Final Evaluation Report

Your Details	
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Project Title	Conservation of Threatened Plant Species in Makueni, Kenya, through Community Mobilization
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1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Evaluation of the restored Millettia vatkei seedlings within Ngutwa-Nzaui area			■	As a post-restoration exercise, we assessed the restored *Millettia vatkei* seedling survival rates and the suitability of the adopted approaches. A total of 1728 *M. vatkei* seedlings (excluding those donated to locals and schools) were evaluated. At the time of assessment, a total of 1446 *M. vatkei* were found alive and surviving, translating to an 83.7% survival rate. A relatively small number of those assessed were found disturbed, e.g., nipped by animals or with discoloured leaves. Based on the three-approach strategy adopted (enrichment, reintroduction, and translocation) in restoring this species, enrichment and translocation were the most suitable. Of the three types of sites (open, exposed, and rocky; partly sheltered and rocky; deep gullies with inaccessible vegetation) previously used to restore the species, partly sheltered and rocky microsites were found to be the best sites for the restoration of the species. Although open, exposed, and rocky microsites had some surviving individuals, it was seen as less appropriate for restoring the *M. vatkei*. A medium disturbance was observed in individuals restored in deep gullied areas with inaccessible thorny vegetation. From that restoration exercise, *M. vatkei* restoration was highly favoured by the augmentation of existing populations and translocation to highly suitable sites within its distribution range. We conducted species distribution modelling, and it was found out that *M. vatkei* distribution was more sensitive to temperature and precipitation variables. Its current habitat stands at 42828.2 km^2 in Kenya. Results from the simulation showed

				that under the most pessimistic scenario (RCP 8.5 emission), *M. vatkei* would be the most vulnerable to climate change and would lose the highest % of its suitable range (% loss = 37.3) in Kenya. Most populations of this species are distributed within Makueni County meaning much of the loss will be encountered in the study area and surrounding areas. Even if some efforts were already overtaken, our results might support further future conservation initiatives. For instance, sacred natural sites were found suitable for restoring this species, since it has the most suitable current conditions, which were predicted to persist in the future. Availability of seeds is another factor to consider in the restoration effort for *M. vatkei*. Although its propagation is possible by seeds, the lack of adequate seeds made this option uncertain and time-consuming. This was, in part, caused by locals who indiscriminately harvest leafy and flower-bearing branches for fodder and for the construction of charcoal kilns. This adversely affects the timing and number of seed produced and also induces pathogenic infections in standing healthy trees. Therefore, vegetative propagation of this species was important in offsetting seed inadequacy. 88% of *M. vatkei* cuttings treated with 0.6% Indole Butyric Acid (I.B.A) rooted compared to 63% control (distilled water). Those treated with I.B.A showed statistically significant positive effects ($P < 0.0001$) on root numbers and length per rooted cutting compared to the control. Unfortunately, the cost implication of synthetic hormones is high for local peasant farmers, and the ease of obtaining them is limited. Consequently, we assessed using natural root-promoting substances (moringa leaf extract, pure honey, cinnamon powder, coconut water, and aloe vera gel) as alternatives to synthetic rooting hormones. Moringa, aloe vera gel, and coconut water treatments showed a significant increase ($P < 0.05$) in both root number and length compared to the control.

Mass-propagation and restoration of Euphorbia friesiorum, Pavetta teitana and Thunbergia napperae within the Ngutwa-Nzaui landscape.				While engaging the locals, a total of 3018 seedlings (1002 *P. teitana*, 1010 *T. napperae* and1006 *E. friesiorum*) were raised in the established community nurseries and restored in suitable microsites. Making great use of the lessons learnt from the restoration of *M. vatkei* (1RSG), a more in-depth and precise approach was pursued in identifying the most suitable areas for restoring the three target species. The current habitat for *E. friesiorum*, *P. teitana* and *T. napperae* in Kenya is 44,932 km^2, 43,728 km^2 and 36,376 km^2 respectively. All of these habitats were predicted to contract to 15,130 km^2, 4,995 km^2 and 13,131 km^2 under RCP 8.5 emission scenario. The projections of future habitat suitability for the target species varied depending on the RCP scenario and differed for each species. According to the model forecasts under RCP 4.5, *P. teitana* had the largest stable habitat (approximately 38,171.52 km^2), while *T. napperae* had the least stable (approximately 3,479.61 km^2) which is 90.4% loss of suitable habitat in Kenya. MaxEnt model projections showed that under the most pessimistic scenario (RCP 8.5), *T. napperae* would be the most vulnerable to climate change and would lose the highest % of its suitable range (36.1%). Although the distribution of all the three-target species was more sensitive to temperature and precipitation, seasonality of precipitation greatly influenced *E. friesiorum* than the other species. Also, the seasonality of temperature had a profound effect on *P. teitana* than all the other species. Further analysis on other factors influencing the distribution of these species such as geographic and human factors is needed for their sustainable conservation.
To enhance the local community's awareness and build their capacity on biodiversity conservation (including				Building the community's capacity for biodiversity conservation was essential in leveraging local knowledge, fostering ownership and stewardship, enhancing social cohesion, and scaling conservation efforts. Using the training of trainers (ToTs) approach, we developed propagation

the target species) and their habitat				protocols and designed a tailored practical guide for the local nursery establishment and management. This involved constructing propagation systems (improvised poly-tunnel), identifying the target plant species, seed collection, handling, storage, and germination. This ToT model aimed at creating a cascade effect, where the trained individuals become trainers, multiplying the impact on other local community members. By design, this aimed to create a supportive network that would continue beyond the initial training, allowing trainers to seek advice, exchange resources, and collectively address local challenges. The success of this self-sustaining cycle of capacity building was evaluated through positive feedback from opportunistic encounters with those trained. Inadequate community awareness of the importance of conserving biodiversity (including threatened species and their habitat) contributes to continued degradation within the study site. Over 3000 local community members were sensitised on the importance of biodiversity, including target threatened plant species and their habitats. We used satellite images and land use land cover changes (LULCCs) maps to show how human activities have adversely affected the provision of ecosystem services within their locality. These changes were quantified from 1987 to 2020 to paint a clear picture of how severe their actions were to biodiversity. For a wider audience, we used local community games, radio stations, and Makueni County government officials to sensitise the locals to the urgent need to conserve the target threatened species and biodiversity. Awareness was enhanced through print media, whereby an illustrated guide of selected threatened, and under-utilised plant species was developed through peer learning and collaboration. By visually showcasing these species and providing relevant information such as diagnostic characters, conservation status, and use, the guide seeks to educate a broader

				audience, including the general public, researchers, and policymakers, about the importance of their conservation and ecological significance.
To promotion of nature-based solutions as alternative sources of livelihood				Livestock keeping, crop farming, sand mining, and charcoal burning are some of the local activities for their livelihoods. This has negatively impacted the environment, hindering the provision of ecosystem services. Therefore, as a short-term intervention, we strengthened the existing hay value chain by promoting suitable hybrid grass ecotypes, such as *Brachiaria* varieties, which have shown great regional potential. As an alternative source of livelihood, the earliest farmers (though very few) to plant the high-protein packed grass are reaping three times from its hay sale compared to the production of maize and beans. Through the Kenya Agricultural and Livestock Research Organization (KALRO), we strengthened this by sowing and distributing its growing splits to over 100 members of the local communities. We ensured the farmers were adequately informed, technically prepared, and organised in groups to enjoy collective efforts to overcome shared challenges and benefit from pooled creativity in developing new products and services. This component was partially achieved as we intend to add value to this chain through standardised bailing, the sale of seeds, and splits to other farmers. The commercialisation of hay is a great potential entry point to controlling destructive activities to biodiversity.

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

a). Achievement of 83.7% survival rate on the transplanted *M. vatkei* seedlings despite unpredictable rainfall within the study area. Also, we determined augmentation and reintroduction as the appropriate approaches. Also, predictive sites indicated that this species favours various landforms, such as partly sheltered and rocky areas. Inadequacy of seeds challenges the restoration of species, especially rare and threatened ones; as a result, we explored vegetative propagation using 0.6% Indole-3- Butyric Acid (I.B.A), which yielded positive results. However, the cost implication and limited nature of acquiring synthetic rooting hormones, especially for local farmers, necessitated investigation with an alternative natural rooting hormone (coconut water, aloe vera gel, moringa leaf extract, cinnamon powder, and pure honey). All except cinnamon powder and honey showed a significant increase ($P<0.05$) in both root number and length of *M. vatkei* stem cuttings compared to the control. Using these natural substances to promote rooting in stem cuttings is applicable as they are cheap and readily available.

b). A total of 3018 seedlings (1002 Pavetta teitana, 1010 Thunbergia napperae, and 1006 Euphorbia friesiorum) were propagated and restored within suitable sites in the study area. Learning from the outcomes of *M. vatkei* restoration, we modelled the target species' ecological niche and potential distribution under projected climate change impacts to enhance our understanding of their behaviour under altered climatic conditions. This simulation sought to prioritise conservation efforts and allocate resources effectively by identifying high suitability habitats or where populations will likely persist under future climate change scenarios. Interestingly, most sacred natural sites (pockets of relatively intact vegetation) within the study area fell under suitable habitats for the target species. These sites were modelled and found suitable under future climate scenarios (the 1950s and 1970s). We believe this can positively contribute to the conservation of the target threatened plant species if locals are too sensitised on the importance of those sites on biodiversity and their livelihoods.

c). Enhancing the local community's capacity and awareness of the importance of conserving biodiversity as well as promoting nature-based solutions. Over 3,000 locals were sensitised to conserving biodiversity, including threatened species and their habitats. Since the majority engage in destructive activities to earn their livelihoods, we promoted nature-based solutions as an alternative livelihood source by strengthening the existing hay value chain by promoting suitable hybrid grass ecotypes such as *Brachiaria* varieties and establishing tree nurseries as businesses. Very few locals carry out the commercialisation of hay and tree seedlings despite being a potential business venture. Feedback from some locals indicates that they earn more than three times from the sale of hay compared to maize and beans.

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

Prolonged drought and unpredictable rainfall within the study site posed one of the greatest and unforeseen challenges during restoration. The long rains (2022) within the study area were characterised by unpredictable patterns of irregular distribution or intensity, which disrupted planting and growth timing cycles. This made it difficult to determine the optimal time for germination and restoration. To effectively manage this unforeseen challenge, we established a stable water storage system and divided routine nursery operations/duties such as watering, weeding, and root-pruning among ourselves. This approach was considered to foster a culture of peer learning where individual members could exchange ideas, offer suggestions, and provide constructive feedback, leading to improved work execution. Through this, we sought efficiency by leveraging individual capabilities, promoting collaboration, establishing clear responsibilities and accountabilities where each local can take ownership of their work, and increasing their commitment and dedication to achieving high quality results. Further, this optimised task coordination by the project team members.

The hybrid grass ecotypes were not enough as previously imagined. Firstly, we could not secure enough seeds from Kenya Agricultural and Livestock Research Organization (KALRO). Secondly, many local farmers needed grass after realising how their fellow farmers were reaping from the sale of hay. We partially addressed this challenge through farmer-to-farmer exchanges, where the few existing farmers shared grass splits with those who do not have them at a small fee. This promoted the introduction of new grass varieties or the expansion of existing grass species in their pastures or forage field. Importantly, these farmer-to-farmer exchanges not only involved the physical exchange of grass splits but also facilitated the sharing of knowledge and experiences. They could discuss their successes, challenges, and best practices related to forage management. This exchange of information promoted peer learning and empowered farmers to make informed decisions about grass selection, establishment techniques, and ongoing pasture management. This is a work in progress, and we would like to continue engaging more local farmers by encouraging them to form groups where they can enjoy collective efforts.

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

Our project appreciated the invaluable role of local communities in biodiversity conservation. Their involvement has proven to be highly beneficial for the conservation of threatened plant species and the communities themselves. One key aspect of their involvement was peer learning. Local communities possess a wealth of knowledge and experience accumulated over generations through their interactions with the environment. The project tapped into this vast reserve of wisdom by incorporating community-based knowledge systems. They have shared their traditional knowledge of plants, including their uses, traditional propagation technologies, and cultivation techniques, some of which have great relevance in modern science. This knowledge exchange has enriched the project and empowered and fostered a sense of ownership, as their expertise and contributions are acknowledged and valued. This collaborative exchange of knowledge enabled locals to learn from each other's strengths, unique perspectives, and practical insights, expanding their knowledge base and gaining new abilities. This diversity of thought ignited innovation and enabled creative problem-solving. By pooling their collective intelligence, communities can tackle complex challenges more effectively and develop new approaches to address their specific needs.

A significant outcome of community involvement has been the establishment of a tree nursery based on community-based knowledge systems that ensure effective propagation and management. By leveraging their knowledge and skills, the project successfully established a tree nursery for propagating and nurturing seedlings for sale, thus diversifying their sources of livelihood. Importantly, the nursery was also intended to serve as a focal point for learning and practising sustainable conservation methods. To sustain the nursery after the project cycle, it was agreed that some of the produced seedlings were not for sale but for on-farm agroforestry purposes. Throughout the project, members were actively involved in seed collection, germination, and plant care, thus gaining hands-on experience in plant propagation and management. This engagement has enhanced their understanding of biodiversity conservation and provided them with practical skills that can be utilised for their livelihoods. For example, the established community nursery propagated the hybrid grass ecotypes, which were later shared among themselves. This was one of the community's greatest benefits from being involved in the project. Learning from their fellow members who were already commercialising hay revealed that the venture presented great benefits to their livelihoods and the environment around them.

Furthermore, the project recognised the importance of collecting successful grassroots community narratives and experiences related to biodiversity conservation. These narratives serve as valuable resources that capture the depth of knowledge embedded in the practices of local communities. They included traditional practices, indigenous techniques, and innovative approaches that have proven effective in conserving biodiversity, such as sacred groves, taboos on plants and animals, controlled grazing, and totemic hindrances. By documenting such narratives, the project sought not only to preserve their cultural heritage but also to promote culturally appropriate conservation and enhance cross-learning and replication of successful strategies elsewhere. An illustrated guide of selected threatened (target species involved) and underutilised plant species in their area has been developed as an outcome of this active community engagement.

Importantly, some locals were engaged as casuals earning something to bolster their daily income throughout the project cycle. Also, we resolved to buy most of the project materials, including food and accommodation, from local businesses. This approach was carefully considered for various reasons; firstly, due to public perception as supporting local businesses resonates positively with the community. Usually, people appreciate projects that prioritise the local community's interests and contribute to their overall wellbeing. This enhances the project's reputation, generates positive word-of-mouth, and potentially attracts more participation and support. Secondly, building personal relationships with local businesses (influential community members) can lead to long-term partnerships and ongoing project support through sponsorships, donations, or discounted prices on materials. Thirdly, apart from fostering community engagement and collaboration, the choice has environmental implications. Buying materials locally reduces the need for long-distance transportation, which can contribute to greenhouse gas emissions. Minimising the carbon footprint associated with the project is a clear demonstration of a quest for environmental responsibility and sustainability.

5. Are there any plans to continue this work?

Yes, there are prospects of continuing with this work. The previous work has accumulated strong evidence on how threatened plant species have often found avenues for survival and persistence within sacred groves and other cultural landscapes. Virtually all the target threatened plant species and other culturally important species were found in stable populations within or around these sacred natural sites within the study area. To further highlight their contribution to conservation within the area, two critically endangered plant species new to science have been recently described from them. Unfortunately, these safe havens for threatened species are fast being lost through preventable human disturbances largely fuelled by cultural erosion and climate change. Therefore, there is an urgent need to conserve these sites as doing so also helps conserve the threatened species and the community's cultural heritage.

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

The project results were disseminated to all the stakeholders in organised workshops and seminars as well as through community games, local radio, and TV stations. For wider coverage, we plan to publish research articles in peer-reviewed journals for the wider scientific community. Also, copies of the final project report will be submitted to the National Museums of Kenya Library, Kenya Forest Service (Wote branch), as well as the environmental department in the Makueni County government.

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

In retrospect, the conservation of threatened species within the study area should be pursued through a biocultural perspective that offers a promising framework for culturally appropriate conservation. By adopting this approach, we sought to value the interconnectedness of biological and cultural aspects of threatened plant species, leading to more effective and sustainable conservation strategies. Most of the target species were found to have a cultural and spiritual significance to local communities. They are often deeply embedded in cultural practices, rituals, and traditional belief systems. Therefore, by recognising and respecting the cultural importance of these plants, this approach can strengthen the bond between communities and their environments, fostering a sense of stewardship and promoting conservation efforts.

From our previous project, the many sacred natural sites within the study area serve as repositories of the community's rich cultural and natural heritage, protected by taboos and totemic hindrances. Because of their dual character as sites of high biological and cultural value, these special places contribute meaningfully to both the conservation of biological diversity and the maintenance of cultural diversity. For example, all four target threatened plant species were found in stable conditions in or around these sites within the study area. Recently, two plant species new to science and critically endangered by IUCN criteria were discovered from such sites within the study area. Importantly, from our species distribution models, these sites will remain stable and suitable for the target species under future climate scenarios (2050s and 2070s) only if there is no human disturbance. Therefore, there is an urgent need to continue sensitising the locals on the importance of protecting the various sacred natural sites within the study area, as doing so contributes to the conservation of biodiversity and cultural values.

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

Yes, the Rufford Foundation logo was used in all materials either produced as a teaching aid or as an outcome of the project activities, including project promotional materials such as branded t-shirts, banners, and species information leaflets. Also, the foundation received publicity through local radio and Tv stations during training and sensitisation meetings/workshops with the stakeholders.

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

Justus Mulinge Munywoki (Lead investigator) - key roles in the overall project management and co-ordination including propagation (Seed collection, handling and sowing), awareness creation and project correspondence.

Itambo Malombe (Dr)- A senior research scientist at the National Museums of Kenya with key roles in site assessment, species identification and restoration. Provided a technical support and guidance through the project cycle.

Jackline Mwende - Agronomist and agricultural extensionist) involved in training good agricultural practices (GAPs) e.g., pollarding, regenerative agriculture, to the locals including other agroforestry practices relevant to the project.

Vivian Kathambi - a research scientist with key roles in awareness creation and in-situ conservation of threatened target species including monitoring and evaluation.

Dominic Masila - local guide/village elder (Ngutwa Village) member of Community Forest Association, facilitated project activities within Ngutwa village.

Jones Muindi - local guide/village elder (Nzaui village, facilitated implementation of project activities within the Nzaui area.

Mutunga Mwakavi - Community field assistant, acted as conduit between the project team and the local community. An active member of some of the relevant Community-Based Organizations across the Ngutwa-Nzaui areas.
Robert Kasee - Project team member with key role in mobilizing local groups, and awareness creation and facilitation of media coverage for wider target audience.

10. Any other comments?

On behalf of the entire project team and the local communities involved, we extend our deepest gratitude for your generous support towards our project. The impact of your support extends far beyond the immediate benefits of preserving our natural heritage to improving the livelihoods of local communities through the enhanced provision of ecosystem services. Thank you for your belief in our shared vision and valuable donation that has not only created a tangible change but has also fostered a sense of collective environmental responsibility and empowered individuals to become guardians of our precious natural resources. We look forward to continuing this journey together, informing you about our progress, and sharing the success stories made possible through your generosity.

PLATE 1: Some of the propagated seedlings; Pavetta teitana, Thunbergia napperae and samples of hardened-off Euphorbia friesiorum.

PLATE 2: Local engagement in the establishment of a community nursery.

PLATE 3: Restoration exercise of the raised seedlings within Ngutwa Nzaui landscape.

PLATE 4: Sensitization on planting trees as viable intervention for adapting to and mitigating adverse effects of climate change during community games. (A) Makueni County Government Deputy Governor, Her Excellency, Lucy Mulili and the Principal Investigator planting Euphorbia friesiorum (see C above), a threatened target plant species endemic to the region and that is locally known as 'Musilia.' (B) Makueni County Executive Committee Member for Gender, Children, Youth, Sports & Social Services, Nicholas Nzioka, preparing to plant a tree. (D) Hon. Elizabeth Mutinda, Area Member of County Assembly (Muvau/Kikumini ward) planting Tamarindus indica. (E) Hon. Douglas Mbilu, the Speaker Makueni County assembly digging a hole in preparation for planting a tree. The Makueni county government is very committed to 'greening' the county through planting trees in schools and other public places.

PLATE 5: Enhancing local community's awareness on the importance of conserving biodiversity including the target threatened plant species and their habitat.

PLATE 6: Improvised poly-tunnels established for raising Brachiaria grass varieties.

PLATE 7: Brachiaria grass planted as an alley crop by locals within their farms.

PLATE 8: Members of the local community posing with raised Brachiaria grass splits during a training workshop.

PLATE 9: Some of the challenges facing biodiversity within the study area; expanded agriculture, fires, firewood, construction and charcoal burning.