Production practices, trends, constraints and opportunities of beekeeping in Arba Minch Zuria District, Southern Ethiopia

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Abstract

Background

Beekeeping is an integral component of animal husbandry and it has highly untapped potential for generating household income for rural livelihood. The study was conducted to assess beekeeping practices, honey production trends, constraints and opportunities of beekeeping in Arba Minch Zuria District of Gamo Zone, Southern Ethiopia. The district was selected purposively based on its beekeeping potential and stratified into three agro-ecological zones. Seven representative Kebeles from the District were selected proportional to their agro-ecological variations. A total of 156 beekeepers were selected using systematic random sampling technique. Cross-sectional type of study was conducted to generate data through formal survey. The quantitative and qualitative data were summarized and analysed using one way ANOVA and cross tabulations, respectively.

Result

Mixed crop-livestock farming system was primary means of livelihood in the study area. The result revealed that most (96.8%) of the beekeepers practiced traditional beekeeping system. The average honeybee stocks were about 4.8 ± 1.78 and 5.2 ± 6.98 colonies per household. The average honey yield was 5.8 ± 0.09 kg and 20.1 ± 0.31 kg per year for traditional and modern beehives, respectively.

Conclusion

There was a decreasing trend of total colony number and honey yield over the last five years (2014–2018). Shortage of bee forage during dearth periods, absconding and honeybee enemies were the most important constraints of beekeeping in the study area, while the availability of huge number of honeybee colonies, existence of ample bee forages and the existence of tourist attraction sites in the study area provides a good market opportunity to sell the honey with a premium price.

Introduction

Ethiopia has the largest honey bee population in Africa and owns a big honey production potential in its varied ecological and climatic zones (Takele, 2014). The country has a huge, and largely untapped potential in the apiculture subsector, endowed with over ten million bee colonies and about two million smallholder beekeepers. The honey and beeswax annual production potential is estimated to be 500,000 and 50,000 tons, respectively. Currently, the country produces only 64,000 tons of honey and 6,000 tons of beeswax that account for more than 25% of production in Africa, making it one of the top ten honey and five beeswax producers on the globe (Apimondia, 2018).

All regions of Ethiopia produce honey, but their production potential is different based on suitability of the regions for beekeeping. There are three types of beehives (traditional, intermediate and frame hives) used for honey production in Ethiopia. The management practices employed as well as types and level of technology are used to identify beekeeping system (Solomon and Seid, 2015). According to Kenesa (2018) honeybee production systems in Ethiopia is predominantly traditional that exercised in two forms as traditional forest and traditional backyard practices based on the management practices, types and level of technology used.

The knowledge and skill of honey and beeswax production of Ethiopian farmers is still very traditional (MoARD, 2010). In many regions of the country, beekeeping is considered as one of income generating activities for resource poor farmers including women, youth and the unemployed portion of the community (Gezahegn, 2001). Honey is a vital factor in job creation and maintaining livelihoods. However, current honey production estimate represents only 8.6% of the country's production potential (MoARD, 2010; Paulos, 2011). The sub-sector is constrained by lack of beekeeping knowledge, shortage of trained manpower, shortage of beekeeping equipment, pests and predators, fires, pesticide threat and inadequate research works to support development programs (Askale et al., 2017).

Beekeeping in Gamo Zone has been a long-standing practice. Gamo Zone is generally known by its great potential for honeybee resources and honey production (Nebiyu and Melesse, 2013). As being one of the beekeeping potential Districts in Gamo Zone of Southern Ethiopia, *Arba Minch Zuria District*, is also known for its better natural vegetation coverage and honeybee colony number in comparison with other districts in Gamo Zone. Beekeeping practice in the district is an integral component of livestock production, and believed to have an important contribution to the rural livelihood. However, there is no compiled and reliable information on beekeeping sub-sector. It is strongly believed that availing such important information for the study area is very helpful for the development plan of the district. Therefore, this study was conducted to give an insight into beekeeping practices, honey production potential and trends as well as major constraints and opportunities in the study area.

Materials And Methods

Description of the Study Area

The study was conducted in *Arba Minch Zuria District*. The general elevation of the *district* ranges from 1150 to 3300 m.a.s.l. The annual rainfall ranges from 800 to 1500 mm and mean annual temperature ranges from 16.3 ^{0}C to 37 ^{0}C. The climatic condition of the *district* is characterized as 14 % highland, 53 % midland and 33 % lowland.

Sampling Procedure and Sample Size Determination

Multi-stage sampling procedure was followed at three different stages. In the first stage, the study District was stratified into three distinctive agro-ecologies. These three strata were lowland (< 1500 m.a.s.l), midland (1500–2300 m.a.s.l) and highland (> 2300masl) (MoARD, 2007). In the second stage, seven

representative '*Kebeles' (the smallest administrative units within the district)* from the district were selected proportional to the agro-ecological variation following purposive sampling technique based on beekeeping potential of the *kebeles*. In the third stage, individual household heads with honeybee colonies were identified and selected using systematic random sampling technique from a list of households in each *kebele*. Beekeepers in the District were used to represent the study population. The sampling units were households keeping honeybee colonies. The sample size required for the study was determined by the formula recommended by Arsham (2005) for survey studies:

$N = \frac{0.25}{SE^2}$ Where, N = sample size and SE = the standard error.

With the assumption of 4% standard error, a total of 156 households were sampled. The sample size from each agro-ecology were selected based on proportion to the total sample size. Thus, 22, 83 and 51 beekeepers were selected from highland, midland and lowland, respectively.

Methods of Data Collection

Cross-sectional type of study was conducted to collect primary data through formal survey, focus group discussions, key informants' interview and field observations. Relevant information was further collected through discussions with the district honeybee experts, development agents (DAs), NGOs and other relevant institutions that play significant role in beekeeping activities of the District. Secondary data, which is used to supplement the primary data, was obtained from Gamo Zone Livestock and Fishery Resource Department (GZLFRD), Arba Minch Zuria District Livestock and Fishery Resource Development Offices (AMZDLFRDO) and each *Kebele* farmers training centres *(FTC)*. Besides, the reports of previous research findings, guidelines, manuals and other published and unpublished documents were also reviewed.

Data Management and Statistical Analysis

The collected data were checked, coded and entered into SPSS software version 24 every day after administering questionnaire to prevent loss of data. The means of quantitative data among agro-ecologies were compared by employing one-way ANOVA. The means were separated using the Tukey HSD test whenever they were statistically significant at $P < 0.05$. Statistical differences among qualitative variables were analyzed in a cross-tabulation. The analyzed data were presented using tables, graphs, charts, frequencies, percentages, means and standards.

Results

Socio-economic Characteristics of the Respondents

The sex category of the study revealed that all interviewed beekeepers were male headed households. The overall mean age of the interviewed beekeepers was 42.90 ± 0.56 years, with a range of 26–68 years (Table 1).

The overall experience of the respondents in beekeeping was 14.85 ± 0.68 years, with a minimum of 3 years and a maximum of 42 years. The average farmland landholding of the respondents was found to be highly significant (P < 0.001) across agro-ecologies. The highest landholding was recorded in lowland whereas the lowest farmland size was recorded in highland agro-ecology.

Table 1
Socio-economic characteristics of the respondents (N = 156)

Variables	Agro-ecology (Mean ± SD)				P-value
	Overall	HL (N = 22)	ML (N = 83)	LL (N = 51)	
Average age (years)	42.90 ± 2.56	43.36 ± 2.22	42.58 ± 3.80	43.22 ± 4.59	0.849
Beekeeping experience (years)	14.85 ± 2.68	14.73 ± 2.36	14.08 ± 1.92	16.16 ± 3.08	0.400
Av. family size	7.01 ± 3.17	6.86 ± 3.74	7.05 ± 5.24	7.02 ± 4.31	0.940
Av land holding (ha)	1.27 ± 0.56	0.68 ± 0.37^{c}	1.12 ± 0.26^{b}	1.78 ± 0.74^{a}	0.000**
Educational level (%)					
Illiterate	19.2	50	12	17.6	0.001**
Read and write	28.8	18.2	25.3	39.2	
Primary school	38.5	31.8	48.2	25.5	
High school	11.5	0	13.3	13.7	
College and above	1.9	0	1.2	3.9	

*** Significant at (p < 0.001); ns = not significant; HL = highland; ML = midland; LL = lowland; N = number of interviewed beekeepers; SD = standard deviations; $^{a, b}$ means followed by different superscript letters in a row are significantly different*

Major farming activities and source of income for households

The primary means of livelihood in the study areas was mixed crop-livestock farming system. Crop production was ranked the first farming activity with an index value (0.460) (Table 2). Accordingly, *enset*, barley, wheat, *teff*, sorghum, maize, haricot bean, common bean, pea, potato, sweet potato, tomato, pepper, cotton, onion, banana, avocado, papaya, mango and lemon were major crops produced in the study area. Among these mango, avocado, papaya, banana, bean, pea and potato were major honeybee plants that provide nectar and pollen to bees. Livestock production (index = 0.272) plays a substantial role in the household food security in the study area. Livestock species kept include cattle, sheep, goat, donkey, horse, mule, poultry and honeybees. Beekeeping (index = 0.119) ranked as third source of income next to crop and livestock production.

Table 2
Farming activities of the respondents in the study area

Activity	1st	2nd	3rd	Index *	Rank
Crop production	91	59	40	0.460	1st
Livestock production	32	42	75	0.272	2nd
Beekeeping	13	19	34	0.119	3rd
Trade	14	31	5	0.116	4th
Others	6	5	2	0.032	5th

** Index = sum of (3×number of responses for the first rank + 2×number of responses for the second rank + 1×number of responses for the third rank) for each farming activity divided by the sum of (3 × total responses for the first rank + 2× total responses for the second rank + 1× total responses for the third rank) for overall activities.*

Beehive ownership and sources of foundation beehive

Majority of the interviewed beekeepers in highland and midland location owned only traditional hive, whereas higher adoption rate of modern hives in lowland location was observed ($P < 0.001$).

Table 3
Beehive distribution and source of foundation beehive in the study area

Variables		Agro-ecology (N = 156)				X^2	P-value
		HL (N = 22)	ML (N = 83)	LL (N = 51)	Overall (N = 156)		
Beehive Type (%)	Traditional beehive only	77.3	55.4	31.4	50.6	21.92	0.000 **
	Both beehives	22.7	44.6	58.8	46.2		
	Modern beehive only	0	0	9.8	3.2		
Source of trad. Hive (%)	Constructed by the beekeeper himself	18.2	19.3	4.3	14.6	5.57	0.062
	Purchased from local market	81.8	80.7	95.7	85.4		
Source of mod. Hive	Supplied by district livestock office	0	40	31.4	33.3	3.26	0.196
	Donated by NGO's	100	60	62.9	64		
	Purchased	0	0	5.7	2.7		

*** Significant at $P < 0.001$, HL = highland, ML = midland, LL = lowland; X^2 = chi-square value; N = number of respondents*

Source of foundation colony and means of stock increment

The majority (85.3%) of the beekeepers obtained their foundation stock by swarm catching. While once the honeybee colony is established, beekeepers initiated to increase their colony number. In this regard, almost all (98.4%) beekeepers used to increase their colony number through catching swarms.

Table 4
Sources of honeybee colony to start beekeeping and means of stock increment

Variables (%)	Response	Agro-ecology (N = 156)				X^2	p-value
		HL (N = 22)	ML (N = 83)	LL (N = 51)	Overall (156)		
Colony source	Gift from parents (%)	4.5	12	9.8	10.3	5.59	0.471
	Catching swarms (%)	90.9	85.5	82.4	85.3		
	Buying/purchasing (%)	0	0	3.9	1.3		
	Gift and catching swarms	4.5	2.4	3.9	3.2		
Colony increment	By swarm catching	100	100	96.1	98.7	4.17	0.124
	Swarm catching and purchasing (%)	0	0	3.9	1.3		

X^2 = chi-square value; N = number of respondents

Honeybee keeping practices

Beekeeping in the study area was practiced as a side line to other agricultural activities (Fig. 1). Except for few landless youths, there were no farmers that merely depend on beekeeping.

Colony holding and honey production

The overall colony holding of beekeepers in the study area was 4.76 ± 1.78 and 5.20 ± 6.98 colony per household in traditional and modern hives, respectively. Statistically, highly significant ($p < 0.001$) difference was observed in mean colony holding in both traditional and modern beehive across agro-ecologies. The lowland agro-ecology had highest (5.87 ± 1.82) colony holding, while the lowest colony holding was observed in highland agro-ecology (Table 5).

Table 5
Average colony holding per household across agro-ecologies.

Agro-ecology	Number of traditional hives with colony				Number of modern hives with colony			
	N	Mean ± SD	Min	Max	N	Mean ± SD	Min	Max
Highland	22	3.64 ± 1.00^{c}	2	5	5	2.60 ± 1.14^{b}	1	4
Midland	83	4.45 ± 1.61^{b}	1	10	35	2.91 ± 1.12^{b}	1	6
Lowland	46	5.87 ± 1.82^{a}	2	10	35	7.86 ± 9.54^{a}	3	60
Overall	151	4.76 ± 1.78	1	10	75	5.20 ± 6.98	1	60
P-value		0.000***				0.007**		
N = number of households								

Concerning the production of honey, the overall honey yield was 5.81 ± 5.09 and 20.05 ± 4.31kg per hive per year in traditional and modern hives, respectively. highly significant difference ($p < 0.001$) in honey yield in both traditional and modern beehives across agro-ecologies (Table 6). The highest honey yield obtained from traditional hive was recorded in lowland location as compared to highland. Regarding the productivity of modern beehives across three agro-ecologies, the highest honey yield was recorded in lowland where as the lowest yield was recorded in highland location.

Table 6
Average honey yield from traditional and modern beehives

Agro-ecology	honey yield /hive/year (Kg)			
	Traditional hive		Modern hive	
	N	Mean ± SD	N	Mean ± SD
Highland	22	5.13 ± 6.19^{b}	5	15.4 ± 5.67^{c}
Midland	83	5.78 ± 4.12^{a}	35	19.1 ± 3.35^{b}
Lowland	46	6.18 ± 5.17^{a}	35	21.6 ± 8.36^{a}
Overall	151	5.81 ± 5.09	75	20.05 ± 4.31
P-value		0.002**		0.001**
*** significant at ($p < 0.01$);^{a,b} column means followed by the different letter(s) differ significantly; N = number of households, SD = standard deviations, Kg = Kilogram*				

Trends in honey yield and colony size

The trend of total colony number and honey yield in the two hive types across the last five years (2014–2018) is depicted in Fig. 2 below. The data collected during the household survey indicated that the trend in total honey yield from traditional hive has decreased from 3600 kg in the year 2014 to 3484 kg in 2015 and then increased to 3796 kg in the year 2016. Then after the yield decreased consistently to 2958 kg in the year 2018, which confirmed the decreasing trend of honey yield in traditional beehives. However, the total honey yield obtained from modern beehives revealed increasing trend from 3869 kg in the year 2014 to 3965 kg in the year 2016 and then decreased consistently to 3213 kg in the year 2018. Honey yield achieved better performance in the years 2016. Considering the trend of total honey yield in both hives, it is also decreasing from 7469 kg in the year 2014 to 6171 in the year 2018. Similarly, the total honeybee colony size across the last five years in both traditional and modern beehives showed decreasing trend. The main reasons for decreasing trend in the bee colony and honey yields were risky utilization of agrochemicals, absconding and lack of bee forage during dearth period according to their importance as revealed in focus group discussion.

Hive placement and colony inspection

About 70.5% of traditional hived colonies and 87.8% of modern hived colonies were placed at backyards indicating that backyard beekeeping is the most common practice of honey production in the study areas (Figs. 2 and 3). The survey result indicated that majority (87.8%) of the colonies in modern beehives were placed at backyard (Table 7).

Table 7
Hive placement practices of the beekeepers in the study area

Hive placement (%)	Agro-ecology				X^2	P-value
	HL (N = 22)	ML (N = 83)	LL (N = 51)	Overall (N = 156))		
Traditional hives (%)					14.13	0.078
Backyard (%)	90.9	73.5	56.9	70.5		
Under the eaves of the house (%)	0	3.6	0	1.9		
Inside a simple shelter	0	1.2	3.9	1.9		
Hanging on trees near homestead (%)	0	4.8	5.9	4.5		
Hanging on trees in forests (%)	9.1	16.9	33.3	21.2		
Modern hives (%)					1.15	0.886
Backyard	100	89.2	84.4	87.8		
Under the eaves of the house	0	2.7	3.1	2.7		
Inside a simple shelter	0	8.1	12.5	9.5		

N = number of households

Colony inspection and apiary visit

Almost all (92.3%) beekeepers have visited and inspected their beehives, of whom (87.8%) undertook external inspection and cleaned their apiary to prevent ants and other insect pests from getting access to hives. internal hive inspection was limited only to modern beehives and was being performed by not more than 46.2% of the sample beekeepers who use modern beehives. Beekeepers inspected colonies when colonies become weak and during honey harvesting seasons.

Major constraints of beekeeping

The major challenges of the beekeeping in the study area were shortage of bee forage specially during dry periods followed by absconding, pests and predators, unwise application of agrochemicals (Table 8).

Table 8
Major constraints of beekeeping in Arba Minch Zuria District

Major constraints	Index	Rank
Shortage of bee forage	0.147	1st
Absconding	0.116	2nd
Pests and predators	0.114	3rd
Unwise application of agrochemicals	0.109	4th
Lack of credit	0.100	5th
Lack of attention (awareness gap)	0.095	6th
Swarming/migration	0.081	7th
Lack of improved beehives and beekeeping equipments	0.073	8th
Inadequate access to training and poor extension service	0.047	9th
Human interference (theft)	0.040	10th
Recurrent drought	0.029	11th
Death of colony	0.027	12th
High rainfall	0.014	13th
Shortage of water	0.004	14th
High wind (storm)	0.003	15th

** Index = sum of (3×number of responses for the first rank + 2×number of responses for the second rank + 1×number of responses for the third rank) for each farming activity divided by the sum of (3 × total responses for the first rank + 2× total responses for the second rank + 1× total responses for the third rank) for overall activities*

Opportunities of beekeeping

Despite all the constraints and challenges currently facing the beekeeping subsector, there are still enormous opportunities and potentials to boost honey production in the District. Based on the information obtained from key informants and focus group discussions as well as field observations, the major opportunities for beekeeping development are:

- The availability of huge number of bee colonies which will give great opportunities for beekeepers who want to expand and produce more honey in the future. Furthermore, the availability of queen rearing centre in the study district for increasing the honey bee colony number so as to increase the honey production.
- The existence of ample melliferous plants that provide pollen and nectar to honeybees

- Availability of tourist attraction sites near to the study area: Arba Minch city is appreciated by the foreign and country visitors because of the presence of different tourist attracting natures like the two rift valley lakes, Abaya and Chamo, the God's bridge in between the two lakes, the forty springs of natural gift, crocodile ranch, as well as the scenic ever green forest which is attractive and green throughout the year. These fascinating gifts of nature have been visited regularly by many foreign and country tourists, which creates good market opportunity for the surrounding beekeepers because they sell their honey product by premium price to the tourists who come to the area for touring purpose.
- Currently, the government is giving stronger emphasis than ever before to the beekeeping sub sector to use it as a tool for poverty reduction and to diversify the national export.
- Employment opportunity: with relatively small start up costs and minimum land requirements, beekeeping offers high opportunity for the landless and youth on communal lands.

Discussions

All interviewed beekeepers were male headed households. Based on the group discussion made with beekeepers, the none participation of women in beekeeping were due to fear of honey bees sting and not have enough time to be involved in beekeeping due to their responsibility to do much of the household activities. The finding of this result is similar with the findings of Sisay et al. (2015) and Shibru et al. (2016) who reported 100% of the interviewed beekeepers in Jigjiga zone and Gambella Zuria and Godere woreda were all male headed households. Moreover, this finding also agrees with the reports of Hartmann (2004) as cited by Getachew (2018), who stated that traditionally beekeeping has been considered mainly as men's job in Ethiopia. Highly significant ($P < 0.001$) difference was observed across agro-ecologies in relation to educational status of respondents. Differences observed in beekeeping experience might be responsible to influence the attitude and adoption of new beekeeping technologies (Hussien et al., 2015). The overall average farmland holding of the respondents was 1.27 ± 0.06 hectares. This result is comparable with the mean national landholding (1-1.5 ha) (CSA, 2017).

The primary means of livelihood in the study areas was mixed crop-livestock farming system. Crop production, livestock production and beekeeping were ranked as first, second and third sources of income, respectively. In line with this result, Kalayu et al. (2017) and Dinku (2018) noted that beekeeping ranked third source for household income in North-East dry land areas of Amhara region and Sidama zone of Southern region, respectively. This is probably due to the fact that the beekeeping operation requires small initial capital with possibility of keeping honeybee in marginal farm lands where crop production is not possible and even by hanging in forest trees far away from homestead when farm land is not available as it was pointed out during discussion with key informants. Besides, trade and other off-farm activities such as weaving, irrigation, fish production and carpentry were also available means to support their subsistence livelihood. This indicates the possibility of keeping honeybees' side by side along with on-farm and other off-farm activities.

The study revealed that almost all (96.8%) of the interviewed beekeepers owned traditional beehive and kept their colony in it. Similar to the current study, Bekele et al. (2017) stated that, the majority (98.26%) of the beekeepers in Bale Zone practiced traditional production system and only few (1.36%) beekeepers started using modern beekeeping practice. Colony and apiary inspection are very crucial to protect honeybee colonies from different natural risks and enemies such as pests, predators, diseases and chemical poisoning (Abebe, 2017). The study revealed that most of the beekeepers used swarm catching to establish their foundation stock. This is due to the fact that farmers could catch colonies easily when reproductive swarming is active. This finding agreed with the reports of Bekele (2017), Kiros and Tsegay (2017) and Dinku (2018) who indicated that majority of beekeepers started beekeeping through swarm catching in Bale zone, Jimma and Illubabor zone, and Sidama Zones, respectively.

Based on the input used and their management practices, two types of beekeeping practices were mainly used for honey production in the district. These are local (traditional) and modern (frame) beehive beekeeping. The traditional beekeeping was practiced in two forms, traditional forest beekeeping in which beehives were hanged on trees with numerous branches in forest without any management employed for bees and bee products, while traditional back yard beekeeping was practiced around homestead with relatively better management provided to bee colonies as compared to forest beekeeping. Regarding modern beekeeping practice, the adoption rate of modern hive was very low due to lack of credit facilities to buy inputs, shortage in supply of beehive accessories, lack of knowledge on how to operate the box hive and weak beekeeping extension services and lack of intervention on beekeeping by government and non-governmental organizations in the study area.

The average colony holding was 4.76 ± 1.78 per head whereas the average honey production from traditional hive was 5.81 ± 0.09 kg/hive/year (Table 5). Highly significant ($p < 0.01$) difference was observed in mean colony holding in both traditional and modern beehives across the three agro-ecologies. This might be due to favourable weather which supports the growth of diverse honey bee plants in the lowland areas (Table 5). Agreed with this, comparable finding reported by Bekele et al. (2017) stated that the average colony holding is 6.26 ± 0.92 colonies per head in Bale zone. However, the current study result was by far lower than the average colony holding observed in the Afar region (10.08 colonies per household) (Gebrehaweria et al., 2018) and Jimma and Illubabor Zone of Oromia region (10.7 ± 4.3 colonies per head) (Kiros and Tsegay, 2017). The current study also indicated that, the average honey yield from modern beehive was 20.05 ± 0.31 kg/hive/year whereas the average colony holding per head was 5.20 ± 6.98 colonies (Table 5). The overall average honey productivity per beehive in traditional and modern beehives was 5.81 ± 0.09 kg and 20.05 ± 0.31kg, respectively (Table 6). Similar to this result, in the same zone of different districts, Nebiyu and Melesse (2013) reported that the average honey yield per year per beehive was 5.88 ± 1.96 and 20.64 ± 4.96 kg for traditional and modern beehives, respectively.

The total honey yield from both traditional hive and modern hives have revealed undulating trend across the five consecutive years (Fig. 2) but generally confirmed the decreasing trend of honey yield in traditional beehives. Honey yield achieved better performance in the years 2016 and 2017 due to better

rainfall distribution, availability of ample bee forages and suitable climatic conditions for honeybees. Considering the trend of total honey yield in both hives, it is also showed decreasing from 7469 kg in the year to 7336 in the year 2018. Similarly, the total honeybee colony size across the last five years in both traditional and modern beehives showed decreasing trend due to multitude of reasons among which irresponsible utilization of agrochemicals, absconding, lack of bee forage and pests and predators were found to be the most limiting factors. In line with this result, Dinku (2018) reported that majority (78.8%) of beekeepers in Sidama zone responded the decreasing trend of honeybee colonies over the past year due to indiscriminate use of agro-chemicals, shortages of bee forages and pests and predators. Similarly, Alemu (2015) noted that majority (84.9%) of the beekeepers in South Wollo and Waghimra Zones of Amhara region responded decreasing trend in the number of honeybee colonies and their products from time to time due to the availability and occurrence of various threatening factors which had an adverse effect on honeybee health and their production potentials. According to this author, presence of pests and predators, poor agrochemicals application on field crops and lack of bee forage as a result of deforestation were the main reasons (threatening factors) for the colony decreasing trends.

The study result indicated that majority of the beekeeper kept their hives at backyard indicating that backyard beekeeping is the most common practice of honey production in the study areas. Agreed with the findings of Alemu (2015) and Haftu & Gezu (2014) who reported that the beekeepers at each of their respective study districts kept majority of their colonies around the backyards of their homestead. The main reasons for beehive placement or apiary selection were close supervision, controlling from theft, and availability of bee flora. Similar findings were reported by Yetimwork (2015) and Abebe (2017). Almost all beekeepers reported overcrowding of honeybee colonies as the major cause for the incidence of swarming. Similarly, absconding was also common problem in the study area which is caused by shortage of bee forage, poor utilization of agrochemicals, honeybee pests and enemies.

Shortage of bee forage during dearth period, absconding pests and predators, risky application of agrochemicals were among major constraints of beekeeping ranked in order of severity. The availability of huge number of bee colonies, existence of ample melliferous plants that provide pollen and nectar, availability of tourist attraction sites near to the study area, strong emphasis from government of Ethiopia on beekeeping sector were available. Therefore, there are huge opportunities and potentials so as to exploit the huge beekeeping potential of the study area.

Conclusion

Beekeeping is mainly considered as men’s job and is performed by only male headed households of economically active age groups. Beekeeping in the study area is characterized as a traditional system practiced in the form of forest and backyard beekeeping. However, no tradition of beeswax collection by majority of the beekeepers. The adoption of improved beekeeping is very low due to high cost of the improved hives and their accessories. From the study it was understood that the total colony population and honey yield is decreasing across the last five years due to multitude of reasons among which unwise utilization of agrochemicals, absconding, lack of bee forage and pests and predators were found to be

the most limiting factors. The amount of honey harvested per hive was differing in the study areas due to agro-ecological variations. The highest honey yield was recorded in lowland agro-ecology, which implies the availability of better vegetation, favourable climatic condition and better colony management practices by beekeepers in lowland locations. The major constraints to exploit the untapped potential of beekeeping activity in the study area were shortage of bee forage during dearth periods, absconding, pests and predators, unwise application of agrochemicals, lack of credit access, poor extension service, lack of attention and recurrent drought.

Abbreviations

AMZDLFRDO
Arba Minch Zuria District Livestock and Fishery Resource Development Offices
ANOVA
Analysis of Variance
FTC
Farmers Training Center
GZLFRD
Gamo Zone Livestock and Fishery Resource Department
HL
Highland
HSD
Honestly Significant Difference
LL
Lowland
ML
Midland
MoARD
Ministry of Agriculture and Rural Development
N
Number of households
SD
Standard Deviation

Declarations

Ethics approval and consent to participate

Not applicable

Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

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Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AAA: the first author and initiator of research idea, data curation, writing - original draft preparation. NYA: principal supervisor who made critical reviews, writing and editing. AB: review & editing. All authors read and approved the final manuscript.

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Figures

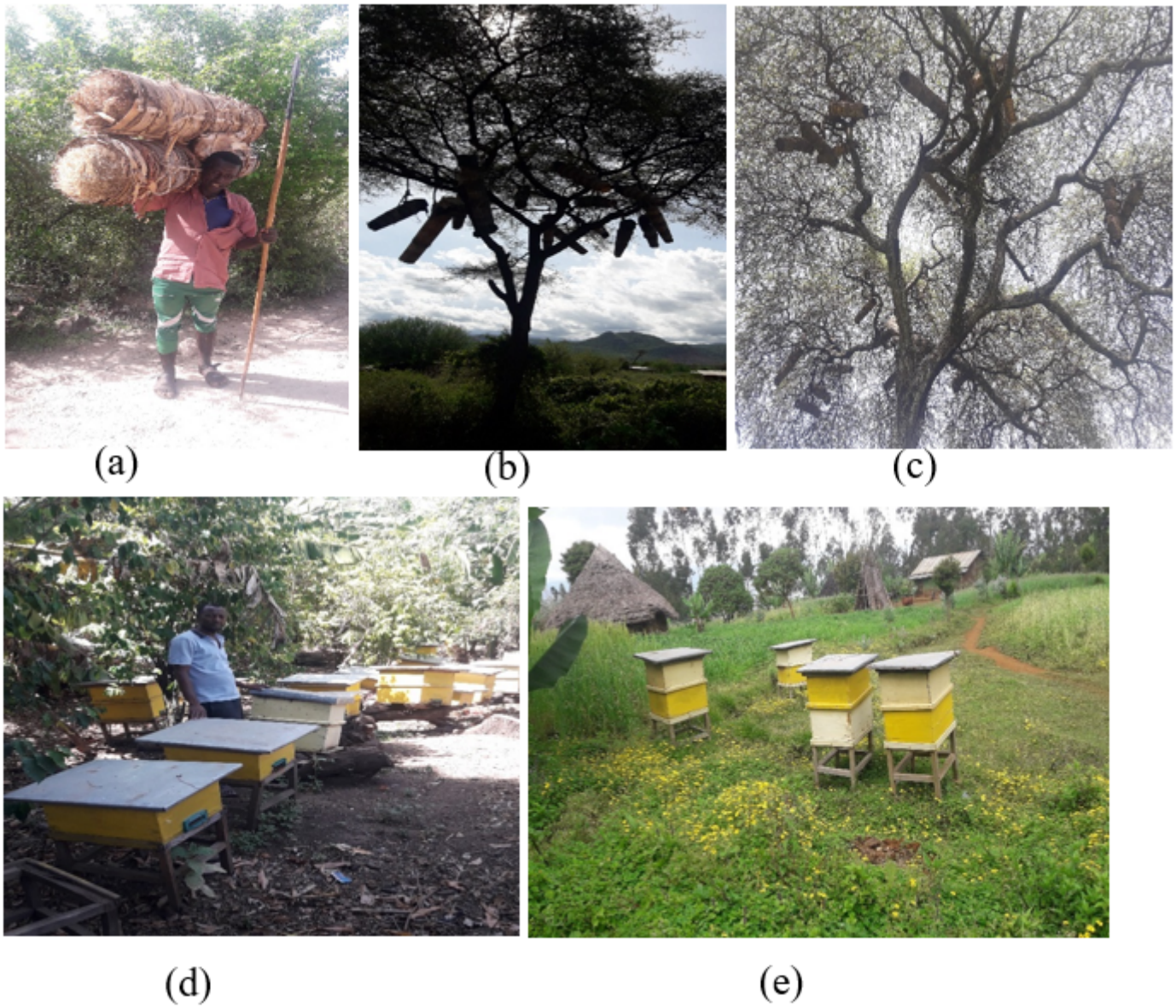

Figure 1

Traditional beekeeping practice: (a) model beekeeper carrying his traditional beehives to hang at forest trees in order to catch swarms; (b & c) numerous traditional beehives hanged at forest trees in order to catch swarms. Modern beekeeping practice: in lowland (d) and highland (e)

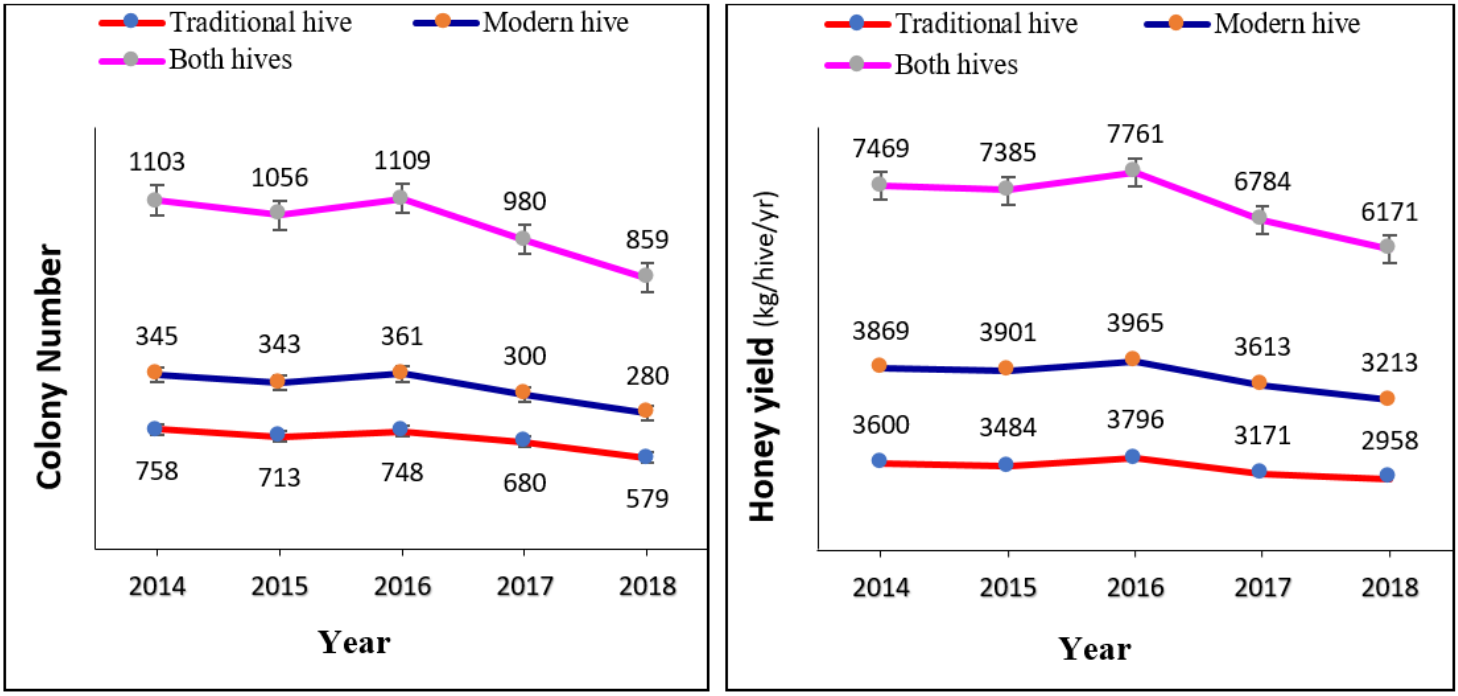

Figure 2

Trends of colony number and honey yield across the last five years (2014-2018)

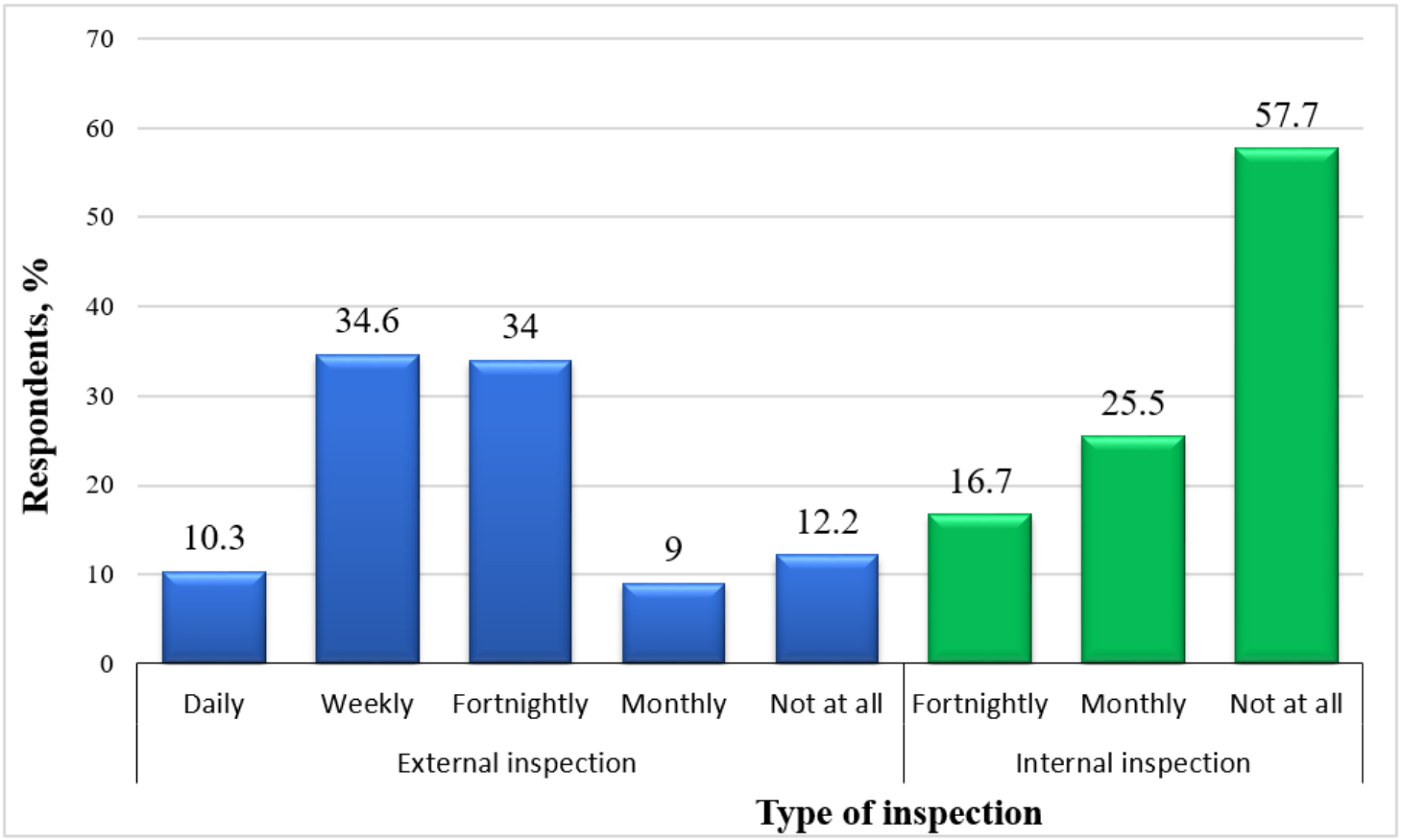

Figure 3

Honeybee colony inspection frequency as reported by beekeepers in the study area