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INVESTIGATING THE CAUSES OF HONEYBEE COLONY MOBILITY IN CENTRAL RIFT VALLEY OF OROMIA, ETHIOPIA

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Abstract: The study was conducted in three districts of Oromia Regional State with the objective to assess the reasons of honeybee colony mobility. Purposive sampling technique was employed to select the districts that represent the three agro-ecologies of the region. A total of 120 beekeepers were selected and individually interviewed using pre-tested semi-structured questionnaire. Key informant interviews and Focus group discussion were used to support interpretation of the interview data. The survey data were performed with the aid of Statistical Package for Social Sciences (SPSS version 20). Simple descriptive statistics were employed in order to have a summary description of the data. The study finding revealed that the mean age of the beekeepers was 46.54 years. The beekeepers had an average experience of 5.76 years where male respondents 89.2% take the largest share to be engaged in beekeeping activities. Beekeeping sector of the area is constrained by pests and predators 16.9%, shortage of bee forage 12.8%, shortage of water 10.4%, unwise application of agrochemicals 9.3%, recurrent drought and deforestation (8.1%), poor hive management 7.4%, high cost of honeybee equipments and accessories 7%, honeybee colony absconding or migration 6.2%, shortage of colony 6.1%, lack of knowledge 5.7%, poor extension services 5.2% and inadequate of business support services 4.9%. The result further revealed that the main causes of colony absconding were pests and predators, shortage of forages, poor hive manipulation, indiscriminate application of agrochemicals, shortage of water, bad weather condition, in appropriate honey harvesting technique were the most prominent and significant causes of colony absconding in the area with responses of 21.2%, 18.4%, 16.3%, 13.9%, 11.9%, 8.1% and 5.4% respectively. Colony absconds had been a major problem confronting beekeepers which had led to total loss or reduction in production of honey and other honeybee products. Thus, to benefit beekeepers from the sector, due attention should be given to solve these constraints.

Keywords: Absconding, Constraints, Honeybee, Colony mobility, Pests, Swarming

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INTRODUCTION

Beekeeping is environmentally sustainable activity that can be integrated with agricultural practices like crop production, animal husbandry, horticultural crops and conservation of natural resources. Thus, it would be one of the most important intervention areas for sustainable development of poor countries like Ethiopia (Gibbon, 2001). Beekeeping plays a major role in socioeconomic development and natural renounces conservation and pollination. Beekeeping provides nutritional, economic and ecological security (Masuku, 2013) and also requires less land, capital and does not take much part of the farmers' time and does not compete with other farming systems for resources (Meaza, 2010). Ethiopia is home to most diverse flora and fauna in Africa. The

forests and woodlands contain diverse plant species that provide surplus nectar and pollen to foraging bees (Kangave *et al*., 2012). These resources coupled with variable climate, huge water resources and other favorable ecological factors enable the country to sustain ten million bee colonies (Alemayehu, 2011). The ideal climatic condition and diversity of floral resources allow the country to sustain around 10 million honeybee colonies, of which 7 million are kept in local beehives under farmers' management condition and the remaining exist in the forests as wild colonies, which makes the highest bee density country in Africa (Nuru, 2002). Having such large resources, the annual honey and beeswax production is estimated around 500,000 and 50,000 tons respectively, however, currently production is limited to 53.7 thousand tons per annum (MoA and ILRI, 2013). Despite the long tradition of beekeeping in Ethiopia, 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 sub sector in the GDP has never been proportionate with the huge numbers of honeybee colonies and the country's potentiality for beekeeping. Productivity is still low, leading to low utilization of hive products domestically and relatively low export earnings. However, like any other livestock sector, this sub sector has been seriously devastated by complicated constraints. One of the prominent factor is migration or seasonal colony absconding.

Migration is unique to tropical honeybee races and may result in movement of 15-100% of all colonies during certain times of the year. However, colonies occupying the same area and experiencing the same weather condition and potentially the same foraging environment can vary greatly in their migration behavior (Schneider, 1990). There are two types of absconding, namely, seasonal absconding or migration and chronic disturbance. Migration or seasonal absconding involves the movement of a whole colony due to resources depletion; declining nest and site (hive) quality. Seasonal absconding involves a period of time prior to moving, when foraging, honey and brood levels are reduced. No such preparation occurs before disturbance absconding (Visscher and seeley, 1982). Temperate Apis millefera, especially wild colonies, may abscond in response to the same reasons as tropical honeybees due to depleting resources and starvation, predation, disturbance, adverse environmental conditions and diseases/parasitism (Koeniger and Koeniger, 1980). Colony migration (seasonal absconding) and Reproductive swarming has a negative effect on honey production since it decreases the honeybee population in the hive. When a colony absconds, the entire colony leaves the hive including all the workers and the queen. This consequently, led to loss of income and sometimes negative profit on the part of the beekeepers (Abebe *et al*., 2016). In the study area, there is no much detailed documented information on the prominent cause of colony absconds. Therefore, the need to study the various parameters that could influence colony absconds and the corresponding management strategies that would reduce this absconding menace becomes a necessity.

EXPERIMENTAL

Study area

The study was conducted in Adami Tulu, Arsi Negele and Kofale districts of Oromia Regional State. The districts were selected based on their potential for beekeeping; representing three agro-ecologies (low altitude, mid altitude lands and high altitude areas). Kofale district is located in West Arsi Zone of the Oromia Regional State about 305 km from Addis Ababa towards Southern direction. The district lie between latitude and longitude of 70 00" N 380 45 E/ 7 N 38.750 E. The annual average rainfall of area is about 1232 mL with a mean monthly rainfall of 102.6 mL. The mean monthly minimum and maximum temperatures are about 5.40C and 19.80C, respectively (OFEDO, 2009). Arsi Negele district is also located in west Arsi zone about 225 km south of the Addis Ababa. Geographically, it is situated in the Ethiopian central rift valley system of 7^0 09'-7^0 41' N and

38^0 25'-38^0 54' E. The annual temperature varies from 10-25°C with annual rainfall between 500-1000 mm. The district lies between 1500-3000 m above sea level. Adami Tulu Jido Kombolcha district is located in East Shoa Zone about 167 km south of Addis Ababa. The district is geographically located at latitude of 70 50' North and longitude of 380 42'E. The District land mass lies between 1500-2000 m above sea level altitude.

Data Source and Sampling Techniques

Data used for the study were collected from primary and secondary sources. Secondary data were collected from past journals, conference proceedings and textbooks. Primary data were collected through direct personal interview and well-structured questionnaire to obtain pertinent information on socio-economic characteristics of beekeepers and the perceived causes and effect of colony absconds on their beekeeping business. Key informant interviews, field observation and focus group discussion were also used to support interpretation of the interview data. Multistage sampling was used to administer 120 copies questionnaire to practicing beekeepers in the study area. The three (3) districts were selected purposively considering different agro-ecology, vegetation potential, honeybee colonies potential and accessibility to the road. Then, two (2) rural kebeles (PAs) were selected from each district using purposive sampling technique based on ecological zones where honey productions were prominent. From each PA 20 beekeepers and a total of 120 beekeepers were selected from identified honey producer farmers using systematic random sampling technique. Due to heterogeneity of the population beekeepers the sample size was determined according to Thrusfield (2005) with 95% confidence interval and 5% absolute precision.

$$N = \frac{1.96^2 \, Pexp \, (1-Pexp)}{d^2}$$

Where,

N=required sample size

Pex = expected prevalence=50%

d^2 =desired absolute precision=5%

Data management and Aanalysis

The collected data were coded, managed and performed with the aid of Statistical Package for Social Sciences (SPSS version 20). Descriptive statistics involved the use of mean, percentages and frequency distribution to analyze age, educational level, beekeeping experience, number of hives and perceived causes of colony absconds.

RESULTS AND DISCUSSIONS

Socio-Economic Characteristics

Results in Table 1 showed that 89.2% of the respondents were male while 10.8 % were only female. About 91.7%t were married with only 5.8% being single. These showed that apiculture business was mainly dominated by male gender and married people in the study area. This could be due to the fear that women have for bee stings. Moreover, female cannot climb up big trees and hence discouraged to engage in the activity. The result of the majority being married indicated that apiculture business was dominated by responsible and matured people who could take decisions jointly with their spouses on their beekeeping business. Educational level of the farming households may have significant importance in identifying and determining the type of development and extension service approaches. Regarding the level of education, 35 percent of those interviewed beekeepers did not receive any formal or informal education. The rest were at different stages of literacy ranging from reading and writing skills to completion of college diploma and above (Table 1). The high literacy level of majority of the respondents would have implications on adoption of improved honey production techniques and consequently on their productivity because adoption of technology had been shown to have positive correlation with education attainment.

Table 1. Socio-economic characteristics of the respondents (N=120)

Parameter	Frequency	%
Sex of respondents		
Male	107	89.2
Female	13	10.8
Educational status		
Illiterate	42	35
read & write	24	20
Grade1-4	20	16.7
Grade 5-8	18	15
Grade 9-12	12	10
Diploma & above	4	3.3
Marital status		
Single	7	5.8
Married	110	91.7
Divorced	3	2.5

Beekeepers who involved in honey production had an average age of 46.54 years with an average experience of 5.76 years (table 2). This survey result showed that people in the most productive age are actively engaged in beekeeping activities. Peoples in the aforementioned age do have the skill & strength to climbing big trees and uplift the hive to hang on branches of big trees. Similarly, a study conducted in Tigray region by Tezera (2013) noted that the age group between 15 and 60 years are considered economically active age group and majority of households in younger age were more likely be energetic in beekeeping activities. The average family size of the sample farmers in the study area was 6.24 persons, with minimum and maximum family size of 1 and 12 persons, respectively. The level of beekeepers' experience was taken to be the number of years that an individual was continuously engaged in beekeeping. This is what one would expect in a situation where people are actively engaged starting from an early age in helping older beekeepers to undertake basic tasks. The mean land holding per the respondents' household was estimated to be 1.58 ha.

Beekeeping practices in the Study area

Ownership Status of Beehive

Out of the total interviewed respondents, about 52% household heads owned traditional hive followed by transitional hive 12.5%, both traditional and transitional hives 11.7%, all the three types of hives 9.2%, movable frame hive 8%, transitional and movable frame hives 6.6% respectively (Table 3). In the study area beekeeping is predominated by traditional production systems since the majority of the respondents hardily understand new technologies. This finding is definitely different from national beehive usage status *i.e.* 95% of the beekeepers are traditional beehive owners but the rest are modern and transitional beehives owners (CSA, 2013). The current study was in agreement with Beyene and David (2007) who reported traditional, intermediate and modern beehives are used for honey production in Ethiopia. Traditional beehive can be prepared by beekeepers from locally materials. According to the survey results beekeepers preferred to use traditional beehive for its simplicity to prepare, high amount of wax yield, less costly, required less inputs and used as bait swarming. According to respondents, transitional is ideal for its better quantity and quality of honey and requirement of little knowledge and accessories materials. On the other hand, modern beehive is better for its better quantity and quality of honey and appropriate for honey harvesting. However, it is too expensive, requires skilled man power and accessories.

Honey yield from different types of beehive

As shown below in (Table 4), the average honey yield obtained from traditional, transitional and frame per hive per year were 5.7 kg, 12.2kg and

18.7 kg in the study area, respectively. This survey result was agreeing with the national average of 5 kg (Gezahegn, 2001 and EARO, 2000), 12-15 kg and 15-20 kg (MOA, 2003) for traditional, intermediate and movable frame hives, respectively.

Honey production trends in the study area

Most beekeepers of respondents 88.6% observed decreasing trends honey production due to shortage of bee forages, colony absconding, decreasing in the number of bee colonies, drought, pesticides and herbicide application, lack of water, lack of improved bee hives and poor management and in order of importance. This result agrees with the results of Tessega (2009) who stated that honeybee products production in Bure district was in a decreasing trend due to shortage of bee forages, drought, pesticides and herbicides application, lack of water and poor management.

Table 2. Age, experience, family size and land holding of respondents

Socio-economic indicators	N	Min	Max	Mean	S.D
Age of house hold (year)	120	22.00	72	46.54	1.87
Beekeeping experience (year)	120	1.00	40	5.76	1.96
Family size (#)	120	1.00	12	6.24	2.42
Land holding (hectare)	120	0.25	10	1.58	2.00

N= number of respondents, SD=standard deviation

Table 3. Beehive ownership by beekeepers in the study area

Types of hive owned	N	%
Traditional beehive only	62	52
Transitional beehive only	15	12.5
Both traditional and transitional	14	11.7
All the three types of hives	11	9.2
Modern beehive only	10	8
Both transitional and modern hives	8	6.6

Table 4. Average of honey yields from different hive types in the study area

Districts	Honey yield (kg)/hive /year		
	Traditional hive	Transitional hive	Frame hive
	Mean±SE	Mean±SE	Mean±SE
Adami Tulu	4.2±0.37	9.46± 0.12	16.2±1.53
Arsi Negele	5.7±1.70	12.7±1.25	18.4±0.12
Kofale	7.3±0.57	14.5±0.65	21.5±0.14
Overall mean	5.7±0.76	12.2±1.3	18.7± 1.08
P-value	P>0.05	P<0.05	P<0.05

Table 5. Trend in honey production from traditional, transitional and frame hives during 2014-2018

Year	Traditional hive	Transitional hive	Framed hive
	honey yield in (kg)	honey yield in (kg)	honey yield in (kg)
2014	2181	279	202
2015	1464	184	162
2016	1553	122	220
2017	1337	103	161
2018	1274	72	128

Sources and Placement of Honeybee in the Study area

Out of the total interviewed respondents, about 64.2% of the respondents replied that they have got their initial colonies by catching swarms followed by gift from parents and catching swarms 17.7%, through inheritance 6.5 %, gift from parents 5.7%, purchased 3.3%, given by government and none governments 2.6% (Table 6). The study results agree with (Gebretsadik and Negash, 2016; Kinati *et al.,* 2012) who reported that catching swarm was the dominant

source of honeybee colonies in the different parts of Ethiopia. The study result also revealed that about 48.4% of the respondents kept their honeybee colonies in the backyard of the house followed by under the roof of the house 27.7%, hanged on the trees near home stead 14.8%, hanged in the forest away from home stead 4.7% and kept in the areas of enclosure 4.4%. This result is in line with the finding of Seyoum *et al*. (2018), who reported that most beekeepers placed their honeybee colonies at backyard in different parts of Ethiopia.

Honeybee colony inspection

Sample respondents were interviewed to describe the frequency of inspecting their apiary and honeybee colonies. Majority 38.5% of the respondents replied that they inspect their honeybee colonies externally if necessary followed by at every month 22.7%, every fifteen days 17.6%, every week 15.7%, and every day 5.5% respectively (Table 7). Moreover, about 48.6% of the respondent replied that they inspect their honeybee colonies internally if necessary followed by at every month 27.5%, every fifteen days 14.7% and every week 9.2% respectively. The study in line with the finding of Getachew (2018); Haftu and Gezu (2014); regarding to internal inspection of their bee colonies, large number of respondent beekeepers (79.3%) of them reported as they inspected not at all except during honey harvesting. Correspondingly, Gebretsadik *et al. (*2016) reported that beekeepers do not inspect hive internally unless to check either the hive was filled with honey or not.

Absconding of Honeybee colonies

According to the study result, about 83.2% of the respondents reported absconding of their honeybee colonies. With the absconding incidence occurred 43.1%, 21.8%, 19.3% and 15.8% from December to February, March to May, November to September and June to August respectively (Table 8). The cause of high absconding in the months from December to February could be associated with the scarcity of bee forages and water in the area. the possible reasons behind could be pests and predators 21.2%, shortage of honeybee forages 18.4%, poor hive manipulation 16.3%, indiscriminate application of agrochemicals 13.9%, shortage of water 11.9%, bad weather condition 8.1%, in appropriate honey harvesting techniques 5.4% and unknown reasons 4.8% were the causes of colony absconding. The present study is in line with Chala *et al*. (2012) who reported similar reasons for absconding in Goma district. The respondents also indicated that honeybee colonies could abscond or migrate as a result of incessant disturbance or poor apiary maintenance. Since, honeybees lived a well-organized and sophisticated life; it is therefore evident that any activity that tends to affect such organized life usually led to their migration to another peaceful area where they could continue their original or planned life.

Control Mechanism of Honeybee Colony Absconds

To reduce and control absconding, respondent beekeepers have different experiences such as avoided the use of pesticides and herbicides 17.4%, close supervisor of colonies 16.5%, provision of supplementary feed and water 15.3%, avoid total removal of all honey combs during honey harvesting time 14.2%, planting of flowering plants near apiary site 12.2%, use queen excluder at hive entrance 10.4%, colony inspection regularly 8.4% and cleaning apiary site 5.6%.

Estimation of financial loss due to Honeybees Absconding in the study area

There was financial loss due to absconding of honeybees from traditional, transitional and framed hives. A total of 758 traditional, 112 transitional and 78 modern beehives were without honeybee colonies due to absconding (Table 10). The mean honey yield of traditional hive per year is 5kg multiplied by 758 give 3790kg. The mean honey yield of transitional hive per year is 15kg multiplied by 112 give 1680kg. The mean honey yield of modern hive per year is 25kg multiplied by 78 give 1950kg. Mean price of one kg honey during the study year, 2018/9 is 200 birr.

Honeybee Colony Swarming and Control Mechanisms

The study revealed that about 62.4% of the respondents in the study area explained that they had reproductive swarming in their apiary while the remaining 37.6% had no know about swarming. According to the survey result the frequency of swarming of honeybee colonies in the study area were every year 65.3%, every season 22.5% and once in two years 12.2%. Most of the respondents reported to use many ways of controlling reproductive swarming among which use large volume of hive 33.2%, suppering of hive 24.4%, removal of queen cells 18.3%, killing new emerged queen 13.5% and swarming return back to the colony 10.6%. The finding was in agreement with Tessega (2009) who indicated that the most widely used method of controlling reproductive swarming by beekeepers of Bure district of Amhara region were removal of queen cell, killing queen of the swarm and reuniting of honeybee colony to its mother, supporting and use large volume of hive as colony increase.

Table 6. Means of colony getting and placement of honeybee in the sub-districts Adami Tulu (n=40), Arsi Negele (n= 40) and Kofale (n=40)

Sources of bee colony	Adami Tulu n(%)	Arsi Negele n(%)	Kofale n(%)	Total n(%)
Catching swarms	27(68.1)	19(48.2)	22(55.3)	77(64.2)
Gift from parents and catching swarms	4(10.2)	7(17.1)	5(12.2)	21(17.7)
Inheritance	3(7.3)	4(10.5)	2(5.1)	8(6.5)
Gift from parents	2(5.4)	5(13.1)	6(16.2)	7(5.7)
Purchased	2(5.2)	3(7.2)	2(4.8)	4(3.3)
Given by government and NGOs	2(3.9)	2(4.3)	3(6.4)	3(2.6)
Placement of honeybee colonies				
In the backyard	23(56.5)	20(49.8)	16(41.2)	58(48.4)
Under the roof of the house	10(26.2)	10(24.2)	13(31.5)	33(27.7)
Hanging on the trees near home stead	4(10.6)	7(18.4)	6(15.4)	18(14.8)
Hanging in forest away from home stead	1(2.5)	2(5.1)	3(6.4)	6(4.7)
In areas of enclosure	2(4.2)	1(2.5)	2(5.5)	5(4.4)

Table 7. External and internal hive inspection frequency by sample respondents (N=120)

Inspection frequency	Internal inspection n(%)	External inspection n(%)
Every day	-	7(5.5)
Every week	11(9.2)	19(15.7)
Every fifteen day	18(14.7)	21(17.6)
Every month	33(27.5)	27(22.7)
If necessary	58(48.6)	46(38.5)

Table 8. Causes and seasons of honeybee colony absconding in the sub-districts Adami Tulu (n=40), Arsi Negele (n= 40) and Kofale (n=40)

Variable	Adami Tulu n(%)	Arsi Negele n(%)	Kofale n(%)	Total n(%)
Occurrence of absconding				
Yes	35(87.4)	34(85.7)	31(78.3)	100(83.2)
No	5(12.6)	6(14.3)	9(21.7)	20(16.8)
Causes of colony absconding				
Incidence of pests and predators	10(24.5)	6(16.2)	8(21.2)	25(21.2)
Shortage of honeybee forages	6(15.2)	8(20.3)	10(23.8)	22(18.4)
Poor hive manipulation	6(15.1)	7(17.4)	7(18.3)	20(16.3)
Unwise application of agrochemicals	5(13.4)	6(15.2)	5(12.5)	17(13.9)

Shortage of water	7(17.5)	5(11.5)	2(5.6)	14(11.9)
Bad weather condition	3(7.6)	4(9.4)	3(7.2)	10(8.1)
Improper harvesting method	2(4.2)	2(5.4)	3(6.3)	6(5.4)
Unknown reasons	1(2.5)	2(4.5)	2(5.1)	6(4.8)
Seasons of colony absconding				
December to February	19(46.5)	17(42.4)	16(40.5)	52(43.1)
March to May	7(18.6)	9(23.6)	9(23.1)	26(21.8)
September to November	9(21.7)	7(17.5)	8(18.8)	23(19.3)
June to August	5(13.2)	7(16.5)	7(17.6)	19(15.8)

Table 9. Control methods of honeybee colony absconding in the sub-districts Adami Tulu (n=40), Arsi Negele (n= 40) and Kofale (n=40)

Parameter	Adami Tulu n(%)	Arsi Negele n(%)	Kofale n(%)	Total n(%)
Avoid the use of chemicals near apiary site	5(11.3)	7(18.2)	8(18.8)	21(17.4)
Close supervision of colonies	7(17.2)	9(21.5)	3(8.2)	20(16.5)
Provision of supplementary feed and water	6(15.7)	5(12.6)	7(17.2)	18(15.3)
Avoid total removal of all honey combs during honey harvesting time	5(12.2)	7(17.8)	6(15.4)	(1714.2)
Planting of flowering plants near apiary site	7(17.4)	4(10.4)	4(9.1)	15(12.2)
Putting queen excluder at hive entrance	5(12.2)	3(7.6)	5(13.5)	12(10.4)
Colony inspection regularly	3(8.5)	3(6.7)	4(10.3)	10(8.4)
Cleaning apiary site	2(5.5)	2(5.2)	3(7.5)	7(5.6)

Table 10. Estimation of financial loss due to colony absconding in the study area

Hive type	Number of colony absconded	Total honey loss in (Kg)	Amount of money loss in (ETB)
Traditional	758	4320.6	864,120
Transitional	112	1680	336,000
Modern	78	1950	390,000

Table 11. Occurrence, frequency and prevention methods of reproductive swarming in the sub-districts Adami Tulu (n=40), Arsi Negele (n= 40) and Kofale (n=40)

Parameter	Adami Tulu n(%)	Arsi Negele n(%)	Kofale n(%)	Total n(%)
Occurrence of swarming				
Yes	19(47.6)	26(64.8)	29(72.5)	75(62.4)
No	21(52.4)	14(35.2)	11(27.5)	45(37.6)
Frequency of swarming				
Every year	23(56.7)	26(64. 5)	29(71.7)	78(65.3)
Every season	10(24.7)	9(22.4)	9(22.5)	27(22.5)
Once in two years	7(18.6)	5(13.1)	2(5.8)	15(12.2)
Seasons of swarming				
September to November	25(62.6)	7(16.7)	23(58.5)	58(48.5)
December to February	3(7.4)	21(52.3)	9(23.4)	32(26.7)
June to August	9(22.7)	7(18.6)	6(14.3)	20(16.5)
March to May	3(7.3)	5(12.4)	2(3.8)	10(8.3)
Control methods				
Use large volume of hive	14(35.4)	12(29.6)	13(32.4)	40(33.2)
Supporting of hive	10(25.6)	10(24.4)	11(26.5)	29(24.4)
Removal of queen cells	6(15.2)	7(18.7)	7(18.3)	22(18.3)
Kill new emerged queen	3(7.5)	6(15.8)	3(8.6)	16(13.5)
Return back to the colony	7(16.3)	5(11.5)	6(14.2)	13(10.6)

Major constraints of beekeeping in the study area

The major constraints of beekeeping in the study area were pests, predators and Diseases 16.9%, shortage of bee forage 12.8%, absconding and migration of honeybee colony 10.4%, agrochemical poisoning 9.3%, recurrent drought and deforestation 8.1%, poor hive management 7.4%, high cost of honeybee equipments and accessories 7%, lack of knowledge 6.2%, shortage of water 6.1%, shortage of bee colony 5.7%, poor extension services 5.2% and inadequate of business support services 4.9%. The current study result was in line with Beyene *et al.,* (2014), Gebretsadik *et al.* (2016), Seyoum *et al.* (2018) who reported that lack of bee forage, honeybee pests and predators and agro-chemicals are the major constraints of beekeeping in all regions of Ethiopia while the level of rank are varied from place to place.

Major honeybee pests and predators

According to the response of beekeepers, the most pests and predators affect bees in the study area were ants 21.8%, wax moth (*Galleria mellonella*) 14.4%, honey badger (*Mellivora capensis*) 13.9%, small hive beetles (*Aethina tumida*) 10.1%), spiders 9.2%, bee-eater birds 9%, lizards 8.5%, snake 7.5%, bee lice (*Braula coecal*) 5.6% Table 13). The current study result was in line with Shenkute *et al*. (2012) also reported that the major honeybee enemies found in Keffa, Sheka and Bench-Maji zone are ants, honey badgers, birds and small hive beetles. Similar findings were reported by Brad (2002) revealed ants, honey badgers, bee-eater birds and wax moth devastate honeybee colonies and products especially during periods of dearth in Gondere province in Ethiopia.

Traditional methods of controlling honeybee predators and pest

Beekeepers practice different control methods to overcome problems of pests and predators of honeybee. Respondents were asked how traditionally to control these pests and predators in their locality and most of the respondents responded positively replied how they were protecting their beehives from most of pests and predators. Accordingly, in the study area the indigenous knowledge of beekeepers used were summarized in Table 14, but this result needs to be proven scientifically by researchers in order to fully benefits the beekeepers from this Apiculture sub-sector.

Table 12. Major constraints of beekeeping in the sub-districts Adami Tulu (n=40), Arsi Negele (n= 40) and Kofale (n=40)

Constraints	Adami Tulu n(%)	Arsi Negele n(%)	Kofale n(%)	Total (%)	Rank
Honeybee pests, predators and Diseases	6(15.4)	7(18.2)	7(17.2)	16.9	1st
Shortage of bee forage	5(13.4)	5(13.2)	5(11.7)	12.8	2nd
Shortage of water	4(10.3)	3(8.5)	5(12.4)	10.4	3rd
Agrochemical poisoning	3(8.2)	5(11.3)	3(8.5)	9.3	4th
Recurrent drought and deforestation	3(7.2)	4(8.8)	3(8.3)	8.1	5th
Poor hive management	3(7.3)	2(5.5)	4(9.4)	7.4	6th
High cost of honeybee equipments and accessories	4(8.8)	3(7.4)	2(4.6)	7	7th
Honeybee colony absconding	2(5.8)	2(5.4)	3(7.5)	6.2	8th
Shortage of bee colony	4(9.1)	2(4.5)	2(4.6)	6.1	9th
Lack of knowledge	2(6.2)	2(5.4)	2(5.6)	5.7	10th
Poor extension services	2(3.8)	3(7.5)	2(4.3)	5.2	11th
Inadequate of business support services	2(5.2)	2(4.1)	2(5.5)	4.9	12th

Table 13. Proportion and ranks of major honeybee pests and predators in the sub-districts Adami Tulu (n=40), Arsi Negele (n= 40) and Kofale (n=40)

Pests and Predators	Adami Tulu n(%)	Arsi Negele n(%)	Kofale n(%)	Total n(%)	Rank
Ants	9(22.4)	10(24.6)	7(18.4)	26(21.8)	1st
Wax moth	6(16.2)	6(14.5)	5(12.4)	17(14.4)	2nd
Honey badgers	5(12.5)	3(8.7)	8(20.5)	17(13.9)	3rd
Small hive beetles	3(7.3)	5(12.5)	4(10.6)	12(10.1)	4th
Spiders	4(9.5)	5(11.5)	3(6.5)	11(9.2)	5th
Bee-eater birds	4(9.6)	3(8.6)	4(8.8)	11(9)	6th
Lizard	3(7.4)	3(7.6)	4(10.6)	10(8.5)	7th
Snake	4(10.5)	2(5.5)	3(6.4)	9(7.5)	8th
Bee lice	2(4.6)	3(6.5)	2(5.8)	7(5.6)	9th

Table 14. Traditional methods of controlling honeybee pests and predators by beekeepers

Pests and predators	Seasons of serious damage	Traditional control methods
Ants	Year-round	Frequent smoking, plastering hive stand with plastic, using local olum Africana/eucalyptus leaf for fumigation, daily follow up and using hot water, using ash, destroying ants nests, killing the queen of ant and smooth iron sheets
Wax moth	Winter	Cleaning the apiary site, cleaning old comb, make colony strong, seasonal management and daily follow-up
Bee lice	Year-round	Cleaning the apiary and make the colony strong
Hive beetles	Winter and autumn	Cleaning the apiary, narrowing the hive entrance, kill and seasonal management
Spiders	Year-round	Make narrow hive entrance, cleaning the apiary, removing of spider's web, killing and follow up
Lizard	Year-round	Removing their nesting site and killing
Snake	Year-round	Clean apiary and killing
Birds	Year-round	Placing the seeming image of human near the hives using cloth, plastics, using stone
Honey badger	Year- round	Use of smooth iron sheet on hive stand, putting barriers, fencing with thorny plants, hanging hives by rope on long trees and chasing with dogs

CONCLUSION

Beekeeping in the study area was dominated by male and females are not encouraged to involve in beekeeping activities and their participation also very limited. The age characteristics of respondents indicated that most of the respondents had the mean age of 46.54 years, which shows that majority of households in younger age and more likely be energetic in agriculture activity in general and beekeeping activities in particular with higher illiteracy level. Majority of the beekeepers had an average experience of 5.76 years and most of the beekeepers got their colony through catching swarm. Majority of beekeeper respondents (48.6%) they were not inspecting internally at all except honey harvesting time. the major constraints affecting the honey sub sector in the study area were bee pests and predators, shortage of bee forage, agrochemical poisoning, absconding and migration of honeybee colony, shortage of bee colony, high cost of honeybee equipments and accessories, recurrent drought and deforestation, shortage of water, lack of appropriate knowledge, poor extension services, poor hive management, inadequate of business were the major constraints affecting the honey sub sector in the study area. Pests and predators of honeybees are protected by implementing traditional means. Colony absconds had been a major problem confronting beekeepers which had

led to total loss or reduction in production of honey and other honeybee products. It could be concluded from the results of this study that pests and predators, shortage of honeybee forages, poor hive manipulation, indiscriminate application of agrochemicals, shortage of water, bad weather condition, in appropriate honey harvesting techniques were the most prominent and significant causes of honeybees' colony absconds in the area.

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