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**CONSERVATION EDUCATION, ALTERNATIVE LIVELIHOOD AND HABITAT  
RESTORATION: THE BEST STRATEGIES FOR CONSERVATION OF  
MAGOMBERA FOREST RESERVE.**

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**ABSTRACT**

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 improved 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 .

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

## 1. INTRODUCTION

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

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

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

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

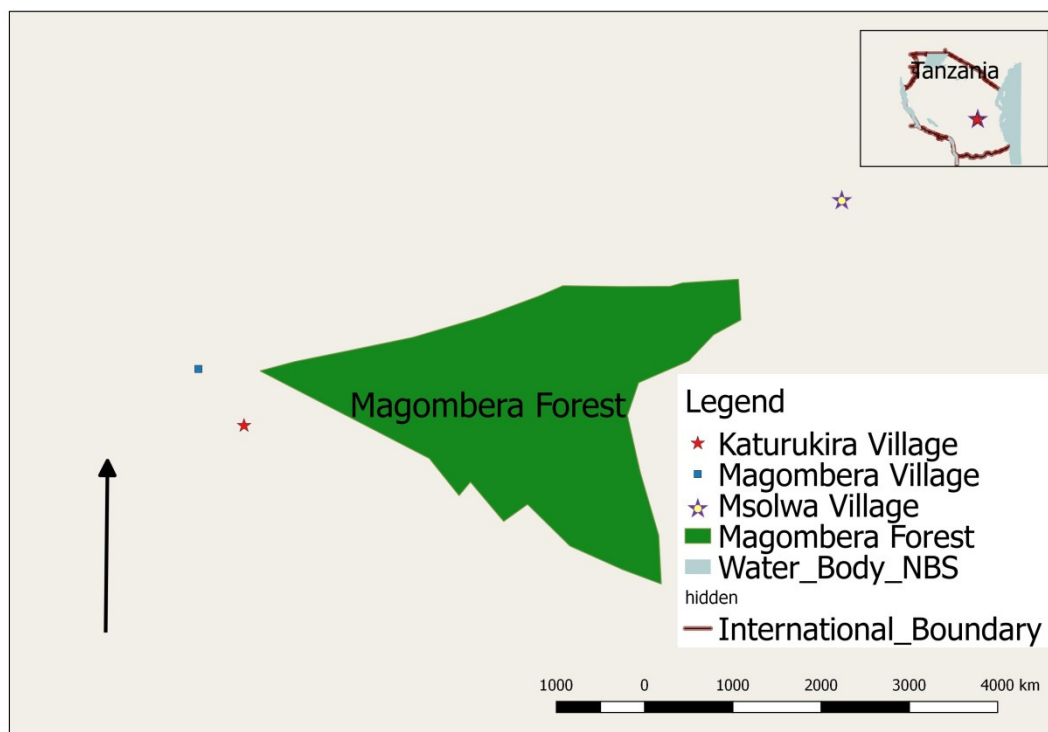
44 Regardless of the important of the forest, awareness on the conservation of the forest to the local communities adjacent to  
45 the forest and the knowledge on sustainable economic utilization of the forest like bee keeping are inadequate. The little  
46 conservation awareness and insufficient skills in sustainable utilization of the forest has led to unsustainable utilization of  
47 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 **resources**, 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** [10, 11]. The **deforestation threats on the forest**  
53 **comes from cutting trees for various uses example building poles, timber, charcoal making, fire wood and among others**  
54 **and incidences of wildfires that destroys the forest vegetation and change the ecology as well. Therefore** restoration of  
55 degraded areas of the Magombera forest through planting of natural **trees** is also very crucial **especially to the areas that**  
56 **have been affected by tree cutting**, and hence this study included both restoration initiatives, provision of sustainable  
57 alternative livelihood and conservation education to community member adjacent to the forest. This study therefore aimed  
58 at enhancing conservation of Magombera forest through creation of conservation awareness to the local communities  
59 neighboring the forest, empowering them through bee keeping project and restoration initiatives to restore degraded areas  
60 of the forest.

## 62 **2. MATERIALS AND METHODS**

### 63 **2.1 Study area**

64 This project took place at Magombera Forest Reserve by involving community members adjacent to the forest. The forest  
65 lies about 6km eastwards from the Udzungwa Mountains National park, **in Kilombero District, Morogoro Region**  
66 **Tanzania (Figure 1)**. Magombera composed of a moist forest, swamp forest, dry woodland and grassland. Some of  
67 **the tree species are Luke's Cynometra tree (*Cynometra lukei*), Large-leaved Memecylon tree (*Memecylon sp*) and**  
68 **Heinsen's Isolona tree (*Isolona heinsenii*) all of these are endangered. Big mammals such as Elephants, Buffaloes,**  
69 **Hippopotamus, Duikers and Primates are found in the forest. The climate is of high humidity, annual rainfall reaches**  
70 **1500mm and average temperature reach 32°C.**The forest is bordered by four villages namely Magombera, Kanyenje,  
71 Katurukila and Msolwa stesheni. Seventy-five community members from the mentioned villages adjacent to the forest  
72 were involved in the project team. **Selection of participants was done purposely for government leaders, villagers who had**  
73 **been involved in some bee keeping activities and students from primary and secondary schools adjacent to the forest.**



**Figure 1.** Map showing the Magombera Forest and neighbouring villages ( source Ngongolo *et al.*, 2019)

## 2.2 Methods

### 2.2.1 Assessment of the knowledge and attitude of people on conservation and improved bee keeping

A list of local communities engaged in some bee keeping from each village adjacent to the forest was provided by local government leaders. The lists was entered in the excel regardless of gender, education level, sex and age. Simple random selection was performed to obtain the required number for study in which each village participated.

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

A series of questions were presented and the respondents were asked to agree or disagree. These allow easier interpretation than open-ended questions [13]. Seventy five Participants responded to pre-prepared questions . For knowledge on improved bee keeping, questionnaire and closed ended questions were used to assess the knowledge of

94 community members. Participants responded to prepared questions which were in Swahili language to ease  
95 understanding. Likert scaling was used to assess the different levels of agreements from respondents where 1=strongly  
96 Disagree, 2=Disagree, 3=don't know, 4=Agree and 5=Strongly agree. Friedman Test Statistic was used to test the  
97 variation on the understanding of the benefits among the respondents. The variables assessed were knowledge and  
98 attitude on conservation and knowledge on beekeeping.

### 99 **2.2.2 Provision of Training**

100 The training involved 30 local communities, 5 local government leaders, 20 primary school pupils and 20 secondary  
101 school students. Trainers were qualified personnel from University of Dodoma (UDOM), Save Nature for Life (SANALI),  
102 Tanzania Wildlife Research Institute (TAWIRI) and district forest and beekeeping officers. The training was participatory  
103 including in class session and field work in the forest. Among others, the training included importance of forest, threats  
104 facing the forest, how to conserve the forest, the benefits accrued from forest conservation, bee keeping techniques  
105 (location of apiary, processing, packaging and marketing). In addition, fliers on such topics were prepared in English and  
106 local language (Swahili) and posted in strategic locations in the villages with high public visit like dispensary, market,  
107 schools, clubs, church, mosque, government and NGO offices. The evaluation of effect of training was undertaken that  
108 involved asking the same set of questions before and after training.

### 110 **2.2.3 Tree planting**

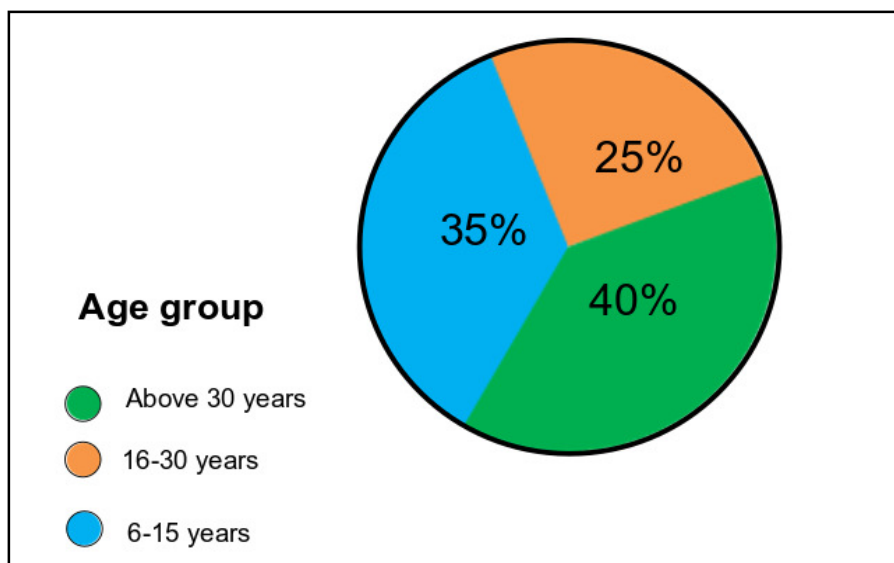
111 Seedlings were planted as part of the practical training where after ten months the survey was undertaken to determine  
112 the number of trees that have survived. Before planting of trees, the number of stumps were counted to determine the  
113 number of tree cuts. Four transect each with 5000m was set randomly in the forest. In each transect 5 plots with the size  
114 of 50m<sup>2</sup> was set at interval of 500m apart. Then the number of stumps per each plot was counted. Trees planted was  
115 determined by assessing the species in reference site. Six hundred seedlings were planted in the forest. The process of  
116 planting trees was done in cooperation with the community members.

## 117 **3. RESULTS AND DISCUSSION**

### 118 **3.1 Knowledge and attitude of people on conservation**

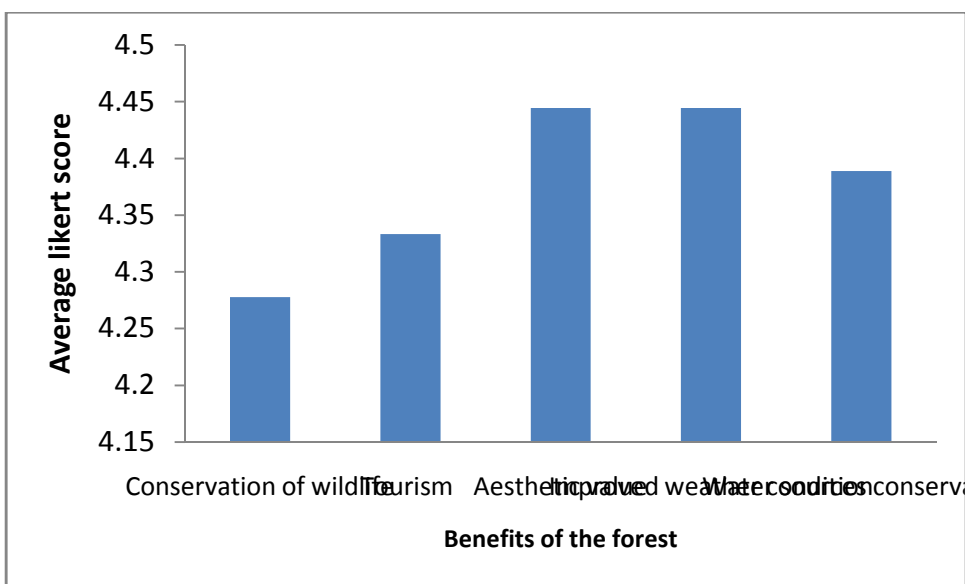
119 Seventy-five people were involved in the assessment. The dominant age in the interviewed cohorts were above 30 while  
120 low response was from age group below 30 years (Fig 1). It was observed that most of the participants know how  
121 valuable the forest is. About 83% of the participants agreed that the forest has positive value. For instance, participants  
122 mentioned values of the forest such as medicinal value and aesthetic value. Likert scaling indicated that participants were  
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126 knowledgeable and agreed to the benefits accrued by the forest (Fig 2). Variation on the understanding of the benefits  
127 among the participants was observed to be statistically insignificant (Friedman Test Statistic = 0.367,  $P=0.98$ ,  $df= 4$ ). The  
128 training enabled to raise local communities' knowledge on the values of the forest.  
129 Despite the fact that community members had some knowledge on the values of the forest, they had little knowledge on  
130 how well to conserve the forest. Moreover, their attitude towards conservation of the forest was negative. There was a  
131 positive change of local community members' attitude towards conservation (Fig 3).



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133 **Figure 1.** Percent of age groups involved in the study.



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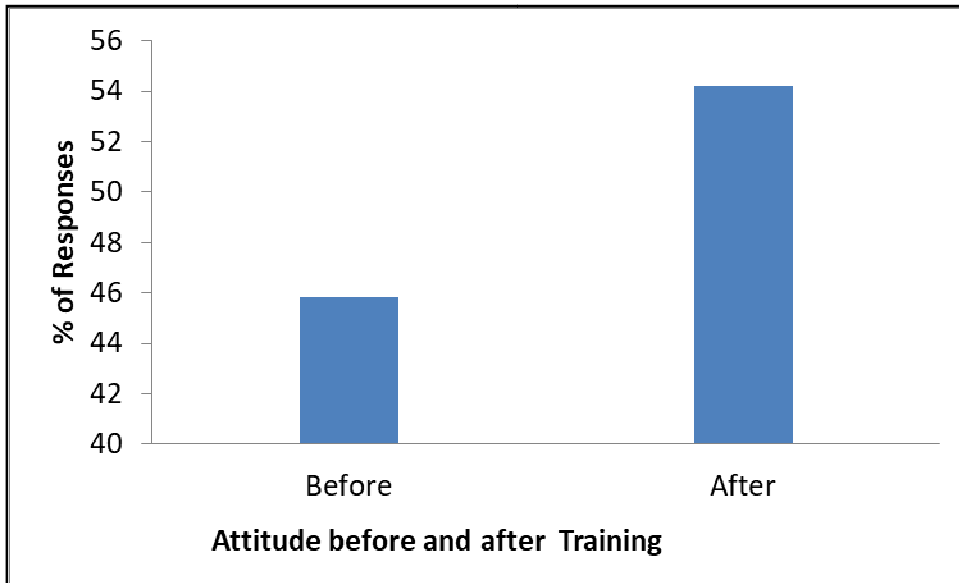
135 **Figure 2.** The likert scaling on the benefit of the Magombera forest. Where by 1-strongly Disagree, 2-Disagree, 3-don't  
136 know, 4-Agree, 5-Strongly agree

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### 3.2 Knowledge on improved bee keeping

Seventy-five community members were participated in the bee keeping project. It was observed that 89% of participants had no knowledge on improved bee keeping. Among these, 90% were peasants and 10% were students. 70% of these peasants who had no knowledge on improved bee keeping were females and 30% were males. Only 11% had little knowledge on improved 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 was 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).

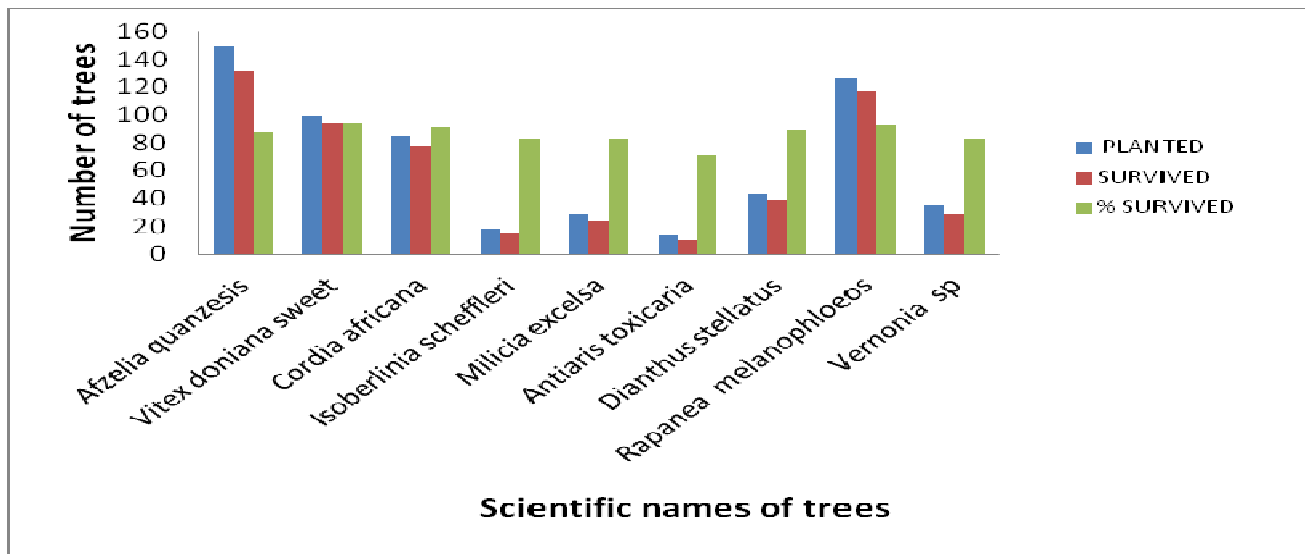
Six hundred trees were planted and almost 89% of trees planted grow and proceed well only 11% of trees planted could not survive. (Fig 4). The restoration initiatives observed to be successful as far as the number of survived trees and the success of their growth is concerned.

**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	No. of stumps
<i>Calycosiphonia spathicalyx</i>	28
<i>Erythrophleum suaveolens</i>	17
<i>Isoberlinia scheffleri</i>	15
<i>Mallotus oppositifolius</i>	6
<i>Dalbergia melanoxylon</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
<b>Total</b>	<b>87</b>

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**Figure 4.** Species and number of seedlings planted and their observed survival rates.

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## 4. DISCUSSION

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### 4.1 Knowledge and attitude of people on conservation

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Contrary to the assumptions of many conservationists that rural populations are almost entirely antagonistic to conservation and ignorant of conservation issues [13], in this study the concept of conserving forests was well supported.

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'Don't know' responses would have been because of communities that are impoverished and do not have the leeway to support the conservation practice even if they support the concept. As [14] pin point the real values of conservation i.e.

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172 water, soil and environmental buffering are appreciated but often elicit a "not in my backyard" response, which in the  
173 context to this study indicates not "at the expense of my livelihood". It has been shown that, raising awareness about  
174 conservation to the local communities surrounding the forest through participatory training and providing alternative way of  
175 livelihood reduces the threats to the forest [9, 10, 11]. When the local communities are empowered in the sustainable  
176 utilization of the forest such as bee keeping, they are able to provide support in the forest conservation [6, 15] argued that  
177 the provision of alternative protein and income-generating sources is one of the best strategies at the community level to  
178 reduce wild meat consumption and trade while aiming to improve local livelihoods.

#### 179 **4.2 Knowledge on improved bee keeping**

180 Most people had no knowledge about improved beekeeping. Very few people were practicing traditional beekeeping  
181 which is not environmentally friendly and less profitable. For example, they used methods that resulted in ecological  
182 degradation (e.g., falling trees). Introduction of improved beekeeping as the alternative livelihood to local community  
183 surrounding Magombera forest save as a means of ameliorating the environmental and livelihood problems. Alternatives  
184 should always be locally relevant, and market analyses should be conducted for alternative income generating activities  
185 [16], 21]. It's the good idea to choose livelihood activities that had already been used to some extent in the project region.

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

#### 197 **4.3 Habitat destruction and Tree planting**

198 The habitat degradation observed to affect the Magombera forest. Much of this destruction is attributed to anthropogenic  
199 activities such as tree cuts and farm extension. It is self-evident that populations and species will suffer when their habitat  
200 becomes degraded or is lost completely [18,19, 20]. In this context, the destroyed habitats need to be restored to rescue  
201 the species with time. To make the initiative meaningful and successful, the involvement of local community members is  
202 very important. This makes people to have the sense of ownership to the forest and the project. In this project,

203 involvement of local communities in planting of trees was found to be good. However, some plant species did not grow  
204 well. This could be due to biotic and abiotic factors. Seedling establishment can be limited by several factors. High seed  
205 predation and low germination rates in some species, competition with pasture grasses, stressful microclimatic conditions,  
206 lack of soil nutrients, reduced mycorrhizal inoculum, and herbivory affect seedlings establishment [21] A number of other  
207 studies have also demonstrated that some native species show growth rates in disturbed areas similar to those of more  
208 commonly used exotic species [20]; this might also be the same case to the well grown species in this project.

#### 209 **4. CONCLUSION**

210 Conservation education and sensitization on the importance of biodiversity should be provided to the communities living  
211 adjacent to the protected area so that they can participate positively in protecting and conserving the area. Involvement of  
212 public (Community-based biodiversity conservation approach) in managing the protected area could be the best option  
213 because people will have the sense of ownership to the protected areas and be ready to protect biodiversity and provide  
214 information concerning poachers and other threats which may destroy biodiversity. This can only happen if people are  
215 aware and involved. Additionally, alternative ways of livelihood relevant to a particular community should be taught to the  
216 community so as to reduce their dependence on the forest for their livelihood.  
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#### 218 219 220 **COMPETING INTERESTS**

221 The authors declare that they have no competing interests  
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#### 223 224 **CONSENT (WHERE EVER APPLICABLE)**

225 Not applicable.  
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#### 227 228 **ETHICAL APPROVAL (WHERE EVER APPLICABLE)**

229 Not applicable.  
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