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Honey production systems (*Apis mellifera* L.) in Kaffa, Sheka and Bench-Maji zones of Ethiopia

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Southwest parts of Ethiopia particularly Kaffa, Sheka and Bench-Maji zones are endowed with very diverse and dense natural forests. This favours for the existence of dense honeybee population and production of large volume of honey. However, detail information on honey production systems of the area was lacking. In this study five representative districts were selected and data on beekeeping practice and its major constraints were collected. Traditional beekeeping system is practiced by more than 99% of beekeepers. The average traditional hives owned/household in Masha and Gesha were significantly higher ($P < 0.05$) than Gimbo, Chena and Sheko districts. Honey yield per traditional hive/harvest in Masha and Gesha were significantly higher ($P < 0.05$) than Gimbo and Chena districts. In the study areas honey contributes 50% of the total household incomes. The major proportion of the honey comes from forest beekeeping. In Kaffa and Sheka Zones, honey harvesting is done by removing all the content of the hive by discarding the colony while, in Bench-Maji Zone, harvesting is done by leaving all brood and some honey to maintain the colony. Prevalence of ant attacks, less adoption of improved beekeeping technologies and management practices, lack of practical skill training, under utilization of apicultural resources are the major constraints which require attention to be intervene.

Key words: Forest, beekeeping practice, honey, beekeepers.

INTRODUCTION

The contrast agro-ecological conditions and availability of diverse floral resources make Ethiopia as one of the very conducive place for the existence of 10 millions of honeybee colonies (Ayalew, 2001), of which farmers keep about seven million in hives and the remaining exist as wild in forest and caves (EMA, 1981). Beekeeping is a long standing practice in the farming communities of Ethiopia (Ayalew and Gezahegn, 1991). More than one million households are estimated to keep bees using traditional, intermediate and modern hives (Gidey and Mekonen, 2010). The annual honey production of Ethiopia is estimated to be 45,300 metric tons which

makes the country to rank first honey producing country in Africa and ninth in the world (FAO, 2010). In the country, more than ten types of traditional hives are used with an average honey yield of 5 to 8 kg per colony per year, the variation of hives is based on their volumes, shapes and the type of materials used to construction (Nuru, 2007). Despite the high potentiality of the country for beekeeping and its extensive practices, beekeeping research conducted in the nation so far did not cover to characterize and document the apicultural resources and associated constraints of the sector for its proper intervention and utilization to specific potential regions (Chala et al., 2012). Having of detail information on the available resources and identifying the challenges are very essential in the formulating of appropriate development strategies for proper utilization of the available

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Figure 1. Map of the study areas. Source: NTFP, 2006.

potentials in a sustainable ways. Southwest parts of the country in general and Kaffa, Sheka and Bench Maji Zones in particular are very potential for beekeeping (Figure 1). The areas are endowed with natural tropical rain forests with suitable climates that favour high honeybee population density and forest beekeeping is widely practiced (Nuru, 2007). Based on morphometric and geographical distribution analysis honeybees from southwest Ethiopia are classified as *Apis mellifera scutellata* (Amsalu et al., 2004). From these honeybee colonies large volume of honey is produced annually (CSA, 2002). In these three Zones the majority of household keep honeybees as source of income from honey sell and beekeeping is an integral part of the farming communities of the area (Nuru, 2007). However, the honey production is very traditional which is practiced mainly by hanging traditional hives on tall trees in the dense forest far from human settlement areas (Hartman, 2004; Nuru, 2007). In areas where the forest covers is substantial the main pillar of income-generation for small scale farmers is beekeeping (Hartman, 2004).

Even though, the areas are well known for their honey production potentials, there is no much detailed documented information on the practical aspects of bee management, post-harvest handling and marketing of honey. Moreover, the number of hives owned, the average productivity of colony, the average annual household income from beekeeping and etc. were not known. Therefore, this study was intended to identify

honey production systems, the major constraints of the sector, the available apicultural potentials of target Zones and finally to recommend the possible intervention areas.

MATERIALS AND METHODS

This study was conducted in Kaffa, Sheka and Bench-Maji Zones of southwest Ethiopia. Out of the 21 districts that are found in the three Zones, the study was carried out in 5 districts, which were purposely selected based on the data of their honey production potential obtained from each Zone Agricultural Departments and proportion of districts in each Zone. Accordingly, Gimbo, Gesha and Chena from Kaffa Zone, Masha from Sheka Zone and Sheko from Bench-Maji Zone were selected (Figure 1). Then from each district three beekeeping potential localities (peasant associations or sub-districts) and 10 beekeepers from each locality, a total of 150 beekeepers, were selected randomly and interviewed using pre-tested semi-structured questionnaire. Semi-structured questionnaire is flexible, allowing new questions to be brought up during the interview as a result of what the interviewee says (Appendix I). From the total of 150 beekeepers interviewed, 60% were from Kaffa, 20% from Sheka and the remaining 20% were from Bench-Maji Zone.

The study used both primary and secondary data to come up with reliable information on honey production system of the selected potential areas. Primary data were collected on the following aspects: socio-economic demographic data, beekeeping practice, training on beekeeping, types of hives used and construction, types of bees and their behaviour, swarm attractants, honeybee management, swarming and absconding, honey harvesting, major honeybee flora, types of honey, pre and post-harvest handling practices of bee products, honey processing and

Table 1. Results of post-hoc analysis (LSD test) comparing the average number of traditional hive owned per household and the average honey yield (kg) per traditional hive per harvest among the study Districts.

District	Average traditional hive/house hold		Honey yield in kg/traditional hive/harvest	
	N	Mean \pm SD	N	Mean \pm SD
Gimbo	21	26.14 ^a \pm 25.75	20	10.53 ^a \pm 5.27
Chena	24	10.79 ^a \pm 8.77	24	12.60 ^a \pm 4.83
Gesha	24	80.83 ^b \pm 74.42	26	16.06 ^b \pm 9.03
Sheko	25	26.36 ^a \pm 16.63	25	14.66 ^{ab} \pm 8.65
Masha	30	81.17 ^b \pm 53.06	29	15.50 ^b \pm 6.06

Different letters in column indicate significant difference between locality means at $P < 0.05$.

marketing, preference of beekeepers to different types of hives, honeybee enemies and indigenous control methods, poisonous plants and stingless bees and major constraints of beekeeping. Secondary data were used to select potential localities based on number of honeybee colonies and honey production acquired from district Agricultural Offices.

The data was analyzed using SPSS (software program for social sciences version 18) program.

RESULTS

Socio-demographic profile

On average, the respondents practiced beekeeping for about sixteen years (16.17 ± 6.88 years, $n = 150$) which shows a long experience they have in honey production. Of the total 150 respondents, 148 were males headed beekeepers and only the remaining two were females headed beekeepers. The average age of respondents was 37 years (16 to 70 years). Regarding the educational status of respondents: 19.3% were illiterates, 52% were at elementary level education, 16.7% were junior level education and 12% were high school complete.

Beekeeping practices

In the study areas beekeeping is practiced by over 60% of the total household. Currently, the practice is undertaken by three types of bee hives: - traditional, intermediate and Zander model box hives. In the area the traditional hive beekeeping practice is the dominant system accounting for more than 99% of the total, while intermediate and modern hives are less used (<1%). Only very few beekeepers reported having intermediate hive that has been supplied by different Non Governmental Organizations like Farm Africa, WIN Rock Ethiopia in Kaffa Zone, Non Timber Forest Products Project in Sheka Zone and Zonal and Woreda Agricultural and Rural development Bureaus.

The overall number of traditional hives owned per household was significantly different among districts ($F = 14.67$, $df = 4$, $P < 0.001$), but the overall honey yield per

traditional hive per harvest was not significantly different among districts ($F = 2.38$, $df = 5$, $P = 0.056$). However, group comparison using multiple comparisons showed variations among districts in both analyses (Table 1). Of the total owned traditional hives, only 40% of the hives were found occupied with bees while the rest were empty. In this study, the average yield of traditional hive is 15 kg/hive/year (range 5 to 20 kg/hive/year). Depending on seasonality and size of the beehives, some farmers indicated that a well-managed traditional beehive can produce up to 20 kg of honey/year/hive. About 316.38 kg of honey is reported to be produced per year per household in average. The average number of intermediate hives owned by the sample respondents was 3 (range 1 to 10 intermediate hives/household). Of these, two were occupied by bees. The average yield is reported to be 18 kg per intermediate hive. About 73 kg of honey is also reported to be produced per year per house hold. The average honey yield of Zander model box hive was 35 kg per hive per year.

Beekeeping training and visit

Of the total 150 respondents, only 29 beekeepers have visited beekeeping center/ organization. From those who visited beekeeping center, 10 respondents were reported to learn about systems of bee management and the rest got exposure on how to feed bees, how to harvest and handle honey, how to select apiary site and handling, properties and uses of honey, beeswax and propolis. Moreover, 43 of the total respondents had taken training on beekeeping for five days on average and the rest were not. According to respondents response the training has helped them to know basic improved beekeeping practices. All respondents including those who had no chance of visiting beekeeping center are interested to be trained about beekeeping.

Bee hive construction

The vast majority (85%) of the producers use traditional



Figure 2. Traditional log hives used in the study areas.

log hives made from local materials and mainly non-processed log *Cordia africana* and *Croton macrostachyus*. In the areas, the ways of constructing traditional beehive differ from Zone to Zone, however it is more or less the same in Kaffa and Sheka Zones while it differs in Bench-Maji Zone in terms of hive length, hive opening style and design of the hive. The length of beehive in Kaffa and Sheka Zones ranges from 0.75 to 1.5 meters ($n = 120$) and in Bench-Maji Zone it ranges from 1 to 2 m ($n = 30$, Figure 2).

Constructing and hanging of traditional beehives are made exclusively for men due to its cumbersome nature and culture. On average, a traditional hive costs ETB 8-9 per unit (€ 0.4) on the local market. A few farmers do construct and hang beehives themselves and some time tend to hire locally skilled people to provide the service. The payment to the service providers is often in the form of honey after harvest. However, the majority use local labour pooling arrangement like “Debo”, communal group working practice, to construct bee hives. A ‘Debo’ consisting of 12 men can construct 12 hives on average with an expense of ETB 60 per “Debo” (€ 2.72) in Bench-Maji Zone, while in Sheka and Kaffa Zones construction of 20 and 50 hives using a “Debo” men may incur an estimated cost of ETB 150 (€ 6.79) and ETB 500 (€ 22.65) respectively. It is in such communal working practice that the contribution of females and children are clearly seen for the production.

In Kaffa and Sheka Zones, farmers construct traditional beehives by dividing a tree trunk in to two halves and carving or making deep grooves to each half. Then the two halves brought together and then wrap it with *Arundinaria alpine* sheath locally called ‘phesha’. Then

they tie them with climbers locally called ‘Hareg’. Finally to take the hives upon trees they use a very long (up to 40 m) and strong rope, which on average costs ETB 120 (€ 5.43) per unit (Figure 3). In Sheka zone few beekeepers make beehive from bamboo (*Arundinaria alpine*) tree with large openings in two ends.

In Bench-Maji Zone, farmers construct traditional beehive in the same way as that of the other two Zones above. But here the hives are open in both ends. Some, Mezengir tribe beekeepers, open one end for the purpose of opening and checking for ripen honey and they make up to 7 small holes along the long side of the hive as entrance for the bees. These openings are supposed to be minimized by bees in their will. The two open ends are used for harvesting and inspection purpose and are closed by plant branches.

Honeybee management and swarm attractants

Farmers, after they hanged the beehives upon tree branches they only check for the occupying of the hives with bees. Some of them visit their suspended hives very often to check for attack of bee enemies and thefts. Of the total respondents, 80% do not inspect their bees. Large proportion of the respondents (77.3%), reported that honey production does not depend on height of the tree on which the hive is suspended.

Beekeepers of the study area have a mechanism of attracting honeybees to the newly and already used hives. They rub/clean the hives with *Clausena anisata* and *Capsicum frutescens* L. and fumigate them with a mixture of leave and bark of a plant *Ekebergia capensis*



Figure 3. Beekeepers climbing on long trees to hang traditional hives using rope (A) and climbers "Hareg" (B).

and wax together in Kaffa and Sheka Zone, but in Bench-Maji Zone they are using bark and scrap of *C. africana* after the log hive construction.

Honey harvesting

Farmers in the study areas have experiences to know whether honey is ripened for harvesting or not. Appearance of high population of bees at the entrance of the hive, increasing of the defensiveness of bees, and completion of flowering periods of honey plants in the surrounding areas are some of the indicators for honey ripening. In Bench-Maji Zone, they check the ripeness by taking out honey combs from the hive hanged on trees. During harvesting all respondents mainly use 'Teff' straw smoke to subdue and push away the bees. Some also smoke *Vernonia amegdalina* leaves and animal dung for the same purpose.

The type of honey and its storage conditions

In Kaffa and Sheka Zones, the types of honey are mainly white, red and the mixture of the two. The source of white honey is mainly from *Schefflera abyssinica* which is the very dominant honey plant in the area. In Bench-Maji Zone, the honey produced is totally red in colour. This is due to the honey plants like Albiza species, *C.*

macrostachyus and *Aningeria adolfi-friederici* which produce red honey.

Most of respondents know that honey is hygroscopic and 91% of them try to put it separately from other products in a safe place until it sold or consumed. Almost all of the respondents reported that there is no adulterated honey in the local markets of their areas so far. Except for some limited amount of honey, which is harvested from homestead, the major part of the honey comes from deep forests. The honey containers mostly used in the three Zones include plastic sack, tin/barrel, clay/log pot, animal skin, gourd pot and plastic containers (Table 3), which help to store honey for long time and air tightened.

Almost all farmers store and transport honey in plastic sack, which costs on average ETB 20 (€ 0.91) in the local markets. In Bench-Maji Zone, the primary storing and transporting material for honey is gourd pot but it has problem of cracking.

Honey processing and marketing

In the case of the study areas, farmers do not process honey before sale. However, the basic processing practice is to chunk the comb honey into a liquid mixture using *C. anisata* and /or *C. macrostachyus* sticks into the honey and compressing the sacks with their foot. And some use direct heating and sunlight to melt their honey.

Table 2. Comparison of honey harvesting related activities among three zones.

Activities/season	Kaffa Zone	Sheka Zone	Bench-Maji Zone
Major harvesting	April – June	April – June	April
Minor harvesting	November – January	November – January	all over the year, at least 4 times
Harvesting system	Bringing log hives to the ground and split the logs to let colony leave away	Bringing log hives to the ground and split the logs to let colony leave away	On the tree using the two large openings without affecting colony
Honey harvesting practice and colony fate	Harvest all honey combs, all brood and larvae. Discard colony on the ground and keep hives in house until next season	Harvest all honey combs, all brood and larvae. Discard colony on the ground and keep hives in house until next season	Harvest two-third of honey only. Leave one-third of the total honey, all brood and larvae in the hive to maintain colony

Table 3. Different honey storing materials and their rank in Kaffa, Sheka and Bench Maji Zones.

No.	Storing materials	Kaffa	Rank	Sheka	Rank	Bench Maji	Rank
1	Plastic sack	+	1	+	1	+	2
2	Tin/barrel	+	2	+	2	-	
3	Clay/log pot	+	3	+	4	+	4
4	Animal skin	+	4	+	5	-	
5	Gourd pot	-		-		+	1
6	Plastic container	+	5	+	3	+	3

+ and – signs are the presence and absence of each storing material respectively.

76% of the farmers strain crude honey by simple drainage to remove the beeswax and any floating impurities simply using their hand.

In the study areas, honey is used as a source of cash income and food that is, home consumption. About 97% of the respondents reported to sell their produce retaining some of it for home consumption. This study reveals that, honey production contributes about 50% to the total household cash income of small scale farmers involved in beekeeping. Their major buyers are 'Tej' brewers and middle merchants in the nearby markets. For 77% of the farmers market price of honey is promising. However, more than 97% of respondents mentioned the price is subjected to fluctuation with seasons. As usual, honey price decrease during main harvesting season in April and increase in other months of the year. On average, they travel about 6 kilometres (6.36 ± 1.78 km, $n = 150$) to sell their product in nearest market place. The average price of honey from traditional, intermediate and improved box hives was 35, 35 and ETB 55 (€ 1.58, € 1.58 and € 2.49) per kg respectively.

Honeybee types

According to the beekeepers description there are two types of honeybees and are identified as red and black

types. The black is the dominant and estimated to constitute 80% of the total honeybee colonies in the three Zones. Farmers described their behaviour as the red ones are more aggressive, productive and smaller in size and have less absconding and swarming behaviour than the black ones.

Stingless bee honey production

Apidae/Meliponinae species

In the area two types of stingless bees (Meliponinae) are known, which are single nest entrance and double nest entrance builders. Double nest builders are about 10% of the total population of stingless bee in the area and are known for their better productivity. Moreover, stingless bee's honey hunters recognize the entrance diameter as wide and narrow and they believe in that the wider one is with more population and more productive. Around 50% of the beekeepers of the area have a chance of harvesting sting less bee honey every year. The major harvesting time is similar to that of honeybee's honey, which is April, and sometimes between November to March. At one harvest an average of 2 L of honey/per nest can be obtained. During harvesting the hunters dig in to the ground up to 10 to 15 cm below the nest of the

Table 4. Dominant honeybee floras, their ranks according to importance and their flowering periods.

No.	Major honey bee floras	Kaffa		Sheka		Bench- Maji		Flowering period
		+/-	Rank	+/-	Rank	+/-	Rank	
1	<i>Schefflera abyssinica</i>	+	1	+	1	-		February – April
2	<i>Vernonia amygdalina</i>	+	2	+	3	+	2	January – February
3	<i>Dombeya torrida</i>			+	2			November - December
4	<i>Syzygium guineense</i>	+	5	+	4			December – April
5	<i>Apodytes dimidiata</i>	+	6	+	5			January – April
6	<i>Ilex mits</i>	+	7	+	6			October - November
7	<i>Allophius abyssinica</i>	+	3	+	7			July
8	<i>Ekebergia capensis</i>	+	4	+	8			January
9	<i>Prunus africanus</i>			+	9			November
10	<i>Croton macrostachyus</i>	+	11	+	10	+		May
11	<i>Jasminum species,</i>			+	11			November
12	<i>Ephorbia species</i>	+		+				
13	<i>Aningeria adolfi-friederici</i>	+	12			+	1	January - May
14	<i>Maesa lanceolata</i>	+	10					July
15	<i>Cordia Africana</i>					+	3	September
16	<i>Manigifera indica</i>	+	9	+		+		Throughout the year

+ and – signs are the presence and absence of each dominant honey bee floras.

bees and take their honey without taking care for their nests and the colony. In the area, all beekeepers reported stingless bee colonies are being affected by honey badgers, ants and moles. Stingless bees honey hunters have practices of straining of a stingless bee honey by decantation and using thick layers of *Ensete ventricosum* fibres which used to retain very fine impurities and allow only the liquid and pure honey passing through. In the area the stingless bees honey has no significant markets and mostly used for home consumption.

Apidae/Trigona species

Honey is also produced from very small stingless bees which belong to the *Trigona* species. The bees mostly nest in hollow of dry trees and any cavity place in the door, window and roofs and can also occupy hanged empty containers. These bees are found in lower altitude areas mainly in Bench-Maji Zone. They produce sweet honey as that of normal honey. 50% of the farmers in Bench Maji Zones reported to harvest Trigona species honey and about one cup or 200cc of honey can be obtained per colony per year.

Honeybee swarming and absconding behaviour

Of the total respondents, 89.3% mentioned that reproductive swarming of honeybee colonies is a frequent phenomenon. However, all of the beekeepers mentioned internal inspection is difficult in traditional hives to control

reproductive swarming. The swarming rate of honeybees is lower in Kaffa and Sheka Zones as compared to Bench-Maji Zone. Selling of honeybee colony is not a common practice in the study areas, as reported by about 85% of the farmers. As the practice is very traditional, the only source of colony is swarming. About 67% of the respondents get bee colony by hanging traditional hives upon trees while the rest get from wild nest.

In the areas the presence of absconding/migration is reported by 100, 91.1, and 90% respondents in Kaffa, Sheka and Bench Maji Zones respectively. The rate in Sheka is lower than in Kaffa Zone. Absconding mostly takes place in January, February, July and August. After absconding of bees, on average 3 and 4 kg of beeswax can be obtained from an average of 10 bee hives which left behind bees in Kaffa and Sheka Zones, respectively. This wax is mainly used for fumigating hives ready for suspending.

Honeybee floras

The dominant honey bee plant in Kaffa and Sheka Zones is *Schefflera abyssinica* followed by *Vernonia amygdalina*. These are the major sources of honey produced in these Zones. However, *Schefflera abyssinica* is rarely found in Bench-Maji Zone. Some of the major honeybee floras of the areas are shown in Table 4.

Bee feed shortage is directly associated with off flowering period of major honey bee forages. Closer to 95% of the respondents reported the occurrence of sever feed shortage following harvesting time mainly in June, July and August. Besides, almost all sample respondents

indicated that there is no provisions of supplementary feeds at the time of severe feed shortage. This is relating with the traditional practices of forest beekeeping. Only few who have intermediate hive supplement them using sugar syrups and roasted pulse flour.

Poisonous bee floras

According to farmers' report, *Euphorbia cottinifolia*, *Datura arborea* and *C. macrostachyus* are reported as poisonous to honeybees. Mostly, in Kaffa and Sheka Zones flower of *C. macrostachyus* reported to cause death to honeybees after completion of its flower. Moreover, honey from *Datura arborea* irritates human beings when eating and *Euphorbia cottinifolia* is well known to kill honeybees.

Honeybee enemies and their traditional controlling methods

The major honeybee enemies found in the areas are ants, honey badgers, birds and small hive beetles in their degree of damages and occurrences. According to the result of this study, the honeybee enemies are causing great losses (40.7%) of total honey production per annum. Honey badger commonly damage honeybee colonies in the months of November to April when there is brood and honey in the hive. Birds attack the bees mainly during the rainy seasons when there is no grain to feed. Beekeepers practice different prevention methods but are not totally efficient which requires developing suitable prevention methods. Some of the cultural practices are as follow: - for ants destroying the ant nest and killing the queen of ant, putting ash around hive stand, tying "Teff" straw on the hive stands and using of another small ant *Cremato gasterchiarinii Emergy (1881)* as biological control. For honey badger they use mechanical barriers putting like thorny woods around the tree; fixing smooth iron sheet on the trunks of a tree where hives are hanged; hanging hives on ficus trees which has very smooth bark which is not suitable for honey badgers to climb on it and tying of thorny branches.

Major constraints of honey production in the area

Some of the major constraints of beekeeping are mentioned below:

- (i) Honeybee enemies namely: ants, honey badgers, birds and small hive beetles.
- (ii) Damaging of honeybee and stingless bee colonies during harvesting which causes drastic population reduction.

- (iii) The forest beekeeping practices that discourage the participation of women and old men in beekeeping.
- (iv) Low adoption of improved beekeeping technology.
- (v) Low productivity of bees due to poor handling conditions.
- (vi) Poor storage conditions of honey.
- (vii) Absence of diversification of bee products (propolis, pollen and other high value of bee products).
- (viii) Lack of skilled man power on apiculture to help beekeepers managing honey bees for better production.
- (ix) Presence of honeybee poisonous plants.
- (x) Reduction of the sustainability of forest based production due to high rate of deforestation.
- (xi) Problems of sustainable marketing of bee products.
- (xii) High risk of forest beekeeping (falling from tall trees)

DISCUSSION

The main pillar for income generation in the forest of southwest Ethiopia is beekeeping, which is highly conservational system for maintaining the forest as a base for sustaining their livelihood (Hartmann, 2004). In the present study, honey production contributes 50% of beekeepers household income. Forest beekeeping usually practiced in far distance from homesteads. Consequently, requires staying overnight in the forest and climbing on very tall trees up to 40 m which is traditionally performed by men (Nuru, 2007). This is because climbing on trees for hanging traditional hives is culturally considered as taboo for females (Workneh, 2011; Chala et al., 2012). Hence, the role of women in forest beekeeping system is very low (Hartmann, 2004). As a result, women are not economically empowered through beekeeping. Furthermore, forest beekeeping has many risks like losing of life and physical disabilities (Hartmann, 2004). According to the respondents, hanging of traditional hives high upon tall trees is to avoid damaging of colonies by ants and wild animals which are affecting such production systems. This is in line with Hartmann (2004) reported that red ants which are the main enemy of honeybees do not occur in forest beekeeping. Moreover, all interviewed beekeepers experienced that, specific types of trees are more preferred than others to attract bee colonies. However, beekeepers experienced that honey production is not affected by the height of trees on which traditional hives suspended. This may greatly favours backyard beekeeping for better management and encourages females' involvement in the sector.

Beekeeping is an indigenous activity inherited from father to son in southwest Ethiopia (Hartmann, 2004). Indigenous knowledge is defined as a knowledge that is unique to a given culture or society (Workneh, 2011). In the present study the adoption of intermediate and improved box hives is very low. This shows that large proportion of the respondents had little exposure to

improved beekeeping practices most likely due to little attention given to the sector so far. Therefore, the sources of beekeeping skill and knowledge are mainly transferred from family and neighbour to generations with little or no changes in the study areas. However, Gidey and Mekonen (2010) reported the higher adoption rate of improved beekeeping technologies and significant increment of honey production in northern Ethiopia. Practical based beekeeping training, apiary visit and education could increase promotion of improved beekeeping technologies in order to obtain the intended amount of hive products (Workneh et al., 2008).

In the present study beekeepers usually construct large number of traditional log hives from selected indigenous tree species: namely, *C. africana* and *C. macrostachyus* trees. Along with tea plantation and wood logging enterprises, manufacturing of traditional hives leads to a higher consumption of forest resources and great concern to destruction of honey bee flora without additional returns (Hartmann, 2004). Moreover, this certainly disturbing the biodiversity and species composition of the natural forests.

In the present study, 99% of the total honey produced comes from traditional hives, this result is in agreement with SOS Sahel (2006). Beekeepers identify honey season by the experiences they developed in respect to their areas (Workneh, 2011). Appearance of high population of bees at the entrance of the hive, increasing of the defensiveness of bees, and completion of flowering periods of honey plants in the surrounding areas are some of the indicators for honey ripening in the present study. In Bench-Maji Zone, harvesting is performed on the tree using either of the two openings, leaving some honey comb, all brood and larvae in the hive to maintain the colony for many seasons (Table 2). However, in Kaffa and Sheka Zones, the majority of beekeepers damage brood, discard their colonies after honey harvest and always start from new swarm every year, this result is supported by Nuru (2007). Beside ecosystem fragmentation, poor harvesting system could be the main cause for current severe declining of honeybee population (Hartmann, 2004). As a result, it is not possible to get a new swarm as required, the occupation rate of bait hives becomes less than 40 percent. Furthermore, the hives probably get occupied very late when the flowering of the area about to cease. In these conditions the new swarm could not produce honey in the same season as those colonies maintained in the hive throughout the year.

After harvesting honey in the forest, because of the rough terrain, it is often transported in varied containers using human labour and back of equines like donkeys, mules and horses (Nuru, 2007). This study reveals that the type of honey produced varies based on honeybee flora available. In Kaffa and Sheka zones beekeepers produce large volume of white honey from *Schefflera abyssinica* while in Bench-Maji zone red honey is

produced from *Albiza* species, *Croton macrostachyus* and *Aningeria adlofi-friederici* plants. This result is supported by Chen et al. (2012) who stated the presence of great variation in price among honeys of different floral origins depending on colour, flavour and taste.

Beekeepers characterize honeybee types in to black and red colour. Moreover, beekeepers described their behaviour as the red ones are more aggressive, productive and smaller in size and have less absconding and swarming behaviour than the black ones, which is in line with Workneh (2011) report. However, body size and pigmentation of honeybees are reported to be changed with altitude (Amsalu et al., 2004). Based on morphometric and geographical distribution analysis of these authors, the type of honeybee race found in the study area is known as *A.m. scutellata*.

Different stingless bees belong to Meliponinae and *Trigona* species are found throughout the study areas. The area is very favourable for the existence of different species of stingless bees and for the production of significant volumes of stingless bees honey annually. Stingless bees are useful not only for honey production and also in maintaining the ecosystem through pollinating different forest trees and cultivated plant species (Kwapong et al., 2010). In the present study, stingless bees honey is believed to have some medicinal value. Similarly, stingless bees' honey reported to have powerful antibacterial activities compared to honey from commercial honeybees (Temaru et al., 2007). Furthermore, it has higher market demand in India with 20 times costlier than normal honey (Kumar et al., 2012). However, there is no big difference between price of stingless honey and normal honey in the case of the current study.

The presence of better bee forage throughout the year in Bench-Maji Zone could encourage reproduction of honeybee colonies frequently and tend to have higher reproductive swarming rate compared to Kaffa and Sheka Zones. This finding is supported by study of Amsalu (2006) dealt with reproductive swarming is positively correlated with higher flowering intensity when brood production reaches at its pick stage. Absconding/migration mostly take place in dry season (January to February) and main rainy season (July to August) following honey harvesting periods and lower flowering plants available. According to the response of beekeepers, the reason behind could be shortage of feed, bee enemies, lack of protection against bad weather and poor management practices, which is in agreement with Chala et al. (2012). This result is also in line with Amsalu (2006) who reported honeybees migrate in response to resource depletion. On the other hand, the current study reveals that, the low absconding/migration rate of colonies in Bench-Maji Zone may be due to honey and brood comb left for bees during honey harvesting time. Moreover, lower absconding/migration rate in Sheka compared to Kaffa could also be associated with

the hive type sometimes used in Sheka Zone, that is, they use hives made from bamboo which is open in both ends enable beekeepers to leave some honey and brood for the colony.

Ethiopia is home to diverse plant species that provide surplus nectar and pollen rewards to foraging bees (Girma, 1998). Hence, there is high possibility to produce good quality forest honey (Sreejith et al., 2011). Particularly, the study area is characterized by the availability of abundant forest plant species (Fichtl and Admasu, 1994) that can greatly favour to produce large volume of organic honey and supply to world markets (Nuru, 2007). However, some plant species are reported to be poisonous to honeybees. Many exotic poisonous bee plants like *Euphorbia cottinifolia* and *Datura arborea* and others are introduced and widely growing as life fence all over the three Zones. These plants are easily propagated by cuttings and also they adapt very easily. Moreover, the plants are not used for any other purposes and are not consumed by any animal species. However, honeybees collect and store pollen grains. This result is supported by Nuru (2007) dealt with pollen analysis of some plants to be poisonous to honeybees and also the honey from these plants suspected to affect the health of human. Moreover, *C. macrostachyus* is also reported to be poisonous plant for honeybees in the study areas, which is supported by Kerealem (2005).

The major problems of beekeeping in the area are honeybee enemies such as ants, honey badgers, birds and small hive beetles which may account for 40.7% of the total honey production loss annually. Similarly, many researchers found that ants attack is the most serious problem in beekeeping sector (Edessa, 2005; Desalegn, 2007). The result also supported by study of Gidey et al. (2012) which reported that bee pests, predators and absconding are major constraints affecting honey sub-sector in northern Ethiopia.

CONCLUSION AND RECOMMENDATIONS

Generally the area is very potential for beekeeping and the majority of the households keep bees. Beekeeping contributes for more than 50% of the total household incomes of the majority of the rural communities in the area. In the area despite the presence of different constraints and challenges, there are high potentials and opportunities to maximize the out puts of the resource to improve the livelihoods of the communities in a sustainable ways. In the areas different tribes have different well developed indigenous knowledge on how to harvest honey successively without discarding colonies (Mezenger tribe); some also know how to protect their bees from ants attack using a biological control (Sheka people). Despite close proximity of the three zones, the better indigenous beekeeping practices are not disseminating to the other zones due to lack of well de-

veloped extension system. Therefore, it requires intervening to change the very old traditional beekeeping practices through adopting improved technologies and management practices and practical skill trainings. Some of the major possible intervention areas are recommended here below.

- (i) Designing effective honeybee enemies controlling methods.
- (ii) Expansion of backyard beekeeping practice, promoting beekeepers important indigenous knowledge and promoting the construction of non timber hives.
- (iii) Introduction of full package improved beekeeping technologies with adequate practical skill training.
- (iv) Eradication of exotic poisonous honeybee plants and replace with suitable indigenous hedge plants which also serve as bee forages.
- (v) Improve the utilization of stingless bee's resources: effort should be made how to domesticate and utilize stingless bee resources without damaging the colony and also their nest.
- (vi) Avoid discarding of bee colonies after honey harvest: beekeepers of the area should be aware on the possibilities of maintaining their colonies for successive harvesting.
- (vii) Improving pre- and post-harvest handling of bee products.

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REFERENCES

- Amsalu B (2006). Seasonal intensity of flowering and pollen-forage selectivity by honeybees, *Apis mellifera bandasii* in central highlands of Ethiopia. Proceedings of the 14th annual conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia pp.3-10.
- Amsalu B, Nuru A, Radloff SE, Hepburn HR (2004). Multivariate morphometric analysis of honeybees (*Apis mellifera*) in the Ethiopian region. *Apidologie* 35:71-81.
- Ayalew K (2001). Promotion of Beekeeping in the Rural Sector of Ethiopia. In Proceeding of the third Ethiopian Beekeepers Association (EBA), Addis Ababa, Ethiopia pp.52-58.
- Ayalew K, Gezahegn T (1991). Suitability Classification in Agricultural Development, Ministry of Agriculture, Addis Ababa, Ethiopia.
- CSA (Central Statistics Authority) (2002). Ethiopian Agricultural Sample Enumeration, Executive Summary, Addis Ababa, Ethiopia.
- Chala K, Taye T, Kebede D, Tadele T (2012). Opportunities and challenges of honey production in Gomma district of Jimma zone, South-west Ethiopia. *J. Agric. Ext. Rural Dev.* 4(4):85-91.

- Chen L, Wang J, Ye Z, Zhao J, Xue X, Heyden YV, Sun Q (2012). Classification of Chinese honeys according to their floral origin by near infrared spectroscopy. *Food Chem.* 135:338-342.
- Desalegn B (2007). Assessment on the effect of ant (*Dorylusfulvus*) on honeybee colony (*Apis mellifera*) and their products in West and Southwest Shewa Zone. Proceedings of fifth National Annual Conference of the Ethiopian Beekeepers Association (EBA), Addis Ababa, Ethiopia pp.13-25.
- Edessa N (2005). Survey on honey production systems in West Shewa Zone. Fourth National Annual Conference of the Ethiopian Beekeepers Association (EBA), Addis Ababa, Ethiopia pp.60-69.
- EMA (Ethiopian Mapping Agency) (1981). National Atlas of Ethiopia.
- FAO (2010). FAOSTAT database on Agriculture and Nutrition. Food and Agricultural Organization of the United Nations, Rome, Italy. Available at:<http://faostat.fao.org/site/569>, accessed 12th Aug. 2012.
- Gidey Y, Bethelhem K, Dawit K, Alem M (2012). Assessment of beekeeping practices in Asgede Tsimbla district, Northern Ethiopia: Absconding, bee forage and bee pests. *Afr. J. Agric. Res.* 7(1):1-5.
- Gidey Y, Mekonen T (2010). Participatory Technology and Constraints Assessment to Improve the Livelihood of Beekeepers in Tigray Region, northern Ethiopia. *MEJS* 2(1):76-92.
- Girma D (1998). Non-Wood Forest Production in Ethiopia.
- Hartmann I (2004). The management of resources and marginalization in beekeeping societies of Southwest Ethiopia. Paper submitted to the conference: Bridge Scales and Epistemologies, Alexandria, March 17-20.
- Kerealem E (2005). Honeybee production system, opportunities and challenges in Enebsa sar midir woreda (Amahara region) and Amaro special woredas (SNNPR), Ethiopia. Unpublished M.Sc. Thesis, Alemaya University, Ethiopia.
- Kumar MS, Singh AJAR, Alagumuthu G (2012). Traditional beekeeping of stingless bee (*Trigona* sp) by Kani tribes of Western Ghats, Tamil Nadu, India. *Indian J. Trad. Know.* 11(2):342-345.
- Kwapong P, Aidoo K, Combey R, Karikari A (2010). Stingless bees. Importance, management and utilization. A training manual for stingless beekeeping.
- NTFP (Non-Timber Forest Products Research and Development Project) (2006). Local valuation of forests in southwest Ethiopia. Student Research Series p.6.
- Nuru A (2007). Atlas of pollen grains of major honey bee flora of Ethiopia.
- SOS Sahel (2006). Community Initiative Promotion (CIP): Kaffa Development Programme (KDP). Synopsis of the study of selected sub sector in Kaffa Zone Ethiopia (Forest coffee, Honey and Cardamom).
- Aravindakshan S, Worku JN, Mir HK, Waliul GM (2011). Exploring the potential of non-timber forest products: the case of Ethiopian honey export to Denmark.
- Temaru E, Shimura S, Amano K, Karasawa T (2007). Antibacterial activity of honey from stingless honeybees (Hymenoptera; Apidae; Meliponinae). *Pol. J. Microbiol.* 56(4):281-285.
- Workneh A (2011). Identification and documentation of indigenous knowledge of beekeeping practices in selected districts of Ethiopia. *J. Agric. Ext. Rural Dev.* 3(5):82-87.
- Workneh A, Ranjitha P, Ranjan SK (2008). Adoption of improved box hive in Atsbi Wemberta district of Eastern zone, Tigray Region: Determinants and Financial Benefits, IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project. Working Paper 10 ILRI (International Livestock Research Institute), Nairobi, Kenya.

Appendix I: Questionnaire for honey production systems in Kaffa, Sheka and Bench-Maji Zones of Ethiopia.
 Organization: Bonga Agricultural research center, southwest Ethiopia.

Zone _____ District _____ Sub-district/Peasant
 association _____ Age _____ Sex _____ Education level _____

When did you start beekeeping? _____
 How did you get beekeeping experience? _____
 What types of hives do you have? _____

No.	Type of hive	Occupied	Empty	Total
1	Traditional (log hive)			
2	Traditional (bamboo)			
3	Intermediate			
4	Modern hive			

Have you ever visited beekeeping center/organization? Yes / No
 If yes, what did you learn from the visit?

Have ever taken beekeeping training? Yes / No
 If yes, for how long and what did you learn from the training?

If no, do you want to get training opportunity? Yes / No

How do you construct traditional hives? _____

- 6.1. From which type of tree species? _____
- 6.2. What is the average length of traditional hive? _____
- 6.3. What the price of traditional hive/unit? _____
- 7. How do you hang traditional hive upon branch of trees?

7.1. Who is responsible from family members to hang traditional hive and why?

7.2. Which types of tree species are preferred for hanging traditional hives?

7.3. Does honey production affected with the height of the tree on which hive hanging? Yes/No

What is the advantage and disadvantage of forest beekeeping?

How do you often manage honeybee colonies in the forest?

What is the source of honeybee colony?

How do you attract swarms? _____

What are the major natural bee plants (trees) in degree of abundances?

No.	Name	Flowering period
1		
2		
3		
4		
5		

Are there poisonous honeybee plants? Yes / No
 If yes, please list them with their side effect.

Honey harvesting
 How do you know whether honey is ripened for harvesting or not?

How do you harvest honey?

average honey yield of different hive types /harvest
 Average honey yield of traditional hive/harvest _____
 Average honey yield of intermediate hive/harvest _____
 Average honey yield of modern hive/harvest _____
 Sting less bees (Meliponinae) honey yield/harvest _____
 Sting less bees (Trigona species) honey yield/ harvest _____

Honey harvesting periods
 Major _____
 Minor _____

Annual honey yield per colony in hive type
 From traditional hive _____
 From intermediate hive _____
 From modern hive _____

What types of honey do you produce? _____
 Do you know honey is hygroscopic? Yes/No
 Is there adulterated honey in local market? Yes/No
 What kind of honey storage materials are you using in order of importance?

How do you process crude honey after harvest?

Honey marketing
 Do you sell honey? Yes/No
 If yes, what is the contribution of honey sell in your annual cash income?

How many km do you travel for selling honey? _____
 Who is your customer? _____
 Is the price of honey promising? Yes / No
 Honey price

No	Honey production system	Honey price (ETB/kg)	
		During harvesting period	During off time
1	Honey from traditional bee hives		
2	Honey from intermediate bee hives		
3	Honey from modern hives		
4	Price of white honey		
5	Price of red honey		
6	Price of mixed honey		
7	Others		

How many types of honeybees do you know? _____
 What are their specific characteristics? _____

How many types of stingless bees do you know? _____
 What are their specific characteristics? _____

Is there reproductive swarming? Yes / No

If yes, in which months of the year swarming takes place and why?

Is there colony absconding/migration? Yes / No

If yes, in which months of the year absconding/ migration occurs and why?

Please list down the major honeybee enemies in order of importance and their traditional control methods.

What are the major constraints of forest beekeeping in order of importance?
