

1
2 **CONSERVATION EDUCATION, ALTERNATIVE LIVELIHOOD AND HABITAT**
3 **RESTORATION: BEST STRATEGIES FOR CONSERVATION OF MAGOMBERA**
4 **FOREST RESERVE.**
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10 **ABSTRACT**
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The Magombera forest is a home of endemic and endangered biological species such as Udzungwa red colobus monkey (*Procolobus gordonorum*) and the Magombera chameleon (*Kinyongia magomberae*). However, the forest is facing high threat of disappearing through the resources extraction pressure from adjacent local communities. The project aimed at improving conservation of Magombera forest by involving the adjacent communities through provision of conservation education, restoration initiatives and bee keeping as alternative way of livelihoods. The study revealed that the concept of forest conservation is well supported, nevertheless, people are extracting resources from the forest for their sustenance. The dependence of the people on the forest is due to lack of alternatives to the forest resources, inability of the people to produce alternatives source of income and little conservation education. The project resulted to a positive community's attitude change towards conservation. The modern bee keeping was introduced to the community and successfully adapted. About 89% of indigenous trees planted for restoring the degraded area of the forest survived, only 11% of trees planted could not survive. There is a need to expand the scale of the project by involving many participants particularly youths that showed strong interest with the project.

Comment [A1]: All across rural Africa people depend upon natural resources within forests and other natural systems – honey collection, bush meat, charcoal, thatch grass, fishing, wild medicine, lumber, etc. They need help in sustainably managing these resources. If the forests have no value to local inhabitants, with human populations expected to double in the next 50 years in Sub-Saharan Africa, they will disappear. At the same time, helping people sustainably manage their natural resources, must fit into a larger plan for development that takes pressures off rural Africa by creating an urbanized middle class, not the majority living in urban slums rotating back and forth between these slums and rural Africa mining these natural systems without regard for the future, being in a survival mode. I suggest the author goes to ResearchGate under my name Andre DeGeorges and download: 1) DeGeorges, P.A. & Reilly, B.K. 2009. The realities of community based natural resource management and biodiversity conservation in Sub-Saharan Africa. Sustainability, 1:734-788. and 2) DeGeorges, P.A. & Reilly, B.K. Process. 2008. A critical evaluation of conservation and development in Sub-Saharan Africa: Last Chance Africa. The Edwin Mellen Press, Lewiston, New York. 7 books, 3,572p. See Chapter 9 on Community Based Natural Resource Management. Also Search 'Integrated Rural Development' – that is trying to solve all the problems on the farm, while failing to deal with helping communities sustainably manage their natural systems including section 11.10.6.2 "Conservation and development" a continuation of failed "integrated rural development" linked to "preservation"


Comment [A2]: Am I missing something?? All across Sub-Saharan Africa, I have seen hollow beehives maybe 3-5 feet long hanging from trees in Wild Africa with no harm to these natural systems. I hope by modern you don't mean it can't be undertaken in these forests, but only on the farm????!!

Comment [A3]: Replanting the trees is fine, but will fail unless the next step is helping the people to sustainably harvest these trees as they mature, as an economic resource. These forests must be managed in collaboration with the rural communities for the multitude of natural resources they produce, 'Green Factories Without Walls'. Then it will be in the interest of the rural community to protect these natural systems from poaching and other misuses such as conversion to agricultural and grazing lands. They will become the game scouts and policemen of THEIR FORESTS.

13 *Keywords:* Magombera forest, alternative livelihood, Modern beekeeping, Restoration
14

15 1. INTRODUCTION

16 Habitat degradation will continue to be a major challenging and severe threat to biodiversity conservation all over the
17 World unless deliberate efforts are taken [1]. Various wildlife habitats in Africa have been destroyed and posing high
18 extinction risks of many species. According to [2, 24], habitat loss threatens 85% of all species described in the IUCN's
19 Red List. Much of this destruction is attributed to anthropogenic activities [3]. There are hundreds, possibly thousands of
20 empirical studies that show species richness declining with fragment size [4]. Tanzania has lost thousands of hectares of
21 forests through deforestation and degradation arising mainly from anthropogenic factors such as unsustainable harvesting
22 of forest products, charcoal making, agriculture expansion, wild fires, urbanization and mining [5]. For instance, Kalunga
23 forest which is among the lowland forests in Kilombero valley have been cleared for agriculture because of their fertile soil
24 and flat terrain [6]. These activities affect ecosystems that are home to many wild species. Magombera forest is among
25 the forests which faces these challenges.

26 Magombera Forest is part of the Udzungwa ecosystem in the southern end of the Eastern Arc Mountain Range in South-
27 central Tanzania. It is located at about 6km from the Udzungwa Mountains National park [6]. The forest is diverse in terms
28 of flora and fauna. It harbors endemic and endangered species of plants and animals like Leopards, Elephants,
29 Buffaloes, Iringa red Colobas monkey, Magombera chameleon,  *Polyalthia verdcourtii* (Huberantha verdcourtii) tree and
30 the large-leaved Memecylon tree [2, 7]. Magombera forest is also the home for other internationally threatened species of
31 plants and animals such as Udzungwa dwarf galago, and hippopotamus. The Forest is also an important place for local
32 communities who depend on the adjacent land for rice and sugar farming. The forest provides invaluable ecological
33 services including protection from floods and soil erosion. The canopy of the forest is mostly intact, however limited
34 regeneration and continued forest use threatens the future of the forest. The vegetation is composed of mature trees with
35 closed canopy, saplings, herbs and grasses.

36 The forest was gazetted in 1955 because of its biodiversity value and water catchment area [6]. Over years after its
37 gazettement, it has been reduced in size and degraded through encroachment and mainly human activities such as trees
38 cutting, deadwood collection, hunting, poaching, trees debarking, fishing and wildfires [6]. The conservation value of
39 Magombera Forest first became known in the 1970s and received international news attention through the scientific
40 discovery of a new chameleon species in 2009, the Magombera chameleon (*Kinyongia magomberae*).

41 After a decade of consultation, planning and cooperation between the Tanzania Forest Services Agency, the Tanzania
42 Forest Conservation Group, local government, communities, the Udzungwa Forest Project (UFP) and the Kilombero
43 Sugar Company, the forest was formally declared as a Nature Forest Reserve on 11th January 2019 [8]

Comment [A4]: Why isn't the government assigning a forester & wildlife biologist to this area to work with the community to sustainably harvest this multitude of natural resources. This paper should be making such recommendations.

Comment [A5]: If the government takes a classical 'Fences & Fines' mentality thus classifying users of the forest's natural resources as poachers – then these resources will continue to be harvested clandestinely with no ability to monitor the offtake in collaboration with the rural community to assure sustainability. To save your revered wildlife, you must first Save the People and make them part of the solution instead of the problem.

44 Regardless of the ~~important~~ importance of the forest, awareness on the conservation of the forest to the local
45 communities adjacent to the forest and the knowledge on sustainable economic utilization of the forest like bee keeping
46 are inadequate. The little conservation awareness and insufficient skills in sustainable utilization of the forest has led to
47 unsustainable utilization of the forest.

48 Experience has shown that, alternative livelihood and awareness to the local communities through training and
49 community-based conservation approach can reduce the threat of the forest [9]. In addition, if the local communities are
50 empowered in the sustainable utilization of the forest like bee keeping, they will definitely provide support in the forest
51 conservation. As means of ameliorating the problems from human to the forest, there is a need to find a sustainable
52 utilization way to benefit the local communities while conserving the forest like introduced bee keeping project in
53 Magombera forest [10, 11]. The restoration of degraded areas of the Magombera forest through planting of natural tree is
54 also very crucial, and hence this study included both restoration initiatives, provision of sustainable alternative livelihood
55 and conservation education to community member adjacent to the forest. This study therefore aimed at enhancing
56 conservation of Magombera forest through creation of conservation awareness to the local communities neighboring the
57 forest, empowering them through bee keeping project and restoration initiatives to restore degraded areas of the forest.

59 2. MATERIAL AND METHODS / METHODOLOGY

60 2.1 Study area

61 This project took place at Magombera Forest Reserve by involving community members adjacent to the forest. The forest
62 lies about 6km eastwards from the Udzungwa Mountains National park. The vegetation cover is composed of natural
63 trees herbs and grasses. The forest is bordered by four villages namely Magombera, Kanyenje, Katurukila and Msolwa
64 stesheni. Seventy-five community members from the fore mentioned villages adjacent to the forest were involved in the
65 project team.

66 2.2 Methods

67 2.2.1 Assessment of the knowledge and attitude of people on conservation

68 Closed and open- ended questionnaires and direct questions and answers methods was used to assess the knowledge of
69 community members on conservation of the forest and biodiversity generally. Questions was formulated in such a way
70 that can assess community's awareness about what species are inhabiting Magombera forest, which practices destroy
71 them, why conserving them and how well to conserve them. Stratified random sampling [12] were used to select
72 participants. Fixed response questions were used to interview the selected households regarding their attitudes towards
73 conservation, causes of their dependence on forest and response towards proposed Conservation and alternatives to
74 forest resources.

Comment [A6]: Why are youth from this area not being sent off to Mweka Wildlife College and other schools to be trained in sustainable management of these forests and their natural resources?? This paper should recommend such actions.

Comment [A7]: Agreed – but given projected population growth, even alternative livelihoods in the area will likely not stop people from using the forest. Also, there is a need to get as many people out of this rural area into a middleclass urban environment. The paper needs to explain how a massive education program by the Western donors and use of foreign aid to get more Foreign Direct Investment (FDI) in Africa resulting in more transformation of Africa's natural resources in Africa with salaries based upon Purchasing Power Parity (PPP) helping to create an urban middleclass in Africa as a means of taking pressure off these rural areas. Currently, Foreign aid benefits Western economies more than African economies with 70–90% returning to the donor country through experts, consulting firms 'Beltway Bandits' and nongovernmental organizations (NGOs), and/or commodity purchase requirements. This paper needs to bring out this issue and demand changes in how the West and the rest of the World collaborate with Africa. This is brought out in the above book and also you can download from ResearchGate: DeGeorges, P.A. 2009. Conservation and development in Sub-Saharan Africa. *International Journal of Environmental Studies*, 66 (5), Oct.: 637-641 and Why reforming foreign aid is critical to the future of Africa, Africans and their wildlife – both under my name Andre DeGeorges.

75 A series of questions were presented and the respondents were asked to agree or disagree. These allow easier
76 interpretation than open-ended questions [13]. Seventy-five Participants responded to pre-prepared questions which
77 were in Swahili language.
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79 **2.2.2 Assessment of the knowledge of people on modern bee keeping**

80 Questionnaire and direct questions and answers methods was used to assess the knowledge of community members.
81 Participants responded to pre-prepared questions which were in Swahili language.

82 **2.2.3 Provision of Training**

83 The training involved 30 local communities, 5 local government leaders 20 primary school's students and 20 secondary
84 school's students. Trainers were qualified personnel from University of Dodoma (UDOM), Save Nature for Life (SANALI),
85 Tanzania Wildlife Research Institute (TAWIRI) and district forest and beekeeping officers. The training includes the
86 participatory training in class and field work in the forest. Among others included importance of forest, threats facing the
87 forest, how to conserve the forest, the benefits accrued from forest conservation, bee keeping techniques (location of
88 apiary, processing, packaging and marketing). In addition, fliers on such topics was prepared in English and local
89 language (Swahili) and posted in strategic locations in the villages with high public visit like dispensary, market, schools,
90 clubs, church, mosque, government and NGO offices.

91 **2.2.4 Habitat degradation and Restoration initiatives.**

92 To determine the level of habitat degradation, we count the number of tree cuts. Four transect each with 5000m was set
93 randomly in the forest. In each transect 5plots with size of 50m² each was set at interval of 500m apart. In each plot, the
94 number of trees cut down was determined. This helped to determine the potential of the forest for bee keeping. Through
95 this project, there was an initiative for restoring degraded area by planting trees. Trees planted in the degraded area were
96 determined by assessing the species diversity in reference site. Six hundred trees were planted in degraded areas of the
97 forest. The process of planting trees was done in cooperation of the community members.

98 99 **3. RESULTS AND DISCUSSION**

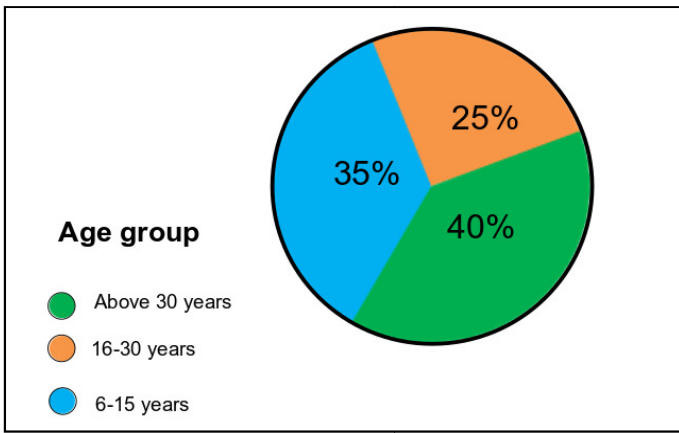
100 **3.1 Knowledge and attitude of people on conservation**

103 Seventy-five people were involved in the assessment. The dominant age in the interviewed cohorts were above 30 while
104 low response was from age group below 30 years (Fig 1). It was observed that most of the participants know how
105 valuable the forest is. About 83% of the participants agreed that the forest has positive value. For instance, participants

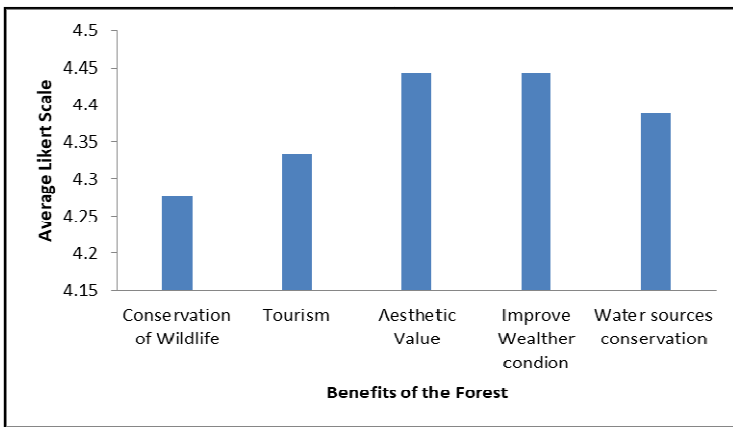
Comment [A8]: Does this include training in sustainable harvest of the different trees and other resources. If not it should be recommended for future training.

106 mentioned values of the forest such as medicinal value and aesthetic value. Likert scaling indicated that participants were
 107 knowledgeable and agreed to the benefits accrued by the forest (Fig 2). Variation on the understanding of the benefits
 108 among the participants was observed to be statistically insignificant (Friedman Test Statistic = 0.367, $P=0.98$, $df= 4$). The
 109 training enabled to raise local communities' knowledge on the values of the forest.
 110 Despite the fact that community members had some knowledge on the values of the forest, they had little knowledge on
 111 how well to conserve the forest. Moreover, their attitude towards conservation of the forest was negative. There was a
 112 positive change of local community members' attitude towards conservation (Fig 3).

Comment [A9]: Good analysis, so now its time to get youth from the area off for training and in the short-term assign personnel from the government to work with the resource users to assure sustainability.



113
 114 **Figure 1.** Percent of age group involved in the study.



115
 116 **Figure 2.** The likert scaling on the benefit of the Magombera forest. Note; Likert scaling, 1-strongly Disagree, 2-Disagree,
 117 3-don't know, 4-Agree, 5-Strongly agree.

Comment [A10]: What is meant by 'Conservation of Wildlife'. CONSERVATION implies SUSTAINABLE USE, not PRESERVATION!! The paper needs to explain what is meant by CONSERVATION as it is not clear in this paper, and if it is not helping the community sustainably manage 'THEIR' natural resources, then a big mistake has been made.

3.2 Knowledge on modern bee keeping

Seventy-five community members were participated in the bee keeping project. It was observed that 89% of participants had no knowledge on modern bee keeping. Among these, 90% were peasants and 10% were students. 70% of these peasants who had no knowledge on modern bee keeping were females and 30% were males. Only 11% had little knowledge on modern bee keeping. Among these, 74% were students and 26% were peasants. After training, it was observed that the number of participants who got the knowledge of beekeeping were high and the level of knowledge to participants also increased (Fig 3). All participants engaged in beekeeping project after the training.

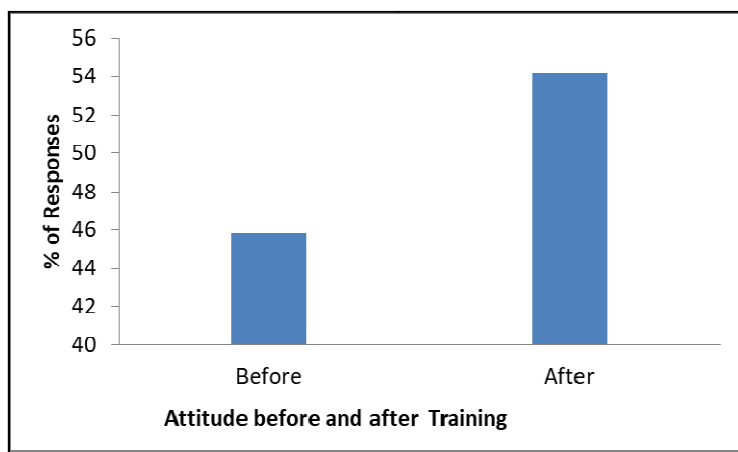


Figure 3. Attitude of people towards conservation of the forest before and after training. The percent of responses were low before training indicating negative response towards conservation and high response after training indicating positive attitude changes.

3.3 Habitat degradation and Restoration initiatives

About 87 stumps were observed, counted and identified. Dominant cutting was observed to *Calycosiphonia spathicalyx* while low cut was observed to *Tricalysia pallens* (Table 1).

Six hundred trees were planted and almost 89% of trees planted grow and proceed well only 11% of trees planted could not survive. (Fig 4). The restoration initiatives observed to be successful as far as the number of survived trees and the success of their growth is concerned.

Table 1 Number of stumps of trees observed and counted as per tree cuts. The higher the number of the stumps, the higher the level of destruction of the particular species and the higher the demand of local community member on the particular plant species.

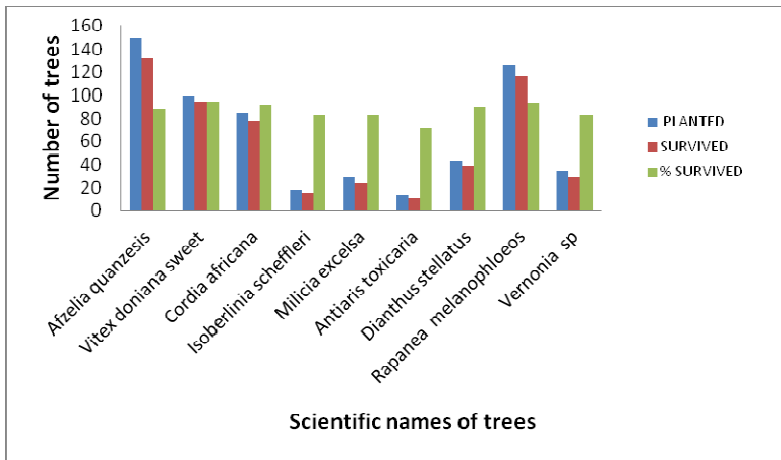
Scientific name	N0. of stumps
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Comment [A11]: What is meant by MODERN BEE KEEPING???. Does this mean bee keeping on the farm or can it also mean bee keeping in the forest as occurs sustainably across Africa. The paper needs to explain this.

Comment [A12]: Explain what is meant by Modern Bee Keeping and how this helped conserve the forest and changed people's attitudes. How as the previous means of bee keeping been destructive to the forest?? Like I stated earlier, I have seen sustainable bee keeping and thus honey collection across Africa. I have also seen local honey collectors follow the Honey Guide (*Indicator* spp.) to bee hives in the wild (See <https://www.npr.org/sections/thesalt/2016/07/21/486471339/how-wild-birds-team-up-with-humans-to-guide-them-to-honey>). There is no reason this can't be undertaken in a sustainable manner.

Comment [A13]: Is there enough knowledge by species of tree to know how many years from planting/natural seeding to potential for harvesting in a sustainable fashion. If this knowledge exists, it needs to be brought out in this paper. A case study in the above-mentioned book DeGeorges, P.A. & Reilly, B.K. 2008. *A critical evaluation of conservation and development in Sub-Saharan Africa: Last Chance Africa*. The Edwin Mellen Press, Lewiston, New York. 7 books, 3,572p can be found in 9.8.9.2 *Communal natural forest management, Guesselbodi, Niger* and 9.8.9.3 *Community-based natural forest management, Gestion des Terroirs, Burkina Faso*. These kinds of examples should be brought out in this paper as examples of how this forest can be sustainably managed.

<i>Calycosiphonia spathicalyx</i>	28
<i>Erythrophleum suaveolens</i>	17
<i>Isoberlinia scheffleri</i>	15
<i>Mallotus oppositifolius</i>	6
<i>Dalbergia melanoxylion</i>	5
<i>Bombax rhodognaphalon</i>	4
<i>Diospyros ferrea</i>	4
<i>Milicia excelsa</i>	3
<i>Cola microcarpa</i>	2
<i>Pachystela brevipes</i>	1
<i>Tabernaemontana pachysiphon</i>	1
<i>Tricalysia pallens</i>	1
Total	87



139 **Figure 4.** Species and number of trees planted for restoration initiatives and their observed survival rates.

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142 **4. DISCUSSION**

143 **4.1 Knowledge and attitude of people on conservation**

144 Contrary to the assumptions of many conservationists that rural populations are almost entirely antagonistic to
145 conservation and ignorant of conservation issues [13], in this study the concept of conserving forests was well supported.
146 Don't know' responses would have been because of communities that are impoverished and do not have the leeway to
147 support the conservation practice even if they support the concept. As [14] pin point the real values of conservation i.e.
148 water, soil and environmental buffering are appreciated but often elicit a "not in my backyard" response, which in the
149 context to this study indicates not "at the expense of my livelihood". It has been shown that, raising awareness about
150 conservation to the local communities surrounding the forest through participatory training and providing alternative way of
151 livelihood reduces the threats to the forest [9, 10, 11]. When the local communities are empowered in the sustainable
152 utilization of the forest such as bee keeping, they are able to provide support in the forest conservation [6, 15] argued that
153 the provision of alternative protein and income-generating sources is one of the best strategies at the community level to
154 reduce wild meat consumption and trade while aiming to improve local livelihoods.

155 **4.2 Knowledge on modern bee keeping**

156 Most people had no knowledge about modern beekeeping. Very few people were practicing traditional beekeeping which
157 is not environmentally friendly and less profitable. For example, they used methods that resulted in ecological
158 degradation (e.g., felling trees). Introduction of modern beekeeping as the alternative livelihood to local community
159 surrounding Magombera forest save as a means of ameliorating the environmental and livelihood problems. Alternatives
160 should always be locally relevant, and market analyses should be conducted for alternative income generating activities
161 [16], 21]. It's the good idea to choose livelihood activities that had already been used to some extent in the project region.

162 Encouragingly, most case-study projects had chosen alternative livelihoods that were pre-existing in communities, this
163 increase the likelihood of uptake and success of the project. A good example of the importance of choosing locally-
164 relevant activities was provided by the relative success of the DABAC project in Cameroon, and the other cane-rat rearing
165 projects in West Africa [17, 22]. The reason that why it worked very well in Cameroon, is because they are already
166 livestock rearers. They know already about chickens and rabbits, and in this respect the cane rat is just a small
167 modification on something that already exists. In comparison, cane rat rearing was unsuccessful in other Central African
168 countries where participants did not have a history of livestock rearing, Gabon wasn't a very favorable environment for
169 (cane rat farming), in the sense that the Gabonese are not naturally livestock rearers, and even less rearers of wildlife. So
170 already it is not an obvious autonomous economic activity for the Gabonese. The same applies to Magombera village
171 community members; they had the knowledge of traditional bee keeping before the introduction of the modern bee
172 keeping. This facilitate the success of this modern bee keeping project in their village.

173 **4.3 Habitat destruction and Restoration Initiatives**

174 The habitat degradation observed to affect the Magombera forest. Much of this destruction is attributed to anthropogenic
175 activities such as tree cuts and farm extension. It is self-evident that populations and species will suffer when their habitat
176 becomes degraded or is lost completely [18,19, 20]. In this context, the destroyed habitats need to be restored to rescue
177 the species with time. To make the initiative meaningful and successful, the involvement of local community members is
178 very important. This makes people to have the sense of ownership to the forest and the project. In this project,
179 involvement of local communities in restoration initiatives was found to be good and restoration initiative was successful.
180 However, some plant species did not grow well. This could be due to biotic and abiotic factors. Seedling establishment
181 can be limited by several factors. High seed predation and low germination rates in some species, competition with
182 pasture grasses, stressful microclimatic conditions, lack of soil nutrients, reduced mycorrhizal inoculum, and herbivory
183 affect seedlings establishment [21] A number of other studies have also demonstrated that some native species show
184 growth rates in disturbed areas similar to those of more commonly used exotic species [20]; this might also be the same
185 case to the well grown species in this project.

186 **4. CONCLUSION**

187 Conservation education and sensitization on the importance of biodiversity should be provided to the communities living
188 nearby the protected area so that they can participate positively in protecting and conserving the area. Involvement of
189 public (Community-based biodiversity conservation approach) in managing the protected area could be the best option
190 because people will have the sense of ownership to the protected areas and be ready to protect biodiversity and provide
191 information concerning poachers and other threats which may destroy biodiversity. This can only happen if people are
192 aware and are involved. Additionally, alternative ways of livelihood relevant to a particular community should be taught to
193 the community so as to reduce their dependence on the forest for their livelihood.
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195 **COMPETING INTERESTS**

196 The authors declare that they have no competing interests
197

198 **CONSENT (WHERE EVER APPLICABLE)**

199 Not applicable.
200

201 **ETHICAL APPROVAL (WHERE EVER APPLICABLE)**

202 Not applicable.
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Comment [A14]: Farm extension will continue unless you can establish a program to maximize the sustainable harvest of a number of natural resources – not just bee-keeping, that makes the forest more valuable to the local community than having it converted to agricultural land, while mining the natural resources for short-term gain.

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