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Absconding of Honeybee Colonies from Beehives: Underlying Factors and its Financial Implications for Beekeepers in Tanzania

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Abstract

A study was conducted to investigate honeybee colonies absconding from beehives and its financial implication among beekeepers in Tabora and Katavi regions, Western Tanzania. Four districts were selected on the basis of adoption of improved beehives. A total of 198 beekeepers were randomly selected for interviews. Data collected from beekeepers using a questionnaire were supplemented with data from focus group discussions and interviews with key informants that included experienced beekeepers, extension workers and subject matter specialists. Drought, presence of bee pests, diseases and predators and shortage of bee forage were identified as major factors causing honeybee colonies to abscond from beehives in the study area. The act of honeybee colonies absconding from hives caused an average annual income loss of TZS 2 894 555.89 (US$ 1822.5) and TZS 1 797 105.02 (US$ 1131.5) among beekeepers using traditional and those using improved beehives, respectively. Such losses were accelerated by beekeepers' failure to uphold good management practices, especially with respect to undertaking regular follow-ups and cleaning of beehives as well as inappropriate harvesting methods. Inappropriate beekeeping practices were found to be the root causes of honeybee colonies to abscond from hives. As remedies to such losses, beekeepers should be advised to use improved hives and uphold good beekeeping practices. The role extension service is vital in creating this awareness among beekeepers in the study area. Lessons from this study are also vital to inform policy and practices in the beekeeping sector in Tanzania and beyond.

Keywords: Drought, Bee Forage, Absconding, Bee Pests and Predators, Financial Loss

1. Introduction

In Tanzania, there is a wide range of vegetation that is suitable for beekeeping. Mainland Tanzania has about 33.5 million hectares of forests and woodlands that are ideal for beekeeping (Marjo and Feek, 2010; Songo, 2015). Almost 20.5 and 13 million hectares of this area comprise unreserved and reserved forests woodlands, respectively. More than 80 000 hectares of the gazetted forest reserves consist of forest plantations that are also suitable for beekeeping. The mangrove forests in Mainland Tanzania that cover about 115 500 hectares are also valuable bee forage resources (Mustalahti and Lund, 2010). Agricultural land is another potential area for beekeeping where substantial bee products can be produced using flowers from agricultural crops such as sunflower, green beans, coffee, sisal and coconut (Omari, 2010).

Tanzania is estimated to have around 9.2 million honeybee colonies with a production potential of about 138,000 tons of honey and 9,200 tons of beeswax per annum (URT, 2012). FAO (2018) reported the national production to be 30,393 (22%) MT and 1,843 (20%) MT of honey and beeswax, respectively. These levels of production are far below the estimated potential. Based on the current production the beekeeping sector has been generating about US$ 2.5 million from export of honey and beeswax annually (MNRT, 2019). The prevailing low

production of bee products in Tanzania is associated with shortage of bee forage, presence of pests and predators, low adoption of improved beekeeping technologies, inadequate supply of beekeeping facilities, unreliable market and poor access to extension services (Kihwele, 1985; Backeus and Ruffo, 2010; Namwata et al., 2013; Igunda; 2013; Kimaro et al., 2013; Minja and Nkumilwa, 2016).

Seasonal absconding of honeybee colonies is another common challenge reported to threaten beekeeping in Tanzania (Nyunza, 2018; Kihwele, 1985). Absconding is defined as the act of a colony which forms a swarm abandoning a hive so as to re-establishes elsewhere. When the colonies move, no bee category (worker, adult or viable immature queens) is left in the hives. Absconding can occur either due to disturbance or induced resource scarcity. Disturbance induced absconding mostly results from partial or total disturbance of colonies by predators, destruction of honey comb by pests or rain water entering in the hives. Disturbance may also be due to poor harvesting techniques, which involve leaving hives on the ground when beekeepers escape from stinging bees. Meanwhile, resources induced absconding results from shortage of bee forage and water, which in tropical habitats occurs mainly during the dry season. During this period there is relatively little flowering, hence reducing food supply for bees for a prolonged period thereby forcing honeybee colonies to move to other areas with better resources (Pradeepa and Bhat, 2014).

In spite of absconding being reported to be detrimental to the beekeeping sector in Tanzania, its magnitude and the underlying causes have not yet been established. Moreover, little is also known about the financial implication among beekeepers using improved and traditional beehives. This study was undertaken to investigate the magnitude of the problem, underlying factors and financial implication of bee colonies absconding from hives among beekeepers in Tabora and Katavi Regions, western Tanzania. This understanding is vital to inform beekeeping practices through targeted policy interventions in the provision of critical support services including beekeeping extension.

2. Materials and methods

2.1 Study Area, Sampling Techniques and Sample Size

The study was conducted in Tabora and Katavi Regions, which are located in the western part of Tanzania within the Miombo woodlands. These woodlands have high potential for sustainable beekeeping owing to their large size and presence of a wide range of bee forage. The study focused on four districts out of eleven within the western Miombo woodlands; three from Tabora Region (Kaliua, Urambo and Sikonge) and one from Katavi Region (Mlele). These districts have a higher proportion of beekeepers who have adopted improved beehives to allow comparison with those using traditional technologies. A total of 198 beekeepers were randomly selected. Out of these, 36 were using improved beehives while the rest were using traditional beehives. Beekeepers in the study areas used different means to get honey bee colonies. The first and most common means was known as “let alone” technique which involved hanging beehives on tree and waiting for colonies to enter. The second approach involved catching colonies that were found at temporary sites such as bees found hanging on trees in the forest as they move from one place to another. Beekeepers used locally made swarm catchers to catch such colonies. Some beekeepers inherited the colonies from their parents. Moreover, some of the beekeepers hanged bee hives in their backyards while other hanged the hives in locations that were far from their homes including Mlele game-controlled area in Katavi Region, beekeeping zone in Katavi Region as well as community forest in both Katavi and Tabora regions.

2.2 Conceptual Framework

Studies conducted elsewhere (Jeil et al., 2020; Lowore, 2020; Ricketts and Shackleton, 2020; Schouten et al., 2020) and in Tanzania (Msofe et al., 2019; Wagner et al., 2019) have revealed that beekeeping is an important livelihood activity among farmers especially in the Miombo woodlands. Such farmers are expected to behave as rational economic agents and are expected to allocate resources for beekeeping so as to maximize revenue. This aspiration is achieved by producing the highest quantity of good quality bee products at the least cost. The cost that beekeepers incur comprises fixed and variable costs. Fixed costs are those associated with acquiring the hives while variable costs are related to labour for installing the hives and follow up activities. Once the hives are acquired and hanged, a beekeeper should strive to maximize revenue by reducing production losses and should take into account the effect of honey bee colonies absconding from beehives.

Quantities of honey and beeswax that are harvested during a particular season are a function of; yield per hive, proportion of hives that were occupied by bees and management practices. Thus, a beekeeper will experience revenue loss if yield per hive and the proportion of hives that are occupied by bees are small. This loss could also be a result of poor management of beehives. The loss from absconding is expected to be huge if most of- or all hives are not occupied. Under these circumstances a rational

beekeeper, is expected to adopt beekeeping technology that ensures minimum loss in bee products and lessens the problem of colonies absconding from beehives. Based on this conception relevant information on absconding and related challenges was collected from beekeepers and key informants in the study area. The information is used to assess severity of identified challenges and effect of absconding on beekeepers' income. Figure 1 presents relationships between key variables underlying beekeepers' abilities to venture into beekeeping and their choice of beekeeping technology (traditional vis-à-vis improved). The benefit (profit) that beekeepers realise from this activity can be significantly reduced when they face various beekeeping constraints including honey bees absconding from hives.

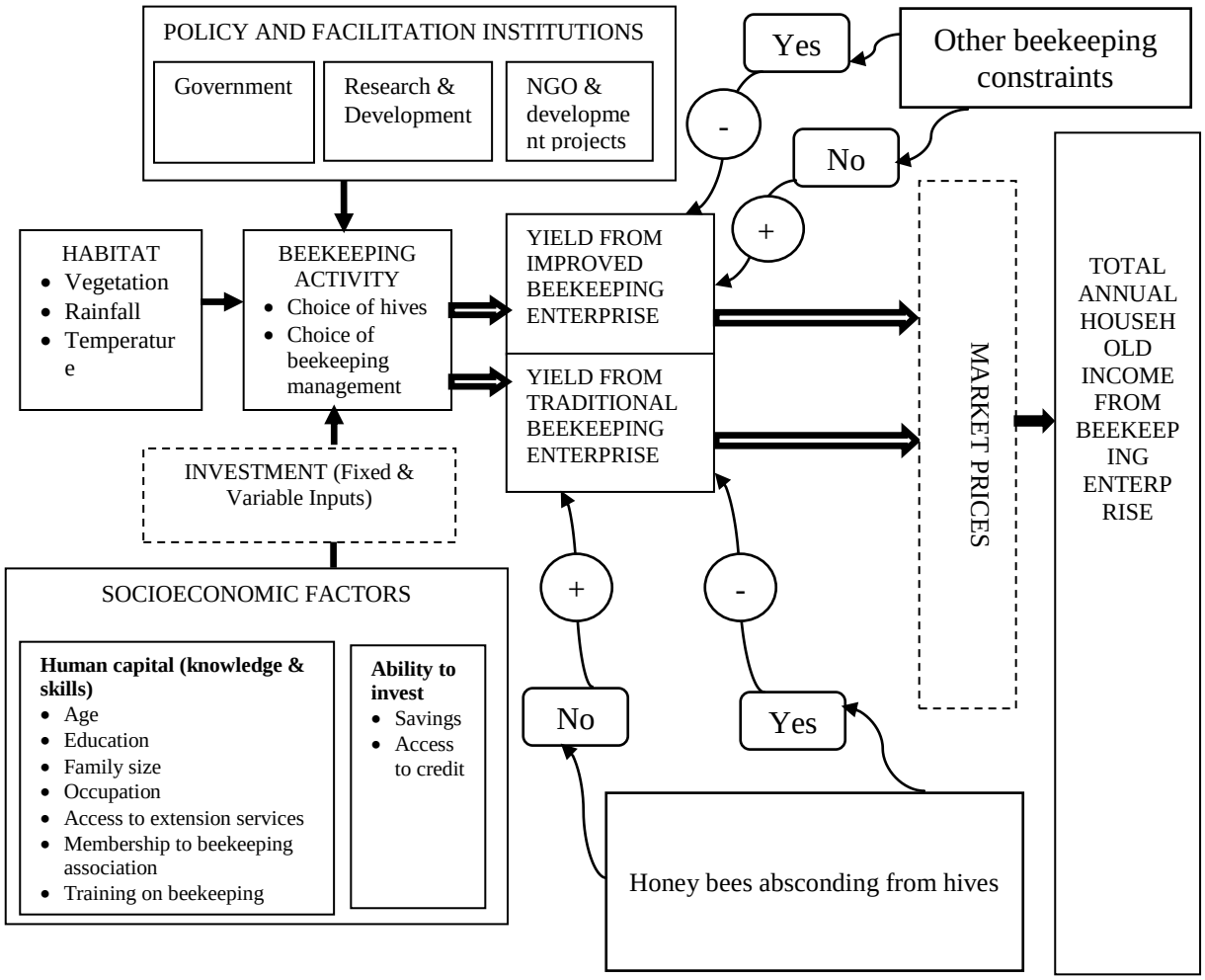

Figure 1. Conceptual framework

2.3 Data Collection and Analysis

Data were collected from beekeepers using a structured questionnaire designed to solicit information with respect to major constraints to beekeeping in the study area, severity of such constraints and financial implications of bee colonies absconding from hives. Data needed to assess the financial implications included; the number of hives owned by a beekeeper, quantity of honey and beeswax produced, honey and beeswax prices prevailing at the time of data collection. Data from households were supplemented with information from focus group discussions and interviews with key informants including selected beekeepers, beekeeping extension agents and subject matter specialists at the Tanzania Wildlife Research Institute (TAWIRI). Data from the household questionnaire were coded, entered and analysed using SPSS computer software. Descriptive statistics such as frequency, means and standard deviations were used to identify the relative importance of constraints facing beekeepers and proposed solutions. Inferential statistics (t-tests) were used to test for mean difference between honey yield per beehive hanged at the backyard and a similar hive hanged in community forest or forest both for traditional and improved beehives. Data from interviews with key informants and focus group discussion were summarized thematically to highlight common aspects about pests, diseases and predators; and how the beekeepers controlled these problems using indigenous knowledge. The quantity of honey and beeswax lost due to absconding of honeybee colonies from beehives was calculated and corresponding losses were computed using observed decrease in quantities of bee products and prevailing market prices.

3. Results and discussion

Within the study area there are two periods for harvesting bee products. The peak harvesting period is from June to August when the largest quantity of honey is collected. This honey is also of higher quality due to better food availability during the rainy season. The minimum harvesting period runs from October to December. To understand better the problem of absconding it was also important to get a general view about other issues related to beekeeping.

3.1 Effect of Apiary Site on Management Practice and Production of Honey

About 52.8% of the beekeepers using traditional and 47.6% of those using improved beehives in Katavi Region kept beehives in their backyards. In contrast the majority (83.7%) of beekeepers using traditional and 87% of those using improved beehives in Tabora Region kept bee hives in forest reserves. Beekeepers in Katavi Region had better access to beehives for inspection and cleaning since their apiary sites were closer to home. The effect of this better management is reflected in honey production where beekeepers hanging hives closer to their residential areas produced more honey per hive compared to those hanged deep in the forest. The difference in honey production is presented in Table 1.

The mean yield of honey per improved beehive hanged at the backyard was 15.39 litres/hive compared to 10.71 litres for the same hive hanged in a forest reserve. Similarly, traditional beehive hanged at the backyard had a mean honey yield of 7.98 litres compared to 6.49 litres per hive hanged in a forest reserve. The observed differences were statistically significant ($p<0.005$).

3.2 Constraints to Beekeeping

Prioritization was done by respondents to identify the most severe constraints in terms of hindering the development of beekeeping in the study area. Table 2 shows the percentage of respondents listing various constraints they faced. Results show that poor road infrastructure was the most severe problem the entire sample faced (17.2% response). The problem was also identified as the most severe by beekeepers using traditional beehives (17.5% response) and improved beehives (13.3% response). Unreliable market ranked second when the entire sample was considered accounting for 14.1% of the responses. However, unreliable market was ranked second (14.5% response) after poor road infrastructure (14.8% response) among beekeepers using traditional beehives while it ranked fourth for those using improved beehives (12.2% response). The difference in beekeepers' opinions in relation to the severity of poor access to market is attributed to their differences in access to extension services. Beekeepers using improved beehives had more contacts with extension agents and promoters of improved beehives who supported them to adopt the technology and access other critical support services including value addition and marketing information.

Ranking by entire sample identified shortage of bee forage (13.6% response) and inadequate supply of beekeeping facilities (13.6% response) as the third most severe constraints. Pests, predators and diseases were fourth in terms of severity (12.6% response) followed by inadequate capital (10% response), theft (5.1% response) and wild fires (4% response). However, shortage of bee forage emerged as the most severe constraint for beekeepers using improved beehives that were hanged in their backyards (17.8). Bees at this apiary site are likely to face more shortage of bee forage compared to bees in hives hanged deep in forest reserves where there is

greater diversity of plant species with varying drought tolerance.

In terms of study regions and categories of beehives; poor road infrastructure to apiary site was the third most severe problem (18% response) among beekeepers using traditional hives in Tabora followed by unreliable markets (13.9% response). However, unreliable market was the most severe constraint (17% response) among beekeepers using traditional beehives in Katavi followed by poor rood infrastructure (16.1% response) to apiary sites. Shortage of bee forage was listed as the fourth most severe problem in Katavi Region, both for bee keepers using improved (20% response) and traditional beehives (17% response). The problem of shortage of bee forage accounted for a larger proportion (16.4%) of the responses by beekeepers using improved beehives in Tabora against those using traditional beehives (11.7%). Similar findings have been reported in Ethiopia and South Africa (Beyene and Verschuur, 2014; Pirk et al., 2014; Yirga et al., 2012; Abebe and Puskur, 2011; Workneh and Ranjitha, 2011). These studies reported drought, honeybee pests, diseases and predators, shortage of bee forage, shortage of beekeeping facilities, poor infrastructures and poor access to markets as the major constraints hindering the growth of the beekeeping subsector.

It should be noted that most of the traditional beehives are hanged deep in the Miombo woodlands where access to transportation infrastructure is poor. Most of the woodlands in Tabora are found within the Ugalla land scape where perennial inundated grasslands and water sources are abundant (Hazelhurst and Milner, 2007). Thus, bees in such areas are unlikely to face the problem of bee forage shortage and this might be the reason why this problem came fourth among users of traditional beehives in Tabora (11.6). Some of the factors leading to absconding were mentioned and found to be associated with significant financial losses.

3.3 Honeybee Colonies Absconding from Hives and its Financial Implication

Table 3 reveals that a significant majority in the entire sample (84.8%) experienced the problem of absconding; being higher among users of traditional beehives (85.8%) than those using improved beehive (80.6%). It is worth noting that the design of improved beehives allows users to easily open the hives for inspection and cleaning which reduces attacks from pests and predators and allows early detection of bee diseases. In general, the problem was more severe among users of traditional beehive in Katavi (93.5%) than Tabora (82.8%). The underlying reasons for absconding were almost similar across beekeepers in the study regions. These reasons are presented in Table 4.

Three major factors were identified to be the underlying causes of honey bee colonies to abscond from hives. The factors arranged in descending order of severity are: drought; presence of pests, diseases and predators; and shortage of bee forage. Moreover, about three percent of entire beekeepers using improved beehives and two percent of those using traditional hives identified wildfires to be one of the reasons for absconding. Occurrence of wild fires was reported by 5.6% of beekeepers using improved hives in Tabora as well as 1.3% and 2.1% of those using traditional beehive in Katavi and Tabora, respectively. Incidents of wildfires were more frequent among beekeepers using improved than traditional beehives because the former tended to kept beehives in their backyards located within community forests that are more prone to wild fires than hives located deep in the forest reserves.

Inappropriate harvesting methods were also reported to be associated with the problem of absconding. Inappropriate harvesting methods involved complete removal of the honey comb implying that no feeds were left for bees. In some occasions, beehives were left on the ground after harvesting, which attracted pests and predators to the hive. Both actions subject colonies to stress thereby increasing the chance of absconding. Similar findings were reported in Ethiopia (Abebe and Puskur, 2011; Kebede and Lemma, 2007) and in the Kingdom of Saudi Arabia (Adgaba et al., 2014).

Ants, bee lice, wax moth and beetles were the major pests while birds, spiders, honey badger and lizards were identified as the major predators of bees. Beekeepers used different indigenous methods to overcome problems caused by the pests and predators including; application of ash as well as tying special ropes around the entrance of hives to serve as trap, which is often referred to as hanging the predator's neck. Other traditional methods included application of dirty engine oil on the outer sides of hives, physical killing of the pests and improving sanitation around hives.

3.3.1 Income losses due to colonies absconding from hives

Further analysis was conducted to assess financial losses arising from absconding of honeybees for both improved and traditional hives. Table 5 shows the annual average income loss due to honeybee colonies absconding from the hives. Given the total number of 103 traditional hives and 45 improved beehives, it would be possible to earn TZS 3 822 298.17 (US$ 2406.7) and TZS 2 450 597.76 (US$ 1543) per household per annum from sales of honey and beeswax. However, the actual annual

income generated from traditional and improved beehives was TZS 927 742.28 (US$ 584.2) and TZS 653 492.74 (US$ 411.5) per household, respectively. Thus, beekeepers who used improved and traditional beehives suffered income loss amounting to TZS 2 894 555.89 (US$ 1822.5) and 1 797 105.02 (US$ 1131.5), respectively (Table 5). Based on these findings, beekeepers under both technologies realised only about a quarter (25% – 27%) of potential income from beekeeping. If the root-causes were addressed, beekeepers would triple their income from this activity thereby contributing to poverty reduction and livelihood improvement.

Table 1. Comparison of honey yield (litres/hive) by location of hives

Types of hives	Apiary sites	n	Mean	Min	Max	Std. Deviation	*t*	df	Sig. (2-tailled)
Improved	Backyard	11	15.39	6	20	5.54	2.37	29	0.02**
	Forest reserves	20	10.71	3	20	5.11			
Traditional	Backyard	32	7.98	2.85	11	2.46	2.16	103	0.03**
	Forest reserves	53	6.49	0.67	18.75	3.99			

** means *p* significant at 5% level of significance.

Table 2. Beekeeping constraints disaggregated by overall sample, samples in the study regions and categories of hives

Constraints of beekeeping	Katavi		Tabora		Category of beehive users				Overall Sample Total (n=198)	
	Improved hives (%)	Traditional hives (%)	Improved hives (%)	Traditional hives (%)	Improved hives (n=36)		Traditional hives (n=162)			
					%	Rank	%	Rank	%	Rank
Shortage of bee forage	20	17	16.4	11.6	17.8	1	13.1	4	13.7	3
Presence of pests, diseases and predators	17.1	15.2	12.7	10.9	14.4	2	12.1	5	12.7	4
Inadequate labour forces	8.6	4.5	-	1.4	3.4	7	2.2	11	3.1	8
Poor infrastructure (roads to the apiary sites)	17.1	16.1	10.9	18	13.3	3	17.5	1	17.3	1
Unreliable markets	11.4	17	12.7	13.9	12.2	4	14.8	2	14.2	2
Inadequate supply of beekeeping facilities	11.4	11.6	14.5	14.3	13.3	3	13.5	3	13.6	3
Theft	8.6	4.5	7.4	5.1	7.8	6	4.9	7	5.2	6
Wild fires	-	1.8	5.5	5.4	3.3	7	4.4	8	4.1	7
Encroachment by livestock	2.9	1.7	3.6	3.4	3.3	7	3.0	10	3.1	8
Restricted entry in the conserved areas	-	1.7	3.6	3.7	2.3	8	3.2	9	3	8
Inadequate capital and poor access to credit	2.9	8.9	12.7	12.3	8.9	5	11.3	6	10	5

Table 3. Prevalence of honeybee colonies absconding from hives

Response on whether beekeeper had experienced absconding of honeybee colonies	Katavi		Tabora		Category of beehive users		Overall sample (n=198)
	Improved hives (%) (n=14)	Traditional hives (%) (n=46)	Improved hives (%) (n=22)	Traditional hives (%) (n=116)	Improved hives (%) (n=36	Traditional hives (%) (n=162)	
Yes	64.3	93.5	68.2	82.8	80.6	85.8	84.5
No	35.7	6.5	31.8	17.2	19.4	14.2	15.2

Table 4. Reasons for honeybee colonies absconding from hives

Reasons for absconding	Katavi		Tabora		Category of beehive users				Overall sample (n=198)	
	Improved hive (%)	Traditional hive (%)	Improved hive (%)	Traditional hive (%)	Improved hive (n=36)		Traditional hive (n=162)			
					Rank	%	Rank	%	%	Rank
Drought	56.5	51.9	47.2	57.3	50.8	1	55.4	1	54.5	1
Pests, diseases and predators	26.1	26.6	25	18.2	25.4	2	21.2	2	21.7	2
Shortage of bee forage	17.4	16.5	22.2	20.3	20.4	3	18.9	3	19.3	3
Wild fires	-	1.3	5.6	2.1	3.4	4	1.8	5	2.5	4
Inappropriate harvesting practices	-	3.7	-	2.1		-	2.7	4	2	5

Table 5. Average annual loss in income due to honeybee colonies absconding from hives

Variables	Types of beehive	
	Traditional beehives	Improved beehives
Average number beehives owned per household (a)	103	45
Average number of beehives harvested per household (b)	25	12
Average number colonies absconding from beehives per household (c)	78	33
Average yield of honey (litres /beehive) (d)	7.59	12.38
Average yield of beeswax (kg /beehive) (e)	1.41	1.16
Market price of honey (TZS/litre) (f)	3,859.30	3,871.60
Market price of beeswax (TZS/kg) (g)	5,544.40	5,627.00
Expected average annual total income per household (TZS) (h): (a*d*f)+(a*e*g)	3,822,298.17	2,450,597.76
Actual average annual income obtained per household (TZS) (i): (b*d*f)+(b*e*g)	927,742.28	653,492.74
Average annual income loss per household (TZS) (j): (h-i)	2,894,555.89	1,797,105.02
Annual percentage income loss per household (%): (j/h) * 100	75.7	73.3

4. Conclusion and Recommendations

Findings of this study indicate that the use of traditional beehives is associated with a higher loss of income compared to improved hives. Such losses were accelerated by beekeepers' failure to uphold good management practices, especially with respect to undertaking regular follow-ups and cleaning of beehives as well as inappropriate harvesting methods. Inappropriate beekeeping practices were found to be the root causes of honeybee colonies to abscond from hives. As remedies to such losses, beekeepers should be advised to use improved hives and uphold good beekeeping practices. The role extension service is vital in creating this awareness among beekeepers in the study area. Lessons from this study are also vital to inform policy and practices in the beekeeping sector in Tanzania and beyond.

References:

1. Abebe, W and Puskur, R. (2011). Beekeeping sub sector challenges and constraints in Atsbi Wemberta District of eastern zone, Tigray Region, Ethiopia. Journal of Agricultural Extension and Rural Development, 3(1), 8-12.
2. Adgaba, N., Shenkute, A. G., Al-Ghamdi, A. A., Ismaiel, S., Al-Kahtani, S., Tadess, Y. and Abebe, W. W. (2014). Socio-economic analysis of beekeeping and determinants of box hive technology adoption in the Kingdom of Saudi Arabia. Journal of Animal & Plant Sciences, 24(6), 1-16.
3. Backeus, I. and Ruffo, C. (2010). Tree Communities and Structural Dynamics in Miombo Woodland, Tanzania. International Journal of Forest Research, 230 (4), 178-185.
4. Begna, D. (2015). Assessment of Pesticides Use and its Economic Impact on the Apiculture Subsector in Selected Districts of Amhara Region, Ethiopia. Journal of Environmental & Analytical Toxicology, 5(3), 1.
5. Beyene, T. and Verschuur, M. (2014). Assessment of constraints and opportunities of honey production in Wonchi district South West Shewa Zone of Oromia, Ethiopia. American Journal of Research Communication, 2(10), 342-353.
6. FAO (2018). Food and Agriculture Organization of the United Nations, FAOSTAT. [www.fao.org/en/#data/QL] (Last updated 26 February, 2019.
7. Hazelhurst, S. and Milner, D. (2007). United States Department of Agriculture (USDA) Forest Service Technical Assistance Trip. 25pp.
8. Igunda, J. S. (2013). Beekeeping in Magu District, Tanzania: status, constraints and contributions to livelihoods. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 115pp.
9. Jeil, E. B., Segbefia, A. Y., Abass, K. and Adjaloo, M. (2020). Livelihood security along beekeeping value chain: lessons from Ghana's beekeeping experience. GeoJournal, 85(2): 565-577.
10. Kebede, T. and Lemma, T. (2007). Study of honey production system in Adami Tulu Jido Kombolcha district in mid rift valley of Ethiopia. Livestock Research for Rural Development, 19: 11.
11. Kihwele, D. V. N. (1985). Constraints responsible for the low quality and quantity of honey and beeswax in Tanzania: A case study of Miombo Woodlands. In Proceedings of the Third International Conference on Apiculture in Tropical Climates, Nairobi, Kenya, 5-9 Nov 1984/hosted by the Government of Kenya; convened by the International Bee Research Association...[et al.]. London: The Association, 1985.
12. Kimaro, J., Liseki, S., Mareale, W. and Mrisha, C. (2013). Enhancing rural food security through improved beekeeping in Northern Tanzania. Livestock Research for Rural Development, 25: 12.
13. Lowore, J. (2020). Understanding the Livelihood Implications of Reliable Honey Trade in the Miombo Woodlands in Zambia. Frontiers in Forests and Global Change, 3, 28.
14. Mahmood, R., Wagchoure, E. S., Raja, S. and Sarwar, G. (2012). Control of Varroa destructor using oxalic acid, formic acid and bayvarol strip in Apis mellifera (Hymenoptera: Apidae) colonies. Pakistan Journal of Zoology, 44(6), 1473-1477.
15. Marjo, V. L. and Feek, J. K. (2010). Export opportunities for African Organic honey and Beeswax. EPOPA Journal, 4, 19 - 25.
16. Minja, G. S. and Nkumilwa, T. J. (2016). The Role of Beekeeping on Forest Conservation and Poverty Alleviation in Moshi Rural District, Tanzania. European Scientific Journal, 12(23), 115.
17. Msofe, N. K., Sheng, L. and Lyimo, J. (2019). Land use change trends and their driving forces in the Kilombero Valley Floodplain, Southeastern Tanzania. Sustainability, 11(2), 505.
18. Mustalahti, I. and Lund, J. F. (2010). Where and how can participatory forest management succeed? Learning from Tanzania, Mozambique and Laos. Society and Natural Resources Journal, 23(1), 31 – 44.
19. Namwata, B. M., Mdundo, K. J. and Malila, M. N. (2013). Potentials and Challenges of Beekeeping Industry in Balang'dalalu Ward, Hanang'District in Manyara, Tanzania. Kivukoni Journal, 1(2), 75-93.
20. Nyunza, G. (2018). Anthropogenic and climatic factors affecting honey production: The case of selected villages in Manyoni District, Tanzania. Journal of Agricultural Biotechnology and Sustainable Development, 10(3), 45-57.
21. Omari, H. A. M. I. D. A. (2010). Analysis of honey value chain and honey value adding activities for traditional beekeeping. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 88pp.
22. Pirk, C. W., Human, H., Crewe, R. M. and vanEngelsdorp, D. (2014). A survey of managed honey bee colony losses in the Republic of South Africa–2009 to 2011. Journal of Apicultural Research, 53(1), 35-42.
23. Pradeepa, S. D. and Bhat, N. S. (2014). Survey on absconding of Apis cerana indica F. colonies at different traditional beekeeping areas of Karnataka. Current Biotica, 8(2), 74-178.
24. Ricketts, K. and Shackleton, C. M. (2020). Integrating livelihoods and forest conservation

through beekeeping in northern KwaZulu-Natal. Development Southern Africa, 37(4), 661-677.

25. Schäfer, M. O., Ritter, W., Pettis, J. S. and Neumann, P. (2010). Winter losses of honeybee colonies (Hymenoptera: Apidae): The role of infestations with Aethina tumida (Coleoptera: Nitidulidae) and Varroa destructor (Parasitiformes: Varroidae). Journal of economic entomology, 103(1), 10-16.

26. Schouten, C. N., Lloyd, D., Sengere, R. W. and Aranka, J. (2020). Optimising beekeeping development programs for improved productivity, income and welfare: a case study of Papua New Guinea. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS), 121(2), 195-206.

27. Songo, K. A. L. I. B. A. (2015). The value chain of honey in Bukombe district in Shinyanga region of Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 106pp.

28. Strauss, U., Pirk, C. W., Crewe, R. M., Human, H. and Dietemann, V. (2015). Impact of Varroa destructor on honeybee (Apis mellifera scutellata) colony development in South Africa. Experimental and Applied Acarology, 65(1), 89-106.

29. URT (2012). Population and housing Census. General report. United Republic of Tanzania. Government Printers, Dar es Salaam, Tanzania. 13pp.

30. Wagner, K., Meilby, H. and Cross, P. (2019). Sticky business-Why do beekeepers keep bees and what makes them successful in Tanzania?. Journal of Rural Studies, 66, 52-66.

31. Workneh, A. and Ranjitha, P. (2011). Beekeeping Subsector Challenges and Constraints in Atsbi Wemberta District of Eastern Zone, Tigray Region; Ethiopia. Journal of Agricultural Extension and Rural Development, 3(1), 8 – 12.

32. Yirga, G., Koru, B., Kidane, D. and Mebrahatu, A. (2012). Assessment of beekeeping practices in Asgede Tsimbla district, Northern Ethiopia: Absconding, bee forage and bee pests. African Journal of Agricultural Research, 7(1), 1-5.