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Contribution of beekeeping to livelihood and biodiversity conservation in–Inyonga Division (Mlele district) Western Tanzania

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Abstract
The study was conducted in Inyonga Division, Mlele district, western Tanzania in July 2014. The study aimed at assessing the contribution of beekeeping to community's livelihoods and biodiversity conservation. A total of 101 beekeepers were interviewed from purposively selected villages. Focus group discussions, Key Informant Interviews and physical observation were also used. Significant difference on number of hives was observed (χ^2 =11.726, df = 2, P = 0.003) in the study villages, no significant difference was detected in hive occupancy rate between hive types (Chi-square =4.127, df=4, p>0.389). Harvesting, processing and packaging of bee products were observed to be done locally, causing a negative impacts on biodiversity conservation due to fire setting in harvesting process. Bark hives were widely used 63% (n=11,928) of the recorded hives. Thus, awareness rising on the use of appropriate beekeeping practices is highly recommended for enhancing biodiversity conservation in Mlele District.

Keywords: beekeeping, livelihood, biodiversity, ugalla ecosystem, mlele district

Introduction
Sustainable beekeeping in many developing countries has been recognized as among the best forms of sustainable agriculture practices that can improve livelihood of rural communities without much investment cost [4]. Tanzania recognizes the role of beekeeping in contributing to livelihood and for biodiversity conservation as emphasized by the beekeeping policy [9]. Beekeeping plays an important role in both livelihoods improvement [12], nature conservation and agricultural production as bees are ranked highly amongst pollinating insects [6; 3]. When done appropriately, beekeeping provides significant reliable income for majority of marginalized communities thus, it is considered to be an important part of livelihoods to forest dependent people in many developing countries [7, 5, 2]. Elsewhere where beekeeping is appropriately practiced through improved skills with reliable markets for bee products, beekeepers are always motivated to support conservation efforts of the related ecosystem [16].

Tanzania is reorganized in Africa as among the few countries that hold large honeybee population potential due to diverse ecological and climatic conditions [9; 1]. In Tanzania, beekeeping contributes up to 33% of household income in the Miombo woodlands [10]. Katavi Region (formerly Mpanda District) is among the high honey producing area in Tanzania [12] with Mlele District being high producing potential areas in the Region. Between, 2011-2014, 815 tones of honey worth TZS 1.57 billion (US$ 944,929.3) and 151.8 tones of bee beeswax worth TZS 937 million (US$ 563,948) were produced in the District (Source: District Records June 2014).

Unsustainable beekeeping practices has always been considered detrimental to forestry because of the large number of trees used in traditional hive construction, and severe burning that sometimes is caused by honey-hunters and beekeepers during harvesting process. Despite being an important beekeeping area, yet reliable information on how beekeeping contributes to the livelihoods and biodiversity conservation in the district is limited. This study aimed at assessing (i) hives types and production capacity, (ii) contribution of beekeeping to the household economy, (iii) harvesting and processing methods, (iv) identifying beekeeping practices that enhance biodiversity conservation. Findings from this study provides important information for feasible recommendations for future sustainable beekeeping in the area.

Material and Methods
The study was carried out in Inyonga Division of Mlele District in July 2014. The District is located in the western Tanzania, (Figure 1) covering an area of 30,787.2 sq.km, characterized by unimodal type of rain fall that starts from November to early April with mean annual rainfall ranging from 920mm to 1,200mm and the average temperature ranging between 26°C and 30°C annually, with an altitude ranging from 1000 to 2500 meters above sea level. The district has a population size of 282,568, of which 139,980 are males and 142,588 females, with average household size of 5.8. The main economic activities are farming, hunting, fishing, livestock keeping, lumbering and beekeeping.

The main data collection tools were through questionnaire survey, Focus Group Discussions (FDGs) that involved different groups (beekeepers, villages leaders and district offices), Key Informant Interviews (KIIs) and Physical visit to some activities such as bee product processing, packaging, market place and a visits to the nearby bee apiary (Mlele Beekeeping Zone) were done. Specifically the tools were used

to assess, type of bee hives and their production level, harvesting and processing methods used, socio-economic impacts of beekeeping household livelihoods and key beekeeping practices that enhance biodiversity conservation in the study area.

Three villages were purposively selected from Inyonga Division, based on the criteria that they were practicing beekeeping and have reasonable number of beekeepers who practice both traditional and improved beekeeping in the study area. Villages selected were Nsenkwa, Ipwaga and Kanoge. A set of structured questionnaire was used, to collect data that covered all the basic information for fulfilling the intended objectives. From the selected three villages 30% of the beekeepers was considered to be a good sample for statistical tests. Data were analyzed using descriptive statistical tools such as frequency standard error, percentages and non-parametric test (Kruskal wallis) were done using SPSS (version 20 of 2014) to describe the socio demographic characteristics of beekeepers. Results are presented in forms of tables, charts, frequencies and graphs. Content analysis was used to analyze data collected through FGD and KII.

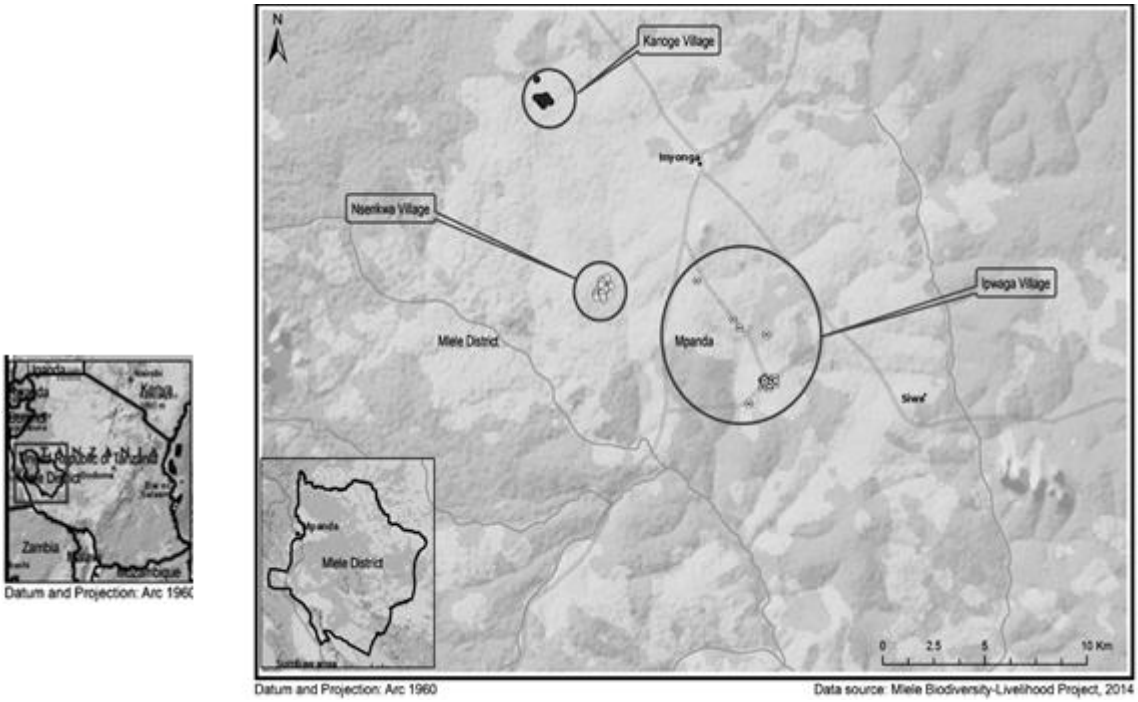

Fig 1: Map showing the location of the study area

Results and Discussion

Socio-economic characteristics of the respondents

A total of 101 beekeepers were interviewed, of which males constituted 92.1% of respondents in the area, indicating that females were less engaged in the activity. Results indicated that, beekeeping in the area is mainly a traditional dominated activity. Traditionally males dominate the beekeeping activity as a forest based practices, which are carried over from one generation to another. Making bark hives that are commonly used and sitting methods requires physical strength; involving tree climbing for hanging hives and during honey harvesting which favor men rather than women. It was also explained that, harvesting process requires long absences from home, which competes with women's family responsibilities. Similar reasons were reported in other African countries were traditional beekeeping is practiced [19]. Results also indicated that, the majority of respondents had access to formal education, 74% (n=101) and that most of them were within the age category of 36-45 years (table 1) which implies most of the beekeepers were in their active age of production. Two prominent ethnic groups, Konongo (45.5%) and Fipa (27.7%) emerged as key beekeepers in the area (table 1).

Table 1: Social characteristics of respondents (n = 101)

		Frequency (n=101)	Percentage (%)
Gender	Male	93	92.1
	Female	8	7.9
Education	Never been to school	1	1.0
	Primary	75	74.3
	Secondary	24	23.8
	Tertiary	1	1.0
Age Category	20-35	18	17.8
	36-45	36	35.6
	46-55	20	19.8
	56-65	17	16.8
	>65	10	9.9
Tribes	Konongo	46	45.5
	Fipa	28	27.7
	Nyamwezi	8	7.9
	Rungwa	4	4.0
Others (Hehe, Bungu, Rungwa, Pimbwe, Sandawe and Sukuma)		15	14.9

Type of beehives and production levels

In this study, majority of beekeepers were reported using

traditional hives, mainly bark and log hives, where 63% of the total recorded hives in the study area (n= 11,928) were bark hives. These were preferred due to less costs and easy availability as compared to improved hives. One bark hive was sold at TZS 3,000 to TZS 5,000; (equivalent to US$ 1.9 to 3.1 respectively) and they were available in the area and sometimes can be easy constructed by family members. Unlike bark hives, improved hives (Tanzania Top Bar Hives and Top Bar Commercial Hives) were reported to have higher costs that ranged between TZS 60,000- 120,000 (Equivalent to US$ 37.5 and 75). At the same time skills and capacity on how to manage the improved hives was lacking among many beekeepers. This was mentioned as among the factors that had pushed back the majority of beekeepers to become less interested in changing from use of bark hives to improved hives. Similar results were reported in Ethiopia, on hive preference as a result of higher costs of modern hives [13]. Honey production per hive was significantly different among the hives types (Kruskal Wallis Test; Chi-square =15.874, df=3, $p<0.05$). According to the respondents, bark hive had higher production level than log hive (Scheffe, $P<0.05$) in both seasons. In major season, average production for bark hive was 22 (±8) kg/ hive while log hive had 17(±8) kg/hive. The average production of bark hives as reported by respondents was slightly higher than what was reported in the past that the average was 20kg per bark hive per season in the study area [21]. The higher production level in bark hives was explained by beekeepers being related to large size of the hives as compared to log hives, which were observed to have smaller volume. This has even considered encouraging beekeepers to continue using bark hives despite its ban since 2010 through the Tanzania Beekeeping Act no 15 of 2002. This is considered by many of beekeeper that using bark hives provide more return in terms of income gains per harvest. A study on comparing the profitability of primary actors in beekeeping production and marketing selling of liquid honey and beeswax revealed that bark hives were profitable as compared to log and other improved hives for beekeepers [18]. However it was strongly recommended that bark hives should be strongly opposed and never be recommended due to severe environmental degradation it causes in its manufacturing process. Furthermore, it was reported that despite the preference of beekeepers, the life span for bark hives, was short as compared to log hives. While bark hive could last for 4-5 years, log hive can stay up to 10-15 years [20]. The fact that bark hives have shorter life span, beekeepers have a tendency of increasing hives each year thus causing more habitat destruction which in a long run will result into severe loss of fodder plants in the area. Generally results indicated that, production at district level has shown an increasing trend for both honey and beeswax (Table 2) for the past three years (2011-2013). However, there are challenges that may lead into declining trend as reported by respondents (57%, n=101) that include prolonged dry season, and forest destruction that has resulted into poor forage plants. The decline of honey resulting from environmental degradation was also reported in Ethiopia with major reasons among other being shortage of bee forages as a result of forest destruction, drought, lack of water and poor management [17].

Table 2: Production trend of honey and beeswax in Mlele District

Year	Honey		Beeswax	
	Tonnes per year	Income (TZS)	Tones per year	Income (TZS)
2011	220	330,000,000.00	25	150,000,000.00
2012	245	420,000,000.00	26.8	187,600,000.00
2013	350	816,666,666.00	100	600,000,000.00
Total	815	1,566,666,666.00	151.8	937,600,000.00

***Source*:** District Beekeeping Office, (Field survey 2014)

Socio-economic contribution of beekeeping at household economy

Beekeeping was considered to be among the important income generating activity at household level of beekeepers. In ranking the contribution of various activities in household economy, beekeeping, emerged as among the main contributor, however contributed differently (χ^2=63.097, df=2, p=0.000) with others (Agriculture and livestock). Beekeeping contributed similar to agriculture (Scheffe, P=0.115) but higher than livestock keeping, this was probably attributed to fewer number of livestock kept by beekeepers and which meant mainly for family use (for example chicken and goats) while dogs and cats were considered as pets. The main bee products recorded were honey and beeswax. Bee products were sold mainly at local markets and at Inyonga Beekeeping Association. Prices fluctuated depending on season and availability of buyers. The price for honey ranged between Tanzania Shillings (TZS) 2,800 (US$ 1.7) to 4, 000 (US$ 3) per kg. Beeswax was sold at an average price of between TZS 7,000 (US$ 4.21) to TZS 8,000 (US$4.81) per kg. The average income per household per year from sale of bee products was TZS 1,200,000 (US$ 722.2) with the highest income recorded among the respondents was TZS 7,000,000 (US$ 4213) per year. Money received depended on the number of hives owned, quality of honey and the price at the market level. An average income per household of respondents was estimated to be TZS 2,800,000 (US$ 1,685.22) per year from different sources with a significant contribution from agriculture and sale of bee products (honey and beeswax). Majority of respondents indicated that the main reason for keeping bees was to obtain income. In terms of human assets, more respondents (50%, n=101) reported to have spent money obtained from bee products to pay school fees for their children while as physical assests 57% of the total interviewed beekeepers (n=101) reported to have spend funds to construct better houses, and with regard to social assets, majority (51%, n=101), reported to spend fund for buying clothes especially for family members (Figure 2 a-c). With this significant contribution to household, the business has attracted a number of villagers who are now engaged in beekeeping. These results are similar to those reported in central Tanzania where majority of beekeepers have spent fund from selling bee products for acquiring social, physical and human assets and in other areas where rural communities practice beekeeping [18, 15]. Simily this is supported by another study conducted in Eatern Tigray Ethiopia [18]. Apart from supporting households through various income related assets, bee products were reported to have many other socio-cultural values at household level, some of the values that were reported by respondents are indicated in Table 3.

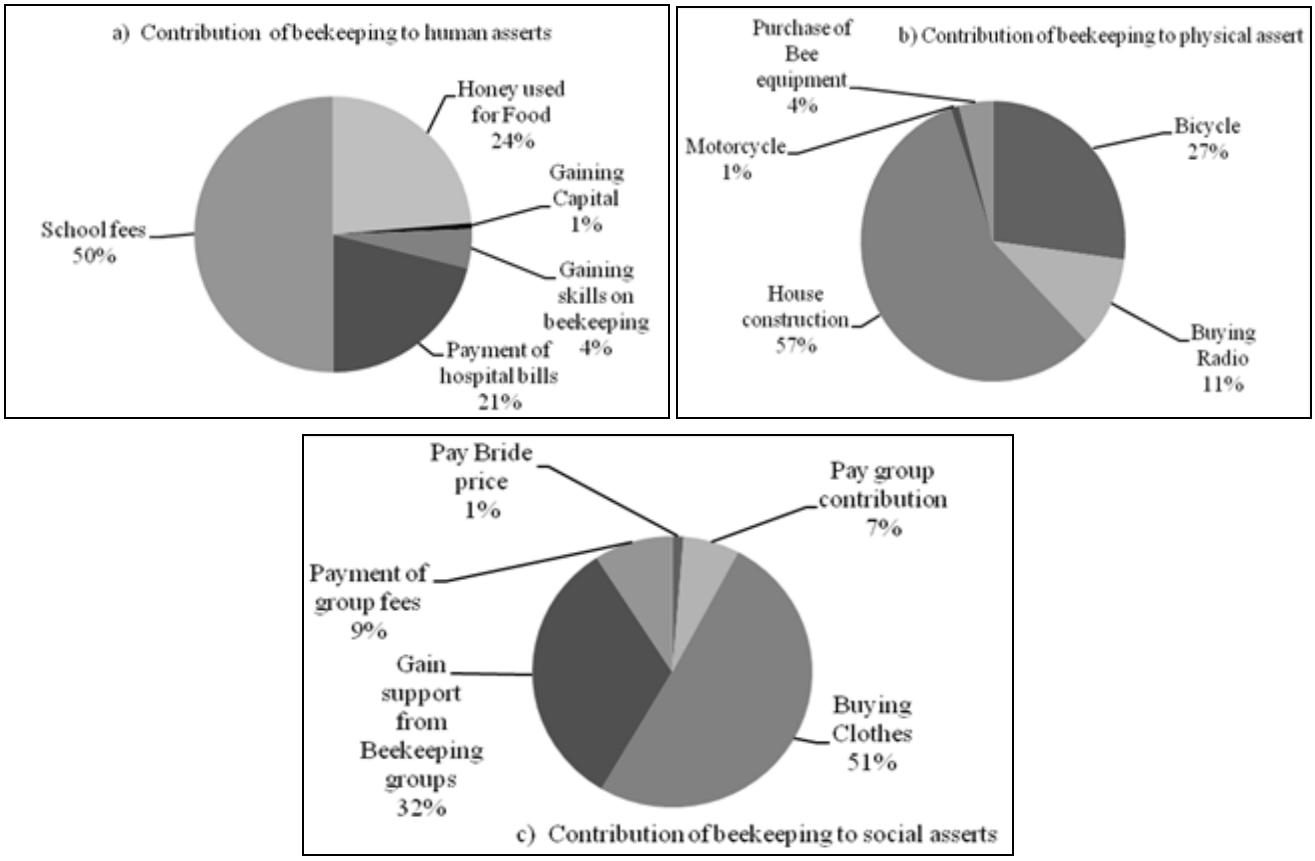

Fig 2: Percentage contribution of beekeeping for household livelihood

Table 3: Other socio-cultural uses of bee products as indicated by beekeepers in the study area

S. No	Bee product	Uses	Description
1.	Honey	Source of food	▪ Honey is used as sugar supplement for tea, porridge, and jam on bread, sweet potatoes, cassava and groundnuts. ▪ Source of raw material for making local brew (Common name: "Wanzuki") ▪ Making juices and local wine (use of some fruits with honey e.g. banana, lemon, orange and honey).
		Source Medicines	▪ Honey is commonly used for treating wounds such as burnt wound. ▪ Treating chest problems: coughing, chest pain and Asthma ▪ Stomach problems: Peptic ulcers and stomach pain ▪ Other diseases treated with honey: Impotence for men, anemia, removes snake poison, throat pain.
2	Beeswax	Baiting material	▪ Use as baiting materials for bees.
		Other uses of beeswax	▪ Source of light through locally made candles ▪ Stopping leakages for kitchen utensils for example buckets.

***Source*:** Field data, 2014

Harvesting and processing methods of bee products

Findings revealed that, almost all the activities are done through traditional knowledge and skills. Use of fire during harvesting was highly pronounce and was reported by all beekeepers as the means to calm bees. However it was reported to causes death and absconding of bee colonies and destruction of important bee fodders. This has a major negative impact on biodiversity loss and more specifically loss of colonies and fodders species. Honey processing was done traditionally (57%, n = 82) through traditional gravity method supported by a traditional strainer made up of tree barks, other methods reported were hand smarshing (28%), and boiling (15%). Beeswax processing was done through boiling and straining using locally made strainer. It was also reported that honey decantation (squizing and melting through sun heat) using 200 litre drums was also common. The hygiene condition of these traditional equipment is questionable as some of these could result into contamination. Traditional processing equipment have been reported to be the major source of poor quality of bee products in developing countries, which has resulted into low income to majority of beekeepers as they are forced to sell their products at less price . These practices need major improvements as they result into low product quality and hence low value which could result into less income and less contribution to household income.

Beekeeping and biodiversity conservation

Despite the high use of traditional methods which causes

negative impacts to biodiversity, beekeepers reported to realize the ecological importance of appropriate beekeeping practices. Beekeepers within the study area were aware of the values of indigenous trees in beekeeping. Appropriate beekeeping practice is among the sustainable form of agriculture that is considered to save most of biodiversity [19]. Plant diversity provides valuable resources for bees at different times of the year. This concept of biodiversity conservation was recognized by most of beekeepers in the area. They have special skills in identifying important bee fodders that are also used as key indicators for siting of beehives. A total of Thirty six (36) species of bee plants representing 21 families were recorded in the study area (Table 3). *Jurbenadia globiflora* (28%, n= 101), *Brachystegia boehmii* (14%), and *Pterocarpus chrysothrix* (12%) ranked the top most important fodder species in the area. The main flowering periods reported were February to May and September to November that resulted into two main harvesting seasons i.e., June - July and November -December but also a minor harvesting season in September. Beekeepers regarded honey harvested in major harvesting season as quality honey as a result of mixed pollen and nectar from a variety of flowering plants. These findings are also supported by other researchers [11], who reported that honey obtained in June (Major season) in Miombo area was considered to be quality and sweeter that honey obtained in October to December (Minor season). In this study honey and beeswax provided important source of income to many beekeepers' families that were reported to be spent for various households needs. These incentives have contributed to beekeepers to increase their awareness on beekeeping for sustainable biodiversity conservation. However, the use of bark hives in the area is an indicator that more tree species are utilized in the process of hive making. However despite this, it was noted that communities through district support have started to learn on the sustainable beekeeping practices. From questionnaire survey, results indicated that, majority of respondents were aware on the value of appropriate beekeeping techniques to biodiversity conservation (93%, n=101). Recognizing the damages resulting from unsustainable beekeeping practices, beekeepers in the area have started to get involved in protecting their bee apiaries. Main initiatives that were reported as initiatives towards sustainable beekeeping include; regular patrolling in bee apiaries by Village Game Scouts (33.7%, n=101), use of appropriate beekeeping practices (21.8%), creation of fire breaks (14.9%) and tree planting campaigns (8.9%). The study also noted that one of the most important initiative through government support was the establishment of the Mlele Beekeeping Zone (MBZ), that has 850km^2 within Mlele Forest Reserve. Memorandum of understanding was signed between Inyonga Beekeepers Association (IBA) and Tanzania Forest Service (TFS) under Ministry of Natural Resource and Tourism to ensure proper engagement of beekeepers in sustainable beekeeping. The use of special focused groups in promoting sustainable beekeeping is an appropriate technique to conserve bee apiaries. sustainable beekeeping, once done properly can generate income without destroying habitats [5]. Therefore supporting sustainable beekeeping in reserved forests means encourage the maintainance of biodiversity which results into increased bee products and more income for beekeepers [21].

Conclusion and Recommendation

Generally, results from this study, revealed that, beekeeping is considered as an important income generating activity in the area and majority of beekeepers are engaged in the activity to gain income for basic family needs.

The use of traditional methods in both production and processing (especially use of bark and fire) were considered to be the major threat and a major cause of biodiversity loss in the area. The methods also could results into low quality of bee products which results into less income to beekeepers. Furthermore, the continuation of traditional methods specifically use of bark hives and fire during the processing process are threatening the important bee fodder such as *Jurbenadia globiflora* species noted to be widely used for making bark hives and other related traditional beekeeping equipment

Results also revealed that despite some damages caused by inappropriate beekeeping activities, beekeepers in the area have started some initiatives to support biodiversity conservation. Awareness on the use of appropriate beekeeping, regular patrolling in bee apiaries and tree planting campaigns, establishment of beekeeping zone and use of fire breaks around the bee apiaries were key conservation initiatives that were noted.

Following the findings obtained from this study we recommend that, awareness creation on the use of appropriate beekeeping techniques is needed for safeguarding and conservation of biodiversity in the area. Further more strenghterning the existsing and establishment of new beekeepers association and beekeeping groups will help in annexing of financial aids, marketing information and inputs from government and non-government organizations. A long term research should be conducted to determine further the adoption of appropriate beekeeping techniques among beekeepers in the area, the level of biodiversity conservation in the bee apiaries and hive type profitability.

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