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## Opportunities and challenges in pollinator's Elevational Movement in Nepal

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### Abstract

In Nepal the migration of honeybee species and its consequences (challenges and opportunities) were not sufficiently studied. So, a survey, field and laboratory study were conducted in Chitwan (Mid-Nepal) and Baitadi (Far-western Nepal) district to determine challenges and opportunities of two species of honeybee namely, *Apis cerana* (Asian honeybee) and *Apis mellifera* (European honeybee) in their elevational migration. The study was conducted in Chitwan and Baitadi districts of Nepal to collect the practical information from farmers on variation of production in rapeseed from 2019 to 2021 due to the migration of two species (i.e., *A. cerana* and *A. mellifera*) of honeybees. Secondary information was gathered from government stakeholders in the district. Field and laboratory study was carried out to understand the effect of elevation and relative humidity in the life span of worker honeybees. In absence or migration of *A. cerana* the species *A. mellifera* of honeybee significantly contributed to pollination and rapeseed production in Chitwan district. The average highest production of rapeseed was 780 kg/ha while lowest was 600 kg/ha in Chitwan district during different timespan. Similarly, during the migration period of *A. mellifera* the species *A. cerana* contributed to improving the production of rapeseed in the Baitadi district. The average highest production of rapeseed in Baitadi district was 650 kg/ha during the year 2019 and lowest of 490 kg/ha in 2021. With increase of elevation and decrease of relative humidity the life span of worker honeybees (both *A. cerana* and *A. mellifera*) gradually increased. Therefore, both the species *A. cerana* and *A. mellifera* have significant opportunities and challenges when they migrate from one place to another in Chitwan and Baitadi districts of Nepal.

**Keywords:** Beekeepers, honeybee, migration, production, rapeseed, yield

### 1. Introduction

Pollinators (insects) globally improve the yield and quality of crop plants by 75% (Klein *et al.*, 2007) [7], but pollination services are in risk globally (Potts *et al.*, 2016) [10]. Decrease in insect pollinators have been reported across most regions of the world where historic data and monitoring programs enable such assessments (Cameron *et al.*, 2011; Powney *et al.*, 2019; Van Klink *et al.*, 2020) [3, 11, 15]. These declines are thought to be driven by a combination of anthropogenic constraints that include agricultural intensification, habitat loss, disease, pesticide use, climate change and environmental factors (Potts *et al.*, 2010; Goulson *et al.*, 2015; Dicks *et al.*, 2021; Müller *et al.*, 2023) [9, 6, 4, 8].

Due to the significant honey production and pollination activities honeybees are considered as highly imperative insects or pollinators in the world & they are also recognized as economically valuable insects. Honey, bee wax, royal jelly, pollen, propolis, and bee venom are all produced by honeybees. They are economically important because they produce honey and bee wax with the service as major pollinators for a variety of agricultural and horticultural crops. Honeybee pollination improves agricultural productivity, influences seed and fruit quality, and facilitates heterosis to be taken advantage. Honeybees are regarded as crucial agent in crop growth and development that produces qualitative and quantitative fruits, flowers, vegetables, or other agricultural products.

The population of *A. cerana* in high altitude regions is declining due to a variety of factors including widespread inclusion and promotion of *A. mellifera* species by the public and private sectors through development invasion, changes in their habitat and biodiversity, non-judicious pesticide use, disease, and parasite attacks and so on (ICIMOD 2001). When two or more bee species struggle for the same pollen and nectar supplies, it has been observed that the *A. cerana* are displaced and dislocated from their habitat by the population species of *A. mellifera* in the same area.

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*A. mellifera* also carries more pollen, is less aggressive, and produces more honey than *A. cerana*, the native bee. For beekeepers that want to decline their colonies as little as possible, it is less prone to swarming (FAO 1986).

Out of nine honeybee species four species are native of Nepal, namely, *Apis laboriosa* (Smith 1871), *Apis dorsata* (Fabricius 1793), *Apis florea* (Fabricius 1787) and *Apis cerana* (Fabricius 1793). The Himalayan world largest honeybee, *Apis laboriosa*, is diversified from 850 m up to 3500 m in northern parts of fragile ecological Himalayan regions.

In order to save from harsh condition of environment, *Apis dorsata* also seasonally migrates back and forth between low (10 m) and uplands (1100 m). During the winter season, when the ambient temperature is decreased below 10 °C in hilly areas, they move within 60 m to 350 m in Terai regions, where the highest ambient temperature is fairly remained above 10 °C throughout the winter period. It is assumed that *Apis dorsata* migrates in low agricultural lands, and they combine in a mass from 25-120 colonies (depend on nesting spaces availability) on a single man-made structure probably they need strong support to hold their huge nest. During such time of the year diverse crop fruits are observed blooming in the area. A single fully-grown nest may have the quantity more than 20 kg including brood, honey, pollen, and adult bees. Due to heavy rainfall, wind, low food & decreased numbers of individual in the colony these honeybees never come together in wet season (THAPA *et al.*, 1999; THAPA 1999) [13, 14].

*Apis cerana*, the eastern hive bees, occurs from 60 m to 3500 m in Nepal. Three subspecies of *Apis cerana*, namely, *Apis cerana cerana*, *Apis cerana Himalaya* and *Apis cerana indica* have been registered in Nepal (Verma 1990) [16]. *Apis cerana cerana* is distributed in high western hilly regions, *Apis cerana Himalaya* abundant in mid-eastern hilly regions and *Apis cerana indica* in plain region of Nepal. The golden bee, *Apis cerana cerana* seems be compatible with *Apis mellifera* in honey production, the bee that release small volume of hone called *Apis cerana indica* also called as black poor bee. The bee, *Apis cerana* observed swarming two time in a year, i.e., one in summer (March-May) and another in winter (November-December).

The population of *A. cerana* colonies noticed in small amount during highly harsh environmental condition and at that time they have rare floral resources in hills of Nepal. Those colonies which cannot migrate from one place to another or abscond die in the mid of the winter by being unable to maintain constant brood nest temperature and by lack of honey. However, the unique feature of *Apis cerana* is that they can vigorously survive even below -0.1°C in high hilly areas, whereas *Apis mellifera* bees are completely freeze at the same temperature, and it becomes challenging for *A. mellifera* to move, brood, migrate or forage during such time period. The study was carried to explore the opportunities and challenges of *Apis cerana* and *Apis mellifera* with their elevational movement in different parts of Nepal (Baitadi and Chitwan).

## 2. Materials and Methods

A study was carried out in Chitwan and Baitadi districts of Nepal during December 2022 to March 2023 to determine the constraints & benefits of *A. cerana* (Asian honeybee) and *A. mellifera*' s (European honeybee) migration or movement. The study site Chitwan has an altitude of 300-350 masl while Baitadi with 400-2900 masl. KII (Key Informant Interview) and FDG (Focus Group Discussion) was conducted to collect primary information on variation of rapeseed production in the districts. Yield and yield attributes of rapeseed were collected both from farmers and the Department of Nepal government during the same time span. The life span of worker honeybees was compared with changing elevation and relative humidity in both altitudes of Baitadi and Chitwan district (conducted field and laboratory investigation).

The recorded data were all tabulated and systematically arranged using MS- Excel which were subjected to Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT-0.05 level) for mean separations using Gen stat software.

## 3. Results and Discussion

### 3.1 Effect of migration of *A. cerana* (Asian honeybee) & *A. mellifera* (European honeybee) in rapeseed in Chitwan, Nepal

**Table 1:** Effect of migration of *A. mellifera* in rapeseed in Chitwan, Nepal

Numbers of Participants	Average yield of rapeseed (kg/ha) in 2019	Average yield of rapeseed (kg/ha) in 2020	Average yield of rapeseed (kg/ha) in 2021
1	400	460	470
2	500	500	490
3	390	385	400
4	410	420	410
5	420	425	440

It was observed that the production of rapeseed was lower than the average maximum yield. *A. mellifera* were considered as appropriate and potential honeybee species in Chitwan (plain region). When these species were moved in

the communities, pollination declined and so the production. Lowest of 390 kg/ha and highest of only 500 kg/ha of rapeseed in average was recorded in the district (Table 1).

**Table 2:** Effect of migration of *A. cerana* in rapeseed in Chitwan, Nepal

Numbers of Participants	Average yield of rapeseed (kg/ha) in 2019	Average yield of rapeseed (kg/ha) in 2020	Average yield of rapeseed (kg/ha) in 2021
1	600	650	700
2	720	710	700
3	750	790	770
4	690	680	700
5	715	725	780

Migration of *A. cerena* have significant impact in the rapeseed production in Chitwan district. The average production found highest with 780 kg/ha while lowest of 600 kg/hac in the district. The movement of *A. cerena* might be recovered by *A. mellifera* in increasing the production (Table 2). Supported our findings that during the absence of *A. cerena*, colonies of *A. mellifera* overtake the pollination and additionally the environmental condition also favor's *A. mellifera* to improve

their potentiality especially with the higher temperature. The result was also supported by Rafiq-Ahmad (1992) [12] that the potentiality of *A. mellifera* in pollination and improving production were significant in field crops.

**3.2 Effect of migration of *A. cerena* (Asian honeybee) & *A. mellifera* (European honeybee) in rapeseed in Baitadi, Nepal**

**Table 3:** Effect of migration of *A. cerena* in rapeseed in Baitadi, Nepal

Numbers of Participants	Average yield of rapeseed (kg/ha) in 2019	Average yield of rapeseed (kg/ha) in 2020	Average yield of rapeseed (kg/ha) in 2021
1	350	390	400
2	420	380	390
3	320	385	400
4	390	400	410
5	340	410	400

In Baitadi, after migration of *A. cerena* in from rapeseed field production of rapeseed observed decreasing. It was found that in the district the average highest of 420 kg/ha during 2019 exceeds the lowest of 380 kg/ha rapeseed production during the year 2020 (Table 3). The result was supported by the

several findings such as Verma (1992) [17] according to whom in absence of *A. cerena*, *A. mellifera* are lethal in higher altitude and the activity of pollination declines those results in lower yield of crops such as oilseeds.

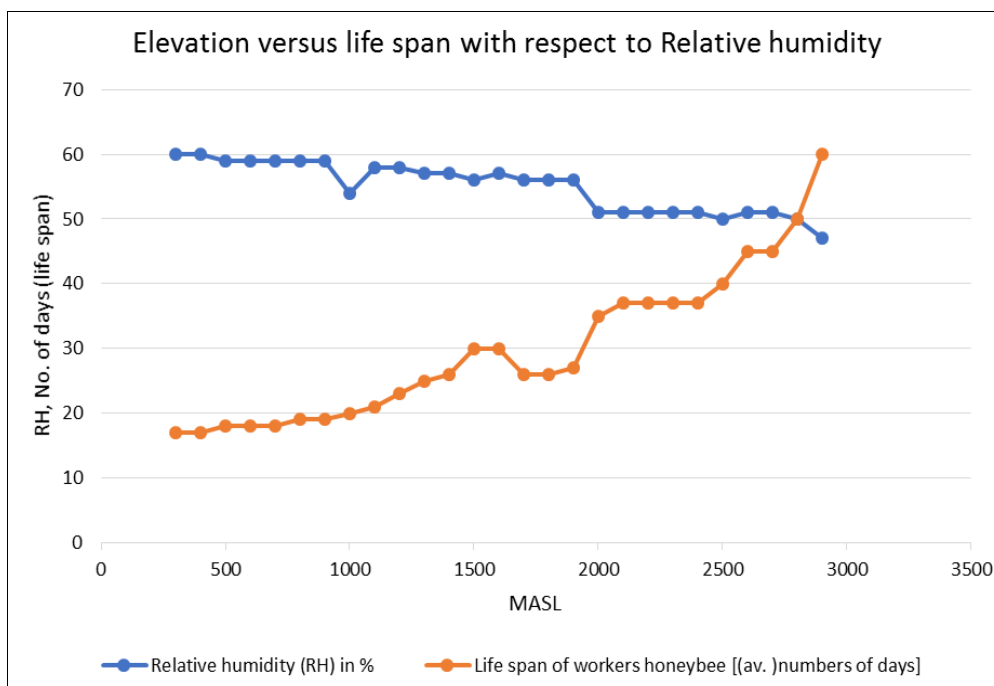
**Table 4:** Effect of migration of *A. mellifera* in rapeseed in Baitadi, Nepal

Numbers of Participants	Average yield of rapeseed (kg/ha) in 2019	Average yield of rapeseed (kg/ha) in 2020	Average yield of rapeseed (kg/ha) in 2021
1	500	550	600
2	610	500	490
3	600	580	610
4	650	600	600
5	620	600	590

It was surveyed that the average highest production of rapeseed in Baitadi district was 650 kg/ha during the year 2019 and lowest of 490 kg/ha in 2021, after migration of *A. mellifera* (Table 4). It was expected that the production increased due to improved involvement of *A. cerena* in

pollination process in absence of *A. mellifera* in the district.

**3.3 Effect of elevation and relative humidity in the life span of worker honeybees [*A. cerena* (Asian honeybee) & *A. mellifera* (European honeybee)]**



**Note MASL:** Meter Above Sea Level

**Fig 1:** Relationship between elevation, relative humidity, and life span of honeybee species

It was recorded that with increasing elevation the relative humidity decreases while average numbers of days (life span) of honeybee workers increases gradually. Lowest lifespan with average of 17 days was observed at 300 masl and 60% RH. Similarly, highest lifespan with average of 60 days found at 2900 masl with 47% RH. Both species *A. cerena* (Asian honeybee) & *A. mellifera* (European honeybee) found equally affected by RH and elevation (Figure 1).

The investigation from Gonzalez *et al.* (2020) [5] supports our findings that increase in elevation have positive effect in growth and life span of honeybees. Cameron and Sadd (2020) [2] have also found similar result that variation in elevation have potential effect in the life span and diversity richness of pollinators such as bees.

#### 4. Conclusion

A study was carried out in Chitwan and Baitadi districts of Nepal during December 2022 to March 2023 to determine the constraints & benefits of *A. cerena* (Asian honeybee) and *A. mellifera*'s (European honeybee) migration or movement. In absence or migration of *A. cerena* the species *A. mellifera* of honeybee found contributing to pollination and rapeseed production in Chitwan district. The average highest production of rapeseed was found to be 780 kg/ha while lowest with 600 kg/ha in Chitwan district during different timespan. Similarly, during the migration period of *A. mellifera* the species *A. cerena* found contributing to improving the production of rapeseed in the Baitadi district. The average highest production of rapeseed in Baitadi district was found to be 650 kg/ha during the year 2019 and lowest of 490 kg/ha in 2021. With increase of elevation and decrease of relative humidity the life span of worker honeybees (both *A. cerena* and *A. mellifera*) gradually increased. Thus, both the species *A. cerena* and *A. mellifera* have significant opportunities and challenges when they migrate from one place to another in the respective districts.

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