

Honey-bee production practices and hive technology preferences in Jimma and Illubabor Zone of Oromiya Regional State, Ethiopia

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Abstract: The study was conducted in two purposefully selected zones of Oromiya Regional State, namely Jimma and Illubabor. The objective of the study was to analyse the honey-bee production and to assess hive technology preferences in the study area. A total of 156 beekeepers were randomly and proportionately selected from four districts (Mana and Gomma from Jimma and Bacho and Yayo from Illubabor). Data were collected through formal survey and secondary sources. Accordingly, the average age of the beekeepers was 40.2 ± 8.13 years with an average of 13.5 ± 6.58 years of experience. The majority of the respondents (53.2%) in the study area got their colonies by catching swarms. Three hive types (traditional, transitional, and frame hive) were found in the study area. More than 70% of the respondents harvested once a year from traditional hives, while 25% of respondents harvested up to three times per year from frame hives. Moreover, an average of 22 ± 4.6 and 16 ± 4.1 kg of honey were harvested from frame and transitional hives per year, respectively. Compared to these two hives, a much lower (7 ± 1.6 kg) amount of honey was harvested from traditional hives. Various honey-bee floras were identified in the study area. Plants such as *Vernonia amygdalina*, *Croton macrostachyus*, and *Schefflera sp.* produce white honey. Half of the respondents' preferred transitional hive followed by frame hive (37.2%). Factors which affect the use of frame hives were lack of equipment (36.5%) followed by wax quality and availability problems (34%). That is why few beekeepers tried to modify the frame hive to solve the problems of wax in vertical frame hive. In order to adopt and sustain modern hive technology, the focus should be on honey-bee equipment as well as wax quality and availability.

Keywords: beekeeping, honey production, hive preference

1. Introduction

Ethiopia has huge potential for beekeeping production because of its endowment with diversity in climate and vegetation resources offering potentially favourable conditions for beekeeping. These have enabled Ethiopia to take around 23.58% and 2.13% of the total share of honey production on African and on a global level respectively [21].

The exact number of people engaged in the honey subsector in Ethiopia is not known. However, it is estimated that more than one million farm households are involved in the beekeeping business using the traditional, intermediate, and frame beehives [13]. It could also be observed that a large number of people (intermediaries and traders) participate in honey collection and retailing (at village, district, and zonal levels), and thousands of households are engaged in tej making in almost all urban areas, while also hundreds of processors are emerging, and exporters are flourishing [3].

Generally, about 4,601,806 beehives exist in Ethiopia, out of which about 95.5% are traditional, 4.3% transitional, and 0.2% frame beehives [3]. Based on the national estimate, the average yield of pure honey from movable frame beehive is 15–20 kg/year, and the amount of beeswax produced is 1–2% of the honey yield [12]. However, in potential areas, up to 50–60 kg of harvest has been reported [14].

Despite the high potentiality of the country for beekeeping and its extensive practices, beekeeping research conducted in the nation so far has not managed to characterize and document the apicultural resources and associated constraints of the sector for its proper intervention and utilization to specific potential regions [4]. Success in beekeeping primarily results from the utilization of improved beekeeping technologies that are suitable for local bee types and conditions [15]. These conditions may generally indicate the importance of considering the biology and ecology of the bees in the selection and adoption of technologies. Besides the technological and biological factors, the socio-demographic conditions of beekeepers were observed to play a significant role in the adoption of technologies. Thus, it was essential to assess the beekeeping production system as a whole and identify the determinants of hive technology preference and the major constraints of this subsector.

According to the Central Statistics Agency (2011/12), Oromia has the largest number of beehives followed by Amhara and SNNP. Jimma, Illubabor, and West Wellega were the areas of Oromia region with the highest number of hives (CSA, 2011/12) [5]. Different case studies and researches are being carried out concerning honey-bee production practices and honey-bee diseases and pests in different areas of the country. However, there is no compiled and tangible information on the

preference of hive technology and management as well as constraints in the potential honey-bee areas (Illubabor and Jimma). Therefore, this research has been initiated with the objective of assessing honey-bee production and identifying the preference of hive technology in the Illubabor and Jimma zones.

2. Materials and methods

The study was conducted in the two neighbouring zones of Jimma and Illubabor, which are found in the south-western part of Ethiopia, having the highest number of hives (CSA, 2011/12) in the Oromia region. According to the zonal offices of Illubabor and Jimma (information from 2014), honey production is one of the most important sources of local earnings. Besides that, Jimma and Illubabor zones share many similarities in their agro-ecological conditions, cropping systems, vegetation types, and climatic conditions. In both zones, the dominant crops are maize, teff, coffee, sorghum, barley, wheat, different pulse crops, finger millet, fruits, vegetables, and spices. Annual precipitation ranges from 1,500 to 2,200 mm with 6 to 9 months of rainfall [5, 16].

Jimma and Illubabor zones have been selected purposefully because of their apiary potentials. A total of four districts (Mana and Gomma from Jimma and Bacho and Yayo from Illubabor) were selected based on the criteria of having large number of participants in beekeeping, beekeeper experience, potential area for beekeeping, abundance of honey-bee colonies, and availability of common bee forage. These were identified with the help of zonal agricultural and rural development offices and agents of the respective districts. A total of 156 beekeepers were randomly selected and interviewed proportionately from the districts. The sample size (N) was determined using the formula recommended by Arsham (2005) as $N = 0.25/SE^2$, where N is sample size, and SE is the standard error at 4%. However, data was pooled and analysed into one zone because of the similarity of results across the districts.

Data were collected from September 2014 to June 2015 through formal survey, secondary sources, focus-group discussions, key-informant interviews, and field observations. Relevant information was further collected through discussions with representatives of the district and zonal office of Agricultural and Rural Development and Development Agents. Formal survey was conducted using semi-structured questionnaire with open-ended and closed-ended questions. The questionnaire was prepared to collect information as: age of the respondent, hive preference, beekeeping and/or management practices, placement of hives, honey-bee inspection, major bee floras, honey yield, and major constraints for adopting improved hives.

The collected data were analysed using appropriate statistical packages for social sciences (SPSS – software version 20). Descriptive statistics, such as mean, frequency, and standard deviation, were used.

3. Results and discussions

The study revealed that the average age of the beekeepers was 40.24 ± 8.13 years, with a range of 25–60 years. This result correlates with Chala et al. (2013) and Gebremedhin (2015), who report that the mean age of the respondents were 40.47 and 40.1 years respectively [4, 11]. The age distribution of beekeepers is generally within the active working age. Regarding their experience in beekeeping, the respondents had an average of 13.51 ± 6.58 years of experience, with a range of 5–28 years of working practice with honey-bees. This indicates that beekeepers have a good knowledge of apiary management and honey usage habits.

The majority of the respondents (53.2%) in the study area got their colonies by catching swarms or as a present from their parents (42.9%). This is in line with Addis and Malede (2014), who reported that 49.2% of the beekeepers started out by catching swarms. (This might be due to the fact that the area is endowed with species of plants that are favoured by bees.) Very few beekeepers (6.4%) were supplied by the government or NGOs. It was possible to buy a colony in the study area, even though only 17.3% of the respondents availed themselves of this opportunity (*Table 1*).

Table 1. Source of bee colonies

Sources	Number of respondents	Percentage
Catching swarms	83	53.2
Gift from parents	57	36.5
Given by Government or NGO	10	6.4
Buying	27	17.3

It can be clearly seen in *Table 2* that half of the respondents preferred transitional hives. However, the average honey-bee colony holding size (10.7 ± 4.3) for traditional was a little bit bigger than two hives. Contrary to the results of this study, Nebiyu and Messele (2013) found that 74.4% of the beekeepers in the Gamo Gofa zone, southern Ethiopia, preferred traditional hives over transitional (11.5%) and modern hives (14.1%) [18]. This might be related to an availability of local materials with the experience and knowledge gap of beekeepers for the preference of hive technologies in different areas of the country. Frame hive was preferred by

37.2% of the respondents next to transitional hive with the least average of colony holding size (6.08 ± 5.01). During group discussions with key informants and zonal offices of the study area, those having an experience in apiary preferred transitional hives for purposes of wax production. In addition, very few beekeepers tried to modify the frame hive – as shown in *Picture 1* –, giving evidence of a better management and obtaining higher earnings. This is consistent with Tessega's (2009) findings, who noted that experienced and skilful beekeepers could do many operations with less facilities [20].

Table 2. Respondents' hive preference and honey-bee colony holding size

Hive type	Number of respondents	Percentage	Colony holding size in different hives (Mean± SD)
Traditional	20	12.8	10.7 ± 4.3
Transitional	78	50	9.51 ± 9.9
Frame hive	58	37.2	6.08 ± 5.01
Total	156	100	



Picture 1. Horizontal frame hive with two and three compartments modified by a beekeeper in Bacho district

As shown in *Table 3*, an average of 22 ± 4.56 kilogram of honey per year from frame hives and 16.2 ± 4.12 kilogram of honey from transitional hives were harvested. Compared to these two types, a much lower (6.97 ± 1.58) amount of honey was harvested from traditional hives. The present result was in agreement with the result reported by Addis and Malede (2014) and Chala et al. (2013), who found that the average honey yield per year/colony was 7.20 ± 0.23 , 14.70 ± 0.62 , and 23.38 ± 0.73 kg for traditional, transitional, and moveable frame hives respectively [4]. However, the mean honey yield obtained from transitional hives in this study area is higher than the result indicated by Nebiyu and Messele (2013) in the districts of Gamo Gofa zone, southern Ethiopia, which is 14.07 kg per hive/year [18]. The productivity of frame hive and transitional in this study is more than triple than that

of traditional hives, which is perhaps because of better management practices such as providing wax foundation sheets, recycling drawn-out combs after honey extraction, and a higher frequency of harvesting. A better honey storing of colonies in box hives with foundation sheet has been reported by [2]. Moreover, the possible advantages of increasing the overall average honey yield of colonies in box hives as compared to traditional hives has been well documented in Nigeria [9]. In this regard, to improve the output of beekeeping, the adoption of improved hives is important.

Table 3. Honey production (kg/hive /year) from three types of hives

Types of hive	Minimum (kg/hive/year)	Maximum (kg/hive/year)	Mean± SD
Traditional hive	4	8	6.97 ±1.58
Transitional hive	7	21	16.2± 4.12
Frame hive	12	32	22 ± 4.56

SD = Standard deviation

As shown in *Figure 1*, more than 70% of the respondents harvested honey once a year from traditional hive. In addition, respondents having transitional (33%) and frame hive (22%) also harvest honey once a year, even though the hive technology is improved. About 53% of the respondents having frame hive were able to harvest twice a year, which is slightly higher than noted for transitional hive (48%) and much higher than the traditional hive (27%).

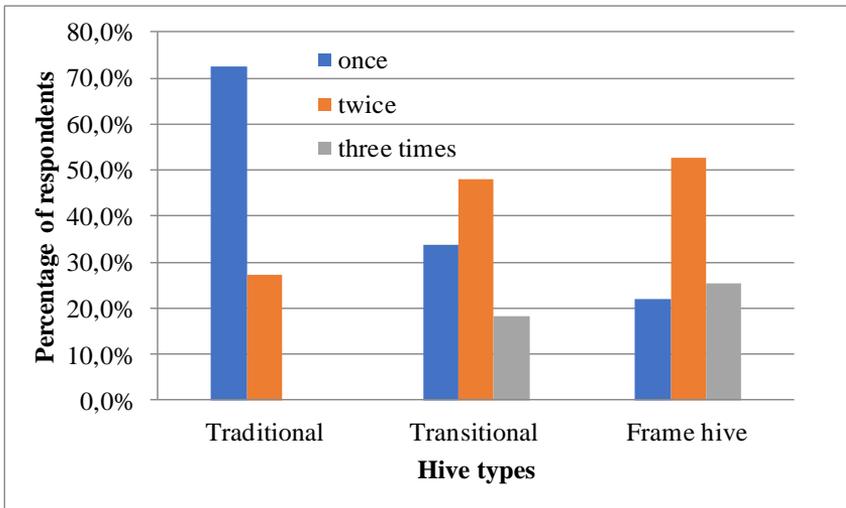


Figure 1. Honey-harvesting frequency for three hives

Moreover, 25% of the respondents' harvested honey three times a year in frame hives, while only 18% of respondents did it in transitional hive, and nobody experienced three times of harvesting a year in traditional hive. This research result was in line with Tessega (2009), who reported honey harvested once or twice, and in some cases even three times in Burie district [20]. This clearly indicates that harvesting frequencies differ within the same area but with different hive technologies. On the other hand, having three times of honey harvesting per year is an indication of the area being convenient for apiculture development.

More than 87% of the sample respondents who owned transitional and frame hive kept their colonies around their homestead (back yard) mainly to enable close supervision of colonies, whereas some of the respondents (12.5% and 6.6%) kept transitional and frame hive, respectively, hanging near their homestead. Besides, 58.9% of traditional bee colonies were kept in forests so that they might attract wild swarms. As mentioned during group discussions, when honey is harvested from traditional hive, absconding happens sometimes, and the hive has to return back, for which they use smoke to attract bees. Only 11% of respondents kept their traditional hive colony in the backyard, which is easier for harvesting as well as inspection than hanging nearby in the forests (*Table 4*). In some places, especially in the western and southern parts of the country, forest beekeeping by hanging a number of traditional beehives on trees is widely practised. In most other parts of the country, backyard beekeeping with relatively better management is common [19].

Table 4. Traditional, transitional, and frame hive placements

Hive type	Back yard (N)	%	Hanging near home stead	%	Hanging near in the forest	%	Total
Traditional	8	11.0	22	30.1	43	58.9	73
Transitional	91	87.5	13	12.5	0	0	104
Frame hive	85	93.4	6	6.6	0	0	91

Regular assessments and rapid detection of honeybee pests at their respective areas has paramount importance to prevent the loss of honey product due to pest attack [7]. However, in this study, both internal and external inspections were done sometimes by 48% and 46% of the respondents respectively. Unlike the external inspection, internal inspection was frequently done by about 29% of the respondents. Approximately 18% the respondents rarely inspect their hives internally. Below 5% of the respondents never inspect their hives, except visiting for harvesting.

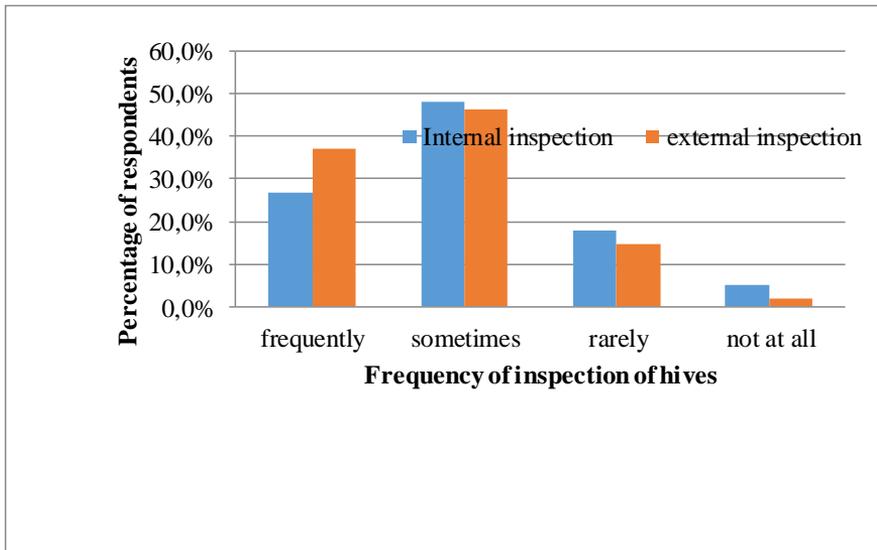


Figure 2. Internal and external honey bee inspections

According to the respondents, various honeybee plants exist in the area. In addition, respondents mentioned that different plants were responsible for the different colours of honey. Accordingly, plants like *Vernonia amygdalina*, *Croton macrostachys*, and *Schefflera abyssinica* produce white honey, while *Syzgium guineense* and *Bidens pachyloma* produce red honey. Similar plant species were identified as major pollen and nectar sources, for honeybees in Manasibu districts (Mathewos et al., 2004) and around the central low-land area (Amssalu 2000). Farmers reported that *Guizotia scabra* was a dominant honeybee forage in both Shashemene and Arsi Negelle districts, followed by *croton macrostachys*. Similarly, they argued that one of the critical factors that drive apiculture development is the availability of adequate quantities and the quality of bee forages.

About 72% of the respondents gave supplementary feed during the dry season, while 28% of the sampled beekeepers did not supplement. This might be due to lack of money to buy the supplementary feeds or may be due to lack of knowledge. Common feeds used as supplements during dry season were sugar, *berbre*, honey, *shiro*, maize powder, and chopped sugar cane.

Respondents gave varied reasons why they did not prefer frame hive technology (Table 6). Accordingly, lack of equipment was the first factor noted by 36.5% of the respondents, followed by wax quality and availability problem (34%).

Table 5. Honeybee forages reported by the respondents in the study area

No	Scientific names	Local name	Plant type
1	<i>Vernonia amygdalina</i>	Ebicha	Shrub
2	<i>Syzigium guineense</i>	Badessa	Tree
3	<i>Eucalyptus spp</i>	Bargemo	Tree
4	<i>Apodytes dimidiata</i>	Oda beda	Tree
5	<i>Acacia sibirana</i>	Lafto	Tree
6	<i>Prunus Africana</i>	Miessa	Tree
7	<i>Schefflera abyssinica</i>	Gatame	Tree
8	<i>Croton macrostachys</i>	Mokonissa	Tree
9	<i>Guizotia scabra</i>	Adala	Herb
10	<i>Cordia Africana</i>	Wodesa	Tree
11	<i>Schinus molle</i>	Turimanturi	Tree
12	<i>Agave sisalana</i>	Kancha	Shrub
13	<i>Allium cepa</i>	Shunkurti dima	Crop
14	<i>Vernonia amygdalina</i>	Girawa	Shrub
15	<i>Gizotia scabira</i>	Hadaa	Shrub/herb
16	<i>Bidens pachyloma</i>	Kelo	Herb

Discussants mentioned that affordability, availability, quality of materials – especially of the hives –, the inferior quality of wax, and lack of accessories were the major factors that hampered to use modern hives in the study area. That's why a few beekeepers tried to modify the frame hive to solve the problem of wax in vertical frame hive, and these hives were made of quality timber, offering better conditions for opening and managing them more easily. Some related problems were identified, such as the lack of skill in modern bee management, which had contributed to colony absconding and low honey production [4].

Table 6. Factors which affect usage of frame hives as reported by respondents

Factors	Number of respondents	%
Lack of awareness	46	29.5%
Skill personnel	24	15.4%
Lack of equipment	57	36.5%
Durability of hive	45	28.8%
Wax quality and availability problem	53	34.0%

Respondents listed pests and predators which affect honey bee like ant, wax moth, birds, spiders, and lizards. According to the response of beekeepers, ant

(65.5%) attack was a serious problem in the study area, followed by wax moth (52.4%). Frequent cleaning of the apiaries, using ash, and killing of the predators were remedies done by some of the respondents. Bee lice were the least problem, mentioned by 6.3% of the respondents. Similarly, Adeday et al. (2012) in Wukro Tigray region noted similar pests and predators [1]. Moreover, according to the result obtained by Debassa and Belay (2015), in Walmara district, 75.4% of the sample respondents lost up to five colonies due to pests and predators [6].

Table 7. Major pests and predators reported by respondents

Factors	Beekeepers who consider pests and predators are important (%)
Ant	65.5%
Wax moth	52.4%
Birds	47.3%
Spiders	26.5%
lizards	7.8%
Bee lice	6.3%

Among the sampled beekeepers in *Table 8*, only 55.8 % had received some training in bee management for two and three days at Farmers Training Center (FTC), near the town and regional city. Of those who had been trained, 58.2% took their training at the nearby town, followed by FTC (26.9%), while the minority (14.9%) were instructed in a regional city with the help of governmental and non-governmental organizations. These results suggest that acquisition of technical skills and knowledge of bee farming were likely to influence the adoption of modern beekeeping technology.

Table 8. Respondents' experience on training of bee management

Training experience	Number of respondents	Percentage
Respondents took training	67	55.8
Respondents did not take training	89	44.2
Total	156	100
Place of training		
At FTC	18	26.9
In a nearby town	39	58.2
In a regional city	10	14.9
Total	67	100

FTC = Farmer Training Centre

4. Conclusion

The productivity of frame and transitional hives is, more than triple than that of traditional hives. This is perhaps because of better management practices, such as providing wax foundation sheets, recycling of drawn out combs after honey extraction, and higher frequency of harvesting. Honey harvesting is done once, twice, or three times a year, and a variation among hive types can be clearly seen in the frequency of honey harvesting. Honey harvesting from frame hives and transitional hives takes place more than twice a year.

Half of the respondents preferred transitional hive, even though the average honey bee colony holding size for traditional was a little bit higher than the two hives. Major factors affecting choice of frame hive technology: lack of equipment, and wax quality and availability problems were mentioned as a first and second factors which affect the adoption of frame hive technology. In addition, pests and predators such as ants and wax moth were problems for honey bee colony in the study area.

Various honey-bee floras, such as *Vernonia amygdalina*, *Croton macrostachyus*, *Schefflera abyssinica*, *Syzgium guineense*, and *Bidens pachyloma*, were identified, which plants are responsible for the different colours of honey. The majority of beekeepers have knowledge in colony feed supplementation during dry season, which has to be adopted by other beekeepers to sustain the colonies. More than half of the beekeepers took training in the study area for two to three days. This suggests that acquisition of technical skills and knowledge of bee farming were likely to contribute positively to farmers' adoption decision. In conclusion, in order to adopt and sustain the modern hive technology, the focus should be on honey bee equipment, hive and wax quality and availability.

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