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SUSTAINABLE BEEKEEPING IN ALGERIA: EXPLORING PRACTICES, CHALLENGES, AND LOCAL HONEYBEE TRAITS FOR NATURAL RESOURCE MANAGEMENT

Haider Yamina*, Adjlane Noureddine, Martin-Hernande Raquel***, Haddad Nizar****, Abdelmounaim Khemmouli*****#**

*M'hamed Bougara University, Faculty of Sciences, Department of Agronomy, Laboratory of Bioinformatics, Applied Microbiology and Biomolecules (BMAB), Boumerdes, Algeria
**M'hamed Bougara University, Faculty of Sciences, Department of Agronomy, Boumerdes, Algeria
***Regional Research and Development Institute for Food and Forestry, Laboratory of Beekeeping Pathology, Centre for Beekeeping and Agroenvironmental Research, Marchamalo, Spain, and Institute of Human Resources for Science and Technology, Albacete, Spain
****Innovations & Business Development, Fresh Del Monte; General Manager, Organic L'Ora, Amman, Governorate of Amman, Jordan
*****Ferhat Abbas University, Faculty of Natural and Life Sciences, Department of Agronomic Sciences, Laboratory of Valorisation of Natural Biological Resources, Sétif 1, 19000, Algeria

Abstract

Honeybees are crucial pollinators, playing a vital role in maintaining plant biodiversity and promoting a healthy natural environment. They serve as bioindicators, reflecting the state of our ecosystems. Beekeeping in Algeria faces significant challenges, particularly the devastating effects of the Varroa mite, an ectoparasite harming bee colonies.

This study aimed at understanding the resilience of Mediterranean bee subspecies in the context of climate change. Conducted in 2021, a survey targeted Algerian beekeeping associations and individual beekeepers. The goal was to characterize beekeeping practices, identify key challenges, and evaluate their impact on natural resources and sustainable development.

The survey reached beekeepers in 19 Algerian provinces, with a total of 200 responses analyzed. The results highlight constraints hindering beekeeping development: drought, high bee mortality, and the presence of bee diseases. These findings suggest that beekeepers who select colonies with strong overwintering and drought resistance capabilities can potentially improve honey production. The COVID-19 pandemic further impacted honey production, leading to lower yields in recent years.

However, positive aspects were also identified, including beekeepers implementing good practices (queen replacement, apiary selection, transhumance) and routine Varroa mite monitoring. Strengthening the role of beekeeping associations in the field is crucial to support the sector's organization and improve its current situation, ultimately contributing to sustainable management of natural resources in Algeria.

Key words: Beekeeping, natural resources, sustainable development, climate change, honeybee, *Varroa*

INTRODUCTION

Honeybees are the most ideal pollinators for agricultural production (Demir et al., 2023; Requier et al., 2023). Bees produce a range of high-value products, including honey, royal jelly, and beeswax, but have recently been impacted by a wide range of biological and abiotic factors (Moritz et al., 2010). Beekeeping in Algeria has always been of great importance on the

Corresponding author

socio-economic level, given the climatic conditions and the important flora favourable to its development. In 2012 the term precision beekeeping was described for the first time by Zacepins et al., 2012.

It is an apiary management strategy based on individual and continuous monitoring of colonies using technological tools (Capela et al., 2023; Meikle and Holst, 2015; Zacepins and Karasha, 2013).

Its primary objective is to minimize resource consumption to maximize bee productivity, which requires a better understanding of the daily needs of the colonies. In Algeria, beekeeping faces a significant challenge in the form of Varroa destructor, an ectoparasitic mite that poses a severe threat to bee colonies (Adjlane et al., 2013; Bendjedid and Achou, 2014; Hazam et al., 2023).

This study within the framework of the MEDIBEES project, which focuses on monitoring the Mediterranean Honeybee Subspecies and their Resilience to Climate Change for the Improvement of Sustainable Agro-Ecosystems, a comprehensive questionnaire was crafted and distributed among beekeepers in the countries collaborating within the MEDIBEES consortium.

The primary goal of this questionnaire was to gather insights from key stakeholders in the apiculture industry, with the goal of identifying the primary challenges and threats facing this crucial sector. It is preferable that authors to submit their article carefully written and checked. Materials submitted with spelling and grammar errors will not be accepted. They must present the results as concisely as possible.

As we delve into the results, this study sheds light on the impediments that have hindered the development of beekeeping in Algeria in recent years, including factors such as drought, elevated mortality rates, and the prevalence of pathologies. The compounding impact of the COVID-19 pandemic on beekeepers' yields is also explored, revealing a concerning decline in honey production over the last two years. Amidst these challenges, positive aspects emerge, showcasing beekeepers practicing effective methods such as queen renewal, strategic apiary selection, and the implementation of transhumance. Additionally, regular screening for varroasis in honeybee colonies reflects a proactive approach to disease management.

This study not only underscores the obstacles facing Algerian beekeepers but also highlights the potential for positive change. It emphasizes the crucial role of beekeeping associations in on-the-ground initiatives, advocating for the organization of the beekeeping sector and the overall enhancement of the current situation. The subsequent sections will delve into the detailed findings of the survey, offering a nuanced understanding of the dynamics shaping beekeeping in Algeria and presenting valuable insights for future sustainability and resilience in the face of evolving environmental challenges.

MATERIAL AND METHOD

The questionnaire was prepared in both English and French using Google Forms. The study was carried out during the year 2021, with the objective of characterizing and understanding the beekeeping activity and its main problems in Algeria, the survey was disseminated in Algeria by e-mail and sent to all beekeeping associations and beekeepers. Visits to the beekeepers were also carried out to obtain the maximum number of responses.

In this article, only the results obtained for Algeria will be presented. In total, 200 questionnaires were analysed. The respondents have apiaries in 19 wilayas of the country. Statistically significant differences among means were compared at the 5 % significance level using the Duncan's test implemented in R software version 4.3.1.

In the course of this study, an examination of apiary distribution highlighted a pronounced concentration in the northern region of Algeria (Fig. 1). Survey respondents reported having apiaries in 19 different wilayas across the country, underscoring the widespread nature of beekeeping activities. Notably, the results illustrated a distinct segregation of beekeeping practices, with a significant preference for relatively undeveloped areas in the northern region. This spatial pattern suggests a tendency for beekeeping activities to thrive in less urbanized environments, possibly owing to factors such as favourable natural conditions or land availability.

Survey Design. To ensure data privacy and participant anonymity, the questionnaire employed appropriate features. The survey commenced by gathering beekeeper demographics and established management practices. Subsequently, it explored beekeepers' observations regarding honeybee traits and behaviors, followed by an evaluation of honey production. Finally, the questionnaire delved into beekeepers' knowledge of prevalent pathogens and their implemented control strategies. However, unanswered questions led to some variation in response completeness.

Statistical Analysis: Unveiling Beekeeping Challenges and Solutions

This investigation will employ a multifaceted approach to analyze the collected data on bee populations, beekeeping practices, and environmental variables. Software programs R (version 4.3.3) and Excel 2016 will be utilized to perform descriptive statistics, the MCA statistic and the chi-square test (X^2). These analyses aim to uncover trends in beekeeping practices within Algeria. By identifying potential challenges that may be impacting bee health, this study seeks to establish recommendations for sustainable beekeeping practices in the region.

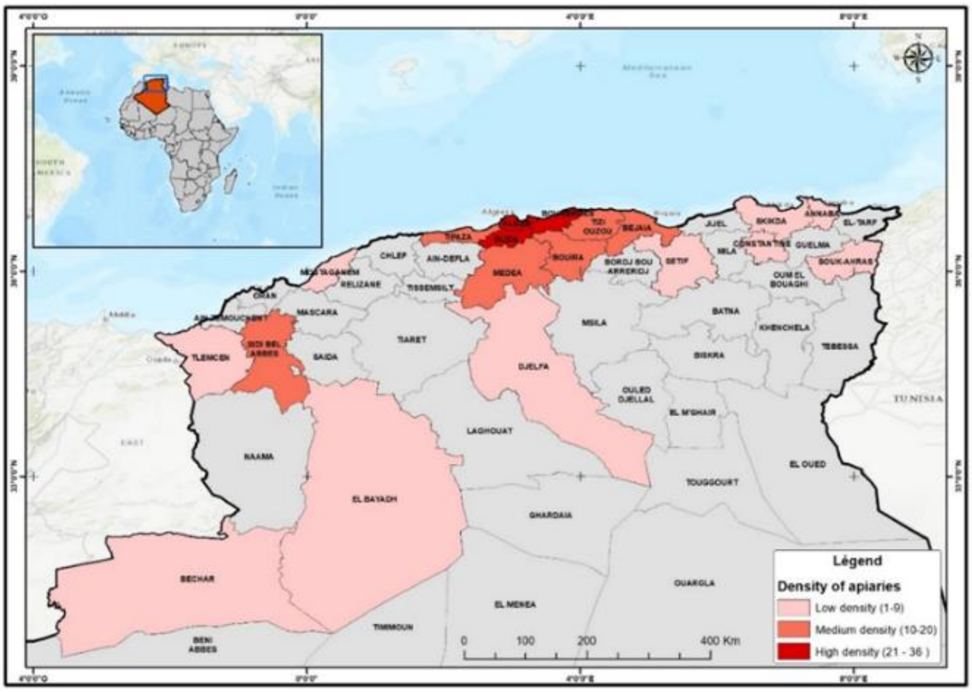

Fig. 1. Distribution of locations where respondents have their apiaries

RESULTS AND DISCUSSION

Sociodemographic. The majority of respondents (97 %) were men, with a predominance in the 31-40 age group. The least represented were those aged 61-70 (4 %) and 41-50 (13 %). Regarding educational level, 35% of respondents had higher education and 39 % had completed secondary school. Most beehives are located in the northern region of Algeria, spread across 19 wilayas, indicating a concentration of beekeeping activities in less urbanized areas (Fig. 2).

Beekeepers play a crucial role in preserving bee species, and they now have access to less invasive solutions for monitoring and predicting hive health (Magnier et al., 2022). Our results show a male dominance in beekeeping, consistent with several studies from the African continent, where men constitute 14 % of beekeepers in Rwanda and 6.7 % in Ethiopia. The very low number of female beekeepers in the studied areas may be due to the perception of beekeeping as a male occupation (Bihonegn and Begna, 2021; Mushonga et al., 2019). A recent study by Farrugia et al., 2022, on beekeeping activities in Malta found that only 8.3 % of adult beekeepers are women. Another study also shows that women are underrepresented in Europe, with

Italy having the highest percentage of female beekeepers (37.5 %) and Spain the lowest (10 %).

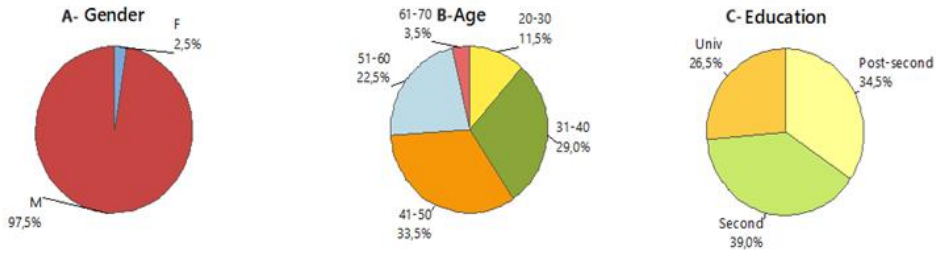

Fig. 2. Demographics of Survey Respondents, Pie chart illustrating the characterization of respondents by (A) gender, (B) age range, and (C) Education

38 % of beekeepers are in the 31-40 age group, while the 61-70 age group is the least represented, with only 4 %. This decline in interest in beekeeping among young adults reflects a broader trend of disinterest in the agricultural sector. It is essential to implement initiatives to attract and engage young people to ensure the long-term economic sustainability of these sectors (Farrugia et al., 2022). The educational level of beekeepers is crucial for identifying and specifying the development and extension services needed for the region (Alemu et al., 2015). In terms of education, 35 % had higher education and 39 % had completed secondary school. Thus, these findings underscore the pivotal role of education in the successful adoption of improved beekeeping practices.

Characterization of apiaries. Most apiaries predominantly house a single subspecies of honeybee. Approximately 95 % of beekeepers (n=190) primarily manage Tellian or Apis mellifera intermissa bees, while 5 % prefer Saharan honeybees, *Apis mellifera (A.m.) sahariensis*. Among respondents, 73 % of beekeepers (n=146) perceive local bees to be endangered, contrasting with 27 % (n=53) who do not share this concern.

The distribution of colonies per beekeeper, depicted in Figure 3, varies significantly. Respondents with the fewest and most colonies manage between 15 and 410 colonies in Langstroth hives. Specifically, 26.5 % of beekeepers (n=53) manage between 50 and 100 colonies, 23.5 % (n=47) have fewer than 50 colonies, and fewer than 5 % (n=10) oversee more than 300 colonies. None reported managing more than 500 colonies in this study.

Beekeeping practices in Algeria primarily adhere to a small-scale model. Only 26.5 % of beekeepers (n=53) manage between 50 and 100 colonies, with 23.5 % (n=47) handling fewer than 50 and less than 5 % (n=10) managing more than 300 colonies. Despite challenges such as vegetation availability, climate change, and part-time engagement among beekeepers, these practices appear stable.

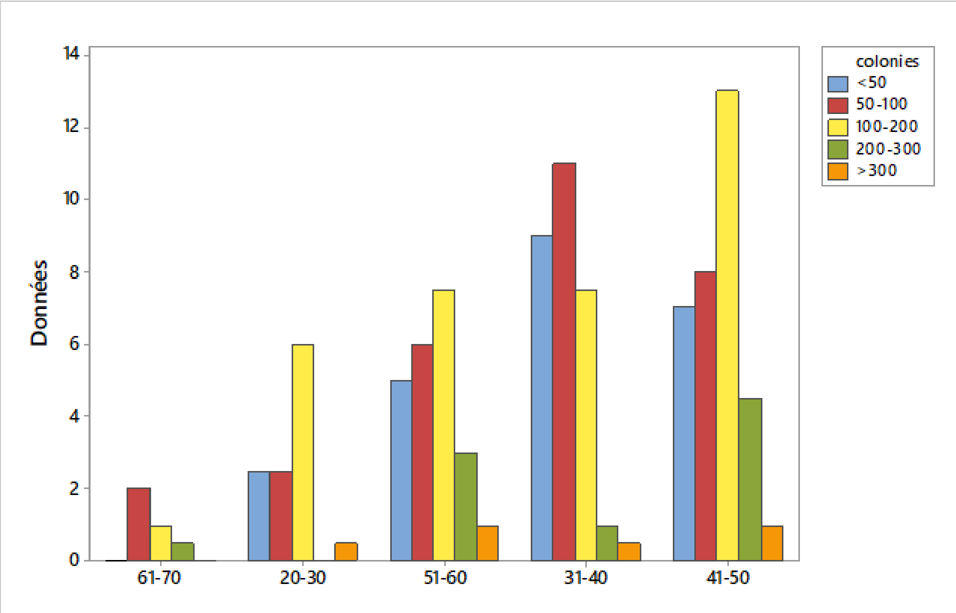

Fig. 3. Distribution of the number of colonies managed

Data from the FAO indicates a rising trend in hive numbers across North Africa since 2000. In 2018, Tunisia and Algeria peaked at 700,000 and 400,000 hives, respectively, while Libya recorded the lowest figures with 36,000 hives in 2000 and 37,500 in 2018. Egypt saw a decline from 1.4 million hives in 2000 to 800,000 in 2018, and Morocco's hive count decreased from 600,000 to nearly 400,000 over the same period.

Characterization of the local Tellian bee *A.m. intermissa*

As most beekeepers maintain the Tellian bee, only the characterization results for this subspecies will be reported, as findings for the Saharan bee are not highly representative. Beekeepers rated nine characteristics on a scale of 1 to 5 (1 being weak, 5 being strong) (Fig. 4). Responses predominantly selected three scores (1 for very weak, 3 for medium, 5 for very strong). The Tellian bee scored predominantly 5 for five traits (swarming tendency, heat tolerance, honey production, drought resistance, and adaptation to the local environment). It scored 3 for Varroa destructor tolerance, while for gentleness, *A. m. intermissa* was mainly rated 1, known for its aggressiveness. These results align with known traits of *A. m. intermissa* and indicate its adaptation to environmental conditions in Algeria.

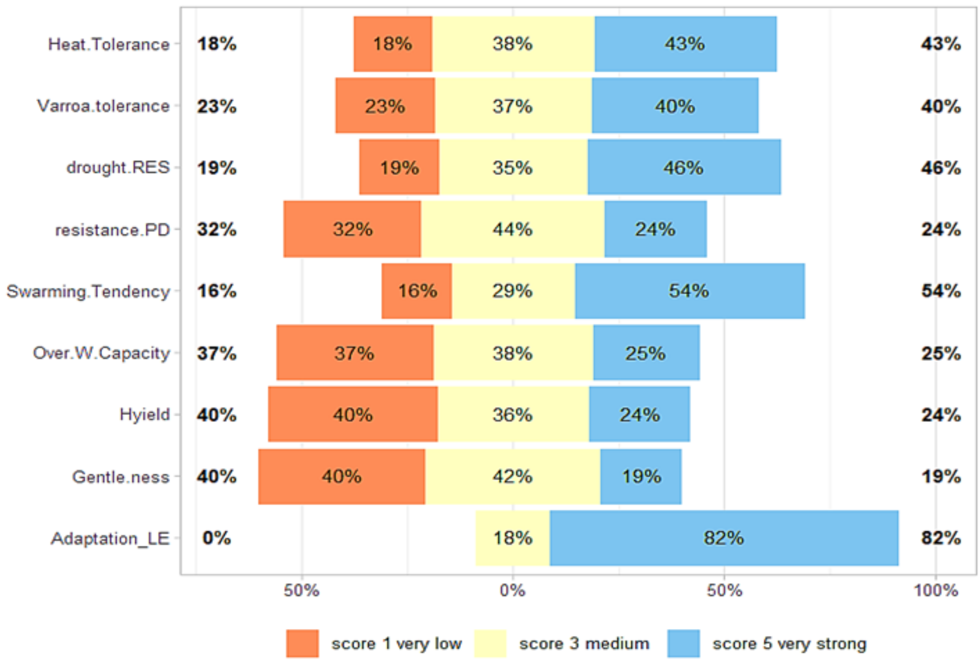

Fig. 4. Distribution of the classification of the Tellian bee, *A. m. intermissa* for nine characteristics. This chart displays the count of different scores (e.g., very low, low, medium, high, very high) for characteristics such as swarming tendency, heat tolerance, over-wintering capacity, and others. Each characteristic is evaluated on a scale, and the distribution of these evaluations across the dataset is visualized here

Given that most beekeepers maintain the Tellian bee, only its characterization results will be reported, with the Saharan bee not being representative. *Apis mellifera intermissa*, often referred to as the "Tellian" or "Punic" bee, is the primary subspecies identified in North Africa (Rinderer, 2013). Regarding queen replacement practices, a significant proportion of respondents indicated the most common interval is every three years (43 %), followed closely by those replacing queens every two years (25 %).

Interestingly, despite this, 69 % of respondents do not engage in queen rearing. This finding contrasts with earlier results, highlighting a discrepancy: while many beekeepers adhere to a specific schedule for queen replacement, a significant portion do not actively participate in queen rearing itself. This introduces a dynamic aspect to beekeeping practices among the surveyed population. Replacing queens in apiaries reflects beekeepers' dedication to maintaining colony health and productivity. Scientific research underscores the management concern posed by poor-quality queens, which can lead to reduced honey production, heightened disease susceptibility, and overall colony decline (Bieńkowska et al., 2020; Gray et al., 2023; Tarpy et al., 2020).

A recent study has highlighted that geography plays a more significant role than subspecies in shaping the genetic composition of Algerian honeybees, revealing distinct population differences between western and eastern regions (Salvatore et al., 2023). *Apis mellifera intermissa* is prevalent across North Africa, including Morocco, Algeria, and Tunisia (Buttel-Reepen, 1906). This subspecies is characterized by its small size, dark coloration, and aggressive defense behavior (Ruttner et al., 1978).

Responses from beekeepers were categorized into three main scores: 1 (very weak), 3 (medium), and 5 (very strong). The Tellian bee received predominant scores of 5 (very strong) for traits such as swarming tendency, heat tolerance, honey production, drought resistance, and adaptation to the local environment. It scored 3 (medium) for varroa destructor tolerance, indicating a balanced response in this aspect. In terms of temperament, *A. m. intermissa* was mostly rated as 1 (low), suggesting a tendency towards aggressiveness. These findings align with the well-established characteristics of *A. m. intermissa*, highlighting its significant adaptation to the environmental conditions prevailing in Algeria.

Local honeybees have evolved over generations to adapt specifically to their environment, developing unique traits that facilitate their thriving on local flora (Alaux et al., 2019; Everitt et al., 2023). Despite not consistently scoring high across all beekeeping traits, the Tellian bee's remarkable adaptation to the local environment remains a noteworthy attribute. These distinctive characteristics collectively contribute to the unique profile of *A. m. intermissa* within the realm of bee species (Bendjedid and Achou, 2014). This research underscores that the indigenous honeybee subspecies, *A. m. intermissa*, demonstrates superior adaptation to local conditions compared to introduced foreign subspecies, as supported by existing data (Büchler et al., 2020; Hatjina et al., 2014).

The biplot displays two main components, Dim1 (dimension 1) and Dim2 (dimension 2), which collectively account for 26.9 % of the variation in the data (13.7 % for Dim1 and 13.2 % for Dim2). Each dot on the biplot represents a specific behavioral characteristic, identified by the abbreviations along the outside of the plot (Fig. 5). For instance, “Heat.Tolerance_score 1” likely refers to a low score on heat tolerance, while “Varroa. tolerance_score 5” represents a high score on Varroa tolerance. The location of a dot on the biplot reflects the relative importance and interrelationships between the behavioral characteristics it represents. Dots that are closer together tend to be more similar, while farther dots indicate greater dissimilarity. The interpretation of specific relationships between behavioral characteristics would depend on the scientific context of the study and researcher background knowledge.

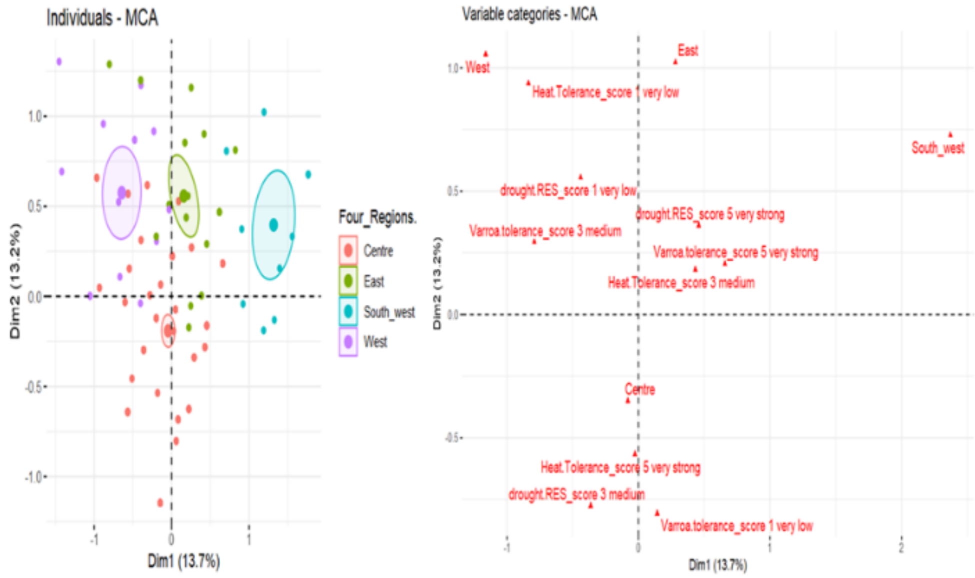

Fig. 5. Multifactor Analysis (MCA) Biplot of Honey Bee Behavioral Characteristics in Algeria

However, some general observations can be made: Characteristics on the left side of the plot seem to be contrasted with those on the right side. For example, “drought.RES_score 1” (low score on drought resistance) appears opposite “Heat.Tolerance_score 5” (high heat tolerance). This may suggest that low drought resistance is associated with high heat tolerance, and vice versa.

Dots in the upper right quadrant, such as “Varroa. tolerance_score 5” and “East,” might represent characteristics that are more prevalent in eastern Algeria. Algerian beekeepers give high scores to bees with a low swarming tendency, indicating a preference for those less likely to swarm. Similarly, gentle bees are favored, suggesting a preference for easier handling. Bees resistant to pests and diseases also receive high scores, highlighting a preference for those less likely to be affected. Regarding honey yield, its position on the graph is ambiguous, requiring more data to determine its relationship with other characteristics.

The position of overwintering capacity is also unclear, necessitating further studies to clarify its relation to other traits. Heat tolerance seems to be a minor factor, probably due to Algeria's relatively mild climate. Finally, Varroa tolerance does not appear to be a significant factor, possibly because of the use of alternative treatments. In summary, Algerian beekeepers show a clear preference for bees with low swarming tendencies, gentleness, and resistance to pests and diseases, although additional studies are needed to clarify the relationships with honey yield and overwintering capacity.

The matrix correlation depicts the relationships between various behavioral characteristics of honeybee colonies and honey yield (Fig. 6).

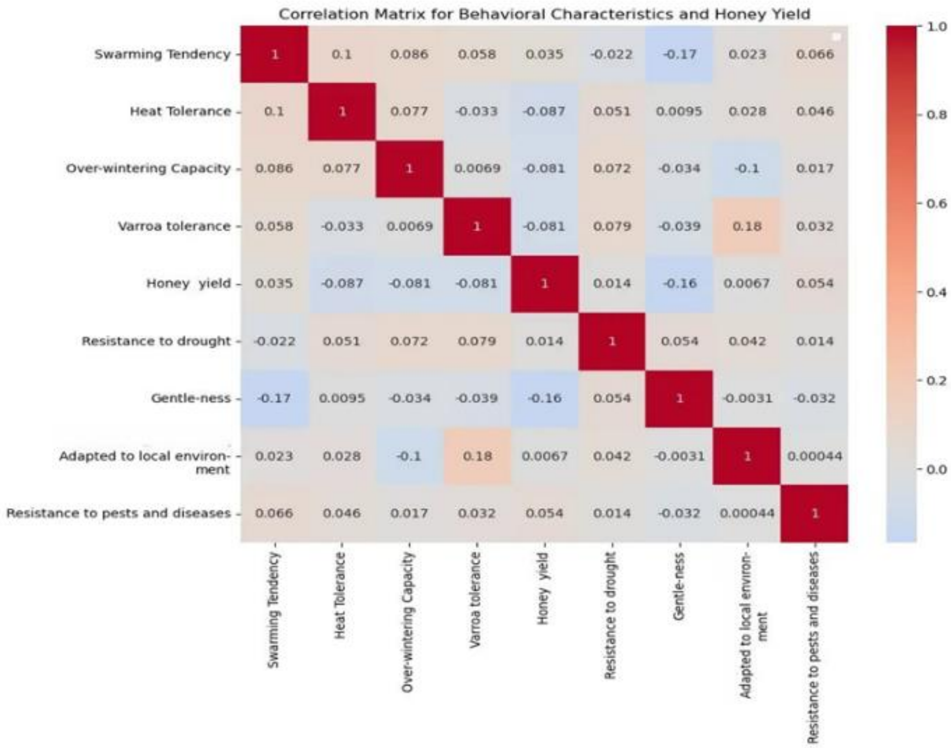

Fig. 6. Correlation Matrix for Behavioral Characteristics and Honey Yield in Honeybee Colonies

Positive correlations indicate that certain characteristics are associated with higher honey yields. For instance, overwintering capacity (0.086) is positively correlated with honey yield. Colonies that survive winter well have a longer foraging season, allowing them to produce more honey. Similarly, drought resistance (0.072) is also linked to higher honey yields, likely because these colonies are more successful at finding nectar during dry periods when flowers are scarce.

In contrast, negative correlations reveal characteristics associated with lower honey yields. Swarming tendency (-0.17) shows that colonies with a high propensity to swarm produce less honey. This is likely because swarming reduces the number of worker bees available for foraging. Varroa tolerance (-0.081) presents a weak negative correlation with honey yield. While some colonies tolerate Varroa mites better, the presence of these parasites can still lead to a decline in honey production. Lastly, gentleness (-0.16) also shows a weak negative correlation with honey yield.

The reason for this correlation is not entirely clear and would require further investigation. In summary, certain behavioral characteristics of honeybee colonies, such as overwintering capacity and drought resistance, are beneficial for honey yield, while others, like swarming tendency and the presence of parasites, have a negative impact. Understanding these relationships can help optimize colony management to maximize honey production. It is worth noting that the majority of correlations in the matrix are weak, indicating that numerous factors influence honey yield. Beekeepers' management practices likely play a significant role in addition to the behavioral characteristics explored here. It is also important to emphasize that the data reflect beekeeping practices and bee behavior in Algeria. These behaviors and their correlations with honey yield may vary in other geographical regions.

Overall Significance

The correlation matrix provides valuable insights into how honeybee behavioural characteristics are associated with honey yield in Algeria. Beekeepers can leverage this information to select and manage honeybee colonies for optimal honey production. However, it's important to remember that correlation doesn't imply causation. Further research would be needed to determine the cause-and-effect relationships between specific bee behaviours and honey yield.

Beekeeping events; Ecological annual trends

Beekeepers were also asked to identify the months in which five distinct events occurred: drone production, queen production, queen fertilization, swarming, and nectar entry into the hive. The overall picture is presented here, but it should be noted that it is expected that there will be a wide variation in responses, as each event may occur at different times of the year, depending on the region in which the apiaries are located.

The months of March, April, and May had a greater number of responses about all the events surveyed, with March being mentioned a greater number of times about drone production 15 % (n=31) and August 10.5 % (n=21), and queen production being very high in March 40.5 % (n=81) and April 40 % (n=80) about the remaining months of the events. At the opposite end of the spectrum are the months of November, December, and January, which were mentioned very few times, with only a reasonable number (>10 responses) for the start of nectar entry into the hive (Fig. 7).

In the survey, beekeepers were tasked with providing insights into the temporal occurrences of significant events in beekeeping, including drone production, queen production, queen fertilization, swarming, and the initiation of nectar entry into the hive. It's important to note that the wide variation in responses is expected, considering that the timing of these events can vary based on the geographical location of the apiaries.

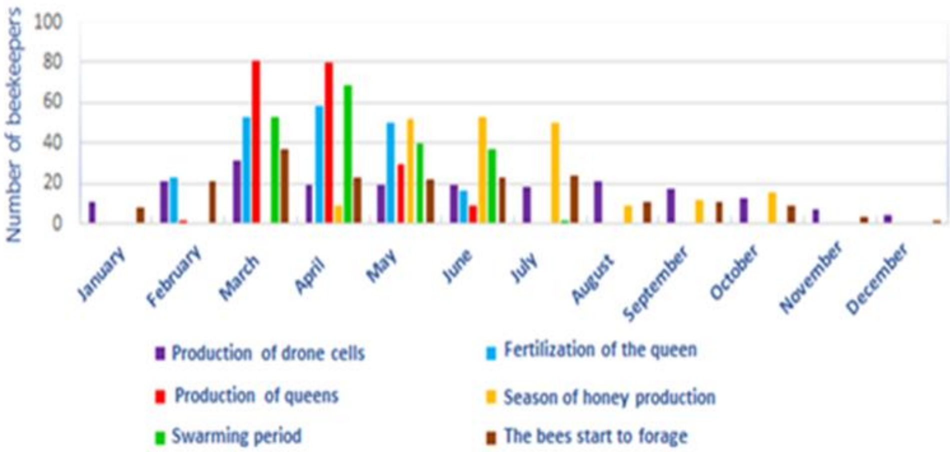

Fig. 7. Distribution of the ecological annual trends (Beekeeping events) for *A.m.intermissa*

The analysis of responses highlighted a pattern where March, April, and May emerged as months with more frequent mentions for all surveyed events. March, in particular, stood out as a significant month for drone production, with 15 % (n=31) of beekeepers mentioning it, and August also garnered attention (10.5 %, n=21). Moreover, queen production exhibited a substantial presence in March (40.5 %, n=81) and April (40 %, n=80) compared to the remaining months. Conversely, the winter months of November, December, and January received fewer mentions, indicating a relative lull in these specific beekeeping activities during this period (Kumsa and Takele, 2014; Sperandio et al., 2019). However, it's noteworthy that even within this quieter period, there were still reasonable numbers of responses, especially concerning the initiation of nectar entry into the hive, emphasizing the bees' year-round activity. This variability in the timing of events underscores the influence of regional and climatic differences on the annual cycle of beekeeping, emphasizing the need for beekeepers to adapt their practices based on the unique conditions of their respective locations. This was evidenced in the ecological annual trends of the native *A. m. intermissa*, which was very contrasting.

Drone production, queen production, and mating showed synchronization with the favorable weather and floral resources occurring early in spring (as early as March) and again during autumn, with a gradual decrease in activity. These reported patterns have important conservation implications that indicate that the Algerian honeybee shows greater adaptation to the local environment. Three main honey-producing periods were reported for *A. m. intermissa*. The first spring harvest started in early April peaking in May, followed by a second summer harvest in late June-July. This was followed by a third honey production season overlapping with September, and October. This is in agreement with Farrugia et al., 2022 the honey-producing months reported by Maltese beekeepers rearing A. m. ruttneri (published results from MEDIBEES data).

Bee plants

A total of 26 different plants were identified by the beekeepers as being the most important for the bees. The answer will depend on the region where the beekeeper has the apiaries. For example, mugwort (*Artemisia herba-alba*) is only found on the flats and was indicated by 16 beekeepers who responded to the survey.

In total, all beekeepers indicated at least one plant and those that were indicated more than 10 times are presented in Table 1. Rosemary and Eucalyptus were indicated more than 30 times by beekeepers throughout the country.

Table 1

Plants indicated by more than 10 beekeepers as being the most important for bees

Plant	**Answers**
Rosemary	36
Eucalyptus	31
Carob tree	20
Wormwood	19
Tamarisk	16
Cloverleaf hedizarum	15
Calandularvensis	12

Beekeepers in this study highlighted the importance of three main plant species for their honey bees: mugwort (*Artemisia herba-alba*), rosemary, and eucalyptus. These plant species are likely important sources of nectar and pollen for honey bees in the study area, and their presence may contribute to the local honey production. The location of apiaries and the surrounding floral sources can affect local honey production (Attard and Douglas, 2017; Bahloul et al., 2022; Gambin et al., 2013). Floral resources are essential for the feeding of honey bee communities (Dalmon et al., 2022).

Honeybees make a significant contribution to biodiversity. The main honey in Algeria comes from Acacia, Pinus, Cupressus, Thymus, Rosmarinus, Citrus, Eucalyptus, and many wild plants (Keshlaf, 2017). In addition to encouraging the protection of these pollen sources, we recommend conducting in-field studies to determine, with scientific rigor, which pollen sources are present in hives and honey.

Beekeeping activities and products

The majority of beekeepers (97 %) typically do not engage in pollination services as part of their beekeeping activities. Only a small percentage, represented by 6 beekeepers (3 %), offer pollination services and have practiced this activity across various crops. The average honey production per colony per year for most beekeepers is around 5 kg (66 %), with only 26 % producing more than 11 kg. When comparing honey production over the last 5 years to that of a decade ago, a significant proportion (86%) of beekeepers believe that the quantity of honey produced has decreased.

Regarding hive products, 160 respondents (80 %) exclusively produce honey, while 26 beekeepers harvest two hive products, primarily honey and propolis (19 responses). Additionally, 6 beekeepers collect three hive products, namely honey, propolis, and pollen (Fig. 8). Honey is the most commonly extracted hive product, as expected (Belguet et al., 2024). Royal jelly is produced by only six beekeepers, and none of the respondents indicated venom production. The majority of beekeepers generate between 0 and 5 kg of honey per year per colony (66 %), with only 8 % producing between 6 and 10 kg. The consensus among more than half of the beekeepers (86 %) is that the quantity of honey produced has declined over the past 5 years.

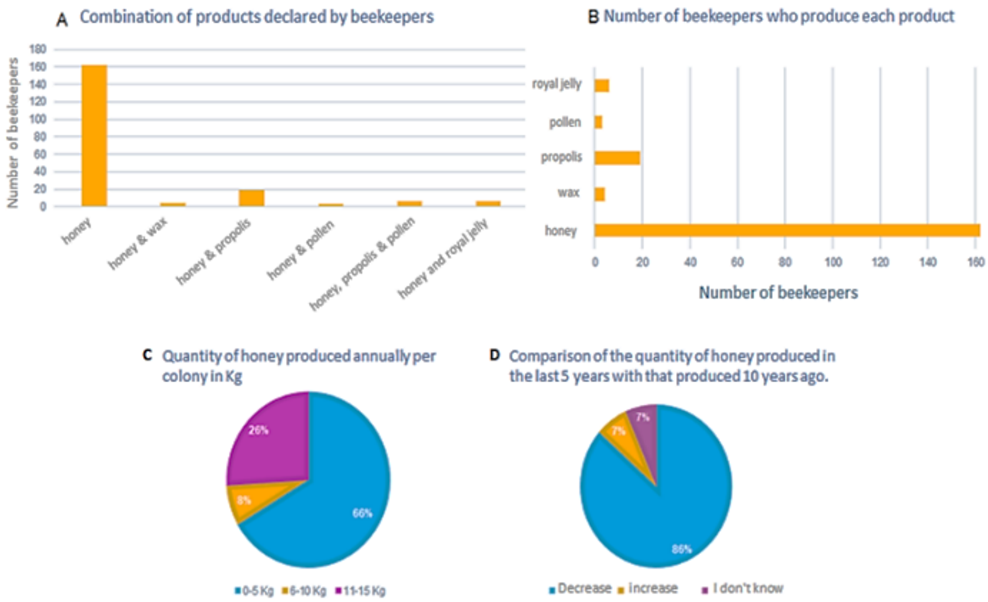

Fig. 8. Hive products produced by respondents: (A) Product combinations reported by beekeepers. (B) Number of beekeepers producing each product. Honey production. (C) Quantity of honey produced annually per colony in Kg. (D) Comparison of the quantity of honey produced in the last 5 years with that of 10 years ago

Lack of forage was the primary cause of colony losses reported by beekeepers in our survey. These losses exhibited a bimodal annual pattern, with peaks in August and December-January. The timing of these peaks corresponds to the arid summer months and the inclement weather in winter, when Algerian honeybees remain active. Queen problems, queen age, and *Varroa destructor* may contribute to winter mortality, as suggested by van der Zee et al., 2014. Furthermore, the extreme aridity in summer in recent years may have prevented bees from collecting sufficient food stores to survive the winter. Intensive honey extraction practices, aimed at maximizing profits, may also contribute to these losses. Notably, a majority of beekeepers indicated that other factors, including pathogens, could be contributing to colony losses. American foulbrood, caused by the bacterium *Paenibacillus larvae* (Galea, 2020), is one possible pathogen, but no other records of pathogens or viruses are publicly available.

Bee has a major role in maintaining biodiversity and agrosystems through pollination (Gallai and Vaissière, 2009). The size of the bee population and the amount of honey harvested are also key factors (Decourtye et al., 2017). In the surveyed beekeeping community, the vast majority (97 %) does not engage in pollination services, with only a small group (3 %) participating in such activities across various crops. Al-Ghamdi et al., 2016, conducted a survey on the beekeeping status in Arabic countries, providing data on honey production per colony in various nations: Algeria (8.75 ± 6.49), Morocco (14.08 ± 6.48), Tunisia (9.00 ± 4.98), Egypt (9.50 ± 3.18), and Libya (12.56 ± 5.64). Morocco was positioned as the top producer, followed by Libya, while Egypt, Tunisia, and Algeria reported honey production below 10 kg per hive. In comparison to the reported average honey yield in Algeria in 2016 (10 kg/hive) and analogous Mediterranean countries such as Spain (10 kg/hive), Italy (15 kg/hive), Greece (11 kg/hive), and Cyprus (11 kg/hive) (EC, 2019), our study reveals a decline in honey production.

The observed low honey harvest per colony and the reported decrease in quantities over recent years among local beekeepers highlight alarming trends in the local apiculture sector. We attribute these declines to various factors, including elevated temperatures in recent summers, diminished forage availability, exposure to pathogens and pesticides, extensive reduction in arable land due to increased urbanization, depletion of weed species and wildflowers, and the rapid conversion of cultivated land for private recreational purposes. Habitat degradation and fragmentation, recognized as key environmental contributors to global bee declines (Decourtye et al., 2010), underscore the urgency for concerted efforts. While a commendable initiative by a prominent local beekeepers' association aims to preserve bee pastures in rural passages between December and May, comprehensive policies, coordinated approaches, and actions from competent authorities are imperative to ensure sustainable land use practices.

Bees naturally suffer from a wide range of parasites and pathogens, the latter including protozoa, fungi, bacteria and viruses. By far, the majority of research has focused on those associated with honey bees. Some bee diseases, such as deformed wing virus (DWV), *Nosema ceranae* and *Paenibacillus larvae* (Genersch, 2010). The ectoparasite *Varroa destructo*r of the honey bee (*Apis mellifera*) is the main cause of periodic colony losses and therefore remains the greatest threat to beekeeping worldwide (Traynor et al., 2020). The prevalence of *Nosema* is linked to particular climatic conditions such as high humidity and a long cold period (Haider and Adjlane, 2021).

Factors influencing beekeeping activity

Figure 9 represents the opinion of beekeepers regarding the impact of certain factors (other than diseases) on beekeeping activity, namely: COVID-19, climate change, agricultural practices, and urbanization. All other factors were identified as factors that negatively influence beekeeping activity, with climate change (89 %), urbanization (75 %), and COVID-19 (74 %) being those that most concerned beekeepers, 43 % of beekeepers consider that "pesticide" agricultural practices have not been affected, and 25 % of beekeepers' responses also consider that urbanization is not a factor that influences beekeeping activity, followed by COVID-19 (21 %). And that 5 % of the beekeepers think that COVID-19 positively influences beekeeping activity followed by 2 % of the answers for climate change, and no answer for urbanization and agricultural practices.

Since the 1990s, synthetic pesticides have been widely considered by scientists and beekeepers as the primary cause of colony collapse (Bonmatin et al., 2017; Colin and Marchand, 2007; Eouzan et al., 2017; Hoppe et al., 2015). In their conclusions, most beekeepers expressed significant concerns about the negative impact of climate change on their activities. The study's findings indicate that Algerian beekeepers are particularly worried about several factors affecting their beekeeping practices, including climate change, urbanization, and COVID-19. Climate change disrupts bee foraging and reproductive patterns, while also facilitating the spread of pests and diseases harmful to bees. Urbanization leads to habitat loss and fragmentation of bee populations, exacerbated by increased pollution. The COVID-19 pandemic has further hindered beekeeping activities in Algeria, complicating colony management and honey sales.

Notably, a significant minority of beekeepers (43 %) believe that agricultural practices, including pesticide use, have not affected their activities, suggesting a potential lack of awareness regarding pesticide risks to bees.

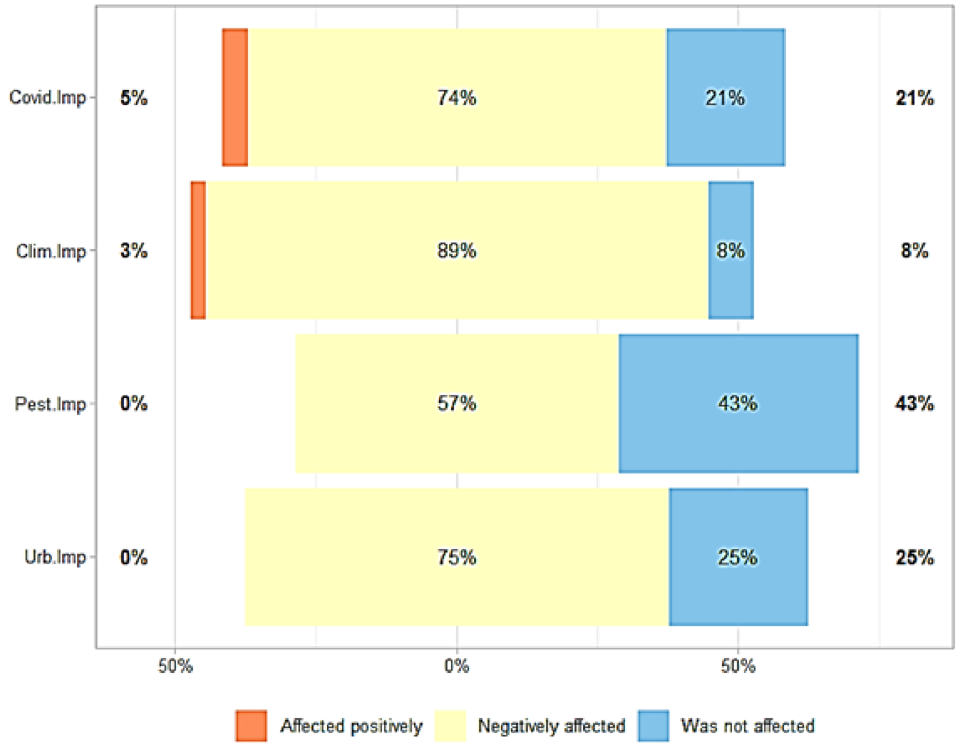

Fig. 9. Beekeepers' views on the impact of various factors (other than a disease) on beekeeping activity

CONCLUSIONS

Beekeepers play a key role in maintaining healthy colonies. By surveying beekeepers, we documented first-hand knowledge of the practices, trends, and challenges currently affecting Algerian apiculture. Synergistic effects from increased losses of foraging resources, high mite and disease pressure, and other factors appear to be contributing to losses to the local apiculture sector.

The results of this study show the constraints on the development of beekeeping in Algeria in recent years, the drought, the very high mortality, and the presence of pathologies. *A. m. intermissa* is highly adapted to arid conditions, and the loss of its gene pool through hybridization with introduced honeybees would be devastating, especially given the threat of climate change.

The correlation matrix revealed that overwintering capacity and drought resistance are positively correlated with honey yield, while swarming tendency and Varroa tolerance show weak negative correlations. These findings suggest that beekeepers who select colonies with strong overwintering and drought resistance capabilities can potentially improve honey production. However, bee behaviour is just one factor influencing honey yield. COVID has had a negative influence on the yield of beekeepers. A very low yield of honey has been obtained during the last two years.

Among the positive points of the survey, were the presence of beekeepers who practice good beekeeping (renewal of queens each year, selection at the level of the apiaries, migratory) as well as the periodic screening of the varroasis in the bee colonies. Beekeeping associations must be on the ground to organize the beekeeping sector and improve the current situation.

The current study encountered certain limitations. We continue to highlight the need to set up measures to comprehensively support the apicultural industry, protect the native Algerian honeybee by isolating it from further introgression, and adopt a more sensitive balance of the steps currently being taken to drive the economy. Furthermore, it establishes a foundation for future investigations in this field. Further research is needed to better understand the specific impacts of these threats on honeybees in Algeria.

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REFERENCES

1. Adjlane N., Haddad N., Doumandji S., 2013, Varroa destructor resistance to fluvalinate in Algeria. Trends in Entomology, no. 9, pp. 35-38;
2. Alaux C., Le Conte Y., Decourtye A., 2019, Pitting wild bees against managed honey bees in their native range, a losing strategy for the conservation of honey bee biodiversity. Frontiers in Ecology and Evolution, vol. 7, pp. 1-4. https://doi.org/10.3389/fevo.2019.00060;
3. Alemu T., Seifu E., Bezabih A., 2015, Postharvest handling, opportunities and constraints to honey production in northern Ethiopia. Livestock Research for Rural Development, vol. 27, no. 5;
4. Al-Ghamdi A.A., Alsharhi M.M., Abou-Shaara H.F., 2016, Current status of beekeeping in the Arabian countries and urgent needs for its development inferred from a socio-economic analysis. Asian Journal of Agricultural Research, vol. 10, no. 2, pp. 87-98;
5. Attard E., Douglas A.B., 2017, Physicochemical characterization of Maltese honey. Honey Anal, vol. 8, pp. 171-191;

6. Bahloul R., Zerrouk S., Chaibi R., 2022, Pollen analysis of honey from Laghouat region (Algeria). Grana, vol. 61, no. 6, pp. 471-480. https://doi.org/10.1080/00173134.2022.2126726;
7. Belguet A., Bouchareb R., Benider C., Guendouz A., 2024, Quality evaluation of some honeys from different flora habitants from Setif, Eastern of Algeria. Natural Resources and Sustainable Development, vol 14, is. 1, pp. 183-188. https://doi.org/10.31924/nrsd.v14i1.159;
8. Bendjedid H., Achou M., 2014, Etude de la Diversité Morphométrique de Deux Populations d'Abeilles Domestiques (Apis Mellifera Intermissa et Apis Mellifera Sahariensis) du Sud Algérien. Synthèse: Revue Des Sciences et de La Technologie, vol. 95, no. 28, pp. 84-95. https://doi.org/10.12816/0027832;
9. Bieńkowska M., Łoś A., Węgrzynowicz P., 2020, Honeybee queen replacement: An analysis of changes in the preferences of polish beekeepers through decades. Insects, vol. 11, no. 8, pp. 1-13. https://doi.org/10.3390/insects11080544;
10. Bihonegn A., Begna D., 2021, Beekeeping Production System, Challenges, and Opportunities in Selected Districts of South Wollo Zone, Amhara, Ethiopia. Advances in Agriculture. https://doi.org/10.1155/2021/2278396;
11. Bonmatin J-M., Sánchez-Bayo F., Janairo B., Isagani J., 2017, Systemic Pesticides: A Worldwide Assessment. De La Salle Universyt Publishing House, 978–9715556484;
12. Büchler R., Uzunov A., Kovačić M., Prešern J., Pietropaoli M., Hatjina F., Pavlov B., Charistos L., Formato G., Galarza E., 2020, Summer brood interruption as integrated management strategy for effective Varroa control in Europe. Journal of Apicultural Research, vol. 59, no. 5, pp. 764-773. https://doi.org/10.1080/00218839.2020.1793278;
13. Buttel-Reepen H. von., 1906, Beiträge zur Systematik, Biologie, sowie zur geschichtlichen und geographischen Verbreitung der Honigbiene. Apistica, pp. 117-201;
14. Capela N., Yoko L. Dupont Rortais A., Sarmento A., Papanikolaou A., Topping C.J., Arnold G., Pinto M.A., Rodrigues P.J., More S.J., Tosi S., Alves T.S., Sousa J.P., Less I., 2023, High accuracy monitoring of honey bee colony development by a quantitative method. Journal of Apicultural Research, vol. 62. no. 4, pp. 741-750. https://doi.org/10.1080/00218839.2022.2098899;
15. Colin M.E., Marchand P.A., 2007, L' apiculture écologique. L'ecologiste, vol. 8, no. 1, pp. 41-43;
16. Dalmon A., Diévart V., Thomasson M., Fouque R., Vaissière B., Guilbaud L., Le Conte Y., Henry M., 2022, Les communautés d'abeilles butinant la même ressource florale échangent-elles des agents pathogènes? La Santé de l'Abeille, Fédération Nationale Des Organisations Sanitaires Apicoles Départementale, no. 307, pp. 85-95;
17. Decourtye A., Mader E., Desneux N., 2010, Landscape enhancement of floral resources for honey bees in agro-ecosystems. Apidologie, vol. 41, no. 3, pp. 264-277. https://doi.org/10.1051/apido/2010024;
18. Decourtye A., Vallon J., Kretzschmar A., Maisonnasse A., Beri C., Alaux C., Frontero L., Girod V.Y. L.C., Dangléant A., 2017, Apis mellifera. Innovations Agronomiques, vol. 55, no. 1, pp. 183-200;
19. Demir E.G., Morkoyunlu A., Kuvancı A., 2023, Importance of honey bee in cherry species pollination (Kocaeli/Turkey). GSC Biological and Pharmaceutical Sciences, vol. 22, no. 2, pp. 40-48. https://doi.org/10.30574/gscbps.2023.22.2.0054;
20. EC - European Commission, 2019, Beekeeping Sector, National Apiculture Programmes 2020-2022;

21. Eouzan I., Garnery L., Sime-Ngando T., Biron D.G., 2017, Les pesticides, la cause du déclin de l'abeille domestique? (C. Bernard, C. Mougin, & A. Pery (Eds.); ISTE Editi). Ecotoxicologie des communautés et impacts sur les fonctions des écosystèmes;
22. Everitt T., Wallberg A., Christmas M.J., Olsson A., Hoffmann W., Neumann P., Webster M.T., 2023, The genomic basis of adaptation to high elevations in Africanized honeybees. Genome Biology and Evolution, vol. 15, no. 9, evad 157. https://doi.org/10.1093/gbe/evad157;
23. FAO, 2018, www.fao.org/faostat;
24. Farrugia D., Martin-Hernandez R., Zammit Mangion M., 2022, Beekeeping in Malta: A Review of Current Practices, Trends and Challenges. Bee World, vol. 99, no. 4, pp. 131-138. https://doi.org/10.1080/0005772x.2022.2113231;
25. Galea T., 2020, The development of 'Varroa destructor'in native 'Apis mellifera ruttneri'and in introduced 'Apis mellifera ligustica'colonies on the island of Malta. University of Malta;
26. Gallai N., Vaissière B., 2009, Guidelines for the economic valuation of pollination services at a national scale. FAO, 17. https://doi.org/hal-02822628;
27. Gambin C., Lanfranco E., Mifsud D., 2013, Pollen Characterisation of Maltese Honey. Journal of Malta Chamber of Scientists, vol. 1, no. 2, pp. 33-46;
28. Genersch E., 2010, American Foulbrood in honeybees and its causative agent, Paenibacillus larvae. Journal of Invertebrate Pathology, vol. 103, S10-S19. https://doi.org/10.1016/j.jip.2009.06.015;
29. Gray A., Adjlane N., Arab A., Ballis A., Brusbardis V., Bugeja Douglas A., Cadahía L., Charrière J.D., Chlebo R., Coffey M.F., Cornelissen B., Costa C.A., da Danneels E., Danihlík J., Dobrescu C., Evans G., Fedoriak M., Forsythe I., Gregorc A., Brodschneider R., 2023, Honey bee colony loss rates in 37 countries using the COLOSS survey for winter 2019–2020: the combined effects of operation size, migration and queen replacement. Journal of Apicultural Research, vol. 62, no. 2, pp. 204-210. https://doi.org/10.1080/00218839.2022.2113329;
30. Haider Y., Adjlane N., 2021, Distribution of Nosema sp. (causative agent of nosemosis in honey bees) in Algeria. AGBIOL 2021. III International Agricultural, Biological & Life Science Conference, Edirne, Turkey, pp. 734-741;
31. Hatjina F., Costa C., Büchler R., Uzunov A., Drazic M., Filipi J., Charistos L., Ruottinen L., Andonov S., Meixner M.D., Bienkowska M., Dariusz G., Panasiuk B., Le Conte Y., Wilde J., Berg S., Bouga M., Dyrba W., Kiprijanovska H., Kezic, N., 2014, Population dynamics of European honey bee genotypes under different environmental conditions. Journal of Apicultural Research, vol. 53, no. 2, pp. 233-247. https://doi.org/10.3896/IBRA.1.53.2.05;
32. Hazam S., Touati S., Touati L., Saher L., Khedidji H., Kaki S.A., Chemat S., 2023, Promising Algerian essential oils as natural acaricides against the honey bee mite Varroa destructor (Acari: Varroidae). Experimental and Applied Acarology, vol. 92, pp. 87-107. https://doi.org/10.1007/s10493-023-00866-4;
33. Hoppe P.P., Safer A., Amaral-Rogers V., Bonmatin J.M., Goulson D., Menzel R., & Baer B., 2015, Effects of a neonicotinoid pesticide on honeybee colonies: a response to the field study by Pilling et al. (2013). Environmental Sciences Europe, vol. 27, no. 1, pp. 1-4. https://doi.org/10.1186/s12302-015-0060-7;
34. Keshlaf M., 2017, The past and present status of beekeeping in Libya. Journal of Apicultural Research, vol. 56, no. 3, pp. 190-195. https://doi.org/10.1080/00218839.2017.1306372;
35. Kumsa T., Takele D., 2014, Assessment of the effect of seasonal honeybee management on honey production of Ethiopian honeybee (Apis mellifera) in

modern beekeeping in Jimma Zone. Research Journal of Agriculture and Environmental Management, vol. 3, no. 5, pp. 246-254;
36. Magnier B., Zacharewicz G., Zacharewicz G., 2022, L' apiculture dirigée par les données et les modèles. The Conversation France, 0-5;
37. Meikle W.G., Holst N., 2015, Application of continuous monitoring of honeybee colonies. Apidologie, vol. 46, no. 1, pp. 10-22. https://doi.org/10.1007/s13592-014-0298-x;
38. Moritz R.F.A., De Miranda J., Fries I., Le Conte Y., Neumann P., Paxton R.J., 2010, Research strategies to improve honeybee health in Europe. Apidologie, vol. 41, no. 3, pp. 227-242. https://doi.org/10.1051/apido/2010010;
39. Mushonga B., Hategekimana L., Habarugira G., Kandiwa E., Samkange A., Ernest Segwagwe B.V., 2019, Characterization of the Beekeeping Value Chain: Challenges, Perceptions, Limitations, and Opportunities for Beekeepers in Kayonza District, Rwanda. Advances in Agriculture, no. 1. https://doi.org/10.1155/2019/5982931;
40. Requier F., Pérez-Méndez N., Andersson G.K.S., Blareau E., Merle I., Garibaldi LA., 2023, Bee and non-bee pollinator importance for local food security. Trends in Ecology & Evolution, vol. 38, no. 2, pp. 196-205. https://doi.org/10.1016/j.tree.2022.10.006;
41. Rinderer T.E., 2013, Bee genetics and breeding. Academic press;
42. Ruttner F., Tassencourt L., Louveaux J., 1978, Biometrical-statistical analysis of the geographic variability of Apis mellifera. Apidologie, vol. 9, no. 4, pp. 363-381. https://doi.org/10.1051/apido:19780408;
43. Salvatore G., Chibani Bahi Amar A., Canale-Tabet K., Fridi R., Tabet Aoul N., Saci S., Labarthe E., Palombo V., D'Andrea M., Vignal A., Faux P., 2023, Natural clines and human management impact the genetic structure of Algerian honey bee populations. Genetics Selection Evolution, vol. 55, no. 1, pp. 1-13. https://doi.org/10.1186/s12711-023-00864-5;
44. Sperandio G., Simonetto A., Carnesecchi E., Costa C., Hatjina F., Tosi S., Gilioli G., 2019, Beekeeping and honey bee colony health: A review and conceptualization of beekeeping management practices implemented in Europe. Science of the Total Environment, 696, 133795;
45. Tarpy D.R., Talley E., Metz B.N., 2020, Influence of brood pheromone on honey bee colony establishment and queen replacement. Journal of Apicultural Research, vol. 60, no. 2, pp. 220-228. https://doi.org/10.1080/00218839.2020.1867336;
46. Traynor K.S., Mondet F., de Miranda J.R., Techer M., Kowallik V., Oddie M.A., Chantawannakul P., McAfee A., 2020, Varroa destructor: A complex parasite, crippling honey bees worldwide. Trends in Parasitology, vol. 36, no. 7, pp. 592-606. https://doi.org/10.1016/j.pt.2020.04.004;
47. Van der Zee R, Brodschneider R., Brusbardis V., Charrière J-D., Chlebo R., Coffey M.F., Dahle B., Drazic M.M., Kauko L., Kretavicius J., Kristiansen P., Mutinelli F., Otten C., Peterson M., Raudmets A., Santrac V., Seppälä A., Soroker V., Topolska G., Gray A., 2014, Results of international standardised beekeeper surveys of colony losses for winter 2012–2013: Analysis of winter loss rates and mixed effects modelling of risk factors for winter loss. Journal of Apicultural Research, vol. 53, no. 1, pp. 19-34. https://doi.org/10.3896/IBRA.1.53.1.02;
48. Wallberg A., Schöning C., Webster M.T., Hasselmann M., 2017, Two extended haplotype blocks are associated with adaptation to high altitude habitats in East African honey bees. PLoS Genetics, vol. 13, no. 5, pp. 1-30. https://doi.org/10.1371/journal.pgen.1006792;

49. Zacepins A., Stalidzans E., Meitalovs J., 2012, Application of information technologies in precision apiculture. A. Zacepins, E. Stalidzans. Proceedings of the 13th International Conference on Precision Agriculture (ICPA 2012);
50. Zacepins A., Karasha T., 2013, Application of temperature measurements for bee colony monitoring: A review. Engineering for Rural Development, pp. 126-131.

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Auteurs et affiliations :

1. **Haider Yamina***
   - *M'hamed Bougara University, Faculty of Sciences, Department of Agronomy, Laboratory of Bioinformatics, Applied Microbiology and Biomolecules (BMAB), Boumerdes, Algeria*
2. **Adjlane Noureddine**
   - *M'hamed Bougara University, Faculty of Sciences, Department of Agronomy, Boumerdes, Algeria*
3. **Martin-Hernande Raquel**
   - *Regional Research and Development Institute for Food and Forestry, Laboratory of Beekeeping Pathology, Centre for Beekeeping and Agroenvironmental Research, Marchamalo, Spain, and Institute of Human Resources for Science and Technology, Albacete, Spain*
4. **Haddad Nizar**
   - *Innovations & Business Development, Fresh Del Monte; General Manager, Organic L'Ora, Amman, Governorate of Amman, Jordan*
5. **Abdelmounaim Khemmouli**
   - *Ferhat Abbas University, Faculty of Natural and Life Sciences, Department of Agronomic Sciences, Laboratory of Valorisation of Natural Biological Resources, Sétif 1, 19000, Algeria*

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Yamina Haider
PhD in Agronomy
Institution: Department of Agronomy, Faculty of Sciences, M'hamed Bougara University; Laboratory of Bioinformatics, Applied Microbiology and Biomolecules (BMAB)
Address: Boumerdes, Algeria
E-mail: y.haider@univ-boumerdes.dz

Noureddine Adjlane
Doctor in Agronomy
Institution: Department of Agronomy, Faculty of Sciences, M'hamed Bougara University
Address: Boumerdes, Algeria
E-mail: adjlanenoureddine@hotmail.com

Nizar Haddad
Doctor in Agronomy
Institution: National Agricultural Research Centre
Address: Amman, Jordan
E-mail: director@narc.gov.jo

ABSTRACT
The honey bee plays a crucial role in maintaining plant biodiversity and environmental equilibrium, making beekeeping a vital activity in Algeria. However, the proliferation of *Varroa* ectoparasitic mites, causing varroasis, poses a significant threat to beekeeping in the region. This study, conducted between March and July 2022, aimed to comprehensively characterize the state of beekeeping in Algeria and identify its primary challenges. The survey was disseminated via email to beekeeping associations and individual beekeepers, with responses from 100 participants subjected to analysis, most of the respondents 97%, are men. 66% of the respondents practice sedentary and 34% transhumance. The findings shed light on the impediments to beekeeping development in recent years, including factors such as drought, elevated mortality rates, and the prevalence of bee pathologies. Notably, a significant portion of beekeepers refrains from conducting mortality analyses. The survey also revealed a substantial decline in honey production compared to previous years. However, positive aspects emerged, such as the presence of beekeepers employing sound beekeeping practices, including frame renewal, colony protection against adverse weather conditions, and the practice of transhumance. Furthermore, periodic varroasis screening in bee colonies was observed as a promising practice. Most beekeepers 98% use annual treatments for *varroa* mites in light of these findings, it is imperative for beekeeping associations to actively engage and take measures to organize and enhance the beekeeping sector, thereby addressing the current challenges.

Keywords: Beekeeping, *Varroa*, Bee Mortality, Honey Production, Environmental Balance.

1 INTRODUCTION

Beekeeping holds significant importance due to its direct influence on the production of various valuable outputs, including honey, beeswax, queen bees, and bee colonies. Additionally, it yields a plethora of other essential products, such as pollen, royal jelly, bee venom, and propolis, which find applications in diverse fields ranging from cosmetics to medicine. The multifaceted nature of beekeeping underscores its pivotal role in both agricultural and industrial sectors, as it contributes not only to the apicultural industry but also to the broader economy and human well-being (Abebe, 2007). The honeybee (*Apis mellifera*) is a valuable resource for the global environment. Although honey and bee products are consumed worldwide, pollination is by far the most valuable contribution of bees. (Aizen; Harder, 2009). Bees contribute to almost 90% of the world's crop pollination (Klein *et al*., 2007).

Bees and pollinators are now major figures in biodiversity because of their ability to pollinate. The threat of their disappearance has revealed the extent to which they represent an essential issue for the agricultural economy, food security, and global health (Dupre; Fortier; Alphandery, 2021). The mechanism of the decline in bee populations has not yet been fully established, although these losses appear to be the result of multiple interrelated factors. The rate of honey bee colony destruction varied according to the diseases and localities considered in the study (Adjlane *et al*., 2018).

The population of the parasite increases during the spring period and then decreases from September onwards in parallel with the decrease in colony size and the quantity of brood of the *Apis mellifera intermissa* (Habbi-Cherifi *et al*., 2019).

This study aims to provide an overview of beekeepers and their practices. It complements data collected previously in similar surveys. It will also make it possible to analyze the health situation of bee colonies and to explain the mortalities and losses of colonies suffered in our hives.

2 MATERIAL AND METHOD

2.1 LOCATION AND PERIOD OF WORK

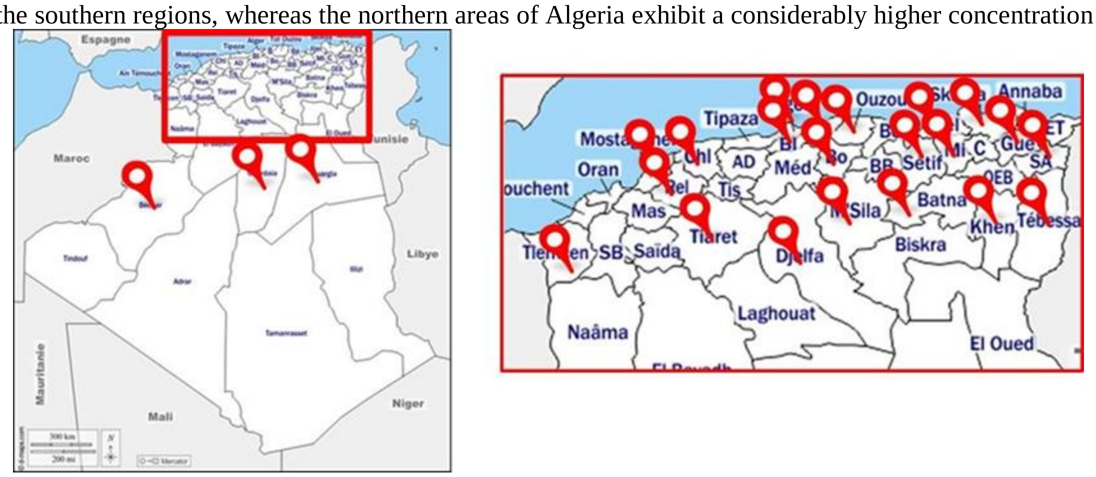
The study was conducted during the year 2022, a survey was carried out between March and July, to characterize and understand the beekeeping activity and its main problems in Algeria. This survey was distributed by e-mail and sent to all the beekeeping associations and beekeepers.

The survey questionnaire focused on the following elements: Characterization of respondents and hives, beekeeping practices, threats to honey bees, and treatments used for varroa control.

2.2 DATA ANALYSIS

The data gathered from both primary and secondary sources were input into Microsoft Excel 2016 spreadsheets, and subsequent data frequencies, tables, and graphs were generated using the same software.

Figure 1. Distribution of locations where respondents have their apiaries. The heat map of Algeria, which displays the distribution of apiaries across the country, reveals a noteworthy pattern. It's evident that there is a relatively lower density of apiaries in the southern regions, whereas the northern areas of Algeria exhibit a considerably higher concentration of apiaries.



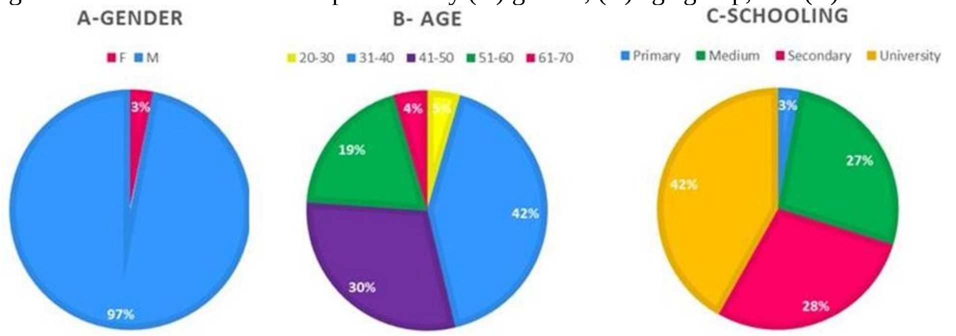
Source: Prepared by the authors themselves.

3 RESULTS AND DISCUSSION

3.1 CHARACTERIZATION OF RESPONDENTS

According to the results obtained, most of the respondents (100 responses, 97%, Figure 2a) are men. Our results, which reveal a prevalence of male participation in the field of beekeeping, align with numerous studies conducted across the African continent. At levels that were similar to findings in another research (Bihonegn; Begna, 2021; Farrugia; Martin-Hernandez; Zammit Mangion, 2022; Sperandio *et al*., 2019). It seems that male predominance in this profession can be attributed to their willingness to endure bee stings and craft their own hives, resulting in reduced initial and ongoing expenses. (Berhe; Asale; Yewhalaw, 2019). The most representative age group belongs to the 31-40 age group and the least representative is the 61-70 age group with only 3 responses (4%), followed by 41-50 with responses (30%) (Figure 2b), age and experience significantly impact the ability to recognize local honeybee species, understand their products, and interpret their behaviors (Aynalem Abejew; Mekuriaw Zeleke, 2017). In terms of education, 42% had higher education and 28% had completed secondary school (Figure 2c). The educational background of beekeepers can play a pivotal role in discerning and specifying the requisite development and extension services tailored for the region (Alemu; Seifu; Bezabih, 2015).

Figure 2. Characterization of respondents by (A) gender, (B) age group, and (C) education.

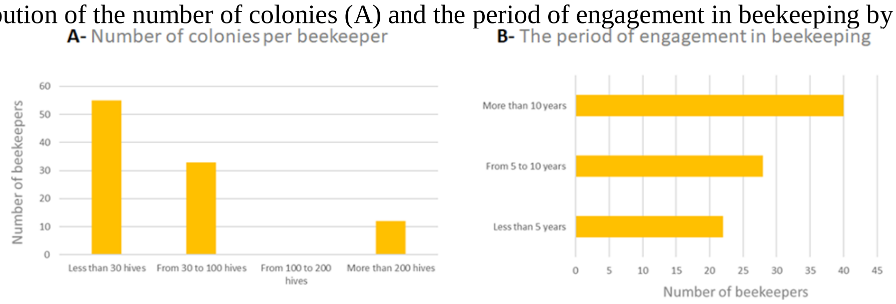


Source: Prepared by the authors

3.2 CHARACTERIZATION OF APIARIES

Figure 3a represents the distribution of the number of colonies by beekeepers, the distribution of the colonies is very variable, and the hives installed of the Langstroth type. According to the total number of colonies, 55 of the beekeepers have more colonies in less than 30 hives, followed by 33 beekeepers who have 30 to 100 colonies, 12 beekeepers who have more than 200 colonies, and no response for colonies from 100 to 200 hives. The persistence of this practice is expected to endure, primarily due to the significant constraints posed by limited land availability and the predominantly part-time nature of beekeeping among the majority of beekeepers (Farrugia *et al*., 2022). Most beekeepers have accumulated more than ten years of experience, accounting for 40 responses out of a total of 100, which is 40% (Figure 3b), it could be attributed to the trend among beekeepers to develop their skills and expertise over the years. Beekeeping is an activity that greatly benefits from experience, as beekeepers learn to better understand bee behavior, manage colonies more effectively, and address various challenges related to bee health. Experienced beekeepers are often better equipped to make informed decisions and solve problems that arise in their hives. Therefore, it is logical that most beekeepers have accumulated significant experience over the years to enhance their beekeeping practices.

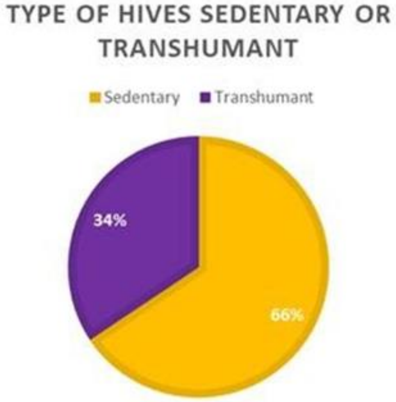
Figure 3. Distribution of the number of colonies (A) and the period of engagement in beekeeping by beekeepers (B).



Source: Prepared by the authors.

Beekeeping can be done in two ways, sedentary or transhumance, with the movement of colonies depending on the floral vegetation. Regarding the type of beekeeping, most of the respondents practice sedentary (66%) and transhumance (34%; Figure 4). Additionally, the extensive practices of migratory beekeeping and commercial breeding can promote gene flow between different bee races in Algeria. Productive beekeeping now uses seasonal transhumance, sometimes massive, towards protected natural areas. The managers of protected natural areas are now expressing concern about ecological interference between honeybees (Apis mellifera) and the many other species of foraging insects. (Cavallin; Rodet; Henry, 2019). A study by Dahmane (2020) shows that most of the beekeepers have secondary activities, and that beekeeping is practiced by a very large number of amateurs, who have a technical level, often, insufficient. In addition, migratory beekeeping practices should be carefully managed to minimize the risk of genetic mixing and the spread of diseases.

Figure 4. Types of beekeeping practiced in Algeria.

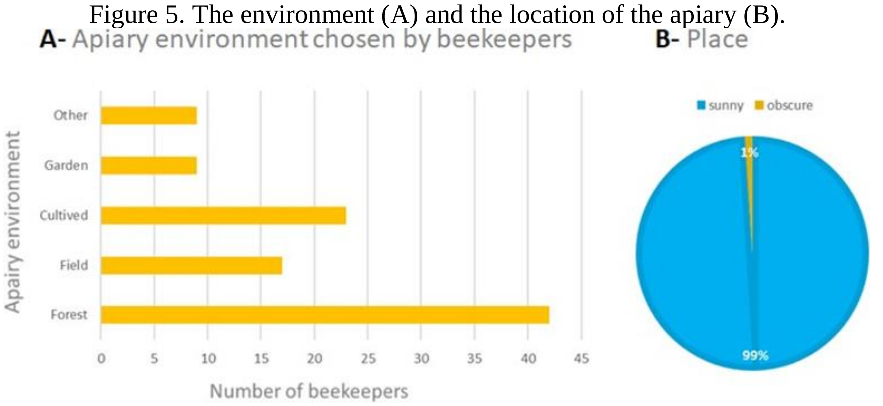


Source: Prepared by the authors.

3.3 BEEKEEPING PRACTICES

Beekeepers have a crucial role in ensuring the vitality of bee colonies (Sperandio *et al*., 2019). The majority of beekeepers place their colonies in forests (42 responses) followed by cultivated (23 responses) and 17 responses for fields. The choice of hive location by beekeepers is sunny (99%) and dark (1%; Figure 5b). In this study beekeepers prefer placing their hives in forests rather than agricultural fields due to concerns about pesticides, aiming to avoid pollution and toxicity associated with agricultural chemicals. This preference stems from beekeepers' deep understanding of the detrimental effects of pesticides on bee health and honey quality. By opting for forest locations, beekeepers also contribute to preserving local biodiversity and safeguarding the natural environment.

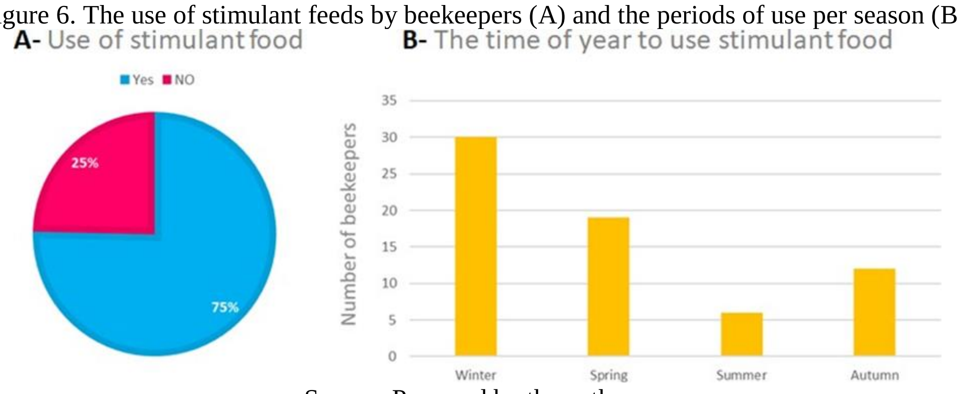
Figure 5. The environment (A) and the location of the apiary (B).



Source: Prepared by the authors.

The main objective of beekeepers is to increase production, in the animal production sector, genetic improvement meets the conditions for moderate breeding; controlled feeding, in beekeeping where the activity remains highly dependent on the climate and natural resources. Most beekeepers use stimulating feeds (75%) (Figure 6a) at different times of the year, with 30 responses for winter followed by spring 19 responses, and autumn 12 responses (Figure 6b), for the duration, the dose used, and the frequency of distribution varies according to the season and the number of hives as well as the development and strength of a colony of bees.

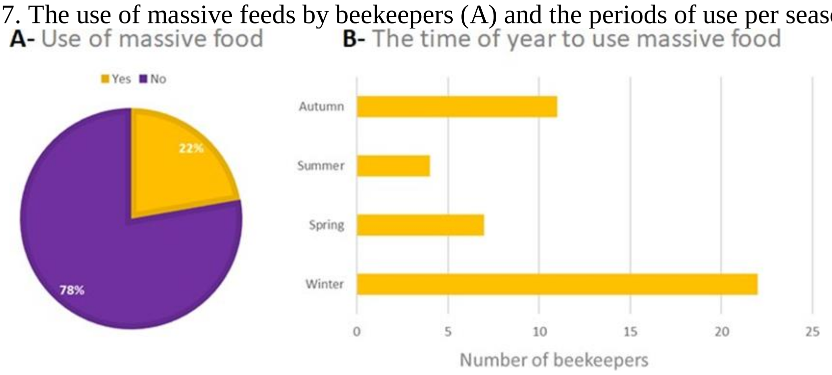
Figure 6. The use of stimulant feeds by beekeepers (A) and the periods of use per season (B).



Source: Prepared by the authors.

The use of mass feeding by 78% of beekeepers (Figure 7a) in different periods of the year, 22 responses for winter followed by autumn 11 responses and 7 responses for spring (Figure 7b). Feeding bees during periods of crop failure in the wild is a particularly specific problem. To compensate for the lack of nutrients in the bees' diet during the poor harvest seasons in the wild, most beekeepers feed the bee colonies with sugar syrup, which, in addition to carbohydrates, lacks a significant amount of biologically active substances. Under these conditions, it is essential to strengthen their strength and vitality by balanced feeding methods with nutritional supplements enriched with biologically active organic substances (Cebotari; Buzu, 2022).

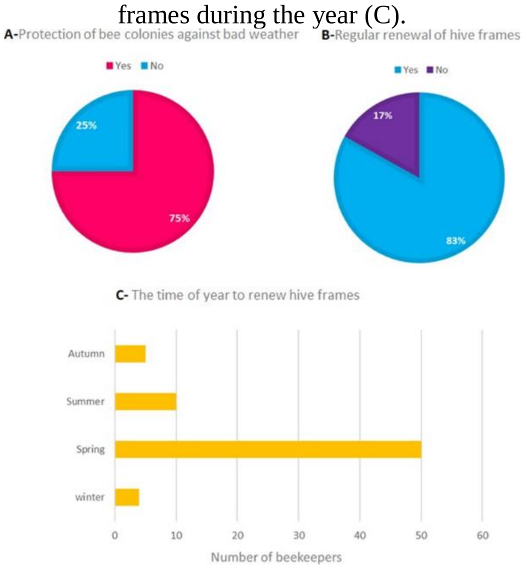
Figure 7. The use of massive feeds by beekeepers (A) and the periods of use per season (B).



Source: Prepared by the authors.

75% of the beekeepers protect their colonies against the weather (Figure 8a), using polystyrene boards, cardboard, and wooden boards during the winter as rain and even snow covers, some beekeepers close most of the flight holes with newspaper against the wind, and for the summer the beekeepers move their hives to less sunny places. 83% of the beekeepers regularly renew frames (Figure 8b), usually in spring (50 responses) (Figure 8c), at the beginning of the beekeeping season when they check the hives and remove old frames with a darker color, or in case of suspicion of a contagious disease, other beekeepers change the frames after the honey harvest.

Figure 8. Protection of colonies against bad weather by beekeepers (A) renewal of frames (B) and periods of renewal of frames during the year (C).



Source: Prepared by the authors.

As one might expect, honey is the most exploited hive product. In most beekeepers' responses comparing honey production this year with previous years, more than half of beekeepers (55%) consider that the amount of honey produced has decreased, due to several biotic and abiotic factors such as drought, climate change, very high mortalities, the presence of pathologies and COVID had a negative influence on the yield which is very low in honey and that (18%) of beekeepers find that honey production is good (Figure 9).

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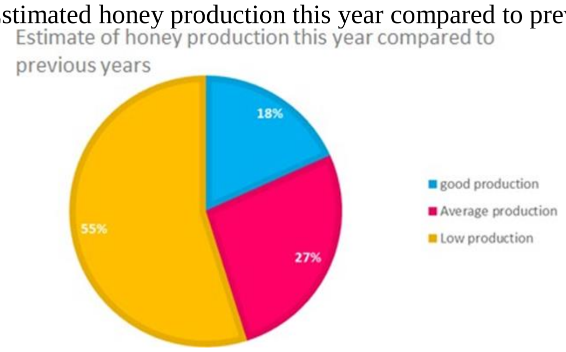
Figure 9. Estimated honey production this year compared to previous years.

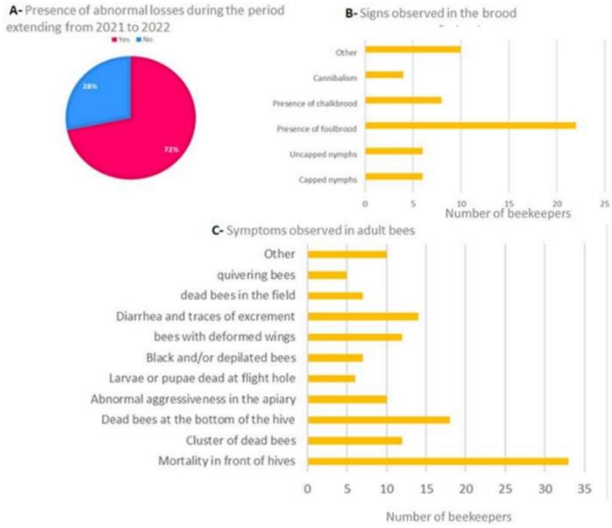


Source: Prepared by the authors.

3.4 THREATS TO HONEY BEES

Bees naturally suffer from a wide range of parasites and pathogens, the latter including protozoa, fungi, bacteria, and viruses. By far, the majority of research has focused on those associated with honey bees. Some bee diseases include deformed wing virus (DWV), *Nosema ceranae,* and *Paenibacillus larvae* (Genersch, 2010). Most beekeepers (72%) consider that there are abnormal losses in the period from 2021 to 2022. (Figure 10a). About the signs observed in broods (22 responses) for the presence of foulbrood, followed by six responses for capped nymphs and uncapped nymphs. On the other hand, 10 beekeepers responded with other signs (Figure 10b). And for symptoms observed in adult bees, the highest number of responses (34) for mortality in front of the hives followed by dead bees at the bottom of the hive (18). Third with 14 responses for diarrhea and dung trails, 7 responses for black and/or hairy bees and dead bees in the field (Figure 10c). Another study in Algeria, it has been reported that 65% and 85% of hives contained *nosema sp.* spores (Chahbar *et al*., 2016).

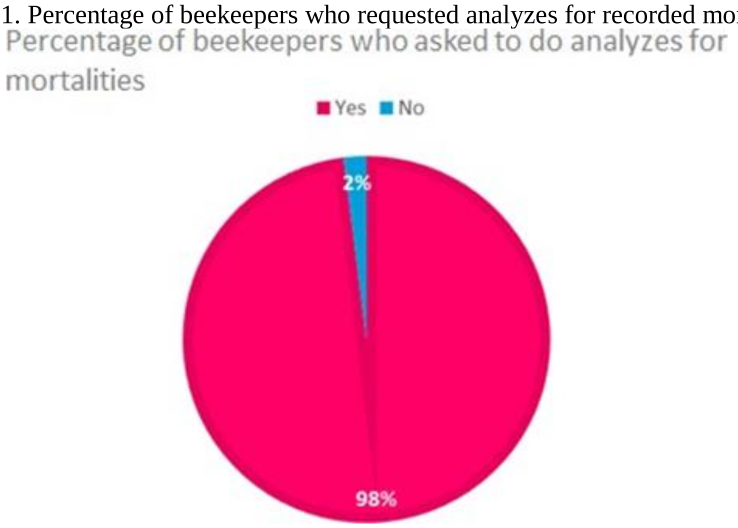
Figure 10. Beekeepers' responses to threats to bees. (A) Percentage of abnormal losses during the period from 2021 to 2022. (B) Signs were observed in the brood. (C) Symptoms are seen in adult bees.



Source: Prepared by the authors.

Only 2% of beekeepers who ask to do laboratory analyzes for mortalities, by sending samples of bees and brood, the results of the analyzes show the presence of American foulbrood and nosemosis. (Figure 11). This low rate of beekeepers seeking laboratory analyses for bee mortalities may be attributed to various factors, including a lack of awareness about the benefits of such analyses, limited access to testing facilities, or perhaps a belief that mortalities are primarily caused by other factors. Further research and outreach efforts could help elucidate the underlying reasons for this limited uptake of laboratory testing among beekeepers. It is essential to provide beekeepers with education about the advantages of collecting samples and utilizing microscopic examination for the diagnosis of prevalent honeybee diseases. Additionally, this educational effort should be complemented by offering necessary tools and access to laboratory services to facilitate comprehensive diagnostics on the samples provided by beekeepers (Mushonga *et al*., 2019).

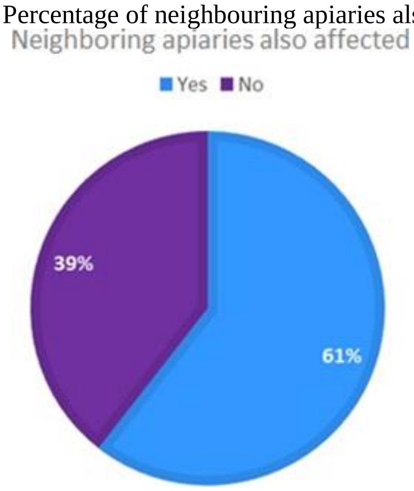
Figure 11. Percentage of beekeepers who requested analyzes for recorded mortalities.



Source: Prepared by the authors.

In more than half of the responses (61%), beekeepers indicate that neighboring apiaries are also affected by the same symptoms in their colonies. (Figure 12). Worker bees collect and disseminate infectious spores from diseased broods within the hive, facilitating their spread. Furthermore, forager bees transport these spores beyond the hive, potentially leading to their transmission between hives during robbing incidents, where weakened and afflicted hives are plundered for honey by bees from other colonies (Stephan; Miranda; Forsgren, 2020; Downs; Ratnieks, 2000).

Figure 12. Percentage of neighbouring apiaries also affected.

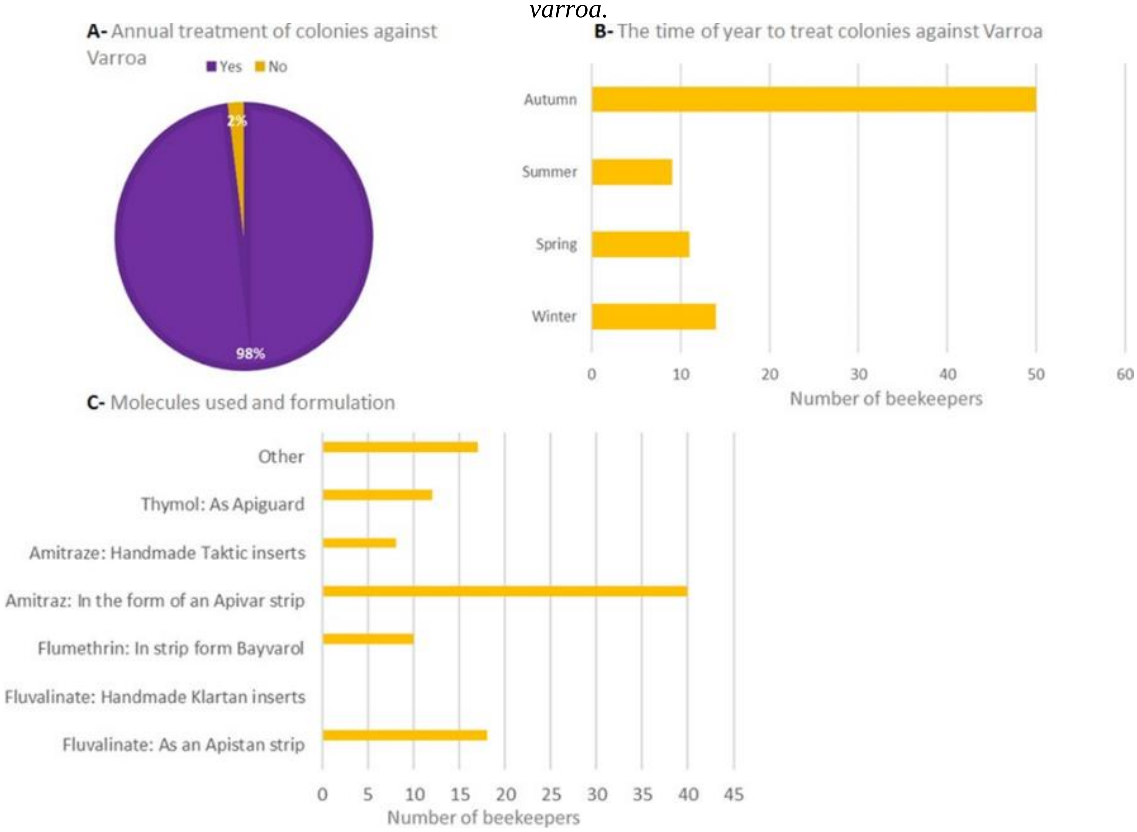


Source: Prepared by the authors.

The invasion of the *Varroa destructor* mite is one of the most dangerous parasitic diseases that have intensified the most valuable attacks, from a production point of view, on useful insect species, such as the *Apis mellifera L*. bee, having a highly accelerated character, with an extremely harmful destructive impact, threatening the existence of the bee colony (Cebotari *et al*., 2013).

Specialized researchers should direct their work towards studying the evolutionary cycle of *Varroa destructor*, its resistance to physical and chemical agents, and the means of destroying it in hives (Louveaux, 1974). Most beekeepers (98%) use annual treatments for varroa mites (Figure 13a). In total, (50 responses) of the beekeepers apply the treatment in autumn followed by twelve responses in winter (Figure 13b). Ten beekeepers did not answer the question. Of the treatments indicated, the most used is Amitraze: in the form of a strip (Apivar) (40 responses), followed by Fluvalinate: in the form of a strip (Apistan) (18), and no beekeepers use Fluvalinate: homemade inserts in Klartanen, in contrast (12 responses) for Thymol: in the form of Apiguard (Figure 13c). We can see that the relationship of beekeepers to the health of bees is mediated by their relationship to nature, which is expressed in the discourse on the drugs proposed to combat *varroa* mites and on alternatives to drugs, mainly the breeding of hardy or productive lines of bees, or those resistant to the parasite. As we have seen, control strategies have evolved since the 1980s and are identified and known to beekeepers. They are spread out over a continuum ranging from natural treatments (without chemicals) to medicines available in conventional chemistry (Faugère; Dussy, 2019, 2021).

Figure 13. Surveillance and treatments against *Varroa* used by beekeepers. (A) Percentage of responses from beekeepers who treat *Varroa* annually. (B) Period of the year of treatment against *varroa*. (C) The treatment molecules were used against *varroa*.



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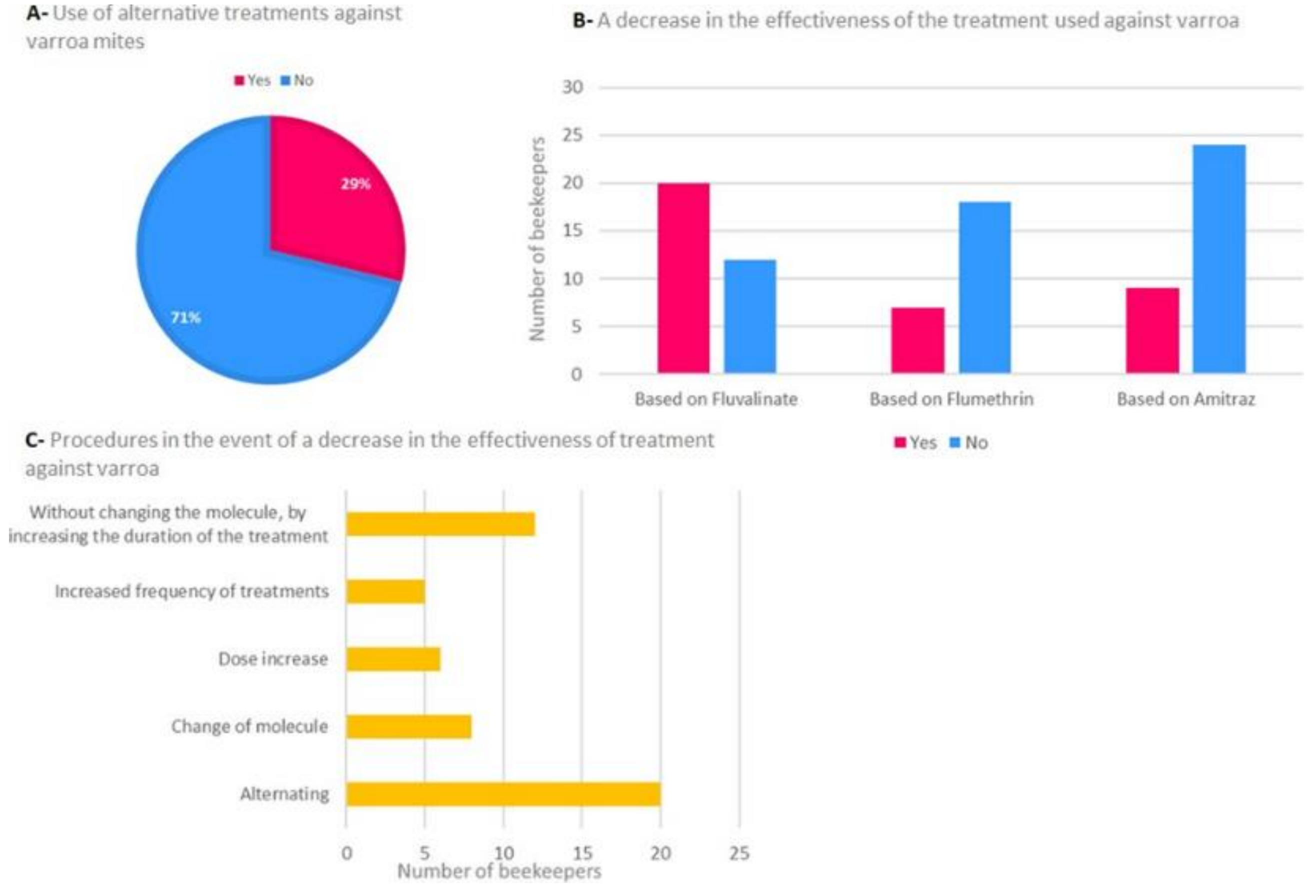
Regarding the opinion of the beekeepers on the different treatments used against varroa mites, 71% of the beekeepers use alternative treatments (Figure 14), such as tobacco leaves, garlic, cider vinegar, oxalic acid, mugwort, thyme, and thyme crystals in the bees' diet. Figure 14 shows the seasons in which varroa monitoring and treatments are applied. *Varroa* monitoring is carried out throughout the beekeeping season. The fluvalinate treatment is the treatment with the lowest efficacy according to 20 beekeepers after the second to third year of the *varroa* treatment, beekeepers also perform several methods to increase treatment efficiencies, the highest number of responses was obtained for the use of alternative or biological treatments (20 responses), followed by the procedure of not changing the molecule, increasing the duration of the treatment (12) and 8 responses for changing the molecule used. (Figure 14c). Another study sought to identify fluvalinate-resistant mite populations in northern-central Algeria, with *Varroa* mortality at 41.23% in fluvalinate-treated apiaries, compared to 81.51% in those receiving an alternative treatment (Adjlane; Doumandji; Haddad, 2013).

Figure 14. Opinion of beekeepers regarding the different treatments used against *varroa* mites. (A) Percentages of beekeepers who carry out alternative treatments. (B) Distribution of responses concerning a decrease in the effectiveness of the treatment used against varroa mites. (C) Methods in the event of a decrease in the effectiveness of the treatment against *varroa*..



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4 CONCLUSION

The results of this study show the constraints and challenges of beekeeping development in Algeria in recent years, the very high mortality, and the presence of pathologies. The majority of beekeepers do not ask for an analysis of the recorded mortalities. The practice has had a negative influence on the yield, which is very low in honey. Among the positive points of the survey, the presence of beekeepers who practice good beekeeping (renewal of frames, protection of colonies against bad weather, practice of transhumance) as well as the periodic detection of varroasis in the bee colonies and the use of biological or alternative treatments. The conservation of honeybee colonies in Algeria requires their protection against various biotic and abiotic factors. Beekeeping associations must be on the ground to organize the beekeeping sector and improve the current situation, as the beekeeping profession has had to deal with significant losses of colonies and a drop in honey production in recent years. Further studies are needed in the future to improve the health situation of beekeeping in Algeria. An issue that demands attention in future research is the effective management of *Varroa destructor*, which continues to pose one of the most significant challenges in the field of beekeeping.

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REFERENCES

Abebe, W. (2007). *Determinants of adoption of improved box hive in Atsbi Wemberta District of Eastern Zone, Tigray Region*. (PhD Thesis). Haramaya University.

Adjlane, N., Habbi-Cherifi, A., Haddad, N., & A. Baz. (2018). Prevalence of acariosis in honeybee colonies of Apis mellifera intermissa in Algeria. *Journal of Entomological Research, 42*(4), 451- 54.

Adjlane, N., Doumandji, S. E. & Haddad, N. (2013). Varroa destructor resistance to fluvalinate in Algeria. *Trends Entomol*, *12*, 123-25.

Aizen, Marcelo A. & Lawrence D. Harder. (2009). The global stock of domesticated honey bees is growing slower than agricultural demand for pollination. *Current biology, 19*(11), 915- 18.

Alemu, T., Eyassu, S. & Amessalu, B. (2015). Postharvest handling, opportunities and constraints to honey production in northern Ethiopia. *Livestock Research for Rural Development, 27*(5).

Aynalem, A. T. & Zeleke, M. Z. (2017). Study on the beekeeping situation, the level of beekeepers knowledge concerning local honeybee subspecies, their productive characteristics, and behavior in Eastern Amhara Region, Ethiopia. *Advances in Agriculture*, 2017.

Berhe, A., Abebe, A. & Delenasaw, Y. (2016). Community perception on beekeeping practices, management, and constraints in Termaber and Basona Werena districts, central Ethiopia. *Advances in Agriculture,* 2016.

Bihonegn, A. & B. Desalegn. (2021). Beekeeping production system, challenges, and opportunities in selected districts of South Wollo Zone, Amhara, Ethiopia. *Advances in Agriculture,* 2021, 1-10.

Cavallin, P., Guy, R., & Mickael, H. (2019). Maîtriser l'impact de l'apiculture sur les insectes butineurs. *Espaces Naturels,* (65), 51-52.

Cebotari, V. & Ion, B. (2022). Conservation and valorisation of bee species apis mellifera carpatica in context climate change. *Scientific Papers: Series D, Animal Science-The International Session of Scientific Communications of the Faculty of Animal Science*, *65*(1).

Cebotari, V., Toderaș, I., Buzu, I. & Olga, P. (2013). Invasion of the Varroa jacobsoni parasite in Apis mellifera Carpatica bee families. Invazia parazitului Varroa jacobsoni în familiile de albine Apis mellifera Carpatica. *Buletinul Academiei de Științe a Moldovei, Științele vieții*, 4- 13.

Chahbar, M., Tefiel, H., Adidou-Chahbar, N., Doumandji-Mitiche, B. & Gaouar, S. B. S. (2016). First spatial distribution of nosemosis (Nosema sp) infected local bee, Apis mellifera intermissa L. in Algeria. *Egyptian Journal of Biological Pest Control*, *26*(2), 357-363.

Dahmane, A. (2020). Apis mellifera keeping in mila district from Algeria; colony management and varroa destructor control practices. *Mellifera, 20*(2), 1-17.

Dupre, L., Agnes F., & Alphandery, P. (2021). *Abeilles. le sacrifice des pollinisateurs*.

Farrugia, D., Martin-Hernandez, R. & Zammit Mangion, M. (2022). Beekeeping in Malta: A Review of Current Practices, Trends and Challenges. *Bee World, 99*(4), 131-138. Doi: 10.1080/0005772X.2022.2113231.

Faugère, E., et Dorothée, D. (2019). *La circulation des connaissances dans les exploitations apicoles françaises*. Les Editions la Discussion.

Faugère, E., et Dorothée, D. (2021). Abeilles, apiculteur· trice· s et varroa: cohabiter en temps de crises ». *Anthropologie & Santé. Revue internationale francophone d'anthropologie de la santé,* (22).

Genersch, E. (2010). American Foulbrood in honeybees and its causative agent, Paenibacillus larvae. *Journal of invertebrate pathology,* 103, p. S10-19.

Habbi-Cherifi, A., Adjlane, N., Medjdoub-Bensaad, F. & Haddad, N. (2019). Dynamics of the population Varroa destructor at the Level of Local Bee Colonies Apis mellifera intermissa in the North Central of Algeria. *Mellifera, 19*(2), 33-42.

Stephan, J. G., Miranda, J. R. de & Forsgren, E. (2020).American foulbrood in a honeybee colony: spore-symptom relationship and feedbacks between disease and colony development. *BMC ecology*, *20*(1), 1-14.

Klein, A. M., Vaissiere, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C. & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences, 274*(1608), 303-313.

Louveaux, J. (1974). The Bee and the Environment. *Bee World*, *55*(4), 150-152.

Mushonga, B., Landouard, H., Gervais, H., Kandiwa, E., Alaster, S., & Basiamisi, V. E. S. (2019). Characterization of the beekeeping value chain: challenges, perceptions, limitations, and opportunities for beekeepers in Kayonza District, Rwanda. *Advances in Agriculture, 2019*, 1-9.

Sperandio, G., Simonetto, A., Carnesecchi, E., Costa, C., Hatjina, F., Tosi, S. & Gilioli, G. (2019). Beekeeping and honey bee colony health: A review and conceptualization of beekeeping management practices implemented in Europe. *Science of the Total Environment*, *696*, 133795.

Downs, S. G. & Ratnieks, F. L. W. (2000). Adaptive shifts in honey bee (Apis mellifera L.) guarding behavior support predictions of the acceptance threshold model. *Behavioral Ecology*, *11*(3), 326-333.

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