Title: Integrated community conservation of biodiversity in agro-ecosystems adjacent to the eastern side of Mount Kenya Forest.

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INTRODUCTION

One third of the world's land area is used for food production and agricultural-ecosystems can be found in almost every part of the world. As such, Agricultural ecosystems harbor a large portion of biodiversity. However, conservation of biodiversity in the world as prioritized other ecosystems such as forests relegating agro-ecosystems to the bottom. Nonetheless, it is widely known that agro-ecosystems plays a crucial role in biodiversity conservation since they offer food, shelter and are key stepping stones for migrating species thus linking fragmented landscapes. Therefore, there are huge benefits from conserving biodiversity thriving in agro-ecosystems.

In Kenya numerous biodiversity studies have been carried out in the forests, lakes and national parks but very few have been carried out within agro-ecosystems although it is an established fact that biodiversity plays a crucial role in agricultural production. Among the key biodiversity services for agriculture are pollination and seed dispersal. Pollination is especially crucial for leguminous plants whereas seed dispersal is important for regeneration of woodlands within agro-ecosystems. Thus conservation of agro-ecosystems biodiversity is extremely important. However, conservation of biodiversity in agro-ecosystem is impossible without involving all the stakeholders. Thus it is imperative to mobilize and build the capacity of local communities in order to achieve this goal. Ultimately this would have a wide spread impact such as on conservation of biodiversity on its own right, tourism, environmental conservation and rural livelihoods improvement. Since the early 1990s the eastern slopes of Mount Kenya have undergone a tremendous change. Population increase and reduction of income from coffee led to overdependence on tea and continuous tillage up to riverbanks for food crops. Clear cutting of trees and natural vegetation followed leading to drying up of some streams.

Rationale

The agro-ecosystems east of Mt. Kenya forest have lost their natural vegetation due to cash and food crops being grown up to the river banks. These together with climate change have resulted in drying up of some streams, soil erosion and landslides (Fig. 1i-iii). Results from First RSG have shown that indeed biodiversity is at risk with low populations of indicator species such as birds and pollinators with stingless bees missing. Beekeepers in the region use the traditional log

hives which have low honey production and encourages cutting of trees. Thus we initiated: tree planting programme, monitoring of indicator species, introduction of modern beehives and revived a local community group as a pillar for capacity building. The current plan is to build on these initial successes through; planting more indigenous and multipurpose trees, motivate more members to adopt modern bee hives through a cost sharing scheme, expand our capacity building topics to include strategies to cope with climate change, continue with indicator species monitoring and initiate sampling of drought resistant crops with a view to encouraging the community to plant them.

Objectives

The main objective of this project was to promote conservation in agro-ecosystem while improving livelihoods through eco-friendly farming.

Specific objectives

i. To document key indicator species
ii. To educate the local community about conservation in agro ecosystems
iii. To collect data and to improve bee keeping practices among the local farmers
iv. To initiate tree nurseries for tree planting purposes (indigenous and multipurpose trees)
v. To collect data on indigenous and drought resistant crops farming in the region

Figure 3: (i) Bare road sides, (ii) clear-cut woodlands and (iii) diminishing rivers

KEY ACTIVITIES UNDERTAKEN AND METHODOLOGY

Documentation of key indicator species

Conservation of biodiversity is normally easier if the species to be conserved and the role they play in an ecosystem is known. However, it has long been realized that there are certain key species the "indicator species" that if found in good numbers in an area then it can be inferred that that habitat is in a good state. Such species include pollinators and seed dispersal agents. During RSG1 we sampled bees, butterflies and birds to infer on the status of biodiversity in our project area. Vegetation surveys were carried out and common trees species were identified and classified according to abundance. To establish species present and abundance in the project area, transect counts were adopted and sweep nets were use to capture bee and butterfly species in three habitats. Transects measured 1km in length and bees were captured two (2) meters on either side of the transects using sweep nets. Species were identified in the field and released, however, those hard to identify were collected in killing jars for later identification by bee taxonomists. Birds were counted on the same transects used for bees and butterflies. A pair of 10x50 binoculars was used. Birds were counted 30metres on either side of the transect. Later the area sampled was calculated and converted into hectares and the findings reported as birds per hectare. Flowering plants that pollinators were foraging on were recorded.

The project area was divided into three sites depending on the dominant vegetation and altitude as follows;

1. Tea dominated – this lies adjacent to Mt Kenya Forest boundary and the main cash crops here is tea. Common trees starting with most abundant include; Grevillea *robusta, Eucalyptus species*, *Musa species, Mangifera indica, Vitex keniensis* and Wattle trees (Fig. 2 i).
2. Tea and coffee dominated- this lies between the tea and coffee zone and as the name suggests tea and coffee co-dominate. Common trees starting with most abundant include; *Grevillea robusta*, *Musa species, Eucalyptus species*, *Cordia Africana,* Avocado species, *Bridelia micrantha*, *Harungana madagascarensis*, Macadamia species., and *Guajava japonicum* (Fig 2ii).
3. Coffee dominated – this is the lowest point and lies furthest from the forest edge and is dominated by coffee as a cash crop. Some of the common trees starting with most

abundant include*; Grevillea robusta, Mangifera indica, Sapium allipticum, Eucalyptus species., Guajava japonicum, Spathodea campanulata, Prunus africana* and *Cordia africana* (Figure 2iii).

Site 1 which lies adjacent to Mt. Kenya Forest boundary is the coldest of the 3 sites, while site 3, is the warmest and lies furthest from Mt. Kenya forest. Site 2 lies between site 1 and 3.

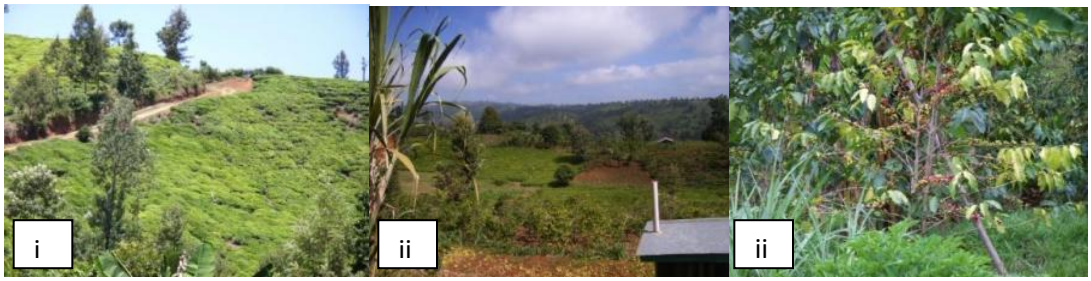

Figure 4: (i) Site 1-Tea dominated, (ii) Site 2-Coffee and tea dominated, and (iii) Site 3-Coffee dominated

During RSG2, we did further surveys of indicator species in different habitats .Some members of the community were trained on sampling and identification of indicator species. In addition a thorough search for stingless bees was carried out.

Environmental education

Community members (groups) responsible for training the rest of the community were trained on all aspects of this project. The project team and the trained groups worked together to create awareness on environment and climate change.

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Community bee keeping

Homesteads were selected randomly within the project area. Thirty five farmers were interviewed with the aid of a questionnaire on bee keeping practices among the local community. Both male and female farmers were interviewed with the youngest farmer being 30 years and the oldest 85 years. The farmers included those who have not been to school and those who have attended various levels of education (Appendix 3a).

We Modern bee hives were issued at a subsidized price to community members. Subsidizing rather than giving ensured members were more responsible for the hives.

Tree nurseries

More tree nurseries were established in cooperation with community members. Priority was given to multipurpose trees and plants that were found to be important during species documentation in RSG1.

Sampling of indigenous and drought resistant crops and trees

Homesteads were selected randomly within the project area. Thirty five farmers were interviewed with the aid of a questionnaire on indigenous trees and crops farming. Both male and female farmers were interviewed with the youngest farmer being 30 years and the oldest 85 years. The farmers included those who have not been to school and those who have attended various levels of education (Appendix 3a).

OUTCOME

Butterflies

From RSG1, sites 1 and 3 had few species of both butterflies and bees whereas site 2 had the highest number of species. In sites 1 and 3, only honey bees (*Apis mellifera*) were recorded, whereas in site 2 honey bees, carpenter bees and solitary bees were recorded. The same trend was established for butterflies with site 2 harboring the following genera; *Junonia*, *Bicyclus* and *Acraea,* whereas only *Junonia* was recorded in site 1 and *Acraea* in site 3. No stingless bees were recorded though incidences of stingless bees being found by traditional beekeepers from the region had been reported.

During RSG2, a total of 45 butterfly species were recorded in the three sites. The highest number was recorded in site 2 (coffee tea dominated) with 32 species, followed by site 1 (tea dominated) with 19 species and lastly site 3 (coffee dominated) with 17 species (Figure 3). Sixteen species occurred only in site 2, eight species only in site 1 and three species only in site 3 (Appendix 1a, b and c). There were three species: *Acraea cabira*, *Cacyreus virilis* and *Junonia terea elgiva,* which occurred in both site 1 and site 2, six species which occurred in both site 2 and site 3, and eight species which occurred in all the three sites (Appendix ld, e and f). This is an indication that some species are habitat specific while others require a habitat matrix to survive.

Therefore for species that preferred specific habitats, they are highly affected by habitat disturbance or clearance, while those that survive in diverse habitats would be less affected. Although, if the larvae food plants and the adult nectar sources occur across different habitat types, they would also be affected, hence the need to conserve different habitats as compared to the monoculture practiced today (tea only or coffee only) with no other types of vegetation. A life fence of multipurpose trees in this case would help to diversify the habitats and to provide a continuous corridor of suitable habitats between farms and from forests to lowlands. The habitats would be further enriched when each farmer plant several plants in their farms. A small portion of the farm planted with fruit trees like mangoes (*Mangifera sp.)* macadamia, guava (*Psidium guajava),* luquats, bananas, would not only provide food and fuel wood but also provide nesting and feeding grounds for beneficial insects like bees and butterflies.

During the month of May, we observed a mixed butterfly migrations involving three genera *Sallya*, *Junonia*, and *Bicyclus*. The butterflies flew from the warmer, coffee dominated sites (site

3) towards the cooler tea dominated areas (Site 1) and into the forest. These butterfly genera seemed to favor *Sapium ellipticum* trees as a food source for their larvae and had left many of these trees defoliated to the disappointment of farmers who use them as food for their cattle. The month of May fall within the long rainy season in Kenya (March-May) and there is increased foliage in the farmlands. During this time, the farmlands are warmer than inside forests, where it's normally cold and dump. Its therefore possible that the butterflies come out to the agro-ecosystems during the long rains to lay eggs as its warmer and there is increased foliage for larvae, but towards the end of the rainy season, (May), when it get hot and dry in the farmlands, the new generation of butterflies fly back to the forest.

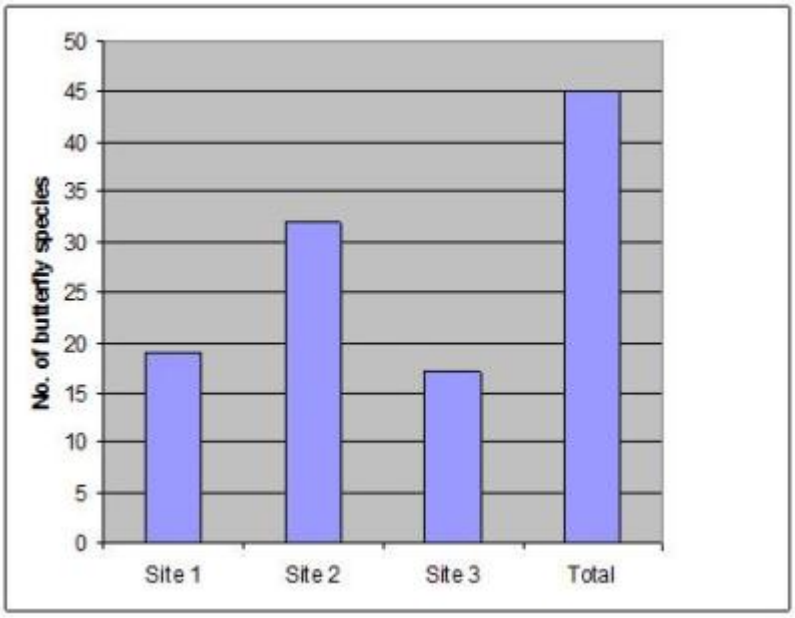

Figure 3. A bar graph showing the number of butterfly species recorded in Site 1 (Tea dominated site), Site 2 (Coffee and tea dominated), Site 3 (Coffee dominated) and the total number of butterflies recorded in all three sites (total)

Bees

We never recorded any stingless bees in the study transects. However we acquired two colonies of *Hypotrigona* and *Plebeina* (Figure 4) from loggers who do selective logging in farmlands for timber and fuel woods. The bees were in a tree log that had been cut outside of our study area, but neighboring site 3 (the warmer coffee dominated site). The colonies have established well, especially for *Plebeina* which has increased in size (according to the frequency and number of foragers seen on the entrance tube bringing nectar and resins). We are experimenting with this colony in the area of multiplying the colonies. We have introduced an empty box hive, smeared with resins and wax next to the tree log, and hope that as the colony increases in size, it will split and one colony might enter the box hive. If this fails to happen, we intend to split the log hive and actively manage the colony.

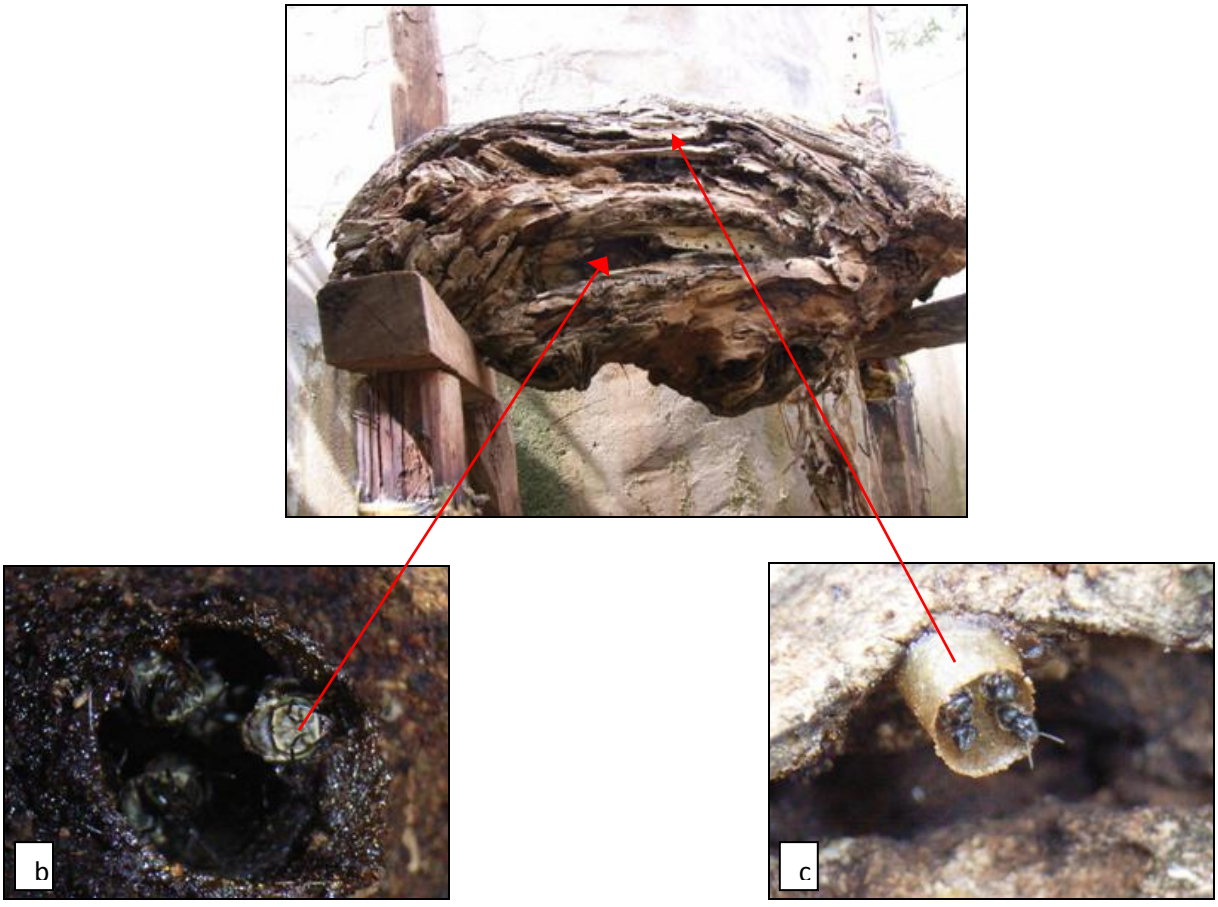

Figure 4: (a) A tree log inhabited by (b) *Plebeina* and (c) *Hypotrigona* genera of stingless bees which are currently undergoing domestication trials.

Birds

A total of 54 bird species were recorded in the three sites (Appendix 2a, b and c). The highest species number was recorded in Site 2 (coffee and tea dominated), followed by Site 1 (tea dominated), and lastly Site 3 (coffee dominated) (Figure 5). Site 2 is an intermediate between the two other sites and has a higher occurrence of plant species than the other two sites and this is the main reason for the higher species number.

Figure 5. A bar graph showing the number of bird species recorded in Site 1 (Tea dominated), Site 2 (Coffee and tea dominated), Site 3 (Coffee dominated) and the total number of birds recorded in all the three sites.

Tree nurseries

More tree nurseries (Figure 6) with emphasis on indigenous and multipurpose trees were established. Many farmers preferred trees like *Cordia*, *Markhamia*, *Croton* and *Prunus*, as they do not destroy soil fertility. Multipurpose trees like Luquats, *Psidium guajava*, Black currants, and Avocado trees, were also preferred as they provide fruits, fuel wood and building poles. Besides Weru Self Help Group (with 5000 trees in their nursery) that we worked with in RSG1, two new groups: Mwitethie Kiroone Women Group (with 4000 seedlings in nursery) and Gichera Enviromental Program-GEP (With 3000 seedlings in their nursery) joined us. We have managed to plant trees with GEP in public areas (Church compounds, Local Primary school compounds and Chiefs Camps). During the tree planting campaigns we explained to the local

communities the essence of planting trees and the effects of clearing trees from their farms on soil fertility, erosion and climate change. The three CBOs (Weru Self Help Group (WeSeHG), Mwitethie Kiroone Women Group, and Gichera Environmental Program (GEP) continued tendering seedlings in their nurseries (GEP 10, 000 trees, WeSeHG and Mwitethie Kiroone Women Groups had 8,000 seedlings each which were planted during the long rains (March-June). Tending seedlings involved watering and addition of manure to ensure seedlings survived during the dry season. We therefore assisted the three CBOs to employ a nursery attendant to water the seedlings during the dry period. During the long rains, local farmers bought the trees at low cost, which they have planted in their farms. This was very encouraging especially for GEP which sold all the 10,000 seedlings at a cost of one Kenyan shilling per seedling. The money was used to buy hives by the members of the group.

Figure 6: Gichera Environmental Programme (GEP) tree seedling nursery

Bee Keeping

The local farmers received the hybrid hives with enthusiasm (Figure 7) and over 30 hybrid hives were issued to the local communities, with 20 hives already occupied by bees. Our plan of cost sharing with farmers was not very successful, as only Gichera Environmental Group was able to buy hives. Due to the difficult economical times facing farmers, (owing to unreliable rainfall, resulting in poor harvests from both food and cash crops) most could not afford to buy hives.

Instead, we decided to issue hives free of charge but on condition that the farmers leave a portion of their land uncultivated and plant trees there. This is a win win situation as farmers will get honey to supplement their livelihood while bees and other pollinators benefit from their habitats being conserved. In addition to issuing hives and as an incentive we have given each CBO protective gears (bee suit, gloves, and smokers) (Figure 8). To ensure proper honey harvesting and less damage to the bee colonies, we trained farmers on proper honey harvesting.

Figure 7: A farmer inspecting his new bee hives, immediately after hanging

Figure 8: A beekeeper being shown how to wear his new bee suit

Indigenous, hardy and drought resistant trees and crops

We collected data on local knowledge and production of indigenous crops and trees among the local communities. At least 20 food and vegetable crops were planted by the farmers interviewed (Appendix 3b). They considered them to be more tolerant to high temperatures and low rainfall. As the crops are less affected by weather, they served as a fall back during harsh environmental conditions when other crops like maize and modern varieties of beans, potatoes and cabbages failed. Unfortunately, these crops are grown at a very small scale and there is little to no management. The problems with the crops that the farmers cited were that the indigenous crops were being attacked by pests and diseases more than before due to habitats simplification. They also reported that the market value of indigenous crops had gone down. Our observations in the field indicated that many indigenous crops have been replaced by modern crops. For instance wild tomatoes have been phased out by modern tomato varieties, indigenous mangoes are being replaced by modern mango varieties.

Farmers also planted trees they considered indigenous, hardwoods or resistant to harsh conditions (Appendix 3 c). The trees were multipurpose, serving as sources of timber, poles, fuel wood, and fodder for cattle and fruits for both humans and animals. One thing they were all unanimous was that these trees did not reduce soil fertility in the areas they were planted as they were deep rooted and that their leaves and fruits rotted easily adding to soil fertility. During adverse weather conditions, food crops did well under the shade of these trees. The major problem with many of these trees was that they took so long to grow and mature. With increased human population many trees have been cut for timber and charcoal burning as a means of income generation. However, the benefits derived from these trees encourage farmers to plant them and wait patiently for them to grow to maturity.

This is a milestone in conservation as these crops and trees contribute to habitat diversity, hence providing several resources ranging from food, shelter to nesting places for organisms found in these areas. Monocultures of only tea, coffee or any other crop, reduces habitat diversity.

CONCLUSION

During RSG1 we came up with the baseline data on key biodiversity indicators in an agro-ecosystem adjacent to a world heritage site (Mt Kenya Forest). In RSG2, we continued to accumulate data on Key biodiversity indicators which is important not only for knowing the current status but also for future comparisons. We established that some indicator species prefer specific habitat types while others can survive in a wide rage of habitat types. This relationship between species and their habitats is very important in conservation. Armed with the information we were able to explain to members of the local community on the need of protecting their environment. We found out that the community was willing to engage in conservation of their environment once they understood the benefits of a good environment and the consequences of not conserving the environment.

With the incentive of beekeeping for honey and other bee products, members of the local community have taken tree planting seriously. They now understand the relationship between trees, the weather and their livelihoods. It's encouraging that farmers are willing to buy tree seedlings especially the indigenous and multipurpose ones to plant in their farms. It is also heartening that some farmers are still growing the indigenous drought resistant crops as fall backs, despite the many challenges faced when growing them. These crops help to diversify habitats for different organisms, contributing to their conservation. If we continue with this drive, we will contribute to restoration of the environment and better livelihoods in the region.

CHALLENGES AND LESSONS LEARNT

As we continue working with the members of the local community, and as they grasp the concept of conservation and how it affects their daily life, sometimes their hopes and expectations rise beyond what we can afford or achieve immediately. For example each individual farmer would like to have hives, bee suits and other honey harvesting tools, but it is not possible for us to provide each farmer with these tools and equipment. We therefore encourage the concept of sharing and cost sharing. Nevertheless, there is light at the end of the tunnel as demonstrated by Gichera Environmental Programme (GEP).They were able to sell tree seedlings and buy hives with the proceeds for the group. They intend as they expand to buy hives

for each member of the group. Other challenges we got from the farmers was on packaging and marketing of honey. Currently farmers are selling honey at the local market which means they are not able to reach the wider market. We plan to help them form a cooperative and acquire a honey processor so that they can process clean honey and be able to sell it at a good price. The other challenge is that not everybody within the project area is able to buy seedlings; we therefore have to come up with ways of ensuring that such persons are not left behind and drag the rest of the community behind in conservation matters.

Water harvesting is an area we have not been able to cater for despite many farmers persistently requesting we help them build concrete water tanks or buy plastics ones to conserve rain water. Lastly, more farmers and community based organizations outside the project area wished we could extend our work to other areas but due to financial constraints we could not extend to other areas.

OBSERVATIONS

The project is picking up well with a lot of support from the local community. But to maintain this good will and momentum, we need to meet the hopes and expectations of the members of the local community. The community needs to perceive direct and tangible benefits from their efforts in conserving the environment. That is why the bee-keeping project should be expanded so that as many farmers as possible own bee hives and form a cooperative so that, they can have a reliable source of income. Butterfly farming is another way the community members can earn an income. In the process of protecting their source of income, conservation of bees and butterflies will be enhanced. As bees and butterflies are pollinators of most crops and trees, chances of increased crop yields due to increased pollination is high, hence a win- win situation for the farmers and the environment. Processing and value addition of fruits harvested from multipurpose fruit trees would also increase farmers' income. Also value addition of indigenous crops will not only increase sources of income, but also encourage more farmers to plant them hence diversifying habitats.

FUTURE PLANS

As there is good will from the local community and increased enthusiasm by neighboring communities, we intend to continue with the project in the current project area and also extend to the neighboring communities. We plan to continue with the monitoring program to accumulate data which will be useful for future comparisons and to monitor effects of climate change on biodiversity. We have plans to supply hives to interested farmers at subsidized prices which can be done through co-financing. We plan to take farmers from other groups to see the strategy employed by Gichera Environmental programme (GEP), selling seedlings and buying hives with the proceeds. Selling of seedlings will not only be to farmers but also to governmental and non-governmental institutions to rehabilitate deforested public lands and forests. We also intend to start owning a tree campaign where an individual pays a certain amount of money and local community members plant a tree for them in public land and their name get to be embedded on the tree. In this way, farmers will increase their sources of income and at the same time involve more people on climate change adaptation and mitigation measures.

To make the project self sustaining and for the farmers to fully own it and continue with environmental conservation even after the grant period is over, we intend to help farmers to form a cooperative to market their honey and other bee products. Also we plan to help them acquire a honey processor so that they can produce clean honey. As a cooperative they will be able to establish a market chain and add value honey and honey products, to fruits and other indigenous crops. For example they could make fruit jam or sell fruit juice or dried fruits. They could also add value to cassavas, sorghum and millet hence creating a wider market for indigenous crops. A wider market for these crops will encourage more farmers to plant them hence habitat diversification and conservation of breeding, feeding and roosting grounds of several organisms.

We are furthering stingless bee research with a view to domesticating them for honey production and pollination purposes. If we can succeed in multiplying the colonies, this knowledge will be passed on to farmers so that they can start stingless bee keeping. Stingless bees produce highly medicinal honey and this benefit coupled with their pollination potential, provides an incentive to farmers especially those with extremely small pieces of land or those with phobia for honey bees.

Finally together with Karatina University College (A constituent college of Moi University) we have agreed to work together to continue with conservation work on the Eastern side of Mt. Kenya forest. Karatina University College is located about 5km from the base of Mt. Kenya. They were impressed with our work and have offered me a position as a lecturer in the School of Natural Resources and Environmental Studies. We will continue with Stingless bee research, honey bee keeping, indicator species monitoring, tree planting and working with the members of the community to ensure we achieve what this project set to do

ACKNOWLEDGEMENTS

This project would not have been successful without inputs from the following; CBOs (Weru Self Help Group (WeSeHG), Mwitethie Kiroone Women Group, and Gichera Environmental Program (GEP), Mr David Nyagah, Alice Benjamen, Francis Njeru, Patrick Gitonga, Elijah Njagi who worked with us tirelessly in environmental education and creating awareness on climate change, adaptation and mitigation measures through door to door campaign. We are grateful to Mr Mugendi and Mr Gitonga for tirelessly assisting in the field and attending to the nurseries. We would like to thank Mr. Murungi, Mr. Kaburu and leaders of the three CBOs for availing land to set up the nurseries. We are exceptionally grateful to the community members who participated in tree planting free of charge having understood the need to work together to conserve our environment for ourselves and for posterity. We also thank the Kenyan ministry of science and technology for granting license to carry out this project. Finally we are grateful to Rufford Small Grants Foundation for funding this project and changing the lives of thousands of people for better.

In a special way we would like to share the loss of Dr. Jasper Mbae Kirika with the Rufford Foundation team. Dr. Kirika died in February 2010 after a short illness. He was a dedicated conservationist who worked hard to ensure that people understood the essence of conservation and how it affected our daily life. We dedicate this report to him. We have taken it upon ourselves to ensure that the conservation work that we started together continues in his honor.

FINANCIAL REPORT

Item	Quantity	Unit cost	Bud-geted Amount	Actual cost	Difference	Comment
1. Global positioning system (GPS), hire days	10	1.6	16	16	0	
2. Sweep nets	1	8	8	7.5	-0.5	The buying price was less by 0.5
3. Hand magnifying glass	1	3	3	2.99	-0.01	The buying price was less by 0.01
4. Entomological forceps	1	1.6	1.6	1.65	+0.5	The buying price was higher by 0.5
5. Insect envelopes, packets	3	4	12	11.55	-0.05	The buying price was less by 0.05
6. Killing jar	1	1.6	1.6	1.59	-0.01	The buying price was less by 0.01
7. Alcohol	1	16	16	16.49	+0.49	The buying price was higher by 0.49
8. Insect storage boxes	1	9.6	9.6	9.6	0	
9. Insect pins, packets	2	4	8	7.99	-0.01	The buying price was less by 0.01
10. Miscellaneous (Phone calls, email, notebooks, pens, flashlights etc)	1	160	160	150	-10	We were able to save 10 pounds
11. Field assistance, person days	200	4	800	920	+120	Due to insufficient rain, we could not transplant the seedlings from the nurseries, we hired field assistants to water and tend the seedlings till the rainy season
12. Automobile hire once in field, days	40	32	1280	1216	-64	Reduced the number of days the automobile was hired
13. Fuel cost	1	1152	1152	1598.5	+446.5	Increased fuel cost in the market
14. Transport from Nairobi to field and back	20	12	240	120	-120	Due to increased cost of transport we reduced transport from Nairobi to field by spending more days in the field
15. P1 subsistence, days	20	20	400	400	0	
16. Lodging costs in the field	40	9.6	384	284	-100	Sometimes we stayed with farmers or camped in their homes to cut on cost, as the cost of living had increased
17. Hives construction	50	20	1000	1000	0	
18. Polythene tubes (10000 pieces)	2	32	64	49.9	-14.10	Reduced on the number of pieces bought, to cut on expenses
19. Supporting poles, Nails etc	1	40	40	38.9	-0.10	The buying price was less by 0.10
20. Watering cans	1	6	6	5.45	-0.55	The buying price was less by 0.55
21. Labor	1	120	120	120	0	
22. Seeds	2	16	32	28.90	-2.10	The buying price was less by 2.10
23. Contingency			287.69	0	0	
Total			6041.49	6007.01	256.06	

APPENDICES

Appendix 1

1a. Butterfly species recorded only in Site 1 (Tea dominated and closest to the forest)

1. *Acraea alicia*
2. *Coeliades forestan forestan*
3. *Eretis vaga*
4. *Lycanidae spp*
5. *Metisella orientalis orientalis*
6. *Sarangesa laelius*
7. *Spialia dromus*
8. *Zizula hylax*

1b. Butterfly species recorded only in Site 2 (Coffee and tea dominated, lies between site 1 and site 3)

1. *Acraea alcinoe camerunica*
2. *Acraea viviana*
3. *Bicyclus smith*
4. *Borbo borbonica borbonica*
5. *Colias electo pseudohecate*
6. *Colotis euippe omphale*
7. *Freyeria trochylus trochylus*
8. *Gegens niso brevicornis*
9. *Junonia oenone*
10. *Junonia sophia*
11. *Lepidochrysops peculiaris*
12. *Metisella quadrisignatus nanda*
13. *Neptis saclava marpessa*
14. *Precis tegula*
15. *Sallya garega garega*
16. *Sarangesa phidyle*

1c. Butterfly species recorded only in Site 3 (Coffee dominated, furthest from the forest)

1. *Hamanumida daedalus*
2. *Lachnocnema bibulus*
3. *Spialia doris doris*

1d. Butterfly species recorded in both Site 1 (Tea dominated) and Site 2 (Coffee and tea dominated)

1. *Acraea cabira*
2. *Cacyreus virilis*
3. *Junonia terea elgiva*

1e. Butterfly species recorded in both Site 2 (Coffee and tea dominated) and Site 3 (Coffee dominated)

1. *Eurema senegalensis*
2. *Lampides boeticus*
3. *Phalanta phantha aethiopica*
4. *Sallya boisduvali omissa*
5. *Ypthima asterope*
6. *Ypthimomopha itonia*

1f. Butterfly species occurring in all the three sites

1. *Acraea eponina eponina*
2. *Actizera lucida lucida*
3. *Actizera stellata*
4. *Bicyclus safitza safitza*
5. *Eurema regularis*
6. *Henotesia perspicua*
7. *Junonia natalica natalica*
8. *Neocoenyra gregorii*

Appendix 2

2a. The total number of birds' species recorded in Site 1 (Tea dominated)

1. African Citril (*Serinus citrinelloides*)
2. African Paradise Flycatcher (*Terpsiphone viridis*)
3. Amethist sunbird (*Nectarinia amethystina kalckreuthi*)
4. Augur buzzard
5. Baglafecht weaver (*Ploceus baglafecht*)
6. Black saw-wing (*Psalidoprocne a. Albiceps*)
7. Black-and-white Mannikin
8. Bronze Sunbird (*Nectarinia k. Kilimensis*)
9. Cape wag tail
10. Collared sun bird (*Anthreptes collaris garguensis*)
11. Common Bulbul (*Pycnonotus barbatus*)
12. Cordon blue
13. Grey backed camaroptera (*Camaroptera brachyuran*)
14. Grey-headed sparrow (*Passer griseus*)
15. Montane White-eye (*Zosterops poliogaster*)
16. Pin-Tailed Whydah (*Vidua macroura*)
17. Red eyed dove (*Streptopelia semitorquata*)
18. Red-Billed Firefinch (*Lagonosticta rufopicta*)
19. Red-Chested Cuckoo (*Cuculus s. Solitarius*)
20. Speckled Mousebird (*Colius striatus kikuyuensis*)
21. Streaky seedeater (*Serinus s. Striolatus*)
22. Tawny-Flanked Prinia (*Prinia subflava melanorhyncha*)
23. Variable sunbird (*Nectarinia venusta)*
24. Village indigo bird
25. White-Eyed Slaty Flycatcher (*Melaenornis fischeri*)
26. White- Bellied Tit (*Parus albiventris*)
27. Yellow-rumped tinkerbird (*Pogoniulus bilineatus*)

2 b. The total number of birds' species recorded in Site 2 (Coffee tea dominated)

1. African Citril (*Serinus citrinelloides*)
2. African Dusky Flycatcher (*Terpsiphone viridis*)
3. African Goshawk (*Accipter tachiro sparsimfasciatus*)
4. African Paradise Flycatcher (*Terpsiphone viridis*)
5. African Pied Wagtail (*Motacilla aguimp vidua*)
6. Amethyst Sunbird (*Nectarinia amethystina kalckreuthi*)
7. Augur buzzard
8. Baglafecht weaver (*Ploceus baglafecht*)
9. Black saw-wing (*Psalidoprocne a. Albiceps*)
10. Black-and-white Mannikin (*Lonchura bicolor*)

11. Bronze Mankin
12. Bronze Sunbird (*Nectarinia k. Kilimensis*)
13. Cinnamon-Chested Bee-Eater
14. Cisticola
15. African Citril (*Serinus citrinelloides*)
16. Collared Sunbird (*Anthreptes collaris garguensis*)
17. Common Bulbul (*Pycnonotus barbatus*)
18. Common Drongo (*Dicrurus a. Adsimilis*)
19. Common Waxbill (*Estrilda astrild*)
20. Grey backed cameroptera (*Camaroptera brachyuran*)
21. Kikuyu white eye
22. Montane White-eye
23. Olive Thrush (*Turdus olivaceus abyssinicus*)
24. Paradise flycatcher
25. Red-Billed Firefinch (*Lagonosticta rufopicta*)
26. Ruppel's Robin-Chat (*Cossypha semirufa intercedens*)
27. Speckled mouse bird (*Colius striatus kikuyuensis*)
28. Streaky seedeater (*Serinus s. Striolatus*)
29. Tawny-Flanked Prinia (*Prinia subflava melanorhyncha*)
30. Variable Sunbird (*Nectarinia venusta*)
31. White-Bellied Tit (*Parus albiventris*)
32. White-Eyed Slaty Flycatcher (*Melaenornis fischeri*)

2 c. The total number of birds' species recorded in Site 3 (Coffee dominated)

1. Amethist sunbird (*Nectarinia amethystina kalckreuthi*)
2. Apalis
3. Augur buzzard
4. Baglafecht weaver (*Ploceus baglafecht*)
5. Black-and-white Mannikin (*Lonchura bicolor*)
6. Broze manikin
7. Bunting
8. Cisticola
9. Collared sunbird (*Anthreptes collaris garguensis*)
10. Common Bulbul (*Pycnonotus barbatus*)
11. Common Drongo (*Dicrurus a. Adsimilis)*
12. Common Waxbill (*Estrilda astrild*)
13. Grey-backed camaroptera (*Camaroptera brachyura*)
14. Hamerkop (*Scopus u. Umbretta*)
15. Speckled Mouse bird (*Colius striatus kikuyuensis*)
16. Olive Thrush (*Turdus olivaceus abyssinicus*)
17. Red-Eyed Dove (*Streptopelia semitorquata*)
18. Silvery-Cheeked Hornbill (*Bycanistes brevis*)
19. Speckled Mousebird (*Colius striatus kikuyuensis*)

20. Streaky seedeater (*Serinus s. Striolatus*)
21. Tawny flanked prinia (*Prinia subflava melanorhyncha*)
22. Variable sunbird (*Nectarinia venusta)*
23. White-Eyed Slaty Flycatcher (*Melaenornis fischeri)*

Appendix 3

3a. A table showing the number of farmers interviewed, their gender, age and level of education (Cass 1-7= Primary education, Form 1-4= Secondary education, Form 5and 6 after secondary education)

Farmer	Gender	Age	Education
1	Male	73	Class 7
2	Female	67	Form 4
3	Female	30	Form 4
4	Male	35	Form 4
5	Male	60	Form 4
6	Male	65	Form 4
7	Male	35	Form 4
8	Female	30	Form 4
9	Female	65	Form 5 an 6
10	Male	40	Class 7
11	Male	55	Class 7
12	Male	75	Class 4
13	Male	65	Form 5 and 6
14	Male	50	Not schooled
15	Female	32	Class 4
16	Male	60	Not schooled
17	Male	50	Class 4
18	Male	60	Tertiary education
19	Male	85	Class 3
20	Male	70	Form 4
21	Male	65	Class 2
22	Male	35	Class 4
23	Male	68	Not schooled
24	Male	40	Class 4
25	Male	50	Not schooled
26	Male	55	Not schooled
27	Male	31	Form 5 and 6
28	Male	35	Class 8
29	Male	30	Class 3
30	Female	45	Class 4
31	Female	40	Form 4
33	Female	80	Not schooled
34	Female	56	Tertiary
35	Female	59	Form 5 and 6

3b. A list of indigenous and drought resistant crops and vegetables grown by the local communities. Names are written in the local language followed by an English or Scientific name.

1. Igwa- Sugarcane Saccharum
2. Ikwa-Yams
3. Managu-Black Night Shade
4. Mangoes- indigenous varieties -Mangifera
5. Marenge- Pumpkin- Cucurbita
6. Mpupu- a kind of legume
7. Mukombi-Finger millet-Eleusine coracana
8. Muvia-Sorgum
9. Mwanga- Cassavas-Manihot esculenta
10. Mwele-Millet
11. Ndengu -Green grams
12. Ndigo (Ndigo ya mwana, Kivunda, Kivovi, Muraru, Gatumia)-locally grown banana varieties
13. Nduma- arrow roots-Colocasia esculenta
14. Ndumu (Mboco)- Locally grown beans varieties
15. Ngwaci-Sweet potatoes
16. Njavi -a type of legume
17. Njugu- Pigeon peas
18. Nthoroko- Cow peas
19. Nyanya-Wild tomatoes
20. Rwoga- Amarantha sp.

3c. A table of Indigenous, hard woods and drought resistant trees and shrubs planted by the local communities and their uses. Names are written in the local language followed by an English or Scientific name.

Indigenous, hard woods and drought resistant trees planted by farmers (Local names followed by English or Scientific names)	**Uses (According to the local people)**
1. Keho-*Markhamia*	Poles, fuel wood, hiding places for birds and insects
2. Macodovia- Butter pear- *Persea americana*	Fruits for human, fuel wood
3. Mbera- Guava-*Psidium guajava*	Fruits for people and birds, poles, fuel wood and live fencing
4. Mtanda- *Ficus lutea*	Fuel wood, leaves add to soil fertility, shade, shelter for birds and insects, hanging of log hives,

5. Muburu-Meru Oak	Timber, fuel wood, fruits eaten by people and birds
6. Mucuca- Luquats	Fuel wood, poles, fruits, live fencing, fodder for cattle, fruit eaten by people and birds
7. Mugereki- a type of hard wood	Timber, poles, fuel wood
8. Mugumo-*Ficus thoningii*	Poles, fuel wood, deed rooted brings water to the surface, leaves and fruits add to soil fertility and eaten by birds, fodder for cattle
9. Mukorwe- *Albizia albicinica*	Timber, Poles, fuel wood, fodder for cattle, leaves used to cover bananas to ripen
10. Mukuu- *Ficus exsasperata*	Poles, fuel wood , fodder, fruits eaten by birds
11. Mukuura- a type of hard wood	Timber, Poles, fuel wood, soil fertility
12. Mukwego- *Bridelia micrantha*	Timber, Poles, fuel wood, soil fertility
13. Murama- a type of hard wood	Timber, poles, fuel wood,
14. Muria- *Prunus africana*	Timber, poles, fuel wood, medicinal, fruits eaten by birds
15. Muringa- *Cordia Africana*	Timber, poles, fuel wood, soil fertility, fruits food for birds
16. Mutare- type of strawberries	Fruits for people, poles, fuel wood, live fencing
17. Mutoo-type of hard wood	Poles, fuel wood, making handles for farming tools.
18. Mutoto- a shrub	Used to make bows and arrows, live fencing
19. Mutundu- *Croton macrostachys*	Poles, fuel wood, medicinal
20. Muvindavidi- a type of hard wood	Timber, poles, fuel wood
21. Muvuti-*Erythrina abyssinica*	Fuel wood, aesthetic (brightly colored flowers around homes), nectar for bees, butterflies and birds
22. Mwage- a type of hard wood	Poles, fuel wood, fruits eaten by people
23. Mwanjati-Camphor	Timber
24. Mwenu- a shrub	Medicinal, fuel wood
25. Ngomora- a type of hard wood	Fruits eaten by people, fuel wood

Appendix 4.

Questionnaire on indigenous crops and trees awareness among the local communities, and factors that affect their growing and consumption that may influence conservation of biodiversity in agro- ecosystems on the eastern side of Mount Kenya forest.

Farmer data

1. Location……
2. Name of Interviewer…… Date:…….
3. Name of farmer (owner of the farm)……
4. Gender: Male [ ] Female [ ]
5. Age (years): ……
6. Marital status: Married [ ] Single [ ]
7. Level of education (Please tick which applicable)
   - Class 1-8 [primary education] [ ]
   - Form 1-4 -level [Secondary education] [ ]
   - Form 5-6 [A-level] [ ]
   - Tertiary [Technical training] [ ]
   - Other [ ]
   - Not gone to school [ ]

Indigenous crops farming (growing)

1. Do you grow indigenous crops and trees? Yes [ ] No [ ]. WHY?
2. Which indigenous crops and trees do you grow in your farm? List them
3. Why do you grow them?
   - Food crop[ ]
   - Cash crop [ ]
   - Fodder crop[ ]
   - Medicine [ ]
   - Improving your land- soil conservation/ erosion and fertility [ ]
   - Aesthetic [ ]
   - For posterity-passing knowledge to younger generation [ ]
   - All [ ]
4. How much of your land is used to grow indigenous crops and trees?
5. How much of each type of indigenous crops do you produce (quantity?) compared to other crops
6. How much do you earn from indigenous crops and trees or save by consuming them
7. Do you spray or add organic and inorganic manure to these crops
8. What are the common pests and diseases?
9. How many years have you been growing indigenous crops and trees?
10. Do they add or destroy soil fertility?
11. Are they affected by weather very much?
12. Do you know of other indigenous crops and trees in your area?
13. Why don't you plant them?
14. Do you know indigenous crops and trees even if you do not plant them?