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Impacts of cooperatives interventions on forest conservation and beekeeping: a case study of Kamaki farmers' cooperative society in Kitui county, Kenya

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Abstract

This study was designed to examine the impact of KAMAKI Farmers Cooperative Society interventions on forest conservation and beekeeping in five locations within the South Eastern part of Kitui County, Kenya. The locations included Kalivu, Athi, Maluma, Kasaala and Ikutha, collectively abbreviated as KAMAKI for the purposes of this study. Cooperative interventions empowered and provided trainings to KAMAKI bee farmers on beekeeping activities, facilitating knowledge sharing and exchange on beekeeping activities with natural resource conservation among bee farmers in KAMAKI. The specific objective of the study was to determine awareness level on the link between forest conservation and beekeeping among bee farmers in KAMAKI. Data were collected on the perception of bee farmers on the link between forest conservation and beekeeping, how bees linked to forest that enhance beekeeping, perception of KAMAKI bee farmers on the ability to plant and identify forest tree types and bee forages for beekeeping. The study adopted a purposive sampling with a sample size of 215 household respondent bee farmers across KAMAKI. Data were gathered through field explorations and observations, Focus Group Discussions and Key Informant Interviews. The data collected was analyzed through descriptive statistics by use of frequency tables. Out of the 215 household respondents bee farmers, 170 trained household respondent bee farmers (79.1%) demonstrated a better understanding on the link between forest conservation and beekeeping compared to 45 untrained household respondent bee farmers (20.9%) who had less awareness on this link. Therefore, the in-depth of the study recommends to KAMAKI Farmers Cooperative Society and Community Based Organizations to continuously provide more trainings that support beekeeping with forest conservation in order to increase household incomes of KAMAKI bee farmers.

Keywords: Cooperatives**;** Forest conservation; Honey production; Natural Resource Management; Afforestation

1. Introduction

Forests are vital sources of bee forages and synergistically beekeeping contributes to the sustainability of forests and to the overall biodiversity wellbeing. Beekeepers can significantly contribute to the sustainability of forests as well as water catchment areas by conserving the existing bee flora and promoting the growth of new plant species (Shackleton *et al*., 2011; Harugade *et al*., 2013; Krishnan *et al*., 2020). In addition to providing honeybee products, honeybees are vital to the pollination of food crops worldwide and the replication of floral diversity. For instance, on average, bee pollination has been shown to increase by 40% the production yields of crops such as sunflower, passion fruits and beans in small scale farms (Kasina, 2007).

The native *Apis mellifera* bee colonies in Africa live in forests where they collect nectar and pollen from a wide variety of flowering plants and forest beekeeping necessitates the construction and installation of artificial beehives in order to increase the number of bee nest sites suitable for honey production in a particular region (Brown, 2014). In light of the expanding human population and associated demand for land, beekeeping offers not only an economical supplement to

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traditional subsistence agriculture but also an ecologically friendly avenue to promote the conservation of natural ecosystems (Munthali *et al*., 1992; Degu and Megerssa, 2020).

The current study focused on five (5) administrative wards within South-east region of Kitui County, Kenya that are actively involved in honey production and forest conservation initiatives. The wards Kalivu, Athi, Maluma, Kasaala and Ikutha collectively make up the acronym "KAMAKI". The study area also constitutes amalgamated communities within the five operating areas of the KAMAKI Farmers' Cooperative Society (https://kamaki.or.ke/). These areas are typical semi-arid environments and beekeeping is an essential component of the farming communities. The majority of households in these areas kept bees mainly for income generation and household consumption, but also for the benefit bees offer as important components of biodiversity ultimately promoting sustainable forest conservation

For the past fifteen (15) to twenty (20) years, the KAMAKI Farmers' Cooperative Society has been operating in KAMAKI. Its goals include educating small-scale farmers about the diverse opportunities that beekeeping offers as well as providing technical trainings on improved beekeeping activities with forest conservation fostering more awareness level on the link between forest conservation and beekeeping among bee farmers in KAMAKI. This ensures that the KAMAKI beekeepers are exposed to modern beekeeping, possess beekeeping skills that led them to be more resilient to shocks, seasonality and stressors enabling them to produce adequate honey yields that generate income opportunities without exacerbating environmental degradation, enhancing forest conservation, crop production and improving the profitability of bee products and services in the present and future. Additionally, a significant forest cover of beekeeping is being conserved within the study area through the concerted efforts by the KAMAKI beekeepers. However, there is no evidence based data on the impacts of the cooperative's interventions among the KAMAKI beekeeping communities. In particular, it remains largely unknown and unquantified how the KAMAKI Farmers' Cooperative Society interventions have impacted forest and biodiversity conservation at large through beekeeping.

The present study aimed to investigate the impacts of the interventions of KAMAKI Farmers' Cooperative Society on forest conservation through beekeeping. The study also aimed to examine the impact of the cooperative's interventions on the awareness levels of the link between forest conservation and beekeeping.

2. Materials and methods

2.1. Description of the study area

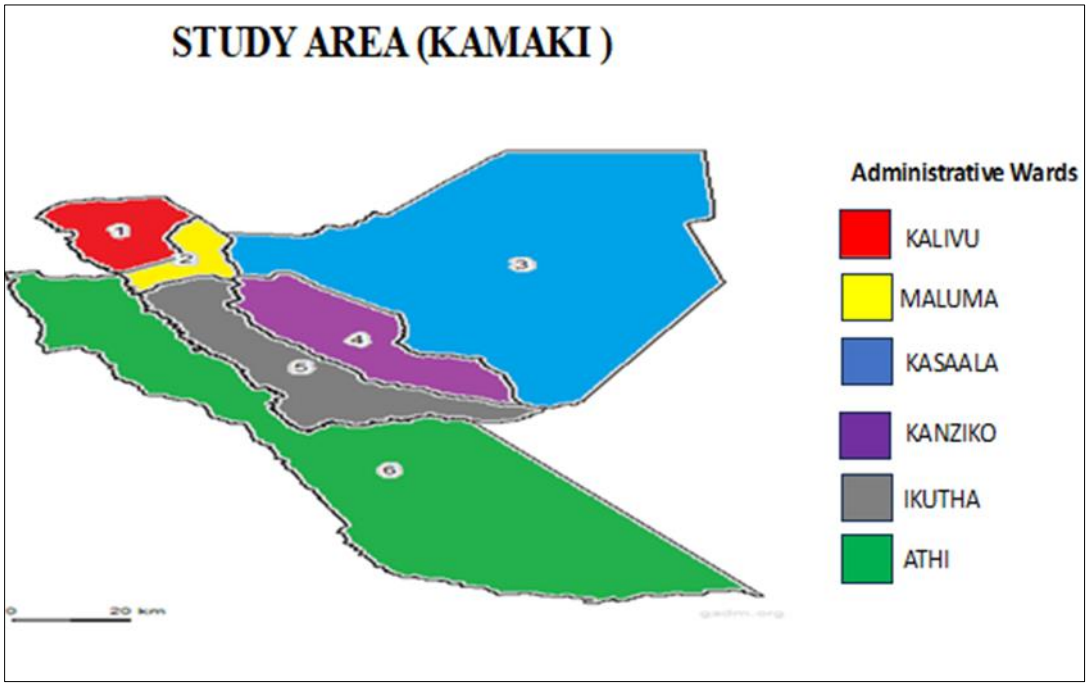

Figure 1 Map showing the Study Area

The research area lies in KAMAKI Cooperative Society's operational areas. The acronym "KAMAKI" stands for; Kalivu, Athi, Maluma, Kasaala and Ikutha in Kitui County; South-eastern of Kenya. These locations are typical Semi-Arid areas

and beekeeping is a major economic activity. In these locations. The majority of homes maintained bees in order to generate cash from the sale of honey. The study areas are shown in the map below:

2.2. Research Methodology

This research employed purposive sampling which allows the researcher to select data sources, target study areas, sample sizes and topics aligned with the specific purpose, needs and objectives of the study (Palinkas *et al*.,2015). Purposeful sampling is particularly useful for pilot studies and for in-depth investigation of a small number of representative samples for research purposes (Palinkas *et al*., 2015). Consequently, the locations of Kalivu, Athi, Maluma, Kasaala and Ikutha – collectively abbreviated as KAMAKI within the south-eastern region of Kitui County were chosen for the study. These locations exhibit varying levels of interest in beekeeping and honey market sales and are home to the KAMAKI Cooperative Society which facilitates the evaluation of cooperative impacts on beekeeping activities. Initially, 250 individuals were selected for the study, representing 50 respondents from each location of KAMAKI. Demographic data including gender, age, education levels, occupational status and beekeeping experience were recorded for each interviewed respondents. The study employed semi-structured questionnaires and a combination of data collection methods such as Focus Group Discussions, Key Informant Interviews, field explorations and observations.

2.2.1. Awareness levels among bee-farmers on the link between forest conservation and beekeeping

The first objective of evaluating the awareness level on the link between forest conservation and beekeeping, the researcher focused on honey-producing areas with bee-farming households. Semi-structured questionnaires were administered to 50 respondents to gain insights into community organization and members' perceptions of this relationship. Data included insights from respondents on the link between forest conservation and beekeeping, the types of forest trees and bee forages. Additionally, representative study participants such as; local government administrative staff and honey retailers were also included in the study due to their perceived knowledge of the bee keeping community's lifestyle. Most of the discussion with respondents focused on assessing the beekeeper's awareness of how forests support sustainable beekeeping and honey production. Leading questions were posed to help identify the types of trees and bee forages considered of relevance to beekeeping. Open-ended questions allowed the beekeepers to list tree species and bee forage types they considered more important in beekeeping. During apiaries and home visits, the researcher explored how beekeepers viewed the impacts of their every-day practices such as frequency of bee hives construction, replacement, and fumigation on the environment. Additionally, the discussions also aimed at determining if the KAMAKI beekeepers were involved in conservation practices that protect or enhance the existing vegetation.

2.3. Statistical Analysis

Descriptive statistical was used to analyze data on perception of trained and untrained bee farmers on the link between forest conservation and beekeeping and ability among trained and untrained bee farmers to identify forest trees and bee forages for honey production and forest conservation.

2.3.1. Awareness levels among bee farmers on the link between forest conservation and beekeeping

The study sought to explore respondents' opinions of forest conservation-beekeeping connection. Five aspects were considered namely: i) Bees obtain food from forest cover; ii) Bees collect pollens and nectars from trees; iii) Different trees give different products (nectar, pollen and seed); iv) Tree planting contributes to forest conservation, and v) Trees planted for climate mitigation are essential for bees (bees' attractants). The table below shows the relative distribution of respondent's responses with respect to these five aspects.

Table 1 Perception on the link between forest conservation and beekeeping in KAMAKI

Criteria	No.of Households	Percent	Valid Percent	Cumulative percentage
Bees obtain food from forest cover	80	37.5	37.5	37.5
Bees collect pollens and nectars from trees	60	27.9	27.9	65.4
Different trees give different products (nectar, pollen and seed)	45	20.9	20.9	86.3
Tree planting contributes to forest conservation	15	6.9	6.9	93.2

Trees planted for climate mitigation are essential for bees (Bees attractants)	15	6.9	6.9	100
Total	215	100	100	

Trained bee farmers in Table 4.1 above had a better understanding on the link between forest conservation and beekeeping than untrained beekeepers. Compared to untrained beekeepers (9.3%), trained beekeepers (27.9%) had a greater grasp of the link between forest conservation and beekeeping indicating that bees get food resources from forests. In contrast to untrained beekeepers (4.7%), trained beekeepers (23.3%) indicated that bees obtain pollens and nectars from trees. Compared to untrained beekeepers (2.3%), trained beekeepers (18.6%) indicated that different species of trees give different products, e.g., nectar, pollen and seeds. Compared to untrained beekeepers (2.3%), trained beekeepers (18.6%) indicated that tree planting was necessary to maintain forest conservation. Lastly, trained beekeepers (4.7%) indicated that tree planted was necessary to mitigate climate change, mostly bees get flowers compared to untrained beekeepers (2.3%) from it respectively.

3. Results

Table 4.1 above show that, trained bee farmers had a better understanding on the link between forest conservation and beekeeping than untrained beekeepers. Compared to untrained beekeepers (9.3%), trained beekeepers (27.9%) had a greater grasp of the link between forest conservation and beekeeping indicating that bees get food resources from forests. In contrast to untrained beekeepers (4.7%), trained beekeepers (23.3%) indicated that bees obtain pollens and nectars from trees. Compared to untrained beekeepers (2.3%), trained beekeepers (18.6%) indicated that different species of trees give different products, e.g., nectar, pollen and seeds. Compared to untrained beekeepers (2.3%), trained beekeepers (18.6%) indicated that tree planting was necessary to maintain forest conservation. Lastly, trained beekeepers (4.7%) indicated that tree planted was necessary to mitigate climate change, mostly bees get flowers compared to untrained beekeepers (2.3%) from it respectively.

3.1. Perception of KAMAKI Farmers on the significance of common bee forages and forest tree types for beeping and forest conservation

During key respondent interviews and Focus Group Discussions, respondents highlighted the positive impacts of various tree species and bee forages for beekeeping, honey production and sustainable forest conservation. They further identified the KAMAKI Farmers' Cooperative Society as the leading organization involved in promoting tree planting and forest management practices through training programs followed by the Kenya Agricultural Research and Livestock Organization. The predominant forest conservation practices among the KAMAKI beekeepers included protecting existing trees, re-afforestation and other forest management practices to counter deforestation.

With regard to the forages and forest trees of relevance to beekeeping, table 4.2 below gives the relative distribution of the common types planted by KAMAKI farmers. *Melia volkensii* was the most common planted plant with about 23.2% of the respondents indicating the planted the species. This was followed by *Acacia cortilis and Acacia melifera both at 20.95*% and *Acacia Senegal at* 11.6% respondents. A paltry 6.0% and 5.1% of respondents expressly planted *Phiostima thoningii, Albizia lebbek and Aazadracchta indica* respectively.

Table 2 Common Forage and plant species identified among KAMAKI bee farmers

Common/Scientific Names	Frequency	Percent	Valid Percent	Cumulative Percent
Mukoloso *(Aazadracchta indica)*	11	5.1	5.1	5.1
Kimweya *(Acacia Senegal)*	25	11.6	11.6	16.7
Ikuu *(Commiphora spp)*	14	6.5	6.5	23.2
Mua (*Acacia cortilis)*	45	20.9	20.9	44.1
Mukau (*Melia volkensii)*	50	23.2	23.2	67.3
Mukokolo (*Phiostima thoningii)*	13	6.0	6.0	73.3
Mukungu (*Albizia lebbek)*	13	6.0	6.0	79.3

Muthia (*Acacia melifera)*	45	20.9	20.9	100.0
Total	215	100.0	100.0	

4. Discussion

4.1. Awareness level on the link between forest conservation and Beekeeping in KAMAKI

The study findings showed a greater understanding among trained beekeepers compared to untrained beekeepers on awareness level on the direct link between forest conservation and beekeeping and there was higher turnout in the identification and planting of forest trees and bee forages and involvement in forest management practices for trained beekeepers compared to untrained beekeepers that enhanced and maintained the link between forest conservation and beekeeping in KAMAKI (Table 4.2). The percentage of trained beekeepers were greater compared to untrained beekeepers on varied explanation elicited on awareness level on the direct link between forest conservation and beekeeping (Table 4.1). The research findings are similar to Bradbear, (2009) who drew evidence of the positive link between beekeeping and forest management from Congo, Benin, Zambia, and Tanzania and explains that ''Apiculture's unique feature as an activity and the fact that its continuation through pollination fosters the maintenance of an entire ecosystem and not just a single crop or species. Most of the bee forages identified in the study areas were dominated by trees followed by herbs and shrubs. According to the research findings; KAMAKI beekeepers typically protected forest trees, herbs and shrubs that are predominated as honeybee forages across the landscape of KAMAKI. Similar findings were reported by Nshama, (2003) and Lalika and Machangu, (2008) who identified and reported that *Acacia spp.*, *Anacardium accidentale* , *Adasomia digitata, Phiostima thoningi, Dalbergia sissoo*, *Acacia cortilis, Eucalyptus canaldulunsis*, *Dobera glabra, Commiphora spp, Fanrea saligna, Prosopis cineraria, Albizia lebbek, Melia volkensii, Ribina pseudoacacia, Terminalia prunioides, Grensia tenax, Gliricidia sepium* were the forest trees and pollen types that honeybee foragers most favoured and beekeepers typically protected and sustained specific forest trees and bee fodder plants around their hives and actively discouraged people from cutting timbers. Similar findings of this study also indicate where KAMAKI Beekeepers also reported and identified few forest fodders like *Phiostima thoningii and Albizia lebbek* were mentioned as useful fodders for hanging hives and fumigation/baiting. Forest trees like *Melia volkensii* and *Acacia melifera* served several functions because of its abundance in all locations of KAMAKI which also found to be the most frequently used tree species for beekeeping in KAMAKI. The KAMAKI beekeepers also reported that the flowering month and flowering period depend on the activity of honeybees related to the frequency, time of visits and duration of foraging for a single type of honeybee plant (Table 4.2). Trainings and awareness raising establishment by KAMAKI Farmers Cooperative Society on knowledge about the identification of bee flora and forest trees for beekeeping helps KAMAKI beekeepers to recognize the honey harvesting season and the management of forests in KAMAKI.

Overall, the researcher discovered that all the sampled 215 household respondent bee farmers representing 100.0 % considered the existential link between forest conservation and beekeeping most of the times due to continuous engagement of planting bee forages and forest trees as well as other forest management practices. In summary, most farmers had been planting varieties of bee forages and forest trees including; *Melia volkensii, Acacia melifera*, *Acacia cortilis* and *Phiostima thoningii and Albizia lebbek* are the best bee forage and forest trees for beekeeping and honey production, while *Aazdracchta indica* and *Acacia senegal* are given the top priority by KAMAKI beekeepers as the major hive making trees. Forest tree species like; *Acacia melifera*, *Acacia cortilis*, *Phiostima thoningii and Albizia lebbek* are the most preferred trees and shrub for fumigation of hive technologies. Some tree species have cross-cutting use like *Melia volkensii* and trees like *Aazdracchta indica* and *Acacia senegal* are mentioned by respondents as useful fodder, fumigation/baiting and hanging of hive technologies for honey production. *Acacia senegal* and *Acacia cortilis* are used as a hive making and fodder trees. This affirms that there is a significant level of awareness on the link between forest conservation and beekeeping among KAMAKI beekeepers in KAMAKI (Tables 4.1 and 4.2).

The descriptive results have demonstrated a significant coverage of beekeeping forest trees and bee forage types in the study area. The descriptive data analysis also showed how KAMAKI beekeepers made it very clear that various beekeeping trees and forage types typically enhanced sustainable forest conservation, beekeeping and high honey production levels. For this reason, the KAMAKI Farmers' Cooperative Society highly motivated KAMAKI beekeepers' participation in several forest management practices through forest conservation initiatives and beekeeping training programs. The KAMAKI beekeepers typically worked on protecting and conserving smaller trees as well as large ones. in order to strengthen the awareness level on the direct link between forest conservation and beekeeping. The KAMAKI beekeepers normally engaged in some planting operations such as planting seedlings and various kinds of bee forages and bee forest trees across the landscape of KAMAKI (Table 4.2).

5. Conclusion

The analysis of awareness level on the direct link between forest conservation and beekeeping was significantly positive and related among trained and untrained household respondent bee farmers in KAMAKI. The KAMAKI bee farmers have benefited from different aspects of beekeeping and forest conservation trainings establishment by KAMAKI Farmers Cooperative Society on sustainable forest management practices which are environmentally friendly for beekeeping and honey production. The study environment was likely under minimal pressure due to KAMAKI Farmers Cooperatives Society intervention in the implementation of beekeeping projects and forest conservation initiatives establishment to farmers.

5.1. Recommendations

This study recommends that KAMAKI Farmers Cooperative Society should continuously educate bee farmers on the essential role of forests in sustaining bee populations and honey production. It also recommends to National Environment Management Authority (NEMA) and Kitui County government should to implement appropriate environmental laws to minimize forest deforestation and pollution in water catchment areas thereby conducting awareness campaigns specifically focused on forest conservation and beekeeping that emphasized on how healthy forests contribute to better bee habitats and in turn higher honey production. KAMAKI Farmers Cooperative Society should continue to incorporate the aspect of sustainability in the design and implementation of forest conservation management practices and beekeeping projects in Arid and Semi-Arid Lands (ASALs). Such sustainable forest conservation initiatives and beekeeping projects are very important in the Arid and Semi-Arid Lands (ASALs) as beekeeping projects are very important for both biodiversity, forest and water conservation. This might also help to minimize misuse of forest resources and water resources as to avoid the risk of climate change.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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