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Beekeeping adoption: A case study of three smallholder farming communities in Baringo County, Kenya

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Abstract

In Kenya, beekeeping offers benefits which could make it attractive to smallholder farmers as a possible strategy for making their livelihoods more sustainable. However, its potential remains largely unexploited and the lack of new entrants is thought to be one key reason for a decline in beekeeping. This paper reports on a study that examined the factors affecting beekeeping adoption in Baringo County, Kenya with a focus on three smallholder farming communities. Semi-structured interviews were conducted with 90 informants in these communities, including 41 new beekeepers, 21 non-adopters, 13 group leaders, 10 village elders and 5 teenagers. In addition, 28 key stakeholders at national and local levels were approached. The findings show that in high traditional beekeeping areas apprenticeship pathway is predominant, while in low traditional beekeeping areas most of the beekeepers follow the traineeship pathway. The main factors affecting the decision of smallholder farmers to take up beekeeping were access to information, land and beehives, availability of alternative income generating activities, perceptions of beekeeping outcomes and performance, access to market, feelings towards bees, and cultural norms. The importance of these factors varies according to interviewee demographics (gender, age and level of education) and location. The findings suggest that to increase the uptake of beekeeping the following should be considered: (a) increasing awareness and knowledge in all locations but particularly in the low traditional beekeeping areas; (b) improving access to improved harvesting tools (e.g. smokers and protective clothing) and to movable comb or frame hives, especially for young people and women; and (c) supporting local social networks.

Keywords: Africa, bees, honey, livelihoods, qualitative methods, semi-structured interview, sustainable livelihood framework

1 Introduction

Since independence from colonial rule, policies and interventions have been implemented in Kenya to increase the productivity of the agricultural sector, stimulate economic growth and transformation, and reduce poverty. Despite these initiatives, the population still depends mainly on small-scale subsistence farming, with households struggling to make a living (Monitoring African Food and Agricultural Commodities, MAFAP, 2013). Beekeeping, which requires very little resource, land and time, could be incorporated into the livelihood strategy of smallholder farming households in order to provide an additional source of income and to spread risk. In addition, bee products may be used domestically as food or to make traditional healthcare remedies (Lowore *et al.*, 2010).

In Kenya, there are a number of reasons why beekeeping adoption by smallholder farming households could strengthen their livelihoods:

– Honey hunting and beekeeping have been practised since ancient times by a number of ethnic groups in agro-pastoral systems (Nightingale & Crane, 1983), so indigenous knowledge and skills are locally available;

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– Kenya has an unexploited potential for beekeeping; only 8 % of the honey potential and 17 % of the beeswax potential are exploited in the country[1];
– On domestic and regional markets for honey and beeswax there is an excess of demand over supply and relatively high local prices (Bees for Development, 2006; Carroll & Kinsella, 2013);
– The Kenyan government and a growing number of development organisations have been supporting beekeepers to improve their practices, to adopt movable comb or frame (MCF) hives[2] and to access markets (Government of Kenya, 2013);
– Cultural restrictions against women keeping bees are declining (Government of Kenya, 2013).

Despite the potentially favourable impact on livelihoods and the underused potential, the number of beehives, and total honey production both declined by a third between 2005 and 2009, although the numbers have slowly increased since then (FAO, 2016).

Various factors may explain the production difficulties, such as (1) natural factors (e.g. degradation of bee habitat), (2) technical factors (e.g. poor beehive quality), (3) human factors (e.g. inadequate practices) and, (4) contextual factors (e.g. access to market) (ibid.; Muli *et al.*, 2015). Another potential factor is the lack of new entrants to replace those moving out of beekeeping (Muriuki, 2010). New entrants may be deterred because traditionally learning beekeeping has involved a long apprenticeship where fathers passed on their knowledge and expertise to their sons (Fisher, 2000; Gichora, 2003). Beekeeping is also not seen as an attractive option by women and young people due to perceived risks (e.g. falling out of trees, and bee stings) (Government of Kenya, 2013). Finally, there is limited access to formal training, credit and land, especially for women and young people (Government of Kenya, 2013; Ahikiriza, 2016).

However, in sub-Saharan Africa generally and specifically in Kenya little research has been carried out on beekeeping decline and very little in-depth qualitative information has been collected. The study aimed to fill this gap by answering three research questions:

– What have the pathways to the adoption of beekeeping been for those that have recently entered (within the last five years)?
– What are the main factors leading smallholder farmers to incorporate beekeeping into their household's livelihood strategy?
– What are the main factors preventing smallholder farmers from taking up beekeeping?

2 Materials and methods

2.1 Research methods

This research used qualitative methods to provide an in depth understanding of peoples' experiences and perceptions. Semi-structured interviews were conducted face-to-face to explore key topics such as motives and capabilities for and constraints on the adoption of beekeeping. General questions were asked first and then followed by more specific or sensitive questions. Follow-up phone interviews were conducted with some informants for two reasons: (1) when some emerging issues were not covered in earlier face-to-face interview and (2) to ask follow-up questions which emerged from analysis of interview. Baringo County was selected as the site for carrying out the research because it is one of the counties with the highest production of honey in Kenya. In addition, based on the most recently available data (Gichora, 2003), beekeeping potential there remains under-exploited, with good bee forage available, traditional skills and knowledge on hand among the communities, and an excess of demand for honey over supply.

Three rural communities were purposively selected in three smallholder farming systems of Baringo County (Fig. 1): (i) the agro-pastoral (AP) system; (ii) irrigated cropping (IR) and (iii) the mixed-farming (MF) system of the highlands.

In AP, people depend largely on pastoralism with indigenous livestock (e.g. meat goats and cattle) and rainfed agriculture with drought-tolerant crops (e.g. finger millet and sorghum) (Kenya Food Security Steering Group (KFSSG), 2015). Bekeeping is a traditional activity and farmers practise it principally using extensive production systems consisting of traditional log hives[3] dispersed in trees. In IR, the Njemps community practises mostly irrigated agriculture with food crops (e.g. maize and beans) and pastoralism with indigenous livestock. They are not traditionally beekeepers and they practise mostly extensive beekeeping. In MF,

[1]The potential of honey and beeswax is estimated at over 150,000 and 15,000 metric tonnes per annum, respectively (Muya, 2004) and the levels of production in 2013 were 12,000 and 2,500 metric tonnes per annum, respectively (FAO, 2016).

[2]The main MCF hives promoted in Kenya were the Kenya Top-Bar Hive (KTBH) for the movable comb hives and the Langstroth hive for the movable frame hives.

[3]A log hive consist of a hollowed-out log, split in half to make two troughs, and the two halves are fitted together again to make a cylindrical hive. Two lids with small holes are provided to close both open ends and allow exit and entry of bees. Log hives are quite easy to make and can last about 30 years (Gichora, 2003; Chengo'le *et al.*, 2008). However, management/harvesting of these hives is difficult, as the hives are high up on trees and the combs are fixed. They are also not environmentally friendly because they are made of threatened indigenous wood (Adjare, 1990).

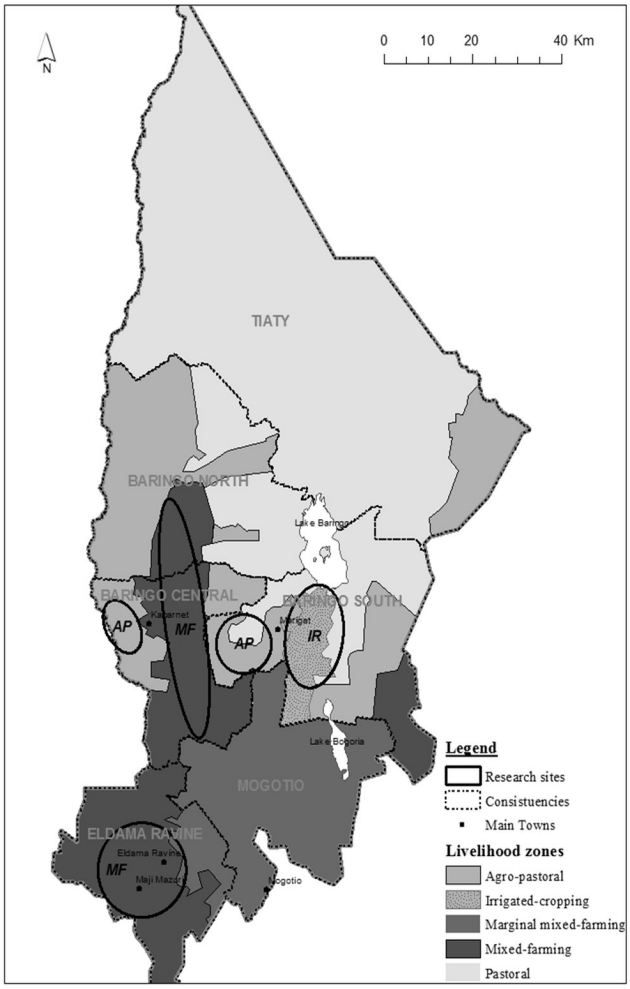

Fig. 1: *Research samplings in Baringo County, Kenya (March 2016 – July 2017).*

small and medium-size farms are predominant, with livestock production (e.g. dairy cattle and sheep) left stationary and rainfed agriculture with a large variety of crops such as food and horticultural crops (e.g. maize, mangoes and coffee). No information existed on beekeeping in MF so far. However, people are likely to be mostly engaged in intensive beekeeping systems (Carroll & Kinsella, 2013) using MCF hives[4], principally Kenyan top bar hives (KTBH), with the hives clustered together in a small piece of land called an apiary.

The honey harvesting seasons differ from one farming system to another (Carroll, 2002). In all systems beekeepers still use traditional methods[5] to harvest their honey. There are two harvesting periods in AP and IR: the main one between November and January, and the minor one between July and August. These harvesting periods occur after the rainy seasons when there are few other farming activities. In the highlands of Kenya, honey is mostly harvested between August and November, in the same period as the main food crops (e.g. maize and beans).

In each farming system, informants were identified through a purposive sampling. The following community members were interviewed (Table 1): new entrants (NE) with less than 5 years of practise; non-adopters (NA)[6]; group leaders (GL); village elders (VE) and children (CH) aged between 12 and 16 years old. A range of key stakeholders of the beekeeping sector at national ($n = 19$) and local levels ($n = 9$) were also interviewed: from academic centres (AC; $n = 3$), development organisations (NGO; $n = 8$), governmental bodies (GB; $n = 10$), independent consultants or retired people (CN; $n = 2$), and private enterprises (PE; $n = 5$). The informants in the communities were identified and recruited with the help of gatekeepers, and a few additional people were approached on the recommendation of the initial interviewees.

2.2 Data collection and analysis

Interview guides were developed for each type of informant, with a list of topics. The beekeepers were asked directly about their own experience: their motivations and capabilities for adopting beekeeping and what made it easier or more difficult to do so. Similarly, the non-beekeepers in the communities and the key stakeholders were asked to give their perceptions of the adoption of beekeeping, based on the people they knew, to provide another perspective.

The interviews were conducted in English with the key stakeholders and in the local language with community members. Two teams of two local researchers (one man and one woman) with experience of interviewing were recruited and trained. One carried out the interview and the other took detailed notes. Female interviewers were specifically recruited to interview the women.

Before starting the study, ethical approval for the research was obtained through the research governance procedures of the University of Aberdeen. Before each respondent was interviewed, he or she was told the purpose of the study, that their participation was voluntary, and that their privacy and confidentiality were assured. After agreement, they were asked to sign a consent form – in Kiswahili for the communities' members and in English for the key stakeholders. Detailed notes were taken by the local interviewers and the interviews with the key stakeholders were audio-recorded. Finally, transcripts were analysed and data coded by topics (e.g. beekeeping adoption), themes (e.g. reasons for non-adoption) and sub-themes that emerged from the data (e.g.

[4]MCF hives are beehives where bees are encouraged to attach their combs to beeswax foundation sheets on movable frames or to construct their combs from the undersides of a series of top-bars. These top-bars then allow individual combs to be lifted from the hive by the beekeeper (Bradbear, 2009).

[5]Beekeepers use a smouldering stick to drive away the bees and do not use protective clothing.

[6]A sample of people who are not keeping bees were matched to the profile of the new entrants from the same specific area or village.

Table 1: *Informants interviewed at community level.*

	AGRO-PASTORAL	IRRIGATED CROPPING	MIXED-FARMING	TOTAL
NEW BEEKEEPERS	**14**	**7**	**20**	**41**
Female	**4**	**5**	**10**	**19**
Youth - 30 or younger	0	1	4	5
Adult - Older than 31	4	4	6	14
Male	**10**	**2**	**10**	**22**
Youth - 30 or younger	5	0	4	9
Adult - Older than 31	5	2	6	13
NON-ADOPTERS	**5**	**4**	**12**	**21**
Female	**2**	**2**	**6**	**10**
Youth - 30 or younger	0	2	3	5
Adult - Oder than 31	2	0	3	5
Male	**3**	**2**	**6**	**11**
Youth - 30 or younger	2	1	4	7
Adult - Older than 31	1	1	2	4
VILLAGE ELDERS	**4**	**2**	**4**	**10**
GROUP LEADERS	**2**	**2**	**9**	**13**
Female	**1**	**1**	**4**	**6**
Youth - 30 or younger	0	0	0	0
Adult - Older than 31	1	1	4	6
Male	**1**	**1**	**5**	**7**
Youth - 30 or younger	0	0	1	1
Adult - Older than 31	1	1	4	6

beekeeping performance). Themes, subthemes and the different types of informants were linked to identify patterns and formulate recommendations.

3 Results

The empirical results are presented under three subheadings corresponding to the three research questions:

3.1 Pathways to beekeeping

Two principal pathways to beekeeping were identified among the communities studied: an *apprenticeship pathway* and a *traineeship pathway* (Fig. 2). These pathways may be differentiated by three main characteristics: the trainer, the knowledge exchanged and the teaching methods.

3.1.1 Apprenticeship pathway

The first pathway is the traditional one: it involves only community members, indigenous knowledge and mostly on the job practical training. A majority of the interviewees that entered beekeeping *via* the apprenticeship pathway were men from ethnic groups that have traditionally kept bees (e.g. Tugen and Keiyo people) and live in AP where beekeeping has been widely practised for many generations. Two sub-pathways may be distinguished depending on the type of trainer (a family member or a skilled beekeeper in the community): the *intra-familial pathway* and the *extra-familial pathway*, with a majority having come *via* the intra-familial pathway.

In the *intra-familial apprenticeship pathway*, knowledge and skills are transferred from older to younger generations. In the past, new-entrants from this pathway became involved in beekeeping by helping a relative (usually a grandfather or father, but in a few cases an uncle or an elder brother) during harvest. They were mostly boys in their early teens (between the ages of 10 and 14 years). Nowadays, young people who follow the intra-familial pathway start their apprenticeship training later, at approximately 18 years of age. A key stakeholder's explanation for this was that children are more likely to be in school than they were in the past[7] and thus not at home to be trained. However, on-the-job training has always been carried out in the evening, usually during weekends. Most beekeepers, nowadays prefer to teach their children after they have finished secondary school as a fall-back in case they are not able to get employment using their educational credentials. For instance, GL3 in AP explained: "*I don't plan to train my children now because of fear that they will drop out of school if they are able to earn money from beekeeping*". Young people who enjoyed helping to harvest continued to help and to learn more about beekeeping. For instance, NGO1, a local development actor, explained: "*Then, I was allowed to climb a tree and assist my father by holding a traditional smoker or holding a container to collect honey*". Apprenticeship training is focused on traditional methods of honey production, in particular harvesting, but

[7] The Kenyan government enacted the provision of free and compulsory education at primary level in 2003.

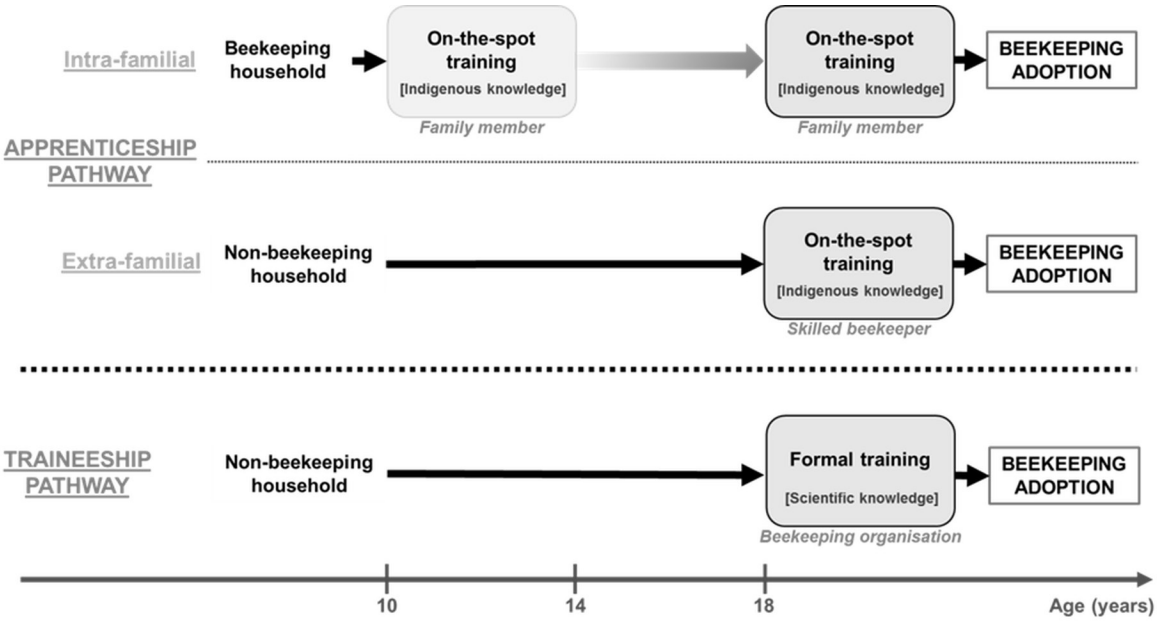

Fig. 2: *Pathways to beekeeping.*

also on how to make and install traditional log hives. Once trained, the young people usually helped their parents with beekeeping activities. They did not set up their own beekeeping enterprise before they had their own household. These new independent beekeepers mostly used inherited or handmade log hives. Some beekeepers started beekeeping with MCF hives (mainly KTBH) after this pathway. However, they were older and had already set up their own enterprise. They bought the hives from personal or family savings or they received them through community-based-organisations (CBOs) (as a donation or loan). A majority of men took up beekeeping on their own after finishing secondary education and before marriage, and were between 18 and 30 years old. Women started later, from 25 onwards, and tended to be married.

In the *extra-familial apprenticeship pathway*, the interviewees mentioned only the training stage before adoption. All of them came from non-beekeeping households and they were taught by skilled beekeepers in the community. They received the same information as the ones from the intra-familial pathway, through similar methods. They started on their own during or just after the training. For instance, NE5, a 35-year-old in IR, said: "*Mr X introduced me to beekeeping. He taught me how to harvest and he invited me to go with him and practice it before I started on my own*". The initial equipment and the age of taking up beekeeping on their own were much the same as for the intra-familial pathway.

3.1.2 Traineeship pathway

In contrast to the apprenticeship pathway, in the second pathway the people learned about beekeeping through formal training provided in an urban area by a formal training organisation (e.g. Baraka College and livestock officers). The training sessions often comprised one or several short seminars and more rarely a period of full-time training. Training was provided mainly on bee health, pollination and business management. Most of the training sessions were provided free, through a partnership between NGOs and livestock officers or a private enterprise. According to many community members and key stakeholders, the main criticism of these training sessions was that they contained too much theory and lacked practice in the field. Most beekeepers from this pathway started beekeeping on their own just after training, using MCF hives and working in CBOs. The beehives were donated or loaned from beekeeping organisations (e.g. development organisations or governmental bodies) or purchased from CBOs' savings. Generally, the producers from this pathway were older than the traditionally trained beekeepers when they took up beekeeping, usually over the age of 30. The respondents who had followed the traineeship pathway were mainly women, members of ethnic groups that were traditionally not beekeepers (e.g. the Njemps people), or people living in MF where a minority of the farmers are beekeepers[8].

[8]This aspect was mentioned by most informants as NGO6, a development actor in MF. He said "*About 30 % of the farmers keep bees in the highlands*".

3.1.3 Changes in pathways or beekeeping adoption

Although no recent data are available on the numbers of people that have attended training in Kenya, the majority of the key stakeholders said that the number being trained by formal training organisations is increasing; in particular women are taking it up. Further, many said that the apprenticeship pathway is declining as a path into beekeeping. Finally, a majority of the informants said that the number of beekeepers is increasing in the MF and IR but decreasing in AP [9].

3.2 Factors preventing beekeeping adoption

3.2.1 Lack of knowledge and awareness

According to most informants, the principal obstacle to beekeeping adoption is not growing up in a beekeeping household and not being offered the opportunity to attend a seminar on beekeeping. For instance, NA2, a 29 year-old man in IR said: "*I have never attended any seminar on beekeeping. None of my relatives at home practice beekeeping and that is why I have never been involved in it*". Respondents in MF and IR were more likely not to be aware of the potential of beekeeping as a livelihood option. When asked specifically a large majority said that they were not aware of the possibility of being invited to a seminar. Furthermore, there was no evidence that they had independently sought out the possibility of training.

3.2.2 Priority to other activities

Many informants preferred livelihood activities with higher and regular incomes , education (cf. 3.1.1) or domestic activities to beekeeping. Paid employment (e.g. as officials or in trade) was identified as the preferred and prioritised activity by all types of informants in all locations, whether beekeepers or not.

> "*I prefer my job in the County Government because the income is higher*" (NA16, a 28-year-old woman in MF).

Self-employment off-farm (e.g. as trader or casual labourer) activities were also preferred in all farming systems to beekeeping, and in MF and IR on-farm activities (e.g. tending crops and dairy farming) were also mentioned as preferred alternatives to beekeeping.

> "*I prefer dairy farming because I get income on a daily basis from my dairy cows*" (NE24, a 39-year-old man in MF).

VE10 in MF also mentioned that there are now more alternative income generating activities than in the past and young people can prioritise these at the expense of beekeeping. He said: "*In olden days it was only about animal keeping and beekeeping as a source of income. For today, there are so many activities that one [a young person] can undertake to earn a living*".

Several informants, including women, mentioned that women lack time due to their domestic responsibilities, in addition to other farming or income generating activities. Thus, women are less likely to take up beekeeping.

3.2.3 Negative perceptions of beekeeping

The attractiveness of beekeeping was also affected by a number of negative perceptions. A majority of the informants explained that non-adopters perceived it as poorly remunerated and hard manual work which did not fit their image of a modern job.

> "*The income earned from beekeeping is low and it would not sustain me and my family*" (NA18, a 32 year-old man in MF).
>
> "*The young people think it is labour-intensive work*" (GB3, a local livestock officer).
>
> "*Nowadays young people see beekeeping as old fashioned*" (NE41, a 36 year-old woman in MF).

Young educated people wanted non-manual jobs with high and regular incomes. Thus, they considered beekeeping as something for uneducated and poor people and as being appropriate for older people.

> "*People think it is for poor people who have no other choice*" (GB5 in MF).
>
> "*People go to school and after school young people are expected to find a job and not to keep hives again! This is the parents' expectations. They think beekeeping is a job for old men and not for educated people. If you are a lady, you have to get married or to become a teacher. Life must improve after education. It should be a blessing for the whole family!*" (RI1, a national researcher).

3.2.4 Lack of land and environmental issues

Lack of land was also an obstacle. In AP, many informants no longer had enough trees on their lands (individual or communal lands) to make a log hive or to hang it, whereas in MF, many beekeepers had insufficient space on their own lands to set up an apiary. Many community members in the highlands said that beekeeping is not possible, because the climate is too cold and the nectar is of lower quality. However, GB5 in MF argued that it is not true because: "*[. . .] there is more bee forage in the highlands and so more potential than in the lowlands*". In IR, climatic shocks like floods were reported as a key reason for people not taking up beekeeping or for abandoning it. For instance, NA5, a 32-year-old man, said that he used to keep bees but he stopped when

[9] As the population is growing significantly in Kenya, including in this region, it is more likely that the actual number of beekeepers in AP is increasing but that they are declining as a proportion of the population.

his ten beehives were swept away by floods. Finally, in MF, which is characterised by a high population density, people considered beekeeping not compatible with farming for two main reasons: competition for land with other agricultural production, and risk of neighbours complaining about being stung by bees.

"*They can stop [keeping bees] in places when landholdings are small and you have conflicts with your neighbour. The problem is the distance between the beehives and the neighbours. Sometimes people are very biased against bees*" (GB1, a national livestock officer).

"*Farmers know by experience that pyrethrum kills bees. Pesticides are also a problem. There is a conflict between crop farming and beekeeping*" (GB5 in MF).

3.2.5 Socio-cultural restrictions

Socio-cultural norms were reported as a key factor preventing women from becoming beekeepers using traditional systems. Women are not expected to keep bees because climbing trees to harvest log hives is seen as too difficult and risky for them. Furthermore, GB3, a local livestock officer, explained: "*Women could not take part because the men are removing their clothes and their gloves and they climb and they harvest mainly at night. Only men can do that*", while AC1, a national academic, pointed out that there is a superstition that: "*If a women opens a beehive, the bees will abscond*". In the Njemps community, women were not even allowed to manage MCF beehives unless working with men. For instance, NE15, a woman in IR, said: "*We installed our first five beehives [KTBH] but later the village elder forced us to remove them because of the Njemps norms. Women are not allowed to keep beehives unless assisted by men in our society*". Another informant mentioned that a man expected not to take up beekeeping if a forefather died while practising it. He said: "*The father of my father fell from the tree during harvesting and died. So I am not supposed to practise beekeeping*" (GB4 in AP). However, a number of key stakeholders informed us that these traditional beliefs and restrictions are fading away.

3.2.6 Fear of bees

Fear of bees influences people's feelings towards beekeeping. Many key stakeholders and community members, in particular in MF and IR, mentioned that non-adoption was due to the perception that bees are dangerous. For instance NA13, a 25-year-old man in MF, explained: "*I decided not to keep bees because they are dangerous to human beings and animals*". A number of beekeepers said that they were afraid of bees when they first became beekeepers. NE14, a 29-year-old woman in IR, said: "*I feared bee stings when I started but later came to realize that bees do not sting unless they are disturbed*".

3.2.7 Limited access to beehives

Difficulty in obtaining beehives is another factor preventing people, especially young people, from taking up beekeeping. A number of beekeepers from the traineeship pathway did not take up beekeeping because they found it difficult to get MCF hives especially purchasing Langstroth hive[10]. As formal training is focused on MCF hives, if they cannot get a MCF hive, they do not have the knowledge and skills to manage or make a log hive.

The few informants who followed the apprenticeship pathway and experienced difficulties in obtaining a hive cited lack of knowledge and/or wood, tools or time to make one.

3.2.8 Lack of knowledge on honey marketing

A few beekeepers mentioned the marketing of the honey as a barrier to taking up beekeeping, in particular, knowing how and where to market it. For instance, NE11, a 31-year-old man in AP, said: "*marketing was a big problem when I started beekeeping because I didn't know how and where to sell my honey*". This issue was very rarely mentioned by the key stakeholders. In contrast, beekeepers generally said that they could easily sell raw or semi-refined honey to a range of customers (e.g. intermediaries and neighbours). So, a lack of knowledge about marketing honey does not seem to be a key barrier.

3.2.9 Beekeeping threats

A number both of beekeepers and of non-adopters said that empty beehives and pests (e.g. honey badgers (*Mellivora capensis*)) discourage some people from taking up beekeeping, or in some cases, lead them to abandon it, as these threats lead to low productivity or having nothing at all to harvest. Empty beehives at harvest time is a common issue either because the bees did not colonise the beehive or because they absconded before harvesting for a variety of reasons (e.g. lack of bee forage, smoke from nearby charcoal production sites). We found that only a few informants in the communities knew how to catch a swarm to colonise a beehive.

"*I attempted to practise beekeeping but abandoned it because the bees do not move into the beehives*" (NA8, a 28 year-old woman in MF).

"*I heard of a few cases were modern beehives (MCF hives) have been abandoned. This is due to bees not having colonised the beehives and the owners not knowing how to trap bees into them*" (NE37, a 32-year-old man in MF).

[10] A KTBH and a Langstroth hive cost respectively two and three times as much as a log hive. MCF hives are never made by the beekeepers themselves because they are complex and require expensive woodworking tools.

3.3 Factors positively influencing beekeeping adoption

3.3.1 The outcomes of beekeeping

The principal factor leading people to take up beekeeping was the income generated from selling honey, especially for those who took it up before the age of 30. It was generally seen as a way of supplementing income rather than as the only or main livelihood activity. For many, especially young people and those living in AP and IR, it was an important way to supplement income from subsistence farming when no other alternatives were available. For example, NE16, a 25-year-old man in AP, said: "*It is difficult to raise enough money to pay school fees. So, I thought of beekeeping as an alternative source of income for me and my family*", while CH5, a 15-year-old girl in AP said: "*I want one day to become a beekeeper and to practise it as a hobby or part time job that can bring me an income while I am in my office*". The priority is given to employment with high and regular income but this does not necessarily mean that beekeeping cannot be taken up as well.

Although the majority of beekeepers considered it a profitable activity, it was generally an additional activity and rarely the principal source of income. However, for some it was their only source of income. For example, NE37, a 32-year-old man who started beekeeping at the age of 28, told us: "*I stayed at home for 2 years after my degree without any job opportunities. This prompted me to start beekeeping as an alternative source of income*".

Market opportunities such as the presence of customers and an attractive price were also important inducements to venturing into beekeeping. These factors were mostly reported by group leaders and key stakeholders.

> "*Many are keeping bees because of the high demand for honey and the available market*" (GL9 in MF).
>
> "*People in the village know who has beehives and they will ask you for honey. Even if you want to give up, people will encourage you to continue*" (GB1, a national livestock officer).
>
> "*Beekeeping is a most profitable activity because the price of honey is usually very high compared to the labour it takes*" (NE4, a 48 year-old woman in AP).

While income is the greatest motivation for starting beekeeping, for some informants honey and beeswax were also important, for their own domestic uses. Many beekeepers said that they usually sold most of the honey they produced and kept only a small amount for own use. Respondents told us that they use honey as a food, as a medicine for themselves and their animals, for brewing honey beer, as dowry payments and as gifts for visitors. According to the key stakeholders, traditional uses of honey have become less common, in particular beer brewing and payment of dowry.

Some women were also attracted to start beekeeping on their own in order to have more control over their life, especially by controlling honey uses and incomes from beekeeping. For instance, NGO2, a national development officer, explained: "*Women are interested in beekeeping because [. . .] they can have cash. [. . .] Because men are careless about decisions on the cash they get from their business. Women love that power of decision*".

3.3.2 Available assets

The second category of factors which play an important role in beekeeping adoption is the availability of assets. Social networks are important, as skilled beekeepers are a source of aspiration and motivation. As illustrated below, children were influenced by their parents, men by an elder and women by seeing others in the community doing it.

> "*I went harvesting with my father and this motivated me to become a beekeeper*" (NE10, a 30-year-old man in AP).
>
> "*I took up beekeeping because an old man in my community encouraged me to take it up*" (NE5, a 35-year-old man in IR).
>
> "*I decided to start because everybody was doing it in the village, so I decided to do it too*" (NE4, a 48-year-old woman in AP).

Beekeeping knowledge and skills (human capital) are also essential for starting beekeeping. Besides the invitation to participate to one or another type of training, GB1, a national livestock officer, mentioned that learning how to avoid bee stings is important. She said: "*People become interested in beekeeping when they are made aware that it is possible to protect themselves from bee stings*".

Availability of physical capital such as beehives, harvesting tools (e.g. smokers and protective clothing) or land, also seems to be a great help when taking up beekeeping. Many beekeepers informed us that they were able to start beekeeping because they inherited one or more beehives and/or materials to make log hives were locally available.

> "*If they [the young people] venture into beekeeping, it is because they inherited beehives*" (GL9 in MF).
>
> "*The availability of materials to make beehives also helped me to decide on the activity*" (NE33, a 26-year-old man in MF).

Many producers from the traineeship pathway took up beekeeping thanks to donations (e.g. equipment and tools) or loans (money and equipment) provided by development organisations or livestock officers. For example, NE18, a 32-year-old woman in TH, said: "*Our group [SHG] was motivated to keep bees by Hand in Hand East Africa, which gave us seven free Langstroth hives*".

According to a few producers, beekeeping was preferred to other income-generating activities because of the low inputs required. For instance, NE13, a 35-year-old woman in

IR, said: "*Our group [SHG] was once invited to Marigat by the Kenya Red Cross society [. . .] we were taught beekeeping and poultry farming. When we went back to the village we decided to do beekeeping as it required less capital investment compared to poultry farming*".

Financial capital was also an important factor. For instance, VE7 in MF explained: "*At this age [late twenties], they have sufficient capital to enable them to purchase one or two beehives to start their enterprise with*".

Finally, natural capital was clearly reported as also being important. Key stakeholders cited the favourable ecological conditions (e.g. presence of bee forage) required to take up beekeeping. In addition, a majority of the key stakeholders and the informants in MF talked about the benefits of beekeeping for the natural environment such as forest conservation and pollination. It is unlikely that these aspects were direct incentives to start beekeeping. However, as these aspects were promoted during seminars, these would probably have had a positive influence on the perception of beekeeping and in turn beekeeping adoption among the trainees.

3.3.3 Mitigation risks

A number of community members talked about beekeeping as a strategy for mitigating risks and stabilising household incomes. According to them, beekeeping is better suited to the climatic conditions than other types of agricultural production. For instance, NE10, a 30-year-old man in AP, said: "*Beekeeping is less vulnerable to climate conditions than crops or livestock*" and VE1 in AP explained: "*I prefer to keep bees because it is not like cattle and goats; bees are not adversely affected by change in rain-fall patterns, though they are somewhat affected by lack of water, but they do not die in drought like other animals*". In a few cases, beekeeping adoption was presented by the informants as a strategy to spread climatic risks associated with other forms of agricultural production, or to cope after a climatic shock such as drought. For instance, NE9, a 35 year-old man in AP, is an interesting example. "*I started beekeeping two years ago when the climatic conditions were so harsh that it resulted in the failure of mangoes and vegetable crops and left me without any income. At that time I had not secured a job at X. I was really affected and my brother advised me to diversify my source of income such that when one sector was not doing well, the other sector was doing well*".

3.3.4 Beekeeping performance

Perceived performance was another key factor influencing beekeeping adoption. Many informants explained that producers spend little time on beekeeping because bee colonies colonise beehives naturally and it is usually not necessary to manage log or MCF hives to produce honey. The principal activities were to install and harvest beehives. For instance, NE5, a 35-year-old man with four log hives in IR, explained: "*Beekeeping doesn't need a lot of time after the installation of the hives. I can leave them until harvesting time comes, unlike other activities [irrigated crops and livestock] which need daily supervision*". Some new entrants also mentioned that little strength or physical activity is required. NE36, a 58-year-old man in MF, even mentioned that he could practice it in his old age. He said: "*Beekeeping requires less effort for my old age*". Finally, many informants mentioned that they started beekeeping because they perceived it as a profitable activity to start or maintain with low start-up and running costs.

> "*The reason why I started beekeeping is because of the profit my father was getting. Because he was able to provide everything for my family through beekeeping*" (NE22, 36-year-old man in AP).
>
> "*The main reason why we started beekeeping is that it is cheaper to start than other forms of agricultural production*" (GL1, a group leader in AP).

However, these factors were rarely reported by the beekeepers in MF.

3.3.5 Attractiveness of MCF hives

Many key stakeholders and a few beekeepers reported the attractiveness of MCF hives. Firstly, MCF hives were a way for young people to practice beekeeping easily and safely. GB3, a local livestock officer, summarised this aspect as follows: "*The young people want something easy to do. [. . .] So, they are interested in beekeeping thanks to the modern technologies*".

Secondly, using MCF hives was a way to modernise the image of beekeeper for some producers in IR and MF. For instance, GB4 explained: "*They [the Njemps people] have started recently when the new technologies came in. The good point is that you are not considered as a poor person*".

Finally, MCF hives improved accessibility for women. As explained by PE4, a national entrepreneur selling frame beehives, they do not need to climb trees to manage their beehives. He said: "*They are mostly in modern beehives since it is accessible to them. No need for a lot of energy*".

3.3.6 Social norms

Finally, social pressures were identified as a factor affecting the adoption of beekeeping in two situations. Firstly, some children were pressured to keep bees by their parents. Concerning this, PE5 said: "*Beekeeping was like an obligation. I had to continue what my parents did*". Secondly, a few informants with traditional religious beliefs pointed to the importance of producing honey to participate in traditional ceremonies: "*During traditional ceremonies like weddings, honey is a compulsory ingredient. It is used to make honey beer that is taken by the old men before the initiation of any wedding activity*" (VE3 in IR).

4 Discussion

This study confirms that AP is a high traditional beekeeping area because most of the farmers are beekeepers and follow the *apprenticeship pathway*. Furthermore, beekeeping adoption was particularly favoured by the accessibility of log hives and social pressure. In MF and IR, a few farmers were beekeepers and the *traineeship pathway* was important. The main barriers[11] were limited access to formal training and technologies and negative feelings towards bees, especially among women and young people. Thus MF is a low traditional beekeeping area, as IR. In all farming systems, formal knowledge has been gaining in importance with the development of training opportunities offered to beekeepers and a growing number of people follow the traineeship pathway. However, there is no evidence that more formal knowledge has been incorporated into apprenticeship training. Furthermore, the loss of indigenous knowledge did not appear prominently in this study as assumed by Muli & Frazier (2011). The three smallholder farming communities present other differences discussed below depending on socio-cultural norms, climatic conditions and socio-economic context.

The main factors mitigating for or against the adoption of beekeeping which emerged in this study are:

(1) Men are more likely to take up beekeeping, especially in the apprenticeship pathway, because women face a number of barriers' including socio-cultural restrictions and the lack of time available to keep bees in addition to their other activities (e.g. farming and household responsibilities). Furthermore, many informants, women and men, said that it is difficult for them (women) to harvest honey from the log hives which are hung high in trees. Therefore, they face additional costs compared to men, because they have to hire men to harvest the honey or use expensive MCF hives[12] (Baraka Agricultural College, 2016). This finding is in line with that of Ahikiriza (2016) in Uganda. However, the current research did not identify, as she did, any difficulty for women in accessing technologies and training. In contrast, many key stakeholders said that women have been receiving growing support to access formal training and technologies. On the other hand, this study showed that traditional attitudes do change and women are attracted by this activity as it enables them to generate an income and take more control over their lives. Women's access to beekeeping is likely to improve in the coming decades, especially via the traineeship pathway.

(2) Access to beekeeping tends to be more difficult for young people. The first reason is that most young people from non-beekeeping households have quite negative perceptions of beekeeping. The second reason is that this activity is not an attractive option for young educated people, even for those living in high traditional beekeeping areas. They prefer non-manual and more secure salaried employment. Therefore, this study confirmed Muriuki's (2010) assumption that young people are reluctant to take up beekeeping because negative attitudes. It also suggested that one possible reason for the decline in new entrants to beekeeping in Kenya is the growing importance of education, which makes beekeeping less popular among young people. In other words, there is a negative relationship between level of education and involvement in beekeeping, as it is the case with other forms of agriculture in Africa (Asciutti *et al.*, 2016). On the other hand, education does not necessarily mean that people cannot keep bees. Indeed, access to knowledge and awareness on beekeeping benefits were found to support beekeeping adoption, even among educated people. The latter can take it up to supplement their other livelihood activities. Furthermore, some young people in AP end up in beekeeping because there is no alternative employment. The final reason preventing young people from moving into beekeeping is that MCF hives and improved harvesting tools are attractive to young people, but they cannot easily access these items. As Ahikiriza (2016) pointed out, improved equipment and tools are more expensive than traditional ones, and young people have limited resources and difficulty in accessing capital unless they are involved in CBOs.

(3) We also noted that the factors influencing adoption vary depending on the climatic and socio-economic contexts. In MF and IR, on-farm activities were preferred alternatives to beekeeping. Indeed, agriculture in general is favoured in these locations thanks to colder and damper climate or presence of irrigation schemes. In contrast, beekeeping was considered as an important income-generating activity in AP. Smallholder household incomes are indeed more vulnerable to climatic risks affecting farming incomes.

(4) Finally, knowledge on honey marketing was considered by a few beekeepers as a constraint, whereas the key stakeholders and the group leaders perceived selling the honey as a positive factor for beekeeping adoption. Thus, this finding may confirmed the argument of Lowore *et al.* (2010) that beekeepers do not necessarily benefit from a high local demand. A proactive behaviour is needed to seize market opportunities and CBOs are better positioned to do so than individual beekeepers, especially in remote areas.

In order to support beekeeping adoption, efforts should be focussed on continuing and intensifying initiatives that increase awareness and knowledge, particularly in low traditional beekeeping areas. Early awareness at school may be effective in raising motivation and reducing inequalities or negative perceptions and feelings based on false informa-

[11] These factors were also mentioned as key constraints for beekeeping development in Kenya, especially in the highlands (Carroll, 2002; Muya, 2004; Muriuki, 2010).

[12] A KTBH and a Langstroth hive cost respectively two and three times much as a log hive.

tion. In addition, better access to improved harvesting tools (e.g. manufactured smokers and protective clothing) and MCF hives could help to limit fear of bees and facilitate beekeeping access, especially for young (educated) people and women. However, three disadvantages of MCF hives, especially Langstroth hives, have been noted: high costs, lack of skills, and low occupation rates. These issues, also raised by Bradbear (2002), would have to be addressed by key organisations supporting beekeepers in Kenya to ensure sustainable benefits and the continuation of this activity. Finally, we suggest that key organisations, particularly formal training organisations, and skilled beekeepers willing to share their experience, along with the CBOs, be supported to improve access to knowledge and technologies.

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