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Assessment on Beeswax Production, Processing and Marketing in Selected Districts of Kafa Zone, Southern Nations Nationalities and Peoples Region (SNNPR), Ethiopia

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Abstract
The study was conducted in the three districts of Kafa Zone of Southern Nations Nationalities and Peoples Region being; Chena, Gimbo and Gesha and three peasant associations (PAs) from each district. The main intention was to identify the production, processing and marketing status of beeswax. The districts were purposively selected based on their potential for honey and beeswax production and marketing. The survey data was collected from 239 selected beekeepers and key informants. According to the survey's result, 94.98% of beekeepers do not practice any processing of honey and sale it in crude form. Only 24(13%) of the respondents practicing collection of beeswax from old combs, 'tej' houses and discarded or broken combs while the majorities (87%) of them discarding it as a byproduct. Of those who were collecting beeswax, only 7(29%) were processing it for selling to central markets and other local purposes such as foundation sheet making, smearing top bars and traditional candle/'tuaf'making. This implies the trends of collecting, processing and marketing of beeswax is at its very infant stages at beekeepers level .Whereas, local mead houses and cooperatives are considered the major actors engaged in processing and marketing of beeswax. According to personal observation during survey, local mead houses are the major sources where beeswax is readily available year round. However, the overall management practice of beeswax at this market segment is very poor.
Keywords: beeswax; production, processing; marketing; Kafa zone.
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1. INTRODUCTION

Beekeeping is an integral part of agriculture mainly aimed for its valuable products; being honey, beeswax, pollen, royal jelly, bee venom and propolis which mostly used in foods, cosmetics, medicines and engineering industries (ARSD,2000;Espolov *et al.,*2014; Gemechis, 2014 and Gezahagne, 2016). It has also inevitable roles for its pollination services (Bradbear, 2009; Ahmed *et al.,* 2013; CLI, 2013; BfD, 2016 Sarka, 2017). The economic benefits of honeybees through pollination is by far exceeds than the worth obtained from their direct products (Mutsaers *et al.,* 2005; Espolov *et al*., 2014).

Next to honey, beeswax is considered as a major and oldest product used by human kind (Nyau, *et al.,* 2013). In the ancient times, it had been used for making various paintings, sculptures, adhesives and as medicinal ingredients and healings (Bogdanov, 2016b). Later on with expansion of Christianity, it had extensively being used for candle making for daily ceremonies in churches (Hartman, 2004). Nowadays, in related to the advancement of technologies and modernization, it has been using for producing over 300 industrial products used in various fields including Cosmetics, foods, pharmaceuticals, arts, engineering and industries (Bogdanov, 2004a; Nuru, 2007b; Ayalew, 2008) resulting for an ever increased demands for this product (Gemechis, 2014).

Ethiopia is endowed with huge natural resources which favors for the existence of over 10 million honeybee colonies potential for producing huge amount of honey and beeswax (USAID, 2008; Getahun and Samuel, 2016). According to Global Development Solution/GDS (2009), the country owns a potential of producing over 500,000 tons of honey and 50,000 tons of beeswax annually. However, it achieved only about 50,000 tones of honey and 5,542 tons of beeswax which is only about 10% of its potentials (FAOSTAT, 2016). With such an amount, it ranks first in Africa for its both honey and beeswax production and ranks fourth and tenth worldwide for its beeswax and honey production respectively (Hartmann, 2004; SNV/Ethiopia, 2005; Sisay, 2015; Gemechis, 2016). Though the country has potentials to meet its beeswax requirements, due to its weak production enhancements and an ever increasing population and urbanization, the domestic demand for beeswax is steadily increasing from time to time to the extent competing the export level(Sarah and Jeroen, 2011;EMDIDI, 2017). Even though the export trends of beeswax is steadily increasing, available export report shows that the mean export level of last eight years (2009-2016) is only 351 tons which is below 10% of its mean annual production (5,542 tons) (FAOSTAT,2016; ATA, 2017). Due to its stability and attractiveness, beeswax is the only animals' product competing to the world market (Aravindakshan *et al*, 2010) and has been used as a main trading commodity with long lasting cultural values in Ethiopia (USAID, 2012; Seid and Solomon, 2015;

Gezahagne, 2016; Ayalew, 2016).

Even though small-scale beekeepers are the major sources of beeswax, the trend of producing beeswax from crude honey is undertaken by very few individuals. As a result, local mead houses, where about 80% of the total honey produce goes; considered as the major sources of beeswax in the country (Hartman, 2004; Girma *et al.,* 2008; Dessalegne, 2012). The average yield of beeswax to be obtained from traditional and modern beehives is estimated to be 8-10% and 0.5-2% of its honey yield respectively (Johannes, 2005; Girma *et al.,* 2008). This revealed the high coverage of traditional hives coupled with availability of potential bee forages are considered as golden opportunities for the production of huge amount of beeswax (Gemechis, 2014).

Kafa zone is one of the areas with huge and core forest places of the country where a predominant number of honeybee colonies managed in traditional hives. It covers about 40% of the regional potentials producing over 132,041.4 kg of beeswax (CSA, 2016). As most parts of the country, beekeeping is mainly aimed with obtaining honey and little attention is given for beeswax production. Hence, the aim of this study was to assess the current status of production, processing, handling practices and marketing of beeswax in the studied areas and identifying major constraints and opportunities for production and marketing of beeswax in order to propose the way forward.

2. LITRATURE REVIEW

2.1. Beeswax production

Beeswax is a valuable product secreted from four pairs of glands located underside of the abdomen of young worker bees (Brown, 2010; Carillo *et al.,* 2015). Honeybees produce wax for constructing their combs and cell capping (QSAE, 2005; KEBS, 2013). Next to honey, it is the second major bee product (Gemechis, 2014; Bakalo *et al.,* 2016) considered as the main trading commodity with long lasting cultural values (USAID, 2012; Seid, 2015; Gezahagne, 2016; Ayalew, 2016). Apart from its use for making comb foundation sheets, beeswax is also widely used in various fields including cosmetics, foods, pharmaceuticals, engineering and industries (Bogdanov, 2004b; 2016b; Hilmi *et al.,* 2011; Gemechis, 2014).

According to FAOSTAT (2016), the country produces about 5,542 tons of beeswax annually which accounts for 33 % of African and 8% of the world's yield. However, the above production amount is estimated based on the gross honey produce excluding the amount of beeswax wasted in rural areas (Save the Children UK, 2006). Similarly, considerable amount (about 25% of the total beeswax produce) will be wasted due to spitting out of beeswax after the consumption of crude honey (Gezahagne *et al.*, 2006; Melaku *et al.,* 2008). According Bradbear (2009), due to the small amount of beeswax produced by small scale beekeepers, it is not as such easy to manage the product obtained from each beekeeper. Hence, most of the beeswax produced in rural areas is wasted as a byproduct (Nuru and Iddosa, 2004; Aravindakshan e*t al,* 2010). According to Awraris *et al* (2012), about 2-3 kg crude beeswax wasted in rural areas from each ten traditional hive whose colonies absconded.

In the country, the rural beekeepers are the primary sources for beeswax production and local mead houses are the primary suppliers of beeswax (MoARD, 2003; Hartman, 2004; Johannes, 2005). A case in point, study by HBRC (2012) cited in Johannes (2005) showed that traditional and intermediate hives are able to produce 8-10% of its crude honey yields while only 0.5-2% of its honey yield will be obtained from movable frame hives. Hence, being majorities of beekeepers are practicing traditional beekeeping system (using traditional hives), the country owns huge potentialities for beeswax production (Awraris *et al.*, 2012; Yetimwork *et al.*, 2014).

Study on comparison of different hive types on its honey and beeswax productivities and colony performance in south and south western parts of the country showed that 2.92 ± 0.27kg, 1.57 ± 0.22kg and 1.54 ± 0.09kg and 0.3 ± 0.03kg of beeswax was obtained from Ethio chefeka, traditional and movable frame hives respectively (Awraris *et al*., 2015).

On the other study at Endamekonnin woreda of Tigray region indicated that 4.12 kg, 3.20kg, 0.24kg and 0.0329kg of beeswax obtained from traditional, KTBH, clay frame and modern hives respectively with significantly higher yield obtained from traditional hives than modern and clay hives. However, there is significant variation between traditional and KTBH (Gebregziabher *et al.,* 2014).

According to Haftu and Gezu (2014), lack of awareness, lack of market accesses, lack of processing skill and lack of processing materials are the major constraints of beeswax production in Hadiya Zone sharing 39.2%, 21.5%,20.5% and 18.5% respectively. Similarly, study by Addisu *et al.* (2017) at Debub Wollo zone indicated that lack of awareness, knowledge gap and market problems are being the major problems for beeswax production sharing 80%, 59.17% and 55.83% respectively. Generally, according to Gemechis (2014), declared that lack of awareness, skills of collection, processing and marketing are core constraints of potential beeswax producing areas of the country.

2.2. Beeswax processing

The Crude beeswax obtained from different sources such as old combs, '*tej sefef*' would be cleansed and formed into a block. Though there are a number of mechanical and chemical rendering methods, the steam wax melter,

the solar wax melter, the wax presser, wax and honey separate and electric melters are the commonly applied methods (Bradbear, 2009).

Due to lack of awareness, skill and inputs, the overall processing and handling practices of beeswax undertaken in traditional ways are inefficient in producing optimum amount of product with preferred qualities (Nuru and Iddosa, 2004; Hilmi *et al*., 2012;Gemmechis, 2014; Samuel, 2017). The country looses over 40% of its annual produce due to the traditional ways of processing practices (Demisew, 2016)

Study by HBRC (2016) on the yield and quality status of beeswax produced through manual, Submerged and solar rendering methods revealed that there is a significant yield variation of beeswax obtained through three methods. Accordingly, the manual and Sub merged methods have better yields with 44.2% and 49.6% respectively than solar method which has only 26.4% yield. However, the solar extraction method has better quality of beeswax product which is less viable to be attacked by wax moths (Bogdanov, 2009).

On the other study by Nuru and Iddosa (2004), the amount of crude beeswax obtained from crude honey will vary from 5 to 65.62% with a mean of 27.5%, and the percentage of pure beeswax obtained compared to its crude beeswax yield ranging from 45.8 to 92.2% with a mean of 73.61%.

In the country, beeswax processing is not common at beekeepers level. However, '*tej'* houses in part are engaged in supplying crude and semi processed beeswax. Cooperatives and Private companies like Apinec, Tutu, Beza mar, Amar, Yeshi mar and others estimated to reach up to 30 in number are major sources of marketable beeswax product (Johannes, 2005; Aravindakshan *et al*., 2010; Demisew, 2016).

2.3. Beeswax marketing

Ethiopia is known to be the leading beeswax producer in Africa and one of the 4 biggest beeswax trading countries in world next to China, Mexico and Turkey (Johannis, 2005; SNV/Ethiopia, 2005; Tessega, 2009; Gemechis, 2014). Due to its pliability and softness, beeswax from Ethiopia is highly demanded at global markets as it is more suitable for blending waxes from other sources (Nuru, 2007b). Beeswax is considered as an opportunistic commodity to fetch foreign currencies. However, due to an ever increased domestic demands and low production, the country trades only about 420 tons or (10%) of its production (Nuru and Eddosa, 2004; Gemechis, 2014; ATA, 2015). However, the total amount of beeswax being traded will reach up to 3000 tons when the illegal export amount is taken into account (BfD, 2007). Due to various actors taking part in marketing of beeswax, the issue of traceability is the major concern (Gemechis Legesse, 2014).

Even though, the marketing channels of the honey and beeswax seems very complex and lacking formal linkages, three channels; namely *'tej'* house channels, the processors and exporters channels, and the beeswax channels are considered as the major honey and beeswax market channels in the country (MoARD, 2013).

According to the available export reports from 2009-16 revealed that the export level of beeswax is very minimum which is below 10% of its production amount though it's an increasing trend (Figure 1).

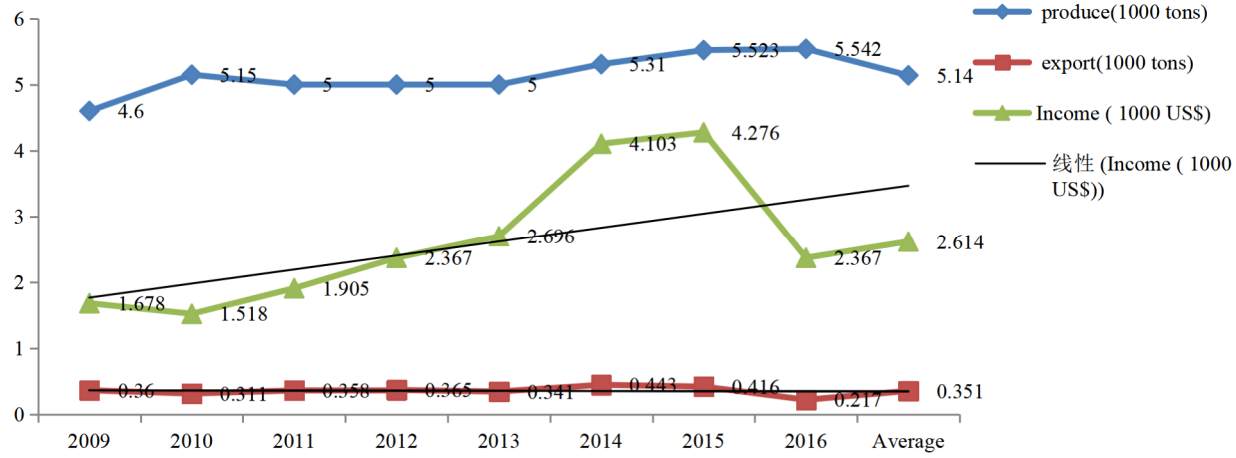


Figure 1. Beeswax production and exports trends (2009-2016) (1000 tons)
Source: FAOSTAT (2016)

3. MATERIALS AND METHODS

3.1. Description of the Study Areas

Kafa zone is one of the zones found in Southern Nations Nationalities and Peoples Region (SNNPR) of Ethiopia; situated at 6º14'28" to 8º7'11'' N latitude and 35º26'37" to 36º 47'28'' E longitude covering an area of 10,602.7 sq. km (Wikipedia, 2017). According to CSA (2017), the population size of the zone is estimated to be 1,102,278 (541,682 male and 560,596 female); of whom 963,852(87%) are rural inhabitants. The agro ecological

classification of the zone includes 11.64% (Highlands), 59.45% (mid lands) and 28.91% (low lands). The area receives almost a year round rain falls with major rainy seasons occurring through March to October (Friis, 1992, USAID, 2005). The mean annual rainfall of the zone ranges from 1000 to 2200 mm (Minyahil, 2015) and the minimum and maximum temperature of the zone is 10.1 and 27.5°C respectively.

The zone includes ten administrative districts; namely, Gesha, Chena, Gimbo, Menjieo (Adiyo), Tello, Cheta, Bita, Gewata, Saylem, Decha and one zonal administrative town (Bonga) (Figure 2).

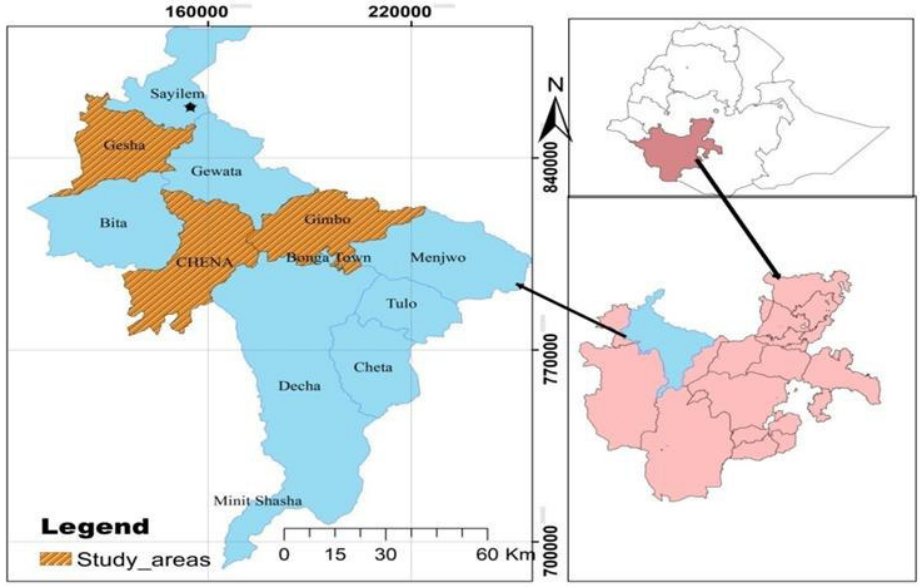


Figure 2. Map of study areas

2.2. Study Areas and Sample Respondents Selection

Three Districts, being Chena, Gimbo and Gesha and three peasant associations/PAs/ were purposively selected based on their production and marketing potentials of honey and beeswax. Respondent beekeepers were randomly selected using ***Yamane's*** **(1967)** calculations (1)

$$SS = {}^{N}/_{1+Ne^2} \quad (1)$$

Where; SS= Required Sample size; N= Total population; e=margin of error (10%)

Accordingly, a total of 239 respondents were sampled from nine selected PAs comprising a total of 330 beekeepers (Table 1). In addition, key informants participating in honey and beeswax value chains were also incorporated for collecting survey data.

Table 1. Number of respondent beekeepers

District	PAs	Total Beekeeper	Sampled Beekeepers
Gesha	Denity	32	24
	Yeshitweri	42	30
	Didifa	34	25
Chena	Wanabola	30	23
	Dimbira	46	32
	Weshi	39	28
Gimbo	Tulla	33	25
	Shomba	27	21
	Yeyibtu	45	31
Total		330	239

3. RESULT AND DISCUSSION

3.1. Socio economic characteristics of the respondents

Of the total 239 respondents, 228(95.39%) of them were male and 11(4.61%) were females. The age distribution (Mean±SD) of respondents was 39.92±8.27; 39.01±8.45; 37.75±8.53 years for Chena, Gimbo and Gesha districts respectively. The overall age (Mean±SD) of studied areas was found to be 38.91±8.43 years ranging from 18 to 72 years. According to survey result on age distribution of the respondents, about 72% of the respondents were found within in a range of 18 to 45 years; about 24% of them within 46 to 60 years and 4.4% are more than 60 years of age (Table 2). This revealed the predominant numbers of beekeepers are found within the range of younger age groups.

Table 2. Sex and Age group respondents

House Hold Characteristics	Variables	Districts (frequency and percentage) Chena	Gimbo	Gesha	Over all
Sex	Male	79(95.18%)	75(97.4%)	74(93.67%)	228(95.40%)
	Female	4(4.82%)	2(2.6%)	5(6.33%)	11(4.60%)
	Total	83(100%)	77(100%)	79(100%)	239(100%)
Age	Mean±SD	39.92±8.27	39.01±8.45	37.75±8.53	38.91±8.43^{NS}
	Range	25-67	20-65	18-72	18-72
	18– 45	52(62.65%)	56(72.73%)	63(79.75%)	171(71.55%)
	46-60	29(35%)	17(22.08%)	11(13.92%)	57(23.85%)
	61and above	2(2.41%)	4(5.19%)	5(6.33%)	11(4.60%)

3.2. Colony holding of respondents

The household colony holding (Mean+SD) of the study districts were 15.84±12.69, 16.88±9.07 and 21.53±10.92 for Chena, Gimbo and Gesha districts respectively(Table 4). There is significant variation of colony holding among study districts at $p<0.05$. Accordingly, Gesha district has significantly higher colony holding than Gimbo and Chena districts (Table 4). The mean colony holding of the area was found to be 18.05±11.27 (Table 4). Similar comparable result, 15 colonies was reported by Awraris *et al.,* (2012). However, it is somehow greater than the mean colony holding of Jima and Illubabor zones which was reported to be 10.3±2 and 10.7±4.3 respectively (Welay and Tekleberhan, 2017). According to Figure 3, colony holding of the respondents in the studied areas ranges from 2 to 92 and about 45% of the respondents own over fifteen colonies.

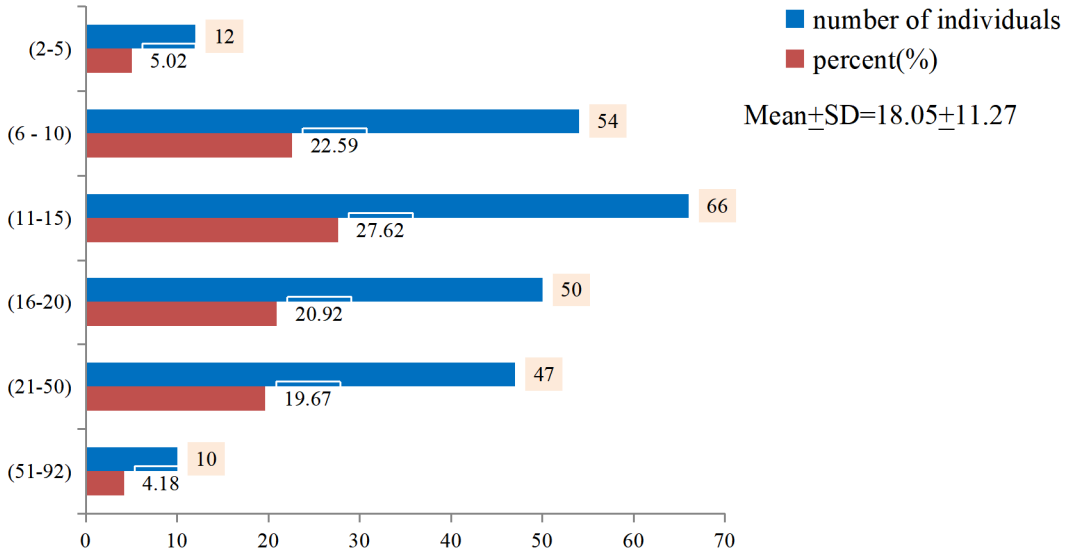


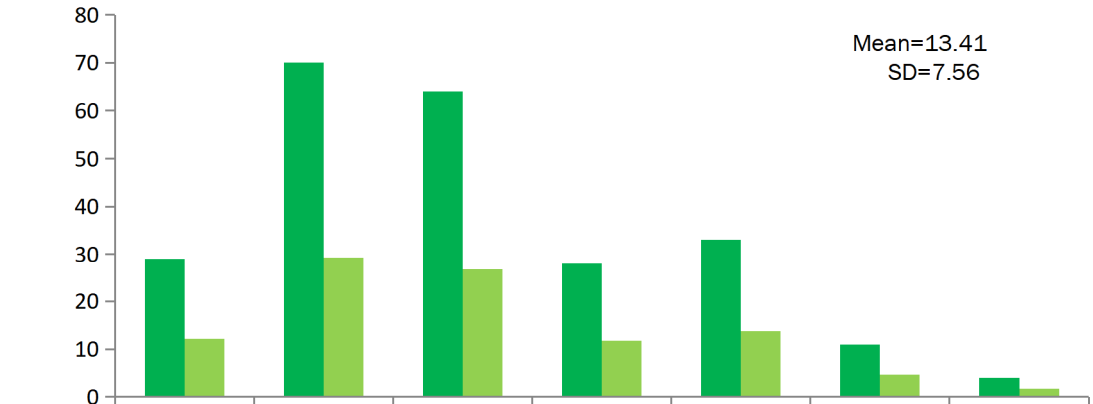
Figure 3. Colony holding of the respondents

3.2. Beekeeping practices

3.2.1. Beekeeping experiences of the respondents

Despite the availability of favorable environments and technologies, beekeeping may not be successful unless accompanied with apt knowhow and experiences (Chala *et al*, 2012).

According to Figure 4, about 59% of the of the respondents have over 10 years of beekeeping experiences and about 41% have less than 10 years of experience. The overall beekeeping experiences (Mean±SD) of the respondents was found to be 13.41±7.56 years ranging from 2 to 45 years. Similarly, the beekeeping experience of the area was reported to be 11.89±3.95 and 16.17±6.88 years by Kasa *et al.,* (2017) and Awraris *et al.,* (2012) respectively. It is also similar with the experience of beekeepers in Jima and Illubabor zone, which was reported to be 13.51 ± 6.58(Welay and Tekleberhan, 2017). The result indicates, even though beekeeping is undertaken in traditional ways, it is considered as long lasting practice in supporting the livelihood of most communities of the areas. Similarly, Tefera (2005) and Yoshimasa (2017) also declared that beekeeping has long been part and parcel of the socio cultural system of South and South western parts of Ethiopia.



	(2-5)	(6-10)	11-15)	(16-20)	(21- 25)	(25-30)	(31-45)
Number	29	70	64	28	33	11	4
Percent	12.13	29.29	26.78	11.72	13.81	4.60	1.67

Figure 4. Beekeeping Experiences of respondents

3.2.2. Reasons for engagement in beekeeping

The need for income sources is the main reason for the engagement of most (59.01%) of respondents in beekeeping activity followed by home consumption, hobby, and training and other supports sharing 21.23%, 15.56% and 5.6% respectively (Table 3). Various studies acknowledged that in related to the huge floral resources, beekeeping is mainly aimed with honey production which is used as the major immediate income sources for most communities of the areas (Hartmann, 2004; Nuru, 2007a; Janet and Andrian, 2014). Similarly, Awraris *et al* (2012) stated that over 50% of the households' income source will be obtained from beekeeping. During survey, 24(10.04%) individuals were found to obtain almost all of their livelihood needs merely from the sale of honey crop. According to few, 5.6% of beekeepers replied, training and input supports provided by governmental and nongovernmental Organizations increased their awareness and motivation to be engaged in beekeeping (Table 3).

Table 3. Reasons for engagement in beekeeping

Reasons for engagement	**Ranks**			**Total**	**Index**	**Rank**
	1st	**2nd**	**3rd**			
Income	206(81.42)	33(30.56)	-	239(59.01)	0.67	1
Hobby	15(5.93)	20(18.52)	28(63.64)	63 (15.56)	0.11	3
Home consumption	24(9.49)	49(45.37)	13(29.55)	86 (21.23)	0.18	2
Training & Other supports	8(3.16)	6(5.56)	3(6.82)	17(5.6)	0.04	4
Total	**253**	**108**	**44**	**405**	**1**	

Index = sum of (3*ranked 1st + 2* ranked 2nd +1* ranked 3rd) for individual reason divided by the sum of (3*ranked 1st + 2* ranked 2nd +1* ranked 3rd) for over all reasons.

( ) = percent

3.2.3. Hive types and honey production

The majorities, 74.88% of hives in the area are locally made traditional hives followed by movable frame/box hives and transitional hives accounting for 14.53% and10.59% respectively (Table 4). The mean colony holding of respondents by hive types was found to be 13.52±5.95, 1.91±4.40 and 2.62±5.07 for traditional, transitional and modern/box hives respectively (Table 4). According to personal observation during survey, even though there are various factors contributing for the minimum adoption levels of improved hives, inaccessibility to road infrastructure was found to be the most determinant factor. To this fact, over 80% of the respondents who have improved hives are found in areas approaching to main roads within a distance radius of about three kilometers from the main roads. This might be due to their higher exposurities for various supports and information sharing. The honey yield estimate of the areas by hive types and districts in the below Table 6, depicts that annual productivity of the colonies was significantly different at ($p<0.05$) among hive types and study districts. Accordingly, Gesha district has significantly higher yield than Chena and Gimbo districts. The mean annual honey productivity of hives in the studied areas was found to be 8.34±2.33, 15.96±2.62 and 27.27±2.74 for traditional, transitional and moveable frame hives respectively (Table 5). The current result is less than Awraris *et al.,*(2012); who reported the productivity of traditional hives was 10.53±5.27, 12.60 ± 4.83, and 16.06± 9.03for Gimbo, Chena and Gesha districts respectively. The difference might be due to the minimum sample sizes of respondents purposively selected during the previous study being, 20, 24 and 26 respondents considered

for Gimbo, Chena and Gesha districts respectively.

The current result is greater than the national report which is 5-8 kg, 10-15 kg and 20-25 kg of crude honey per hive from traditional, transitional and movable frame hives respectively (Nuru, 2007a). It is also greater than Goma district which was 7.20±0.23kg, 14.70±0.62kg and 23.38±0.73kg from traditional, transitional and movable frame hives respectively (Chala, *et al.* 2013).

Table 4. Share of honeybee colony holdings by hive types

Hive types	Districts							
	Chena		Gimbo		Gesha		Overall	
	Total	Mean±SD	Total	Mean±SD	Total	Mean±SD	Total	Mean±SD
Traditional	980(75)	11.80 ± 5.10^{b}	952(73.2)	12.36 ± 5.57^{b}	1300(76)	16.46 ± 6.12^{a}	3232(75)	13.52 ± 5.95
Transitional	151(11.5)	1.82±5.52	150(11.5)	1.95±3.38	156(9.2)	1.97±3.99	457(11)	1.91 ± 4.40^{Ns}
Movable frame	184(14)	2.22±5.58	198(15.2)	2.57±3.99	245(14.4)	3.10±5.46	627(15)	2.62 ± 5.07^{Ns}
Total	**1315**	**15.84 ± 12.69^{b}**	**1300**	**16.88 ± 9.07^{b}**	**1701**	**21.53 ± 10.92^{a}**	**4,316**	**18.05±11.27**

*Letters with different superscript across rows indicates significant difference of hive numbers among districts; ( ) indicates percent

Table 5. Honey yield based on hive types and districts

Districts	Hive types										
	Traditional			Transitional			Movable frame			Over all	
	Total Hives	Total Yield (Kg)	Yield/hive (Mean±SD)	Total hives	Total Yield(kg)	Yield/hive (Mean±SD)	Total hives	Total Yield(kg)	Yield/hive (Mean±SD)	Total hives	Total yield (Kg)
Chena	980	7,703	$7.86\pm2,16^{b}$	151	39,2411	14.85 ± 1.8^{b}	184	4762	25.88 ± 1.85^{b}	1315	404,876
Gimbo	952	7,759	8.15 ± 2.14^{b}	150	2279	15.19 ± 2.78^{b}	198	5215	26.34 ± 2^{b}	1300	15253
Gesha	1300	11,906	9.02 ± 2.53^{a}	156	2,753	17.65 ± 2.42^{a}	245	7093	28.95 ± 2.92^{a}	1721	21752
Total	**3232**	26,955	**8.34±2.33**	**457**	7,294	**15.96±2.62**	**627**	17098	**27.27±2.74**	4336	441,881

*Letters with different superscripts within columns indicates significant variation of honey yield among districts

3.2.4. Honey processing

Honey processing is imperative to maximize the benefits incurred from beekeeping by obtaining additional incomes both from honey and beeswax. In the area, the predominant, about 93% of the respondents are selling their honey product in crude form.

Of the total **627** box hives counted during the survey, 376(60%) are constructed by local carpentries (Photo 1). Under such types of hives, beekeepers do not use hive frames instead they use top bars and harvesting will takes place in the same manner with that of transitional hives. A total of 72 beekeepers have modern/movable frame hives. Of whom, only 7(9.72%) can extract their honey using honey extractor and the rest 65(90.28%) sell it in crude forms (Table 6). Beekeepers strain their honey for the purpose of home consumption, selling and as gifts for their families accounting for 48%, 36% and 16% respectively. This indicates, processing of honey at beekeepers level is not common in the areas.

As depicted in Table 5, the total honey yield of respondents was estimated to be 441,881 kg. Hence, the amount of beeswax to be obtained would be 35,350.5 to 44,188 kg (i.e. 8-10% of crude honey yield). Based on the current local prices of beeswax (200 EB or 7 US$), the amount of income would be **7,070,100 to 8,837,600 EB** or **10, 10,014 to 12, 62,514 US$**. This revealed it would be a huge economic losses when reckoned country wise. Lack of awareness (31.47%), considering as it will reduce the amount of honey yield (25%), lack of processing materials (22.94%), small production (13.24%) and consumers preferences (7.35%) are listed to be major reasons for not processing their honey (Table 6). According to Tesema (2016), lack of straining materials and skill (49%), knowledge gap on how to strain (36%),Consumers preference (23%) were reported to be the major constraints for processing of honey at Guji Zone. Study by Addisu *et al.,* (2017) also indicated that lack of awareness (66.67%), lack of materials (51.85%), consumers' preference (24.44%), small production (1.48%) and

considering as it will reduce the amount of honey (0.74%) were reported to be the major reasons for not processing honey in South Wollo Zone. Similarly, Biresaw *et al*., (2015) also reported that considering as it will reduce the amount of honey (55%), Lack of materials (24.5) and lack of knowledge 20.5 % were listed as the core reasons for not straining honey in Haramaya district.

Photo 1: Locally constructed box hive

Table 6. Honey processing

Parameters	**Variable**	**Freq.**	**%**
Do you strain honey from traditional and transitional /frameless box hives?	Yes	12	5.02
	No	227	94.98
Purposes of straining honey?			
For home consumption		12	48
For sale		9	36
For family gifts		4	16
Total		25	100
Materials used for straining			
Honey presser		10	83%
Sieves		2	7%
Reasons for not straining	Lack of awareness	107	31.47(1)
	Lack of materials	78	22.94(3)
	Consumers preference	25	7.35(5)
	Reduces the amount of honey	85	25.00(2)
	Small production	45	13.24(4)
	Total	340	100
Do you use honey extractor for movable frame hives?	Yes	7	9.72
	No	65	90.28
Total respondents who have moveable frame hives		72	100

( ) denotes ranks of reasons for not straining honey

Photo 2: Some of honey processing/extracting materials at beekeepers level

3.3. Training and Other supports

As honeybees are very complex and wild creatures, detail knowhows about their nature and manipulation skills are paramount to maintain them and obtaining better rewards (Mutsaers, 2005). To this fact, the less adoption of technologies are partly emanating from their misuses. Hence, training and regular followups are very imperative to maximize the benefits from the sub sector. Only 63(26.36%) of the respondents have got training on beekeeping (Table 7). Of whom, 21(33.33%) have got training for morethan five days; about general bee managements, bee product handling, transitional/ethio-ribrab hive making and queen rearing. Where as 42(66.67%) of them have got training for less than five days about honeybees management and bee products handling and chefeka/ethio ribrab hive making. The total training dates (Mean±SD) of the repondents was 4.15±3.00. The result is similar with Awraris *et al.*(2012) who reported lack of training and technical supports, shortages of skilled man power are some of the major constraint of beekeepers in the areas.

The zone has various governmental and non governmental stake holders taking part in supporting beekeeping subsector. Of which Kafa Forest Bee Products Development And Marketing Cooperative Union (KFBPDMU) and Apicec Agro industry PLC are the major ones providing trainings, inputs, credit services and market facilitations for beekeepers. Other organisations; such as Aspire, ATA (Agricultural Transformation Agency),AGP(Agricultural Growth Program),WV(World Vission),NABU (Nature and Biodiversity Conservation Union),(KBCU) Kafa Biosphere Conservation Union providing various supports to beekeepers in line with conserving natural forest biosphere of the areas.

Table 7. Training

Parameters	**Variables**	**freq.**	**%**
Have you got any training on beekeeping ?	Yes	63	26.36
	No	176	73.64
	Organizer/host	**freq**	**%**
Who trained you(Organizer)?	BoA/BoLivestock and fishery dev't	19	15.57
	KFBPDMU	7	5.74
	AGP	30	24.59
	Aspire	13	10.66
	HBRC	3	2.46
	Apinec	12	9.84
	Unknown	38	31.15
	Total	122	100

3.4. Beeswax Production, Processing and Marketing

3.4.1. Uses of beeswax

Beeswax has a numerous economic values worldwide particularly in industrially developed countries for making various products. However, in developing countries like Ethiopia, its benefit is limited for local purposes only (Aravindakshan *et al.,*2010). In the country, the greater amount of beeswax is used for making traditional '*tuaf*'/candles which has been used for daily ceremonies for Ethiopian Orthodocs churches. In the study areas, beeswax has been used for smoking bait hives, making foundation sheets, making candle/'*tuaf*', for smearing top bars and for baking '*enjera*' /'*masesha'* sharing 57.93, 10.03%,7.77%, 5.50 and 2.91% respectively (Table 8). A considerable number (about 15.86%) of individuals do not know any values of the beeswax and mostly discarding it as byproducts.

Table 8. Major uses of beeswax in the studied areas

Uses of Beeswax	Freq	%
To smoke bait hives	179	57.93
For making foundation sheets	31	10.03
For making candle or '*Tuaf*'	24	7.77
For baking '*injera*'/'*Masesha*'	9	2.91
For Smearing top bars	17	5.50
Don't know any values	49	15.86
Total	309	100

3.4.2. Beeswax production and collection

Of the total 239 respondents, only 24(10.04%) of them are practicing collection of beeswax from absconded colonies, broken and discarded combs, empty combs during harvesting, from extracted honey, left over after consumption of crude honey and from /'*tej*' houses sharing 41.38%, 29.31%, 22.41%, 5.17% and 1.72% respectively(Table 9). Lack of awareness, small production, market problems, lack of processing skills, Lack of processing materials, lack of knowhow about its economic benefits and lack of interests are the major constraints for beeswax collection in the studied areas sharing 26.34%, 22.28%, 18.21%, 12.52%, 10.08%, 7.80% and 2.76% respectively(Table 9). The current result is similar with Haftu and Gezu (2014) who reported that lack of awareness about the product (39.2%), lack of beeswax market (21.5%), lack of processing skill (20.8%) and processing materials (18.5%) are major reasons for beeswax collection in Hadiya zone. Similarly, Addisu *et al.,* (2017) reported that lack of awareness (80%), knowledge gap about its economical benefits (59.17%) and market problems (55.83%) are the major constraints of beeswax production in South Wollo zone. On the other study by Biressaw *et al.*(2015) at Haramaya district indicated that lack of knowhow (77.7%), lack of processing skills(12%), lack of processing materials (9.6%) and lack of markets(5.3%) are reported to be the core problems for the collection of Beeswax.

Table 9. Beeswax collection

Parameters	Variables	Freq	%
Do you collect beeswax	Yes	24	13.33
	No	156	86.67
If yes, from where you collect			
From Absconded colonies		24	41.38
From broken, discarded/old combs		17	29.31
Empty combs during harvesting		13	22.41
leftovers after consuming the honey		3	5.17
Collection from '*tej*' houses		1	1.72
Total		58	100
If No, why?			
Small production		137	22.28(2)
Lack of processing skills		77	12.52(4)
Lack of processing materials		62	10.08(5)
Lack of market		112	18.21(3)
Lack of awareness		162	26.34(1)
Lack of knowhow about its economic value		48	7.80(6)
Lack of interests		17	2.76(7)
Total		615	100

( ) indicates ranking of reasons for not collecting beeswax

3.4.3. Beeswax processing and storage

The beeswax should be processed as soon as possible after collection and stored in clean, cool and dry places in wrapping papers, in containers made of stainless steels, glasses or plastics for best preservation of its color and aroma (Bogdanov, 2004b, KEBS, 2013). From the total of 24 individuals who collect the beeswax, only 7(29.17%) of them practicing processing beeswax. The rest 17(70.83%), merely using the crude waxes for local purposes mainly for smoking bait hives. The beekeepers use the processed beeswax for selling, making foundation sheets and smearing top bars sharing 20%, 30% and 50% respectively (Table 10). The ways of storages is significantly varying between the wax processers and non processers. Accordingly, non processing beekeepers will not bothering about the ways of its storages as it is only used for local purposes. Beekeepers store beeswax for shorter times with curiously before processing and storing longer by forming it in block forms. They also use various storage mechanisms and materials to protect its deterioration. Accordingly, 50% of whom keep at aerated places, 29.17% using fertilizer bag, 16.67% storing in any materials and 4.17% using plastics (Table 10). Wax moths are the major threats of beeswax. It can be prevented by melting the raw beeswax and

storing in cool, light and airy places, treating with *Bacillus thuringiensis,* sulphur, acetic acids and formic acids (Bogdanov, 2016a). Beekeepers in the study areas will reduce the wax moth attacks by placing the beeswax in aerated places, processing the crude wax and soaking in the water. Whereas, mixing with table salt (NaCl) is also practiced by some *'tej'* houses to prevent wax moth attacks.

Table 10. Beeswax processing and storages for beekeepers and processors

Beeswax processing methods	**Freq.**	**%**
Sack extraction	7	29.17
No processing	17	70.83
Total	24	100
What do you do with the processed beeswax?		
Selling	2	20
For making foundation sheets	3	30
For smearing top bars	5	50
Total	10	100
How long you store the beeswax?		
1. For Beekeepers		
Storing up to one week before processing and for up to two years after processing and molded	1	4.17
Storing up to two weeks before processing and for unlimited times if kept in aerated place after processing in block form	3	12.50
More than two months before processing and for unlimited times if placed in aerated places and periodically soaked in water to kill the moth	2	8.33
Storing up to one month before processing and up to 2-3 years after processed /molded/	1	4.17
For more than two years without processing	2	8.33
I don't know	1	4.17
For one year without processing	4	16.67
Immediately using for smoking hives	10	41.67
Total	24	100
2. For cooperatives		
For up to one week before processing and up to 3 months after processing and molded	1	50
From 1 to 2 weeks before processing and 0.5-1year after processing	1	50
Total	2	100
Materials used for storing beeswax		
1. For Beekeepers		
Fertilizer bag	7	29.17
Keeping at aerated places without containers	12	50.00
Plastics	1	4.17
Any materials	4	16.67
Total	24	100
2. For cooperatives		
Fertilizer bag or sacks	1	25
Putting at aerated and clean rooms	2	50
Wrapping with plastics	1	25
Total	4	100
Source of beeswax for movable frame hives		
Agricultural office	2	4.08
Own sources	4	8.16
Own and agricultural office	1	2.04
No use of wax for frame hives	42	85.71
Total (having frame hives)	49	100

a) b)

Foto 3: Beeswax produced by beekeepers (a- Chena district

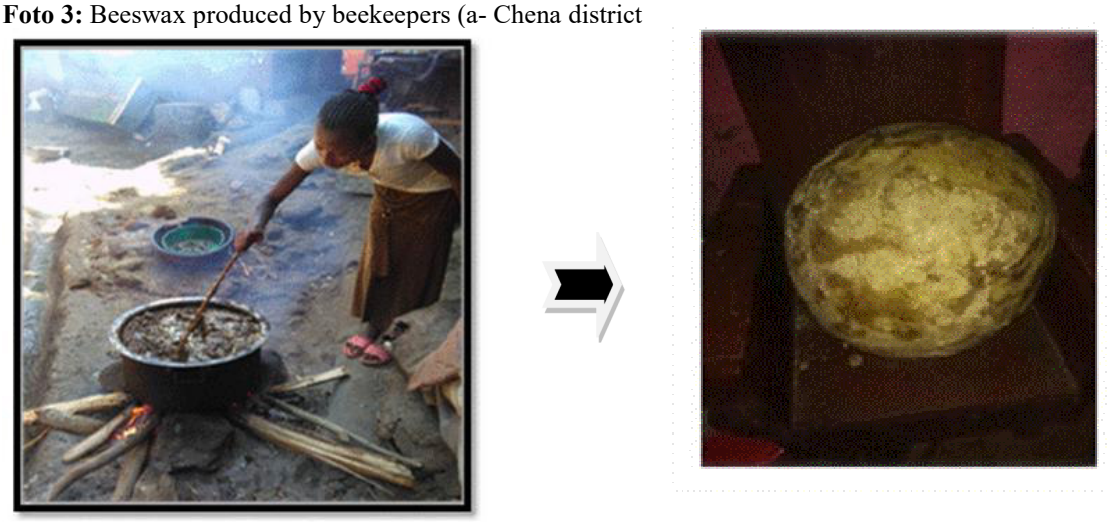


Photo 4: Beeswax production at local mead /'*Tej'*/ houses (Chena district)

3.4.4. Beeswax adulteration

Adulteration of beeswax with other foreign materials such as animal tallow, candles, are thought to be a serious and cross cutting issues deteriorating the quality status of beeswax produced in the country (Nuru, 2007b; Gemechis, 2014; Meseret and Taye , 2017). About 97.22% of the respondents replied that they do heard/encountered with adulteration of beeswax. However, 2.78% of them replied that rarely there is a case of adulterated beeswax which is distributed by Agricultural office and at local '*tej*' houses (Table 11). Some '*tej'* houses will mix beeswax with '*kocho'* (a local food prepared by scraping the stem of *Enset ventricosum* plant and fermenting), by masking it in beeswax blocks to obtain additional incomes by increasing its weight. They mix '*kocho'* in small amount which not more than 1 to 4 ratios.

Table 11. Adulteration of beeswax in the studied areas

Is there beeswax adulteration practice in your areas?	**Freq**	**%**
Yes	5	2.78
No	175	97.22
Who are adulterators?		
'Tej' houses	2	28.57
Merchants from other areas	5	71.43
Total	7	100
Adulterants used		
*'Kocho'/enset (*for '*tej' houses)*	2	28.57
Animal tallow, candles (for merchants)	5	71.43
When adulteration does occur?		
Has no specific times (for '*tej'* houses)	2	100
Some times when wax bought by agricultural offices, NGOs.	5	100
Ways of mixing adulterants		
Mixing the *'kocho'* after extracting the wax(for *tej* houses)	2	100
I don't know(for wax from other sources)	4	80
Melting and mixing (for wax from other sources)	1	20
How do you identify the adulterated wax?		
lacks uniformity, bees do not visit (for '*tej'* houses cases)	2	100
Bees do not visit(for both cases)	5	100
Sticking to wax molding (for wax from other sources)	1	20
Has pungent smell(for '*tej'* houses cases)	2	100

3.4.5. Beeswax marketing

Beeswax is a commodity with prestigious international market value that can be economically beneficial and with pro-poor credentials (BfD, 2006). Of the total 239 respondent, only two of them were engaged in processing beeswax for marketing purposes. They collect the crude beeswax from extracted honey, old combs and empty combs during harvesting, discarded combs from around and from left over after the consumption of crude honey. They regularly processing and depositing the beeswax and selling after certain months when the required amount is gained. According to their responses, lack of regular market access is the core problem to be engaged in it and maximizing their production levels. As a result, they sell their processed beeswax periodically transporting to central markets (Addis Ababa). Annually, they may process 30 to 50 kg of beeswax. Local mead/'*tej*' houses are the major sources of crude beeswaxes/'*sefef*''/ and marketing takes place. Various studies also declared that '*tej'* houses are the only major sources of beeswax in the country where it is readily available year round (Hartman, 2004; Johannis, 2005; Ayalew, 2008; Aravindakshan *et al*, 2010).

According to discussion made with '*tej'* houses, there is no formal marketing for beeswax/'*sefef*''. However, there are peoples who are coming from other areas at any times and collecting the crude and semi processed beeswax from '*tej'* houses and trading to central markets. The prices for one kilogram of beeswax is ranging from 25 to 40 ETB for crude beeswax/'*sefef*'' and 150-200 ETB for extracted beeswax. The price for beeswax does not have significant variations based on seasons and study districts.

Apinec- is a private company which collects the crude honey from the producers of the areas and its own apiaries; extracting and selling the purified beeswax in the form of blocks or by preparing foundation sheets. Unlike other actors taking part in production, processing and marketing of beeswax, Apinec has better potentialities having modern processing machineries used for extracting beeswax and preparing foundation sheets. It also owns mini laboratory to check the qualities of honey which is going to be packed and sent for central/export markets.

Cooperatives are the other actors who are engaged in processing and marketing of beeswax in the study areas. They collect crude honey from member beekeepers, processing and sending to the union (Kafa Forest Honey Development and Marketing Union) which then conveying to central markets. Of the total 239 respondents during survey, 177(74.06%) of them are registered as members of the cooperatives while the rest 62(25.94%) are not members.

3.4. 6. Challenges and opportunities of beeswax production and marketing

The area has huge untapped potentiality for beeswax production. The dominant traditional ways of beekeeping, existence of honey and beeswax marketing union which has long term planning to establish cooperatives at each district and existence of private limited processing company (Apinec agro industry) are considered as golden opportunities for the production and marketing of beeswax. However, the current production and marketing status of beeswax is very limited compared to the potentials of the areas. Lack of regular buyers (24.38 %), knowledge gaps about its economic values (19.38%), lack of market information (18.13%), lack of trainings and

technical supports (11.88%) skill and Knowledge gaps about product handling (12.5%) and low prices (10.33%) are considered as the core constraints of beeswax production and marketing identified at beekeepers level (Table 12). Whereas, shortages of supplies, sustainable market accesses, shortages of processing materials and storage facilities are listed as the core constraints of beeswax production and marketing at processors levels. McGill (2016) also stated that despite the efforts done by government and other entities in trying to incentivize beeswax production in the country, lack of market accesses is one of the most striking constraints for those who engaged in production. According to the responses from cooperatives, most of the beekeepers have wishes to be registered as a member of cooperative basically in search of various supports. However, there is a great awareness problem in supplying their products (honey and beeswax) timely to the cooperatives.

Table 12. Major challenges of beeswax production and marketing in the study areas

Major challenges of beeswax marketing	Freq	Percentage	Ranks
Lack of regular buyers	78	24.38	1
Lack of market information	58	18.13	3
Knowledge gaps about its economic values	62	19.38	2
Skill and knowledge gaps about product handling	40	12.5	6
Low prices	38	10.33	7
Lack of training and other supports	44	11.88	5
Total	320	100	

4. CONCLUSION AND RECOMMENDATIONS

In related to the abundance of immense natural resources, beekeeping is widely practiced by most inhabitants of the areas serving as major instant income sources for most individuals. Local retailers, whole sellers, *'tej'* houses, cooperatives, collectors, private companies, are known to be the major honey and beeswax market chain actors in the areas. However, '*tej* 'houses, processors and cooperatives are identified to be the major actors taking part in processing and marketing of beeswax. Irrespective of the hive types used, honey harvesting is commonly undertaken by cutting the combs from the hives or frames. About 93% of the beekeepers sell their honey in crude forms due to lack of awareness, considering as it will reduce the amount of honey yield, lack of processing materials and small production. Moreover, straining of honey from movable frame hives and use of foundation sheet is practiced by very few individuals. In the areas, only about 13% of beekeepers are engaged in collection of beeswax from old combs, broken combs, '*tej'* houses and leftovers after the consumption of honey. The ways of managing beeswax in general and '*tej*' houses in particular is very poor and some '*tej*' houses add table salt (*NaCl)* as preservative against wax moth attacks. Hence, awareness creation on the economic benefits of beeswax, training on the production, processing and handling of beeswax product is very crucial. Establishing and capacitating the cooperatives at local level is also very imperative to handle the wastages of the product as well as maximizing their profits. On the other hand, encouraging agents or investors to actively participate on production, processing and marketing of beeswax and introducing and demonstrating some robust beeswax processing technologies is also very important. Moreover, awareness creation and follow-ups on appropriate management aspects of beeswax should be given to producers in general and '*tej'* house owners' in particular and the impact of preservatives (NaCl) on the quality aspects of beeswax needs further investigation.

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