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Challenges and opportunities of honey production in north- east dry land areas of Amhara National Regional State, Ethiopia

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The study aims to evaluate major challenges, opportunities and future prospects of bee keeping and honey production in three districts of Waghimra Zone (Abergell, Sekota and Gazgibala). **To collect data, 332 respondents were selected using systematic random sampling from the three districts. Data were collected using semi-structured questionnaire, observation, keyinformant interveiw and focus group discussion. Data were analyzed using descriptative statistics and analysis of variance (ANOVA) using statistical package for social science (SPSS) version-20. The results of this study indicated that beekeeping is one of the most important income generating activities besides other agricultural activities. The major challenges identified were prevalence of pests and predators, recurrent drought, indiscriminate application of pesticides and herbicides, lack of bee forage associated with deforestation, lack of credit service for the beekeeping sector, absconding and migration of bee colonies, high cost and limited availability of modern beekeeping equipment's and accessories, shortage of water, and lack of skill in beekeeping management. It has been revealed that the opportunities for beekeeping in the study areas were the existence of abundance of honeybee colonies, availability of potential flowering plants, sources of water for bees, increasing market demand for beehive products, existence of soil and water conservation practice and area enclosure in the area, beekeepers' experience and indigenous knowledge and socio-economic value of honey. Thus, based on these findings, improving the awareness of the beekeepers through training and strong extension service, supplying cheap bee keeping inputs, capacitating to beekeepers to control the pests and predators are important to address the identified challenges and to improve the overall honey production in Waghimara Zone.**

Key words: Bee colony, beehives, beekeeping, challenges, honey production, opportunities.

INTRODCTION

Beekeeping is a sustainable form of agriculture, which is beneficial to the environment and increases yield of food and forage crops through the pollination action of bees. It is a very long-standing practice among the farming communities of Ethiopia (Martin et al., 2012). It is a promising sideline farm activity for the rural households.

It directly and indirectly contributes to the income of households and the economy of the nation (MoARD, 2003).

Despite the long beekeeping tradition, having the highest bee density and being the leading honey producer as well as one of the largest beeswax exporting countries in Africa, the share of the apiculture subsector to the gross domestic product (GDP) has been negligible in Ethiopia. Productivity of the sub-sector has always been low, leading to low productivity of honey and relatively low export earnings. Thus, the beekeepers in particular and the country in general are not benefiting from the subsector as expected (Tadesse, 2001a).

As the country has immense natural resources for beekeeping activity, this sub sector has been devastated by various complicated constraints as clearly stated by Teklu et al. (2016). According to Chala et al. (2012), drought, decline in vegetation coverage and subsequent changes in natural environments, pests and predators, and indiscriminate applications of chemicals are causes for low honey productivity and improved beekeeping practices in the country. In line with the aformentioned impeding factors, there are also other major constraints that affect beekeeping subsector in Ethiopia such as: lack of beekeeping knowledge, shortage of skilled manpower, shortage of bee equipments, poor infrastructural development, and shortage of bee forage and lack of research extension (Kerealem, 2005).

According to Haftu et al. (2015), Ethiopia is recognized as top ten producers of honey globally which is clearly observed in the last few years with significant increment, however, the nation's output is still below 10 % of its production capacity, and this entails the existence of notable challenges strangulating the sector. As clearly stated by Tolera et al. (2014), the low yield of honey and other beekeeping products resulted from insufficient management practices and lack of adequate beekeeping training.

To put in place appropriate remedial interventions that would lead to enhanced productivity of the beekeeping subsector, understanding the prevailing major challenges, opportunities and future prospects of bee keeping and honey production is very vital. This necessitates the need for generating site specific database under specific production scenarios. In this regard, little research has been done so far to identity the overall smallholder beekeeping production constraints in Waghimara Zone (Abergell, Sekota and Gazgibala).

This study aims to fill this existing information gap. Hence, the objective of this study was to investigate the smallholder beekeeping production constraints as well as opportunities, and to suggest possible solutions for the identified constraints at their production environment.

MATERIALS AND METHODS

This study was conducted in three sites namely Abergell, Sekota and Gazgibala districts in Waghimara Zone of Amhara National Regional State, Ethiopia (Figure 1). The three districts were selected among the many districts due to their potential for honey production. Waghimara Zone is located 435km far from Bahir Dar, and 720 Km from Addis Ababa. The area is located at 12°N latitude and 38° E longitudes at an altitude of 500 to 3500 masl with annual rain fall of 150 to 700 mm which is an erratic type of rainfall. The annual average temperature ranges from 15 to 40°C. The soil type and climate are similar to those in many dry land areas of Ethiopia. Cattle, small ruminant, poultry and equines are the major livestock species kept in the Zone (unpublished report of WZLFRD, 2016/17). In the Waghimara Zone, there is huge potential of beekeeping, which is an integral part of the animal husbandry. It is a common culture and farming practice. Most of the beehives are virtually kept at backyards and modern beehives are common that farmers' have familiarized with its use nowadays (Table 1).

Study design

Crossectional study design was used for this assesement since the study was conducted in three districts having different agro-ecologies (Highland, Midland and Lowland). Thus, the data were collected from these three districts with different agro-ecology through data gathering instruments such as houeshold survey with semi-structured questionnaire, observation, keyinformant interveiw and focus group discussion. The design helped us to assess and make comparative analysis of the data collected from the three districts and nine peasant associations.

Sampling techniques and sample size

Purposive and systematic random sampling techniques was used for this study. From the total of 7 destricts in Waghimra Zone, three of them were selected purposely based on their agro-ecology and beekeeping potentials. Totally nine PAs (kebeles) were selected out of 67 PAs from the targeted districts once more by considering their agro-ecology. The sample household beekeepers were selected using Systematic (N^{th}) sampling technique that gives equal chance for the Nth repersentative samples from a list of farmers participated in beekeeping activity within the nine PAs. Thus, a single household respondent was used as sampling unit, and the total households included in this study were determined according to the formula given by Yamane (1967) with 95% confidence level of the households from the total beekeepers. 9 PAs were selected as follows:

$$n = \frac{N}{1 + N(e)^2}$$

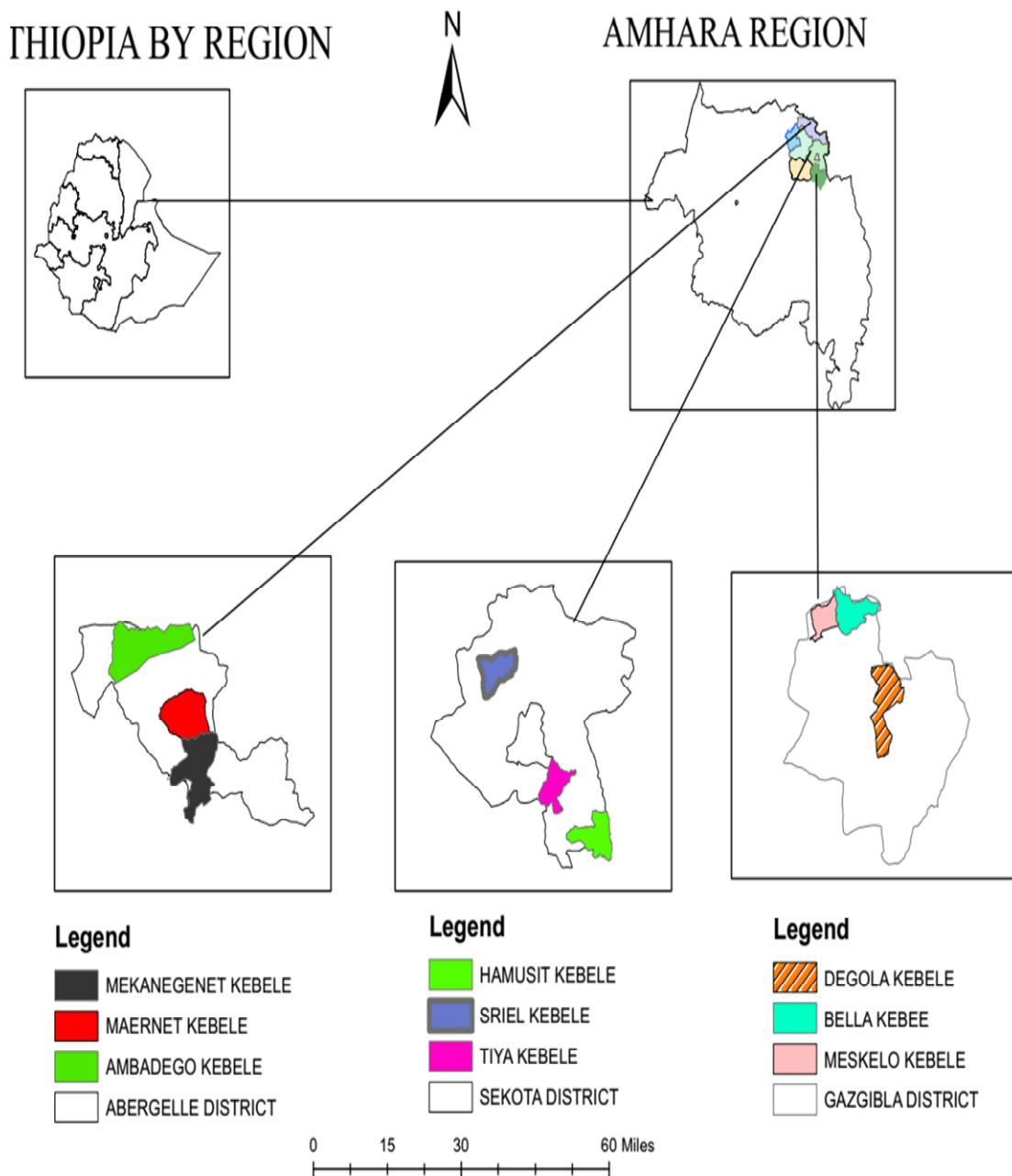*Corresponding author. E-mail: zewduwondifraw@dmu.edu.et.

Figure 1. Map of the study area (Abergelle, Gazigibale and Sokata Districts).

Where:

n= Sample size, N= population size, e = the desired level of precision

Totally, 332 sample household beekeepers were determined from the three target districts and hence, the representative samples from each district (Sekota =165, Gazgibala =105 and Abergelle = 62) were also determined based on the number of beekeeper households in each district. In addition, sample size (N) was also tested by the formula recommended by Arsham (2005) as **N** = 0.25/SE^2, where **N** is sample size, and SE is the standard error in order to validate its significance level.

Methods of data collection

In order to carry out this field survey study, discussion was undertaken initially with Waghimra Zone head of Livestock and Fisheries Resources Department, and bee experts of the selected districts. In addition, the researcher made a discussion with the heads of targeted districts Livestock and Fish Resources Head

Table 1. Waghimra Zone bee colony distribution by districts.

S/N	Districts	Area coverage		Bee resource		Bee colony per km^2(h/r)
		km^2(h/r)	Zonal share	Bee colony	Zonal share	
1	Sekota town	9375.96	1.07	1.544	2.02	0.165
2	Sekota	167156.29	19.03	21.702	28.37	0.130
3	Dehana	167631.40	19.09	12.105	15.82	0.072
4	Ziquala	170162.64	19.38	14.771	19.31	0.868
5	Abergelle	160658.64	18.29	3.393	4.44	0.021
6	Sehala	95077.15	10.83	8.106	10.60	0.085
7	Gazgibala	108133.16	12.31	14.874	19.44	0.138
Subtotal Zonal		878195.30	-	76.495	-	1.479

Source from: Waghimra Zone Animal and Fish Resources Department (2016).

Office, and bee experts for the selection of nine PAs. In the study, primary and secondary data were used to generate qualitative and quantitative information. Additionally, secondary data that has relevance to this study was collected from both published and unpublished sources.

Questionnaire

Primary data were collected from 332 household beekeepers using semi-structured questionnaire on demographic and socio-economic data, numbers of bee colonies, honey production potential, current practices and other beekeeping practices.

Focus group discussion (FGD)

FGD was undertaken with PAs leaders; development agents (DAs) and beekeeper farmers with best experience (30 participants, that is, 10 participants in one district) were purposely selected and participated in three districts. The FGD was carried out by means of guidelines (checklists) for participants and the discussion focused on: major challenges, opportunities and future prospects of bee keeping and honey production in the targeted districts.

Key informant interview

Key informant interview was under taken with three Zone bee and livestock experts, nine bee and livestock experts in 3 districts, 9 model beekeeper farmers and 3 beekeeping researchers. Totally, 24 key informants were interviewed in order to gather more of qualitative information deeply that was used to supplement, crosscheck and validate the data obtained through household survey.

Observation

Observation was anther instrument used in this study. From the total 4,250 beehives (traditional, modern and transitional), 366 sample hives were selected for field observation from 50 randomly selected households with in the 332 beekeeper sample household respondents. During observation, the researcher used guidelines on different beekeeping activities such as: framed and traditional hive placement, hives management, pest and predator, hive products, honeybee flora condition, dry season feeding and seasonal bee colony activities.

Method of data analysis

Quantitative data were organized and entered in to Microsoft Office Excel 2007, and analyzed using descriptative statistics and statisitical package for social sciences (SPSS) statistics version 20.

RESULTS AND DISCUSSION

Demographic characteristics of the respondents

As presented in Table 2 from the total sample, 93.4% were male and 6.6% female headed beekeeper, respectivelly. This result agrees with Haftu et al. (2015) who reported 93% of the interviewed beekeepers were male and only 7% were female headed beekeeper.

Similary,Taye et al. (2014) reported that 94.4% of the interviewed small scale beekeepers involved in honey value chain were males, where as 5.6% involved in honey value chain were females. Thus, it is posible to generalize that only few number of women participated in the beekeeping practice in the study area because there were different socio-cultural factors that impeded females to engage in beekeeping practice such as: beekeeping activities are mostly done at night; females can not afford the current bee colonies and beekeeping equipment price; females could not resist the agreesive behavior of bees. Almost half of 49.7% beekeeping participants lived in the high land agro-ecology whereas, the lowest number of beekeeping participants that is 18.7% lived in the low land areas, and the rest 36.6% of them lived in mid land agro-ecology.

The majority of beekeepers (59.9%) age ranges between 15 to 49 years. This indicates more than half of the beekeepers were under the productive age who can actively engage in beekeeping practice in study area.

Table 2. Demographic characteristics of the sample household beekeepers.

Category	Variable	Study area						Over all (N= 332)	
		HL (N=165)		ML (N=105)		LL (N=62)		F	Percentage (%)
		F	Percentage (%)	F	Percentage (%)	F	Percentage (%)		
Sex	Male	157	95.2	99	94.3	54	87.1	310	93.4
	Female	8	4.8	6	5.7	8	12.9	22	6.6
	Total	165	100	105	100	62	100	332	100
Age (years)	15-29 years	33	20.0	19	18.1	2	3.2	54	16.3
	30-49 years	75	45.5	48	45.7	22	35.5	145	43.7
	50-64 years	34	20.6	32	30.5	33	53.2	99	29.8
	>65 years	23	13.9	6	5.7	5	8.1	34	10.2
Marital status	Single	5	3.0	6	5.7	3	4.8	14	4.2
	Married	128	77.6	80	76.2	44	71.0	252	75.9
	Widowed	15	9.1	11	10.5	10	16.1	36	10.8
	Divorced	17	10.3	8	7.6	5	8.1	30	9.0
Educational status	Illiterate	91	55.2	53	50.5	27	43.5	171	51.5
	Reading and writing	30	18.2	18	17.1	11	17.7	59	17.8
	Primary (1-4)	30	18.2	20	19.0	14	22.6	64	19.3
	Junior (5-8)	10	6.1	10	9.5	6	9.7	26	7.8
	Secondary (9-12)	4	2.4	4	3.8	4	6.5	12	3.6
Experience in beekeeping activity (years)	1-5 years	38	23.0	24	22.9	15	24.2	77	23.2
	6-10 years	43	26.1	27	25.7	16	25.8	86	25.9
	11-20 years	40	24.2	25	23.8	15	24.2	80	24.1
	>21years	44	26.7	29	27.6	16	25.8	89	26.8
Family size	1-5 family	52	31.5	33	31.4	20	32.3	105	31.6
	6-10 family	108	65.5	67	63.8	42	67.7	217	65.4
	11-15 family	5	3.0	3	2.9	2	3.2	10	3.0
Position of household head in community	Political leader	67	40.6	43	40.9	25	40.3	135	40.7
	Spiritual leader	15	9.1	10	9.5	6	9.7	31	9.3

Table 2. Contd.

Elder	17	10.3	11	3.3	6	9.7	34	10.2
Community member	39	23.6	25	23.8	15	24.2	79	23.8
Kebele team leader	12	7.3	7	6.7	4	6.5	23	6.9
Kebele police	15	9.1	9	8.6	6	9.7	30	9.0

Source: Field survey, December-March, 2016/17, HL=highland, ML=midland, LL=lowland, N=number of respondents, F= frequency.

This result was comparable to the finding of Chala et al. (2012) who reported that average age of beekeeper in Gomma districts South West Ethiopia was 40.47 years.

As inicated in Table 2 from the total respondents, about 51.5% of them were illiterate, 19.3% attended primary education, 17.8% of them can read and write; 7.8% beekeepers attended junior education and the rest only 3.6% of beekeepers attended secondary education. This result was similar with the findings of Taye et al. (2014) that they reported 33.3% of beekeeper were illiterate. On the contrary, it vary from the findings of Tessega (2009) who reported that only 15.1 % were illiterate whereas 84.9% of them were literate. The difference might be due to in acessibilty of both formal and informal education in the Waghimara Zone esspicially in previous years.

Regarding respondents experience in beekeeping activity, 26.8% beekeepers have more than 21 years experience, 25.9% have from 6 to 10 years, 24.1% have between 11 to 20 years and the rest 23.2% of them had an experience of beekeeping from 1 to 5 years. The study of Chala et al. (2012) reported beekeepers had an average experience of beekeeping (5.66 years. Therefore, beekeepers in this study area had better experience of beekeeping than Chala's report.

As indicated in Table 2, 65.4 % of respondents had the family size of 6 to 10); 30.6 % them had family size of 1 to 5 and the rest 3 % of beekeepers had 11 to 15 family size. This indicated that the average family size of Waghimara Zone is so large that they need diversified source of income in addition to crop production and animal husbandry for generating income like beekeeping activities in order to improve farmers economic status. The current study was supported by Teklu et al. (2016) as they reported that the minimum and maximum family size of respondents were 5 and 7 respectively.

Socio-economic characteristic of the respondents

The major source of households income were from crop production which accounted for 27.7%, livestock production 23.8%, beekeeping activities 16.9% and irrigation which accounted 15.4% in descending order as shown in Table 3.

Therefore, beekeeping is the third ranking source of income for the beekeeper households in the study area. In relation to agro-ecology, beekeeping accounted for 21.8% source of income for households next to crop and livestock production which accounted for 30.5 and 26.1%, respectively in high land area of the study area and similarly beekeeping is the third ranking source of income in low land area which accounted for 16.1% next to crop and livestock production that accounted for 27.4 and 24.2%, respectively. On the other hand in the mid land area, beekeeping accounted only for 9.5% as source of income which is the lowest compare to high land and low land agro-ecologies as indicated in Table 3. In line with this result, Beyene and Verschuur (2014) reported that beekeeping ranks second source of income accounting for 26.27% share of household income.

Livestock and honeybee colonies holding of sampled households

The major types of livestock owned by respondents on average were goats 22.34, sheep 21.12, bee colony 13.11, poultry 9.46, cattle 6.03 and equines 1.76 per household in descending order as stated in Table 4. Regarding the number of bee colonies per household, the minimum and

Table 3. Socio-economic characteristics of the sample household in beekeeping.

Category	Variable	Study area						Over all (N= 332)	
		HL (N=165)		ML (N=105)		LL (N=62)		F	Percentage (%)
		F	Percentage (%)	F	Percentage (%)	F	Percentage (%)		
Source of income	Crop prod	52	31.5	23	21.9	17	27.4	92	27.7
	Livestock prod	43	26.1	21	20	15	24.2	79	23.8
	Beekeeping	36	21.8	10	9.5	10	16.1	56	16.9
	Irrigation	23	13.9	22	21	6	9.7	51	15.4
	Trade	7	4.2	15	14.3	5	8.1	27	8.1
	Service	4	2.4	14	13.3	4	6.5	22	6.6
	Fish prod	0	0	0	0	5	8.1	5	1.5
	Barley	42	25.5	23	21.9	2	3.2	67	20.2
	Sorghum	28	17	22	21	20	32.3	70	21.1
	Teff	22	13.3	21	20	16	25.8	59	17.8
Major crop cultivation in the study area	Pea	17	10.3	10	9.5	0	0	27	8.1
	Wheat	41	24.8	15	14.3	0	0	56	16.9
	Bean	15	9.1	14	13.3	0	0	29	8.7
	Oil crop	0	0	0	0	15	24.2	15	4.5
	Cowpea	0	0	0	0	9	14.5	9	2.7

Source: Field survey, December-March, 2016/17, HL=highland, ML=midland, LL=lowland, N=number of respondents, F= frequency.

the maximum bee colonies were 2 and 84, respectively with an average of 14.64 bee colonies. There is significant difference among beekeepers in having bee colonies. In supporting this finding, Yetimwork (2015) confirmed that beekeeper owned a maximum of 100 bee colonies and a minmum of 1 bee colony with an average bee colonies of 5.8 per household. Beekeepers revealed that they practiced beekeeping for getting cash income, consumption, dowry or gift and for breeding in descending order. This was similar with the findings of Nebiyu et al. (2013) who reported that the main purpose of beekeeping was for both income and household consumption depending on their importance (Table 4).

Traditional beehives

As indicated in Table 5, 68.4% of beekeepers used traditional hives for honey and bees wax production. This is due to lack of appropriate honey processing materials, lack of bee equipments and protective materials (like modern beehives, casting mold, frame wires, beeswax) and skilled manpower. This result was in agreement with the findings of Nebiyu et al. (2013) as 87.80% of beekeeping practices are covered by traditional beehives. These indicated

beekeepers highly depend on traditional beehives than modern and transitional beehives. Most of the beekeepers (83.4%) constructed their own traditional beehives from local materials such as: comb hives from lumber and others from mud (which is a mixture of clay, cow dung and ash), different trees, like 'Ekima' *(Terminalia glaucescens*) and 'bamboo' (*Arundinaria alpine*). However, the rest 16.6 % beekeepers bought locally constructed beehives and some of them borrowed it from other beekeepers that had extra beehives.

As shown in Table 6, in the highland area, the maximum and the minimum traditional beehives per household were 50 and 2, respectively with

Table 4. Average livestock and honeybees number per household head.

Variable	N	Min	Max	Mean	S.E
Number of cattle per household head	332	2	15	6.03	0.188
Number of goat per household head	332	5	100	22.34	0.974
Number of sheep per household head	332	3	84	21.12	1.182
Number of pultry per household head	332	4	30	9.46	0.226
Number of bee colonies per household head	332	2	84	14.64	0.937
Number of equines per household head	332	1	5	1.76	0.058

Source: Field survey, December-March, 2016/17, SE=Standard Error, N=number of respondents.

Table 5. Number of beehive in the study area.

Type of beehives	Min	Max	Study area			
			HL N=165	ML N=105	LL N=62	Over all N=332
			Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE
Taditional	2	84	9.31±1.105	7.18±0.48	10.13±1.36	8.79±0.625
Transitional	1	8	2.29±0.302	2.04±0.285	1.83±0.306	2.11±0.182
Modern	1	21	3.78±0.637	3.78±0.44	7.38±1.09	4.38±0.414

N=number of respondents, SE=Standard Error, HL=highland, ML=midland, LL=lowland.

average number of 13.59±2.4 hives per household. In mid land area, there was high variation of beekeepers in having traditional beehives per households with the minimum and maximum of 2 and 84, respectively, which was more than other two agro-ecologies and the average traditional hive per household was 26.6±5.3. The average traditional hives per household in low land area was 16.4±4.9 which is more than the high land area and less than the mid land area whereas the minimum and maximum beehives per household were 2 and 63, respectively. There were significant differences on the practice of traditional beekeeping among the three agro-ecologies. In addition, traditional hives variability of having different shapes was attributed to the different climate conditions of the area and the beekeepers different honey production systems and techniques.

As shown in Table 7, the average numbers of traditional hives owned per household were 8.79±0.625 whereas the minimum and maximum hives per household were 2 and 84, respectively. The result indicated that there is no significant difference among beekeepers in Waghimara Zone. According to Addis et al. (2014) in and around Gonder, average numbers of traditional honeybee colony owned per household were 7.58 whereas the minimum and maximum beehives per household were 1 and 60. In relation to agro-ecology in the high land area, the average number of traditional hives per household was 9.3±1.1, in the midland 7.2±0.5 and in the lowland 10.13±1.4. Beekeepers have more traditional beehives per household in low land area than other agro-ecologies.

Transitional beehives

Beekeepers who owned transitional beehives were 7.8 % which was the smallest number as compared to traditional and modern beehives. As indicated in Table 7, the average numbers of transitional beehives owned per household was 2.11±0.18 whereas the minimum and maximum hives per household was 1 and 8, respectively. There were none significant difference on the practice of transitional beekeeping among the three agro-ecologies.

Modern beehives

Among the sampled beekeeper, 23.8% of them reported that they had modern beehives for their beekeeping activity. Similarly, Haftu et al. (2014) reported 8.5% of household beekeepers owned modern beehives in Hadya Zone. This indicates that the adoption rate of improved technology (modern beehives) is very low because of the cost of constructing and purchasing of modern beehives and due to lack of harvesting and processing equipment's to use modern beehives. In modern (frame hive), the average number of hives per household was 4.38. This was better than the findings of Tessega (2009) with the average number of modern hives per household (3.73). In low land area, beekeepers had relatively more number of modern beehives per household (7.38) than other two agro-ecologies due to beekeepers better awareness and good experience of getting high productivity of honey. Thus, the overall beekeepers practice of using modern

Table 6. Honeybee colonies holding per household in the study area.

Variable	Study area	N	Min	Max.	M±SE	S.D
Traditional hives colony only owned/households	HL	46	2	50	13.59±2.37	16.110
	ML	29	2	84	26.62±5.33	28.708
	LL	19	2	63	16.36±4.99	21.211
Transitional hive colony only owned/HH	HL	16	1	8	3.38±0.657	2.630
	ML	10	1	5	2.00±0.471	1.491
	LL	7	1	5	1.86±0.553	1.464
Framed hive colony only owned/HH	HL	24	1	15	3.71±0.724	3.544
	ML	15	2	15	5.87±1.032	3.998
	LL	10	1	21	8.00±2.006	6.342
Traditional and Transitional hive colony owned/households	HL	13	3	6	3.69±0.328	1.182
	ML	9	3	6	4.00±0.441	1.323
	LL	5	3	6	4.00±0.632	1.414
Traditional and Modern hive colony owned/households	HL	38	3	30	10.95±1.20	7.429
	ML	24	3	21	9.21±1.169	5.725
	LL	7	3	26	12.86±3.08	8.174
Transitional and Modern hive colony owned per households	HL	19	2	5	3.42±0.299	1.305
	ML	12	2	5	3.00±0.348	1.206
	LL	10	2	5	3.20±0.389	1.229
Traditional, Transitional and Modern hive colony owned/HH	HL	9	4	10	5.78±0.722	2.167
	ML	5	4	8	6.00±0.707	1.581
	LL	5	4	10	6.40±1.030	2.302

HL=highland, ML=midland, LL=lowland, N=number of respondents, S D= Standard deviation, S E =Standard Error.

Table 7. Honey yield, cost of beehives and bee colony and harvest frequency.

| Variable	Min	Max	Study area			Over all N=332
			High Land N=165	Mid Land N=105	Low Land N=62	
			Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE
Traditional (kg)	5	50	8.90±0.63	10.53±0.82	12.89±1.02	10.16±0.46
Transitional (kg)	8	30	12.93±0.24	13.28±0.39	16.00±0.77	13.61±0.23
Modern hives (kg)	15	50	25.62±0.91	21.89±0.83	19.63±1.00	23.32±0.57
Price colonies (ETB)	500	2500	973.33±37.9	973.33±41.5	912.90±60.2	930.42±25.6
Prices of one transitional beehives (ETB)	100	120	105.45±0.61	105.90±0.85	103.39±0.87	105.21±0.44
Prices of one modern beehives (ETB)	1000	1500	1116.06±15.4	1228.57±17.5	1175.41±22.	1187.61±10.4
Frequency of honey harvest per annum of traditional hives	1	3	2.54±0.43	2.03±0.85	1.82±0.102	2.24±0.43
Frequency of honey harvest/yrs of transitional hives	1	2	1.33±0.037	1.27±0.43	1.10±0.038	1.27±0.024
Frequency of honey harvest per annum of modern hives	1	2	1.19±0.031	1.27±0.04	1.23±0.054	1.22±0.023

N=number of respondents, S E =Standard Error.
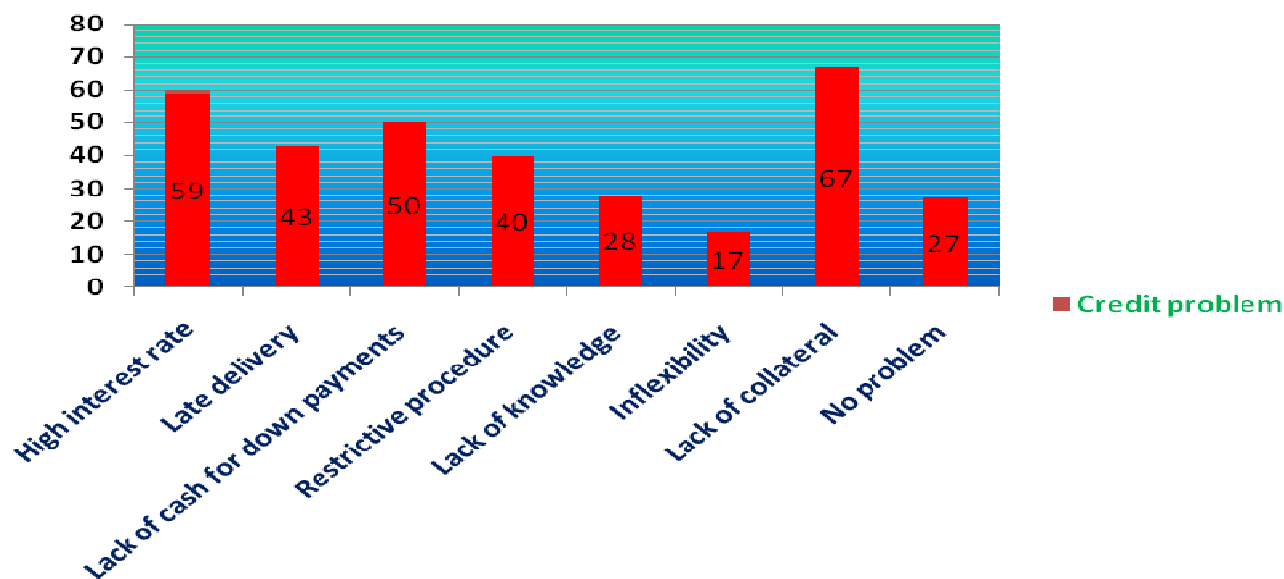
Figure 2. Credit problem for beekeeping activities in the study area (N=332).

beehives had a significant difference among the three agro ecologies (Table 7).

Challenges that hamper beekeeping practice and honey production

There were different major challenges of beekeeping practice and honey production in the study areas like; credit problems, pests and predators, lack of beekeeping equipments and protective materials, drought, indiscriminate applications of agro-chemicals etc.

Credit problems to carry out beekeeping practice

As illustrated in Figure 2, shortage of credit service to undertake beekeeping practice was ranked as priority problem in the study area. This is due to lack of collateral (20.2%), high interest rate (17.8%), lack of cash for down payments (15.1%), late delivery (13.1%), restricted procedure (12.1%), beekeepers lack of knowledge (8.4%) and inflexibility (5.1%) in descending order. For instance, from the total sampled beekeeper, only 8.2% of them reported, as they did not face problems in relation to credit sources whereas the majority 91.8% of them reported as they encountered the different challenges stated earlier. Beekeepers were not able to get collateral because the credit service was given for them in groups, which lack clear individual accountability, and hence it was mostly abused and miss used by some group members who got the credit service. This finding is similar with Tessega (2009) that he reported beekeepers have severe problem to get credit due to high interest rate, late delivery, and lack of cash for down payment, restrictive procedure, lack of knowledge, inflexibility and lack of collateral in descending order.

Pest and predators

As described by Desalegn (2001), Ethiopia, as one of the sub-tropical countries, the land is not only favorable to bees, but also for different kinds of honeybee pests and predators that are interacting with the life of honeybees. As reported in EEPD (2006), pests and predators cause a serious devastating damage on honeybee colony within short period of time and even overnight.

As indicated in Table 8, the major pests and predators, which harmed beekeeping practice and honey production in the study area were listed: The most important pests and predators in honey production are bee eater birds (1st), ants (2nd), wax moth (3rd), spiders (4th), lizards (5th), honey badger (6th), hama got or *mogoza* (7th), bee lice (8th), beetles (9th) and wasps (10th) as ranked in descending order by the respondents. In relation to this finding, Tewodros (2010) found that the most important pests and predators which harmed honeybees were wax moth, bee-eater birds, ants, and honey bag her, and lizards.

Similar finding was reported by Malede et al. (2015) as ants, honeybadgers, bee eater birds, waxmoth, spiders, termites, and snakes causing devastating damage to honey bee colonies and products within a short period of

Table 8. Major pest and predators challenging the beekeeping practice.

Variable	Study area									Over all (N=332)		
	HL (N=165)			ML(N=105)			LL (N=62)			F	%	Ranks
	F	%	Rank				F	%	Ranks			
Ants	24	14.5	2nd	13	12.4	2nd	10	16.1	1st	47	14.2	2nd
Wax moth	23	13.9	3rd	12	11.4	3rd	9	14.5	2nd	44	13.3	3rd
Bee lice	9	5.5	9th	9	8.8	6th	7	11.3	4th	25	7.5	6th
Spiders	20	12.1	5th	12	11.4	3rd	4	6.5	6th	36	10.8	4th
Bees eater birds	27	16.4	1st	15	14.3	1st	9	14.5	2nd	51	15.4	1st
Hama got (mogoza)	18	10.9	6th	11	10.5	4th	4	6.5	6th	33	9.9	6th
Lizards	21	12.7	4th	10	9.5	5th	5	8.1	5th	36	10.8	4th
Wasps	6	3.6	10th	4	3.8	8th	3	4.8	7th	13	3.9	8th
Beetles	3	1.8	11th	7	6.7	7th	4	6.5	6th	14	4.2	7th
Honey badger (Death head hawks month)	14	8.5	8th	12	11.4	3rd	8	12.9	3rd	34	10.2	5th

%= percentage; F= Frequency.
Source: Field survey, December-March, 2016/17.

time. This result was also supported by Teklu et al. (2016) as they reported that the major problems of beekeeping practice in the area are honeybee enemies such as ants, honey badgers, birds and small hive beetles which accounted for 20% of the total honey production loss annually.

Agro ecologically, bees eater birds were identified as number one enemies of honey bees in the high land and in the mid land agro-ecologies whereas they were identified as the second major enemies in the low land agro-ecology because in the low land areas ants were the major enemies of honeybees. The second major identified pests, which harmed the honeybees in the study area, were ants. Agroecologically, ants were identified as the second major enemies of pests in the high land and mid land agro-ecologies; however, they are the 1st major enemies of honeybees in the low land areas. This result also supported by Chala et al. (2012) as they reported beekeepers witnessed that bee colonies suffered from ants which results in death of adult honey bees in the hive and absconding of bee colony.

Moreover, wax moth was ranked as the third major type of pests that harmed honeybees because beekeepers did not conduct continuous follow up and removing of the old combs affected by wax moth larva. Additionally, spider and lizards were ranked as the fourth major pests and predators, which attack the honeybees. Lizards were ranked as the fourth major enemies of honeybees in the high land areas whereas they were identified as the fifth major predators of honeybees in the mid land and lowland areas. On the other hand, spiders were identified as the third major pests which harmed the honeybees in the mid land; however, they were ranked as the fifth and sixth major enemies of honeybees in the highland and low land areas, respectively as indicated in Table 8.

In general, bee-eater birds, ants and wax moth were the first, second and the third major enemies of honeybees in the study area, respectively. In order to address these challenges, beekeepers used different techniques to protect the major pests and predators. For instance, beekeepers protect bee-eater birds by placing gum plants where the birds rest near the apiary; killing the birds using smoke at their nest and by chasing away the birds at times when they visit the apiary in morning and afternoon times when birds mostly visit apiaries.

Beekeepers used the gums of *Tapinanthus aurantias* which is a type of shrub in order to protect bee's eater birds. To protect ants, most of the beekeepers used dung, fresh ash, mud, malatione and hot water, burning the ants with water, destroying ants' nests, and pouring engine oil around the beehives stands. Additionally, beekeepers protected wax's moth by applying different techniques such as: cleaning apiary, removing the old comb, strengthening the bee colony with giving supplementary feeding, fumigation with the seed of Noug (*Guizotia abyssinica*) and narrowing the entrance of beehives.

Honeybee poisoning plants

There were different poisoning plant species like: trees, shrubs, herbs and field crops that have a negative effect on honeybees, beehive products and humans. Beekeepers identified 4 major tree species, 6 species of shrubs, 2 cultivated field crop types and 1herbs as poisoning plant species in their surroundings as indicated in Table 9. In line with this study, Kerealem (2005) reported that nectar or pollen of poisonous plants was toxic to honeybees, and the honeys produced from their

Table 9. Honeybee posing plant in the study areas.

| Name of the plant species | | | | | Effect on | | |
Local name (Agewugna)	Scientific name	Floral type	Source of pollen and nectar	Flowering calendar (month)	Bees	Beehive products	Humans
Neem tree	*Azadirachta*	Trees	-	-	X	-	-
Yeferenj suf	*Heliantnus annus*	Field crop	Pol/ Nec	September	X	-	-
Dikuan tilla	*Verbena officinalis*	Herbs	Pol/Nec	July	X	-	-
Ater	*Pisum sativum*	Field crop	-	September	X	-	-
Kichib	*Euphorbia tirucalli*	Shrubs	-	Year round	-	X	X
Kalkalda	*Euphorbia Spp.*	Shrubs	-	Year round	-	X	X
Acacha	*Acacia saligna*	Trees	-	-	X	-	-
Chiret	*Agave sisalana*	Shrubs	Pol/Nec	September	-	X	X
Kulqual.	*Euphorbia Spp*	Shrubs	Pol/Nec	March	-	X	X
Eret	*Oleo berhana*	Shrubs	-	September to Oct	-	X	-
Azo harege	*Clematis hirusta*	Shrubs	-	March	X	-	-
Shola	*Ficus*	Trees	-	January-February	X	-	-
Shisha	*Boscia anquistifolia*	Trees	Pol/Nec	April	X	-	-

Source: Field survey, December-March, 2016/17.

nectar were toxic to humans. Based on his finding, he recommended that removing those poisoning plants around apiary site, developing improved and local bee forage species were solutions to address the problem. The result of this study agrees with previous findings of Yetimwork et al. (2015) as they reported that about 43.6% of experienced beekeepers identify the major poisonous plants in their surroundings. Plants like *akacha (Acacia saligna), qnchb (Euphorbia species)*; limo or false *neem (Melia azedarach)* and *neem (Azadirachta indica)* are identified as poisons. This result is supported by Chala et al. (2012) as they reported that only experienced beekeepers listed few poisons plants in their locality. These can be plants whose nectar or pollen is toxic to the bees themselves, and those in which the honey produced from their nectar are toxic to humans.

Indiscriminate utilization of agro-chemicals

FAO (2012) reported that the present increasing use of pesticides and herbicides is severely threatening bee colonies implying conflicts of crop and honey production. The use of chemicals and pesticides for crop pests, weeds, Tsetse fly, mosquitoes and household pests control brings the possibility of damaging the delicate equilibrium in the colony, as well as the contamination of hive product as reported in EFSA (2012). The promotion of some agricultural inputs such as pesticides and herbicides for cereal crop production as well as the use of deadly chemicals for malaria eradication program have substantially

reduced honey production in the study area. As shown in Table 10, most of the beekeeper (62.7%) reported as they used agro-chemicals for crop pest protection, to control weeds, malaria, external parasites and house pests which bring the real possibility of damaging the delicate equilibrium in the bee colony and contamination of beehive products. Large number of respondents (39.5 %) used agro-chemicals for the purpose of controlling weeds, 24.4% of them for malaria control, 20.8% for crops pest control, and the rest 15.4% of beekeepers used agro-chemicals for controlling external parasites. Relatively, large number of beekeeper reported that they used agro-chemicals for controlling weeds; however, in the study area there is large number of family size (6.57 per household) that could be used as a source of family labour to control weeds instead of

Table 10. Use of agro-chemicals (pesticides and herbicides) in the study area.

Category	Variable	Frequency of the respondents (N=332)
		N (%)
Use of agro-chemicals (Pesticides and Herbicides)		
Do you use agro-chemicals	Yes	208 (62.7)
	No	124 (37.3)
Months of using agro-chemicals	July to August	168 (50.6)
	September to October	29 (8.7)
	November to December	35 (10.5)
	January to February	40 (12.0)
	March to April	30 (9.0)
	May to June	30 (9.0)
Purpose of using agro-chemicals	Weeds	131(39.5)
	Crops pest control	69 (20.8)
	Malaria	81(24.4)
	External parasite	51(15.4)
Types of agro-chemicals use in the study area	2.4-D	106 (31.9)
	Diazole	59 (17.8)
	Malathion	37(11.1)
	Sevin	22 (6.6)
	DDT	46 (13.9)
	Deltamethrin	62 (18.7)
Affect honeybee by agro-chemicals	Yes	202 (60.8)
	No	130 (39.2)
Impacts of chemicals on honeybees and beekeepers	Dead of bees	138 (41.6)
	Absconding	129 (38.9)
	Low beehive products	65 (19.6)
Honeybees lost due to use of chemicals in 5 years	One up to five bee colonies	141 (42.5)
	6-10 bee colonies	68 (20.5)
	11-15 bees colonies	43 (13.0)
	16-20 bee colonies	49 (14.8)
	> 21 bee colonies	31 (9.3)
Estimated honey production (kg) per years	10-20 kg of crude honey	128 (38.6)
	21-40 kg crude honey	95 (28.6)
	41-60 kg crude honey	64 (19.3)
	>61 kg crude honey	45(13.6)
Estimated in prices (ETB) per years	1.000-2,000 ETB	122 (36.7)
	2.001-4,000 ETB	106 (31.9)
	4.001-6,000 ETB	57(17.2)
	>6.001 ETB	47(14.2)

Source: Field survey, December-March, 2016/17, N= number of sampled respondents.

using agro- chemicals, which has a strong negative impact on the honeybee colonies, and honey production in the study area.

As indicated in Table 9, different types of agro-chemicals used by farmers such as 2, 4-D, Diazole, Malathion, Sevin, DDT and Deltamethrin. This result agrees with previous findings, (Sintayehu, 2016) as he reported different pesticides and herbicides used by farmers like: Malathion, Sevin, DDT, 2-4 D, Acetone, Roundup/Glyphosate, Topic, and Palace are commonly used separately or in combination. This result is similar to other studies like Kerealem et al. (2009) who reported that the spraying herbicides destroying bee forage like herbs and shrubs which is used as sources of bee forage. The use of pesticides that kill bees and herbicides are not only toxic to bee colonies but destroy many plants that are valuable to bees as sources of pollen and nectar.

Impact of the utilization of agro-chemicals on beekeeping practice and honey production

According to Bekele (2015), the use of pesticides and herbicides for crop pests, weeds, *Tsetse* fly, mosquitoes and household pests control brings into focus the real possibility of damaging the delicate equilibrium in the colony, as well as the contamination of hive products. Among the various kinds of chemicals, only insecticides and herbicides are now major problems to the beekeepers especially chemicals used for crop protection are the main pesticides that kill the honeybees. Most of the sampled beekeepers (60.8 %) reported that they had awareness on the negative impact of using agro-chemicals on honeybees and honey production whereas the rest (39.2 %) of beekeepers reported that agro-chemicals do not affect honey bees and honey production. However, in the study area, the overall average estimated honeybee colony and honey production lost per household/ year due to use of agro-chemicals were 5.1 bee colony and 31.9 kg of crude honey respectively. The estimated honey production lost in price per household in a year due to the indiscriminate application of agro-chemicals was 4,125.37 ETB as shown in Table 10. This study is similar with previous evaluation in that, due to agro- chemicals aplication, some beekeepers lost their colonies totally as discribed by Taye et al. (2014).

High cost and scarcity of beekeeping equipments and accessories

98.19 % of the beekeepers in the study area reported as there was shortage of beekeeping equipments and protective materials such as: smokers, protective materials (veil, gloves, boots, and overall), casting mold, honey extractor, bee brush, honey presser, water sprayer, frame wire, chisel, un capping of fork, queen excluder, embedded etc, in descending order. This result was similar to Edessa (2005) who reported that an introduction of improved beekeeping technology to rural communities are beyond the affording power of beekeepers, and they are not easily availabile even for those who can afford to it. Similarly, Taye et al. (2014) stated that, some of the bee equipments such as modern beehives, wax printers and honey extractors are very expensive and thus, farmers could not afford to purchase and use these equipment's. Based on the sampled respondents, the distribution of beekeeping equipments was relatively better in the mid land area than the low land and the high land areas. This is due to the presence of different non-governmental organizations (NGOs) in the area, it is also the center of Sekota Dry Land Agriculture Research Center that works as a research in queen rearing practice for distributing to the beekeepers.

Major challenges that hinder beekeeping practice and honey production

As indicated in Table 11, the major challenges and problems that hider beekeeping practices and honey production were pests and predators, drought, agro-chemical spraying (herbicides and pesticides), poor farmers' awareness for adopting technologies, and lack of bee forage associated with deforestation. In addition, shortage of beekeeping equipments and materials; shortage of water' lack of knowledge in bee management, high cost of modern beehives and shortage of accessories, absconding, hive product adulteration, lack of training/skills of beekeeping, shortage of honeybee colonies; swarming; honeybee disease; death of bee colonies in case of unknown disease*;* illegal colony marketing; and poor extension services related to beekeeping.

This result agrees with the report of Malade et al. (2015) that stated various constraints and challenges that hamper beekeeping and honey production sub sector. Some of them are shortage of bee forage, application of chemicals, pest and predator (ants, birds, spiders, honey badger, termite, snake, and wax moth), lack of rainfall, absence of policy in apiculture and others. Similarly, Kerealem et al. (2009) found that shortage of bee forage, threat of pesticide, honeybee pest and predators, poor infrastructure development, and shortage of bee equipments, which were reported as the major beekeeping constraints in Amhara National Regional State.

Agro ecologically, the first major challenges that impeded beekeeping practices and honey production in the study area were pests and predators which attacked honeybee colonies. It was identified as the first major

Table 11. Major challenges that hinder beekeeping practice and honey production.

Variable	Highland (N=165)			Midland (N=105)			Lowland (N=62)			Over all (N=332)		
	N	Percentage (%)	Rank	N	Percentage (%)	Rank	N	Percentage (%)	Rank	N	Percentage (%)	Rank
Lack of bee forage associated with deforestation	11	6.7	3rd	5	4.8	4th	3	4.8	2nd	19	5.7	4th
Shortage of beekeeping equipment and materials	8	4.8	6th	5	4.8	4th	3	4.8	2nd	16	4.8	5th
Pests and predators	16	9.9	1st	8	7.6	2nd	4	6.5	1st	28	8.4	1st
Absconding	7	4.2	7th	4	3.8	5th	3	4.8	2nd	14	4.2	7th
Drought	12	7.3	2nd	10	9.5	1st	4	6.5	1st	26	7.8	2nd
Shortage of water	7	4.2	7th	5	4.8	4th	3	4.8	2nd	15	4.5	6th
Pesticides and Herbicides Application	10	6.1	4th	7	6.7	3rd	4	6.5	1st	21	6.3	3rd
Swarming	5	3.0	9th	4	3.8	5th	2	3.2	3rd	11	3.3	10th
Lack of knowledge (in bee management)	7	4.2	7th	4	3.8	5th	3	4.8	2nd	14	4.2	7th
Marketing problems	2	1.2	12th	3	2.9	6th	2	3.2	3rd	7	2.1	14th
Lack of training/skills of beekeeper	7	4.2	7th	4	3.8	5th	1	1.6	4th	12	3.6	9th
Shortage of bee wax's(pure) for modern beehives	4	2.4	10th	4	3.8	5th	1	1.6	4th	9	2.7	12th
Shortage of honey bee colonies	5	3.0	9th	4	3.8	5th	2	3.2	3rd	11	3.3	10th
Death of bee colonies (due to mill and *michi*)	4	2.4	10th	4	3.8	5th	2	3.2	3rd	10	3.0	11th
Salle of honey with bee wax's any honey	3	1.8	11th	3	2.9	6th	3	4.8	2nd	9	2.7	12th
High prices cost of modern beehives and shortage accessory	9	5.5	5th	3	2.9	6th	2	3.2	3rd	14	4.2	7th
Poor extension services related to beekeeping	5	3.0	9th	3	2.9	6th	2	3.2	3rd	10	3.0	11th
Lack of business supports services	2	1.2	11th	2	1.9	7th	2	3.2	3rd	6	1.8	15th
Deforestation	7	4.2	7th	4	3.8	5th	2	3.2	3rd	13	3.9	8th
Poor design of transitional beehive	4	2.4	10th	2	1.9	7th	2	3.2	3rd	8	2.4	13th
Illegal colony marketing	6	3.6	8th	3	2.9	6th	1	1.6	4th	10	3.0	11th
Poor farmers a wariness for adopting technologies	11	6.7	3rd	7	6.7	3rd	3	4.8	2nd	21	6.3	3rd
Hive product adulteration	6	3.6	8th	4	3.8	5th	2	3.2	3rd	12	3.6	9th
Honey bee diseases	6	3.6	8th	3	2.9	6th	2	3.2	3rd	11	3.3	10th

Source: Field survey, December-March, 2016/17, N= number of sampled respondents.

Table 12. Classification of the major honeybee plant species in the study area.

Honeybee plant species	Frequency	Percentage (%)	Ranks
Trees	26	27.4	1st
Shrubs	24	25.3	2nd
Herbs	11	11.6	4th
Grass	5	5.2	5th
Filed crops	18	18.9	3rd
Horticulture crops	11	11.6	4th
Overall	95	100.0	-

Source: Field survey, December-March, 2016/17.

challenge in the high land and low land agro-ecologies whereas it was identified as the second in mid land agro-ecology rather drought was ranked as the first major challenge in the mid land areas. On average, throughout the three agro-ecologies, drought were identified and ranked as the second major challenge of beekeeping practice and honey production in the study areas. However, this challenge was identified as the 1st impending factor of beekeeping practice in the low land and the mid land areas whereas it was the second in the highland areas in relation to agro-ecology. This result is similar to Teklu et al. (2016) as they reported that pest and predators, shortage of bee colony, lack of training/skill of beekeeper, high cost of bee hives, shortage of bee forage, lack of business support services, marketing, beekeeping materials/ equipments, chemical application, absconding, swarming, diseases and storage facility/post-harvest handling, etc, in descending order.

The sample beekeepers confirmed, as drought was a serious challenge in the low land area than other two agro-ecologies. Recurrent drought was observed in these areas from 2 to 3 times within each five years due to deforestation, caused by rapid population growth and overgrazing. The third major challenge which impeded the practice of beekeeping and honey production in the study area, was using pesticides and herbicides as indicated in Table 13. In relation to agro-ecology, agro-chemicals were highly used by farmers in the low land areas than the high land and mid land areas because farmers owned large farmland size and hence they used more herbicides to control weeds. They also used pesticides to control pests such as malaria, external parasites of sheep and goats, and to prevent crop pests.

Shortage of bee forage

Shortage of bee forage leads a devastating problem that retards the production and productivity of honeybee colonies especially during the drought period. This constraint is highly associated with lack of rainfall and insufficient availability of bee forage as stated by Malede et al. (2015). Taye et al. (2014) also justified that bee forage problem is directly related with deforestation of forest coverage for timber making, construction, firewood and expansion of agricultural lands, which occur especially during the dry season, and beekeepers migrate their bee colonies from their area to other for searching bee forage. Moreover, there are environmental changes in Ethiopia in terms of erratic rainfall patterns and deforestation that worsen the problems beekeeping sub-sector as reported in Oxfam (2008).

Absconding and migration

Absconding is anthor swarm activities pattern which is not a reproductive mechanism. The colony in its selected site subsequently experienec difficulties with ants or other pests, due to lack of water or even lack of food. Consquently bees leave their site for another or abandoned their hives at any season of the year for different reasons such as: lack of forage, incidenec of pest and preditors, during havesting, sanitation problem, bad weather condition and bee diseases as stated by Chala et al. (2012).

Potential of honeybee plant flora and their flowering calendar

As shown in Table 12, sampled respondents identified 95 species major honey bee plant species such as: trees, shrubs, field crops, herbs and horticulture crops in their environment. Among this honeybee flora; 26 species of tree, 24 species shrubs, 18 species of field crop, 11 herbs and field and 5 grass species have been found to be the dominant honey bee plants of the study area in a descending order.

The major sources of honeybee plants in terms of preference by honeybees and abundance from the tree

Table 13. List of honeybee plant species and flowering time.

Name of the honeybee plant species in the study area		Floral type	Source of (Pollen and Nectar)	Flowering calendar (month)
Local name (Agewugna)	Scientific name			
Tsalwa	Acacia asak	Trees	Pol/ Nec	April
Key Girar	Acacia seyal	Trees	Pol/Nec	May
Abiqa	Acacia tortolis	Trees	Pol/Nec	May
Firtata	Adanonia digitata	Trees	Pol/Nec	June
Sibqana	Albezia amara	Trees	Pol/Nec	May
Goza	Balanite aeqyptica	Trees	Pol/Nec	April
Shisha	Boscia anquistifolia	Trees	Pol/Nec	April
Wanza	Cordial Africana	Trees	Pol/Nec	May
Bahirzaf	Eucalyptus camaldlensis	Trees	Pol/Nec	May
Qundoberberia	Schinus molle	Trees	Pol/Nec	March
Dokima	Syzygium guinecs	Trees	Pol/Nec	April
Ekima	Terminalia glaucescens	Trees	Pol/Nec	April
Giba	Ziziphus spinachristi	Trees	Pol/Nec	September
Bisana	Croton macrostachyus	Trees	-	January to Feb
Sesbania	Sesbania sesban	Trees	-	January
Wareka	Ficus vasta	Trees	-	March
Endodo	Phytolacca dodecandra	Trees	-	January-March
Muja	-	Trees	-	August
Shola	Ficus	Trees	-	January-Feb
Koso	Hagenia abyssinica	Trees	-	October-Nov
Kitkita	Dodonea angustifolia	Trees	Pol/ Nec	Year round
Degta	Calpurnia aurea	Trees	-	October-Dece
Kokoba	Maytenus senegalensi	Trees	-	Nov-January
Girawa	Vernonia Spp.	Trees	-	Nov-January
Bisana	Croton macrostachy	Trees	-	March –April
Tid	Juniperus procera	Trees	-	Janua-March
Echileqana	Acacia brevispica	Shrubs	Pol/Nec	May
Gumarna	Acacia mellifera	Shrubs	Pol/Nec	May
Chiret	Agave sisalana	Shrubs	Pol/Nec	September
Malqoza	Asparagus Spp.	Shrubs	Pol/Nec	March
Mentese	Grandiflorum	Shrubs	Pol/Nec	July
Kushele	Echinops Spp.	Shrubs	Nectar	Spetember
Dedeho	Euclea shoperi	Shrubs	Pol/Nec	March
Kulqual.	Euphorbia Spp	Shrubs	Pol/Nec	March
Matta	Grewia villosa	Shrubs	Pol/Nec	July
Bahir kulqual	Opunitia Spp.	Shrubs	Pollen	June
Kentaftafa	Pterolobium stellatum	Shrubs	Pol/Nec	March
Enbacho	Rumex nervosus	Shrubs	Pol/Nec	March
Girawa	Vernonia Spp.	Shrubs	Nectar	April
Eret	Oleo berhana	Shrubs	-	Sept – Oct
Agam	Carissa edulis	Shrubs	-	Oct to Dec
Beles	Opuntia Spp.	Shrubs	-	April to June
Kalkalda	Euphorbia Spp.	Shrubs	-	Year round
Sensel	Justicia shimeriana	Shrubs	Pol/Nec	August
Gumero	Capparis micrantha	Shrubs	Pol/Nec	June
Teketila	Tapinanthus aurantias	Shrubs	Pol/Nec	September
Kichib	Euphorbia tirucalli	Shrubs	-	Year round
Azo harege	Clematis hirusta	Shrubs	-	March

Table 13. Contd.

Lucina	Leucaena lecucocephala	Shrubs	Pol/Nec	August-Sept.
Terilucern	Chamaecytisus prolifererus	Shrubs	-	Feb/June-July
Gomen zer	Brassica Spp,	Field crops	Pol/ Nec	September
Noug	Guizotia abyssinica	Field crops	Pol/ Nec	September
Selit	Sesamum indicum	Field crops	Pol/ Nec	August
Mashila	Sorghum bicolor	Field crops	Pol/ Nec	September
Bekiela	Vicia faba	Field crops	Pol/ Nec	September
Bekolo	Zea mays	Field crops	Pol/ Nec	August
Berbere	Capsicum annuum	Field crops	-	Sept-Nov
Telba	Linuum vsitatissiumum	Field crops	-	Sept-Oct
Zikakibe	Ocumum basilicum	Field crops	-	October
Duba	Pumpkin	Field crops	-	July-Oct
Abish	Trigonella foeniculum	Field crops	-	December
Tosign	Thymus schimperi	Field crops	-	July-Sept
Tenadam	Ruta chalepensis	Field crops	-	October
Meser	Lens culiaris	Field crops	-	January
Shembera	Cicer artietinum	Field crops	-	November
Shinkhrt	Allium cepa	Field crops	-	Year round
Teamatim	Lycopersicon esculentum	Field crops	Pol/Nec	Jun-Sept.
Teff	Teff ergoistatis	Field crops	-	Sept-Oct
Aluma	Achyranthus Spp.	Herbs	Pol/Nec	September
Adey ababa	Bidens Spp.	Herbs	Pol/Nec	August
Tej matebia	Hypoestes trifolia	Herbs	Pol/Nec	September
Aba timara	Ocimum bacilicum	Herbs	Pol/Nec	August
Dikuan tilla	Verbena officinalis	Herbs	Pol/Nec	July
Maget	Trifolium Spp.	Herbs	Nectar	August
Kessie	Lippie adoensis	Herbs	-	September
Gishra		Herbs	-	July-Sept
Feto	Lepidium sativan	Herbs	Pol/Nec	September
Yefyel	Plectranthus Spp.	Herbs	Pol/Nec	August
Tirunba	Zantadescha Spp	Herbs	Pol/Nec	September
Serdo	Cynodon dactylon	Grass	Pollen	August
Wariat	Digitaria abyssinica	Grass	Pollen	August
Senbelet	Hyparrhenia rufa	Grass	Pollen	August
Sar	Unidentified grass Spp	Grass	Pollen	August
Gorteb	Plantago Spp.	Grass	Pollen	August
Mango	Mangifera indica	Horticultural crops	Pol/ Nec	April
Avocado	Persea American	Horticultural crops	-	Sept.-Dec
Banana	Musa paradisca	Horticultural crops	-	Sept.- Oct
Muze	Mush x paradisiacal	Horticultural crops	-	Year round
Papaya	Carica papaya	Horticultural crops	-	February
Coffee	Buna	Horticultural crops	-	April-June
Lemon	Citrus Spp.	Horticultural crops	-	Sept-Oct
Cotton	Gossypium	Horticultural crops	-	Sept-Oct

Table 13. Contd.

Gesho	Rhamnus prinoides L.	Horticultural crops	Pol/Nec	Jun-July
Zeyitun	Psidium guijava	Horticultural crops	Pol/Nec	March

species were *Acacia asak, Terminalia glaucescens, Acacia seyal and Acacia tortolis.* In relation to shrubs like: *Grandiflorum, Acacia mellifera, Asparagus Spp., and Euclea shoperi* in descending order. Some of the field crop species for honey bee flora were *Sorghum bicolor, Zea mays, Ocumum basilicum, Guizotia abyssinica and Sesamum.* Other sources of honeybee forage were herbs like: *Hypoestes trifolia, Ocimum bacilicum, Bidens Spp.and Verbena officinalis,* etc, and other honeybee flora species types were grasses like *Cyndo dactylon, Hyparrhenia rufa, (Unidentified grass Spp.), Plantago Spp and Digitaria abyssinica,* in descending order as indicated in Table 13.

The respondents reported as all grass species provide only pollen whereas all tree, shrubs, herbs, field crops species identified provided both source of pollen and nectar for honeybee in their environment. This study was strongly agreed to by Abebe et al. (2014) who reported *A. tortolis, O. bacilicum, Becium grandiflorum, H. trifolia, Sorghum bicolor, Bidens spp., Guizotia abyssinica, Echinops Spp., Vernonia Spp.,Grewia bicolor, Brassica spp., Eucalyptus camaldlensis, Aloe berhana, Un-Identified spp., Acacia asak, Ziziphus spinacristi, Opuntia Spp., Acacia mellifera, Euphorbia Spp.* and *Acacia seyal* have been found to be the dominant honey bee plants of the study area.

In order to maximize honey production, the availability of potential flowering plants is the main parameter for an area to be considered as potential for beekeeping practice and honey production; however, the honeybee flora is diminishing from time to time in the study area due to the expansion of agriculture deforestation, soil erosion and rapid population growth. This finding agrees with the result of BOA (2016) that reported as the regions vegetation cover is quite small especially the high forest area was not greater than 5 % and hence in the region, there is high degradation of natural resource base, which demands strong conservation and rehabilitation efforts.

Major opportunities and potentials of honeybee production in the study area

There are many opportunities to increase the over all production of beekeeping in Waghimara Zone because the area has many opportunities and potentials for the production of honey. Some of these opportunities are the experience and the indigenous knowledge of the beekeepers, high demand of honey in the area and the attention given for this subsector. In addition, conducive agro-ecology and adaptation of the local honeybee races (*Apis mellifera monticola)* to the recurrent drought due to low tendency for reproductive swarming and migration are also important opportunities.

As indicated in Table 14, the first major opportunities and potentials of beekeeping practice and honey production in the study area was abundance of huge number honeybee colonies. Secondly, the availability of potential flowering plants like: *A. asak, T. glaucescens, Grandiflorum, A. mellifera, Asparagus, H. trifolia, O. bacilicun, Bidens spp, S. biccolor, Zeamays and O. basilicum.* Another major opportunity was high market demand for beehive products in the domestic market. High market price of honey triggered farmers to engage in beekeeping practice. The fifth ranked potential and opportunity for beekeeping practice and honey production was high soil, water conservation, water shed practice and area enclosure. This created good opportunity for the growth of bee plant flora especially in the high land and mid land agro-ecologies. Sampled beekeepers reported that water shed practice and area enclosure could be used as job opportunities for organized youth groups to engage in beekeeping practice. The sixth ranked major opportunity and potential of beekeeping practice and honey production in study area was its socio-economic value because honey is used for different socio-economic values such as source of income to cover various household expenditures; for medicine, consumption, different cultural and ritual ceremony.

The seventh ranked major opportunity and potential of beekeeping practice was presence of government organisations (GOs) and NGOs who were involved in beekeeping practice, for instance, they supplied credit service in cash, beehive, bee colony, bee equipments and they gave short term training on beekeeping practice especially to the adult females and youth. The eighth ranked major opportunity was the availability of micro financial institutions for small-scale credit facility like the (ACSI) which give credit service to farmers in form of cash.

In addition to this, beekeeper had their own indigenous knowledge like: their own swarm controlling mechanisms providing supplementary feed at times of drought season. There is also the development of infrastructures in the

Table 14. Major opportunities of beekeeping to identify by the respondents.

Variable	Study area									Over all (N-332)		
	HL (N=165)			ML(N=105)			LL (N=62)			Frequency	Percentage (%)	Ranks
	Frequency	Percentage (%)	Ran	Frequency	Percentage (%)	Ran	Frequency	Percentage (%)	Rank			
Abundance of huge number of honeybee colonies	20	12.1	1st	12	11.4	1st	9	14.5	1st	41	12.3	1st
Availability of potential flowering plant	18	10.9	2nd	9	8.6	3rd	8	12.9	2nd	35	10.5	2nd
Water availability	17	10.3	3rd	8	7.6	4th	6	9.8	4th	31	9.3	3rd
Indigenous beekeepers knowledge	14	8.5	6th	6	5.7	6th	4	6.5	6th	24	7.2	8th
Market demand for beehive products	15	9.1	5th	7	6.7	5th	7	11.3	3rd	29	8.7	4th
Establishment of livestock and fish resources department office	7	4.2	11th	6	5.7	6th	2	3.2	8th	15	4.5	10th
Presence of GOs and NGOs who are involved in beekeeping activities	13	7.9	7th	7	6.7	5th	5	8.1	5th	25	7.5	7th
High soil and water conservation practice and area enclosure	16	9.7	4th	8	7.6	4th	4	6.5	6th	28	8.4	5th
Beekeeping experience of the farmer	10	6.1	9th	6	5.7	6th	3	4.8	7th	19	5.7	9th
Availability of tourists in the area	6	3.6	12th	4	3.8	8th	2	3.2	8th	12	3.6	12th
Road construction	5	3.0	13th	8	7.6	4th	2	3.2	8th	15	4.5	10th
Availability of micro-finance institution for small scale credit facility like (ACSI)	9	5.5	10th	5	4.8	7th	3	4.8	7th	17	5.1	8th
Availability of queen rearing center in Sekota Dry Land Agricultural Research Center	3	1.8	14th	9	8.6	3rd	2	3.2	8th	14	4.2	11th
Socio economic value	12	7.3	8th	10	9.5	2nd	5	8.1	5th	27	8.1	6th

area for easy access of beehive products and to get beehive inputs easily. Another opportunity of the study area is the presence of research area in nearby Sekota Dry Land Agricultural Research Centre (SDLARC) who is involving in queen rearing practice and studying the major constraint of the beekeepers in the locality. The institute also provides training to beekeeper farmers, bee experts and technicians and also supplied different beekeeping inputs or equipments or materials to improve beekeeping practice and honey production. Furthermore, it has the role of disseminating new techniques to beekeeper farmers like splitting and queen rearing techniques as indicated in Table 14.

In line with this, Atsbaha et al. (2015) reported that the major opportunities for bee keeping are: existence and abundance of honeybee, availability of potential flowering plants, availability of water sources for bees, beekeepers experience and practices, land rehabilitation and credit availability. In general, based on the beekeeper response, key informant and participants in the focus group discussion confirmed that the study area has ample opportunities and potentials for beekeeping practice and honey production, however, the expected output from this subsector has not been exploited yet due to various challenges and problems stated in this study (Table 11).

CONCLUSIONS

It can be concluded that beekeeping in Abergell, Sekota and Gazgibala districts contribute a great deal to the household welfare in terms of income generation. Beekeeping activities in the study area is the third income generation tasks next to crop and livestock production. The area is suitable for honeybee production because of availability of honeybee colony, different bee forages in different season and better experience in rearing beekeeping. Various constraints have been bottleneck to exploit the untapped potential of bee keeping in the study area. The major ones are lack of rain fall due to consecutive drought in

the area, lack of bee forage associated with deforestation, prevalence of pest and predators, shortage of water, poor farmers awareness and indiscriminate agrochemical utilizations, and shortage of beekeeping equipment were reported by the respondent households as the most important constraints of honey production in the districts. Regardless of availability of constraints, beekeeping was found to have a number of opportunities which demands for the sub-sector to be encouraged in the study area. Based on the results of this study, the following recommendations are forwarded for improving beekeeping activities in the study areas.

RECOMMENDATIONS

(1) Designing effective honeybee pests and predators controlling methods.
(2) Introduction of full package improved beekeeping technologies with adequate practical skill training on all bee keeping trends and queen rearing practices on which farmers get and enhance a bunch of queens and new colonies
(3) The awareness of the farmers should be improved by different training activities and it is essential to establish strong linkage between the farmers, the development agents and the research institutions.
(4) Providing sufficient beekeeping equipments and credit also increases the farmers involvement in beekeeping practices.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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