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Biodiversity of Honey Bees and Different Beekeeping Methods in Madhya Pradesh

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Abstract:

Present study was carried out at different locations nearby the Nemand and Chambal region of Khandwa district and the information was collected from beekeepers of different villages of the region about different aspects of beekeeping such as bee flora, practices adopted, and awareness about incidence, management of diseases and enemies and their own experience about the apiculture. The incidence of EFB disease was observed in some villages. *Varroa* Mite infestation was observed by the beekeepers of Ahmadpur village in September and in July 2019 and February 2020 in Ajanti and Bastoli villages, respectively. *Tropilaelaps clareae* mite incidence was observed negligible in the region during the study period. Larvae and pupa of greater wax moth were the most destructive stages. These were observed in Ambapat, Amlani, Anjaniya Khurd, Badgaon Mal and Nayagaon villages of the region during August to November 2019 causing considerable losses to bee colonies. Ant attack was observed in the bee colonies during August to October 2019 by beekeepers of some Mirghan villages. Beekeepers are using terramycin and 1% soap & formalin solution for management of European foulbrood disease in different villages. Beekeepers from some village are using Sulphur, Mite strips and veticol for management of *Varroa* Mites. For wasps, destruction of wasp nests, honey baits mixed with different insecticides and different types of traps were adopted. Dusting of Fenvalerate around colony box is done for management of Ants in some villages. Proper Hygiene, protection and care isbeing taken for effective management of honeybee colonies.

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

Keywords: diseases, pests, management, Apis mellifera L., Nemand region, wasp, ants, bee-eater birds

1. Introduction

The beekeeping with European honey bee, *A. mellifera* L. is practiced in the region both under stationary and migratory conditions. At present, there are approximately 4500-5000 beekeepers in the region currently having 55,000-60,000 colonies (*Apis mellifera* L.) that yields approximately 5,124 tons of honey (KVK Morena, 2017), leading Morena district at the top in Madhya Pradesh for honey production. The cropping system of the Chambal region provides abundant flora for honey bees therefore, this zone of Madhya Pradesh is a paradise for beekeepers not only for the state but also for neighboring states such as Rajasthan and Uttar Pradesh, thus has an enormous potential for profitable beekeeping. It has tremendous back up of bee flora from field crops also as from horticultural crops. Therefore, commercial bee keeping is very popular in this area from October to April. Presently beekeeping industry is facing many challenges throughout the world. Among these, a major constraint in beekeeping developmental programs is the depredation of a large number of diseases and enemies. Honey bees are attacked by many diseases and insect pests, which cause weakness of colonies and ultimately low honey production. These enemies include diseases, insect pests, wasps, ants, *Apis dorsata*, bee-eater birds, etc. Of all these enemies, some feed on honey, some on wax and rest on brood and adult bees. All these diseases, insect pests and other enemies causes moderate to severe damage to honey bee colonies and the same constraints are faced by beekeepers of the region which impairs the health and normal working of honey bees.

European foulbrood is very common all over the world, where *Apis mellifera* L. exists (White, 1912). In India, this disease was recorded for the first time in *A. cerana* from Maharashtra during 1970 (Diwan *et* al., 1971). 2.52 to 2.92 per cent mortality of brood was reported first time in India in *A. mellifera* colonies during 1998 (Chandel *et al.*, 1999) [8] due to sac brood. Varroa mite parasitizing the *A. mellifera* is responsible for loss of more than 50% colonies worldwide (Shaw *et al.*, 2002; Topolska *et al*., 2010; Martin *et al*., 2012; Nazzi *et al*., 2012) [18, 23, 15, 16].

90 per cent apiaries and 50 per cent colonies of state of Haryana are affected by this mite (Gulati *et al.*, 2009) [12]. The incidence of *T. clareae* was noticed throughout the year in colonies of *A.*

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

mellifera in Punjab with peak infestation during March-April and October-November (Gatoria *et al.,* 1995) [11]. In India, greater wax moth was observed throughout the years in both higher and lower altitudes, but peak infestation was recorded during May to September. However, (Brar *et al*., 1985) [7] recorded 16 to 19 per cent infestation in *A. mellifera* colonies in north India. Rana *et al.* (2000) [17] reported peak predatory wasp activity from August to November in Himachal Pradesh (av. 208-252 wasps/ day) whereas it was July to September in Jammu (av. 13.5 wasps/ day) (Abrol and Kakroo, 1998) [2].

Ecologists tend to blame pesticides for the honey bee decreasing population, as new products known as neonicotinoids have been in use from the late 1980's. Neonicotinoids are systemic insecticides which affect insects' nervous system. They are suspected to affect all pollinator insects, though studies are performed on honey bee hives as they are easier to control and measure. The toxicity of these chemicals is undeniable in high doses and they even pose a risk for mammals (Tomizawa, 2004) –humans included (Koshlukova, 2006)− and birds (Fishel, 2005) and that is why both, the EPA in the US and the EFSA in the UE, have restricting policies and continue on screening and founding new studies on this substances (EFSA, 2013; US EPA, 2014). Furthermore, it has been proved that these pesticides can persist in water and soil (Van Dijk et al., 2013). If these chemicals mean a decline in pollinator insect population, they also mean a reduction of insectivorous birds (Hallmann, 2014), so they could threaten wildlife diversity and, therefore, ecosystems.

Honey bee colonies are considered superorganisms due to their social life, so reproduction means to produce more colonies. This process is called swarming and usually takes place in spring, where there is plenty of food for them (Mortensen, 2013).

For swarming, a colony produces several daughter queens. Before they reach their adulthood, the mother queen and most of the worker bees will go all together as a swarm to look for a new place to stablish a new colony. Meanwhile, when the daughter queens reach their adulthood, they will fight until only one survives. In her first two weeks of life, this queen will fly out the hive to find a drone congregation place and mate with about 15 drones. She will save their sperm to use it during her entire life. Days later, she will begin to lay eggs (Mortensen, 2013; Akratanakul, 1990).

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

Honey bees are not the only pollinator insect, but by pollinating, they contribute to global food production. They are considered good general pollinators (they have no specificity for any plant) and their hives can be moved and placed near to different croplands during some days in order to help with the pollination (Mortensen, 2013; Adjare, 1990; Crane, 1992). Honey bees pollinate flowers when they forage on nectar and pollen. They carry pollen on their bodies and accidentally transfer it from one flower to another (Nieto et al., 2014).

So, it is of prime importance that beekeepers should be aware of these potential damaging factors and can well protect their honey bee colonies to get the maximum benefit from beekeeping venture. Despite the fact, only few attempts have been made. Hence, there was a need for qualitative study and survey of insect pests, pathogens, predators and other enemies of A. mellifera L. with the changing scenario of environmental conditions, and this survey study was conducted to provide comprehensive research information on their occurrence which may immensely be helpful for beekeepers to take care of their honeybee colonies.

2. Material and Methods

The survey study was conducted in different locations and villages nearby the Chambal region during April, 2019 to March, 2020. Information on various parameters and practices followed for *Apis mellifera* L. rearing *viz*., enemies, awareness and management practices adopted by beekeepers for maintenance of bee colonies, honey storage practices, migratory route followed by the beekeepers and their own experience about the apiculture was gathered and compiled. For this survey, a structured questionnaire was prepared and administered to collect information from beekeepers of Mirghan, Matkora, Ancholi, Dhurkuda, Bastoli, Koda, Ganjrampur, Nayagaon villages of the Chambal region of Madhya Pradesh. General information about themselves, family, address, location of apiary, number of active colonies, availability of bee flora, honey flow sources, route and duration of migration, their experience about beekeeping venture and constraints faced by them.

The data on different enemies of *A. mellifera* L. experienced and observed by beekeepers was recorded and average colony loss was calculated. Information about Name of disease, pest and other enemies experienced by the beekeeper, period of incidence of enemies, loss of colonies due to enemy attack etc. and management practices adopted by a beekeeper for various enemies was

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

gathered.

3. Results and Discussion

General information:

The survey conducted across different villages of Chambal region revealed that beekeepers maintains 40-500 colonies of *A. mellifera* as stationary and migratory beekeeping. They used to migrate their colonies from Morena to different floral belts of Madhya Pradesh and nearby districts of Uttar Pradesh and Rajasthan during the periods of dearth. This region of Madhya Pradesh holds an important position in copious honey production in India. Morena District tops the state inproduction of honey.

Majority of the bee keepers trained under various training programs on regular basis through KVK, Morena now works as master trainers at other private organizations to promote bee keeping venture. With all this knowledge, beekeepers adopts modern package of practices and techniques for beekeeping. Since the average land holding per person in this area is quite low, even many people being landless, they were totally dependent on beekeeping for their livelihood. Hence, apiculture has formed a major source of employment for them. Herewith the honey production, queen rearing and multiplication of honeybee colonies is being commonly practiced in the study area.

Floral sources and Migratory cycle:

The sources of bee flora for surplus honey production varies in the region as shown in the Table 1. Important sources of bee flora reported by beekeepers of the region includes sesame, green gram, black gram, pearl millet, medium duration pigeon pea and Celery (Ajwain) during July to October at, Coriander, rape seed and mustard during November to February and Berseem during mid-March tomid-May. Rapeseed and mustard flora provides abundant nectar and pollen which mainly helps in the strong build-up of colonies. During the rest of the year, the flora of forest plants such as adusa (*Adhatoda vasica*), kher (*Acacia catechu*), drum-stick (*Moringa oleifera*), shisham (*Dalbergia sissoo*), and neem (*Azadirachta indica*) are available in abundance. The major bee flora sources reported by beekeepers during the survey were mentioned as major honey flow sources in the Report of the Beekeeping Development Committee conducted by EAC-PM, GoI, June 2019 and other previous studies (Tomar, *et al.*, 2014; Yadav *et al.*, 2014) [22, 26].

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

According to the survey studies, beekeepers of Chambal region are following different migratory cycles (Table 2) for *A. mellifera*: 1) Mid November to Mid-February: Rapeseed and mustard as major honey source in Morena, Bhind, Sheopur and small parts of Shivpuri district of Madhya Pradesh and Dholpur and Bharatpur districts of Rajasthan. 2) Mid-February to March: Coriander as a major honey source in Ashoknagar and Guna districts of Madhya Pradesh. 3) April to Mid-May: Berseem as a major honey source in Morena, Dabra block of Gwalior and Sheopur districts of Madhya Pradesh. 4) June to July: Pearl millet as a major honey source in Morena, Bhind and Sheopur districts of Madhya Pradesh and during August- September to Etwah, Hathras and Aligarh districts of Uttar Pradesh. Throughout the summer months, some beekeepers also prefers to migrate their colonies for Kher, Babool and other forest flora to Bhateshwar and nearby forest belt of Rajasthan. 5) October- November: Pigeon pea as a major honey source to Morena, Sheopur and parts of Bhind of Madhya Pradesh. For celery (Ajwain) to Shivpuri districts of Madhya Pradesh.

Incidence of diseases and management practices in *A. mellifera:*

The information collected from beekeepers on the incidence of diseases and insect pests in honey bee colonies along with their period of incidence, annual colony loss and management adopted by beekeepers (Tables 3) revealed that incidence of European Foulbrood is commonly observed and Sac brood is occasionally observed in the region. The incidence of EFB disease was observed from September to November 2019 in Mirghan, Bastoli and Dhurkuda villages, when there is scarcity of floral sources in the region. It was also observed in some parts of Matkora and Ancholi villages during July and February 2020. Incidence of this disease is due to the lack of floral sources and weak colony strength. Abrol and Ball (2006) [3] conducted a survey in different apiaries of Jammu during 2003-2004 and reported that 10-15 per cent colonies suffered from European foulbrood disease. The symptoms of the disease included sudden weakening of the colonies. The disease was noticed during dearth period and high infestation was noticed.

Mites such as *Varroa destructor* and *Tropilaelaps clareae* also causes considerable damage to bee colonies. *Varroa* Mite infestation was observed by the beekeepers of Nayagaon village in September. It was also observed in July 2019 and February, 2020 in Matkora and Bastoli villages of the Chambal region, respectively. *T. clareae* mite incidence was observed negligible in the region during the study period. This mite attack is due to the change in weather parameters such as

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

temperature and relative humidity.

Greater Wax moth is also an important insect pest of honeybees which in the condition of severe infestation, can destroy the entire combs/ colonies and abscond the bees within 2-3 days. Larvae and pupa of greater wax moth are the most destructive stages. It was observed in Mirghan, Matkora, Ancholi, Konda, Ganjrampur and Nayagaon villages of the region during August to November 2019 causing considerable losses to bee colonies. Severe infestation occurs due to many reasons such as inactivity of honeybees, continuous bad and cloudy weather conditions, weak colony strength, lack of floral sources, and improper hygiene of beehive.

Beekeepers are applying different chemicals, adopting various traditional and modern practices for management of diseases, insect pests and other enemies in *A. mellifera* (Table 4). Terramycin and 1% soap & formalin solution are used for management of European foulbrood disease in Mirghan, Dhurkuda and Bastoli villages. Beekeepers from Nayagaon village are using Sulphur, Mite strips and veticol for management of *Varroa* Mites in *A. mellifera* colonies. Regular monitoring of honeybee colonies aids much in the successful management and controlling of most of the diseases, insect pests and other enemies. Several mites and pest infestations and microbial, bacterial and viral infections cause severe loss to the colonies. Sulphur dusting, formic acidfumigation etc. is effective against mites Gupta (1988) [13].

Incidence of enemies and management practices in *A. mellifera:*

Apart from diseases and insect pests, attack of other enemies such as Wasps, Ants, Bee-eater Bird and Giant honeybees (Table 4) also causes damage to *A. mellifera* L. colonies and destroys the comb hives rapidly. Wasp was reported to cause nuisance to bee colonies during July to October 2019 by the beekeepers of Mirghan, Matkora and Konda villages and during February 2020 in Nayagaon village. Ant attack was observed in the bee colonies during August to October 2019 by beekeepers of Konda, Nayagaon, Matkora, Bastoli andMirghan villages. Bee eaters also caused nuisance to colonies during July to October 2019 in Ganjrampur, Bastoli and Mirghan villages and during February 2020 in Matkora village of Chambal region. These enemies mostly visits in the morning hours and attacks colonies mostly due to continuous bad/ cloudy/ stormy weather. Birds are also very important threat to bee colonies (Brar 2016) [6]. Blue bee-eater (*Nyctyornis athertoni*) can eat average 270 bees per 13.5 minute, and incidence of bird was reported in February monthin Nauni, Solan.

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

For the management of wasps, destruction of wasp nests (Bhutani, 1950 and Singh, 1962) [5, 20], honey baits mixed with different insecticides (Wafa *et al.,* 1969 and Aihara, 1980) [24, 4], and usage of different types of traps (Hussein, 1989; Shoreit, 1998 and Abou ElEnain, 1999) [14, 19, 1] are the methods adopted by beekeepers. Dusting of Fenvalerate around colony box is done for management of Ants in Nayagaon, Matkora, Mirghan and Bastoli villages. Proper Hygiene, protection and care has been taken for effective management of honeybee colonies. The important insect pests like Greater Wax Moth and other enemies like Ants were observed by beekeepers have also been discussed while describing weather effect on incidence of pests of Honeybee (*Apis mellifera*) in Gird zone of Madhya Pradesh (Singh, *et al.,* 2009) [21].

The information collected from beekeepers of Chambal and Nemand region shows that they are aware about the important bee flora sources, diseases, insect pests, other enemies and their effective management practices. No such survey was conducted in the region earlier.

Seasonal management practices adopted by beekeepers for the *A. mellifera* apiary:

Checking the queen health is observed in autumn season and if required, a young and healthy queen is developed and replaced with the old queen in the colony. Winter packaging to withstand harsh conditions of weather is sometimes done during very low temperature conditions and artificial feeding is done when needed. During the summer months, the colonies are placed in shady conditions, water needs are checked regularly and honey is extracted. Colonies are maintained at dry places and regular checking of colonies for diseases and pest infestation during heavy rainy days in monsoon season. In summer months, the winter packaging of colonies is removed as the temperature is increased and artificial feeding is done to sustain the colony strength.

Sr. No.	Common Name**	Scientific Name	Family	Region
1	Sesame*	*Sesamum indicum*	Pedaliaceae	Morena, Sheopur and Bhind
2	Green gram	*Vigna radiate*	Leguminoseae	Morena, Sheopur and Bhind
3	Black gram	*Vigna mungo*	Leguminoseae	Morena, Sheopur and Bhind
4	Pearl millet*	*Pennisetum glaucum*	Poaceae	Morena, Sheopur, Bhind, Shivpuri, Hathras, Aligarh, Sikar
5	Pigeon pea*	*Cajanas cajan*	Leguminoseae	
6	Celery (Ajwain)*	*Apium graveolens*	Apiaceae	Shivpuri

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

7	Sorghum	*Sorghum bicolor*	Poaceae	Sheopur and Morena
8	Rapeseed*	*Brassica* spp.	Brassicaceae	Morena, Sheopur, Bhind, Shivpuri, Dholpur and Bharatpur
9	Mustard*			
10	Fenugreek*	*Trigonella foenum graecum*	Leguminoseae	Ashok Nagar and Guna
11	Coriander*	*Coriandrum sativum*	Umbellifereae	
12	Gram	*Cicer arietinum*	Leguminoseae	Morena, Sheopur, Bhind, Shivpuri, Guna and Ashok Nagar
13	Okra	*Abelmoscus esculentus*	Malvaceae	Sheopur, Shivpuri and Morena
14	Garlic	*Allium sativum*	Amaryllidaceae	
15	Onion*	*Allium cepa*	Alliaceae	
16	Berseem*	*Trifolium alexandrinum*	Leguminoseae	Morena, Gwalior and Sheopur
17	Citrus*	*Citrus* spp.	Rutaceae	Morena, Sheopur, Bhind, Shivpuri, Guna and Ashok Nagar
18	Papaya	*Carica papaya*	Caricaceae	
19	Pea	*Pisum sativum*	Leguminoseae	
20	Adusa	*Adhatoda vasica*	Acanthaceae	Morena, Sheopur, Bhind, Shivpuri, Guna, Ashok Nagar, Bhateshwar and nearby forest belt.
21	Kher	*Acacia catechu*	Leguminoseae	
22	Drum stick*	*Moringa oleifera*	Moringaceae	
23	Shisham*	*Dalbergia sissoo*	Fabaceae	
24	Neem*	*Azadirachta indica*	Meliaceae	
25	Eucalyptus*	*Eucalyptus* spp.	Myrtaceae	
26	Ber*	*Ziziphus mauritiana*	Rhamnaceae	
27	Mehandi	*Lawsonia inermis*	Lythraceae	
28	Babool	*Vachellia nilotica*	Fabaceae	
29	Gulmohar	*Delonix regia*	Fabaceae	
30	Madhu Kamini	*Murraya paniculata*	Rutaceae	

Table 1: Important bee flora of different locations of the Nemand and Chambal region.

*Major honey flow sources, **as per information provided by beekeepers during survey

Table 2: Migratory route followed by the beekeepers of the region throughout year.

Sr. No.	**Period**	**Major Honey Source**	**District**	**State**
1.	Mid Nov.- Mid Feb.	Rapeseed and Mustard	Morena, Bhind, Sheopur and small part of Shivpuri	Madhya Pradesh

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

			Dholpur and Bharatpur	Rajasthan
2.	Mid Feb.- March	Coriander	Ashoknagar and Guna	Madhya Pradesh
3.	April-Mid May	Berseem	Morena, Dabra block or Gwalior and Sheopur	Madhya Pradesh
4.	June-July	Pearl millet	Morena, Bhind, Sheopur	Madhya Pradesh
	Aug- Sept		Etwah, Hathras and Aligarh	Uttar Pradesh
			Sikar and Alwar	Rajasthan
	Summer Month	Kher, Babool	Bhateshwar and Forest belt	Rajasthan
5.	Oct- Nov	Pigeon Pea	Morena and parts of Bhind and Sheopur	Madhya Pradesh
		Celery (Ajwain)	Shivpuri	Madhya Pradesh

Bee diseases/ pests	**Name of Area/ Village**	**Months of prevalence**	**Annual Colony Loss (%)**	**Management by Beekeepers**
European Foulbrood	Mirghan	September-October	16.00	• Sugar solution (50%). • Remove and destroy the infested frames and colonies. • Treat the infested frames by dipping the frames in 1% Soap and1% Formalin solution. • Dusting of Terramycin 250mg on the infected brood afterextraction of honey. • Antibiotics (only after extraction of honey).
	Matkora	June-July	10.00	
	Ancholi	February-March	12.00	
	Dhurkuda	October-November	17.00	
	Bastoli	September-October	15.00	
	Konda	June-July	11.00	
Varroa mite	Nayagaon	September-October	16.00	• Cage the queen for 21 days to stop the disease cycle. • Can be physically removed by sugar dusting method. • Fumigate Formic acid 85% @ 5 ml inside the box. • Smoke fumigation by using sulphur. Burn and smoke the thickpaper treated with 30% • Potassium Nitrate solution. Use of mite strips @1-2 strips/ boxand veticol @2-3 drops/ box.
	Matkora	June-July	10.00	
	Bastoli	February-March	13.00	
Greater Wax Moth	Mirghan	August-September	19.00	• Proper storage of empty boxes and frames.
	Matkora	August-September	22.00	
	Ancholi	September-November	16.00	• Remove old combs during times of food scarcity
	Konda	September-October	16.00	

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

	Ganjrampur	October-November	15.00	when colonysize shrinks. • Use of formic acid in winters to induce bees' activity. • Fumigation by- Sulphur, Ethylene dibromide, Paradachloro-benzene, celphos during storage of empty frames. • Destroy infested frames and boxes. Seal all the holes and cracksinside the hive box. • Scrape away any eggs, wax moth faeces and pupa of wax mothand expose the empty frames and boxes to the sunlight. • Cleaning the boxes at the fortnightly intervals, and free fromdust and debris. • Always use clean wax on the starter strips.
	Nayagaon	August-September	19.00	

Table 3: Incidence of diseases and pests of *Apis mellifera* L. experienced by beekeepers of the Chambal region

Table 4: Status of enemies and management practices in *A. mellifera* adopted by beekeepers

Sr. no.	Enemies	Causal organism	Name of Area/ Village	Period of incidence (Month)	Annual Colony Loss (%)	Management by Beekeepers
1.	Wasp	*Vespa* spp.	Mirghan	September-October	8.00	• Killing the wasp queen at the early times of theiroccurrence. • Destroy all the nests/ colonies of wasps within 2 kmfrom the apiary site. • Entrance of the hive should be small. • Use Wasp trap for effective control of wasps.
			Matkora	July-August	4.00	
			Konda	August-September	9.00	
			Nayagaon	September-October	6.00	
2.	Ants	*Lasius niger*	Konda	September-October	8.00	• Dig and destroy the ant hill. • Put legs of hive stand inside the water filled inplastic cups. • Dusting of Fenvalerate 0.4% DP.
			Nayagaon	September-October	9.00	
			Matkora	August-September	10.00	
			Bastoli	August-September	7.00	
			Mirghan	August-September	9.00	
			Ganjrampu	July-August	4.00	• Don't leave any brood combs exposed to

ISSN- 2394-5125 VOL 7, ISSUE 19, 2020

3.	Other enemies	*Apis dorsata* L. Bee-eater Birds	r			Bee- eaters. • Scarecrows scaring the birds, including varioussound-producing devices • Scaring the birds by drum beating and stone peltingloud noises

4. Conclusion

Beekeeping with *Apis* mellifera L. species in Chambal region is profitable under stationary as well as migratory conditions, since colonies gained strength and produced surplus honey. These were also divided when migrated to floral belts. Beekeepers of the study region were aware about the modern techniques of beekeeping. The incidence of various diseases, pests and other enemies was moderate. Beekeepers reported considerable loss due to diseases, insect pests and other enemies in *A. mellifera* colonies. According to them, the annual colony loss percentage caused due to all diseases, insect pests and other enemies was invariably varied from 4 per cent to 22 per cent. Many of them are using scientific techniques of beekeeping and their management. They have adequate knowledge of availability of natural floral sources and have detailed knowledge about migratory routes to be followed during the dearth periods. Beekeepers adopts modern package of practices and techniques for beekeeping. Since the average land holding per person in this area is quite low, even many people being landless, they were totally dependent on beekeeping for their livelihood. Hence, apiculture formed a major source of employment for them. Herewith the honey production, queen rearing and multiplication of honeybee colonies is being commonly practiced in the study area. Beekeepers of this region are adopting safer and effective methods for management of diseases, insect pests and other enemies. These studies suggested that though beekeepers are aware about important beekeeping practices but still there is need to impart scientific knowledge for profitable beekeeping.

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