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Assessment of Honeybee Pests and Predators in East Wollega Zone, Oromia National Regional State, Ethiopia

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Abstract

The study was conducted with a cross-sectional study to ass's honeybee pests and predators. A questionnaire survey and apiary site observation were administered to 104 beekeepers and 52 apiary sites with two honeybee colony samples from each site. Totally (104 honeybee colonies), were examined from frame box hives for diagnosis. The main reasons for a honey bee colony and product lessening ranked by respondents were 1st pets and predators, 2nd Honeybee pathogen, and 3rd miss use of agrochemicals. The majority of the honeybee colonies were infested by ants 538(21.3%), beetles 378(14.9%), and wax moths 315(12.5%), in all districts. Among all pests and predators listed by respondents, honeybee colonies were absconded by ants 213(8.4%), wax moths 194(7.7%), and beetles 193(7.6%). After having identified the major pests, beekeepers were requested to rank them in order of their importance and the result indicated that Ants (1st), beetles (2nd), Wax moths (3rd), and honey badgers (4th) were the most harmful pests in order of degree of their importance.

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Colonies, Pests, predators, Infestation, Oromia.

Introduction

Ethiopia is one the sub-tropical countries, the land is not only favorable to bees but also to different kinds of honeybee pests and predators that were interfering with the life of honey bees (Desalegn Begna, 2001). Honeybee colonies are subject to several natural stress inducers and enemies including weather, natural disasters, pests, predators, parasites, and diseases (Lawal and Banjo, 2008). Honeybee pests are nowadays a major concern for local beekeepers (Al-Ghzawi *et al.,* 2009).

The presence of numerous pests in the colonies confirmed that pest infestation is a problem in beekeeping in the tropics. The pests are responsible for the destruction of the colony and the decline in its establishment. Pests and predators cause devastating damage to honeybee colonies and at most times cause swarming, absconding, or colony collapse. The honeybee pests interact with the life of honeybees by synchronizing their activity with the beekeeping cycle in Nigeria (Oyerinde and Ande, 2009).

The adequate methods for defining and assessing the causes of death in honey bee colonies are not well implemented. This makes it difficult to assign annual die-offs to specific causes, and that makes it difficult for beekeepers to know what problems should be demanding their greatest attention.

A well-defined list of symptoms for each honey bee pest, and predator allows for differential diagnosis of honey

bee pathologies. Due to this difficulty in diagnosing a problem, it will be necessary to collect and archive samples of bees regularly. Honey bee colony health has received considerable attention in recent years, with many studies highlighting multifactorial issues contributing to colony losses. Disease and weather are consistently highlighted as primary drivers of colony loss, yet little is understood about how they interact.

Consequently, the study was carried out directed to the general objective of creating baseline data on the current status of honeybee colony health problems with the objectives of assessing the occurrence of honeybees, pests, and predators and determining the effect of honeybee pests and predators on honey bee colonies and their products in the study areas.

Materials and Methods

Description of the Study Area

The study was conducted in the East Wollega Zone, Oromia Regional State, approximately 332 km from Addis Ababa, the capital city of Ethiopia. The zone is located at 36 0 30'00″ to 36 0 45'00″ longitude and 9 0 05'00″ to 9 0 15'00″ latitude, with elevations ranging from 1000 m to 3207m. The annual rainfall of the zone ranges from 1500 mm to 2200 mm, with a mean annual temperature of 15-200 C (CSA 2005, 2007). The districts covered in this study were Diga, Gida Ayana, Gobu Sayyo, and Wayu Tuka.

Study design and Sampling procedure

A cross-sectional study was conducted on honeybee colonies to assess the prevalence of common honeybee pests and predators with Varroa mites and bee-louse from the adult workers of honey bees. A questionnaire was administered to each apiarist to assess the honeybee pests and predators in the study area.

Adult honeybees and, if possible, sealed brood samples were collected from sampled honeybee colonies from each sampling locality. In the absence of a sealed brood, empty old brood combs were used to observe remnant symptoms of disease attacks. Moreover, field observations were carried out on the presence of pests, and the necessary records were obtained. In addition to this, beekeepers were asked if there were any occurrences of some diseases in the past (like chalkbrood), but which has not been observed, and their reports were recorded.

Adult honeybee and Brood sampling

A cross-sectional study was carried out in the East Wollega Zone in Diga, Gida Ayana, Gobu Sayo, and Wayu Tuka by considering beekeeping with transitional and modern beekeeping methods to identify the major types of pests and diseases that cause significant economic loss in honey bees by observing and collecting samples from the colonies. To examine honeybee pests, 52 beekeepers from one apiary site and 104 honeybee colonies were collected from all districts. The beekeeper should be 2 km-5 km far distant from each other. Internal and external inspections were performed and adult honeybees and broods were collected for laboratory diagnosis. Finally, the prevalence of the apiary level and infestation/infection at the colony level was calculated using the protocols of (Vanenglesdorp *et al.,* 2013) protocols:

Ifestation/Infectious

$$= \frac{number\ colonies\ examined\ positive}{total\ number\ of\ colonies\ examined} * 100$$

Field examination for major honeybee pests

Field observations and diagnoses were conducted through colony inspections of the major honeybee pests and predators. Pests and predators of honeybees cause devastating damage to honeybee colonies and, at most, cause swarming, absconding, or colony collapse, which is a challenge for beekeeping in tropical and subtropical countries. The occurrence and economic importance of major honeybee pests (including wax moths, small hive beetles, ants, spiders, bee-eater birds, honey badgers, bee lice, lizards, and dead hawk moths). etc.).

All the study areas were determined through beekeeper interviews using semi-structured questionnaires and internal and external hive inspections. Moreover, clinical symptoms and infested combs, adults, and larvae of small hive beetles, wax moths, and other decayed materials were observed in the hive by inspecting the bee hives described by Neumann *et al.,* (2013).

The presence of small hive beetle infestation (*Aethina tumida*) was identified through its adult, larvae or pupae, and colony examination methods, and the Larvae of SHB had pairs of prominent brownish dorsal spines on each segment with pairs of anterior prologs only. Based on Ellis *et al.,* (2013), wax moth larvae have no spines, but the number of setae (hairs) on each segment with eight pairs of prologs (3 pairs, 4 pairs, and one pair on the

anterior, abdominal, and last segments, respectively). Unlike the Small hive beetles, these species produce silken galleries.

Laboratory Examination of Varroa Destructor

This study followed the standard methods for Varroa detection (Dietemann *et al.,* 2013). From each sample of honeybee colonies, 250 adult honeybees were brushed from the brood comb directly into a wide-mouth plastic container. The collected adult bees were killed using 70 % ethyl alcohol, placed in 10 ml of 1% detergent-water solution then vigorously shaken for 1 min to dislodge mites. The mites were collected by filtering the solution through a ladle (8- to 12-mesh) which held the mites back and discharged the solution. The wire gauze was turned down to white paper, on which the presence/absence of the mite was examined and counted.

For brood examination, samples of 5 × 5 cm brood comb areas from the drone and/or worker pupae broods were collected. Approximately 100 pupae were randomly removed from the cells using forceps and checked for the presence of Varroa mites on the worker and/or drone pupae. The number of var mites observed in both diagnoses (adult and brood) was recorded.

Laboratory examination of tracheal mite

Samples of 20-30 adult honeybees were randomly collected from the colonies and preserved by adding 70% alcohol. The head and first pair of legs of honeybees were removed using scissors. Transverse-section thoracic disks were sliced and placed directly in a small bottle containing 10 percent potassium hydroxide (KOH). The sliced thoracic disks in KOH were heated and stirred gently near the boiling point for approximately 10 min until the soft internal tissues dissolved, exposing the tracheal rings. The disk-trachea suspension was examined for mite infestation under a light microscope (Sammataro *et al.,* 2013).

Data management and statistical analysis

The collected data were stored in Microsoft Excel and SPSS software (SPSS version 23) for analysis. The statistical analysis used in the study varied depending on the type of variable and information obtained. The summarized data are presented in the form of tables and figures. The data collected through semi-structured questionnaires were analyzed using descriptive statistics, and the ranking of the different types of beekeeping constraints, a common cause of honeybee colony and yield decrease, control method of bees from agrochemicals, and the effect of pests and predators on honeybee colonies obtained in the study were determined using the rank index formula described by Musa *et al.,* (2006):

Rank index=sum of (5 × number of households ranked first + 4 × number of households ranked second + 3 × number of households ranked third + 2 × number of households ranked fourth + 1 × number of households ranked fifth) for an individual reason divided by the sum of (5 × number of households ranked first + 4 × number of households ranked second + 3 × number of households ranked third + 2 × number of households ranked fourth + 1 × number of households ranked fifth) for overall reasons.

Results and Discussion

Socio-demographic characteristics of the respondent

Of the 104 sample households, 2.9% were female and 97.1% were male. About 45.2% of the respondents' ages ranged from 18 to 42 years. Regarding the occupational status of the beekeepers, 99% were farmers. Most beekeepers practice beekeeping as part of crop production in the study area.

This result shows that the beekeepers in the study area were more productive. Based on the education status of respondents, about 40.4%, 34.6%, and 23.1% of respondent beekeepers had attended elementary, and secondary school, and others could read and write, respectively. Beekeeping activity in the study area was practiced by both educated and non-educated beekeepers, but beekeepers with better educational backgrounds were more productive because they adopted efficient beekeeping technologies for beekeeping.

Beekeeping activities and potentials

Based on respondents and visual observation the beekeeping activities in all districts have been practiced sideline with other agricultural activities (100%). There were no respondents who depended only on beekeeping. Most beekeepers started beekeeping before 1994(92.3%) with traditional beehives, 1994-2004 (49.0%) with traditional beehives and transitional beehives, 1994-2004 (29.8%) with transitional beehives, 2005-2015(35.6%) with movable frame box beehives and after 2015(40.4%) with movable frame box and (28.9%) with transitional

beehives. This indicates the use of modern beekeeping technologies was increasing and that beekeepers were related between the age of 31-42 years (table 2). The beekeeping experience has a positive correlation with the usage of improved beekeeping technologies ($P<0.01$). Most of the respondents were shifting their traditional beekeeping to transitional and frame box beekeeping systems.

Apiary site Inspection by Beekeepers

Participated respondents were interviewed to describe the frequency of inspecting their apiary and honeybee colonies. The majority of the beekeepers inspect their apiary and colonies every day (70.2%), and some of the respondents replied that they take a look externally into the hives per week, (28.8%) and per month (1.0%) per month (table 4).

The trend of honeybee colonies and products

Based on the majority of the respondents, the trend of honeybee colonies and their Products was decreasing some of the beekeepers also responded that honeybee colonies yields were increasing and others responded that stable (figure 2). As a result of the data, most beekeepers faced a shortage of food for their honey bee colony and faced no products. Sometimes the colony population and their products were decreasing due to various factors.

Reasons for decreasing honeybee products

The major causes of honey bee colony and yield decrease ranked by respondents were 1st pets and predators, 2nd Honeybee diseases, and 3rd inappropriate agrochemical application (Table 5). All of these factors resulted in a decrease in productivity and honeybee colony population. The results are in agreement with Kerealem *et al.,* (2009) and Mulisa Faji and Fekadu Begna (2017) shortage of bee forage is ranked first due to population pressure, lack of land use policy, and the high demand for farmlands put pressure on mountainous areas to be used for crop production and livestock grazing.

These create deforestation, soil erosion, and, irreversible ecological degradation. Shortage of bee forage is directly associated with an off-flowering period of major honeybee forages (Kidane Mollaw, 2014).

Similarly (Desta, 2017) indicated that the presence of honeybee pests and pathogens, prevailing bad weather (prolonged precipitation and freezing and heavy wind speed), Lack of knowledge and skill in honeybee pest and disease control, application of agrochemical (direct spray of pesticide on bee visited crops), shortage of bee forage, poor or absence of practice of hive shading, Lack of practice of hive inspection and shortage of improved hive types were ranked in the decreasing order of their importance.

Honeybee Pests and Predators

After having identified the major pests, beekeepers were requested to rank them in order of their importance and the result indicated that Ants (1st), beetles (2nd), Wax moths (3rd), and honey badgers (4th) were the most harmful pests in order of degree of their importance (Table 6).

Honeybee colonies infested and absconded by pests and predators

Based on the beekeeper's response majority of honeybee colonies were infested by ants 538(21.3%), by beetles 378(14.9%), and by wax moths 315(12.5%), in all districts. Among all pests and predators listed by respondents honeybee colonies were absconded by ants 213(8.4%), wax moth 194(7.7%), and by beetles 193(7.6%) in all study districts Table 7). The infestation of beetles was high however it was lower than wax moths in attacking honeybee colonies.

In this study 52 beekeeping sites and 104 honeybee colonies were examined for major honeybee parasites (Varroa mites, bee lice, and tracheal mites), adult honeybee diseases (Nosema and Amoeba), and brood diseases (Chalkbrood, American, and European Foulbrood) with their prevalence in the study area. However, the prevalence of AFB, EFB, SBD, and tracheal mites was not confirmed during the study period.

It has been related to the findings of (Desalegn Begna, 2001; Desalegn Begna and Amssalu Bezabeh, 2001; Desalegn Bezabeh and Yosef Kebede, 2005; Desalegn Begna and Amssalu Bezabeh, 2006) that indicates fifteen different types of economically important pests were investigated with their magnitude of damage and distribution. According to these findings, ants, wax moths, mice, birds, honey badgers, wasps, death's head hawks moths, bee lice (*Dracula coca*), beetles, lizards, toads, prey-mantis, spiders, pseudoscorpions (*chelifer species*) were among the major honeybee pests registered locally.

Table.1 Socio-demographic characteristics of households

Socioeconomic Variables	Category	N	Percentage (%)
Sex	Female	3	2.9
	Male	101	97.1
age	18-30	31	29.8
	31-42	47	45.2
	43-45	17	16.3
	56-68	6	5.8
	>69	3	2.9
Occupaon	Farmer	103	99
	Merchant	1	1
Education level	Can Write And Read	24	23.1
	Elementary	42	40.4
	Secondary	36	34.6
	Diploma	2	1.9

Table.2 Beekeeping activities and potentials

Time category	Hive type	Frequency (%)
<1994	Traditional	92.3
	Transitional	5.8
	Moveable frame box	1.9
1994-2004	Traditional	49
	Transitional	29.8
	Moveable frame box	21.2
2005-2015	Traditional	35.6
	Transitional	27.8
	Moveable frame box	35.6
>2015	Traditional	31.7
	Transitional	28.9
	Moveable frame box	40.4

Table.3 Apiary Site Inspection by Beekeepers

Inspection Schedule	N	Frequency (%)
Everyday	73	70.2
Per week	30	28.8
Per month	1	1.0
Rarely	0	0.0

Table.4 Cause of honeybee colony and yield decrease

Common problems	Relative degree of importance					index	Rank
	1st	2nd	3rd	4th	5th		
Lack of bee forage	9	11	14	13	30	0.093	6
Lack of water	0	0	0	3	24	0.015	8
Drought	0	0	0	0	3	0.002	9
Absconding	11	11	14	8	28	0.092	7
Unwise use of agrochemicals	13	18	38	12	2	0.138	3
Pests and predators	61	14	22	3	0	0.216	1
Decrease in price of honey	15	8	23	34	1	0.122	5
Honeybee disease	32	45	11	4	0	0.19	2
The high price of bee equipment	19	21	24	5	0	0.13	4

Index *= Sum of (5*ranked 1st+ 4* ranked 2nd+3* ranked 3rd+2* ranked 4th+1* ranked 5th) for individual reasons divided by the sum of (5*ranked 1st+ 4* ranked 2nd+3* ranked 3rd+2* ranked 4th+1* ranked 5th) for overall reasons.*

Table.5 Honeybee pests and predators

Pest and predators	Relative degree of pests and predators effects					Index	Rank
	1st	2nd	3rd	4th	5th		
Ants	72	33	7	0	0	0.138	1
Honey badgers	15	29	41	12	2	0.122	4
Bee lice	0	0	0	27	40	0.083	6
Beetles	25	58	17	11	0	0.137	2
DHHM	2	5	13	33	31	0.103	6
Wax moth	3	8	40	42	7	0.123	3
Spiders	0	4	12	11	29	0.069	7
Wasps	0	0	1	22	25	0.059	8
Bee-eater birds	2	7	24	39	26	0.121	5
Lizard	0	0	1	4	12	0.021	9
Varro mite	12	1	0	0	0	0.016	10

DHHM=Dead head hawks moth

Index *= Sum of (5*ranked 1st+ 4* ranked 2nd+3* ranked 3rd+2* ranked 4th+1* ranked 5th) for individual reasons divided by the sum of (5*ranked 1st+ 4* ranked 2nd+3* ranked 3rd+2* ranked 4th+1* ranked 5th) for overall reasons.*

Table.6 Honeybee colonies infested and absconded by pests and predators

Honeybee colonies infested and absconded	Study districts				Colonies in All Districts
	Diga	Gida Ayana	Gobu Sayo	Wayu Tuka	
Total colony owned by respondents	674	693	584	579	2530
Number of colonies infested by wax moth	77(14.8%)	90(13.9%)	63(11.9%)	85(15.0%)	315(12.5%)
Number of colonies absconded by wax moth	43(8.3%)	58(8.9%)	42(7.9%)	51(9.0%)	194(7.7%)
Number of colonies attacked by bird	71(13.6%)	103(15.9%)	64(12.1%)	64(12.2%)	307(12.1%)
Number of colonies absconded by birds	19(3.7%)	24(3.7%)	21(3.9%)	21(4.6%)	90(3.6%)
Number of colonies infested by beetles	102(19.6%)	107(16.6%)	90(17%)	79(13.9%)	378(14.9%)
Number of colonies absconded by beetles	43(8.3%)	58(8.9%)	42(7.9%)	50(8.9%)	193(7.6%)
Number of colonies attacked by honey badger	73(14.0%)	89(13.8%)	73(13.8%)	80(14.2%)	315(12.5%)
Number of colonies absconded by honey badger	29(5.7%)	44(6.8%)	29(5.5%)	36(6.4%)	138(5.5%)
Number of colonies infested by ants	139(26.7%)	143(22.1%)	149(28.1%)	107(18.9%)	538(21.3%)
Number of colonies absconded by ants	49(9.4%)	64(9.9%)	54(10.2%)	46(8.1%)	213(8.4%)
Number of colonies infested by head hawk moth	59(11.3%)	74(11.5%)	39(7.4%)	66(11.7%)	238(9.4%)
Number of colonies absconded by death head hawks moth	20(3.8%)	32(5.0%)	24(4.5%)	23(4.1%)	99(3.9%)
Total colonies attacked/infested by predators/pests	521(77.3%)	606(87.5%)	478(81.9%)	486(83.9%)	2091(82.6%)
Total honeybee colonies absconded	203(30.1%)	280(40.4%)	212(36.3%)	232(40.1%)	927(36.6%)

Table.7 Prevalence and Infestation of *Varro destructor*

Study Districts	N=52	Varroa Mite In Apiaries		Varroa Mite In Sealed Brood		N=104	Infestation of varroa	
		+Ve	%	+Ve	%		+Ve	%
Diga	11	11	100	10	90.9	22	21	95.5
G/Ayana	13	11	84.6	12	92.3	26	25	96.2
G/Sayo	15	15	100	14	93.3	30	27	90
W/Tuka	13	12	92.3	12	92.3	26	24	92.3
Overall	52	49	94.2	48	92.3	104	97	93.3
X^2 for prevalence and infestation	Chi square = 1.36 P-value = 0.71							

N=Number of apiary sites examined, +Ve= Number of sites found positive

Table.8 Local control practices of honeybee pests and predators

	Local Control method
Ant	Clean the apiary, Place fresh ash, plaster hive stands with mud or cement, put metals between the hive and hive stands, and pour used engine oil around the hive stand daily follow up and use hot water, using ash.
Honey Badger	Chasing and Killing, Fencing of the apiary, using dogs to keep at night
Bee-Eater Birds	Placing the seeming image of humans near the hives using cloth, plastics, „access „and or stone
Wax moth	Clean apiary, remove old comb, strengthen the colony, remove empty hives from the apiary, seasonal management, daily supervision
Lizard	Removing their nesting site
Death's-Head Hawkmoth	watch and kill on hive entrances
Beetle	Cleaning hives, narrowing the hive entrance, hand picking, and killing.

Figure.1 Map of the study area

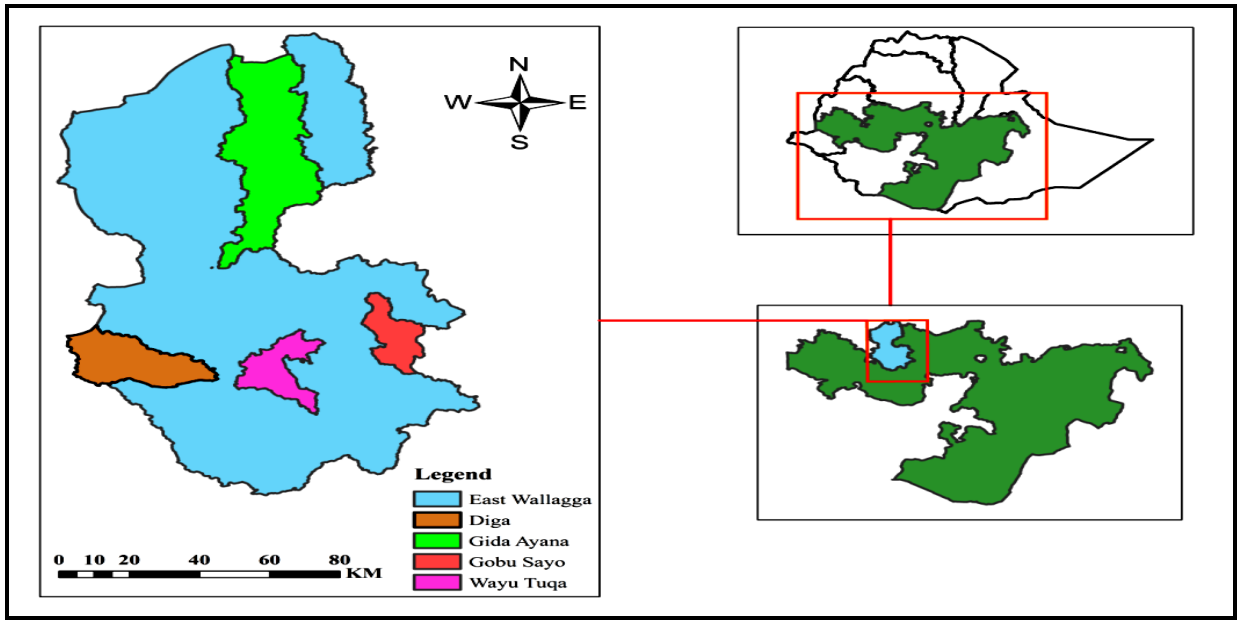
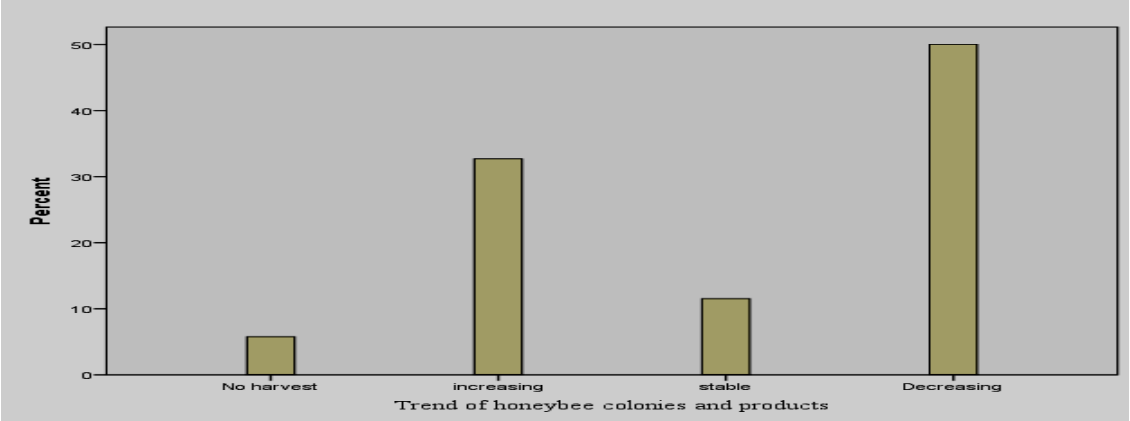


Figure.2 The trend of honeybee colonies and products



Prevalence and infestation of Varroa mites

From the total of 52 samples of apiary sites examined for the prevalence of varroa, 49 sites (94.2%) and similarly, from the total of 52 beekeeping sites examined in the sealed brood, 48(92.3%) beekeeping sites were Varroa mites positive. From the total of 104 honeybee colonies examined for infestation of Varroa mites in adult bees, 97 (93.3%) honeybee colonies were during the study period (Table 12).

The varroa destructor infestation was limited during the dearth period. The infestation was higher in the active period than in the dearth period. The difference in infestation in the active period may be due to more availability of pollen sources for brood rearing that related to egg laying of varroa in the brood, as brood rearing depends on bee forage availability in the area and the result indicates that the infestation rate was higher in the active period than in the dearth period.

Local control practices of honeybee pests and predators

Beekeepers use different methods to control honeybee pests and predators. They listed the method as follows in Table 8.

Conclusion and Recommendations

Beekeeping is important to rural communities by providing a variety of goods honey, wax, and pollen in particular, and enriching the ecosystem by pollination. Based on the results the majority of beekeepers inspect their apiary and colonies every day, per month, and month respectively. The trend of the honeybee colony and its Products was decreasing and some of the beekeepers also responded to honeybee colonies and yields were increasing and others responded to stable. The major causes of honey bee colony and yield decrease ranked by respondents were pets and predators, Honeybee diseases, and appropriate agrochemical applications. The major pests, ranked in order of importance were Ants, beetles, Wax moths, and honey badgers the most harmful pests in order of degree of their importance. Based on respondents and field observation majority of honeybee colonies were infested by ants, beetles, and wax moths, and also honeybee colonies were absconded by ants, wax moths, and, beetles in all study districts respectively. The infestation of beetles was high however it was lower than wax moths in attacking honeybee colonies. From the total of 52 samples of apiary sites examined for varroa, 49 sites were positive for Varroa mites. Beekeepers use different cultural methods to control honeybee pests and predators. To save honeybee colonies from honeybee pests and predators, beekeepers and others attend regular honey bee colony management and use local and cultural pests and predator control methods.

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