American Journal of Agricultural and Biological Sciences

Research Article

Seasonal Pattern of Varroa Mite Infestation and Its Impact on Honey Production in *Apis mellifera* Beekeeping in Chitwan, Nepal

Sujan Amgai[1, 2] and Kedar Devkota[2]

[1]*Beekeeping Development Center, Bhandara, Chitwan, Nepal*
[2]*Agriculture and Forestry University, Rampur, Chitwan, Nepal*

Article history
Received: 26-10-2025
Revised: 02-04-2026
Accepted: 10-07-2026

Corresponding Author:
Sujan Amgai
Beekeeping Development Center, Bhandara, Chitwan, Nepal
Email: sujanamgai@gmail.com

Abstract: Honeybee colony health and productivity are severely affected by infestations of Varroa mites, which have become one of the most significant threats to apiculture due to their role in colony weakening, reduced productivity, and increased colony losses worldwide. The study was conducted in Chitwan district to assess beekeepers' perceptions on mite infestation in different seasons, its effect on honey production, and the management practices adopted by the beekeepers. 120 beekeepers were selected using simple random sampling as respondents, and information on beekeeping management practices and beekeepers' perceptions was gathered using a pre-tested semi-structured questionnaire. Beekeepers reported that the Varroa mite infestation and honey production varied across the season. Most of the beekeepers perceived that mite infestation was higher in spring and summer whereas honey production remains comparatively low. Thereafter, infestation gradually decreased, reaching its low level in autumn (10.40%), when honey production increased to 22.60%. However, mite infestation began rising again in winter which is peak season for the honey production as well. The increase in mite infestation may be due to abundant forage availability and increased brood that favor mite population growth. Almost half of the beekeepers experienced moderate loss of honey production of 5-15% due to mite infestation, highlighting the remarkable impact of mite infestation on honey production. Similarly around one fourth of beekeepers reported colony losses due to mite infestation, showing the persistent threat posed by Varroa mites. Beekeepers were practicing various management practices to control the mites; among them formic acid was the most widely used treatment, followed by combinations of formic acid with local treatment measures. Overall, the results highlight that although the mite infestation is manageable their persistent occurrence may reduce honey production and remains significant challenges to sustainable beekeeping in Nepal.

Keywords: *Apis mellifera*, Mite Infestation, Honey Production, Season, Management Practices

Introduction

Worldwide, beekeeping enterprise is widely practiced agricultural activities (Vural and Karaman 2010), and is valued for its high potential to support rural livelihoods, providing additional income to the rural poor, conserving biodiversity, and enhancing crop productivity through pollination (Devkota, 2020; Girma and Gardebroek, 2015; Gratzer et al., 2021). Beekeeping has been practiced since long time in Nepal and is regarded as a promising sector for employment generation and income diversification (Aryal et al., 2015; Devkota, 2020; Devkota et al., 2025). Although commercial beekeeping in Nepal was started in 1989 with *Apis cerana* whereas its commercialization accelerated after the introduction of European honeybee *Apis mellifera* in 1994, leading to rapid expansion in the Terai region due to higher honey production (Devkota, 2020). Honey production has steadily increased almost by 10 folds in twenty years' time period showing the high potential of the beekeeping (MoALD, 2023). Beekeeping is not only accounted for the honey production, it major contribution was in pollination contributed around $477 million which is approximately 10% of the AGDP of Nepal (Devkota, 2024). Despite of the high potential of beekeeping, multiple factors like pathogens, parasites, pesticide exposure, and poor nutrition have direct impact on beekeeping (Alger et al., 2018; Carreck et al., 2010; Higes et al., 2008; Human et al., 2014).

Among the factors, the various diseases and pests are considered the most, which reduce their hive productivity, performance, and overall health (Evans, 2003; Sanford et al., 2007; Tutun et al., 2018). The Varroa mite (*Varroa destructor*) is the ectoparasite, regarded as the most damaging pest of managed *Apis mellifera* colonies worldwide (Anderson and Trueman, 2000; Ayan et al., 2019; Guzman et al., 2009; Jack and Ellis, 2021; Kovacic et al., 2023), which not only weaken colonies, but also serve as the vector to transmits various viral pathogens (Chen and Siede, 2007; Genersch and Aubert, 2010; Traynor et al., 2020). Every year, thousands of colonies are weakened or destroyed by mite infestations, leading to significant losses in honey and other bee products (Woyke, 1985). Colony losses and reduced honey yield due to mite infestations, have been reported across Asia, including China (Youguan et al., 2000), Pakistan (Rehman, 2018), Nepal (Shrestha and Gautam, 2020; Wilde et al., 2000) and India (Chhuneja et al., 2004).

Varroa mite infestation is regarded as major problems in beekeeping, as it directly affecting colony health and honey production. Thus, this study was conducted to assess the beekeepers' perceptions on the seasonal pattern of mite infestation, its effect on honey production and management practices used by the beekeepers to control the mites in Chitwan district of Nepal.

Materials and Methods

Study Site

Chitwan district was selected as the study area as it serves as the hub of *Apis mellifera* beekeeping in Nepal (BDC, 2023) shown in Figure 1. The district has a subtropical climate with distinct spring, summer, autumn, and winter seasons, which supports diverse flowering plants throughout the year. Agriculture is the dominant land-use system, with 87.3% of cultivable land under cultivation with major crops including paddy, maize, wheat, oilseeds, and millet/buckwheat (ADO, 2023). These crops, along with wild flora, provide continuous forage resources for honeybees, making the district suitable for commercial beekeeping. The district comprises approximately 17,500 bee hives managed by around 450 commercial beekeepers, producing about 500 metric tons of honey annually, highlighting the economic importance of beekeeping in the region (BDC, 2024).

Data Collection and Analysis

A multistage sampling techniques were adopted to collect the relevant datasets in the year 2025. Three local levels namely Kalika, Khairahani and Rapti municipalities of Chitwan district were selected purposively. A simple random sampling technique was used to select the beekeeping respondents from the sampling frame of beekeepers obtained from the Beekeeping Development Center (BDC), Chitwan (BDC, 2024). 120 beekeepers who were actively managing at least 30 bee hives were included in the study to ensure the focus on commercial scale operations. Primary data were gathered through in person interviews with the respondents using a pre-tested semi-structured questionnaire. The questionnaire was pre-tested with a 10 beekeepers those who were from the outside of the study area. Necessary amendment was done on the questionnaire before conducting the final survey. The final questionnaire was designed to collect relevant information on socio-demographic characteristics of the respondents, status of honey production in different season, knowledge and perception on the Varroa mite's infestation, season of infestation, control measures and honey and colony losses due to mite infestation. The collected data were coded, edited and entered in MS-excel. Similarly, mean, frequency and percentage were calculated to summarize the results and figures were prepared using the R software (version 4.5.1).

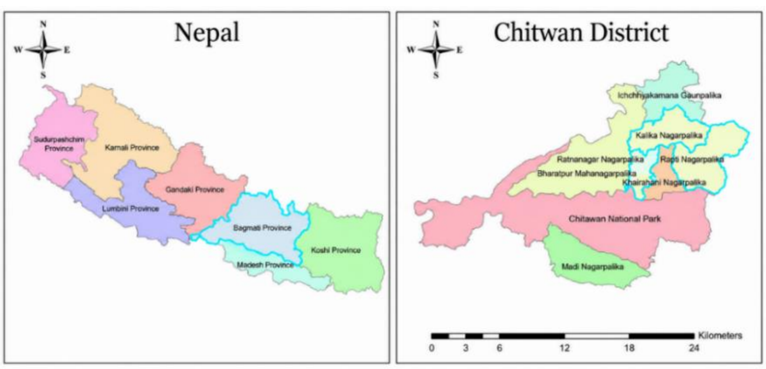


Fig. 1: Map of study site

DOI: 10.3844/ajabssp.2026.25.31

Results

Socio-Demographic Characteristics of Respondents

The socio-demographic characteristics of beekeepers, including gender, education, and number of bee hives, were shown in Table 1. Beekeeping was largely dominated by males (93.33%), indicating limited female participation in this sector. More than 95% of the beekeepers were educated, with 41.67% having completed secondary education, while only 3.33% were illiterate. Regarding the number of bee hives, the majority of beekeepers (58.33%) managed 50-100 bee hives, followed by 21.67% managed more than 100 bee hives. The number of bee hives indicates that most beekeepers were commercial.

Beekeepers' Perception on Honey Production and Mite Infestation Level

During the spring and summer seasons, the beekeepers reported that honey production was low, while mite infestation was high (40.3% and 26.7% respectively). In autumn season the beekeepers responded that mite infestation decreases to 10.4% with moderate increase in honey production (22.6%). However in winter season they observed that honey production reach to peaked (60.10%) while mite infestation started to increase again (22.6%) as shown in Fig (2). Beekeepers observed that mite infestation begins to increase in winter, possibly due to high brood levels in bee colonies (Rapeseed forage). They reported that the infestation reaches its peak in spring likely due to multiplication of mite population. Similarly, they observed a gradual declines in mite infestation during summer and finally reaches its low level in autumn (Fig. 2).

Honey and Colony Losses Due to Mite Infestation

Nearly half of the beekeepers (43%) experience honey production losses of less than 5% due to mite infestation, suggesting the problem remains relatively manageable. However, 50% of beekeepers reported moderate losses between 5-15%, while 7% faced severe losses exceeding 15% (Fig. 3A). On an average, the overall honey losses across all beekeepers was calculated at 9.67%, suggesting that mite infestation poses a considerable challenge to honey production. The study revealed that only one-fourth of beekeepers experience bee colony losses due to mite infestation, suggesting the problem remain relatively manageable but indicates persistent threat to beekeeping (Fig. 3B). These results underscore the need for continuous monitoring and timely treatment to prevent smaller losses from escalating into large-scale colony declines that could undermine beekeeping sustainability.

Table 1: Socio-demographic characteristics of respondents in the study area

Variables	Frequency	Percentage
Gender of beekeepers		
Male	112	93.33
Female	8	6.67
Education of beekeepers		
Illiterate	4	3.33
Primary level	34	28.33
Secondary level	50	41.67
Higher education level	32	26.67
Number of bee hives		
Less than 50 bee hives	24	20.0
50-100 bee hives	70	58.33
Greater than 100 bee hives	26	21.67

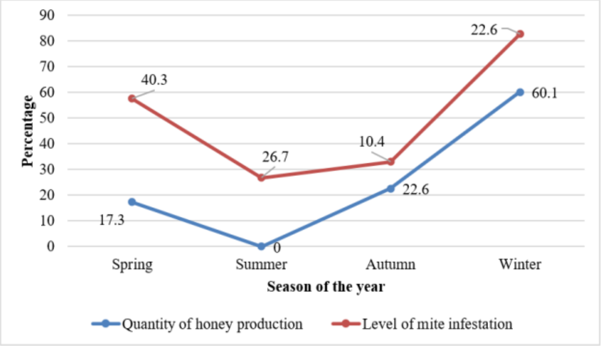
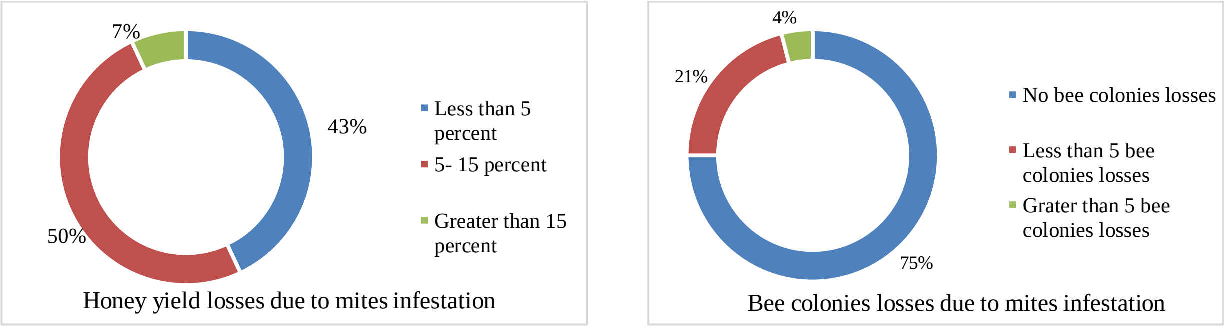


Fig. 2: Honey production and mite infestation level in different season



(a) (b)

Fig. 3: Honey and colony losses due to mite infestation

DOI: 10.3844/ajabssp.2026.25.31

Management Practices to Control Mite

The respondents adopted different management practices to control the Varroa mite infestations. Among the different management practices the use of formic acid was the most widely used treatment method to control the Varroa mites. Around 85% beekeepers (104) reported that they used formic acid alone, showing it as the most preferred and trusted option for mite control (Fig. 4). Meanwhile, 82 beekeepers combined formic acid with local treatments, suggesting that they rely on an integrated approach to enhance effectiveness. Similarly, 75 beekeepers reported using formic acid and Apistan alternately, reflecting efforts to prevent resistance and improve control. In contrast, only 16 beekeepers relied solely on local treatments such as Menthol oil 5-10 drops per hive, extract of leaf and root of sweet flag, curry leaf plant, leaf of holy basil, leaf of *Azadirechta indica*. Some beekeepers also practice queen caging to control Varroa mite (Fig. 4). Overall, the beekeepers used the formic acid, either alone or in combination with other treatments, was the most effective and widely adopted management practice among beekeepers. Furthermore, the application methods of menthol oil, Apistan strips, and formic acid used by beekeepers in the study area (Fig. 5).

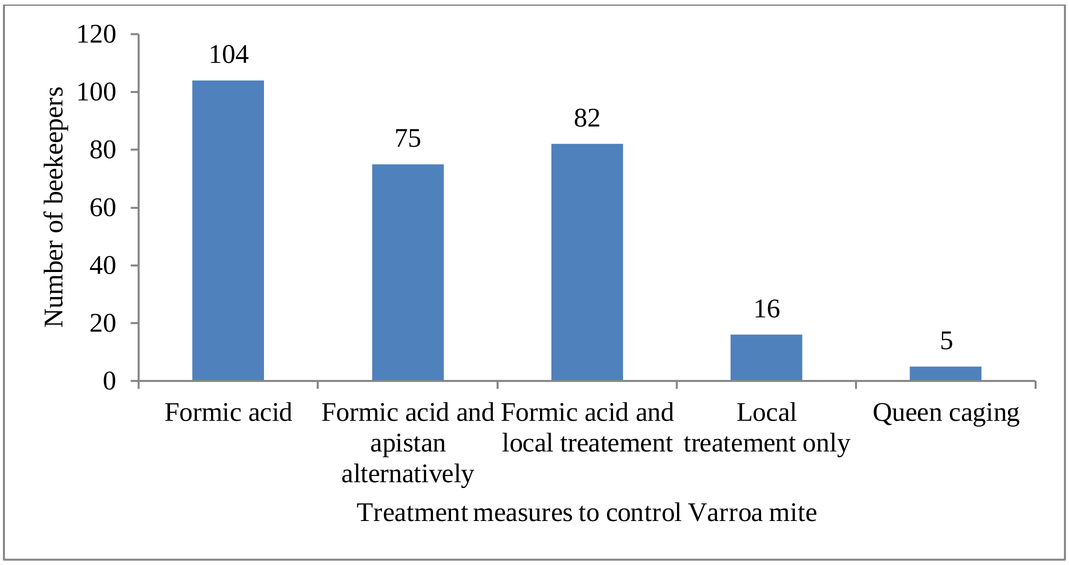


Fig. 4: Management practices adopted by beekeeper to control Varroa mite

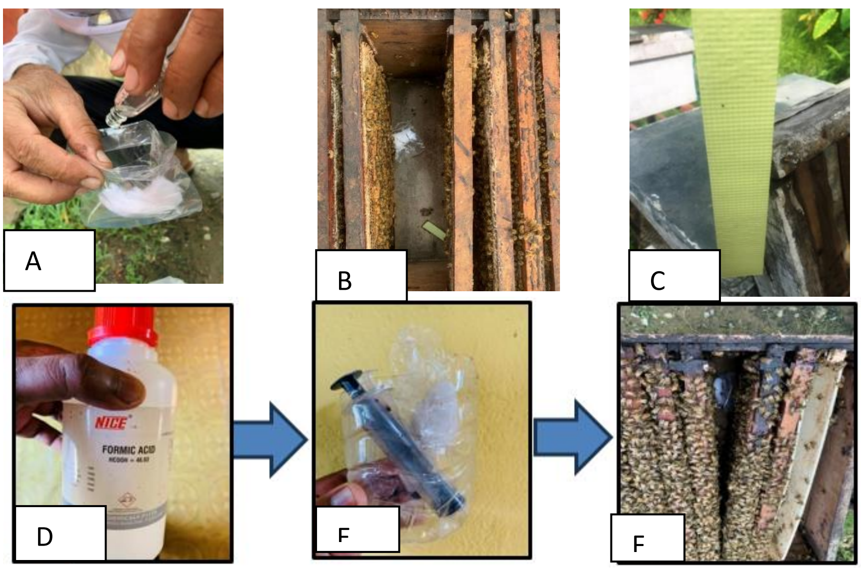


Fig. 5: A) Application of Menthol oil on cotton. B) Placement of Menthol oil treated cotton at the base of the hive. C) Use of Apistan strips in bee colonies. D, E and F) Formic acid application process adopted by beekeepers in the study area

Discussion

The study attempts to analyze the beekeepers' perception on the Varroa mite infestation and the Varroa infestation season in the *Apis mellifera*. The beekeepers were dominated by the male with a secondary level of education. The gender differentiation in the beekeeping reflects that the beekeeping is tedious, heavy and needs a lot of travel. Normally, the beekeepers used to harvest 83% of honey during the autumn and winter seasons. This pattern is typical of the previous study of honey harvesting, which occurs through early autumn, peaking after major nectar flows (Devkota, 2020; Pokhrel, 2009). Our results illustrate the beekeepers perception of the Varroa mite infestation, where they perceived that the mite's infestations persisted in colonies throughout the year. It was reported that mite's population gradually increased in winter and peaked in spring (Neupane, 2009; Renz and Rosenkranz, 2001; Shrestha et al., 2020). Beekeepers reported that the presence of mites immediately causes no damage to the beehives, whereas long-term infestation may cause economic loss by reducing the honey production by around 10%. Under such circumstances, effective management practices are crucial, as unchecked infestations negatively affect bee health, reduce honey yields, and weaken colonies (Neupane, 2009; Shrestha and Gautam, 2020).

According to the beekeepers perception the formic acid, menthol oil and botanical extracts were widely used to control Varroa mite infestations. Beekeepers perceived these treatments as effective and safer for the bee colonies. Soft chemicals, including essential oils and organic acids, are naturally derived substances that do not leave harmful residues in colonies or hive products (Devi et al., 2019). However, some beekeepers still relied on synthetic chemicals such as Apistan (Fluvalinate) for mite control. Farmers reported using Apistan either alone or in rotation with formic acid to improve treatment effectiveness and reduce mite infestation. Some studies has shown that prolonged use of synthetic chemicals developed the resistance to the Varroa mites and affect beeswax quality (Devi et al., 2019; Maggi et al., 2010; Roth et al., 2020). The resistance development of the synthetic miticides had encouraged the development of alternative control strategies, such as essential oils, organic acids, biotechnical methods, and Integrated Pest Management (IPM) (Ayan et al., 2019; Devi et al., 2019; Underwood and López-Uribe, 2022). Within IPM, mechanical approaches include screened bottom boards, drone brood removal, and powdered sugar dusting; biological options involve entomopathogenic fungi and mite predators; and chemical methods range from soft chemicals (organic acids, essential oils, thymol) to hard chemicals (Apistan, Amitraz, Fluvalinate) (Devi et al., 2019; Rosenkranz et al., 2010; Roth et al., 2020; Underwood and López-Uribe, 2022).

The beekeepers have further emphasized the regular monitoring and timely treatment application to minimize the colony loss and sustain the colony health (Underwood and López-Uribe, 2022). Similar studies have reported that unmanaged Varroa mite infestations can reduce honey production, weaken colonies, suppress immunity, and eventually lead to colony collapse (Traynor et al., 2020). Furthermore, Varroa mites are known vectors of several viral pathogens, including Deformed Wing Virus (DWV), which significantly increases colony mortality and reduces colony productivity (Gajger et al., 2025). Therefore, effective mite management is essential not only for maintaining honey production but also for ensuring overall colony health and pollination services.

Conclusion

The study revealed that a unique relationship exists between honey production and mite infestation across different season. We found a distinct seasonal relationship between honey production and mite infestation, with high infestation and low honey production during spring and summer, and increasing infestation alongside peak honey production in winter. Although average honey yield losses due to mite was approximately 10%, the transfer of viral diseases is a major challenge in beekeeping. Colony losses due to mite infestation were relatively limited, yet the presence of mites remains a persistent threat to beekeeping sustainability. Beekeepers adopt diverse management practices, with the use of formic acid as the major treatment. Overall the study highlights the need for routine monitoring of colonies, seasonal management and the implementation of integrated pest management (IPM) strategies to reduce mite infestation and the consequent losses in honey production. Enhancing farmer training on the sustainable use of mite control practices, promoting safer treatment options, and conducting further research on Varroa associated viral diseases and locally available botanical treatments will be essential for improving honey bee health and ensuring sustainable beekeeping development in Nepal.

Abbreviations

AGDP: Agricultural Gross Domestic Product; ha: hectare; IPM: Integrated Pest Management; DWV: Deformed Wing Virus.

Acknowledgment

The authors thank the Beekeeping Development Center, Bhandara, for providing beekeeper lists and technical support, and all beekeepers of Chitwan district for their valuable participation during the survey.

Funding Information

Authors did not received any grant or financial support to conduct the research or publication of this article.

Author's Contributions

Sujan Amgai: Conceptualization, data collection, formal analysis, writing original draft preparation.

Kedar Devkota: Supervision, methodological guidance, writing review and edited.

Ethics

The authors confirm that this manuscript is an original work, has not been published previously, and is not under consideration elsewhere. All authors have read and approved the final version of the manuscript and declare that no ethical issues are associated with this study.

Data Availability

The corresponding author will provide the datasets upon reasonable request.

Conflicts of Interest

The authors did not have any conflicts of interest to disclose.

References

ADO. (2023). *Annual progress report: Fiscal year 2022/23*.

Anderson, D. L., & Trueman, J. W. H. (2000). Varroa jacobsoni (Acari: Varroidae) is more than one species. *Experimental & Applied Acarology*, *24*(3), 165–189. https://doi.org/10.1023/a:1006456720416

Aryal, S., Thapa, R., & Jung, C. (2015). An overview of Beekeeping Economy and Its Constraints in Nepal. *Journal of Apiculture*, *30*(3), 135. https://doi.org/10.17519/apiculture.2015.09.30.3.135

Ayan, A., Tutun, H., & Aldemir, O. S. (2019). Control methods against Varroa mites. *International Journal of Advance Study and Research Work*, *2*(11), 19–23.

Alger, S. A., Burnham, P. A., Lamas, Z. S., Brody, A. K., & Richardson, L. L. (2018). Home sick: Impacts of migratory beekeeping on honey bee (*Apis mellifera*) pests, pathogens, and colony size. *PeerJ*, *6*, e5812. https://doi.org/10.7717/peerj.5812

BDC. (2023). *Annual progress report*. Fiscal Year 2022/23, Beekeeping Development Center, Chitwan, Nepal

BDC. (2024). *Annual progress report*. Fiscal Year 2023/24, Beekeeping Development Center, Chitwan, Nepal

Carreck, N. L., Ball, B. V., & Martin, S. J. (2010). Honey bee colony collapse and changes in viral prevalence associated with Varroa destructor. *Journal of Apicultural Research*, *49*(1), 93–94. https://doi.org/10.3896/ibra.1.49.1.13

Chen, Y. P., & Siede, R. (2007). Honey Bee Viruses. *Advances in Virus Research*, *70*, 33–80. https://doi.org/10.1016/s0065-3527(07)70002-7

Chhuneja, P., Singh, J., Gatoria, G. S., & Brar, P. K. (2004). Varroa mite-A potential threat to Indian apiculture. *Indian Bee Journal*, *66*(3–4), 112–122.

Devi, S. D., Devi, M., & Chitralekha. (2019). Different methods for the management of Varroa mite (Varroa destructor) in honey bee colony. *Journal of Entomology and Zoology Studies*, *7*(4), 178–182.

Devkota, K. (2020). Beekeeping: Sustainable Livelihoods and Agriculture Production in Nepal. *Modern Beekeeping - Bases for Sustainable Production*, 90707. https://doi.org/10.5772/intechopen.90707

Devkota, K., dos Santos, C. F., Ferreira, A. B., & Timberlake, T. P. (2024). Assessing the economic and nutritional value of pollination services in Nepal. *Scientific Reports*, *14*(1), 25037. https://doi.org/10.1038/s41598-024-75584-x

Devkota, K., Ghimire, S., Timberlake, T., Ferreira, A. B., & dos Santos, C. F. (2025). Beekeeping Development in Nepal: Benefits of Apis cerana Despite Lower Honey Production than *Apis mellifera*. *Bee World*, *102*(2), 50–55. https://doi.org/10.1080/0005772x.2025.2532228

Evans, J. D. (2003). Diverse origins of tetracycline resistance in the honey bee bacterial pathogen Paenibacillus larvae. *Journal of Invertebrate Pathology*, *83*(1), 46–50. https://doi.org/10.1016/s0022-2011(03)00039-9

Gajger, T., I., Abou-Shaara, H. F., & Smodiš Škerl, M. I. (2025). Strategies to Mitigate the Adverse Impacts of Viral Infections on Honey Bee (*Apis mellifera* L.) Colonies. *Insects*, *16*(5), 509. https://doi.org/10.3390/insects16050509

Genersch, E., & Aubert, M. (2010). Emerging and re-emerging viruses of the honey bee (*Apis mellifera* L.). *Veterinary Research*, *41*(6), 54. https://doi.org/10.1051/vetres/2010027

Girma, J., & Gardebroek, C. (2015). The impact of contracts on organic honey producers' incomes in southwestern Ethiopia. *Forest Policy and Economics*, *50*, 259–268. https://doi.org/10.1016/j.forpol.2014.08.001

Gratzer, K., Wakjira, K., Fiedler, S., & Brodschneider, R. (2021). Challenges and perspectives for beekeeping in Ethiopia: A review. *Agronomy for Sustainable Development*, *41*(4), 46. https://doi.org/10.1007/s13593-021-00702-2

Guzmán-Novoa, E., Eccles, L., Calvete, Y., McGowan, J., Kelly, P. G., & Correa-Benítez, A. (2009). *Varroa destructor* is the main culprit for the death and reduced populations of overwintered honey bee (*Apis mellifera*) colonies in Ontario, Canada. *Apidologie*, *41*(4), 443–450. https://doi.org/10.1051/apido/2009076

Higes, M., Martín-Hernández, R., Botías, C., Bailón, E. G., González-Porto, A. V., Barrios, L., del Nozal, M. J., Bernal, J. L., Jiménez, J. J., Palencia, P. G., & Meana, A. (2008). How natural infection by Nosema ceranae causes honeybee colony collapse. *Environmental Microbiology*, *10*(10), 2659–2669. https://doi.org/10.1111/j.1462-2920.2008.01687.x

Human, H., Archer, C. R., du Rand, E. E., Pirk, C. W. W., & Nicolson, S. W. (2014). Resistance of developing honeybee larvae during chronic exposure to dietary nicotine. *Journal of Insect Physiology*, *69*, 74–79. https://doi.org/10.1016/j.jinsphys.2014.03.012

Jack**,** Cameron J., & Ellis, James D. (2021). *Integrated pest management control of* Varroa destructor *(Acari: Varroidae), the most damaging pest of* Apis mellifera *L. (Hymenoptera: Apidae) colonies*. *Journal of Insect Science, 21*(5), 6. https://doi.org/10.1093/jisesa/ieab058

Kovacic, M., Uzunov, A., Tlak Gajger, I., Pietropaoli, M., Soroker, V., Adjlane, N., Benko, V., Charistos, L., Dall'Olio, R., Formato, G., Hatjina, F., Malagnini, V., Freda, F., Otmi, A., Puškadija, Z., Villar, C., & Büchler, R. (2023). Honey vs. Mite—A Trade-Off Strategy by Applying Summer Brood Interruption for Varroa destructor Control in the Mediterranean Region. *Insects*, *14*(9), 751. https://doi.org/10.3390/insects14090751

Maggi, M. D., Ruffinengo, S. R., Negri, P., & Eguaras, M. J. (2010). Resistance phenomena to amitraz from populations of the ectoparasitic mite Varroa destructor of Argentina. *Parasitology Research*, *107*(5), 1189–1192. https://doi.org/10.1007/s00436-010-1986-8

MoALD. (2023). *Statistical Information on Nepalese Agriculture 2021/22. Government of Nepal, Ministry of Agriculture and Livestock Development*.

Neupane, K. R. (2009). Honey bee mites and their population variation in Apis spp. during different seasons. *Journal of the Institute of Agriculture and Animal Science*, *30*, 159–166.

Pokhrel, S. (2009). Comparative benefits of beekeeping enterprise in Chitwan, Nepal. *Journal of Agriculture and Environment*, *10*, 46–59. https://doi.org/10.3126/aej.v10i0.2129 https://doi.org/10.55817/ixvm2800

Rehman, H. U. (2018). Prevalence of anemia in pregnant women in district Karak, Khyber Pakhtunkhwa, Pakistan. *Journal of Entomology and Zoology Studies*, *6*(1), 169–171.

Renz, M., & Rosenkranz, P. (2001). Infestation dynamics and reinvasion of Varroa destructor mites in honey bee colonies kept isolated and in groups. *Apidologie*, *32*(5), 492–494.

Rosenkranz, P., Aumeier, P., & Ziegelmann, B. (2010). Biology and control of Varroa destructor. *Journal of Invertebrate Pathology*, *103*, S96–S119. https://doi.org/10.1016/j.jip.2009.07.016

Roth, M. A., Wilson, J. M., Tignor, K. R., & Gross, A. D. (2020). Biology and Management of Varroa destructor (Mesostigmata: Varroidae) in *Apis mellifera* (Hymenoptera: Apidae) Colonies. *Journal of Integrated Pest Management*, *11*(1), 1–6. https://doi.org/10.1093/jipm/pmz036

Sanford, M. T., Demark, H. A., Cromroy, H. L., & Cutts, L. (2007). Featured Creatures: Varroa Mite, Varroa destructor. *University of Florida Institute of Food and Agricultural Science*.

Shrestha, M., Wegener, J., Gautam, I., Singh, M., Schwekendiek, C., & Bienefeld, K. (2020). Individual-Level Comparisons of Honey Bee (Hymenoptera: Apoidea) Hygienic Behavior Towards Brood Infested with Varroa destructor (Parasitiformes: Varroidae) or Tropilaelaps mercedesae (Mesostigmata: Laelapidae). *Insects*, *11*(8), 510. https://doi.org/10.3390/insects11080510

Shrestha, N., & Gautam, I. (2020). Seasonal prevalence of Asian honeybee ectoparasitic mite Varroa destructor Anderson and Trueman, 2000 in Madanpokhara Apiaries, Palpa, Nepal. *Nepalese Journal of Zoology*, *4*(2), 61–67. https://doi.org/10.3126/njz.v4i2.33885

Traynor, K. S., Mondet, F., de Miranda, J. R., Techer, M., Kowallik, V., Oddie, M. A. Y., Chantawannakul, P., & McAfee, A. (2020). Varroa destructor: A Complex Parasite, Crippling Honey Bees Worldwide. *Trends in Parasitology*, *36*(7), 592–606. https://doi.org/10.1016/j.pt.2020.04.004

Tutun, H., Koç, N., & Kart, A. (2018). Plant Essential Oils Used Against Some Bee Diseases. *Turkish Journal of Agriculture Food Science and Technology*, *6*(1), 34–45. https://doi.org/10.24925/turjaf.v6i1.34-45.1502

Underwood, R., & López-Uribe, M. (2022). Methods to Control Varroa Mites: An Integrated Pest Management Approach. *Penn State Extension*.

Vural, H., & Karaman, S. (2009). Socio-Economic Analysis of Beekeeping and the Effects of Beehive Types on Honey Production. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, *37*(2), 223–227. https://doi.org/10.15835/nbha3723298

Wilde, J., Woyke, J., Neupane, K. R., & Wilde, M. (2000). Comparative evaluation tests of different methods to control Tropilaelaps clareae, a mite parasite in Nepal. *Proceedings of the Seventh International Conference on Tropical Bees and Fifth Asian Apiculture Association Conference*, 249–251.

Woyke, J. (1985). Tropilaelaps clareae Delfinado and Baker: A serious pest of *Apis mellifera* L. in the tropics but not dangerous for apiculture in temperate zone. *American Bee Journal*, *125*(7), 497–499.

Youguan, L., Hairong, W., & Bangyk, K. (2000). A new record of parasitic mite on honey bee in China. *Proceedings of the 7th International Conference on Tropical Bees and 5th Asian Apiculture Association Conference*, 309–312.