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Constraints and Prospects of Apiculture at Malakand and Selected Areas of Punjab, Pakistan

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Abstract

The objective of the present study was to identify the number of honey bee colonies, species of honey bees, threats to the colonies, flora availability and average honey productivity from each colony in the bee farm located in District Dir, Malakand, Swat and selected areas of Punjab during 2018-2019. A survey was conducted through questionnaires and dialogues with the beekeepers and residents in the study area. The actual bee hives were also visited to see the bee hives and associated constraints and prospects. Maximum honey production was recorded in Chakwal (45Kg/colony per annum) followed by Talagang (20Kg/colony per annum) while in District Dir, Malakand and Swat, the annual honey production was recorded almost uniform during the study period with average production of 10 Kg/colony per annum. Common flora for nectar production in the study area included *Ziziphus jujuba*, *Acacia modesta* and *Eucalyptus lanceolata*. Common honey bee fauna included *A. melliffera* and *A. cerana*. Major threats for the decline of honey bee fauna included impacts of climate change, predation by other insects, pollution, scarcity of flora, pesticides, American foulbrood and chalk brood diseases and varroa mites' infestations. High and unpredicted rain fall also disturbed management of honey bees in the study area. The study area has great potential of honey production. It has been concluded that honey production can be enhanced with scientific approach and the use of modern technology for beekeeping associated with mitigation of the threats that causes decline of honey bee fauna.

1.Introduction

Apiculture is the art and science of beekeeping for the production of valuable bee hive products like honey, propolis, royal jelly, wax and bee venom along with the provision of pollination services to a large number of flora worldwide. Honey bees are social insects living in the form of colony. The colony consists of drones, worker, soldier and a single queen. Honey bees are present in all parts of the world except extreme Polar Regions (K. A. Khan, Ghramh, Ahmad, El-Niweiri, & Mohammed, 2021).

Honey bees their various stages of life, their living pattern, their relationship with each other and with its environment, their advantages and disadvantages, and to study how to make them more and fruitful and enhance their population by different ways is called Apiculture. Honey bees produced honey which is their waist. Honey is made up of different nutrients, vitamins and ions. In the same way it is a valuable nutritive food containing different sugar molecules proteins, amino acid and minerals. Honey is used as drugs, healing of wounds and a high source of energy. In Pakistan there are four species of honeybees namely *Apis mellifera, Apis Cerana, Apis Dorsata, Apis florea.* Other than *Apis mellifera* they are the most important crop pollinator. *Apis mellifera* is migrated from Russia and Australia during 1979 (Luca, Pauliuc, & Oroian, 2024).

In addition to water honeybees gathers two foods; nectar is converted into honey and act as carbohydrates, while pollen fulfil the colony minerals, fats and proteins. They don't maintain a large amount of stored pollen, other than their current need (Hoover & Ovinge, 2018).

Honeybees are insect that come under order Hymenoptera and family Apidae and are halometabolus. There are four species of honey bees in Pakistan on morphometric, behavioral and biogeoprapic studies based 26 subspecies have been identified (Yadav, Kumar, & Jat, 2017).

Honeys contain about 80% of the sugar which is absorbed by the body. That is how homey is the best source of food for the age of all peoples. As we discuss earlier, *Apis cerana* is one of the four honey bee species of the genus *Apis* (Family Apidae, Subfamily Apinae). *Apis mellifera* is the only species that found throughout the world, while the other species of the Pakistan found inside the Asia. *Apis cerana* is also known as Asian honey bee, Indiana honey bee, and Asian hive bee from all these names people of the Asia know the *Apis cerana* which is used for honey production and also used for the pollination of plants for hundreds of years. Some concept show that *A.cerana* is the closest sister of the *A.mellifera*, showing as wide as range and capacity for variation and adaptation, both the species can tolerate different climate changing environment. A similar to *A. mellifera, A. cerana* genetically and morphologically subdivided into many strains that is not same in their behavior and also their ecological basis, particularly between tropical and temperate strains (Koetz, 2013).

The decline of honeybees is because of many pathogen bacteria, the well-known example of pathogen bacteria is (*Paenibacillus* larvae) which effect larvae of honeybees and which causes sufficient damage to the honeybee's population. The P. larva is the most serious common disease of the honeybee's broods in the entire world. Many types of antibiotics have been developed to control *Paenibacillus* larvae but several problems may have connected with it with continue use. These problems include quality of the honey which is used by the human which affect the health and decrease the life time of the honeybee. The mite Varroa is a damaging parasite of honeybee *A. mellifera* is now one of the most important worldwide pest that beekeeper has to face. Many several acaricides have been developed to control the Varroa infection upto some extent. Most

important is to use natural product against Varroa infection in honeybee's colonies among these, thymol, formic acid and oxalic acid have showed promising effect (Sonmez Oskay, Uygur, Oskay, & Arda, 2025).
The objective of the present study was to study the constraints associated with beekeeping and find out prospects that may enhance the apiculture sector in the study area.

2. Review of Literature

(Otis, Taylor, & Mattila, 2023), Has reported threats to apiculture sector in Japan. The major threat was the goliath hornet, *Vespa mandarinia* Smith (ssp. *latilineata* Cameron), genuine vermin for Japanese apiculture. Impossible to miss propensities were: Exclusive underground nidification, conical and sporadic brush surface and inadequate home envelope, mating before homes, frequent extranidal trophallaxis, and attacks on homes of other social wasps and bumble bees. The assault comprised of three stages, chasing, butcher and home occupation. It was accepted that the propensity for assaulting other social wasps was connected to apiaries and *Apis mellifera* Linne, into Japan. The reason for the calamitous harm to hives was single counterattacks by *A. mellifera,* which has no successful protection. A Study was led on the botanical nectar generation (volume, fixation, all out sugar content) of 76 types of a phryganic network close Athens, Greece. The mean qualities per blossom are 0.76 micro litters, 55.1 % and 0.43 mg, individually. The middle date of blooming isn't identified with any of the nectar esteems estimated. Nectar parameters were family and life-structure participations, together with blossom profundity and shape. Labiatae are the most nectar-remunerating species, differentiating to Composite of the network. Therophytes produce fundamentally less nectar than herbaceous perennials. Species with blossoms > 4 mm profound yield more nectar than those with shallow flowers; the result demonstrates that Nectar focus is adversely connected with bloom profundity (Ortiz, Fernández-Díaz, Pareja, Escudero, & Arista, 2021)
An examination was directed on different parts of beekeeping or apiculture, including state assessment programs, starting nuts and bolts, salary sources and spending plans, protection, Africanized honey bees, natural confirmation, and different honey bee irritations and infections and data on instructive and preparing openings. This distribution is planned as a guide for anybody keen on starting or growing a beekeeping. Makers should know about their states apiary laws concerning review, enlistment, and grants, just as naming and advertising benchmarks and pesticide application laws and pesticide warning laws in respect to honey bees. Beekeepers need to think about risk protection; the likelihood of Africanized cross breed honey bees assuming control over the hives and every one of the nuisances and maladies that impact honey bees and their states. Beekeepers need to ceaselessly screen new advancements in apiculture (Duncan, Cunningham, & Dearden, 2022).
Cavern sketches in Spain (6000bc) demonstrate the relationship of bumble bees with human, when our predecessors taking nectar from wild honey bees homes, which shows that beekeeping is the most established professions. Honey-honey bee had just been around for about 40– 50 million years or more and had developed from its chasing wasp precursors and had turned into a vegetarian. The relationship of Bees advanced with blooming plants, changed and shaded the world in which we live. This developmental harmonious relationship is the critical motivation behind why our reality seems as though it does today. It is a calming thought that, if honey bees and other pollinating creepy crawlies were vanish from earth, people and different creatures would not keep going for longer time (Cramp, 2018).

Beekeepers of Pakistan face issues and extra challenges. In Pakistan in the main season after *A. mellifera* honey bees where presented the biggest nectar crops were recorded with yearly nectar yields averaging 40-50Kg per settlement. At that point, in 1981 beekeepers began to report issues related with the ectoparasitic bumble bee parasite *Tropilaelaps clareae*. This parasite has a comparable life-history to the notorious Varroa mite in that it imitates inside the bumble bees' fixed brood cells. It is about a large portion of the span of Varroa, has a long and slim body shape and its characteristic host is *A. dorsata*. With a scope of climatic conditions and territory types, Pakistan has a rich honey bee fauna that incorporates somewhere around three types of local *Apis* bumble bees. These are the smaller person bumble bee *A. florea*, the slope bumble bee *A. cerana*, and the stone bumble bee *A. dorsata*. Likewise, *A. andreniformes* and *A. laboriosa* is very likely present. The principal presentation of *A. mellifera* into Pakistan (at that point some portion of India) was endeavored amid 1908, yet these states soon kicked the bucket. Amid the following 60 years a further 15 endeavors to present *A. mellifera* from different places in Europe and Russia into Pakistan happened. Be that as it may, all fizzle with the provinces kicking the bucket of obscure causes inside a few seasons. At that point, at long last amid 1977-79, settlements (bundled honey bees) from Australia were effectively settled at the National Agriculture Research Center (NARC) in Islamabad. Pakistani beekeepers in the bumpy locales were keeping up *A. cerana* states as their principle wellspring of nectar production. As of now there are an expected 2,000 beekeepers in Pakistan overseeing somewhere in the range of 200,000 and 300,000 *A. mellifera* provinces delivering around 7,500 tons of nectar every year (Traynor et al., 2020).

3. Materials & Methods

3.1. Study Area

The present study was carried out at District Dir, Swat and Malakand of Khyber Pakhtunkhwa and selected areas of Punjab Province, Pakistan to identify the total number of honeybee colonies, species of honeybees, and threats to the colonies, flora availability and average honey productivity from each colony during 2018-2019. Dir area was visited in 3rd week of March 2019 on different dates. Malakand area was visited on 18th of March and 27th April 2019 and Swat area was visited in 4th week of April, 2019 and Punjab in October 2018.

The area of District Dir is 5280 km² and is at an elevation of 1420m.The latitude of district Dir are from 35º 12' 20.99" north and their longitudes are from 71º 52' 32.02" east. Of surveyed villages, Asbanr and Bambolai are mountainous with Brassica, palosa, keno, lachi, kawary, bera.

The Malakand District is at an elevation of 844m. Its area is 952km² with latitude of 34º 33' 56" and longitude of 71º 55' 49". In Malakand, Batkhela is at an elevation of 683m and latitude is 34º 37' 12.00" north and longitude is 71º 58' 12.00". Its area is 100,1km². It is mounted up with palosa, lachi and spin kikar. Geographical coordinates of Thana are 34° 38' 26" North, 72° 4' 29" East and 709m above the sea level. It is mountainous with vegetables and a fruit includes peas, tomatoes and fruits include plums, apricots, persimmons and peaches. The Swat is located in KP, Pakistan. Its latitude is 35º 22' 42" north and longitude is 72º 10' 47" east. It is at an elevation of about 2,000m above the sea level. Kota is mountainous with palosa and bicond. The Punjab is at an elevation of 300m above the sea level. Its area is 205,344km² with latitude of 31º 8' 49.668" north and longitude of 75º 20' 28.385" east. Talagan is mountainous with jera and kikar. Chakwal is mountainous with palosa, bicond, shautal and lachi.

3.2. Questionnaire

The present study was based on the questionnaires. The samples of questionnaires were distributed among the honeybee keepers in Dir, Swat, Malakand and Punjab areas. Information was gathered from each site by using questionnaires. The questionnaires contain the questions which were food in case of emergency, Type of *Apis* spp, and disease during their egg hatching season, breeding potential and accumulation of plant juice, No. of Bees per colony etc. The survey was also conducted through dialogue with the people of the area. The people were either in groups or individually. The respondents were asked various questions regarding the past history of beekeeping of the area. They were also asked to provide present information. After the dialogue practical activity was also undertaken. It was done to visit actual site and take observation regarding strength of hive and type. The actual bee hives were also visited to see the bee hives per their information.

3.3.Collection of samples

An average of 10 samples of honey bees were collected from each hive and then transferred them to Mason jar. For the preservation of adults, ethyl acetate was used, and the larvae were preserved in 70% of ethyl alcohol. The collected bees were frozen and put on a paper towel to dry for 10 minutes before pinning. For pinning, stainless steel pins and pinning block (Styrofoam) were used. The specimens were held between thumb and forefinger and a size 2 pin was inserted through the scutum on the thorax and it was about 80% up from the top of pin. For smaller specimen we put a small dab of glue to the top of pin and then put the bee on its back and lay the pin across the underside between the thorax and abdomen. The pinned specimens were air dried for at least 3-5 days. The dry specimens were labeled by putting location labels and genus, species below the locality label and then mounted in insect box. Collected data were analyzed using MS Excels 2007.

3.4.Specific Characters of *Apis* Species

The four honey bee species, *Apis mellifera, Apis cerana, Apis dorsata and Apis florea* are different from one another in morphology (size, hair, wing venation, copulatory organ), nesting behavior and Distribution. The fore wing length of smallest bee *A.florea* is 6.06mm and largest bee *A.dorsta* is 14.50mm. While fore wing length of *A.mellifera* is 9.70 and *A.cerana* is 9.02. Hind wing of the *A.florea*is variable. In *A.cerana* and *A.dorsta* the hind wings are present while in *A.mellifera* the hind wings are absent. The Thoracic mass was found to be 7.6mg in *A.florea* and 45.5 mg in *A.dorsata*. *A.florea* and *A.dorsata* have large sexual. There is a fivefold range in worker body mass, but less than twofold range in the size of queens and drones. The *A.florea* and *A.dorsata* are single comb open air nesting species while *A.mellifera* and *A.cerana* are multiple comb cavity nesting species and fly with higher speed compared to *A.florea* and *A.dorsata.* The multiple-combs *Apis* has large body size, long hair and dark color. *A.florea* and *A.dorsata* are tropical species. *A.mellifera* and *A.cerana* adapted to cold climate (Rutter, 2013).

4. Result

Respondents of Asbanr, Dir Lower used to catch a swarm of bees and keep that in a wooden box and then transferred the box to an artificial comb. They had natural type of apiaries and they obtained 10 Kg of honey per colony per year. They fed bees with natural flora of the area i.e. Brassica, KwaryLachi, Palosa, Keno and Bera. They

examined the brood nest of their colonies twice per year. The bees were in the house for one year and made splits (in spring season) every year. They requeened their colonies after every year. During unavailability of flora they fed the bees with home-made pollen supplements. The common *Apis* species of this area was *A.cerana* (Table 1).

In District Malakand, 3 villages were surveyed. The area had comparatively more bees than areas of District Dir. Respondent of Thana kept their bees in wooden boxes and had managed type of apiary. They obtained 10 Kg honey per colony annually. They fed bees with natural flora of the area i.e. palosa and Lachi. The bees were in the house for one year and made splits after every year and also requeen their colonies after every year. They examined the brood nest of their colonies 24 times in a year. During unavailability of flora they fed the bees with home-made pollen supplement. The most common species of this area is *Apis mellifera* (Table 1).

Respondent of Batkhela obtained 10 Kg honey per hive annually. They kept their bees in wooden boxes and had managed type of apiary. They make splits after every year. The most common species of this area is *Apis mellifera* (Table 1). Respondent of Nallu Thana obtained 10 Kg honey per colony annually. The kept bees in wooden boxes and fed them with natural flora but during unavailability of flora they fed them with home-made pollen supplement. They make spills and requeen after every year. The most common species of this area is *Apis mellifera* and *A.cerana* (Table 1).

In District Swat, a locality visited was kota. Respondent of kota obtained 10 Kg honey per colony annually. The bees were kept in wooden boxes and were fed with natural flora. During unavailability of flora or diets they were fed with home-made pollen supplement, sucrose syrup and commercial pollen supplements. They produce their own queens by swarming. In spring swarms can be seen. The most common species of this area was *Apis mellifera* and *A.cerana* (Table 1).

In Punjab, 2 localities were visited and 2 persons were contacted. Respondent of Talagang kept their bees in wooden boxes and fed bees with natural flora in managed type apiary. During unavailability of flora and diets the bees were fed with home-made pollen supplement. They produce their own queens by swarming and in fall swarms can be seen. They examine the brood nest of their colonies four times in a year. *A.mellifera* is the common species of this area (Table 1). Respondent of Chakwal kept their bees in bee boxes. The bees were fed with artificial diets with composition and also with natural flora available in the area. They obtained 42-45 Kg honey by squeezing cut combs in cloth. In summer swarm can be seen. They examine the brood nest of their colonies every day. *A.mellifera* is the common species of this area (Table 1).

4.1.Colonies and Honey production

In 2018-2019 the honey production with unit Kg per colony was obtained and showed that maximum production was observed in chakwal (45Kg) as compared to bambolai (10Kg), Talagang (20Kg), Thana (10Kg) (Table 2). Thana produces the highest number of colonies while Bambolai and Asbanr have lowest (Table 1). Thana Produce the Highest number of bees per colonies while Bambolai and Asbanr have lowest. In kota the observed maximum honey production was 10Kg (Table 2).

4.2.Major threats to colony

From the collected data we observed some of common diseases, mites and pesticides, in the study areas.

In Asbanr and Bambolai the most common disease found in the honeybees was dizziling of honey bees. This disease is caused by Green Housefly. The green housefly

enters the colony where they lay eggs and eat the larvae of bees. The varroa mites were also found in the colonies and were the leading cause of colony death over the winter. In these areas different pesticide compounds have been detected in wax combs of colonies used in agricultural and urban environments. These residues come from pollen that bees collect on flower. These residues absorbed into the wax combs when the bees store the pollen in the colony. The unavailability of diet and climatic change in these areas leads to colony losses. Man-made pollution of dirt and dust was also the cause of colonies losses in these areas (Table 3). In Asbanr and Bambolai, 10% of colonies lost due to average number of significant visible kills across the operation each year due to pesticides. 20% of colonies were lost due to average number of times brood seems to be way below normal. 2% of colonies were lost due to average number of times pupae fail to emerge.100% of colonies were lost to dehydration. 20% of colonies were lost to being overwhelmed by Varroa.10% of colonies were lost with many adults with deformed wings. 10% of colonies were lost to tracheal mite infestations. 100% of colonies were lost to an Ant invasion. 80% of colonies were lost to wasp predation (Table 5).

In Thana, European foulbrood disease, and Chalkbrood disease and varroa mites were major threats to the colonies. 10%-15% of colonies were lost to average number of "significant" visible kills across the operation each year. 2%-4% of colonies were lost to average number of times pupae fail to emerge. 10% of colonies were lost with many adults with deformed wings. 20% of colonies were lost to American foulbrood disease. 5% of colonies were lost with population reduced and retarded swarming. 15% of colonies were lost to ant invasions. 20% of colonies lost to wasp predation (Table 5).

In Batkhela, 20% of colonies were lost to average number of "significant" visible kills across the operation each year and 1-2% were lost to average number of pupae fail to emerge. 70% colonies were lost to dehydration. 10% colonies were lost with many adults with deformed wings. 20% colonies were lost to American foulbrood disease and 10% were lost to tracheal mite infestation. 15% colonies were lost to being overwhelmed by varroa. 20% colonies were lost to an ant invasion and 15% were lost to wasp predation (Table 5).

In Nallu Thana, half of the colonies were lost due to average number of "significant" visible kills across each operation. 20% of colonies were lost when the brood seems to be way below normal. 4% of colonies were lost to average number of times pupae fail to emerge. 100% lost due to dehydration, especially after move to dry spot. 30% of colonies were lost to being overwhelmed by varroa mites. 100% lost to flooding. 10% lost to Ant invasions. 20% colonies were lost to wasp predation (Table 5).

In swat kota, 15-30% colonies were lost when brood seems to be way below normal. 3-10% colonies were lost to average number of pupae fail to emerge. 60% colonies were lost to dehydration. 100% colonies were lost to flooding. 20% colonies were lost with many adults with deformed wings. 20% colonies were lost to American foulbrood disease and 20% were lost to tracheal mite infestation. 40% colonies were lost to being overwhelmed by varroa. 30% colonies were lost to Ant invasions and 30% were lost to wasp predation (Table 5).

In Talagang Punjab, 20% of colonies were lost to American foulbrood disease. 60% of colonies were lost to tracheal mite infestations. Colonies were lost or totally lost due to mismanagement. 10%-15% of colonies were lost to average number of "significant" visible kills across the operation each year. 50% 0f colonies were lost to dehydration especially after moves to dry spots. 40% of colonies were lost with many adults with deformed wings. 100% of colonies were lost to flooding. 100% of colonies were lost to wasp predation (Table 5).

In Chakwal, 50% of colonies were lost to average number of "significant" visible kills across the operation each year. 30% of colonies were lost to average number of times of brood seems to be way below normal. 10% 0f colonies were lost to average number of times pupae fail to emerge. 30% of colonies were lost to dehydration. 20% of colonies were lost with many adults with deformed wings. 15% of colonies were lost to tracheal mite infestations. 10% of colonies were lost to American foulbrood disease. 100% of colonies were lost to flooding. 30% of colonies were lost to ant invasions. 20% colonies were lost to wasp predation (Table 5).

Table 1. ***Status of Apis species in Dir, Malakand Swat & selected areas of Punjab***

Table ***2: Annual honey production in 2018-2019 in district Dir, Malakand, Swat & Selected areas of Punjab***

Study Area	**Annual Honey Production (Kg/Colony)**
District Dir	
Bambolai	10Kg
Asbanr	10Kg
District Malakand	
Batkhela	10Kg
Nallu Thana	10Kg
Thana	10Kg
District Swat	
Kota	10Kg
Punjab	
Talagang	20Kg
Chakwal	45Kg

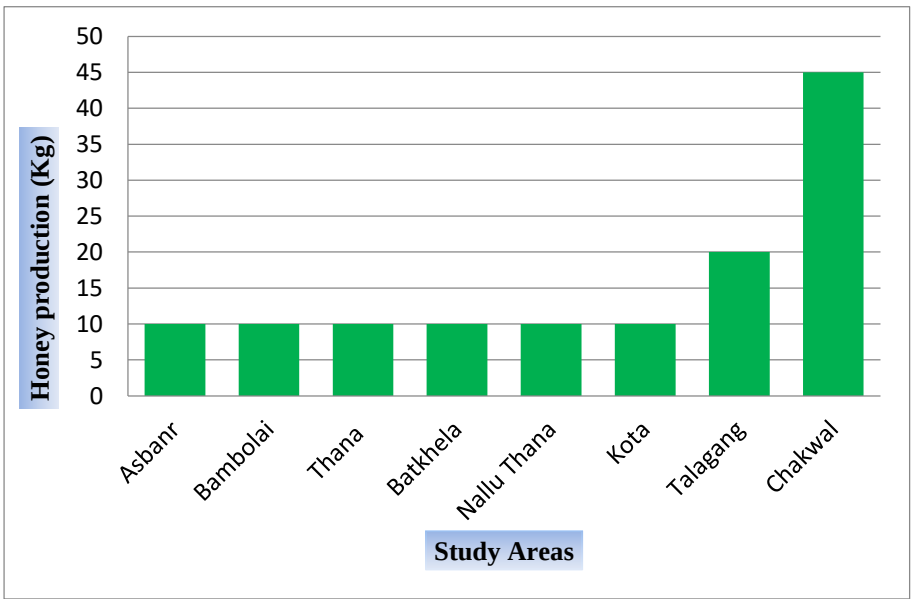


Figure 1. ***Annual honey production from District Dir, Malakand, Swat and Selected***

S No.	Study Area	Name of beekeeper	Type of Apiary	No. of Colonies	Type of *Apis* spp.	Honey Production Kg/Colony	Flora	No. of Bees per Colony
District Dir								
1	Asbanr & Bambolai	Bakht wahid	Natural	1	*A.cerana*	10 Kg	Brassica	1500
							Palosa	
							Keno	
							Lachi	
							Kwaray	
							Bera	
District Malakand								
2	Thana	Kaleem ul allah	Managed	500	*A.mellifera*	10 Kg	Palosa	60,000
							Lachi	
3	Batkhela	Asif Khan	Managed	200	*A.mellifera*	10Kg	Palosa	30,000
							Lachi	
							Spin Kikar	
4	Nallu Thana	Sadam	Managed	150	*A.mellifera& A.cerana*	10 Kg	Palosa	30,000 - 50,000
							Lachi	
District Swat								
5	Kota	Muhammad Anwar	Managed	180	*A.melifera& A. cerana*	10 Kg	Appricote	45,000
							Bicond	
							Kikar	
							Brassica	
Punjab								
6	Talagang	Shah Hussain	Managed	120	Form bees	20 Kg	Jeera	24,000 - 30,000
							Kikar	
7	Chakwal	Nawab khan	Managed	180	*A.mellifera*	45 Kg	Palosa	16,000 - 20,000
							Bicond	
							Shautal	
							Lachi	

areas of Punjab

Table 3. ***Major threats to colony of honeybees***

Areas	Diseases and Parasites	Pesticides	Unavailability of Flora	Impact of Climatic change	Pollution
Asbanr	Varroa mites, Green housefly enter the comb, lay eggs and eat larvae of bees	Diafenthiuron, carbofuran, Imidacloprid, Permethrin	During winter season (November and December)	Snow Fall, High precipitation	Human made dirt and dust
Bambolai	Varroa mites , Green housefly enter the comb, lay eggs and eat larvae of bees	Diafenthiuron, Carrbofuran, Imidacloprid, Permethrin, Malathion	Mostly in the month of November and December	Snow Fall, High precipitation	Human made dirt and dust
Thana	European foul brood Disease, American foulbrood, Disease ,mites, Varrea and Chalkbrood	Diafenthiuron, Malathion, Carbofuran,	In the month of June, October, November and December	Thunder storm, High precipitation	Fog
Batkhela	American foulbrood disease, Chalkbrood disease, Varroa mites, Tracheal mite infestation	Endosulfan, Carbofuran, Diafenthiuron, Malathion	During Winter (October, November And December)	High Precipitation, Heavy Rain	Fog, Dust and Dirt
Nallu Thana	American foulbrood disease, varroa mites, Deformed Larvae	Permethrin, Imidacloprid, Carbofuran, Malathion	In the month of June, October, November, December	Thunder storm, High Precipitation	Fog
Swat Kota	Chalkbrood, Cancer, bees fall from boxes and swallowed by Dyrea	Diafenthiuron, Malathion, Carbofuran, Permethrin	During winter (October, November, December)	Thunder Storm and Heavy Rain	Fog, Dust and dirt from vehical
Talagang	American Foul brood Disease, Tigs and tracheal mites infestations	Diafenthiuron, Endosulfan, Malathion, Copper Oxychloride	During winter season and also in the month of June and July	Change in temperature, Flooding	Only spray
Chakwal	American Foul Brood Disese, Ants invasion, wasp predation, Hybrid Disease(larva dry), Cancer and Varroa mites	Diafenthiuron, Malathion, Endosulfan, Carbofuran	During winter season and in the month of June and July	Flooding	Only spray

Table 4. ***Species specific characters of Apis spp.***

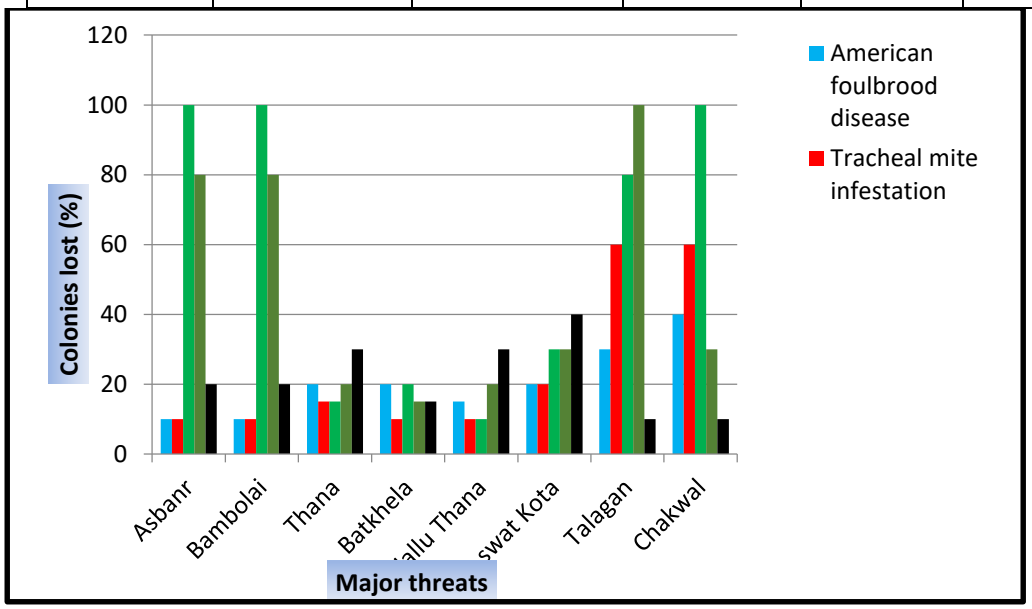
Character	A. florea	A. dorsata	A. cerana	A. mellifera
Fore Wing length (mm)	6.0-6.9	12.5-13.5	7.27-9.02	7.64-9.70

Tomenta	Tergite 3-6	3-6	3-6	3-5
Hind wing: Extension of radial vein	Variable	Present	Present	Missing
Melittin: sequence of amino acids (deviation of mellifera-type)	5 amino acids changed	3 amino acids changed	0	0
Drone 1. Endophallus	1 pair of cornua: Bulb a thin tube	4 pair of very long thin cornua: short bulb	1 pair of cornua, rudiments 3 others, no chitin-plates	1 pair of cornua: Bulb with chitin-plates
Drone 2. Basitarsus 3	Deep incision with plumose hair +spines	Thick pad of sturdy branched hair	Thin pad of plumose hair	Thin pad of plumose hair
Behaviour 1. Capping of drone cells	Solid	Solid	Perforated	Solid
Behaviour 2. Nest	Single comb encircling twig to form a "dance floor", fixed with cell bases	Single big comb fixed at bottom side of branch or rock, fixed with midrib	Several comb in cavity, fixed with comb	Several comb in cavity, fixed with comb
Communication	Sun-oriented dance on platform open to the sky	Sun-oriented dance on vertical comb open to the sky	Sun-oriented dance on vertical comb in cavity	Sun-oriented dance on vertical comb in cavity
Distribution	Sympatric	Sympatric	Sympatric	Allopatric

Table 5. ***Major threats to colony health***

Figure 2. ***Major threats to colony health***

Areas	American foulbrood disease	Tracheal mite infestation	Ant Invasion	Wasp predation	Varroa mites
Asbanr	10%	10%	100%	80%	20%
Bambolai	10%	10%	100%	80%	20%
Thana	20%	15%	15%	20%	30%
Batkhela	20%	10%	20%	15%	15%
Nallu Thana	15%	10%	10%	20%	30%
Swat Kota	20%	20%	30%	30%	40%
Talagang	30%	30%	20%	30%	10%
Chakwal	10%	15%	30%	20%	10%
Mean	16.9%	15%	40.6%	36.9%	21.9%



5. Discussion

The present study was conducted at District Dir, Malakand, Swat and selected areas of Punjab, Pakistan during 2018-2019to evaluate the constraints and prospects of apiculture sector. In this study, total number of colonies in diverse sites, major threats to colonies, loss of colonies due to diseases and pests and annual honey production potential was evaluated in the studied areas. According to the recent results in District Dir, District Malakand and District Swat the number of honey production per colony was uniform while in Punjab, honey production per colony was higher. It may be due to ecological and bionomic issues and causes involved high temperature, moisture in air, environmental pollution and high amount of rainfall which were not compatible for bee rearing, their development stages and affect the productivity of honey. The most important task of beekeeping in the study area involve the maintenance and many honey

bees, accessibility of prospective flowering season of plants, sufficient amount of water for bees, beekeepers experience and practices, socioeconomic value of honey and marketing situation of bee products.

Maximum honey production was interconnected with enough food stuff and qualified beekeeper. In 2007, a study was carry out by Tsutsumi at United State in which he reported that 2443,000 colonies of *Apis mellifera* showed 27.5Kg honey production per colony (Toni, Djossa, Yedomonhan, Zannou, & Mensah, 2018). The influences of these conclusions are that the beekeeper follows the modern method of bee forming, advanced skill of bee rearing and availability of extra balance diet. In 2013 a study was carried out in District Chakwal, which reported that in average of 23Kg honey per colony may be constructed per annum (Qaiser, Tahir, Taj, & Murad, 2013).

Honey production in northern Ethiopia decreases up to 13Kg honey per colony by using traditional methods. At the same time, an impressive increase in honey production up to 30 Kg honey per colony in the same area was perceived by the efforts of trained beekeepers (Etxegarai-Legarreta & Sanchez-Famoso, 2022). Majority of beekeepers in the current study areas, follow the modern method of bee farming therefore since 2018-2019, massive increase in honey production and colony size fall out. This may suggest that complete knowledge in beekeeping activity followed by modern honey processing techniques improve and arouse the production of export quality honey in north west Pakistan. But some beekeepers follow the traditional method of bee farming. Khan et al., noticed that decrease in honey production and colony size in District kohat and karak is due to the use of old method of bee forming (S. Khan, Somerville, Frese, & Nayudu, 2020).

The present data indicate consistent declines in honey bee's colony numbers in the study areas. From the results it was reported that the major problems in beekeeping arise from bee character or environmental factors that are beyond the control of beekeepers. As a result, lacking knowledge, diseases, and attack of pests, mites and predators were the top challenges for beekeeping in the areas. The common diseases found were American foulbrood disease, chalk brood disease and European foulbrood disease. The high rainfall in the area also distributed the rearing and honey production. The use of pesticides was also the major threats to the colonies loss of the study areas. Dai et al., reported that honey bees population have been reduced in regions of Europe and North America due to the toxicity of pesticides. They also reported that most of the death occurs at larval stage than pupae stage due to pesticides exposure and thus impacted larvae survivorship (Dai et al., 2018).

Insecticides and fungicides are most commonly used pesticides by the farmer in Pakistan. The pesticides used in agriculture effecting honey bee health and decline honey bee population. One of the pesticide, imidacloprid leads to honey bee colony collapse disorder (Ahmad, Khan, Khan, Ghramh, & Gul, 2021).

In 2008, heavy use of pesticides was observed in Swat valley, which results 75% of decreased in the natural honey production. 90% 0f of daily honeybee's death are due to the use of pesticides (K. Khan et al., 2022).

In District Karak and Bannu, the higher level of AFB was due to migratory beekeeping activities, While District Kohat honey bee farm have higher level of AFB prevalence which produce shocking effects on honey production. The untreated foulbrood disease destroys bee population and wipes out an apiary (Anjum et al., 2018).

6. Conclusion and recommendations

Maximum honey production was associated with enough food reservoirs and qualified beekeepers. American foulbrood disease, European foulbrood disease and chalk brood

disease were the main constraints to apiculture sector. Varroa mites, wasps and ant invasions also badly affected the honeybee's colonies. The excessive use of pesticides in agriculture crops to control the pests were risky to the biodiversity and affected honey bee health and led to the destruction of entire colonies in the study area. The decline of honey bee fauna was mainly the result of anthropogenic activities, unavailability of flora, climate change impacts and pollution.

It has been recommended that the beekeepers should be trained, made familiar with modern scientific approaches in the field of apiculture and should be provided with enough funds to obtain maximum outcome from beekeeping services. The farmers should use eco-friendly pest control measures and must apply integrated pest management practices for the control of pests in their agricultural fields and should not only depend on chemical control measures. This will enhance the potential of apiculture sector.

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