women and 25 men. An obvious development of this project is to confirm the percentage conversion of this method and then roll out this technique more widely.

5 Monitoring and evaluation

Regarding M&E, the method was discussed at the project's inception with technical partners. It was agreed to maintain a monitoring frequency of once per quarter by the technical partners and twice per year with other stakeholders. Each partner is responsible for data collection related to their own activities.

Over time, it became apparent that a three-month interval was too long to effectively address emerging challenges. Consequently, since the beginning of YR2, coordination meetings among partners have been held every two months. The main challenges discussed during these monitoring meetings include:

- Delay in green charcoal production**:** By the end of YR1, only 0.7 tonnes had been produced. To address this, a new production site was established at Andrangazaha, which offered a high production potential. To operationalize this, a change request was submitted to provide necessary infrastructure at the new site.

- Delay in business plan development**:** Each partner is required to establish a support schedule for the graduates to accelerate the production of business plan. Additionally, the recruitment of a consultant was deemed necessary to strengthen coaching efforts.

- Excessive flooding in carbonization zones**:** It was decided to establish two carbonization areas per production site, with the second location situated at a higher elevation to allow continuous activity during flood periods.

- Transportation issues: Due to the rising cost of fuel (required to transport the green charcoal) the initial sales point planned for the offshore tourist island of Sainte Marie was deemed to no longer be financially viable. As a result, the sales point was relocated to Fenerive-Est.

- Excessive product stock in warehouses: The product remains relatively unknown to consumers. It was concluded that concerted advertising efforts should begin immediately.

Participatory Evaluation

A participatory evaluation was conducted on October 17, 2024, with the involvement of all stakeholders, including local Mayors and Fokontany' presidents. Key discussion points included:

- Environmental progress: Significant improvements were noted in environmental indicators.

- Low charcoal sales: Sales of produced charcoal remain slow. Proposed solutions included establishing sales points in municipal centers and enhancing advertising campaigns.

- Competition from illegal charcoal: The market is currently dominated by low-priced illegally produced charcoal (that benefit from paying no tax). To address this, it was proposed that the local forest officer conduct regular inspections to control illegal charcoal circulation.

6 Lessons learnt

As the project was newly introduced in the intervention area, both in terms of the raw material (Melaleuca) and the cooperative structure, several important lessons emerged during implementation.

-Importance of community awareness and engagement : Initially, the importance of local awareness-raising was underestimated. The majority of community members were not enthusiastic about the project, perceiving it as unprofitable. At the same time, the project team moved too quickly towards the exploitation phase without ensuring adequate community buy-in. Although 70 members were officially registered during the first year, none began exploitation activities. In the second year, only four members were actively engaged. This prompted a renewed community sensitization effort, which resulted in a rise to 28 active members in YR 3. By the end of the project, 62 members were actively involved. This experience highlights the necessity of allowing sufficient time to communicate project goals clearly to stakeholders and ensure their meaningful participation from the outset. It is important to understand that lives of rural Malagasy are precarious and a high level of confidence is required before people are willing in accept the risk of investing in innovations.

-Capacity transfer to local communities **:** A second key lesson concerns the transfer of skills and competencies to local communities. Several training modules were delivered during the course of the project. It was initially assumed that by the end of the project, cooperative members would be capable of autonomously managing the structure and its membership. However, project evaluations indicated that cooperative leaders still lacked the necessary capacity to manage such a community-based enterprise effectively. From an environmental standpoint, the project significantly overachieved its targets. However, with respect to poverty reduction objectives, progress remained limited. Given the low literacy levels in the target communities, the project duration of two years and nine months was insufficient to achieve sustainable development outcomes or ensure lasting capacity transfer. It is estimated that a minimum of five years would be needed to achieve more robust and enduring results. For such innovative projects, it is essential that promoters ensure the provision of strong technical support and adequate equipment to effectively empower project participants.

-Multisectoral Collaboration **:** The third lesson relates to the importance of collaboration among partners. One of the success factors of the project was its involvement of various technical departments and community actors within the consortium, each contributing their specific expertise. This collaborative and multidisciplinary approach proved critical in overcoming the initial challenges faced at project launch, addressing operational issues, and ensuring compliance with the applicable regulations. The diversity of expertise within the team emerged as a core strength of the project.

-Administrative and financial flexibility **:** At the administrative level, the possibility to revise the budget (Change request) three months before the end of the fiscal year was much appreciated and valued. However, withholding of the final budget tranche could pose a serious challenge for certain grantees. Without sufficient reserves, it would be extremely difficult to carry the project through to completion. We were fortunate that this was not an issue in our case, and we were able to access an advance from MBG. However, less fortunate grantees may not be able to access such resources to provide an advance to cover Darwin Initiative-related expenses. In such a situation the project would have been forced to cease prematurely without the ability to pre-finance activities.

7 Actions taken in response to Annual Report reviews

In response to the latest feedback, all reviewers' comments have already been addressed accordingly. However, we propose to refine the response to one comment after obtaining the final information at the end of the project.

Annual report1:

Reviewer'scomment, point 5. "*It is not clear whether the project is also aiming to increase the income of cooperative members through the green charcoal model, or whether improvements to income are limited to charcoal producers only. It would be helpful to understand whether the project is aiming to support an increase in income for members of the Green Charcoal Cooperative (GCC) as a result of the investment into the cooperative through project activities*".

Project Leader's reponse: "Yes, the cooperative must achieve autonomy to ensure its continued operation beyond the end of the project. To this end, following the development of the business plan in YR2, it was decided a profit-sharing mechanism whereby 30% of profits from charcoal production would be allocated for reinvestment in the cooperative, allowing it to sustain its activities. Meanwhile, 60% of the profits would be distributed among charcoal producers. The remaining 10% would be retained as a resilience fund to provide temporary support in the event of work disruptions caused by severe environmental events, such as cyclones, which are frequent at this site.

The final financial results for YR3 reported a total profit of MGA 5,009,174 (approximately £830.34), distributed as follows:

- 30% (MGA 1,502,752.2 / £249.1) allocated for cooperative reinvestment;
- 60% (MGA 3,005,504.74 / £498.2) distributed among active members as a production premium, equivalent to MGA 2,662 (£0.44) per bag;
- 10% (MGA 500,917.4 / £83) retained to support the cooperative's ongoing operations as well as resilience fund.

8 Risk Management

So far, all identified project risks have been managed by implementing the mitigation strategies proposed in the original proposal, with annual reviews. One risk, however, has remained beyond our control: the increase in transportation costs due to rising fuel prices. Initially, we proposed the use of a motorboat to deliver the products to the sales points. To reduce transportation-related expenses, we have opted to rent vehicles at a lower cost.

9 Scalability and Durability

In the region, a few profit-oriented structures exist, such as cooperatives, primarily operating in the agricultural sector. However, the cooperative supported under this project is unique in that it is a formal organization utilizing invasive plant species as raw material. One of its key strengths lies in its governance: it is managed directly by locals, with technical staff serving only as facilitators and advisors. The initiative has increasingly gained traction in the region, with more and more families engaging in this activity. According to our survey in 2023, 147 families are currently involved in charcoal production. Yet, aside from cooperative members, none of these individuals are operating legally.

Among charcoal producers within Cooperative, several project components have emerged as strong incentives:

- They operate within a proper legal and regulatory framework providing a sense of security (i.e., freedom from the risk of fines or imprisonment).

- Cooperative members benefit from shared infrastructure such as a secure storage facility, reducing risks of theft, and access to transportation assets such as Kubota vehicle.

- The market price for green charcoal of *Melaleuca* is approximately 1.5 times higher than that of charcoal from other species.

- The cooperative holds a registered trademark certificate, granting it exclusive rights to produce charcoal from this species (Evidence Output 3.1 Figure 7).

Support from technical services and elected officials is anchored in several factors:

- The project aligns with and contributes to multi-sectoral policies from various ministries, particularly in natural resource conservation and local development.

- The formalization of activities enhances institutional revenue flows: benefiting COBA, local municipalities, ministries, and the central government.

- It promotes human development and strengthens both household and regional economies.

- The initiative helps mitigate charcoal shortages, a critical energy source in Madsagascar for both rural and urban households.

During project wrap-up workshops, local authorities, particularly mayors, strongly advocated for both geographic expansion and an increase in cooperative membership. Furthermore, at the December 2024 Biodiversity Festival, the issue of wood-energy policy was prominently discussed. A consensus emerged among stakeholders that, starting in 2026, energy policy should prioritize the use of invasive species as a renewable resource. The associated technical policy document is expected to be developed with support from a separate funding source. This is a very significant outcome from this project.

In reference to the project's proposed exit strategy, as stated, the following milestones have been achieved or are planned:

- Technical capacity of the cooperative for autonomous management : We are currently halfway toward achieving full autonomy. Continued technical support is still required for at least one more year. MBG technicians, in collaboration with government technical services, are committed to maintaining this support. We recommend that project-acquired equipment be handed-over to these partners to facilitate ongoing capacity-building efforts.

- Financial capacity to operate and maintain mutually beneficial mechanisms with charcoal producers **:** The 2024 operational results, particularly through performance-based bonuses have significantly incentivized producers. At the cooperative level, profits (MGA 1,502,752.2 / £249.1) after covering all operational costs, including depreciation, will support both ongoing operations and reinvestment. Currently, the cooperative has only one generator and one sewing machine for the three green charcoal production sites. This equipment is necessary for sewing the green charcoal packaging. To facilitate this activity, in 2025, the Cooperative plans to purchase an additional engine and sewing machine to support expanding production sites.

- Future development through geographic and product diversification**, t**he cooperative is now considering expanding its operations to include charcoal production from other invasive alien species such as *Grevillea banksii* and *Acacia mangeum*, both abundant in Pointe-à-Larrée. Out of seven new sites represented during the final project workshop, two (Sainte Marie and Foulpointe) have already expressed interest in replicating the Pointe-à-Larrée model. Feasibility studies for geographic expansion are underway, although infrastructure and equipment must meet minimum standards to ensure product quality.

-Sustainable growth through revolving funds and seed capital : A revolving fund has been established, seeded by £3,315 in start-up funding. The current balance in the cooperative's bank account is MGA 30,067,206.83 (£4,996.65). This demonstrates that the operations have led to increased efficiency and improved financial performance within the Cooperative. (Evidenced Scalability and Durability: Figure 31).

Given the current situation, it is anticipated that over the next two years the cooperative, with continued support from its partners, will focus on:

-Strengthening leadership and practical management skills;

-Expanding its membership base to boost production capacity and generate surplus funds for investment in new regional sites.

Therefore, geographic expansion may not be realistically feasible until 2027, unless the cooperative or host sites secure additional external funding earlier to support infrastructure development and equipment acquisition.

10 Darwin Initiative identity

We are proud to have received funding through the Darwin Initiative and have formally acknowledged the support of the UK Government in various forms:

- All infrastructure established under the project bears commemorative plaques in three warehouses facilities (Output 4.4 Figure 13b);

- All communication materials produced carry the Darwin Initiative logo, initially alongside the Biodiversity Challenge Funds logo, which was later replaced by the UK International Development logo. These materials include 240 brochures, 240 flyers, five types of posters, and two roll-up banners (Evidence Darwin Initaitaive identity, Figure 32);

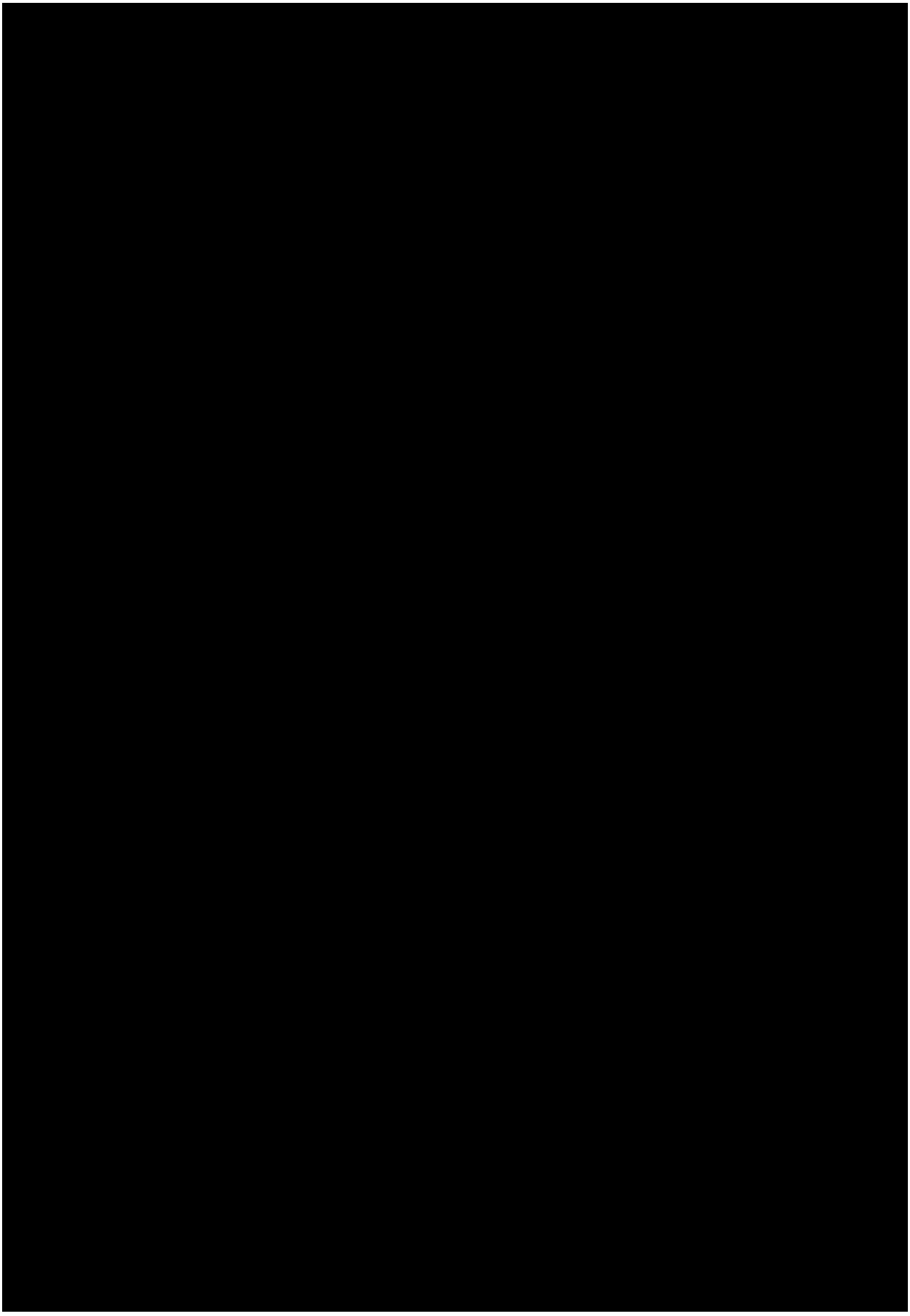
- All equipment acquired under the project is labeled with project-specific stickers: five motorcycles, one Kubota vehicle, one boat, and all other items such as laptops (Evidence Darwin Initiative identity, Figure 33);

- All payment vouchers issued through the project also display the logos of the Darwin Initiative and UK International Development;
-Communications and outreach efforts include 17 Facebook posts, four national television broadcasts, and one YouTube video, all of which mention the Darwin Initiative or display the relevant logos, for example: on the link on youtube,https://youtu.be/XTLJEITLgQY?si=IXQ3laDrv8stq72t.

Several target groups have become familiar with the Darwin Initiative through this visibility, including local communities (via payment vouchers), the business sector (through economic fairs), as well as authorities and state representatives through participation in regional and national events such as economic fairs and exhibitions during Environment Day celebrations and at British Embassy. During these events, communication materials such as posters and roll-up banners are exhibited, while brochures and flyers are distributed.

Since the official project launch in October 2022, authorities and state representatives have been well informed about the Darwin Initiative's support for the green charcoal initiative. This visibility has continued throughout the implementation phase, especially during three separate events where infrastructure was inaugurated during which officials read the commemorative plaques referencing UK Government funding through the Darwin Initiative before cutting the ceremonial ribbons. The same level of visibility was ensured during the final project workshop held in March 2025.

11 Safeguarding



[redacted]

12 Finance and administration

12.1 Project expenditure

Project spend (indicative) since last Annual Report	2024/25 Grant (£)	2024/25 Total actual Darwin Initiative Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (se below)	[redacted]			

	[redacted]			
Consultancy costs				
Overhead Costs				
Travel and subsistence				
Operating Costs				
Capital items (see below)				
Others (see below				
End of project audit fee				
TOTAL	71 364.47	58 490.88		

Staff employed **(Name and position)**	**Cost** **(£)**
Razanamamy Laurita, graduate Internship	[redacted]
RABODOHARIVOLA ALBINE THERESINE , Accountant	
RABODOHARIVOLA ALBINE THERESINE Graduate - Internship	
Timothee, graduate Internship	
Toto Fabrice, graduate Internship	
DESCOMBES Ianosca: Assistant Project Manager	
JOSSO TIANARIFIDY Angelos, Head Forest Policing	
RAKOTONDRAZANDRY Guy, Accountant	
RAFARA AVOTRINIAINA ANDRIAMANDIMBISOA, Monitoring and Evaluation Officer	
LEHAVANA Adolphe, Project Manager	
ANDRIANIRINA ANDOTIANA FITAHIANA: Research Manager	
LESABOTSY Pascal, Assistant Research Manager	
RAHARIJAONA Volanirina Hanta : National Safeguarding focal point	
TOTAL	

Capital items – description	Capital items – cost (£)
None	0
TOTAL	

Other items – description	Other items – cost (£)
	0
TOTAL	

12.2 Additional funds or in-kind contributions secured

Matched funding leveraged by the partners to deliver the project	Total (£)
Fonds Français pour l'Environnement Mondial (FFEM) (Agence Française de Developpement) (Tree planting, forest patrols, a portion of team's salary, overheads, environnemental education/sensibilization, PA gouvernance and collective manageme supports)	[redacted]
Conservation Allies (Mixed brigade missions to support Rangers'fore patrols	
Franklinia Foundation (Seedling production of native species, salary for Research manager and two nurserymen)	
GEF/ Strengthening the Network of New Protected Areas (S2NPA) fo seedling production and forest patrols in Year2	
TOTAL	

Total additional finance mobilised for new activities occurring outside of the project, building on evidence, best practices and the project	Total (£)
GEF/ Strengthening the Network of New Protected Areas (S2NPA) (for tourism infrastructure building at Pointe à Larrée in year3).	[redacted]
TOTAL	

12.3 Value for Money

The implementation of the project was primarily carried out by local communities. They were fairly compensated based on the nature and scope of their contributions. As the cooperative was established by the community members themselves, and they serve as its shareholders, they did not receive additional payment for tasks performed on behalf of their own cooperative. Activity supervision was mainly assigned to on-site project agents and members of the local Federation, which significantly reduced transportation costs.

In terms of capacity building and coaching for cooperative members, when the necessary expertise existed within partner government institutions, these responsibilities were assigned to them as part of their public service mandate. In such cases, the project covered only accommodation, per diem, and transportation expenses. Consultants were recruited only when the required expertise was not available among partners. All consultants hired were Malagasy nationals residing in Madagascar, which also contributed to minimizing transport and logistical costs.

With regard to the procurement of project equipment and construction materials, a minimum of three pro-forma invoices was systematically requested to ensure transparency and cost-efficiency. Given that Pointe à Larrée is a low-lying marshy zone next to the sea and exposed to a perhumid climate, it was essential to select robust materials capable of withstanding humid conditions. Therefore, supplier sourcing extended to the national level (including Antananarivo) and, rarely, when necessary, internationally, where reputable suppliers are unavailable nationally. For instance, all digital cameras were procured from the United States due to cost and quality considerations but transported by friends at not cost. The few capital items requested were thus selected based on a combination of competitive pricing and product durability.

In conclusion we are proud that this was a project conceived by Malagasy to respond to Malagasy needs and implemented by Malagasy.

13 Other comments on progress not covered elsewhere

In many externally funded projects, government institutions are typically limited to supervisory or monitoring and evaluation roles. In this project, however, they were fully engaged as implementation partners rather than external observers. This active involvement fostered a strong sense of ownership among government actors, who expressed pride in the project's achievements and demonstrated a clear commitment to promoting and disseminating its results.

It is widely recognized that many large-scale projects, despite receiving significant funding and setting ambitious goals, often struggle to generate lasting impact or ensure sustainability. In many cases, projects fade from public and institutional memory only months after their conclusion. In contrast, now, three months after the formal completion of this project, local stakeholders continue to support the cooperative, and its activities remain ongoing and productive. Despite recent flooding, the cooperative produced 148 bags (approximately 2.3 tons) of green charcoal between April and May 2025. In June 2025, the cooperative also took part in World Environment Day celebrations, showcasing its products through exhibitions and sales. These results indicate that while the approach may take time to yield visible outcomes, it is indeed effective and sustainable in the long term.

A second key consideration is the mobilization of additional funding. Owing largely to the visibility and credibility of the approach promoted under the Darwin Initiative, the Livelihoods Fund for Family Farming (L3F) has committed to supporting conservation efforts in Pointe à Larrée for an additional two years, with confirmed funding of £76,669. This new support provides an opportunity to deepen socio-economic and environmental impacts, and to demonstrate that medium-scale control of invasive species, specifically *Melaleuca,* is both feasible and effective across the remaining 500 hectares of infested land in the Peninsula. To fully achieve this ambition and ensure long-term results, however, sustained funding over a longer period will be essential.

14 OPTIONAL: Outstanding achievements of your project (300-400 words maximum). This section may be used for publicity purposes.

I agree for the Biodiversity Challenge Funds to edit and use the following for various promotional purposes.

South-South transfer of competence

Through much of Africa large segments of the population rely on charcoal for cooking. Madagascar is no exception and here the production of charcoal from native tree species is one of the main threats to the country's forests. In a project funded by the Darwin Initiative, located on the Pointe à Larrée Peninsula in central-eastern Madagascar, we are incentivising the production from charcoal from the abundant and problematic, alien, invasive tree *Melaleuca quinquenervia* so as so reduce the pressure on a small fragment of very rare littoral forest: home to an extraordinary diversity of threatened species. As part of the process, we wanted to find appropriate approaches to increase the conversion rate of the *Melaleuca* wood to charcoal. Higher conversion rates mean more charcoal, more charcoal means more profit, and more profit means better livelihoods for locals and reduced pressure on the native forest. While typical conversion rates are 10%, our research showed that methods used in Benin achieved up to 28% conversion. To discover how this extraordinary improvement was achieved we went to find out. In Benin we were generously hosted by CoForMO team, who over ten days showed us their method of charcoal production and taught us exactly how it was done. The technique is called the *Meule Casamançaise* and it differs from the traditional methods used in Madagascar because the system operates based on pyrolysis,ie, in the absence of oxygen, whereas the traditional technique relies on combustion, which involves the introduction of oxygen into the furnace through ventilation. An additional benefit of this method is that it can capture and condense the smoke as a by-product called wood vinegar. This oily, black, pungent liquid is well known in Benin but totally unknown from Madagascar. In Benin wood vinegar is valued as a pesticide, to preserve wood, and even as a medicine. An example of the chimney used in the Casamançaise charcoal oven was taken back to Madagascar and now replicates are being made locally so that we can roll out this exciting approach at our project site. Trials are also being made to test the efficacy of the wood vinegar as a pesticide and wood preservative. If we can successfully replicate this approach in Madagascar, using an alien tree species, then the impact on rural people and biodiversity could be huge. More philosophically, success would demonstrate, once again, how African problems can benefit from African solutions!

File Type (Image / Video / Graphic)	File Name or File Location	Caption, country and credit	Online accounts to be tagged (leave blank if none)	Consent of subjects received (delete as necessary)
Image	Adopting the Casamance Kiln Model in Madagascar	Adopting the Casamance Kiln Model at Pointe à Larrée, Madagascar, (Adolphe Lehavana)		Yes
Image	Bottled Wood Vinegar Produced by the Samy Antsika Cooperative, Madagascar	Bottled Wood Vinegar Produced by the Samy Antsika Cooperative, Fenerive-Est, Madagascar (Adolphe Lehavana)		Yes
Image	Melaleuca quinquenervia Population Invading Aquatic Ecosystems at Pointe à Larrée	Melaleuca quinquenervia Population Invading Aquatic Ecosystems at Pointe à Larrée, Madagascar (Stanislas Rajaonary)		Yes

Image	Purified Melaleuca Wood Vinegar in Madagascar	Purified Melaleuca Wood Vinegar in Fenerive-Est, Madagascar (Adolphe Lehavana)		Yes
Image	Two Malagasy Representatives with the Beninese Team	Two Malagasy Representatives with the Beninese Team, Benin (Emmanuel Aklou)		Yes

Annex 1 Report of progress and achievements against logframe for the life of the project

Annex 1 Report of progress and achievements against logframe for the life of the project

Project summary	Progress and achievements
Impact : The ecosystems of the Pointe-à-Larrée PA are restored to a more natural condition while local people obtain needed fuel-wood and access improved livelihoods from "green" charcoal.	For biodiversity conservation, tree cutting for charcoal production using native species was reduced to zero within the protected area (PA), with an overall reduction of 67% in the buffer zones. In the PA, forest structure improved significantly, which was positively correlated with population increases of key lemur species such as *Eulemur fulvus*. Habitat quality in previously degraded areas showed marked improvement, shifting toward more natural conditions. This was evidenced by the progressive reappearance of native plant species and the development of rare and threatened taxa (Evidence Impacts Figure 25). In terms of poverty reduction, 62 members, organized within a cooperative, benefited from a capacity-building program supported by material inputs and infrastructure. This enabled them to develop and produce green charcoal, a product that had no market presence at the project's outset but is now commercially available on local and regional markets. The project also contributed to local community well-being by generating "green" employment opportunities (440 temporary jobs) and supporting both community-based and state institutions through tax revenues generated from project-related activities.
Outcome*:* A self-sustaining approach to the use of IAS is launched that demonstrably reduces the threat of Melaleuca at Pointe à Larrée PA while providing fuel-wood and income for local people.	
Outcome indicator 0.1: By YR 1 *Melaleuca* eliminated over 10 hectare of the PA; by YR2 over 20 hectare; and by YR3 over 30 hectare	Melaleuca has been removed over 5.7Ha in YR1; 32.5Ha in YR2 and 22.3Ha in YR3. By the end of the project, Melaleuca was controlled over 60.5 hectares, including 31.9 hectares within the PA and 28.6 hectares in the buffer zone (Evidence Outcome O.1 Figure 17).
Outcome indicator 0.2 By YR3 the growth of native trees in restoration zones is at least 10% greater than in control areas where large *Melaleuca* stems have not been eliminated.	In YR3, no natural regeneration of native tree species was observed in the zones where Melaleuca had been controlled but a a total of 16,252 seedlings of two rare and endemic species, *Faguetia falcata* and *Syzygium emirnense* (that favour this habitat), were planted over an area of 12.8 hectares, with survival rates of 72.8% and 88.8%, respectively. Additionally, a emergence of abundant native herbaceous marsh species was recorded, reaching an abundance of 304 stems/m^2. In the control plots, a few naturally regenerating seedlings were of native trees were present; however, their development to maturity was unlikely due to the dominance of *Melaleuca*. (Evidence see Output1.2 Table3 and Outcome O.2 Figure19,e; Outcome O.2 Table 9).
Outcome indicator 0.3 By YR3, with easy access to Melaleuca charcoal for local people, the number of infractions within the PA for exploiting native trees for charcoal has fallen by 50% compared to T0	In YR3, the harvesting rate of native species dropped to zero within PA and to 84 stems in the buffer zones, compared to 7 and 240 stems, respectively, at baseline (T0). This represents a 100% reduction in the PA and a 65% reduction in the buffer zones (Evidence, Outcome O.3, Table 10)."
Outcome indicator 0.4 Income from charcoal exploitation increased by 25% for 30 charcoal makers in Y1, 60 charcoal	In Year 3, the average income of each of the charcoal producers who are members of the cooperative reached MGA 571,178 (approximately £260.37). At the start of the project none of these people were

makers in Y2 and 100 in Y3 compared to zero as baseline	active in charcoal production (Evidence, see Output 2.1, Table 5).
Outcome indicator 0.5. Consumption of Melaleuca charcoal by residents in two major conurbations close to PA (Soanierana Ivongo and Sainte Marie) increased from 0% in T0, to 10% in Y1, to 20% in Y2 and 30% in Y3 compared to charcoal of native species	As a baseline, there was no green charcoal of Maleleuca present in the region. In YR3, the production accounted for only 0.6% of total charcoal consumption in the target localities (Sainte Marie, Pointe à Larrée and Soanierana Ivonga). However, there was a noticeable shift toward the use of alien speciesespecially from *Acacia mangium*, and *Grevillea banksii*. According to our surveys at project end, charcoal derived from native species now represents only 13.73% of consumption, compared to 78.6% at the start of the project (Evidence, Outcome O.5, Table 11).
Output 1: *Melaleuca* eliminated from high priority restoration zones within the PA thereby enhancing natural regeneration	
Output indicator 1.1 By YR1 study published identifying high priority zones for restoration through the elimination of Melaleuca.	By YR1, the area occupied by *Melaleuca* has been mapped, covering a total of 568 hectares across the peninsula, including 31.9 hectares within the Protected Area (Evidence Output 1, Figure 2).
Output indicator 1.2 By YR 1 adult stems of Melaleuca (stem dbh >5cm) eliminated over 10 hectare; by YR2 over 20 hectare and by YR3 over 30 hectare.	In YR1, a total of 5.7 hectares within the PA was cleared of *Melaleuca*, including individuals of all stem diameter classes, from saplings to mature trees and increased to 38.2 hectares in YR2, reaching a cumulative total of 60.5 hectares by YR3 (see Evidence Output 1.2, Table 3).
Output indicator 1.3 By YR1, 50, by YR2 100 and by YR3 150 women involved in removal of Melaleuca	In YR1, 40 women participated in the removal of *Melaleuca*. This number increased to 80 in YR2 and to 251 in YR3. Women represent 57% of a total of 440 individuals involved in the removal of *Melaleuca*, including 189 men (Evidence Output 1.3, Table4).
Output 2. Melaleuca charcoal produced preferentially by local people and accesses lucrative markets with livelihood benefits for locals.	
Output indicator 2.1. By YR1 protocol demonstrated in "real world" conditions that enables charcoal to be produced from *Melaleuca* with no more than 15% loss of efficiency compared to charcoal produced from native trees (some loss of efficiency must be expected and this will be compensated by greater sale's price)	By YR2, two introduced improved carbonization technologies, "Meule à Tirage Inversé" (MATI) and Casamance Kiln, have significantly enhanced charcoal yields, achieving increases of 2.0-fold and 2.8-fold, respectively, compared to the traditional method, irrespective of the wood species used. Furthermore, it has been demonstrated that the time required to process stems of both native species and *Melaleuca* is now approximately equal (Output 2.1, Figure 4). In terms of market value, *Melaleuca*-based charcoal commands a premium, with unit prices 1.5 times higher than the equivalent volume of charcoal made from native species. This price differential can be explained by the superior quality of the former compared to the latter (Evidence, Output 2.1, Table 5)
Output indicator 2.2 In YR1, YR2 and YR3 respectively, 30, 60 and 100 charcoal producers obtained 25% increase in household income from charcoal (currently zero *Melaleuca* charcoal as baseline)	The number of "green" charcoal producers was zero in YR1; this increased to 4 in YR2 and reached 28 in YR3. On average,per person, they earned MGA 571,178 annually (approximately £260.37) as new income. Based on the unit price, this represents a 51% increase compared to charcoal from other species (Evidence, see Output 2.1, table 5).
Output 3. Melaleuca charcoal appreciated by urban populations and product sale strategy supported sustainably	
Output indicator 3.1 Permits obtained to provide a legal context for the project to exploit and sell charcoal from *Melaleuca* – including definition of mechanism to ensure that	The operating permit is up-to-date and renewed annually (Evidence, Output 3.1, Figure 6). In addition, the Cooperative Samy Antsika obtained a registered trademark certificate for green charcoal produced from *Niaouli*, valid for 10 years, until 2034 (Evidence, Output 3.1, Figure 7).

the charcoal being sold is really from *Melaleuca.*	
Output indicator 3.2 Annually, 100% of charcoal produced by charcoal producers purchased by Cooperative and delivered to sale's point directly accessible to consumers	In YR1, no production was recorded. In YR 2, the entire output was successfully distributed to consumers. By YR3, to date, 80% of the production had been delivered to consumers (Evidence, Output 3.2, Table7).
Output indicator 3.3. By Y1, two sale's points installed and functional in Soanierana Ivongo and Sainte Marie	The sales'point in Sainte Marie was cancelled due to high transportation costs. In Soanierana Ivongo, collaboration was established with local retailers (Evidence, Output 3.3, Figure 8). An additional sales outlet was installed in Fenerive-Est, located within the MBG office.
Output indicator 3.4. Volume of charcoal sold by Cooperative of Melaleuca charcoal producers increases annually from zero at T0 to 20 tons by Y1, 40 tons by Y2 and 60 tons by Y3.	Volume of charcoal sold: YR1 =0; YR2= 2.13 tons ; YR3=18.53 tons out of 23.25 tons produced as cumulative volume. As summary, total sale was 18.53tons representing 31% of the target 60 tons (See evidence output 3.2 Table 7).
Output indicator 3.5. Y2, a business plan and a manual procedure elaborated showing the overall strategy of the cooperative for the sustainability investment including the extension of investment areas	By YR3, the business plan is operational and available for viewing here: https://mobot.mg/conservation/pointe-a-larree-site/di-melaleuca/
3.6. From Y 1 to Y3, at least 10 Leaders of the cooperative trained on at least six themes relating to the management and governance of the cooperative	By YR3, 12 members of the Cooperative had received training on various themes related to capacity-building, including management, leadership, good governance, financial literacy, and product marketing. They also received support in applying a business plan. However, evaluations revealed that their capacities remain limited and that continued support is still required. Despite these challenges, the members were able to establish a collaboration agreement regional retailers and initiate the implementation of a marketing strategy (Evidence: Output 3.3, Figure 8; Output 3.6, Figure 9).
Output 4. Promising model of a new relationship with IAS demonstrated to land managers (including PA managers) and public awareness on IAS (threats and opportunities) increased	
4.1. In YR1, YR2, and YR3 interested parties informed of the project and its progress by means of one dedicated website and bi-monthly social media posts.	Cumulatively, 17 posts on Facebook, 4 broadcasts on national television, and one video on YouTube were produced over the project years. All stakeholder groups involved in green charcoal operations and environmental issues, including local communities, operators, consumers, authorities, and government officials, were informed and sensitized through various formats (Evidence Output 4.4, Figure 13, 14, 15).
4.2. In YR3 at least 10 land managers (including Protected Area Managers) visit Pointe-à-Larrée to evaluate project.	In YR3, a total of 28 participants, including 8 PA Managers as well as local and regional stakeholders participated in a capitalisation workshop, followed by a field visit (Evidence Output 4.2: Figure 10, 11a,b).
4.3. In YR3 one article describing and objectively evaluating the project will be published in a peer reviewed journal	No articles have been published to date; however, one manuscript is currently in preparation. The abstract has been sublitted and accepted for presentation at the AETFAT International Congress, to be held in August 2025 in Ghana (Evidence Output 4.3: Figure 12).
4.4. From Y2 to Y3, annually 20,000 people informed or sensitized of project results through four annual participations	Over the three-year duration of the project, through the implementation of five communication strategies, it is estimated that approximately 65,530 individuals were reached nationwide. The

in local, regional, national celebration events, 24 annual radio broadcasts	breakdown is as follows: - Biodiversity Festival: An estimated 10,300 people reached over three years ; - Participation in World Environment Day**:** Awareness activities reached approximately 12,000 individuals ; **-** British Embassy Exhibition Stand (June 13, 2024)**:** Approximately 90 individuals informed of the project including 3 Ministers ; - Participation in Economic Fairs (2023 and 2024)**:** Approximately 3,140 people reached ; - Digital and Mass Media Outreach**:** An estimated 40,000 individuals reached through online and broadcast platforms (Evidence Output 4.4, Figure 13, 14, 15)

Annex 2: Project's full current logframe as presented in the application form (unless changes have been agreed)

Project Summary	SMART Indicators	Means of Verification	Important Assumptions
Impact: The ecosystems of the Pointe-à-Larrée PA are restored to a more natural condition while local people obtain needed fuel-wood and access improved livelihoods from "green" charcoal.			
Outcome: A self-sustaining approach to the use of IAS is launched that demonstrably reduces the threat of Melaleuca at Pointe à Larrée PA while providing fuel-wood and income for local people.	O.1 By YR 1 *Melaleuca* eliminated over 10 hectare of the PA; by YR2 over 20 hectare; and by YR3 over 30 hectare. O.2 By YR3 the growth of native trees in restoration zones is at least 10% greater than in control areas where large *Melaleuca* stems have not been eliminated. O.3 By YR3, with easy access to Melaleuca charcoal for local people, the number of infractions within the PA for exploiting native trees for charcoal has fallen by 50% compared to T0 O.4 Income from charcoal exploitation increased by 25% for 30 charcoal makers in Y1, 60 charcoal makers in Y2 and 100 in Y3 compared to zero as baseline O5. Consumption of Melaleuca charcoal by residents in two major conurbations close to PA (Soanierana Ivongo and Sainte Marie) increased from 0% in T0, to 10% in Y1, to 20% in Y2 and 30% in Y3 compared to charcoal of native species	O.1 Annual maps showing zones where *Melaleuca* eliminated (using GPS Unit) O.2 Measurements of changes in stem basal area of native trees annually in zones where *Melaleuca* controlled and control zones. O.3. Annual analysis of infractions within PA for production of charcoal from native trees recorded in ranger log books O.4 Survey using household notebooks recording the daily income from production and sale of Melaleuca charcoal from T0 to T3 O.5. Annual surveys of sales from a representative sample of charcoal sellers in Soanierana Ivongo and Saint Marie.	Focused and on-going exploitation of Melaleuca for charcoal followed by hand removal of young plants (unsuitable for charcoal production) will significantly reduce the abundance of this species with consequent rewetting of marsh habitats and increased growth of native swamp trees hitherto suppressed by dense stands of this species. While it is more time consuming to make charcoal from Melaleuca (because it is necessary to remove a thick layer of spongy bark) new bark compared to native trees this obstacle can be largely mitigated by providing access to bark-removing equipment and facilitating access to more lucrative markets for "green charcoal"
Output1. *Melaleuca* eliminated from high priority restoration zones within the PA	1.1 By YR1 study published identifying high priority zones for restoration through the elimination of Melaleuca	1.1 Article published on-line showing map of zones within PA where: a) large stems of Melaleuca are abundant, and b) that were historically marshes or swamps.	It is possible to eliminate this species from defined areas of the PA by a combination of exploitation for charcoal followed by repeated cycles of compensated hand removal of young plants. Repeated removal of seedlings will be necessary because this species germinates

thereby enhancing natural regeneration	1.2 By YR 1 adult stems of Melaleuca (stem dbh >5cm) eliminated over 10 hectare; by YR2 over 20 hectare and by YR3 over 30 hectare. 1.3 By YR1, 50, by YR2 100 and by YR3 150 women involved in removal of Melaleuca	1.2 Analysis of counts of number of individuals of *Melaleuca* per unit area in restoration zones and mapping of zones where the adult plant has been effectively eliminated. 1.3 Quarterly compilation and analysis of attendance records	freely from a soil seed bank. Single women are considered a vulnerable group, unemployed and if their security is assured in the forest, they can actively participate in the implementation of the project.
Output 2. *Melaleuca* charcoal produced preferentially by local people and accesses lucrative markets with livelihood benefits for locals	2.1. By YR1 protocol demonstrated in "real world" conditions that enables charcoal to be produced from *Melaleuca* with no more than 15% loss of efficiency compared to charcoal produced from native trees (some loss of efficiency must be expected and this will be compensated by greater sale's price) 2.2 In YR1, YR2 and YR3 respectively, 30, 60 and 100 charcoal producers obtained 25% increase in household income from charcoal (currently zero *Melaleuca* charcoal as baseline)	2.1 Published online report of research to quantify effort (intensity of labour multiplied by time) invested to produce one unit of energy from *Melaleuca* charcoal compared to the equivalent from charcoal produced from native trees 2.2. Annual analysis of household records of participating charcoal producers (i.e. within the Cooperative) showing volume of charcoal produced and income received by charcoal producers	Appropriate sustainable technologies can be identified elsewhere in the World and introduced to Madagascar to effectively process *Melaleuca* trees despite its very thick spongy bark. *Melaleuca* charcoal performs well in traditional and improved charcoal stoves and lucrative commercial markets can be identified and accessed for "green" charcoal by motivated business team. If *Melaleuca* charcoal is lucrative as we plan it to be, *Melaleuca* within the PA may become rare and uneconomical to exploit. While this is a good result for local biodiversity but be assume that value chain associated with this activity can continue to operate by exploiting the large populations of this plant existing outside of the PA. In these zones, if seedlings are not removed, then the exploited populations will quickly regenerate.
Output 3. Melaleuca charcoal appreciated by urban populations	3.1 Permits obtained to provide a legal context for the project to exploit and sell charcoal from *Melaleuca* – including definition of mechanism to ensure that the charcoal being sold is really from	3.1. Documents providing legal framework and the validation mechanism for this project.	While charcoal produced from certain native trees will likely be preferred by local people over Melaleuca charcoal (because they are familiar with using the former and also because has a

and product sale strategy supported sustainably	*Melaleuca.* 3.2 Annually, 100% of charcoal produced by charcoal producers purchased by Cooperative and delivered to sale's point directly accessible to consumers 3.3. By Y1, two sale's points installed and functional in Soanierana Ivongo and Sainte Marie 3.4. Volume of charcoal sold by Cooperative of Melaleuca charcoal producers increases annually from zero at T0 to 20 tons by Y1, 40 tons by Y2 and 60 tons by Y3. 3.5. Y2, a business plan and a manual procedure elaborated showing the overall strategy of the cooperative for the sustainability investment including the extension of investment areas 3.6. From Y 1 to Y3, at least 10 Leaders of the cooperative trained on at least six themes relating to the management and governance of the cooperative	 3.2 Audits of transmission of annual purchase and sale of the cooperative 3.3. Annual sales accounts of *Melaleuca* charcoal from the two sales points 3.4. Audit of accounts of the cooperative 3.5. Annual reports and minutes of workshop for validation of the documents 3.6. Minutes of the training, and evaluation of knowledge and skills acquired by the trainees immediately after the training and 6 months later	greater energy production per unit volume), legal access to wood of native trees is now non-existent and therefore *Melaleuca* charcoal will become an acceptable alternative. - Poor governance and management of the cooperative could induce tension between members and compromise the sustainability of the project but such tensions can be effectively reduced by providing training cascades, and effectively applying the manual of procedure (with periodic supervision from the services concerned and the sanction measures in the case of non-compliance with internal rules) -The Pointe à Larrée area is a zone frequently impacted by cyclones could interrupt the supply of stocks to places of sale, a supply plan will thus be reinforced during the dry seasons to avoid product shortages during bad times.
Output 4. Promising model of a new relationship with IAS demonstrated to land managers (including PA managers) and	4.1. In YR1, YR2, and YR3 interested parties informed of the project and its progress by means of one dedicated website and bi-monthly social media posts. 4.2. In YR3 at least 10 land managers (including Protected Area Managers) visit Pointe-à-Larrée to	4.1. Availability of webpage and count of number of social media posts. 4.2. Written evaluation of invited land managers to project including evaluation of the potential to	-High rates of illiteracy and conservatism (e.g use of charcoal from native species) may slow down behavioral change and diminish popular appreciation of "green" charcoal but the importance of these factors will be diminished through a robust program of popular communication using simple key messages

public awareness on IAS (threats and opportunities) increased	evaluate project. 4.3. In YR3 one article describing and objectively evaluating the project will be published in a peer reviewed journal 4.4. From Y2 to Y3, annually 20,000 people informed or sensitized of project results through four annual participations in local, regional, national celebration events, 24 annual radio broadcasts	complete a similar endeavour in their zone of intervention. 4.3. Publication of peer-reviewed article 4.4 Estimation of the number of people sensitized for each event organised or attended, and monthly estimation of people listening to the local radio according to the coverage area	carefully crafted for each target group.

1.1. Launch of project with full range of local stakeholders including: Regional launch, village meetings around PaL; radio broadcasts; courtesy visits with representatives of local government and decentralised technical services. Listen to feedback and address concerns.

1.2. Work with local government and decentralised technical services to provide a legal framework for this initiative

1.3 Work with Regional Direction of Environment and Sustainable Development (RDESD) to conduct research to develop annual prospections and developing exploitation plans and contract and specification clauses, map priority zones with PA for the elimination of Melaleuca (= restoration zones)

1.4. Research Manager (RM) and RDESD direct monthly members of the “green charcoal cooperative” (GCC) to the restoration zones and ensures exploitation protocols are respected.

1.5 Rangers ensure daily patrols to make sure none of the charcoal burners cut native species.

1.6 RDESD supports Rangers in law enforcement and control in the case of infractions

1.7 Federation Lovasoa (FL) organises, mobilises and plans intervention of community members for each Association COBA, removing seedlings and sapling of Melaleuca, tree planting.

1.8 Head Forest Policing (HFP) from Missouri Botanical Garden and FL direct three monthly participatory monitoring patrols to assess the cutting rates of native species within the PA

1.9 RM directs female members of the GCC in work to remove young plants of Melaleuca from restoration zones and pays them fair compensation for their work.

1.10 Assistant Project Manager (APM), RDESD conduct three-monthly monitoring for compliance with the clauses in the specifications of Melaleuca exploitation contracts.

2.1. Study trip by PM and President of GCC to Indonesia to identify best practice for the production of charcoal from Melaleuca

2.2. Purchase tools to enable efficient conversion of *Melaleuca* into charcoal

2.3. PM conducts training workshops for members of GCC in best practice for the conversion of *Melaleuca* into charcoal.

2.4. PM and Development Manager (DM) coaches the charcoal producers and GCC in best practice for two first months

3.1 Regional Direction of Industry, Trade and Consumption (RDITC) conducts diagnostic to identify strength, weakness, threat and opportunity

3.2. A small team of recent graduates in business (two graduates) and in accounting (two graduates) develop marketing strategy and business plan of the cooperative with assistance of RDITC

3.3 RDITC and a Consultant businessman coach graduates on developing marketing strategy and business plan

3.4 Workshop organised for all stakeholders to validate business plan, manual of procedure and internal rule of the cooperative

3.5 RDITC and Consultants conduct training the Leaders of the Cooperative on at least six topics.

3.6 GCC organises stocks of charcoal on site for transport, purchase charcoal from producers as start-up funds

3.7 GCC rents two sale's point (in Soanierana Ivongo and in Sainte Marie).

3.8 GCC hires two sale managers in Sainte Marie and in Soaniarana Ivongo and one skipper

3.9 GCC builds one warehouse at Pointe à Larrée for facilitating the marine route transportation from Pointe à Larrée to sale's points and extend existing warehouse close to national road.

3.10 GCC purchases a motorboat and equipment for provision of supply from Pointe à Larrée to sale's points

3.11 Monthly, RDESD validates that charcoal for sale originates entirely from *Melaleuca* and conducts control of stock in the warehouse

3.12 RDITC delivers agreement of sale

3.13 GCC and DM implement marketing strategy for sale

3.14 DM conduct surveys for assessing the needs of consumers (risk mitigation activity).

3.15 DM coaches GCC for implantation of business plan

3.16 RDITC, following each training session, conducts monthly technical monitoring for the two first months, afterwards three-monthly monitoring to continue coaching

3.17 All partners and local authorities conduct half-yearly participatory monitoring of the project progress

3.18 PM develops collaboration with businesses for shipment and sale

4.1. Consultant webmaster creates website for this project that will act both as a focal point for communicating progress with interested parties (including results of studies) and also as a method of attracting buyers

4.2. PM provides bimonthly updates of Project' progress on social media

4.3 PM and DM organises monthly broadcasts on local radio to explain about the threats and opportunities of IAS and also to provide more detail about this project

4.4 FL organises annually a festival of biodiversity including exhibition of charcoal of Melaleuca and some documents for sensitization

4.5. PM, APM and partners attend regional and national events (e.g. World Environment Day, World Women's Day, economic fairs) to communicate about the project

4.6. Workshop for interested parties at the end of the project to share information on methods, inputs, outputs, overall results, and issues arising.

4.7. Representatives of ten of the institutions attending the workshop invited to make a site visit so that they can properly evaluated the project and consider whether this approach can be applied in some form at the sites where they work.

4.8. Peer-reviewed article published describing the project approach, describing its results and evaluating conditions for wider application.

Annex 3 Standard Indicators

Table 1 Project Standard Indicators

DI Indicator number	Name of indicator	Name of Indicator after adjusting wording to align with DI Standard Indicators	Units	Disaggregation	Year 1 Total	Year 2 Total	Year 3 Total	Total achieved	Total planned
DI-A01	Number of people from key national and local stakeholders completing structured and relevant training	Number of local people completing training on six topics related to management structure, Leadership, commercialisation, financial education, Casamance kiln, regulations of timber exploitation, safeguarding	People	Men/women	51/5	20/1	35/13	106/19	60/10
DI-A03	Number of local/national organisations with improved capability and capacity as a result of project.	Number of cooperative with improved capability and capacity as a result of project	Number of organisations	Organisation type	1	1 (the same structure as YR1)	1	2	1
DI-A06	Number of people with improved access to services or infrastructure for improved well-being	Number of people with improved access to warehouse for storage of green charcoal product, boat, kubota for transporting green charcoal products	People	Men/women	61/9	6/1	The same individuals as YR1 and YR2	67/10	80/20
DI-A07	Number of government institutions/departments with enhanced awareness and understanding of biodiversity and associated poverty issues	Number of technical services benefiting cross-training and understanding of biodiversity and associated poverty reduction	Government institutions	Govt. Organisation Type	2	8	7	17	2
DI-B01	Number of new/improved habitat management plans available and endorsed	Number of ecosystems having research plan for removal of Melaleuca and for ecological restoration post-control endorses by government service	Number	Ecosystem	2	0	0 the same as YR1	2	2

Table 2 Publications

Title	Type (e.g. journals, manual, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)
Gestion et valorisation de *Melaleuca quinquenervia* (Cav.) S.T. Blake, une espèce invasive à Pointe à Larrée, dans le Centre-Est de Madagascar.	Journal	Adolphe Lehavana and Chris Birkinshaw (Abstract submitted)	Male	Malagasy	Association pour l'Etude Taxonomique de la Flore d'Afrique Tropicale	Pending

Annex 5 Supplementary material (optional but encouraged as evidence of project achievement)

1. Abstract of the presentation at AETFAT

Checklist for submission

	Check
Different reporting templates have different questions, and it is important you use the correct one. Have you checked you have used the **correct template** (checking fund, scheme, type of report (i.e. Annual or Final), and year) and **deleted the blue guidance text** before submission?	Yes
Is the report less than 10MB? If so, please email to BCF-Reports@niras.com putting the project number in the Subject line.	
Is your report more than 10MB? If so, please consider the best way to submit. One zipped file, or a download option, is recommended. We can work with most online options and will be in touch if we have a problem accessing material. If unsure, please discuss with BCF-Reports@niras.com about the best way to deliver the report, putting the project number in the Subject line.	Yes
If you are submitting photos for publicity purposes, **do these meet the outlined requirements** (see section 14)?	
Have you included means of verification? You should not submit every project document, but the main outputs and a selection of the others would strengthen the report.	Yes
Have you provided an updated risk register? If you have an existing risk register you should provide an updated version alongside your report. If your project was funded prior to this being a requirement, you are encouraged to develop a risk register.	Yes
Have you involved your partners in preparation of the report and named the main contributors	Yes
Have you completed the Project Expenditure table fully?	Yes
Do not include claim forms or other communications with this report.	