Professional Apiculture in the Netherlands:

Sector Analysis

ACBEE
PROJECT

Professional Apiculture in the Netherlands: Sector Analysis

Wageningen, the Netherlands

28-06-2024

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Disclaimer

This project was a collaboration between the Beroepsvereniging Nederlandse Imkers (BVNI) and students from Wageningen University & Research (WUR). However, this is not an official collaboration between the BVNI and WUR. This project was carried out for the purpose and completion of the Academic Consultancy Training (ACT) program offered by WUR.

Preface

We, a group of 8 students with different backgrounds and educational programs, conducted a sector analysis for the professional beekeeping sector in the Netherlands commissioned by the BVNI (Beroepsvereniging Nederlandse Imkers) from 13 May to 5 July 2024. This analysis is part of the Academic Consultancy Training (ACT) of Wageningen University & Research. During this period, we conducted a literature review and interviews with professional beekeepers, sellers of bee products, researchers, and advisors in the beekeeping sector. These interviews provided us with new knowledge about beekeeping, offered a different perspective, and even inspired us to start beekeeping ourselves!

First of all, we would like to thank Harmen Hendriksma for sharing his knowledge about professional beekeeping and guiding us as commissioner. In addition, we would like to thank our coach Jean-Paul van Rie for coaching, feedback, guidance and support. We would like to thank Ria Hulsman for her feedback, help, and professional insights as an academic advisor. Finally, we would like to thank the people we interviewed for answering our questions, sharing their vision and transferring their enthusiasm and passion for beekeeping.

Team ACBee

Wageningen, June 28, 2024

Summary

This sector analysis was conducted for the Beroepsvereniging Nederlandse Imkerij (BVNI). The BVNI had a request for an updated overview and sector analysis on professional beekeeping since the report by Blacquière et al., "*Vision on beekeeping and insect pollination: analysis of threats and bottlenecks*" was published in 2009. Therefore, the following research question was investigated: "What strategies can the BVNI employ to promote and implement long-term economic and environmental sustainability for the Dutch apicultural sector and its stakeholders?" Based on Blacquière et al. (2009), this report was formulated with different insights under six different factors: social, environmental, technical, economic, political, and legislative aspects.

The Dutch beekeeping sector, primarily composed of hobbyists and a small group of professional beekeepers, holds limited influence on a European scale. This marginal role poses challenges, as professional beekeepers may struggle to gain credibility with key stakeholders, hindering access to subsidies and facing legislative barriers due to differing practices from hobbyists. Maintaining regular communication with stakeholders, even during busy periods, is crucial for organisations like BVNI. "Het Imkersoverleg" plays a central role in lobbying efforts for Dutch beekeepers, aiming to align national beekeeping policies and prevent conflicting regulations within the Netherlands. Collaborating with other countries and Dutch sectors that have a strong influence in the European Union (EU) such as agriculture and seed production strengthens the sector's influence in the EU.

Managed honeybees may have a negative effect on native wild bees, according to nature organisations and agencies such as Insect Knowledge Centre EIS. However, the results of studies on the possible effects of managed honeybees on wild bees are mixed. These mixed results give rise to debate in the beekeeping sector as to whether restrictions on placing hives in Amsterdam and nature reserves such as the Biesbosch are justified. Concrete evidence for the long-term effects of competition between honeybees and wild bees is scarce and requires additional research to give more definitive evidence to better inform policy decisions.

Future regulations will likely mandate hive registration to enhance disease control, particularly for threats like Varroa, which is currently the foremost concern in Dutch beekeeping. Economically, the Dutch apicultural sector has untapped potential, notably in undervalued pollination services, complicated by inadequate valuation methods.

Effective management of Varroa mites requires rigorous monitoring, Integrated Pest Management (IPM), responsible use of miticides, and support for selective breeding programs. Investment in research, education, and training for beekeepers is essential. Concurrently, combatting the Asian hornet demands advanced tracking technologies, innovative traps, and eco-friendly controls like electric traps and beehive muzzles. A holistic approach addressing Varroa mites, Asian hornets, and other threats ensures healthier honeybee populations, sustainable management practices, and preservation of vital pollination services.

In conclusion, the small size of the Netherlands limits the ability to address many challenges faced by beekeeping in the country. Given the relatively minor influence of the Dutch beekeeping sector within Europe, one of our main recommendations is to prioritize collaboration among associations and beekeepers to tackle these challenges. Additionally, there should be a stronger lobbying effort for more unified regulatory protocols, a greater emphasis on the exchange of knowledge within the sector, and more data collection, which is essential for research.

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1 Introduction

Honeybees and their provided pollination services play an instrumental role in the agricultural sector by contributing to over 30% of food production across the globe (Khalifa et al., 2021). The apicultural sector is essential in the Netherlands, where pollination services contribute to approximately one billion euros per year (Blacquière et al., 2009). Profits generated by professional beekeepers are marginal in comparison to those generated by for example farmers in the agricultural sector (Blacquière et al., 2009). However, professional beekeepers and the pollination services their bees provide have a significant impact on agricultural production. The lack of proper compensation for pollination services results in less appeal for new professionals in the field of apiculture (Blacquière et al., 2009; Breeze et al., 2016).

Unfortunately, the sector faces several issues threatening its survival, factors like fluctuations and unpredictability of climatic conditions increase the chances of colony collapse due to a lack of resources for bees, droughts, and disease establishment in hives. (Blacquière et al., 2009; Flores et al., 2019; Van Espen et al., 2023). Moreover, droughts and lack of resources, together with fragmentation and habitat loss due to rationalisation of agriculture and biodiversity loss, result in decreased nectar flow and fewer food sources for bees. In addition to these, diseases-related colony losses, disconnection from politicians, and lack of awareness of non-apicultural bodies are the concerns for current Dutch apiculture.

Additionally, invasive species are migrating to different continents and countries, leading to possible new threats such as the Asian hornet. Together with diseases, caused by the Varroa mite for instance, disease-related colony losses have increased. Furthermore, the increase in these threats further raises financial costs for professional beekeepers (Rucker et al., 2012).

Besides this, legislative guidelines in the apicultural sector within the European Union (EU), including the Netherlands, are limited when it comes to disease and pest management protocols (Blacquière et al., 2009; Van Espen et al., 2023). The Dutch apicultural sector has around 20 professional and 8000 hobbyist beekeepers. This significant difference in numbers creates a disconnection between politicians and professional beekeepers, making it difficult for professional beekeepers to receive the same level of support and recognition as hobbyists from politicians and other stakeholders (Personal interview 8, In person, June 2024). This results in a lack of awareness about the critical role and importance of professional beekeepers by non-apicultural bodies.

Increased concerns from the “Tweede Kamer der Staten Generaal” about the increasing starvation of the bee colonies and the possible impacts on Dutch agriculture in 2008 led to an investigation into the honeybees in the Netherlands (Blacquière et al., 2009). The aim was to obtain insight into the strengths, weaknesses, opportunities and threats of beekeeping and insect pollination, resulting in a vision named: “Visie Bijenhouderij en Insectenbestuiving: Analyse van bedreigingen en knelpunten” by Blacquière et al. (2009) which was a basis for policy and further research initiatives.

The BVNI has highlighted the need for updated data and sector analysis for professional apiculture in the Netherlands since the publication of the 2009 report by Blacquière et al. (H. Hendriksma, personal communication, May 2024). The lack of comprehensive data on the professional apiculture sector in the Netherlands provided by beekeepers hinders the ability to address key challenges and support the sustainability of the professional apicultural sector in the Netherlands. If this knowledge gap is not addressed, professional beekeepers in the Netherlands might continue to be under-represented and undervalued in the agricultural sector, exacerbating current issues such as insufficient funding, insufficient collaboration with other sectors, and the lack of initiatives to support their businesses.

To solve the lack of an updated overview about the Dutch apiculture sector since the report provided by Blacquière et al. (2009), this project intends to analyze existing strengths and weaknesses and identify threats and opportunities in the current (professional) beekeeping sector by answering the following main research questions:

"What strategies can the BVNI employ to promote and implement long-term economic and environmental sustainability for the Dutch apicultural sector and its stakeholders?"

With its corresponding sub-questions:

- How have the Strengths, Weaknesses, Opportunities and Threats in the beekeeping sector changed since the report by Blacquière et al. (2009)?
- Which strategies can be used to increase the appreciation of pollination services that bees provide to crops and nature by farmers and policymakers?
- What methods can be used to convey the findings to the stakeholders, so they can integrate these opportunities into their practices?

The report will provide information needed for long-term economic and environmental sustainability of the Dutch apicultural sector to relevant stakeholders and policymakers. This project aims to update the norms and provide an analysis of the current apicultural sector in the Netherlands, to ensure a future-proof sector which works in harmony with stakeholders in the agriculture sector, biodiversity/nature sector, and with the government. In this way, a sustainable business model for (professional) beekeepers, to survive the long run, can be created ("Modern Beekeeping," 2020).

To address the research questions, literature was reviewed about the different factors of the PESTEL analysis (**P**olitical, **E**conomic, **S**ocial, **T**echnological, **E**nvironmental and **L**egislative) and was analysed with the SWOT technique (**S**trengths, **W**eaknesses, **O**pportunities and **T**hreats). This sector analysis was conducted by carrying out qualitative interviews with key stakeholders within the sector. Further elaboration on this methodological approach will be provided in Chapter 2: Materials and Methods. Chapters 3 to 9 will present the information derived from the PESTEL analysis, followed by Chapter 10 which will focus on the recommendations and provide conclusive answers to the research questions.

2 Materials and methods

To address the research questions, a qualitative study was conducted to gain insights into the trends within the professional beekeeping sector in the Netherlands. This involved conducting interviews with various stakeholders in the apiculture sector to obtain first-hand information. Additionally, secondary information was gathered from a wide range of literature sources to obtain both broad and specific information on different topics. For the purpose of the project directed at supporting the BVNI, it was decided to focus the information search into the mainland Netherlands region, where the BVNI has active members. The information search therefore did not include municipalities or countries of the Kingdom of the Netherlands in the Caribbean region.

2.1 Data collection

To achieve a wide overview of the apiculture sector in the Netherlands information was gathered from a variety of sources. Interview recordings and an online questionnaire were utilised to unveil specific information on stakeholder viewpoints. While the primary focus was on interviews, the online questionnaire provided additional contextual insights. Interviews were carried out and literature review was performed for a variety of topics involved in beekeeping. Literature was obtained from sources ranging from economic data, legislations, scientific articles, opinion blogs and others.

Some keywords and search terms used to find relevant literature are included below:

- **Social:** beekeeping organisations, beekeeping in the Netherlands, beekeeping size Netherlands.
- **Environmental**: managed honeybees, wild bees, genetic diversity, climate change, competition, displacement.
- **Technical**: *Varroa destructor*, Asian hornet, Nosema, natural selection, Darwinian method, selective breeding, miticide, small hive beetle, *Aethina tumida*, colony loss, American foulbrood, *Tropilaelaps*, disease control, disease monitoring, invasive species.
- **Economic**: economic, macroeconomic, valuation, pollination services, honey market, bee products.
- **Political/Legislative**: EU regulations, EU directives, imported honey, hive registration, disease notification, disease control, EU funding, Dutch funding, EU apiculture projects, Dutch honey, honey testing, invasive species, Dutch legislations (by province), pesticides, banned products.

Searches were performed in relevant databases such as Scopus, Consensus, Google Scholar and WUR Library Services for scientific literature. For legislations and policies, the EU-Lex database was used for relevant information on European laws. For Dutch policies and legislations, information was sourced from official governmental websites of the Netherlands, as well as from specific websites and databases of individual provinces and municipalities.

The criteria for including material, such as scientific papers, economic data, or legislations, was mainly based on the year of publication and the geographical region they were based on. As the aim of this report is to update the sector information since the 2009 paper by Blacquière et al., the information used in this report was in majority published after 2009. Moreover, the focus was on information based on relevant geographic regions, mainly within Europe. For economic data, available data from the Netherlands and other members of the EU was used where possible. Additionally, data was extrapolated and examples from other regions of the world were used to compare Europe or the Netherlands. For legislations and policies, the research was focused on the European Union and member states, as well as provincial policies within the Netherlands.

2.2 Interviews

The interview participants were selected based on their expertise in the field of apiculture, with the aim to recruit interviewees from a variety of diverse backgrounds in the sector. For example, researchers, business owners, professional beekeepers, and hobbyist beekeepers.

The qualitative interviews were structured with a set of planned questions that were asked to all participants. These questions can be found in Appendix B. Additionally, more specific, in-depth questions were included where relevant based on the knowledge and background of each person interviewed.

Some key questions and topics covered in the interviews are as stated below:

- What are the biggest challenges you face as a professional beekeeper?
- What problems do you expect to encounter in the future?
- Is beekeeping reliable enough to develop an income?
- What sort of funding or subsidies do you receive and from where?
- What improvements are needed in the beekeeping sector?

To collect information from interviewees, qualitative interviews were conducted either online or in person, considering the availability of beekeepers and the budget allotted to this project. Additionally, based on the preference and convenience of the participants, interviews were either conducted in English or Dutch, where Dutch interviews were further translated to English by Dutch mother-tongue team members. To ensure accuracy in data collection, the interviews were recorded using audio recording devices after the consent of the interviewee was provided. In addition to the audio recording, at least two members from the team were involved in taking the minutes during the interview. Moving further, the transcription was cross-checked with the audio recordings to verify the collected data.

2.3 Questionnaire

A short questionnaire comprised of 12 questions was distributed among 100 hobbyist beekeepers as an online form with open questions. From these, we received answers from 43 respondents. The questions covered major topics such as issues that beekeepers might be currently facing in the sector, concerns regarding funding and government support, tackling invasive species and diseases, costs related to beekeeping and others. The full set of questions can be found in Appendix C.

2.4 Data Analysis

All the findings from the literature and the interviews were integrated into the six factors of the PESTEL Analysis:

- **P**olitical
- **E**conomic
- **S**ocial
- **T**echnical
- **E**nvironmental
- **L**egal

For readability and an improved structure of the report, it was decided to change the order of the PESTEL to SETEPL.

- **S**ocial
- **E**nvironmental
- **T**echnical
- **E**conomic
- **P**olitical
- **L**egal

In this way, the report follows a funnel structure and will start with the social factor, followed by environment, technical, economic, political, and legal (SETEPL). Once the main factors were identified, the information was further subdivided into the SWOT Analysis to identify the:

- **S**trengths
- **W**eaknesses
- **O**pportunities
- **T**hreats

These findings were summarized into tables at the end of each section. To avoid lengthy and complex tables, some sections have more than one SWOT table. After the main points from the results were noted, the information was used to make recommendations specified in Chapter 10. These recommendations can also be found in a list format in Appendix A.

2.5 Integration of Data

A total of ten interviews were conducted. The opinions, facts, and perspectives from all the interviewees were collected and cross-referenced with the literature to identify overlaps or contradictions between the beekeepers and the literature. Additionally, opinions gathered from the survey were used to back up or contrast different viewpoints in the sector and highlight the different sentiments from professional and hobbyist beekeepers. Subsequently, all the findings that were aligned with or contrasted against the scientific literature were merged in a comprehensive way into the report.

2.6 Ethical Considerations

All interviewed participants were provided with information about the study's aims, methods, potential risks, and benefits. Before every interview, oral consent was requested before starting the interview. Interview recordings were mainly utilized as contextual references to inform and guide the research process and were not made public. The specific statements made by participants were not directly cited or quoted in the study. Instead, the insights gained from these recordings provided a deeper understanding of the research context, adding to interpretation and analysis of the literature. To maintain confidentiality and anonymity of the interviewed participants within the report they were assigned with a number. Only team members are given access to the corresponding participant numbers. Data will be retained from May 2024 until July 2026 in accordance with WUR guidelines and then securely erased.

2.7 AI usage

In this report, we utilized artificial intelligence (AI) tools exclusively for the purposes of restructuring, rephrasing, and translating content. The aim was to enhance clarity, coherence, and accessibility while maintaining the original meaning and intent. The AI tool used for this process was GPT-4 by OpenAI. This language model assisted in refining the language of the report, ensuring that it was expressed in a clear and concise manner. Translation was important as substantial sources used, such as literature and governmental sources, were in Dutch.

To ensure the integrity and accuracy of the content, the restructured, rephrased, and translated sections were thoroughly reviewed by team members. This review process verified the accuracy and appropriateness of AI modifications, ensuring that the essence and key points of the original content were preserved.

2.8 Limitations

This study faced several limitations that may impact the generalizability and comprehensiveness of the findings. The research team primarily consisted of members with a background in Biology. While this provided a strong foundation for understanding technical aspects, it may have limited perspectives from other relevant disciplines such as social sciences, potentially affecting the range of the analysis.

The project was carried out two months before summer. These months are the peak activity periods for beekeepers, which may have constrained the availability of potential participants for interviews. The limited timeframe of this project did not allow for follow-up interviews or the opportunity to schedule additional sessions with participants who were unavailable during the initial periods.

The study mainly focused on professional beekeepers, and limited data from hobbyist beekeepers was used. This focus on professionals provided valuable insights into commercial beekeeping practices but may have overlooked important perspectives and practices prevalent among hobbyists, which could offer a broader view of the beekeeping community.

3 Social

In 2018, the Netherlands had 8,393 beekeepers (van Dooremalen & Rijksdienst voor Ondernemend Nederland, 2022), representing approximately 1.40% of the beekeepers within the European Union. According to Rossi (2017), the total number of beekeepers in Europe in 2016 was approximately 600,000. The number of beehives further highlights the marginal role of the Dutch apiculture sector within the European Union. In 2018, there were about 81,600 hives in the Netherlands (van Dooremalen & Rijksdienst voor Ondernemend Nederland, 2022), representing only approximately 0.5% of the total beehives in the European Union, which exceeded 16 million hives in 2016 (Rossi, 2017). Despite its relatively small size compared to the broader European Union, the sector is organized in different associations as explained in this section. However, the social aspects of the apiculture sector need some new focus points, particularly in the organization of these associations to strengthen their role in the media and to improve the conditions for future beekeepers via knowledge transfer.

3.1 Organisation of the Sector

In the Netherlands, many beekeepers are affiliated with an organised beekeeper association. The professional beekeepers are represented by the Beroepsvereniging Nederlandse Imkers (BVNI). This association consists of 23 members, including professional beekeepers, shops, seed companies and advisors (BVNI, n.d.) Most hobbyist beekeepers (more than 8,500) are part of the Nederlandse Bijenhoudersvereniging (NBV), an association established in the Netherlands and aimed at supporting hobbyist beekeepers (*Nederlandse Bijenhoudersvereniging - NBV*, n.d.).

BVNI

The BVNI is an association established in 2014 to collaborate on financial aspects of beekeeping and to have the possibility to discuss relevant topics from different backgrounds with multiple professional beekeepers (Personal interview 5, Video call, June 2024). To become a member, a beekeeper needs to be dependent on income from an apiary or be employed as a professional beekeeper at a farm or apiary. Additionally, the company needs to be registered with the Chamber of Commerce. The association states different objectives on their website (BVNI, n.d.), which could be summarize into three main objectives. First, they enhance beekeeping practices in the Netherlands by business exchanges, the development of initiatives and active development to promote innovation. Additionally, they aim to educate and inform stakeholders by developing knowledge, advising farmers on crop pollination and publishing information and opinions on pollination efficiencies for the media. Finally, they focus on supporting and recognizing the beekeeping community by cooperating with everyone who is enthusiastic about beekeeping and acknowledging the BVNI as a quality organization, resulting in promoting quality though standardization and certification. To enhance these objectives, the BVNI organizes regular meetings and by acting as an interlocutor for stakeholders (BVNI, n.d.). They ask for a membership fee of €500 for each year, except from the first year (€150) (BVNI, n.d.). However, it is unclear how they achieve their objectives or share information about their services. Currently, the BVNI appears to have a more individual focus, as their website primarily lists their members and provides links to their individual websites, offering little information on how the association collectively achieves its objectives.

Considerations within the sector

Due to the individual focus within the association, various interviewees have suggested that they should broaden their focus and look for opportunities to strengthen their market position and political influence. This topic will be discussed in more detail in Chapter 7.2 “Lobbying and communication with other stakeholders”.

In addition to strengthening their market position and political influence, it is suggested to make efforts to provide more structure to the organisation of the BVNI (Personal interview 5, Video call, June 2024). During spring and summer, professional beekeepers occupied with maintenance and transportation of hives, simultaneously this period is crucial for maintaining contact with key stakeholders such as the media or government. During this season various problems arise, such as invading pests and predators, or lack of biodiversity for nectar-sourcing. To make sure the opinions of (professional) beekeepers are also represented, it could be helpful to have a representative of the professional beekeeper sector. It was suggested that it would be beneficial to have external individuals handle the administration and contacts, rather than having the beekeepers manage these tasks themselves (Personal interview 5, Video call, June 2024). This would ensure that the BVNI is well represented when media opportunities arise. Simultaneously, this would enhance the opportunity to work together with farmers during the off-season. During this period, engagement and meetings with agricultural organisations could help define a better collaboration between the farmers and professional beekeepers. Resulting in a better understanding of the importance of helping each other, as both parties rely on each other.

Additionally, there are common misconceptions of the apicultural sector, which can be as simple as failing to understand the difference between solitary bees, honeybees, and bumblebees, worsening the challenge of information asymmetry among key stakeholders and the general public (Personal interview 5, Video call, June 2024). Creating more awareness within the agricultural sector by collaboration and by representing the sector in the media could result in a better understanding of the importance of the working procedures and focus point of professional beekeepers since they are different from the hobbyist beekeeper. For instance, professional beekeepers focus in providing pollination services, whereas hobbyist beekeepers have a variety of reasons for maintaining bees; from harvesting honey to re-introducing biodiversity.

3.2 Knowledge transfer

The Netherlands currently faces the problem of an aging beekeeper population, a common problem in all European countries (Guiné et al., 2021). There is a noticeable gap between the younger generation and the aging demographic of professional beekeeping experts. Blacquière et al. highlighted in 2009 that it is difficult to find enthusiastic young beekeepers. Contrastingly to the report in 2009, in recent years, there has been a surge in young hobbyist beekeepers, perhaps due to media coverage on "saving the bees" or the increased availability of beekeeping courses. However, during an interview it was mentioned that the younger generation has many different hobbies and does not have enough time to invest on taking care of the colony health (Personal interview 10, In person, June 2024). Additionally, the method of knowledge transfer has shifted to digital knowledge platforms and courses. However, it seems that becoming a skilled beekeeper requires practical experience and insight from experienced beekeepers. Completing a series of short courses quickly is insufficient; one must learn the profession thoroughly, starting with the basics, to ensure that colonies are maintained properly (Personal interview 10, In person, June 2024). For this reason, many young beekeepers that perform beekeeping as a hobby are not interested in pursuing a career as professional beekeepers.

Several interviewees highlighted the need to focus more on training hobbyist beekeepers (Personal interview 5 & 6, Video call; Personal interview 8, In person, June 2024). They feel that there is a lack of knowledge, particularly concerning pollination services, although there is substantial research by Wageningen University & Research and InHolland hogeschool for example. Additional training could improve the pollination services provided by hobbyist beekeepers. To become a beekeeper in the Netherlands there exists privatised education such as basic courses or queen breeding courses offered by the NBV. However, there is no standardised, public education to become a professional beekeeper organised by governmental organisations in the Netherlands. In several countries there is education to become a master beekeeper, such as in the United Kingdom, where one can train to be a master beekeeper within 7 years (British Beekeepers Association, n.d.). In contrast, aging beekeepers are generally very dedicated to their hobby, resulting in a wealth of practical knowledge passed down from within families over many years (Blacquière et al., 2009). This valuable knowledge could be lost if it is not documented and made accessible to new beekeepers. A significant opportunity lies in providing more information through the BVNI website and by integrating beekeeping and pollination services as a theme in conventional education programs for horticulture for example. This could also help recruiting more people that are enthusiastic for the beekeeping sector by making more information available. This is possible by inviting beekeepers as guest lectures or provide opportunities to do internships at apiaries.

SWOT: Social

STRENGTHS

- **Knowledge**: Significant knowledge is gained by the aging beekeeper population.
- **Sector organization**: Nearly all beekeepers are members of an organization, making them easily accessible.

WEAKNESS

- **Time shortage**: During spring and summer, beekeepers lack time to represent the sector in the media.
- **Small sector**: The Dutch apicultural sector is small in comparison with the European Union. Few professional beekeepers may hinder their collective strength to lobby as it increases competition in the market.

OPPORTUNITIES

- **Education**: Enhancing professional public education can improve beekeepers' knowledge and hive health.
- **Collaboration**: Strengthening collaboration within and outside the sector (e.g: municipalities) can enhance market position and political influence, especially with agricultural organisations, to seek more engagement to define better collaboration during off-season.

THREATS

- **Knowledge loss:** Valuable knowledge is at risk of disappearing due to the aging beekeeper demographic
- **Public awareness**: Not enough investment into public outreach to inform about issues beekeepers currently face.

4 Environmental

This section discusses the causes and effects of conflicts between managed honeybees and the native wild bees in the environment. Moving further, different opinions of researchers and beekeepers, possible causes for the spread of pathogens, and possible benefits of co-existence between wild and managed honeybees are discussed. Followed by an examination of different species of honeybees around the world and in the Netherlands, looking at characteristics of locally popular subspecies of *Apis mellifera* such as Black bees, Buckfast bees, and Carniolan bees. This section also evaluates the negative impact of climate change on flower nectar secretion and availability, harvesting behaviour of the honeybees, and how pest survivability is increased due to climate change.

4.1 Effects managed honeybee populations on native wild bees

Honeybees play a crucial role in the pollination of plants (Van Espen et al., 2023a). However, both honeybees and wild bees rely on the finite natural resources provided by flowers. Over the past few decades, concern has arisen over the possibility that managed honeybees may have a negative effect on native wild bees. Reasons for this are (1) the competition for floral and nesting resources, but also (2) indirect effects via changes in plant communities and (3) possible transmission of pathogens (Mallinger et al., 2019). These possible effects have been studied thoroughly the past decades, however, results about the possible effects of managed honeybees on wild bees are variable (Mallinger et al., 2019).

(1) In the studies looking into competition, results were highly variable with 53% reporting negative effects on wild bees, while 28% reported no effects and 19% reported mixed effects.

(2) Studies examining effects of honeybees on plant communities reported 36% positive (e.g. Promoting native species) and 36% negative effects (e.g. Promoting invasive plant species), with the remainder reporting no or mixed effects.

(3) Studies examining pathogen transmission 70% reported potential negative effects of managed bees on wild bees.

These mixed results give rise to debate in the beekeeping sector about whether the harsh restrictions on beekeeping, that are mentioned in 7.3 “Competition between wild and managed bees”, are justified. The main concern of keeping managed honeybees in nature reserves is exploitative competition, which means that several species compete for the same limited resources. Exploitative competition is speculated to be the predominant factor determining species occurrence on spatial and temporal scale. However, this has hardly ever been evidenced because it requires fine assessment of nectar and pollen (Requier et al., 2018). Besides this, concrete evidence on long term effects of competition between honeybees and wild bees is also scarce and needs additional research (Mallinger et al., 2017).

The primary viewpoint within the beekeeping sector is that the competition between honeybees and wild bees is not a significant issue (Personal interview 2, In person & Personal interview 6, Video call, June 2024). In their opinion, the problem is not the overabundance of honeybees but the underabundance of flowering plants, which is also in line with some of the literature about competition (Ropars et al., 2019; Wignall et al., 2020; Personal interview 1, In person, June 2024). The lack of flowering plants in urban areas is also an issue highlighted by hobbyist beekeepers, who would like to see more green areas with native flowers in public spaces and roadsides (Questionnaire, June 2024). However, in study areas where effort was done to mitigate the negative impact of honeybees on wild bee populations by planting wildflower strips, the benefits of these wildflower strips did not offset the negative effects on wild bees (Angelella et al., 2021). Honeybees are generalists and might outcompete native solitary pollinators. However, they have co-evolved with these species, making it difficult to prove long-term negative effects. In ecology, competition is a natural event and part of evolution (Personal interview 4, In person, June 2024).

Overall, there seems to be an effect of honeybees on wild bees, but because this effect is highly variable per context, context specific regulations and measures are therefore the most fitting solution in the Netherlands (de Groot et al., 2022). However, to be able to produce context specific measures several aspects are required:

- Food availability maps.
- Beehive registration.
- Development of criteria depending on the terrain.
- Development of a method to identify vulnerable habitats, where beehives cannot be placed.
- Testing area effects.

Synergizing effects between honeybees and wild bees

Besides the possibly negative effects of honeybees on wild bees there are also synergies between the species. Interactions between honeybees and wild bees have been shown to result in enhanced pollination services. Plants that mainly profit from higher pollinator diversity instead of pollinator abundance can especially profit from this symbiosis (Brittain et al., 2013). Besides this, wild bee abundance can increase efficiency of honeybee pollination up to 5-fold, this is caused by the behavioural interactions between wild and honeybees (Greenleaf & Kremen, 2006).

4.2 Genetic diversity

There are at least 33 subspecies of *Apis mellifera* described based on geography and morphological variation. Honeybees were first aggregated into four major lineages (A, C, M, and O) based on morphometry and biogeography. Lineage A is present in Africa (11 subspecies) and in the Iberian Peninsula, O in the Middle East (9 subspecies), M in Northern and Western Europe, including the Netherlands (3 subspecies), and C in Southeastern Europe (10 subspecies)(Espregueira Themudo et al., 2020; Ilyasov et al., 2020). The existence of a fifth lineage from north-eastern Africa named Y was proposed and supported using mitochondrial DNA (Franck et al., 2001).

A queen that mates with multiple drones (polyandry), produces genetically diverse workers that carry different genes from their respective fathers. By doing this, a queen minimizes the risk that all her worker offspring do not carry highly susceptible genes by males, increasing the probability that the colony will survive. Thus, polyandry yields benefit by reducing the variance in disease prevalence among colonies, brood variability and hygienic behaviour associated with a greater disease recovery (Tarpy, 2003). Increased genetic diversity influences a wide range of phenotypes in honeybee colonies such as antimicrobial compound expression, pathogen resistance, thermoregulation, foraging behaviour, and colony defence, all essential to colony survival and response to environmental stress (Espregueira Themudo et al., 2020).

When genetic diversity is decreased, the number of workers in a colony performing some tasks may decrease. Alternatively, less specialized workers will perform such tasks, decreasing the efficiency of the colony. This may originate from high selection pressure for traits based only on queen performance but ignoring the genetic contribution of drones or failing to maintain sufficient levels of genetic diversity within a colony (Espregueira Themudo et al., 2020).

In the Netherlands, the primary honeybee species is *Apis mellifera*, this comes under the M lineage with three subspecies, namely Black honeybees, Buckfast bees, and Carniolan honeybees. Beekeepers use this species for honey production and pollination services in the Netherlands depending on beekeeping practices and regional preferences, a distribution of bee species in the Netherlands is shown in the chart below (Figure 1). The notable subspecies and strains include:

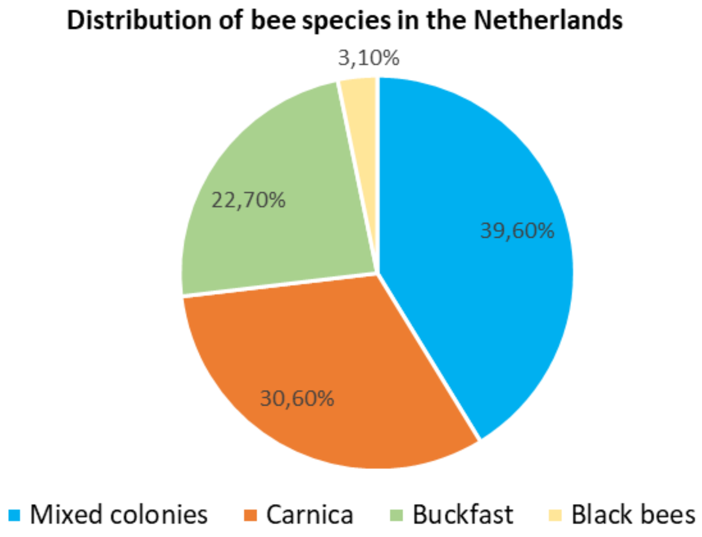

***Figure 1**: Distribution of bee species colonies by beekeepers in the Netherlands in 2019. The above pie chart depicts that mixed colonies were most common (39.6%), followed by Carnica (30.6%), Buckfast bees (22.7%), and black bees (3.1%). Data retrieved from (Tom en Cornelissen, 2020).*

Black honeybees

Black honeybees (*Apis mellifera mellifera),* also known as European honeybees, are native to the Netherlands, these bees are used for breeding in Northern Europe due to their adaptation to winters. However, hybridisation with southern subspecies threatens black honeybees' genetic purity and useful traits. Crossbreeding black honeybees with sub-species like *A. m. carnica* has led to the genetic dilution of black honeybees, making them less adapted to their local ecosystems and potentially more prone to diseases and pests (Ilyasov et al., 2016).

Buckfast bees

The Buckfast bee (*Apis mellifera ligustica*) is a hybrid developed by Brother Adam of the Buckfast Abbey in the UK, these bees are an extensive crossbreed and are popular among beekeepers for their desirable traits such as disease resistance, gentleness, and productivity. Contrarily these bees have been described as a challenge to sustain in the future due to several issues (Sebestyen, 2021). For instance, these bees exhibit no swarming behaviour and are non-aggressive, which poses a significant threat. More specifically, Buckfast bees show a lack of natural breeding as a result of no swarming, resulting in no successive generations. Additionally, few beekeepers in the Netherlands believe their inability to defend against invaders or parasites further compromises their survival (Personal interview 10, In person, June 2024).

Carniolan honeybee

Carniolan honeybees (*Apis mellifera carnica)* are distinct race of the European bee family and most abundantly found in the Netherlands. The most acclaimed traits of the Carniola bee are its calm and docile behaviour on the comb, disease resistance, low winter consumption, long tongue (therefore able to reach more nectar in long and narrow flowers), less prone to hive robbing, and minimal propolis use. These characteristics make this bee species economically viable. However, it reduces brood production when there is less nectar. This can hinder the colony growth and harvest. To avoid this type of scenario, the beekeeper must intervene with additional sugar syrup and protein (Anderson, 2023).

From the interviews it is evident that there are different opinions among Dutch beekeepers about importing foreign bees into the Netherlands. Few believe it is useful to import bee species for improving the beekeeping practices and honey production. Contrastingly, others think it is important to maintain and promote local bees' genetic diversity which can easily adapt to the changing environmental conditions (Personal interview 2, In person, June 2024).

4.3 Climate change

Climate change will inevitably have an impact on society, and honeybee keeping will most likely not be an exception to this. Despite the natural ability of *A. mellifera* to thrive in many different climate zones (from Africa to Europe to eastern Russia) there has been clear evidence that honeybee keeping is impacted by climate change for different reasons (Neumann & Straub, 2023; Van Espen et al., 2023b).

Nectar flow

There is a wide variety of impacts that can be induced by climate change, mainly problems arising from fluctuating temperatures. Higher temperatures can result in lower nectar secretion, which can directly impact honey production (Gordo & Sanz, 2006). Another possible impact is the altering availability of nectar resources. The rising temperatures from climate change can disrupt the flowering season of plants, by either shortening or lengthening the blooming period or affecting the starting date of flowering (Medina-Cuéllar et al., 2018). The activity of honeybees is also regulated by temperature, these shifts can result in phenological mismatches between flowering plants and honeybees (Van Espen et al., 2023b). This has impacted honey production, specifically honey based on a certain flower species. To be classified as a certain honey (e.g. thyme honey or lavender honey) a certain percentage of the specific pollen is needed. When other flowers are blooming simultaneously, the specific pollen percentage decreases, making it harder to produce authentic thyme honey for example. Consequently, these products must be labelled as honey with a high percentage of thyme instead of thyme honey, this has already impacted some of the large wholesalers in the Netherlands (Personal interview 5, Video call, June 2024).

Another direct effect of climate change; heavy rains or lack of them for long periods of time, can also negatively impact the production of nectar and the harvesting behaviour of bee colonies (Pătruică Silvia et al., 2020), resulting in lower honey production.

Pests and diseases

Pests which are already plaguing honeybees, such as Varroa, can benefit from milder winters, resulting in an increased winter survival of Varroa mites (Vercelli et al., 2021). Climate change can also have a possible impact on the brood-free period of honeybees, due to rising temperatures the brood-free period becomes shorter or even absent, while these brood-free periods are essential for the treatment of Varroa (Noël et al., 2020). This can result in higher winter colony losses (van Espen et al., 2023). Besides Varroa other pests can also profit climate change, either due to milder winters or due to extended ranges across the globe, such as the Asian hornet, greater wax moth, and small and large hive beetle (van Espen et al., 2023).

The potential effects of climate change are perceived as a bigger threat by professional beekeepers than by hobbyist beekeepers, most likely because professional beekeepers are already operating at maximum capacity against climate change, but also because professional beekeepers are more alert to warning signals of their colonies (van Espen et al., 2023). However, there is still optimism about the adaptation of the *A. mellifera* to climate change, because of the aforementioned adaptability of the species (van Espen et al., 2023).

SWOT: Environmental

STRENGTHS

- **Genetic diversity**: Genetic diversity and polyandry help in disease resistance, colony survival, and stress adaptability.
- **Pollination**: In addition to giving essential pollination services, honeybees maintain plant diversity.

WEAKNESS

- **Limited natural resources**: Potential competition between wild and managed bees for the few available food resources.
- **Non-aggressive**: Natural breeding and colony defence are areas where Buckfast bees and their hybrids fall short.

OPPORTUNITIES

- **Co-existance**: Honeybee-wild bee interactions improve pollination services.
- **Wild bees**: Abundance of wild bees may enhance the pollination efficiency of honeybees by 5-fold.
- **Regulations**: Policies such as beehive registration and maps of food availability serve to mitigate the impact on wild bee populations.

THREATS

- **Temperature**: As temperatures rise, blooming times and bee activity get mismatched, which lowers bee productivity and efficacy.
- **Uneven rains**: Prolonged dry conditions or heavy rainfall due to climate change disrupt nectar secretion and bee harvesting behaviour.
- **Pests**: Warmer weathers increase survivability of pests, results in higher winter loss and affecting bee health.

5 Technical

One of the biggest struggles for professional apiculture are the prevention, monitoring and management of diseases and pests. A significant concern in the field of apiculture is the phenomenon of colony loss, marked by a smooth or sudden decline of bees in the hive. This phenomenon is already known for many years, with the most significant losses occurring during overwintering. However, the specific patterns responsible for these losses are not yet known due to the many possible factors involved such as diseases and pests. This section begins with a discussion on the impact of colony loss. It then focuses on the two primary factors: the Varroa mite and an emerging threat, the Asian hornet. The chapter concludes by exploring other significant pathogens and diseases associated with colony losses, namely the small hive beetle, American foulbrood, *Tropilaelaps*, and Nosema.

5.1 Colony losses

Prevention of honeybee COlony LOSSes (COLOSS) is an international non-profit association of scientific professionals dedicated to researching and preventing honeybee colony losses. Since 2009, an annual questionnaire is sent to beekeepers in Europe to gather data on winter colony losses. For the 2019-2020 season, a loss of 15.6% of the production colonies was reported for the Netherlands (Gray et al., 2023). According to the COLOSS survey, the losses were attributed to mortality (55.1%), unsolvable queen problems (41.7%), and natural disasters (3.9%). Cornelissen & Tom (2020) reported a decrease in colony losses since 2005-2006.

It is challenging to determine the main factors resulting in colony losses. These factors can be split into natural and anthropogenic drivers. Natural drivers consist of mites, various viruses, microsporidia, bacterial infections, and fungi. Anthropogenic drivers include pesticides, climate change, invasive species, GMOs, land use and management, and environmental pollution. Additionally, the interactions between these factors significantly impact colony health. Beekeeper knowledge and management practices also play a crucial role in managing colony losses. Research has shown that hobbyist beekeepers with small apiaries and little experience had twice as much winter mortality as professional beekeepers (Jacques et al., 2017). Therefore, addressing colony losses requires a multifaceted approach, incorporating improved beekeeper education and the knowledge to mitigate both natural and anthropogenic factors. The following paragraphs will address some of the main causes regarding colony losses.

5.2 Varroa mite *(Varroa destructor)*

Varroa mites, particularly *Varroa destructor* (Figure 2), is the most significant threat to honeybee populations in Europe, including the Netherlands. They are known to cause problems such as the spread of diseases and overall weakening of bee colonies if not decimating a colony. Understanding the dangers of Varroa mite infestations and finding methods to counter these mites is crucial for the health and sustainability of honeybee colonies in the Netherlands. For example, the prevalence of Varroa in US reaches 85% while the overall infestation level was 8.2% (Abban et al., 2024). However, in the Netherlands there is no data available on these subjects. Beekeepers say that all Dutch honeybees are infested with Varroa but there is no official data confirming this.

Varroa mites are the vectors for several harmful viruses. This includes, for example, the Deformed Wing Virus (DWV) and Varroa destructor virus-1 (VDV-1). These viruses are transmitted to bees when the mites feed on their haemolymph, possibly leading to significant colony losses (Shen et al., 2005; Posada-Florez et al., 2020). When viral loads are high in colonies, it often correlates with increased colony mortality, especially during overwintering (Shen et al., 2005). This can be very sudden in some cases, mostly referred to as colony collapse disorder (CCD) (Francis et al., 2013). When fighting different diseases, research has proven that implementing Integrated Pest Management (IPM) and quality beekeeping practices are key for maintaining low infestation levels (Delaplane et al., 2005; Jack & Ellis, 2021; Bava et al., 2022). IPM is an environmentally friendly approach to pest control that uses a combination of techniques and strategies to manage pest populations in an effective, economic, and sustainable way. These methods contain a combination of various control tactics, including economic thresholds, monitoring, prevention strategies, and the combination of cultural, mechanical, genetic, biological, and chemical controls.

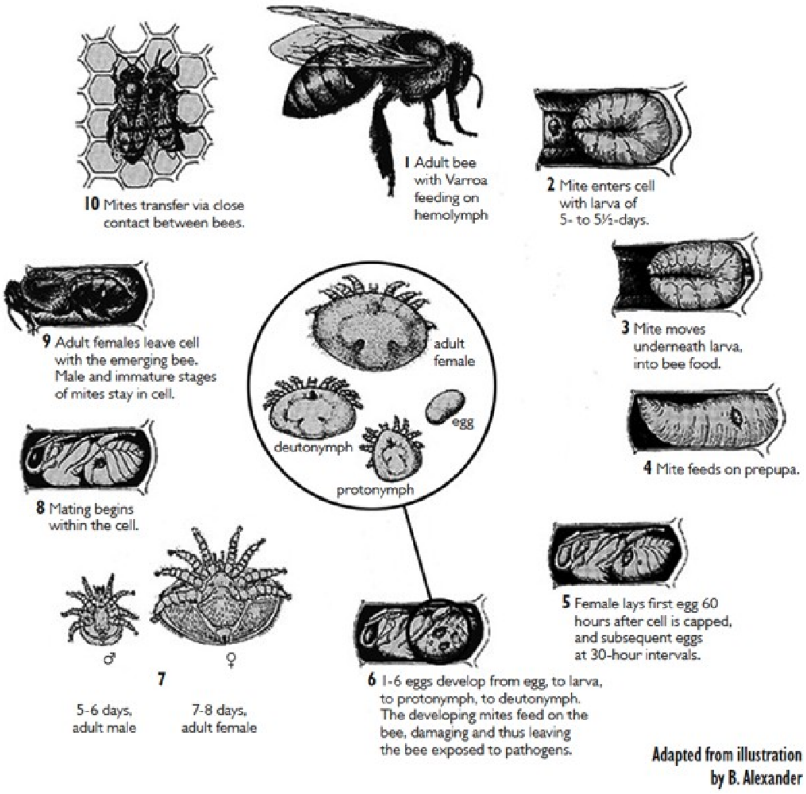

***Figure 2**: The life cycle of* Varroa destructor (*Honeck et al., 2015*).

Miticides

A short-term counter to this pest, oxalic acid and formic acid are commonly used chemicals to treat Varroa within beehives. These substances show high effectiveness rates exceeding 90% for oxalic acid while formic acid shows efficacy rates around 60% on phoretic mites in field studies (Campolo et al., 2017). These substances also seem to have low toxicity and leave very little residues, even after multiple treatments (Bogdanov et al., 2002; B. Cornelissen et al., 2012). It should however be noted that these measures should be used responsibly and accordingly to prevent buildup in honey (Matysiak et al., 2018). Some also call for the use of miticides such as Apivar (amitraz). Amitraz, however, is illegal to use in beekeeping in the Netherlands due to the damage it does to human health when used on the hives and due to residues in the environment. Moreover, these kinds of miticides are also prone to resistance buildup (Traynor et al., 2020).

Resistance breeding

For a long-term solution, genetic adaptation is most likely required. This reduces the costs by preventing the need for counter measures which can cost a lot of money. “Natural selection” using the Darwinian method for Varroa resistance involves allowing bee populations to develop resistance traits with minimal human intervention. This approach promotes genetic diversity and adaptability, which are crucial for the long-term survival and resilience of bee populations (Neumann & Blacquière, 2017;

Blacquière & Panziera, 2018; Mondet et al., 2020). However, this Darwinian selection can be a slow process, often requiring many generations to achieve significant improvements in resistance. During this period, many colonies may succumb to mite infestations, leading to high mortality rates (Guichard et al., 2023). Without proper financial support, professional beekeepers are most likely unable to carry this loss. Therefore, selective breeding could be used to find faster solutions.

Selective breeding currently seems to focus on enhancing specific Varroa resistance traits such as Varroa sensitive hygiene (VSH), lower mite reproduction and grooming behaviour. This method could possibly produce more resistant colonies more rapidly than the Darwinian method and gives consistent results (Seltzer et al., 2022). For example, traits like suppressed mite reproduction (SMR) and VSH have been successfully selected in various breeding programs, showing significant reductions in mite populations (Panziera et al., 2017; Mondet et al., 2020). However, VSH can be very costly to hive growth which may lead to its eventual abandonment in favour of less costly resistance traits. Moreover, Kruitwagen et al. (2017) found that naturally selected honeybee colonies resistant to *Varroa destructor* did not groom more intensively, suggesting that grooming behaviour alone may not be a significant factor in natural resistance. This brings up the question whether single behavioural changes are going to be long term effective. Similarly, Blacquière & Panziera (2018) advocate for leveraging honeybees' natural resilience, emphasising that traditional breeding often undermines natural defences by selecting for traits beneficial for production rather than resilience. They propose that emphasising natural selection could lead to more robust and disease-resistant colonies preserving the traits that are important to a specific region and reproductive traits. Moreover, it is a method which can be implemented with ease and low cost everywhere, while selective breeding depends on insemination equipment and specific knowledge and skills. Norton et al., (2021) highlighted the potential for selective breeding to influence virus evolution. Their research found that breeding practices might inadvertently favour virus strains better adapted to their bee hosts, indicating the need for careful breeding strategies to avoid unintended consequences. It should also be noted that human controlled resistance breeding can lead to reduced genetic diversity if not done carefully. This increases the risk of inbreeding and makes colonies more vulnerable to other diseases and environmental changes (Von Virag et al., 2022).

Despite these challenges, selective breeding can yield significant reductions in mite populations and enhance overall colony health if managed properly. Future research should continue to explore the genetic basis of resistance traits and refine breeding strategies to enhance the sustainability and effectiveness of Varroa mite management in honeybee populations (Guichard et al., 2023). Future research should continue to explore the genetic basis of resistance traits and refine breeding strategies to enhance the sustainability and effectiveness of Varroa mite management in honeybee populations (Guichard et al., 2023). An example of this is the "Bee Health Action Program", which focuses on breeding programs to create bees resistant to Varroa. The initiative supports a noble cause in helping the beekeeping sector (Rijksoverheid.nl, 2013). However, its success and the interest it generates remain uncertain due to significant divisions within the sector concerning bee breeding for resistance.

Entomopathogenic fungi

Other possible solutions can be found in entomopathogenic fungi like *Metarhizium anisopliae* and *Hirsutella thompsonii* (Kanga et al., 2002, 2007). These fungi are not dangerous to the bees and do not have any known side effects. *H. thompsonii* showed to kill Varroa mites with a 90% lethal time of around 4 days. They also found that the fungus remained present on the mites for up to 42 days after the treatment. However, the success of these treatments does seem to depend on factors including spore effectivity, application methods, and environmental conditions making it hard to use (James & Hayes, 2007; Rodríguez et al., 2009). Therefore, more research is still required in entomopathogenic fungi before these can reliably be used (Bava et al., 2022).

Environmental & Mechanical strategies

Several investigated mechanical and environmental methods can support other countermeasures to Varroa mite and can be integrated into Integrated Pest Management (IPM). For example, screened bottom boards are hive floors with a screen that allows mites to fall out of the hive, reducing re-infestation. A meta-analysis demonstrated that screened bottom boards significantly reduce Varroa populations compared to traditional wooden floors, making this method possibly effective for lowering mite levels as part of an integrated control strategy (Liu et al., 2020).

Another method involves removing drone broods, a preferred Varroa breeding site, to disrupt the mite lifecycle. Studies show that drone brood removal is effective in reducing mite populations without negatively impacting colony development, significantly lowering mite levels when combined with other IPM strategies (Coffey, 2007). Alternatively, caging the queen to create a brood break interrupts the Varroa lifecycle by temporarily stopping brood production. While effective in reducing mite populations, brood interruption can negatively impact colony strength if not managed carefully (Jack et al., 2020). Lastly, one can dust its bees with powdered sugar causing mites to lose their grip and fall off the bees. This method is useful for reducing mite levels, particularly when used regularly, and it is a non-chemical approach that can be integrated into broader IPM strategies (Haber et al., 2019).

SWOT: Technical (Varroa & colony loss)

STRENGTHS

- **Chemical treatments**: Oxalic and formic acids are effective miticides with high efficacy rates, offering immediate relief from Varroa infestations.
- **Integrated pest management (IPM)**: Combines multiple pest control methods, promoting sustainable and effective Varroa management.
- **Mechanical methods**: Techniques such as screened bottom boards and drone brood removal effectively reduce mite populations.

WEAKNESS

- **Lack of data**: In the Netherlands, there is no official data on Varroa infestation levels, leading to uncertainty in management strategies.
- **Slow genetic adaptation**: Natural selection for resistance traits is a slow process, risking high colony mortality during the transition period.
- **Long term breeding effects**: Selective breeding on single behavioral changes are probably not going to be effective in the long term.

OPPORTUNITIES

- **Natural selection methods**: Darwinian selection allows bee populations to develop natural resistance traits with minimal human intervention, promoting genetic diversity and long-term resilience.
- **Research on fungi**: Entomopathogenic fungi like Metarhizium anisopliae show promise as biological control agents for Varroa mites.
- **Environmental strategies**: Implementing techniques like powdered sugar dusting and queen caging can enhance IPM strategies and reduce mite populations without chemicals.

THREATS

- **Disease spread**: Varroa mites are vectors for harmful viruses (e.g., DWV, VDV-1), leading to increased colony mortality and potential colony collapse disorder (CCD). They are the single highest threat to beehives.
- **Economic impact**: Without proper treatment knowledge Varroa will cause enormous losses.
- **Reduced genetic diversity**: Improper resistance breeding can lead to inbreeding and increased vulnerability to other diseases and environmental changes.

5.3 Asian hornet (*Vespa velutina*)

Since the introduction of the Asian hornet (*Vespa velutina*) from Asia into Western Europe, specifically France in 2004, this invasive species has rapidly spread across Europe (Requier et al., 2018). In October, up to 70% of the diet of the hornet consist of predation on the European honeybee (*A. mellifera*) (Villemant et al., 2014, as cited in Requier et al., 2018). The hornets fly in front of the hive, capturing bees as they exit and enter the hive. The impact of hornets on beehives can be measured using two parameters; homing failure (HF) due to hornet predation and foraging paralysis (FP) due to hovering hornets (Requier et al., 2019). Research by Require et al. (2018) and Monceau et al., (2018) showed that an increase in hornets surrounding beehives decreases the flight activity of the bee colony. Additionally, reduced flight activity leads to increased homing failure. This study also indicated that winter mortality of bee colonies depends on the size of the adult population and the honey reserves which are both negatively affected by a higher hornet load. Exact numbers on the effect of the Asian hornet on the Dutch bee colonies are unknown until now, even for Italy, France, and Spain there are no scientific quantifiable numbers known yet. Some diverse notifications could be found ranging from no effect on the honey yield up to 30% loss of the yield (Cornelissen et al., 2018). The same holds for the effect on the number of colony losses which ranged between 7.5% and 30% (Monceau et al., 2014). Beekeepers in the south-west of France reported losses between 30% and 80% of honeybee colonies (Laurino et al., 2019).

Several strategies exist to control the Asian hornet. The most used strategies are the trapping options for the queens and destruction of the nest. Although, trapping methods may attract various other species and thus impact local biodiversity. Progress is being made in developing trapping systems based on sex pheromone attraction to selectively attract hornets (Require et al., 2019). Besides this, the traps do not have a significant effect on controlling the hornet according to Thiéry et al. (2023). Another solution is found in the use of electric traps such as the electric harp (Figure 3). Rojas-Nossa et al. (2022) found that electric traps can protect the honeybees from the predation and decrease foraging paralysis. This results in a healthier colony than ones without electric trap protection. Thiéry et al. (2023) investigated the possible side effects of these electrical harps on local biodiversity and found they had minimal influence on non-target species. Another study by Requier et al. (2019) found a positive effect of beehive muzzles (Figure 4) on reducing foraging paralysis of the bees which result in an increased survival probability of the colonies when stressed by the Asian hornet.

To increase effort in reducing hornet populations, it is important to destroy the whole nest rather than only capture some of the hornets. The homing instinct of the hornet is used to find the locations of the nests. A study carried out by Kim et al. (2019) proposes a method for tracking Asian hornets. The most suitable approach is via radio-telemetry with a lightweight sensor less than 0.25 grams to detect where the nest is. However, this method can be limited due to the weight and dimensions of the device. Although there is ongoing research to find more appropriate ways, this method is not used in the Netherlands yet due to excessive costs (Personal interview 8, In person, June 2024).

***Figure 3**: Set up of the electrical harps in front of the beehives, perpendicular on the flight direction of the bees (Rojas-Nossa et al., 2022).*

***Figure 4**: Set up of a beehive muzzle for the entrance of the beehive (Requier et al., 2020).*

SWOT: Technical (Asian hornet)

STRENGTHS

- **Effective trapping solutions**: Development of electric traps and pheromone-based traps can selectively target hornets, reducing their impact on bee colonies with minimal influence on non-target species.
- **Nest destruction**: Utilizing the homing instinct of hornets to locate and destroy entire nests is a proven method for controlling their population.

WEAKNESS

- **Inconsistent data**: Lack of comprehensive scientific data on the impact of the Asian hornet on beehives in Europe, including the Netherlands, hindering effective management.
- **Non-target species impact**: Traditional trapping methods can attract and harm other species, negatively affecting local biodiversity

OPPORTUNITIES

- **Advanced tracking methods**: Adoption of radio-telemetry for tracking hornet nests can improve nest destruction efficiency, despite current limitations due to cost and technology constraints.
- **Research and development**: Continued research on selective trapping systems and beehive protection measures can lead to more effective and sustainable control methods.

THREATS

- **High predation rates**: Asian hornets prey heavily on European honeybees, causing significant reductions in bee populations and honey yields, leading to potential colony losses.
- **Foraging paralysis**: Presence of hornets around beehives reduces flight activity and increases homing failure, negatively impacting colony health and winter survival rates.

5.4 Other pathogens and diseases

Small hive beetle (Aethina tumida)

The small hive beetle (*Aethina tumida*) is an invasive species found worldwide. Due to trade and the transport of bee products and beehives, the small hive beetle has spread from sub-Saharan Africa to all continents except Antarctica. Since 2014, the small hive beetle has also been introduced in southern Italy. Until now, the beetle has not been observed in the Netherlands. Although the current climate of the Netherlands is not favourable, research has shown that rising temperatures and changing climatic conditions are creating a more suitable living environment for the small hive beetle in the Netherlands (Cornelissen et al., 2019).

The Western honeybee serves as the primary host of the small hive beetle. These beetles coexist in modest numbers within beehives alongside the bees. This does not necessarily pose a problem, as the bees naturally clean the hive by removing beetle larvae and eggs. Beekeepers also play a vital role in minimizing the number of beetles within the beehive. Only when beetle populations become relatively large the damage to the hive can escalate, potentially causing it to collapse within two weeks (Cornelissen & Hendriks, 2020). Climate affects the number of reproductive cycles of the beetles per year, impacting larval and egg production per year. The beetle lays its eggs inside the beehive, and the larvae feed on available hive resources (honey, pollen, brood, and young bees), causing structural damage to the honeycomb. This can lead to honey fermentation due to yeast (*Kodamaea ohmeri*) introduced by the beetles, rendering the honey unsuitable for consumption (Cornelissen, 2015).

For Australia and Florida, USA, the costs for beekeepers increased upon the introduction of the beetle. In Florida, the estimated cost for the first year after introduction was $3 million USD for a total beekeeping sector of about $23 million (Cornelissen, 2015). Due to the differences in beekeeping practices compared to the Netherlands, it is challenging to estimate the potential costs for the Dutch beekeeping sector. Although, if beekeepers gain the knowledge and experience to prevent the damaging effects of the small hive beetle, the problem can be manageable (Cornelissen, 2015).

American Foulbrood

American foulbrood (also; severe bee rot, *Pestis apium*) is considered the most contagious and destructive infective disease for honeybees worldwide (Locke et al., 2019). However, it has not been a problem in the Netherlands for the past 10 years, making it a lesser threat for professional beekeepers (Personal interview 3, Phone, June 2024). Outbreaks in the Netherlands occur about once or twice a year (Werkgroep diagnose en bijengezondheid, n.d.), with the last outbreak being in 2021.

It is a brood disease that is exclusive to honeybee larvae (*A. mellifera* and subspecies), caused by the gram-positive spore-forming bacteria *Paenibacillus larvae*. Infection of larvae usually takes place via ingested spores via honey or other food within the first 36 hours after hatching, multiplying in the midgut, migrating to the hemocoel, and killing the larvae within 3 to 12 days dependent on the genotype of *P. larvae.* Further degradation of the larval remains by *P. larvae* turns it into a red-brownish semi-fluid, ropy substance (Figure 5). Because of a lack in nutrients the bacteria start producing spores and this substance dries up to a hard, highly contagious substance that contains large amounts of spores.

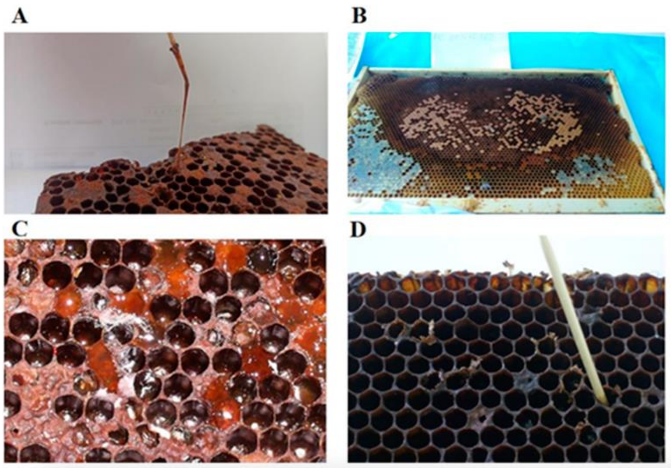

Figure 5*: (A) Dead larva in brood cell transformed into a ropy mass. (B) Scattered brood cells from AFB-infected larvae. (C) Moisture, color change, concavity, and holes in cell caps. (D) Bee comb cells after cleaning and drying of dead larvae contents* (Matović et al., 2023).

Spores are a dormant form of *P. larvae* that are resistant to extreme physical and chemical conditions, they can survive for over 35 years and can revive when the environment becomes more favourable. There can be over one billion spores in a single larval cell in a brood comb and as little as ten can be lethal for a newly hatched larva (Matović et al., 2023). Spores are transmitted via adult bees carrying spores while going to other colonies (drifting) or by bees robbing contaminated honey from other hives (robbing). Exchanging brood frames and keeping many hives in proximity are even more crucial factors in transmission. Burning of clinically symptomatic hives are generally considered as the only effective method for controlling outbreaks. Antibiotics are not allowed for treatment, nor effective in eradication. An alternative more sustainable and chemical-free quarantine management method based on early warning systems can also be used. Because *P. larvae* is a larval disease and does not affect adult bees, infected colonies can be quarantined from the rest of the apiary and the adult bees of non-brooding hives can be shaken onto new equipment (shook swarm method)(Wilson & Skinner, 2019). Inspection of the next brood and using separate equipment from the rest of the apiary for the following years is essential for this method to be effective.

European foulbrood is considered less serious than American foulbrood. It is caused by the bacterium *Melissococcus plutonius* and it gives very similar clinical symptoms as American foulbrood but does not produce spores and is therefore treatable. To differentiate between European and American foulbrood a simple rope test is effective in the field. A small stick is used to stir a cell showing signs of the disease, then pulled out slowly. If the cell contents demonstrate stringiness, it is American foulbrood, if it does not, it is European foulbrood. Also, foulbrood test kits are available. Treatment is not always necessary but possible treatments include the shook swarm method or placing healthy broods into infected colonies to increase nutritional competition and prevent the bacteria in infected cells from multiplying (Mueller et al., 2020).

Tropilaelaps spp.

Next to Varroa, *Tropilaelaps* spp., originating from Asia, is another mite species that can threaten honeybee colonies. The giant honeybee (*Apis dorsata*) is the original host of the *Tropilaelaps*, although they have expanded their host range to the Western European honeybee since these bees were introduced in Asia. The mites have a similar reproduction cycle to the Varroa mite although the cycle of the *Tropilaelaps* is shorter. However, unlike the Varroa mite, *Tropilaelaps* can survive only one to two days on an adult bee alone (Schäfer, 2018). Due to their smaller mouths, they are unable to perforate the cuticle of adult bees. Instead, they feed on the haemolymph (blood system of invertebrates) of the developing bee in the brood (larvae), which results in a reduced lifespan of adult bees by compromising their health. Up to 50% of the bee larvae may experience starvation (Schäfer, 2018). *Tropilaelaps* infestations can cause a colony to abandon their brood and hive, or even lead to colony collapse. The mites are transported via adult honeybees, making the risk of an outbreak significant when infected beehives are moved. The mites are distributed across Southeast Asia and since at least 2021 present in the Krasnodar region, southern Russia causing colony collapses of over 50% (Figure 6) (Brandorf et al., 2024; Friedrich-Loeffler-Institut, 2018). Research has shown that human activity contributes to the spread of these mites, as does the changing climate, because sustaining bee brood population provides food for the mites throughout the entire year (Anderson & Morgan, 2007). The similarities between

Figure 6*: Map with regions where Tropilaelaps has been found marked in brown (Brandorf et al., 2024).*

Varroa and *Tropilaelaps* means that the same detection and control measures can be used. Detection methods include examination of capped brood cells, soapy water, or alcohol wash, bumping of brood frames with older pupae on a piece of paper or counting the mites that drop. Control measures include chemical control with thymol and formic acid, management control by interruption of brood rearing, and breeding for hygienic and grooming behavioural traits (de Guzman et al., 2017).

Nosema

Nosematosis is one of the most common and widespread diseases for adult honeybees, often occurring in spring. Before Varroa entered Europe, it was the main cause of disease in the Netherlands. Nowadays it is still frequently occurring in the Netherlands and requires good management practices with focus on rejuvenation of the colonies (Personal interview 3, Phone, June 2024). Also, in the USA it is still considered a serious disease with an average nationwide prevalence of 99.73% with 6.8 billion spores notified per bee (Abban et al., 2024). It is caused by the parasitic fungal microsporidium *Nosema apis (N. apis) and Nosema ceranae (N. ceranae)*, it is a single cell and produces spores that can withstand extreme temperatures and dehydration and can revive after 4 years at -20 °C (Özgör & Keskin, 2017). *N. ceranae* is more prevalent and virulent than *N. apis*, but both result in nosematosis affecting the host immune system and coinfection with both species in a single host is possible (Sinpoo et al., 2018). After oral ingestion via infected feed or faeces *N. ceranae* 'fires' a hollow tube that pierces the host cell membrane of cells in the intestinal tract and injects its fluid where it then settles and starts dividing into multiple spores. The life cycle takes approximately 96 hours and fills the host cell in 6 to 10 days causing it to burst and release billions of spores into the intestinal tract causing dysentery. Spores are excreted with the faeces and transmission via faecal spots, honey, wax, royal jelly, and pollen(Marín-García et al., 2022). Infected bees suffer from energetic stress and hunger as food sharing is impaired between bees, impairing the ability to fly, and affecting hive behaviour and number of bees in infected hives. Synergistic effects of pesticides like glyphosate, fipronil, imidacloprid, thiacloprid and difenoconazole can, together with fungicides on pollen, increase bee mortality making the use of pesticides and fungicides an important factor in infected colonies (Alaux et al., 2010; Aufauvre et al., 2012; Marín-García et al., 2022).

Detection of Nosema species can be done minimally via clinical signs (reduced honey production, disoriented bees and increased older bee mortality) because clinical signs are not present in low-level infections. Molecular detection methods are more reliable, and they should be carried out on forager bees collected at the hive entrance. Signs of severe infection are decreased brood and colony growth, vibrating honeybee workers and increased dead honeybees in front of the hive and on the comb. Bees showing dilated abdomen and brown faecal marks on the comb and the front of the hive are also signs (Marín-García et al., 2022).

General good beekeeping and prevention practices like clean hives, adequate nutrition, clean moisture, and avoiding stressors are important for controlling nosematosis. A fresh start with new hive frames and a sunny stand is especially important. Since there are no antibiotics allowed to be used in the EU other measures have been researched and shown to be effective to a certain extent like plant-essential oils, probiotics, royal jelly, propolis, and more currently, entomopathogenic fungi show positive effects (Aufauvre et al., 2012).

SWOT: Technical (Other pathogens & diseases)

STRENGTHS

- **Natural hive cleaning mechanism**: Western honeybees naturally remove small hive beetles' eggs and larvae, minimizing initial infestation impact.
- **Early detection**: Effective diagnostic tools like rope tests for foulbrood help in distinguishing between European and American foulbrood, aiding in timely intervention.
- **Diverse control options**: Non-chemical methods such as shook swarm and burning of infected hives are available for managing American foulbrood outbreaks.

WEAKNESS

- **Lack of effective treatments**: Limited treatment options for American foulbrood due to antibiotic restrictions and ineffective chemical eradication methods.
- **Complex diagnosis**: Differentiating between American and European foulbrood can be challenging without specific diagnostic tools, impacting timely intervention.
- **High economic impact**: Potential for significant economic losses for beekeepers due to honey spoilage and hive collapse from small hive beetle infestation.

OPPORTUNITIES

- **Research advances**: Ongoing research into sustainable management practices for diseases offers promising alternatives.
- **Technological innovations**: New diagnostic tools and treatments, such as molecular detection methods for nosema species, for disease management improvement.
- **Climate adaptation strategies**: Increasing temperatures prompt adaptation strategies against small hive beetle spread.

THREATS

- **Global spread**: Global trade and transport increases risk of small hive beetle introduction into new regions
- **Pesticides**: Synergistic effects of pesticides and fungicides on pollen may exacerbate nosematosis outbreaks
- **Limited control options**: Inadequate control measures against Tropilaelaps mites due to their ability to survive and spread rapidly via adult bees, potentially leading to colony collapse.

6 Economic

The apicultural sector of the Netherlands is modest in size, with approximately 80,000 bee colonies, but plays a key role in the broader, overshadowing agricultural sector of the Dutch economy. The Dutch beekeeping sector stands to benefit greatly from growth-oriented economic policy. This section will conduct an analysis of the current strengths and weaknesses of the economic aspects of Dutch apiculture as well as provide insight as to how the economic longevity may be threatened or improved by policy and practice. While there are many potential revenue streams available, for example bee breeding, leasing hives for display, and selling propolis just to name a few, our economic analysis of Dutch apiculture will be focused on pollination services and the honey market as these are the most significant sources of income for beekeepers.

6.1 Pollination Services

Pollination services are an important source of revenue for professional beekeepers around the world and this is certainly the case in the Netherlands as well, which is why this report will consider this profession with special scrutiny relative to other forms of income such as selling propolis or bee breeding. It is widely believed that the valuation of pollination services is severely underestimated (Breeze et al., 2016;Feuerbacher et al., 2024; Personal interview 1 & 8, In person, June 2024). Experts wonder why clients from other sectors “pay so little for such an important and costly function: pollination of agricultural crops” (Blacquiere et al., 2009). This report will consider key factors of pollination service valuation, including the estimation of economic benefits provided to the agents of the agricultural sector and competition among professional, hobbyist, and semi-professional beekeepers. This report will also explore potential solutions and opportunities for stimulating sectoral growth, including import regulation, registration, and marketing.

Valuation Methodology

The challenges to valuing pollination services are experienced in major economies around the world, but they are being identified and addressed differently. By considering related research conducted in foreign apicultural sectors, this report intends to provide new insight for further research catering to the Netherlands’ apiculture. The United Kingdom, a large economy with a sizable apicultural sector of 200,000 colonies (Chauzat et al., 2013) compared to the Netherlands’ 81,600 colony count as of 2018 (Van Dooremalen & Rijksdienst voor Ondernemend Nederland, 2022), is a notable example. A study conducted in the United Kingdom (Breeze et al., 2017) used survey data of beekeepers in Wales and southeast England to assess the valuation of pollination services by comparing payments made to beekeepers with the economic benefits associated with stimulating the crop yield of apple farmers. Breeze et al. (2017) found that these benefits amounted to around 86-149 times higher than the payment provided to the supplying beekeeper. Evidently, there is a staggering potential for severe undervaluation of pollination services, but it is important to also consider the scope of this research. Survey data was gathered mostly from hobbyist beekeepers (92% of survey respondents), characterized by owning less than 50 hives and typically having less than 5 years of experience, therefore this study mainly analyses valuation among small-scale beekeepers. We justify the external validity of these results to Dutch beekeeping with reports from experts of the field that hobbyists have extensive market power in the Netherlands relative to professional beekeepers. This is further backed up by the stark contrast in member count of the BVNI (23 members) and the NBV (8,500 members) (Personal interview 8, In person, June 2024). Due to their strong influence over the equilibrium price for pollination services, it is possible that the undervaluation would extend to professionals by way of simple market dynamics. When interviewed, researchers and beekeepers alike agreed that pollination services are likely undervalued when comparing the payments provided to supplying beekeepers with the associated economic benefits for farmers (Personal interview 2 & 4, In person, June 2024; Personal interview 3, Phone, June 2024; Personal Interview 6, Video call, June 2024). Further research into the inputs and outputs of pollination services is recommended for the sake of improving valuation methodology used in the Netherlands. More specifically, we implore future research to apply the methodology of Breeze et al. 2017 to the Dutch apicultural sector to further explore pollination service valuation and the perceptions of beekeepers, farmers, and third parties. Necessary modifications include a larger sample with cross sectional distinguishing professional, semi-professional, and hobbyist beekeepers by hive count or profit cutoff ranges.

The Netherlands deserves close attention on this matter of correcting the valuation of pollination services because apiculture is an instrumental production input for agriculture, a famously important sector for the Netherlands. Approximately 16% of turnover from Dutch seed companies is invested into research and development. Moreover, 70% of vegetable seeds used worldwide can be traced either directly or indirectly back to seed companies based in the Netherlands(Made in Holland: Seed Valley: Leading the World of Plant Breeding, 2014). Pollination is necessary for seed production and research, therefore, even though the Dutch apicultural sector may be small, its role in the wider economy is paramount. This should be reflected in pollination service pricing. A case-study of German pollination services found that the value of these services was around 33% higher when including effects on seed production (Feuerbacher et al., 2024). It is important to note that heterogeneous characteristics among crop and seed varieties make it challenging to discern a range of value added by pollination services, because some crops such as strawberries require more visits from rented bees as compared to tomatoes, to name an example.

Competition with Hobbyists

Flawed valuation of pollination services is partially attributed to hobbyist beekeepers undercutting professionals with cheaper prices. When interviewed, beekeeper advisors indicated that hobbyists supplying pollination services negatively impact prices that professionals may command (Personal interview 6, Video call; Personal interview 8, In person, 2024). In many cases, pollination services may be provided for free in the interest of stimulating honey production, except for when pollinating greenhouse farms because they do not provide sufficient nectar (Personal Interview 6, Video call, June 2024). Hobbyist beekeepers are not dependent on the profitability of their hives, although it is important to note that many hobbyists are considered semi-professional when operating at relatively large scales. Consequentially, professional beekeepers specializing in pollination services may be significantly less competitive. Hobbyists and semi-professionals certainly deserve a place in the sector, but their dominance detracts from the overall economic growth of apiculture by inadvertently mitigating the efficient valuation of pollination services. Clients with higher demand will, theoretically, tend to hire professional services to take advantage of larger colonies, but smaller-scale clients will recognize hobbyist pricing as more affordable for their needs. A key weakness of Dutch apiculture, hobbyists charging low fees (or none at all) for pollination services detract from the welfare of professional producers in the market. In other words, competition between hobbyist and professional beekeepers challenges the efficient valuation of pollination services.

Farmer-Beekeeper Information Asymmetry

There are various reasons explaining why farmers may stop using pollination services provided by professional beekeepers, but they are largely due to information asymmetry between beekeepers and their clients. This can be remedied through marketing efforts, by beekeepers and related organisations, highlighting the importance of healthy hives and expertise when contracting professional beekeepers for pollination services. According to scientific literature, farmers may reject professional pollination services because they would rather rely on cheaper pollination from neighbouring farms with beehives, they have difficulty measuring the impact of professional pollination services quantitatively, or as previously stated, they would prefer to save money and contract hobbyists. Moreover, some farmers may feel their production methods become too constricted when receiving professional pollination because they cannot use certain pesticides or practices (De Groot et al., 2015). While most farmers recognise the importance of pollinating their crops, many do not understand the difference in quality among hobbyists and professionals (Personal interview 5, Video call, June 2024). To name a key distinction, a professional beekeeper is more likely to have a better understanding of how to pollinate specific crops with specific bee species. For example, blueberry farmers use honeybees in combination with bumblebees to ensure the presence of pollinators throughout the entire growing season (De Groot et al., 2015). A hobbyist is less likely to understand this because relative to professionals they have less practical experience and/or training in beekeeping. By emphasising the importance of professional expertise, including the fact that a typical professional beekeeper has a higher quality education regarding pollination, beekeepers can help farmers realise the added value associated with professional pollination services.

Beekeeper Registration

One method of improving our collective understanding of pollination service valuation is to increase the rate of beekeeper registration in the Netherlands. This is a key opportunity for improving economic efficiency. When interviewed, legislation advisors have explained that hobbyist beekeepers are often reluctant to register their hives because they do not recognise the importance of widespread registration (Personal interview 8, In person, June 2024). That importance being increased monitoring of invasive species, increased financial support from the EU, and accurate data collection of apiculture in the Netherlands. In relation to pollination services, increasing registration will improve stability in valuation across different scales of apiaries. The sector may benefit from financially incentivizing hobbyist beekeepers to register, for example by providing a controlled subsidy for common production costs. By facilitating knowledge transfer, compliance with regulation, and general organisation among beekeepers, researchers, and policymakers, increased registration will make the apicultural economy more efficient.

Value Estimation

In the report on beekeeping by Blacquière et al. (2009), a total value of pollination was estimated. At the basis of this estimation was the report by Gallai et al. (2009), which estimated pollination value to be 10% of world food production value. This method and statistic are still referenced in recent papers (Khalifa et al., 2021). The most recent estimation of the total production value of the Dutch food production estimate is 36.234 billion euros (CBS, 2023), however those numbers still include floriculture, which makes up 18% of the total. Excluding this, we remain with 29.711 billion euros, of which 10% is a total pollination value of 2.9 billion euros. However, this statistic accounts for pollination of all pollinators, rather than solely honeybees.

Giving an accurate estimate of the percentage of pollination conducted by managed pollinators is difficult. A report by De Groot et al. (2015), found that wild pollinators were responsible for 60% of apple pollination and for 18% of blueberry pollination. This shows there is great variety and defining an accurate percentage is difficult and context dependent. Blacquière et al. (2009), assumed an 83% share of honeybees on total pollination, based on Losey & Vaughan (2006). This results in a staggering valuation of 2.41 billion euros provided by honeybee pollination.

6.2 Honey Market Dynamics

As previously mentioned, the apicultural sector of the Netherlands is modest in size relative to most EU nations. Even though they are just as productive as the EU average, producing 21kg of honey annually per hive, Dutch beekeepers are facing an uphill battle with imported honey. With production capacity capped at an annual output of 1200 tons of honey (Tom et al., 2023), out of the EU's total 286,000 tons, Dutch honey is priced relatively high to compensate for relatively expensive production costs, given the difference in production scale. In fact, the price of honey in the Netherlands places third in most expensive per kilogram in the EU with 12.27 euros/kg, assuming the honey is purchased directly from the producers. This is disproportionate to the rest of the EU, where the average price per kg of honey bought at the site of production is 6.25 euros (European Commission, 2024).

Theoretical Insight

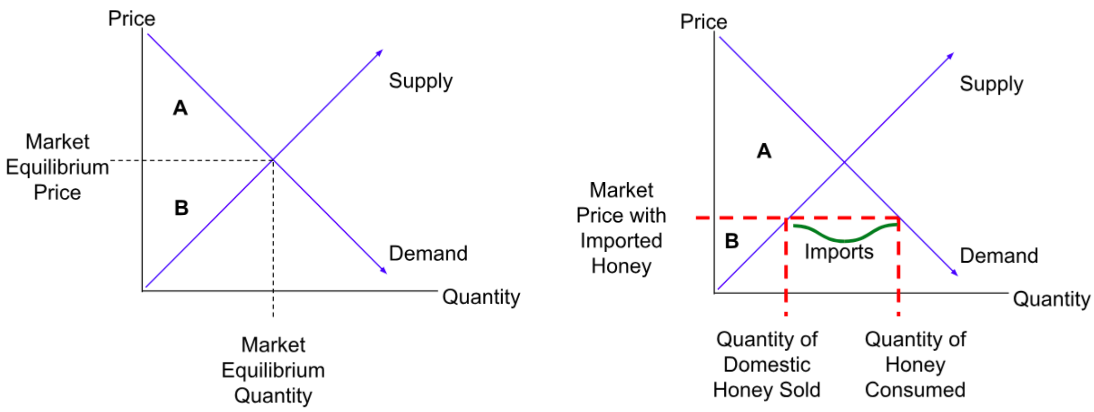

***Figure 7**: Diagram on the left represents the theoretical equilibrium of the Dutch honey market. Diagram on the right represents the adjustments when cheaper, imported honey is introduced theoretically. Area A represents consumer welfare. Area B represents producer welfare.*

Figure 7 showcases the theoretical effects of cheaper, imported honey on the Dutch honey market through two supply and demand diagrams. Imported honey acts as a substitute good for domestic honey, meaning consumers will essentially treat them as the same good, buying whichever is cheaper to maximize their personal welfare. This is beneficial for the consumer, as they enjoy lower honey prices, but it stifles growth among domestic honey producers because they cannot sell as much. We can see this in the diagram on the right, as the amount of producer welfare (labelled as area 'B') has reduced because the "quantity of domestic honey sold" is less than it was prior to the introduction of imported honey. With higher production costs and less market power, Dutch honey producers are at an economic disadvantage. This will be improved with increased regulation of imported honey, which would further restrict lower quality honey from being imported into the Netherlands, or simply discourage its consumption by informing consumers of the difference in quality. Without regulation, in the long run, cheaper imported honey would discourage honey production among honey producers domestic to the Netherlands. Clearly this is suboptimal for producers, but consumers could be vulnerable to fluctuations in access to imported honey, thereby reducing consumer welfare as well as that of producers.

Global Honey Production and Competition

In addition to the rest of the EU, Dutch beekeepers selling honey must also compete with honey suppliers from around the globe. Many producers from countries such as China and Argentina can afford to ask for even lower prices because they harvest honey before it has fully matured, which produces a higher volume at the cost of a higher moisture level (Personal interview 3, Phone, June

2024). Moreover, cheaper honey is usually diluted with sugar to produce larger quantities. With a lower "world" price, Dutch honey suppliers experience economic costs of selling less product than they would be able to if the equilibrium price point was equivalent to the domestic price. This is more convenient for consumers but does not foster growth in the Dutch apicultural sector as honey is, of course, an important source of revenue for beekeepers.

SWOT: Economics

STRENGTHS

- **Key stakeholder in agriculture**: Beekeepers are ecologically imperative to agriculture, which is especially important for the Netherland's seed production.

WEAKNESS

- **Flawed payment**: Currently, pollination services are underpaid relative to the value provided.
- **High production costs**: Costs of beekeeping are high and trending upwards.
- **Competition between hobbyists and professional beekeepers**: Hobbyists without motivation to profit pressure professionals to sacrifice welfare, reducing profitability of pollination services.

OPPORTUNITIES

- **Subsidies**: Subsidizing significant costs of entry-level beekeeping would stimulate sectoral growth.
- **Incorporating benefits to seed production in pollination service valuation**: Studies show this can result in a 33% higher valuation of honeybee pollination.

THREATS

- **Invasive species**: New invasive species can have drastic effects on the economic welfare of the beekeeping sector, by mechanism of colony loss.
- **Substitutes flooding market**: Imported honey acts as a substitute for domestic honey, meaning domestic suppliers are becoming less competitive in the honey market

7 Politics

In recent years, much attention from the government, nature conservation organisations, the public, and research bodies has been focused on the importance of bees. Altogether, these different bodies and stakeholders have slowly built the pressure for change in the way we view, manage, support and profit from wild and honeybees. These new perspectives towards the apicultural sector have led to more research opportunities and funding from the European Commission for projects focused on improving apiculture. Additionally, local Dutch municipalities and provinces have taken steps towards the protection and conservation of wild bees. This section focuses on funding by the Dutch government and the European Union, lobbying for the Dutch beekeeping sector in the European Union and communication with other stakeholders, and regulations regarding competition between wild and managed bees.

7.1 Funding by the Dutch government & European Union

The EU Commission allocates funding to EU member states for beekeeping-related initiatives. Each member state then decides how funding will be distributed into the apicultural sector. Funding provided by the EU may be used for activities such as research into disease resistance, monitoring strategies, or supporting individual beekeepers. The EU Commission allocates subsidies for each member state based on their number of registered beehives present (Commission Delegated Regulation 2015/1366, 2015). Since 2017, the Netherlands has received between 173,971 and 295,974 euros annually from the EU Commission directed at the apiculture sector (Table 1) (Commission Implementing Decision 2016/1102, 2016; 2019/974, 2019 & 2021/974, 2021). The Dutch government then doubles the funds received by the EU for its apicultural programme (Rijksdienst voor Ondernemend Nederland, 2022). In comparison, apicultural giants in Europe, such as Greece, Spain, France, and Romania received more than 6 million euros each in 2021 and 2022 by the EU (Commission Implementing Decision 2021/974, 2021). This underlines that the funds received by the Netherlands are merely a fraction of the total funds allocated to EU apiculture, totalling 40 million euros in 2020 and 60 million euros in 2021 distributed across 28 member states. Despite the dependency on apiculture for the success of agriculture, there is a lack of awareness towards much-needed subsidies and funding for apiculture in the Netherlands.

Additionally, the allocation of funds from the Dutch government to different apicultural activities within the Netherlands has been unclear until more recent years. Currently, the Dutch government allocates all the funding to research programmes for bee health, particularly for “combating beehive invaders and diseases” with an emphasis on varroosis (van Dooremalen & Rijksdienst voor Ondernemend Nederland, 2022). However, the general consensus points towards disagreement in the distribution of these funds solely for research institutions (Personal interview 8, In person, June 2024). Many hobbyist beekeepers are also unaware that the Netherlands receives EU subsidies for apiculture. From a questionnaire sent to hobbyist beekeepers (June 2024), 21% of respondents emphasised their lack of knowledge towards government support and would like to learn more about available funds.

Table 1: Allocation of funding from EU Commission towards the apiculture sector in the Netherlands (euros per year). These funds are doubled by the Dutch government.

Year	2017	2018	2019	2020	2021	2022
EU funds (euros)	173,986	173,971	174,000	190,000	295,172	295,172

The EU Commission has several initiatives founded by member states to contribute research and programmes for sustainable beekeeping, monitoring bee stressors and health, and delivering research output that is relevant for policy making. For example, the PoshBee initiative constituted 42 research institutes distributed in several member states (European Commission, 2023a). Together they contributed 9 million euros, however, the Netherlands did not take part in this initiative.

In the past decade, the Netherlands has been more involved in other EU projects in an effort to improve beekeeping. One of these projects, the B-GOOD initiative, aims to monitor and research honeybee health and colony stability. It aims to help beekeepers by using computer assisted programs and remote monitoring of beehives. This EU-funded project involved two research institutes in the Netherlands (Stichting Beep and Wageningen University & Research), which together received almost 2 million euros for the research (European Commission, 2023b). This project was created by the EU Commission as part of a research and innovation trial to make European beekeeping healthy and sustainable (European Commission, 2024c). A part of this project focuses on mapping food availability for bees – for example to record the plants available in a particular region, their blooming time, and production of pollen (European Commission, 2024a). Currently in the Netherlands, the “Bee Landscape” project also aims to improve availability of food sources for bees, yet it also focuses on improving wild pollinator species (van Rooij et al., 2023). It is highlighted by several members of the sector that projects like these should also be implemented into helping the beekeeping business. For example, by mapping honeybee food availability in the Netherlands, beekeepers can safely and more effectively decide where to place beehives in areas where they will not interfere with wild pollinators. However, the involvement of Dutch professional beekeepers in this project, and also the continuation of the project, are unclear.

SWOT: Politics (EU and Dutch funding)

STRENGTHS	WEAKNESS
• **EU funding for apiculture sector available:** Funding based on size of apicultural sector for each member state, this is determined by quantifying the number of hives in the country. • **EU funded projects**: Netherlands involved in EU funded research projects related to bee health and disease monitoring	• **Transparency of funding in Netherlands**: It is unclear how and where the Dutch government distributes EU and Dutch funding for different apicultural activities • **Small apicultural sector**: The Netherlands receives a small fraction of EU funding because the apiculture sector is considered small due to no formal registration of the number of hives in the country
OPPORTUNITIES	**THREATS**
• **Registering hives:** Promoting an organised professional apiculture sector with accurate number of registered hives will provide more EU funds in the long run • **Dutch funding for professional beekeepers**: accurate and transparent registration would offer trust and transparency to Dutch government and invite opportunities for direct subsidies from the government	• **Distribution of funds**: The distribution of EU funds within the Netherlands is not considered fair by many stakeholders. Currently, all funding is delivered to few research organisations, which provokes anger amongst beekeepers.

7.2 Lobbying and communication with other stakeholders

The BVNI and NBV, along with ImkersNederland and BD imkers (biodynamic beekeepers), form part of “Het Imkersoverleg (IO)”. This organisation communicates with different governmental instances such as the European Union, Ministry of Agriculture, Nature, and Food Quality (LNV), the Dutch Food and Consumer Product Safety Authority (NVWA), and the Dutch Enterprise Agency (RVO) on behalf of the apicultural sector (Personal interview 3, Phone, June 2024). Het Imkersoverleg represents the interests of Dutch professional and hobbyist beekeepers in the European Union. However, lobbying in both the European Union and the Dutch government is challenging (Personal interview 8, In person, June 2024). This is because the Dutch beekeeping industry accounts for less than 1% of the colonies in Europe (Chauzat et al., 2013). Professional beekeepers are often seen as hobbyists by politicians and civil servants (Personal interview 8, In person, June 2024). However, since the interests of hobbyist and professional beekeepers differ, this perception can lead to various issues. For instance, there is a risk that professional beekeepers are not taken seriously by key stakeholders, such as nature organisations and governmental bodies. This misperception can hinder their ability to secure subsidies and may result in legislative barriers, since the working procedure of hobbyist beekeepers is less professional.

To still advocate for the interests of professional apiculture in the Netherlands, collaboration with other countries sharing the same interests for professional beekeepers is possible (Personal interview 8, In person, June 2024). Additionally, it is important for the BVNI and the professional beekeeping sector to collaborate with other sectors in the Netherlands that are strongly represented in the EU and have an interest in the activities of honeybees and professional beekeepers, such as the agricultural sector (LTO, NFO) or the seed production associations in the Netherlands (Plantum) (Personal interview 3, Phone & Personal interview 8, In person, June 2024). Furthermore, it is helpful to educate civil servants about the importance of honeybees and the pollination of plants and crops. It often happens that policies are implemented without hearing or inviting the different parties involved (Personal interview 8, In person & Personal interview 5, Video call, June 2024).

7.3 Competition between wild and managed bees

There is currently a strong focus on protecting wild pollinator species, and there is a strong emphasis from nature conservation organisations to redirect the focus from honeybees into wild pollinators. The most prominent initiative by the Dutch government regarding pollinator conservation is the “Bed & Breakfast for Bees” (Rijksoverheid.nl, 2018), which focuses on wild bees and biodiversity conservation. The initiative incorporates many projects aimed at increasing wild pollinator numbers and diversity but does not put much emphasis on honeybees or strategies to support both wild and managed bees in one ecosystem.

Currently in the Netherlands, there are no programmes focusing on managed bees or support for pollination services regarding agriculture. This is perhaps due to new policies and governmental decisions based on limited information from nature conservation institutes. Without input from both nature conservation institutes, and the apicultural sector, this creates skewed or biased information regarding all forms of beekeeping and bee conservation. For instance, the “B&B for Bees” is mostly guided under a partnership with Naturalis and other nature conservation organisations, and not much input from other research organisations and apicultural bodies.

To add to this dilemma, the Dutch government announced their plans to restrict the placement of beehives in the metropolitan area of Amsterdam to encourage wild pollinators (Reemer et al., 2020). This strategy intends to make certain areas in Amsterdam “honeybee-free” by incorporating a 1000m radius from green areas with no honeybee hives. While this decision is well intended and formulated by a variety of stakeholders, it is rather drastic and without input from professional beekeepers in the area that rely on the vegetation already present in Amsterdam (Nieuwenhuis & Timmermans, 2015). It also blames honeybees for the displacement of wild pollinators, instead of other factors such as local fauna, urban pollution or land management which can all affect wild bees (Nieuwenhuis & Timmermans, 2015).

Similarly, in the Biesbosch nature reserve, there are clashes about beehive placement and wild pollinator displacement. While beehives are not allowed to be placed within the reserve, the presence of honeybees is still prominent as beekeepers place hives in surrounding farms and neighbouring fields. Nature conservation organisations argue that the excessive placement of hives (more than 4 per square km) is a problem for wild pollinators due to competition for nectar with the honeybee. Currently it is estimated that the number of hives can reach up to 25 per square km at the border of the nature reserve (Hollandse Delta & waternatuurlijk.nl, 2022). On the other hand, beekeepers argue that honeybees are not the cause of wild bee displacement, and that other factors should be investigated, such as mowing, or farm animal placement which destroy wild bee nests (Linnartz, 2023; Verrips & Linnartz, 2023).

As a response to the demand for beehive control, the province of Zuid-Holland initiated a proposal in 2022 to regulate commercial beehive placements near the reserve. They highlighted issues such as the large influx of beehives from outside the region and even beyond the Netherlands and a lack of registration of these hives. Additionally, unlabelled beehives of unknown origin cannot simply be removed as these are commercial property. Because of these pitfalls, it is also difficult to implement a permit system for beekeepers. The new regulation suggests the following guidelines to solve the problem (Provincie Zuid-Holland, 2022):

- Nation-wide registration of beehives to track origin and ownership of hives.
- Prevent accumulation of beehives surrounding the reserve by creating a buffer-zone of 3-5km.
- Permit requirement for placing beehives near the reserve.
- Annually renewed lease agreements on surrounding farmland that restricts the placement of beehives.

However, from several interviews, the perception of beekeepers and honeybees in relation to wild pollinators is quite different from that of nature conservation organisations. The main sentiment is that there is not substantial evidence that suggests honeybees out-compete and displace wild pollinators and that the interplay of many factors can affect both wild and managed bees (Personal interviews 1, 8 & 10, In person, June 2024). This complex and undefined relationship between bees is prone to ignite argumentation on the topic of regulations and policymaking. What is currently missing in the argument, is for beekeepers to work together and with other researchers and government agencies so that professional beekeepers can voice their opinions and increase their leverage on these policies.

SWOT: Politics (Managed vs wild bees)

STRENGTHS	WEAKNESS
• **Protection of wild pollinators**: Policies have a strong focus on protecting and promoting wild bee pollinators (e.g: "B&B for bees" initiative)	• **No focus on honeybees**: Policies do not put much emphasis on honeybee protection, these only focus on wild bees • **Wild vs honeybees**: There is an unclear definition on the relationship between honey- and wild bees, which is sometimes used to make policies based on a lack of data.
OPPORTUNITIES	**THREATS**
• **Protection of natural reserves**: New regulations implemented against overpopulating natural reserves with hives • **Placement of hives from abroad restricted**: Some municipalieties are considering regulating hives from abroad in Dutch reserves, this will allow local Dutch beekeepers to make use of the land and plants	• **Governmental decisions from limited sources**: Pressure for drastic decisions against hive placements created by media and popular sentiment. Some decisions made from limited scientific sources and limited stakeholder opinions • **Blame on honeybees**: Municipalities blame honeybees for displacement of wild pollinators instead of other urban factors like land managment, pollution, habitat fragmentation.

8 Legislation

Increased interest in bees has resulted in policy changes, new support from local and European governments, and new legislations since the paper published by Blaquière et al. in 2009. There is much focus on creating an organised apiculture sector by introducing regulations involved in registration and placement of beehives, disease management, monitoring strategies, treatment of beehives, and usage of pesticides. Additionally, within the EU, new policies have emerged regarding the honey market, which can be beneficial for Dutch honey producers in the following years. This section focuses on the (potential) regulations on beehive registration, disease and pest management, pesticides and hive treatment, honey production and imports, and discrepancies in regulations.

8.1 Beehive registration

Currently in the Netherlands most beehives are not registered, since it is not mandatory. However, professional and hobbyist beekeepers in the Netherlands will potentially need to register their bee colonies, as the registration of hives is expected to become mandatory in the near future (Personal interview 6, Video call, June 2024; Nederlandse Bijenhouders Vereniging, n.d.; n.). It is expected that ownership of more than 25 hives will mean an annual registration fee (Kreike & Imkersoverleg, 2023). This regulation will stem from the Animal Health Law ((EU)2016/429) and will ensure an understanding of the number of hives per area, the location of hives, and the beekeeper responsible for the hives. With beehive registration, it is easier to prevent and control an outbreak of American foulbrood and other diseases, because the hive and the beekeeper are traceable (Nederlandse Bijenhouders Vereniging, n.d.).

It is suggested that the registration will be conducted once a year in February. However, opinions are divided on the best timing for the annual registration (Personal interview 3, Phone, June 2024). For example, it is impossible for beekeepers that focus on greenhouse pollination to register all the beehives during pollination season because their hives are continuously multiplied and divided according to the demand for pollination services. For them, a midwinter counting would be more feasible (Personal interview 3, Phone, June 2024). The interviewed beekeepers agree that the registration should not take much time (Personal interview 6, Video call, June 2024). They also believe that the information on hive ownership should remain anonymous as some beekeepers do not wish to express their number of owned hives. If this information becomes public, it could lead to discussions between beekeepers about competition for flowers between hives. In addition, this could lead to discussions about the potential competition of honeybees with wild bees between wildlife organisations and beekeepers.

From a questionnaire sent to hobbyist beekeepers (June 2024), opinions on hive registration were varied. While some beekeepers believe that hive registration is needed to maintain an overview of the sector, others believe that it would be a hassle and do not recognize any benefits from registration of hives. With a registration requirement, the Dutch apiculture sector can become more transparent in the monitoring of outbreaks of diseases and pests and can thus potentially be seen as a useful and necessary 'sector' in agriculture and horticulture. In addition, it is expected that with hive registration more subsidies will be available for the Netherlands, as some beekeepers and researchers believe that Dutch apiculture is undervalued in the European Union (Personal interview 6, Video call & Personal interview 8, In person, June 2024).

SWOT: Legislation (Beehive registration)

STRENGTHS

- **EU funds**: Registration provides information on the sector size, which determines funding delivered by EU commission.
- **Disease and ownership tracking**: Easy to trace location and history of hives to track disease spread and contact owners

WEAKNESS

- **Variability of opinions**: Opinions on whether registration is needed in the sector are variable. Some agree, but some disagree that it is necessary. Leads to inconclusion on whether hives should be registered or not by law
- **Lack of awareness on importance of hive registration**: Most beekeepers do not see the reason or importance of hive registration.

OPPORTUNITIES

- **Nation-wide hive registration**: To make the number of hives in the Netherlands become more clear. Will lead to transparency and organisation of the sector. Will enable recognition on the importance of apiculture in the Netherlands.
- **More EU funding**: More registered hives will result in larger proportion of funds derived from the EU commission for NL apiculture.

THREATS

- **Registration is not mandated yet:** Leads to issues with misplaced hives and ownership. Difficult to track the size of the sector and the magnitude of disease spread

8.2 Disease and pest management

The commercialisation and global trade of honeybees has increased the risk of transmissible diseases and parasites. Within the EU, many invasive parasites and predators of bees are now established species. Notification of some bee diseases is currently mandated in the Netherlands and other EU member states (Commission Implementing Regulation 2018/1882, 2018), and infected colonies must be reported to the Dutch Animal Diseases Reporting Center of the NVWA. As of 2018, the presence of four bee diseases or pathogens in colonies must be reported to the NVWA (NVWA, n.d.-a):

- Small hive beetle (*Aethina tumida*)
- American foulbrood
- *Tropilaelaps* spp. (*Tropilaelaps clareae* and *Tropilaelaps mercedessae*)
- Varroa mite (*Varroa destructor*)

However, a substantial proportion of the beekeepers in the Netherlands do not perform regular monitoring of hives for these diseases (Personal interview 4, In person & Personal interview 7, Video call, June 2024). Some beekeepers (particularly hobbyist beekeepers) also choose to not treat hives against Varroa mites. This is deemed problematic for professional beekeepers as it can cause infestation levels to soar and promote the spread of mites both within and between apiaries. Varroa and the involved diseases, are themselves a threat to bees and the industry. However, a lack of regulated disease monitoring initiatives can also present itself as a threat. Additionally, while it is mandatory to report such diseases and parasites, there is no mandated control for these (NVWA, n.d.-e).

Ideally, to control the spread of these diseases, new regulations on control and monitoring must be implemented. There are many research initiatives on developing new monitoring strategies or breeding resistant bees (Rijksoverheid.nl, 2013; Project VaRT | Arista Bee Research, n. d.; Blacquière & Panziera, 2018). However, a solution to infectious diseases and colony collapse will need to incorporate both research initiatives and governmental policies to control the spread of pathogens and enforce the treatment of beehives.

The Asian hornet is spreading to the Netherlands from other parts of Europe and has been present in the Netherlands since 2017 (NVWA, n.d.-a); (*Waarneming.Nl*, n.d.). As of 2016, the Asian hornet can be found on the European Union's list of invasive alien species (EU 1143/2014), this gives member states the duty to detect and remove nests present in nature, when this is not possible the population must be managed to limit spread or damage (European commission, n.d.).

Currently in the Netherlands, citizens can report an Asian hornet through Waarneming.com with a picture, where experts verify the species (NVWA, n.d.-a). If confirmed, the public is asked to catch and freeze the queen from April to June. From July to September, it is recommended to track the flight direction of the hornet they found. The responsibility for elimination and management actions for the implementation of the EU Exotics Regulation lies within Dutch provinces, together with water and land managers and others this policy is implemented (NVWA, n.d.-a).

According to the professional Dutch beekeepers, the Asian hornet is currently a significant problem for beekeepers in various countries such as France. Dutch beekeepers see the further spread and increase of the Asian hornet as a threat to Dutch beekeeping because it primarily preys on bees (Personal interview 6, Video call & Personal interview 8, In person, June 2024). The beekeepers believe that the government, in this case the NVWA, should take more initiative in combating the Asian hornet instead of delegating this responsibility to the provinces, as this results in inconsistent policies being implemented across Dutch provinces. This is a sentiment shared by both professional and hobbyist beekeepers. Additionally, Dutch beekeepers suggest that the NVWA should hire specialists who are specialized in locating and combating the Asian hornet to help mitigate the issue (Personal interview 5, Video call, June 2024).

SWOT: Legislation (Disease & pest management)

STRENGTHS

- **Disease notification in EU mandated**: Several bee diseases must be notified by law. Asian hornet is in EU list of invasive alien species, member states must remove nests. There is a general initiative by governments to control bee diseases and alien species.
- **Notification of diseases**: Netherlands has NVWA webpage dedicated to reporting notifiable diseases.

WEAKNESS

- **Presence of bee diseases**: Several bee diseases are present in Dutch apiaries, but only 4 are deemed notifiable diseases
- **Lack of disease control guidelines**: Notification of diseases is mandated, but control measures are not. Asian hornet sightings can be reported to the Waarneming.com but only a few municipalities carry out active nest removals from reports.

OPPORTUNITIES

- **EU initiatives for disease control**: There are several EU-funded initiatives for breeding resistant bees or monitoring strategies. The Netherlands is involved in some of these.
- **Beekeeper pressure on policies**: Beekeepers believe the Asian hornet is a big threat to their bees, and encourage the government to create more policies for control.

THREATS

- **Non-uniform monitoring**: No mandated monitoring or disease control means that a large portion of beekeepers (particularly hobbyist) do not perform regular pest monitoring

8.3 Pesticides and hive treatment

From 1990, beekeepers can report pesticide and herbicide spray damage to the NVWA through their association or through the NVWA (NVWA, n.d.-d). According to Elshout, 2005, spray damage means: "The indirect damage that occurred when bees collected pollen and/or nectar from crops that had been treated (sprayed) with a substance toxic to bees. This includes the bees' drinking places between the sprayed crops and the created toxic puddles that occurred after the spraying". It is important to report (suspected) spray damage to the NVWA, as the purpose of these reports is to identify bee mortality caused by these plant protection products and prevent spray damage to honey- and wild bees (Lubek et al., 2020; NVWA, n.d.-c). This data is discussed by the working group 'Bestuivende insecten en gewasbeschermingsmiddelen en biociden' after which the NVWA can take measures. If a plant protection product has been used according to the instructions and damages the bee colony, then further regulation may be allowed or the authorization of the product in question may be withdrawn (Lubek et al., 2020).

In the period between 2015-2020, about 15 incidents of potential spray damage per year were reported. Of these, only three cases were proved to be caused using plant protection products (Lubek et al., 2020). In these three cases the substance Fipronil was detected, there are no plant protection products authorized with Fipronil in the EU, therefore its use is illegal. No updated data is publicly available on spray damage reports after 2020, making it unclear whether this trend has continued. However, some hobbyist beekeepers have highlighted their concerns regarding the use of harmful plant protection products (Questionnaire, June 2024). Several hobbyists voice their concerns regarding the lack of governmental action against such harmful pesticides, and they stress the need for lobbying as was done against glyphosate in the past.

Most growers and farmers follow the regulations, otherwise their products will no longer be accepted by distributors and supermarkets (Personal interview 6, Video call, June 2024). In addition, the (incorrect) use of illegal pesticides also has negative effects for the growers and farmers since it reduces the pollination of crops. When pesticides with possible side-effects on bees are being used, the beekeeper is usually informed in time by the farmer, after which the decision can be made to relocate the bee hives (Personal interview 6, Video call, June 2024).

Besides the use of illegal pesticides, the incorrect use of pesticides is another major cause of spray damage to bee colonies. Reasons for this in the past were found to be incompetence, disinterest, intentional or accidental (Elshout, 2005). If plant protection products that are toxic to bees are used, they should be used when bees are not flying (Elshout, 2005; Personal interview 8, In person, June 2024). When errors of judgment are made by a grower, this can unintentionally lead to the death of honeybees and other pollinators. If the perpetrator of spray damage is known and a violation of the law: 'gewasbeschermingsmiddelen en biociden' is found, there is a chance of compensation for the damage to the hives (Elshout, 2005; NVWA, n.d.-e).

For Varroa control, chemical miticides were used in the past with negative side effects on bees and human health (bijen@wur, 2010). The industry has opted for a more sustainable way of Varroa control. Currently, organic acids such as oxalic acid and formic acid are mainly used. However, these agents are not authorized for common use, but their use is tolerated. Thymovar and Apiguard are examples of authorized products for use as veterinary medicines to control Varroa, other authorized products can be found at the Veterinary Drug Information Bank: 'diergeneesmiddeleninformatiebank' (College ter Beoordeling van Geneesmiddelen, n.d.). The use of agricultural miticides is a recent trend for Varroa control. Although these seem to be effective in controlling Varroa, it is not recommended to use miticides as they can have negative effects on human health, the bees and bee products (bijen@wur, 2010).

SWOT: Legislation (Pesticides & hive treatments)

STRENGTHS

- **Banned pesticides**: New bans on harmful plant protection products to protect the environment, including protecting wild and honeybees.
- **Notification of pesticide damage**: Netherlands has NVWA webpage dedicated to reporting suspected pesticide damages on beehives

WEAKNESS

- **Varroa treatments**: Unclear regulations on the use of certain chemicals (oxalic and formic acid) to treat hives.
- **Honey products**: Exposure to pesticides and Varroa treatments can have a negative effect on honey and other bee products

OPPORTUNITIES

- **Farmer-Beekeeper agreements**: The agreements between these two parties for using pesticides can maintain a healthy relationship between the two. These agreements could potentially be made legally binding.

THREATS

- **Incorrect use of pesticides**: Legal pesticides can still be harmful to bees and other organisms when used incorrectly.

8.4 Honey production and imports

The EU currently imports large amounts of honey from many countries worldwide. In 2023, the Netherlands was ranked 11th in the world, with a total of 14,698,100 kg of imported honey (World Integrated Trade Solutions, 2023). Honey imported into the Netherlands originates mainly from Germany, Belgium and China, but altogether, the Netherlands imports honey from more than 51 countries worldwide (World Integrated Trade Solutions, 2023).

While there are certain regulations in Europe defining the legal requirements for honey to be sold in the EU, the testing system for imported honey is currently not standardised. There are multiple types of analysis for honey quality worldwide (Puścion-Jakubik et al., 2020), and this makes quality testing in imported honey a challenge. Imported honey is often poorly tested and of substandard quality due to the harvesting methods and production processes involved in each country or through adulteration with added sugars. There are also issues with the marketing of these products and not enough information on the origin and processing of these, which ultimately misleads customers. For instance, lack of regulation on the maximum temperature for processing honey leads to the destruction of its medicinal properties, rendering it less viable for manufacturing cosmetics and medical products (Personal interview 8, In person, June 2024). Additionally, the low cost of production of imported honey is far more competitive than the prices of honey in the Netherlands, which are one of the highest in Europe.

A major threat to the honey market in the Netherlands regarding the lack of regulations is the absence of rigorous testing of Dutch honey. Because Dutch honey is produced in smaller quantities than honey in other countries, testing each batch is not beneficial for the beekeeper. Because of this lack of testing, and the high amount of imported honey in the Netherlands, there is a risk that Dutch honey may also be adultered or blended with lower quality imported honey. Since no testing is performed, it is easy to market the honey as "Dutch", when there could be other honey blends incorporated to dilute the product and increase profits. This is indeed misleading, but there is an opportunity for the future of pure, artisanal Dutch honey to be properly labelled and marketable by conducting proper testing of imported, as well as locally produced honey.

Many of these issues have been noted by the EU commission, and there are plans to develop new regulations regarding imported honey quality. According to EU regulations, bottled honey must be labelled with one of the following three options: 'blend of EU honeys', 'blend of non-EU honeys' or 'blend of EU and non-EU honeys' (Council Directive 2001/110, 2001). A new legislation coming into force in 2026 will ensure all honey in the EU clearly states its origins and percentages on labels. This will include stating the country where the honey was harvested, and the percentage of the honey blend for each country of origin (Directive 2024/1438, 2024).

However, there are still issues regarding the transparency of honey harvesting and post-harvest processes, such as heating and drying, that also need to be addressed in legislation. To tackle this issue, the EU commission plans to unify all testing systems with a single protocol. This will standardize the analysis of honey quality and region of origin for the entire EU. This strategy will be established as a Union reference laboratory to detect undesired processes such as adulteration, overheating, and pollen removal processes (Directive 2024/1438, EU Commission). This will help Dutch beekeepers that rely on honey products as a source of income by promoting the EU market into purchasing universally checked EU-sourced honey.

SWOT: Legislation (Honey production & imports)

STRENGTHS

- **New European laws:** Recent legislations that will come into action soon (2026) to regulate honey imports and quality testing

WEAKNESS

- **No testing local honey:** Netherlands produces good quality honey, but also imports high volume of low-quality honey. However, no testing is done for local honey products which could be diluted with other honey blends or sugars

OPPORTUNITIES

- **New honey regulations:** Laws will clarify origins of bottled honey and will protect customers. Dutch artisanal honey can be protected from cheap blends
- **New standardised testing system:** This can avoid low quality honey being used for medical products

THREATS

- **Non-standardised testing:** Lack of standard honey testing in Europe at the moment, which enables the imports of low quality honey.
- **No imported honey tracking**: Vague labelling of imported honey makes it easy to lose track of where honey originates from. Low quality honey blends with Dutch honey and incorrectly marketed, misleading customers with honey blends

8.5 Discrepancies in Regulations

There are contrasting policies based on each province in the Netherlands. Each province can settle its own policies regarding beekeeping regulations, disease notification, honeybee-free natural reserves and more. This can be especially problematic for themes such as disease control. For example, for the invasive Asian hornet (*V. velutina*) there is a general reporting system for the Netherlands, however, different provinces tackle the invasive species differently. Some regions attempt to track and take down hornet nests, such as the city of Amsterdam (AVBB, n.d.), while others have not implemented control measures. However, these measures are not enforced, they serve only as guidance. There are also different regulations on where beehives can be placed. Some municipalities do not allow placement of beehives within a 30m radius of urban areas. These different regulations are not clearly highlighted within a single framework, and it makes it difficult for professional and hobbyist beekeepers alike to be aware of all the different regulations. This seems to be an important focus point for the future of policymaking, and it would benefit the entire sector to have unified, clear and straightforward access to all the regulations per province, or as per the whole nation.

9 Conclusion

In conclusion, this report, based on the findings of Blacquière et al. (2009), has uncovered significant new insights into the professional beekeeping sector. To improve disease control, The upcoming mandatory hive registration will help to monitor American foulbrood outbreaks. Besides this, hive registration can also be used to improve Varroa control, since Varroa mites are widely recognized as the greatest current threat to beekeeping. Efforts to manage Varroa mites involve monitoring, Integrated Pest Management (IPM), responsible use of miticides, and support for Darwinian and selective breeding programs. For the management of the invasive Asian hornet, advanced tracking methods, innovative traps, and eco-friendly controls like electric traps and beehive muzzles are being investigated. Next to the formerly named threats for bee survival, ecological concerns persist over the impact of managed honeybees on native wild bees with mixed research results prompting debates on whether restrictions on hive placement in urban and protected areas are justified. Economically, the chief concerns include the inefficient valuation of pollination services and competition in the honey market being dominated by foreign suppliers. With a broad spectrum of professional to hobbyist beekeeping, there is much competition among beekeepers with very different definitions of appropriate pricing for pollination and pollination services have been found to be commonly undervalued to a high degree in large apicultural sectors around the world.

The Dutch beekeeping sector, comprised mainly of hobbyists and a smaller group of professional beekeepers, holds too little influence within Europe to tackle all of these challenges. Mainly because this lack of influence poses challenges for Dutch professionals in obtaining subsidies and legislative differences from hobbyists. Because of this, it is crucial for the BVNI to stay engaged with stakeholders consistently, even during busy periods. “Het Imkersoverleg” plays a key role in this, especially in advocating for Dutch beekeepers and promoting clear national policies. Collaboration with international partners and Dutch sectors such as agriculture and the seed production within the EU can enhance the sector's influence. Lobbying for the interests of the BVNI can be increased by collaboration with other countries and agricultural organisations like Plantum, NFO and LTO which have high interest in the services provided by professional Dutch beekeepers. These organisations already have a strong influence in the European Union. By focusing on practical solutions, ongoing research, and education, Dutch beekeepers can strengthen their resilience and contribute to sustainable apiculture practices locally and globally.

10 Recommendations

Based on the strengths, opportunities, weaknesses, and threats identified in the results, this section will provide strategic recommendations to implement the environmental and economic sustainability for the Dutch apicultural sector and its stakeholders. Recommendations are also summarised in Appendix A.

10.1 Social

Due to the aging beekeeper population in the Netherlands, specific technical knowledge may be lost over time. It is therefore recommended to enhance professional public beekeeper education, organised by the government, to improve knowledge preservation and contribute to a more experienced beekeeper population. Additionally, it is recommended to strengthen the collective representation of the sector. The BVNI organisation could be more effective and more valuable if they increase collaborative efforts within and outside of the sector to strengthen their market position and political influence by, for example, communicating actively with municipalities or provincial governments. This will enhance the BVNI's market position and increase its political influence over policymaking. Additionally, improving collaborations with agricultural organisations could increase the engagement between both parties during off-peak seasons. The BVNI's presence and representation in the media could also be more prominent to get more awareness to different stakeholders, including consumers and citizens.

10.2 Environmental

Unclear effects of honeybees on wild bees

There is a lack of clarity within the beekeeping sector regarding the effects of honeybees on wild bees, which results in an aversion to the measures taken against honeybees in certain areas. Currently, this results in a "beekeepers vs. researchers" situation, both having a negative judgement of each other. To improve this, there is a need for more in-depth investigation on how this affects the apicultural sector, as a whole. Therefore, more research on the competition is recommended, so actual cases of competition in the Netherlands can be shown and elaborated to beekeepers.

Hive placement framework

Once there is more clarity on competition in the Dutch landscape, a contextual framework for guidelines on hive placement needs to be developed. Currently, measures against the placement of beehives lack consideration for specific contexts. It is essential to create a framework that considers the unique characteristics of different areas, such as habitat vulnerability, carrying capacity, and environmental variables. This framework should then be integrated with beehive registration and ongoing studies to assess the effectiveness of implemented measures. Such an approach will form the basis for a new strategy to manage honeybee placement. Until this framework is established, placing beehives near nature areas should be done with caution, since a lot of literature indicates some form of competition.

Climate change

To better combat the effects of climate change on the beekeeping sector, the exchange of knowledge is crucial. This exchange of knowledge happens face to face between beekeepers but can also be shared through training and educational programs. Promoting the latter can help in sharing knowledge as widely as possible and preparing the sector for future climate change induced problems.

Genetic diversity

The honeybees should have high genetic diversity to help them adapt to the changing environment and improve colony survival. While Varroa mite is the major threat to the bees now, this can be tackled by creating pest-resistant strains using controlled breeding. However, this breeding should be done carefully enough to avoid reducing genetic diversity which could make bees susceptible to other threats.

10.3 Technical

Colony losses

Since one of the biggest challenges facing the apicultural sector is colony losses, particularly during the winter, it is important to understand the problem by researching its underlying causes. Currently a lot of research is already being done and possible solutions are found, however there are still problems resulting in a need for more research on the factors causing colony losses.

Data shortage

To address the impact of the different threats, there is a need to gather data about the actual impact on the beehives. The lack of specific data on the impact of the Asian hornet or Varroa mite infestation levels in the Netherlands is a significant barrier to understanding and addressing the issue. Monitoring and surveillance programs would be beneficial to accurately assess the Asian hornet population in the Netherlands and determining their impact on beehives. This information would be valuable for stakeholders in making informed decisions. However, monitoring alone is insufficient; methods are needed to protect beehives from the Asian hornet. Different solutions are already in use, but more research could make them more environmentally friendly and effective. Neighbouring countries have faced this challenge for some more years, incorporating their strategies could help to improve the Dutch approach and make it more effective.

Effective Varroa management

To effectively manage Varroa mites in the Netherlands, several steps should be taken. Establishing comprehensive monitoring and data collection systems is crucial to accurately assess infestation levels and their impacts. Promoting and implementing Integrated Pest Management (IPM) practices that combine chemical, biological, mechanical, and genetic strategies will help manage Varroa mites sustainably. Beekeepers should be educated on the responsible use of oxalic and formic acids to prevent residue buildup and monitor for resistance development to adapt miticide use strategies accordingly.

Support for selective breeding programs focusing on Varroa resistance traits is essential, with financial and technical assistance provided to maintain genetic diversity and colony resilience. Increasing funding for research on entomopathogenic fungi and other biological controls, along with investigating the genetic basis of resistance traits, will refine breeding strategies and explore the potential impact of breeding practices on virus evolution to mitigate unintended consequences.

Education and training for beekeepers

Education and training programs for beekeepers on IPM, selective breeding, and other Varroa management strategies should be developed, fostering collaboration between researchers, beekeepers, and policymakers to share knowledge and best practices. The emphasis should be on maintaining high hygiene standards in apiaries to prevent the spread of diseases but should also incorporate the recognition of symptoms and control methods of common diseases and pests. Implementing these recommendations will improve the health and sustainability of honeybee populations in the Netherlands, ensuring better management of Varroa mite infestations and preserving vital pollination services.

Besides this, it is recommended that the Dutch apicultural sector is prepared for new pests and diseases that may arise due to climate change such as the small hive beetle. This could be done by investigating the potential risks and developing appropriate quarantine and response plans. In addition, biosecurity measures could improve the disinfection and inspection of imported hives and bee product, since humans play a significant role in the spread of new diseases and pests such as the *Tropilaelaps* mites.

In conclusion, decreasing colony losses requires a multi-faceted approach involving more research, data collection, and proactive measures. In doing so, better understanding and approach of the factors contributing to colony loss can be achieved.

10.4 Economic

Defining the distinction between hobbyist and professionals

The distinction between hobbyists and professionals should be defined more clearly by way of nation-wide registration. More EU and Dutch subsidies will become available with a higher beehive registration count. In addition, the registration of bee hives will facilitate data collection, invasive species monitoring, and the regulation of market power distribution. By further distinguishing beekeepers according to scale, pollination service valuation will become more efficient because clients will have a better understanding of the beekeeper's qualities and the value they offer.

Honey regulation

Increasing regulation on honey products is key to allocating more market power to Dutch honey suppliers, as imported honey is much cheaper. Specifically, quality control legislation will make it more difficult for fraudulent honey to negatively influence honey prices. Labelling should also specify the location of origin and be enforced stringently to prevent fraudulent honey. Import restrictions may be used to facilitate growth among professional honey producers in the Netherlands.

Supporting new beekeepers

To grow the Dutch apicultural sector, it is recommended that funding be allocated towards new, professional beekeepers to lower their entry costs with subsidies. This will address the difficulty hobbyists and newcomers face when breaking into the Dutch professional beekeeping industry, thereby improving the market power of professional beekeepers. Moreover, it will broaden the age demographic of beekeepers, providing more opportunities to secure the longevity of beekeeping expertise.

Asymmetric information

Information asymmetry among beekeepers, farmers, policymakers, and other key stakeholders should be addressed by increasing marketing efforts to communicate and agree on the value of pollination services. This will facilitate the efficient valuation of pollination services by bringing awareness to unique benefits provided by professional beekeepers. Moreover, this will mitigate competition among hobbyist and professional beekeepers. It is important to highlight the need for further research on beekeeping in the Netherlands, specifically regarding the impact and attribution of pollination services by honeybees on EU seed exports and the valuation methodology used for pollination services in the Netherlands.

10.5 Politics, Regulations & Legislation

Beehive registration

It is recommended to introduce mandatory beehive registration in the Netherlands. This registration will facilitate the prevention and control of disease and Varroa outbreaks by making bee colonies and beekeepers traceable. Additionally, beehive registration increases transparency in the Dutch beekeeping sector, potentially enabling apiculture to be recognized as a formal sector within Dutch agriculture and horticulture. In addition, it is expected that more EU subsidies will become available for the Netherlands when beehive registration is introduced. It is suggested to carry out hive registration once a year in winter. To ensure effective and correct registration of the hives, this can be developed into an annual event, with education on registration being provided.

Monitoring

It is recommended to regularly monitor beehives for notifiable diseases and to actively control diseases and Varroa. Effectively monitoring and controlling diseases and Varroa leads to infestation levels and reduces the chance of spread of diseases and Varroa both within and between apiaries. New regulations on control and monitoring are suggested to manage the spread of notifiable diseases and Varroa mites. These regulations should include policies to control pathogen spread and enforce specific treatment methods for beehives. To effectively monitor and control diseases and Varroa beekeepers need to follow courses. The government could also make some of these courses mandatory and cover the costs to stimulate this. In addition, it is important to implement the control of diseases and invasive species such as the Asian hornet on a national scale and ensure municipalities implement the same policy.

Pesticide control

Although not many incidents of spray damage occur, communication between the farmer and professional beekeeper about the usage of potentially damaging pesticides is crucial. This allows agreements to be made and potential damage to be prevented. The use of agricultural miticides is a recent trend for Varroa control. It is not recommended nor allowed to use these miticides for beekeeping as they can have negative effects on human health, the bees and bee products.

Transparency on subsidy distribution

There is little to no insight as to how EU subsidies are distributed to research efforts in the Netherlands. To make this clearer for the sector, it could be promoted to publish annual reports on the distribution of subsidies and the proportions delivered to each party to promote transparency on the support provided by the government. In addition, several professional beekeepers indicated that the projects carried out with the EU subsidies should match the issues and the real-life problems beekeepers are facing. For example, mapping honeybee food availability in the Netherlands to effectively decide where to place beehives.

Collaboration within and outside the sector

Collaboration with other countries sharing the same interests and principles can help in lobbying for the Dutch apiculture sector. Additionally, other sectors in the Netherlands that benefit from the activities of honeybees and have more influence in the EU can help in lobbying for the interest of Dutch beekeepers.

Currently the testing system for imported honey is not standardised. Therefore, a single protocol is needed for the standardization of testing honey quality to increase the transparency of the honey market. Next to this protocol, the EU should also invest in research about low-cost testing of small batches of local honey. This would stimulate the use of smaller amounts of EU honey by honey importers and consumers.

In Amsterdam and a few nature reserves in the Netherlands, rather drastic measures are being taken by banning honeybees from these areas because honeybees might compete with solitary bees for nectar. It is advisable for Governmental institutions and nature organisations to discuss the current situation with the various parties and find a middle ground in the policies that are currently being implemented, since there is too little communication between the different parties about the different interests and perceptions.

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Appendix A: Recommendations summary

Social

Preserve and transfer knowledge: Valuable knowledge may be lost due to the aging beekeeper population. Enhancing and lobbying for professional beekeeper education can improve knowledge preservation and attract the interest and increase the opportunity of people that wish to pursue professionalism in beekeeping.

Strengthen collective representation: Organisations could be more effective and valuable if they collaborate more efficiently with farmers/agriculture sector, including during off-season.

Visibility of BVNI: invest in transparency and increase presence on social media and on the BVNI website.

Acquisition of additional funding: More funding from governmental and nongovernmental organisations to cover staff members to support lobbying efforts and communication/visibility of the professional beekeepers sector/BVNI.

Environmental

Creating protected zones: Maintain buffer zones to promote wild bees and prevent over-accumulation of beehives around natural reserves

Create context dependent framework on competition: Currently measures taken to prevent competition between wild and honeybees are not focused enough on context specific factors. There is a need for a framework with measures that are based on the context specifics or different areas.

Transfer of knowledge: Provide training and educational programs to beekeepers on beekeeping practices under changing environmental conditions.

Develop resistant strains: Encourage genetic diversity and engage in breeding pest-resistant bee strains.

Technical

Varroa

Data Collection and Monitoring: Conduct comprehensive surveys and implement a nationwide monitoring program to collect data on Varroa mite prevalence and infestation levels.

Integrated Pest Management (IPM) Practices: Encourage the use of screened bottom boards, drone brood removal, queen caging for brood breaks, and powdered sugar dusting as part of Integrated Pest Management (IPM) practices. Promote IPM among beekeepers, including monitoring mite levels, setting economic thresholds, and combining various control methods to reduce mite levels.

Responsible Use of Miticides: Encourage the judicious use of effective miticides like oxalic and formic acids, while enforcing bans on harmful miticides like amitraz.

Education and Awareness: Increase funding for educational programs to update hobby beekeepers on varroa detection, best practices, new technologies, and sustainable Varroa mite management methods to reduce overall varroa populations in the Netherlands

Breeding and Genetic Research: To effectively manage Varroa mites in the long term, promote genetic adaptation through natural selection to enhance resilience and genetic diversity, while also employing selective breeding for specific resistance traits like Varroa sensitive hygiene and suppressed mite reproduction. This dual approach, supported by financial aid for beekeepers and integrated pest management practices, will enhance the sustainability and effectiveness of Varroa mite control in honeybee populations.

Research on Entomopathogenic Fungi: Fund research on using entomopathogenic fungi as biological control agents for Varroa mites, optimizing application methods and environmental conditions.

Asian hornets

Comprehensive Monitoring for Asian Hornet Impact: Implement comprehensive monitoring and surveillance programs to accurately assess Asian hornet populations and their impact on bee colonies, facilitating informed management decisions.

Innovative Trapping Systems for Hornet Control: Promote the development and deployment of effective trapping systems utilizing sex pheromones and innovative technologies like electric traps to mitigate hornet predation and reduce colony losses.

Environmentally Friendly Methods for Bee Resilience: Prioritize research and development into environmentally friendly methods, such as beehive muzzles and nest destruction, to enhance bee colony resilience against Asian hornet attacks while minimizing adverse effects on local biodiversity.

Other diseases

Implement Early Detection and Monitoring: Develop comprehensive monitoring programs at ports of entry and within beekeeping areas. Utilize traps with pheromones and other attractants to monitor beetle populations. Train beekeepers to recognize early signs of infestation and report sightings promptly.

Enhance Biosecurity Measures: Strengthen protocols for disinfection and inspection of imported hives and bee products. Educate stakeholders on the importance of strict biosecurity to prevent beetle introduction.

Invest in Research and Preparedness: Allocate resources for research on beetle biology, behavior, and potential impacts. Collaborate with researchers, beekeepers, and government agencies to enhance preparedness and response strategies.

Promote Education and Awareness: Provide educational resources and training on beetle identification and integrated pest management strategies. Raise public awareness about the risks of beetle introduction and the need for early detection.

Implement Integrated Pest Management (IPM) Strategies: Develop IPM strategies tailored to local conditions to mitigate beetle impacts. Encourage cultural practices and sustainable control methods among beekeepers.

Facilitate Collaboration and Regulation: Strengthen regulatory frameworks for coordinated responses to beetle incursions. Promote collaboration between stakeholders to share information and best practices.

Adapt to Climate Challenges: Monitor climate conditions and assess beetle suitability in changing environments. Develop adaptive strategies to mitigate climate-induced risks for beekeeping.

Economics

Subsidies: To counter the aging beekeeper sector, subsidies can help attracting new and younger people into the business.

Clear communication about the difference between hobbyist and professional: A clearer communication about what the differences are between hobbyist and professional pollination can help in creating a healthier market. People need to understand why there is a large gap between hobbyist and professional.

Elaborate study of financial situation: Clear and substantiated numbers on the beekeeping sector are still scarce, more studies need to be done on the economics

Politics

Transparency of fund distribution: Dutch government can publish an annual comprehensive report which publicly states where the funding is distributed.

Dutch funds: Dutch government could begin a direct funding programme for professional beekeepers

Hive registration: This should be mandated to increase EU funds. Offer some of the funds to beekeepers that register their hives.

United stakeholder opinions: Beekeepers, research organisations and governmental agencies must work in unison to make new policies regarding the relationship of wild and honeybees.

Increase beekeeper leverage: Beekeepers and other players in the apiculture sector must voice opinions and increase leverage regarding drastic governmental decisions without beekeepers' input.

Hive registration: This should be mandated to increase EU funds. Offer some of the funds to beekeepers that register their hives. Market Dutch honey: The new legislation will allow pure European honey to be more easily marketed, giving Dutch honey a competitive advantage over imported honey.

Legislation

Beehive registration

Public reach: Increase public reach by research organisations for beekeepers and for governments to understand the importance of disease tracking.

Annual hive registration event: Make hive registration an organised event each year to count accurately the hives and receive more funds from EU.

New incentives for hive registration: More registered hives increase EU budget allocation to the Netherlands, but the funding is given to research organisations. Incentivise beekeepers by distributing some budget to them if they register hives.

Disease and pest management

Enforced control strategies: Treatment of hives should be enforced after notification of a disease. This can be combined with courses on hive treatments available for all beekeepers.

Nation-wide policies: Policies for disease and invasive species control should be uniform across the entire nation and should not be regionally dependent.

Pesticides and hive treatment

Strict enforcement of illegal substances: Monitor and test for traces of illegal plant protection products and unauthorized beehive treatments in honey.

Notification requirements: Strengthen regulations requiring farmers to notify nearby beekeepers about the planned use of pesticides and allow enough time for relocating beehives.

Hive damage compensation: Ensure that compensation for bee losses due to unauthorized pesticide use is fair and covers insurance for beekeepers.

Honey production and imports

Market Dutch honey: The new legislation will allow pure European honey to be more easily marketed, giving Dutch honey a competitive advantage over imported honey.

Local honey testing: Continue enforcing the testing and proper labelling of imported honey, and implement similar measures for locally produced Dutch honey to discourage blends of local and imported honey.

Appendix B: General interview questions

General Interview Questions for Professional Beekeepers (and other members)

All responses are confidential, and information will remain anonymous.

We will use the information that is provided to create an informative report on the current state of the beekeeping sector in the Netherlands

General Information

1. What is the name, age, and gender of the interviewee?
2. What is your relation to the BVNI?
    a. How long have you been a member?
    b. What is your relation to other beekeeping associations and/or hobbyist beekeepers?
    c. Why did you join the association in the first place?
    d. What benefits were you hoping to find by joining these associations?
3. How did you start with beekeeping and what was your motivation?
4. How do you stay up to date? Do you follow any education or training?
5. How will your beekeeping business be continued when you retire?
6. Who are your main competitors?
7. How do you define a good beekeeper?

Beekeeping Practices (Technical aspects)

1. How many beehives do you have?
2. What are the biggest challenges you face as a professional beekeeper today?
    a. For example, diseases, invasive species, colony collapse or regulations?
    b. What are the most common diseases and pests you encounter, and how do you treat/manage them?
3. What are your primary strategies for monitoring and maintaining colony health?
4. What challenges do you face from the people who receive your pollination services?
5. Which problems do you expect to encounter in the future?
6. Which problems have you already solved?
7. What opportunities do you see for growth and innovation in the beekeeping industry?
8. Are there any transport or supply chain issues that you face?

Economics

1. How many do you earn from your beekeeping practices?
2. Is there variability in income/economics within seasons?
    a. Are there changes in demand for pollination services for example?
    b. Is it reliable enough to sustain you year-round?
    c. Have you seen a growth in your business in the last years/decades or has it been stable?
3. Do you feel fairly compensated for the pollination services you provide?
    a. How is your relationship with customers?
4. How is the quality of beekeeping insurance?
5. Do you have a special focus for beekeeping? (Like pollination services, honey, biodynamic, queen breeding?)
    a. What are your revenue streams and their proportions for these products?
    b. How do you market them?
    c. Can you discuss any challenges you face in the market, and how you overcome them?

    d. Any new market trends that are creating new revenue opportunities?
6. Could you detail the costs of beekeeping? What are the initial costs and what is spent in an average year?
7. Do you receive government funding/support?
    a. Where does it come from and in which form?
    b. Where is it intended for? (Subsidies, tax breaks, etc.)
8. How long did it take for your apiary to become profitable/a reliable source of income?
9. How do you advertise your services to farmers and customers?
    a. Are you restricted to a certain district?
    b. Can you provide services all over the Netherlands?
    c. Are there regulations about where you can provide services (in different countries)?

Politics and Policy
1. Do you feel supported and appreciated by the government or other institutions? (E.g. By legislations)
2. How do current Dutch policies and regulations affect your beekeeping practices?
3. How would you like to be supported by the government?
4. What would you like to see from the government?
5. Which improvements would you like to see from beekeeping associations?
6. What changes or improvements would you like to see in the regulatory landscape for beekeeping?

Sustainability and Environmental Impact
1. What practices do you implement to ensure sustainable beekeeping, looking at the environment?
2. How do you collaborate with local farmers and landowners to provide foraging resources for your bees?
3. What are your thoughts on the impact of climate change on beekeeping, and how are you adapting?

Research and Innovation
1. Are you involved in any research projects or collaborations with academic institutions?
2. What new technologies or methodologies have you adopted in your beekeeping practices?
3. How do you stay informed about the latest developments in apiculture?

Education and Advocacy
1. How do you contribute to the education of new beekeepers and the general public about beekeeping?
2. What are the biggest misconceptions about beekeeping you encounter, and how do you address them?
3. Can you discuss your involvement with BVNI and how the organisation supports professional beekeepers?

Other
1. Are there any other things that you think we need to be aware of or find more information about?
2. Do you feel that you might be missing some knowledge you want to know more about, or find more information about? (For example, the type of governmental support available, biodiversity, bee health and diseases, etc.)
3. Can you share a particularly memorable or challenging experience from your beekeeping career?

Appendix C: Questionnaire

Questionnaire for Hobbyist Beekeepers

All responses are confidential, and information will remain anonymous.

We will use the information that is provided to create an informative report on the current state of the beekeeping sector in the Netherlands

1. Wat is uw reden om bijenkolonies te houden en waarvoor gebruikt u ze? (Bijvoorbeeld bestuiving van gewassen, verkoop van honing enz.) Meerdere antwoorden zijn mogelijk.
2. Hoeveel bijenkolonies houdt u?
3. Verdient u geld met bijenproducten en/of diensten? Zo ja, hoeveel (ongeveer)?
4. Waren er voor u obstakels voor het betreden van de bijenhouderij, zo ja welke?
5. Wat zijn momenteel de grootste uitdagingen voor u als bijenhouder?
6. Waaruit bestaan de grootste kosten van het bijenhouden?
7. Ontvangt u overheidsfinanciering/steun voor uw bijenhouderij (subsidies, belastingvoordelen, enz.)? Zo ja, hoeveel (ongeveer)?
8. Is er regelgeving die uw bijenhouderij stimuleert/ondersteund of waar u hinder van ervaart? Licht toe indien van toepassing.
9. Welke veranderingen of verbeteringen zou u graag zien in de regelgeving omtrent bijenhouderij?
10. Welke problemen verwacht u in de toekomst tegen te komen? (Bijvoorbeeld invasieve ziekten en plagen, gebruik van pesticiden, weersomstandigheden enz.)
11. Heeft u het gevoel dat u kennis mist waar u meer over wilt weten of waar u meer informatie over wilt vinden? (Bijvoorbeeld het soort beschikbare overheidssteun, biodiversiteit, bijengezondheid en -ziekten, enz.)
12. Zijn er nog andere zaken waarvan u denkt dat wij hiervan op de hoogte moeten zijn of waar wij meer informatie over moeten vinden?