

## BIOSECURITY AND GOOD BEEKEEPING PRACTICES IN BEEKEEPING

### Arıcılıkta Biyogüvenlik ve İyi Arıcılık Uygulamaları

Ayşe Ebru BORUM

Balıkesir University, Faculty of Veterinary Medicine, Department of Microbiology, Balıkesir, TURKIYE, Corresponding author / Yazışma yazarı: ebruborum@balikesir.edu.tr, ORCID No: 0000-0002-6916-8982.

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#### ABSTRACT

Biosecurity measures in beekeeping (BMBs) include measures taken to prevent the spread of diseases by minimizing the movement of microorganisms and pests in the apiary, preventing diseases and pests in the environment from reaching the apiary or reducing their effects. Biosafety principles aim to prevent infectious factors from entering the apiaries and spreading by humans, bees, feed, and technological systems in order to prevent them from adversely affecting bee health or honey quality. Good beekeeping practices (GBP) prevent or minimize the entry of important bee diseases and pests into the apiary and the spread between colonies and apiaries. Prevents negative effects on bee health, honey safety, honey quality, and production efficiency. BMBs can be effective if GBPs are implemented. In this study, it is aimed to provide information about bee health, protection from bee diseases, preventing the spread of diseases and pests among other colonies and apiaries in the same apiary, biosecurity and good beekeeping practices necessary to obtain quality and reliable bee products.

**Keywords:** Biosecurity measures in beekeeping (BMBs), Good beekeeping practices (GBP), Honey bee

#### ÖZ

Biyogüvenlik uygulamaları, arılıktaki mikroorganizma ve zararlıların hareketini en aza indirerek hastalıkların yayılmasını önlemek ya da çevrede görülen hastalık ve zararlıların arılığa ulaşmasını engellemek ya da etkisini azaltmak için uygulanan tedbirleri içerir. Biyogüvenlik ilkeleri, arı sağlığının veya bal kalitesinin olumsuz etkilenmesini önlemek için, bulaşıcı etkenlerin arılıklara girmesini, ayrıca insan, arılar, yem, teknolojik sistemler tarafından yayılmasını önlemeyi amaçlamaktadır. İyi arıcılık uygulamaları önemli arı hastalık ve zararlıların arılığa girişini, koloniler veya arılıklar arası yayılmayı önler ya da minimize eder. Arı sağlığı, bal güvenliği, bal kalitesi ve üretim verimliliği üzerindeki olumsuz etkileri önler. Biyogüvenlik uygulamaları (Biosecurity measures in beekeeping-BMBs) iyi arıcılık uygulamalarının (Good beekeeping practices-GBPs) yapılması durumunda etkili olabilir. Bu çalışmada, arı sağlığı, arı hastalıklarından korunma, arılık içi ve arılıklar arasında hastalık ve zararlıların yayılmasını önlemek, kaliteli ve güvenilir arı ürünleri elde etmek için gerekli biyogüvenlik ve iyi arıcılık uygulamaları hakkında bilgi vermek amaçlanmıştır.

**Anahtar Kelimeler:** Arıcılıkta Biyogüvenlik Önlemleri, İyi Arıcılık Uygulamaları, Bal arısı

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### GENİŞLETİLMİŞ TÜRKÇE ÖZET

**Amaç:** Biyogüvenlik, hayvanlara ve hayvanlar arasında bulaşıcı hastalık bulaşma risklerini azaltmak için tasarlanmış bir dizi önleyici tedbirdir. Aynı zamanda biyogüvenlik, sağlıklı ve biyolojik olarak sağlıklı hammadde ve hayvansal kaynaklı gıda maddelerinin üretimi için önemli bir gerekliliktir. Arıcılıkta biyogüvenlik ise arılardaki zararlı veya hastalıkların başlaması ve yayılması riskini azaltmak için tasarlanmış önlemlerdir. Biyogüvenlik uygulamaları, arılıktaki mikroorganizma ve zararlıların hareketini en aza indirerek hastalıkların yayılmasını önlemek ya da çevrede görülen hastalık ve zararlıların arılığa ulaşmasını engellemek ya da etkisini azaltmak için uygulanan tedbirleri içerir. Biyogüvenlik ilkeleri, arı sağlığını veya bal kalitesini olumsuz etkilemesini önlemek için bulaşıcı etkenlerin arılıklara girmesini, ayrıca insan, arılar, yem, teknolojik sistemler tarafından yayılmasını önlemeyi amaçlamaktadır. Biyogüvenlik uygulamaları (Biosecurity measures in beekeeping-BMBs) iyi arıcılık uygulamalarının (Good beekeeping practices-GBPs) yapılması durumunda etkili olabilir. İyi arıcılık uygulamaları, arıların insanlar, bal arıları ve çevre için optimal sağlığı elde etmek için uyguladıkları bütünleştirici faaliyetlerdir. Bu nedenle, GBP'lerin uygulanması koloni sağlığı ve toplumu üzerinde olumlu bir etkiye sahiptir. Ayrıca yüksek üretim standartlarını destekler. Bu tür uygulamalar arıcılık faaliyetleri için geçerli genel önlemlerdir ve dünya çapında kabul görmektedir. Hastalığa özgü değildirler ve arılar tarafından kovan ürünlerinin birincil üretiminde uygulanmaları amaçlanmıştır. Arıların günlük arıcılık yönetiminde karşılaştıkları zorlukları başarıyla çözmelerini sağlar. GBP'ler genel arıcılık yönetimi, veteriner ilaçları, genel hastalık yönetimi, hijyen, arı besleme ve sulama, kayıt tutma ve eğitim başlıkları altında sınıflandırılır. Bu çalışmada BMBs ve GBPs uygulamaları anlatılmıştır.

**Tartışma:** Başarılı bir arıcılık için biyogüvenlik şarttır. Bal arılarının ve tüm bal arısı endüstrisinin korunmasında arıcılara önemli görevler düşmektedir. Bal arısı biyogüvenliği, bal arılarını zararlıların girişinden ve yayılmasından korumak için tasarlanmış bir dizi önlemdir. Bal arısı biyogüvenliği, her arıcının, arılığı ziyaret eden ziyaretçilerin veya arılıktaki çalışan her kişinin sorumluluğundadır. Arıcılar ve çalışanları hastalık ve zararlı önleme, ayırt etme ve kontrolü konularında mutlaka gerekli eğitimleri almış olmalıdır. Arıcılar önceden plan yapmalıdır. Böylece bir hastalık veya zararlı

tespitinde yapılması gerekenleri bilirler. Tüm arıcılar bir biyogüvenlik planı yazmalı ve durumları değiştikçe bunu düzenli olarak güncellemelidirler. Arıcının bireysel biyogüvenlik önlemleri, kendi arılığına yakın ve çevre bir bölgedeki diğer arıcılarla işbirliği yaparak geliştirilebilir. Böylece, bir bölgedeki tüm arılıklara yönelik biyogüvenlik tehditleri minimize edilebilir. Arılık biyogüvenliğinin bölgesel düzeyde desteklenmesi, bölgedeki diğer tehditlerin potansiyel kaynağı ve doğasının anlaşılması sonucu daha etkili mücadele ve korunma sağlar. Arılığa yakın bölgelerdeki arılıklar, yabancı koloniler ve kayıtsız kovanlar, potansiyel biyogüvenlik tehditleridir. Arıların zararlı ve hastalıklara maruz kalması en aza indirilmelidir. Kovanların yağma edilmesini önlemek için arı kolonileri güçlü tutulmalıdır. Arıların yeni bölgelere hareketi, hastalıklara maruz kalınması için yeni riskler oluşturur ve kovanların yer değiştirmesi, mümkün oldukça, minimumda tutulmalıdır. En az bilinen hastalık olan "sıcak noktalar" önlenmelidir. Arılar, yem ve ekipman sadece güvenilir ve saygın kaynaklardan temin edilmelidir. Yeni getirilen arılarda hastalık olmadığından emin olmak için bu arılar satın almadan önce veya getirildikten sonra, diğerlerinden ayrı tutulmalı ve test edilmelidirler. İkinci el ekipmanlar uygulamadan önce sterilize edilmelidir. Arıcılar diğer arıların, alet ve ekipmanlar ya da kendi kovanlarından bala erişmelerine izin vermemelidir. İyi arıcılık uygulamaları, sürdürülebilir ve dayanıklı bir arıcılık sektörünün temelidir. Arılık yönetiminde GBP'lerin günlük olarak uygulanması, birçok olumlu etkiyle sonuçlanır. Maliyeti düşürür, kovan başına daha fazla üretim ve arıcılar için daha yüksek gelir gibi ekonomik faydalar sağlar. Veteriner ilaçlarının daha güvenli kullanılmasını sağlayarak daha iyi güvenlik önlemleri alınır. Ayrıca bu ilaçların kullanımını minimize eder, daha güvenli ve sağlıklı ilaç kullanılarak arı ürünlerinde kalıntı problemini azaltır. Böylece halk sağlığını korur. Daha kaliteli arı ürünleri elde edilmesini sağlar. Bal arılarının genel performansı üzerinde olumlu etki göstererek arı sağlığı ve kaliteli arı ürünü elde edilmesinde önemli rol oynar.

**Sonuç:** Bölgesel biyogüvenlik önlemleri, potansiyel risk kaynaklarını belirler. Buna uygun önlemler alınmasını sağlar, çevredeki arıcılar ve uzmanlar ile işbirliği yaparak etkili korunma ve mücadele sağlar. Ayrıca potansiyel risk kaynaklarının bulunduğu bölgelerde uygulanan biyogüvenlik önlemleri ile çevre arılıklara yayılımını önler ya da azaltır. Bal arısı biyogüvenlik stratejilerinin uygulanması, bölgesel biyogüvenliğin temelini oluşturur ve bu da

ulusal biyogüvenliği destekler. Arılıklarda, kovanlarda ve bal evlerinde iyi arıcılık uygulamalarını belirlemek, doğrulamak ve uygulamak önemlidir. Bu yönetim stratejileri, her zaman uluslararası işbirliğinin yanı sıra arılıklarda iyi arıcılık uygulamalarının ve biyogüvenlik önlemlerinin geliştirilmesi ve sürdürülmesiyle sağlanır.

### INTRODUCTION

Bees play a crucial role in the complex ecosystems. Bees are not the only pollinators, they are one of the most important and effective. They are very important in the pollination of wild species and endemic plants. Bees carry out about 80% of all pollination worldwide. It ensures the growth and development of valuable ecosystems. There are approximately 19,000 species of bees described in the world, and all are grouped under the general term "wild bees", with the exception of the domestic honey bee *Apis mellifera* L. (Thakur 2012).

Biosecurity is a set of preventive measures designed to reduce the risks of transmission of infectious diseases to and between animals. At the same time, biosecurity is an important requirement for the production of healthy and biologically healthy raw materials and foodstuffs of animal origin. Biosecurity in beekeeping is the measure designed to reduce the risk of transmission and spread of pests or diseases to bees. Biosafety practices include measures taken to prevent the spread of diseases by minimizing the movement of microorganisms and pests in the apiary, preventing diseases and pests in the environment from reaching the apiary, or reducing their effects. Biosafety principles aim to prevent the entry of infectious agents into apiaries and to prevent the spread of these agents by humans, bees, feed and technological systems in order to prevent adverse effects on bee health and honey quality. Biosecurity measures in beekeeping-BMBs can be effective if good beekeeping practices (GBPs) are implemented (Hayes 2014, Novak et al. 2015, National Bee Biosecurity Program 2016).

Good beekeeping practices are integrative activities carried out by beekeepers to achieve optimal conditions for honey bees, humans, and the environment. The application of GBPs has a positive impact on colony health and society. It also supports high production standards. GBPs applications are general measures applied in beekeeping activities. It is also accepted worldwide. They are not disease-

specific and are intended for application in the primary production of hive products. It enables beekeepers to successfully solve the difficulties they face in daily beekeeping management. GBPs are classified under the headings of general beekeeping management, hygiene, meeting the food and water needs of bees, veterinary services, general disease management, record keeping, and education. Good beekeeping practices prevent or minimize the entry of important bee diseases and pests into the apiary and their spread between colonies or apiaries. Prevents negative effects on bee health, honey safety, honey quality and production efficiency. It is important to identify, verify and implement good beekeeping practices in apiaries, hives and honey houses. In addition to international cooperation, it is necessary to develop and maintain good beekeeping practices and biosecurity measures in apiaries (Formato and Smulders 2011, FAO 2020, FAO 2021, Tlak Gajger et al. 2021).

Honey bees have been used for years for the production of honey, beeswax, royal jelly, propolis, pollen and poison. In addition, bees are very important for fruit, vegetable, seed production, pollination, protection of wild plant communities and biodiversity (Rose et al. 2014, Pufal et al. 2017, Tlak Gajger et al. 2021).

Biosecurity is essential for successful beekeeping. Beekeepers have important duties in the protection of honey bees and the honey bee industry. Honeybee biosecurity is a set of measures designed to protect honeybees from the introduction and spread of pests and disease agents. Honeybee biosecurity is the responsibility of every beekeeper, visitor to the apiary or anyone working in the apiary. Beekeepers and workers must have received the necessary training on the prevention, discrimination and control of diseases and pests. Beekeepers should plan ahead. Thus, they know what should be applied in the detection of a disease or pest. All beekeepers should write a biosecurity plan and update it regularly as their situation changes (Hayes 2014, Novak et al. 2015, Plant Health Australia 2016).

Individual biosecurity measures can be developed by beekeepers in and around their apiary in collaboration with other beekeepers. Thus, biosecurity threats to all apiaries in a region can be minimized.

Beekeeping biosecurity should be supported at the regional level. Thus, as a result of understanding the

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potential source and nature of threats in the region, more effective struggle and protection are provided. Beehives, wild colonies and unregistered hives in areas close to beehives are potential biosecurity threats. Exposure of bees to pests and diseases should be minimized. Bee colonies must be kept strong to prevent the hive from being plundered. Moving bees to new areas create new risks for diseases and pests. Therefore, the displacement of the hives should be kept to a minimum as possible. The bees that make up the colony and the food and equipment used in the apiary should only be obtained from reliable sources. Used equipment must be sterilized before use. Other bees in the apiary should not be allowed access to tools, equipment or honey used in new hives (Chauzat et al. 2013, Hayes 2014, FAO 2020).

Regional biosecurity measures identify potential sources of risk. It plays a role in taking appropriate measures and cooperates with beekeepers and environmental experts to ensure effective protection and control. In addition, it prevents or reduces its spread to other apiaries in the vicinity with biosecurity measures applied in areas where potential risk sources are located. The implementation of honeybee biosecurity strategies forms the basis of regional biosecurity, which in turn supports national biosecurity (Ahmad et al. 2007, Al-Waili et al. 2012).

### Basic principles for biosecurity in beekeeping;

- Reducing bees' exposure to pests and diseases
- Controlling pests and diseases
- Controlling the spread of undetected disease in an apiary
- Keeping accurate records
- Hive and equipment maintenance

Barrier system and recognizing of diseases (Hayes 2014, FAO 2020, FAO 2021).

### Recording:

Good recording is an essential part of any business. Complete records of all actions and observations related to biosecurity should be kept and maintained. Hive and apiary information must be kept accurately and reliably. Attention should be paid to new, abnormal events and pests in the hive. Photographic and written records of all abnormal situations should be kept.

Sample registration information is summarized in Table 1.

Table-1. Beekeeping registration information\*

Tablo-1. Arıcılık kayıt bilgileri

Registration information
Hive number
Queen arrival date
Drugs administered and their dates
Honey chamber date
Honey harvest date and amount
Dates of the occurrence of diseases and pests in the hive
If migratory beekeeping is done, the places and dates visited
The hive used and its features
Syrup/Patties applying dates
If the hive has been united or divided, the origin and dates of the other hives
Colony/Swarm dates imported from abroad and the regions where it was obtained
General climatic conditions and data
Information about beekeepers in the vicinity (approximately 5 km)

\*Table information Bal arısı yetiştiriciliği, ürünleri, sağlığı, Dora, 2021, Editörler Ahmet Doğanay Levent Aydın, Bölüm Genel Arıcılık, Kovan Kaydı Tutma, Levent Aydın, (67-68)

### Responsibilities of Beekeepers in Biosafety Practices

Beekeepers must be registered with national public and private institutions. Up-to-date records with beekeepers and contact information are required. Thus, an emergency disease or emergency can be informed quickly. It is very important to have up-to-date registration and contact information to be informed about decisions regarding disease control

and eradication. Beekeepers should report the notifiable diseases in national legislation. It is important to report these diseases in a short time in order to control and eliminate the diseases that need to be reported. Apiary areas should be determined. Identifying apiary areas with clearly visible signs with contact information will enable the beekeeper to be reached quickly in case of a natural disaster emergency or other potential threat to bees. Hives should be inspected regularly for pests and diseases. All beekeepers should take precautions to minimize the risk of spreading pests and diseases both in their own apiary and in that of other beekeepers. Beekeepers should regularly check their hives for pests and diseases. Beekeepers must control or eliminate pests and diseases and manage weak hives. If a beekeeper detects pests or diseases in a hive, he or she should take precautions for infected hives and prevent their spread to other hives and surrounding apiaries. Robbery is very effective in the spread of infectious diseases. In order to prevent weak hives from being robbed by other bees, these hives should be immediately removed from the apiary or controlled to prevent robbing. The hive and the honey in the hive should be brought to a state where robber bees cannot enter. If the pest or disease is a notifiable disease, it should be controlled or eliminated in accordance with legislation. Beekeepers should have minimal knowledge of distinguishing and controlling pests and diseases. All people working with bees should know how to distinguish between pests and diseases in their hives. They should have up-to-date information on combating and controlling pests or diseases detected. Hives should be properly arranged and marked. Hives should be kept strong to minimize the risk of disease spreading. Beekeepers should make sure that the outer surfaces of each hive are solid and that the flight hole is designed to a standard. Beekeepers should not allow hives or equipment to be exposed or neglected. Pests and diseases spread as a result of the robbery of exposed hives. In addition, clean and safe water should be kept in the apiaries for the water needs of the bees. Beekeepers should apply a barrier system. The main route of disease spread in an apiary or between apiaries occurs when the beekeeper transfers infected materials between hives before disease symptoms are detected. A well-controlled barrier system prevents the source of disease and its potential spread. This will make it easier to control and eliminate the disease. The barrier system is a method in which apiaries are

divided into smaller subunits and no transfer of potentially infected materials is made between subunits. Hives and hive components in one subunit are not interchangeable with those in another subunit. The larger the apiary, the more important the barrier system, but how the barrier system should be conducted will depend on the apiary-specific conditions (AVMA 2017, Hayes 2014, FAO 2020, FAO 2021).

Beekeepers should maintain biosafety records. It is essential for good beekeeping and good record keeping for good biosecurity. Actions, controls, practices and struggles should be recorded. Good biosecurity is the common responsibility of all beekeepers.

### **Investigation and Measures to be Taken for Bee Pests and Diseases**

Regular monitoring is an essential part of honeybee biosecurity practices. Practising good sanitation and hygiene will help prevent pests and diseases from entering, settling and spreading in apiaries. Workers, visitors, vehicles and equipment can spread diseases and pests. For this reason, it should be ensured that they are clean and hygienic before entering and leaving the apiary. The health status of the hives, honey bees and their brood should be checked frequently (Plant Health Australia 2016).

It is very important to detect exotic or endemic pests and diseases in a short time. Bees, broods and hives should be inspected regularly to identify signs of pests and diseases. Early detection of exotic pests and diseases ensures rapid control and minimal spread of these pathogens. If it is not possible to destroy or limit the disease or pest, emergency planning, cooperation and information sharing with official institutions and organizations is made if necessary. Early detection and reporting of any pests, diseases or symptoms can prevent or minimize long-term damage to the honeybee industry. It can also reduce the quarantine time of the apiary or apiaries (Formato and Smulders 2011, Novak et al. 2015, National Bee Biosecurity Program 2016).

Diseased hives pose a risk to healthy hives in the apiary and beekeepers in the surrounding area. Beekeeping activities and contaminated hives and equipment are the main reasons for the spread of the disease among hives in an apiary. If an exotic pest or disease is suspected as a result of the examinations, general measures should be taken to

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control the pest and disease and to protect the apiary (Plant Health Australia 2016, National Bee Biosecurity Program 2016, Rana and Mishra 2022).

### General Precautions

The hive or area where the disease and pest are found should be marked. Human and equipment access to the beehive and surrounding area should be limited. Hands, clothes, equipment and tools in contact with the suspected hive/bees or apiary should be washed and disinfected. Sick or suspicious hives and bees should never be removed from the apiary. Beekeeping activities should be stopped until a definitive diagnosis is made (National Bee Biosecurity Program 2016, Plant Health Australia 2016, FAO 2020).

When a definitive diagnosis is made, the instructions given should be followed. No beehives, honeycombs, bees, machinery, tools and equipment should be removed from the apiary. Entry and exit to the apiary should be restricted. All activities that may affect the apiary in the region and cause the factors to go out of the region are stopped or allowed on a limited basis. People, machines and vehicles in the area are carefully planned withdrawn from the area (Bouga et al. 2011, FAO 2020, FAO 2021).

### Methods of protecting bee health

Clean hives and equipments should be purchased. Second-hand hives and equipments should be obtained from beekeepers who regularly control pests and diseases. Before purchasing, it should be noted that the hive and hive equipment are standard and free of pathogens and should be checked if possible. The newly purchased hives should be isolated from the old hives for 6-12 months to ensure that they are healthy. Used beekeeping equipment must be sterilized before being used in the apiary (AVMA 2017, Andrews 2020).

Beekeeping and bee equipment should be cleaned regularly. Before starting to work in the apiary, wax, propolis or honey residues in the hive and other beekeeping equipment should be cleaned regularly. Honey harvest machines, honey containers and other equipment should be cleaned before and after each use. Waste materials must be disposed of appropriately and safely. Residual honey should be removed or covered to prevent the bees from robbing the exposed combs and beeswax. Good hygiene practices should be maintained around the apiary, and wax residues, old honeycombs and old hives that can attract and harbor pests and diseases

should be removed from the apiary (National Bee Biosecurity Program 2016, Plant Health Australia 2016).

Precautions should be taken to protect bee health. Accurate and reliable information should be obtained about beekeeping, bee diseases and pests. Pest and disease risks should be determined for each apiary, clinical findings should be well known and necessary precautions should be taken. Appropriate measures for pest and disease control should be developed. In addition, all applications and treatment details should be recorded. A barrier management system should be implemented to reduce the risk of pests and diseases spreading within and between the apiaries (AVMA 2017, Andrews 2020).

Regular comb replacement should be done. New wax foundations should be given to the hives for maximum three years. Hives should be left healthy and queen bee should be replaced every two years. Honeycombs should be checked regularly during spring, summer and autumn, and risky, abnormal or adverse conditions should be taken into account (FAO 2020, FAO 2021, Jensen 2022).

For swarming control, suppers, hives and honeycombs should be given to overcrowd colonies, extra queen bee cells should be removed, and the hive should be kept healthy and strong.

One of the important methods of protecting bee health is to conduct regular and conscious hive inspections. Brood, adult and colony examinations should be done regularly in spring, summer and autumn. If the climatic conditions are not suitable and there are people or animals in the environment that will disturb the hive, no control should be made. The activity in the hive should be checked, and it should be determined whether there are dead or flightless bees at the entrance of the hive. In addition, it should be ensured that pollen is brought to the hive. Control records should be kept, and any disease and pest cases or suspicions should be checked. Using too much smoke when opening hives can excite or disturb the bees. While the hives are being examined, one should always act calmly and systematically, and avoid sudden or harsh movements. While the hive is being examined, attention should be paid to the queen bee and no harmful behavior should be done. Propolis extracted from the hive, empty frame, etc. materials should not be left in the apiary, they should be kept in closed environments. Thus, these materials that can transmit bee diseases and pests can be kept under

control (Hayes 2014, Smart et al. 2016, Andrews 2020, FAO 2021).

### Precautions to be Considered in Supply of Queen Bee and Worker Bees

To minimize the risk of transmitting pests or diseases to an apiary:

Queen bees and other bees should be sourced from companies that take biosecurity, hygiene, health testing and recording seriously. Queen bees, worker bees and honeycombs with brood supplied from outside should be checked regularly within one month from the date of entry to the apiary. Records should be kept of where the bees, queen bees and brood combs were procured from outside, the date of supply, and the contact information of the company (AVMA 2017, FAO 2021).

### Biosecurity signs

Well-designed biosafety signs informing visitors that the biosecurity management of honey bees in the apiary are important and that maintaining it is a shared responsibility. Biosafety signs at apiary entrances should include the beekeeper's name and contact phone number. In cases where the hives are moved to different places, the hives should be marked and placed in the new hive area. Biosafety signs are also important, providing contact information in the event of an emergency such as chemical pesticide application, disease and pest detection, forest fires or flooding. One of these markings is a 600 x 900 mm corflute panel with four holes to be placed on doors to properties or apiaries. The second is an A4 corflute sign that can be fixed to each beehive or moved with each hive section (National Bee Biosecurity Program 2016, Plant Health Australia 2016, FAO 2021). (Figure 1)



Figure 1: Biosecurity sign\*

Figür 1: Biyogüvenlik işareti\*

\*<https://nationalsafetysigns.com.au/safety-signs/honey-bee-biosecurity-sign-en32217/>

### Transport of Hives

Moving the hives to different regions for honey flow or pollination causes pests and diseases to spread easily to other regions or apiary areas. The following measures should be taken to reduce this risk.

Hive movements should be minimized. Constant relocation and transportation of hives cause stress in honey bee colonies. Hives, honey and beekeeping equipment should be secured or sealed to prevent robbery by honey bees.

When moving hives to a new site, attention should be paid to disease threats from abandoned and weak hives near the site. Before transporting beehives between regions, information should be given to authorized institutions, and a signed health and transport certificate should be obtained.

It should be informed about the presence of endemic pests and diseases in the region to be visited if possible (National Bee Biosecurity Program 2016, Plant Health Australia 2016, FAO 2020, FAO 2021).

### Movement of vehicles, machinery and equipment

Honey and beeswax can adhere to vehicles and all beekeeping equipment, including forklifts, trucks, hive tools and bee boxes can carry pests and diseases. Then pests and diseases can spread and infect another apiary (National Bee Biosecurity Program 2016, Plant Health Australia 2016, Andrews 2020, FAO 2021).

The risk of pest and disease entry should be reduced through equipment and tools. Especially after visiting other apiaries, vehicle parts should be cleaned and washed from honey, wax and other colony residues. The movement of vehicles inside the apiary should be limited. Borrowed or second-hand beekeeping equipment and machinery must be cleaned and sterilized before being transported to the apiary. All tools and equipment should be cleaned and sterilized regularly, including hive sections, pallets, boxes, gloves and other equipment used in the apiary. Checking and cleaning machinery and equipment is easier and cheaper than dealing with a new pest or disease (National Bee Biosecurity Program 2016, FAO 2020, FAO 2021).

### Biosecurity Measures for Significant Infections and Pests in Bees

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Most of the bee deaths in the world are caused by *Acarapis woodi*, *Paenibacillus larvae*, *Melissococcus plutonius*, *Aethina tumida*, *Tropilaelaps* spp. and *Varroa* spp. (FAO 2020, FAO 2021, TECA 2020).

Biosecurity, protection and control measures for different pests and pathogens are shown in the tables (Table 2-6).

**Table-2. Varroosis**

**Tablo-2. Varroosis**

<b>Varroosis (causative agent: <i>Varroa destructor</i>)</b>	
<b>Protective Measures</b>	<ol style="list-style-type: none"> <li>1. Varroa tolerant/resistant colonies should be selected</li> <li>2. Varroa control should be done using pollen drawer hives.</li> <li>3. Bees, brood and swarms, clinical studies of varroa-related diseases (Acute bee paralysis virus (ABPV); Kashmir bee virus (KBV); Israeli Acute Paralysis Virus (IAPV); Deformed wing virus (DWV), Kashmir bee virus (KBV)) should be obtained from colonies without symptoms.</li> <li>4. The most appropriate treatment should be done considering the ways of transmission of Varroa.</li> <li>5. The number of Varroa mites should be kept below the harmful threshold in each colony.</li> <li>6. Good knowledge of the symptoms and transmission routes of varroosis and viruses should be obtained.</li> </ol>
<b>Control active/emergency measures</b>	<b>and</b> <ol style="list-style-type: none"> <li>1. Varroosis should always be treated according to national legislation and regulations.</li> <li>2. Diagnostic methods such as powdered sugar method, CO2 test, and mite drop should be applied to measure varroa levels after treatments and throughout the year in the spring, at the beginning of the beekeeping season or before harvest.</li> <li>3. All colonies of the apiary should be treated at the same time and in the same area.</li> <li>4. Depending on the type of treatment and the product used, colonies should be conditioned prior to treatment to achieve maximum effectiveness.</li> <li>5. The efficacy of acaricide treatments should be monitored by controlling conditions such as a decrease in varroa, absence of varroa symptoms, and absence of varroa in adult bees after treatment.</li> <li>6. At least two treatments should be carried out per year.</li> <li>7. Necessary applications should be made to prevent varroa resistance.</li> <li>8. The health of drone-producing colonies should be checked, especially for viruses.</li> <li>9. To control Varroa, preferably organic beekeeping permitted drugs should be used.</li> <li>10. Sufficient numbers of healthy bee colonies should be supplemented to strengthen weak colonies when the varroa infestation level is too high.</li> <li>11. The original colony and swarms without offspring should be treated with oxalic or lactic acid.</li> </ol>



Table- 3. American foulbrood

Tablo-3. Amerikan Yavru Çürüklüğü

American foulbrood (AFB) (causative agent: *Paenibacillus larvae*)

Control and active/emergency measures	
	<ol style="list-style-type: none"> <li>1. Ropiness test (toothpick test) should be performed to confirm the clinical outbreak of foulbroods in the apiary.</li> <li>2. Quick management of affected hives.</li> <li>3. In asymptomatic colonies, materials such as comb honey and hive waste should be sent to the laboratory for the diagnosis of <i>Paenibacillus larvae</i>. In order to control the infection, P. larvae control should be carried out by taking samples of hive debris from the colonies, adult nurse bees, and honey stored in combs during the winter season.</li> <li>4. If there is a suspicion of AFB in the apiary, dead bees, hive remains, combs with brood, honey, etc. samples should be taken and sent to appropriate laboratories for diagnosis.</li> <li>5. When the diagnosis of AFB is confirmed, the brood and combs of all colonies of the affected apiary with or without clinical symptoms should be destroyed. Wax must be handled safely to control the disease.</li> <li>6. Hives showing clinical symptoms of AFB should be destroyed according to national legislation</li> <li>7. All beekeeping equipment such as bee hives, mating boxes, combs, frames, queen cages, etc., of symptomatic colonies should be disinfected or burned. All beekeeping equipment of asymptomatic hives in apiaries diagnosed with AFB should also be disinfected.</li> <li>8. Asymptomatic colonies in other apiaries of the same beekeeper who are positive for AFB should be checked frequently in terms of clinical findings.</li> <li>9. Asymptomatic hives with AFB outbreaks should also be tested with a field kit, etc. Samples should be taken from normal and suspicious colonies and sent to the laboratory for the diagnosis of the agent.</li> </ol>

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Table-4. European foulbrood

Tablo-4. Avrupa Yavru Çürüklüğü

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European foulbrood (EFB) (causative agent: <i>Melissococcus plutonius</i> )	
<b>Control and active/emergency measures</b>	<ol style="list-style-type: none"><li>1. Measures should be taken quickly in the affected hives to control the disease.</li><li>2. If there is a suspicion of an EFB outbreak in the apiary, clinical findings such as larva and honeycomb appearance should be checked for diagnosis.</li><li>3. Samples should be taken from clinically suspicious hives and sent for laboratory diagnosis.</li><li>4. Queen bees should be purchased from breeders who do not have EFB and can provide certificates if possible.</li><li>5. Applications should be made according to national legislation in hives showing clinical symptoms of EFB.</li><li>6. In cases of a clinical epidemic, infected beekeeping equipment such as beehives, mating boxes, combs, frames, queen cages, etc. of EFB symptomatic colonies should be disinfected.</li><li>7. When the laboratory diagnosis of <i>M. plutonius</i> is positive in asymptomatic colonies and disease symptoms are observed in other hives of the same apiary, hive controls should be increased.</li><li>8. In order to diagnose the presence of <i>M. plutonius</i> by PCR method or microbial isolation, samples such as brood, adult bee, stored honey, etc. should be taken from asymptomatic colonies during the winter season or in epidemic situations.</li><li>9. EFB kit should be applied in the apiary to diagnose clinical EFB outbreak in symptomatic hives.</li><li>10. The swarms obtained by the shaking method should be used in infected colonies. If the infection is limited and the cells with a small number of brood are affected, the brood combs should be removed.</li><li>11. In cases of clinical outbreaks in the apiary, all beekeeping equipment of EFB-asymptomatic colonies should be disinfected.</li><li>12. If there is a sour smell when opening the hive, it should be suspected.</li><li>13. For rapid eradication of EFB in the apiary, colonies should be destroyed if less than 20% of the affected colonies are. However, if it is over 20 per cent, economic losses should be prevented by applying the shaking method.</li></ol>

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Table-5. Nosemosis

Tablo-5. Nosemosis

Nosemosis (causative agent: <i>Nosema apis</i> or <i>N. ceranae</i> )	
<b>Protective Measures</b>	<ol style="list-style-type: none"> <li>1. Full and empty combs in beehives with a reduced population, few worker bees or collapsed hives should not be reused.</li> <li>2. Contamination of water sources in the apiary with feces or dead bees should be prevented.</li> <li>3. Queens and worker bees should be obtained from breeders who do not contain <i>Nosema</i> spp.</li> <li>4. If possible, honey bees resistant to <i>Nosema</i> spp. should be selected and raised.</li> <li>5. Honeycombs in hives with signs of diarrhoea should be removed and destroyed.</li> <li>6. Diagnosis of nosemosis. Samples should be taken from forager bee honey bees in the early autumn or spring.</li> <li>7. Appropriate pathogen control should be applied to ensure a proper balance in individuals in the bee colony.</li> <li>8. Colonies should be strengthened in autumn and spring using stimulant integrators or feed supplements.</li> </ol>
<b>Control and active/emergency measures</b>	<ol style="list-style-type: none"> <li>1. When bees are infected with <i>Nosema</i> spp, the colony should be treated.</li> </ol>

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Table-6. Aethinosis (small hive beetle)

Tablo-6. Küçük Kovan Böceği

Aethinosis (Small hive beetle [SHB]) (causative agent: *Aethina tumida*)

### Protective Measures

1. It should be known about the morphology of SHB eggs, larvae and adults.
2. To detect SHB, knowledge of hive inspection methods should be obtained.
3. Frames, honeycombs and other materials that may be attractive and edible to *A. tumida* should not be left outside the hives.
4. Only healthy and strong colonies should be kept in the apiary.
5. Only young queens with hygienic behavior should be used.
6. Living materials such as hives, queen bees, adult bees, etc. at risk from areas where SHB is or can be found should not be transported to the apiary.
7. Care should be taken that the bees close all the frames in the hive without leaving any empty space.
8. Special traps should be used for rapid visual detection of SHB.
9. The presence of SHB should be checked periodically by taking a sample of hive remains or honey.
10. Materials such as wax, honeycombs, pollen etc. at risk should not be transported to the apiary from areas where SHB is or may be found.
11. Queen-bee excluder should be used to prevent the presence of brood in the upper parts of the hive.

### Control and active/emergency measures

1. It should be ensured that the bees close all the frames in the hive. No free space should be left on the SHB. Empty frames should be removed.
2. Frames, combs or other materials that may be attractive and edible to *A. tumida* should not be left outside the hives.

3. Periodic hive inspections should be carried out to detect and eliminate adults and larvae.
4. The movements of the hives should be followed meticulously. The identity of the hives, their date of departure and the exact location should be recorded.
5. Transport conditions should be controlled by properly insulating beekeeping equipment to prevent the spread of SHB during transport.
6. The survival of the SHB eggs and the development of larvae should be prevented by keeping the stock combs in a cold room with a temperature below 10 °C or relative humidity of below 34%.
7. When bees are given pollen, protein feed and supplements, they should be given in small amounts each time so that they can consume them in a short time. These supplements are a good substrate for SHB growth.
8. Only healthy strong colonies should be kept in the apiary.
9. Movements of products and wax should be carefully monitored.
10. Traps should be used to monitor and control the presence of SHB in the apiary.
11. Only young queens with hygienic behavior should be kept.
12. Queen-bee excluder should be used to prevent the presence of brood in the upper parts of the hive.

**\*Table 2-6 information is taken from TECA 2020 and FAO 2020.**

Biosecurity measures in beekeeping-BMBs can only be useful if good beekeeping practices (GBPs) are applied systematically. Adoption of GBPs helps the beekeeper establish strong and healthy colonies, limit disease and epidemic, and reduce or limit the damage caused by disease (Moritz et al. 2010, FAO 2020, TECA 2020).

Good beekeeping practices are the foundation of sustainable and resilient beekeeping industry. Daily application of GBPs in apiary management result in many positive effects. It reduces costs, and provides economic benefits such as more production per hive

and higher income for beekeepers. Better safety measures are taken by making the safer use of veterinary drugs. It also minimizes the use of these drugs and reduces the residue problem in bee products by using safer and healthier drugs. Thus, it protects public health and provides to obtain better quality bee products. It plays an important role in obtaining bee health and quality bee products by having a positive effect on the general performance of honey bees (Bogdanov 2006, Tomljanović et al. 2012, TECA 2020, de Jongh et al. 2022).

#### **Good Beekeeping Practices**

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They are integrative activities applied in beekeeping and apiculture by beekeepers to achieve optimal health for humans, honeybees and the environment. GBPs have a positive impact on colony health and society while promoting high production standards (FAO 2021, Rana and Mishra 2022).

### 1. General Beekeeping Management

#### 1.1. Apiary Management

The flora of the area to be selected as an apiary, its honey and pollen capacity and water resources should be evaluated. Beehives should not be placed in windy areas. There should be no pollutants near the apiary, vehicles should be able to enter the apiary easily, and bees should be able to reach the nectar, pollen and clean water sources easily. Suitable areas should be selected for apiculture controls (FAO 2021). Apiaries should be far from city settlements, traffic and industrial settlements. The number of hives in the apiary should be adjusted according to the season, pollen and nectar sources. Beehives should not be placed in damp areas and directly on the soil. Beekeeping should not be installed on sloping, uneven or slippery areas (FAO 2020, TECA 2020).

The work area in the apiary should be kept clean. Grass in the area should be mowed periodically to reduce hazards such as fire, snakes and ticks. This practice is also important in the early detection of mass bee deaths in the surrounding area (TECA 2020, FAO 2021).

Hive entrances should be placed in such a way that the sun can reach throughout the day, starting from the early hours of the morning. Thus, bees can start their activities as soon as possible, even on cold days. The hives should be placed in such a way as to provide the most suitable working conditions. There should be no tall grass and bushes at the hive entrances (FAO 2020, TECA 2020, FAO 2021).

Beekeeping equipment should not be left abandoned in the apiary. The drifting of bees should be prevented, too many colonies should not be kept in a single row. Broken or neglected hives should be removed from apiaries to prevent theft and looting (FAO 2020, FAO 2021).

#### 1.2 Colony Management

Hive management practices should be carried out in accordance with the region, season and strength of the colony. Except for those of high genetic value, queen bees should be replaced every 2-3 years

(Büchler et al. 2013, Büchler and Uzunov 2017). A program for beehive control should be planned and followed. In the spring, strong colonies should be divided and swarm formation should be prevented. Clustering should be prevented by adding new basic honeycombs as needed. Prevent swarming by placing supers. Structures that narrow the hive entrance should be removed, and the hive entrance hole should be widened if necessary. Queen bees that do not genetically prefer swarms should be selected. Old and deformed combs should be removed from the hive and swarf formation should be prevented. The hive entrance hole should be narrowed in cold seasons and widened in hot seasons. Hive entrance narrowing also prevents robbing. The queen bee should be marked according to the year of birth. The hive entrance should be placed in such a way that the sun can reach from the early hours of the morning. Dragging of bees should be prevented by making numbers or different geometric signs in different colors at the front and entrance of the hive. The year in which the combs were placed should be marked and recorded. Necessary measures should be taken to ensure good air circulation in the hive (TECA 2020, FAO 2021, de Jongh et al.2022).

#### 1.3 Wintering

Empty frames in the hives should be removed before wintering. The size of the hive entrance should be reduced. Hive maintenance should be performed. Damaged or broken parts and old paint should be replaced. There should be sufficient food storage in the outer frames. Insert a follower board frame to reduce the volume of the hive nest.

#### 1.4. Transport

In cases of notifiable bee diseases, legal obligations regarding restrictions on colony and animal movement must be complied with. Only healthy colonies should be moved. Hives should not be moved during the hot hours of the day. In addition, the hives should be transported by providing adequate openings for ventilation.

#### 1.5 Bee Health

The bees and offspring that will form the basis of the colony should be obtained from healthy colonies. Joining, splitting or honeycomb transfers between hives should only be done in healthy hives. New bee colonies should only be purchased after a thorough examination for honeybee diseases, preferably with a veterinary health certificate. Only healthy and

strong colonies should be kept in the apiary. Apiaries and bees; pesticides, heavy metals, etc. should be placed in areas free from environmental pollutants (Even et al. 2012). While the hives are being strengthened, the balance between the nurse bees and the offspring should not be disturbed. In order to strengthen weak colonies, preferably brood and young nurse bees should be used together. Genetic selection should be done to have queen bees more resistant to diseases and adapted to local climatic conditions. Newly brought or purchased colonies and weak colonies in the apiary should be kept in a quarantine apiary separate from other hives for at least 1 month in order to control disease and prevent disease transmission. Behaviors that cause stress in bees should be avoided (Moritz et al., 2010, Even et al. 2012, National Bee Biosecurity Program 2016, Rivera-Gomis et al. 2019, FAO 2020, TECA 2020).

### 1.6. Hygiene

Beehives should not be placed directly on the ground. It should be kept at least 10 cm above the ground. To avoid contamination of honey with *Clostridium botulinum*, honeycombs should not be placed directly on the ground. During the transport of honeycombs from the apiary to the harvest area, contact of the combs with dust should be avoided. Hygiene rules should be followed when working with dead, sick and weak colonies. Good hygiene should be applied in the control of the weak or dead colony in the apiary. Periodic cleaning of clothes, gloves and other beekeeping equipment used in beekeeping should be done. After inspection of hives affected by infectious diseases, contaminated equipment should be disinfected. Hives should be kept clean. The hive and beekeeping equipment should always be clean and usable. Old hive and used beekeeping equipment taken from dubious sources should be disinfected.

Bees and swarms of unknown origin or newly acquired should be checked for diseases and pests, and isolated from other hives in the apiary for about 1 month. All records regarding the origin of the disinfectant and materials applied, the dates of application, cleaning and disinfection of the equipment or honey house should be kept (FAO 2020, TECA 2020, FAO 2021).

### 1.7. Human health

Protective clothing and beekeeping tools should be used when visiting honey bee colonies. The hive should not be placed in areas where toxic and

allergic plants are high. During hive controls, corticosteroids or other drugs should always be kept within easy reach to prevent anaphylaxis, etc. Necessary precautions should be taken while lifting and carrying weights (Plant Health Australia 2016, FAO 2020, TECA 2020, FAO 2021).

## 2. Veterinary Drug Use

Licensed veterinary drugs should be used for nationally registered or legally imported honey bees. The dosage and method of administration of the drugs used in the treatment must be done correctly as described in the instructions for use. Illegal treatments should not be administered. Treatments performed and their dates should be recorded. The washout period of veterinary products should be taken into account, and the products obtained from the treated hives should not be used for human consumption until the washout period has passed (TECA 2020, FAO 2021).

Most of the drugs used in the treatment of bee diseases and pests contaminate the hive equipment and honey. It also creates resistant pathogens and weakens bees. Therefore, appropriate treatment methods and drugs should be selected for disease control. Drugs with minimal harmful effects on the environment, additives and residues should be preferred. Also, mechanical/biological control may be the best option. Biological products with minimal risk to human health and minimal additive and residue problems are the safest method of treatment. Instruments and equipment used to administer a treatment must be appropriate and properly calibrated. Required storage conditions for veterinary drugs and supplements must be observed. Used tools and equipment should be disposed of in accordance with biosafety rules (FAO 2020, TECA 2020, FAO 2021).

## 3. Disease Management

### 3.1 Precautions to be taken to prevent diseases

New bee colonies should be obtained from healthy and disease-free beekeepers. If possible, they should be procured from colonies with health certificates. Newly brought colonies to the apiary should be kept isolated from other colonies in the apiary for at least one month to monitor for disease and prevent contamination.

Hives should be carefully checked for clinical symptoms of disease in the spring and during the beekeeping season. Queen bees in colonies with a

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clinical history of AFB and EFB should be replaced. Dead bees and unhealthy colonies should be removed quickly from the apiary (Eyer et al. 2016). Samples should be taken for laboratory diagnosis from colonies with sick or dead bees. Hives should be carefully and periodically inspected to monitor colony health. An integrated pest management (IPM) approach avoids unnecessary treatments and the development of drug resistance (FAO 2020, TECA 2020, FAO 2021).

In cold and rainy weather, hive control should not be done unless it is mandatory. Hives should be arranged in such a way as to facilitate the return of bees to their own hive. Thus, it minimizes the risk of drift and disease transmission between colonies. Too many hives should not be placed in a single row, necessary precautions should be taken when the bee hives are crowded, a distance of >1 m should be left between the hives, and numbers or identification marks should be placed at the hive entrances (FAO 2020, TECA 2020, Kyle et al. 2021).

Beekeeping tools and equipment should be cleaned regularly and disinfected if necessary. Wax and propolis from tools and equipment should be scraped off regularly. All combs and waxes from colonies that have died as a result of an infectious disease should be removed and properly destroyed. 30% of the honeycombs should be renewed every year. More disease-resistant colonies should be selected and produced. Queen bees that are more resistant to diseases and adapted to local climatic conditions should be selected (Moritz et al. 2010, Novak et al. 2015, FAO 2020).

### 3.2. Disease control and active struggle

In cases of a notifiable disease, the veterinary regulations of the competent authorities must be observed. All beekeeping materials, tools and equipment should be cleaned and disinfected after use in apiaries with contagious diseases. In case of any signs of illness, a veterinarian or specialist should be consulted. Frames, adult bees and honeycombs with brood should not be changed between hives without making sure that the colonies are healthy. During hive controls, the order of healthy, suspicious and diseased hives should be followed. Queen and drone bees should be selected from the strongest, disease-resistant and most productive hives. Appropriate samples should be taken from colonies with suspected diseases and sent to specialist laboratories for diagnosis (Moritz et

al. 2010, Novak et al., 2015, Plant Health Australia 2016, FAO 2020).

Diseased hives in the apiary should be isolated and necessary precautions should be taken to prevent the spread of the disease in the apiary (Plant Health Australia 2016, FAO 2020).

Hives, beekeeping tools and equipment should be disinfected with appropriate methods and chemicals. The disinfection of iron and wooden equipment should be done by flaming. If possible, disposable equipment such as rubber gloves should be used during controls. Colonies affected by infectious diseases and epidemics should be destroyed by burning (Moritz et al. 2010, Novak et al. 2015, Plant Health Australia 2016, FAO 2020).

The health status of the colonies should be recorded. Infection dates, diagnosis, the identity of affected colonies, treatments and results of diseased/infected colonies should be recorded. All records of application routes, dosages, application dates, etc. All disinfectants and other chemicals used in the apiary should be kept safely (Novak et al. 2015, FAO 2020, TECA 2020).

### 4. Bee nutrition and water needs

It should be documented that there are no AFB, chalkbrood, Nosema, or EFB pathogen spores in honey, pollen or food supplements used in bee feeding. Honey and pollen should not be given to bees from dubious or unreliable sources. Artificial feeding should be done during periods when the nectar flow is not sufficient, and winter storage should be done if necessary. During the wintering period, it should be ensured that sufficient food is stored in the hive. If necessary, bees and swarms should be given food supplements. Open feeding should not be done in the apiary to prevent theft or the spread of diseases. There should be clean and safe water sources in the apiary. Sufficient water must be provided during the transportation of beehives (Dolezal and Toth 2018, Rivera-Gomis et al. 2019, TECA 2020).

### 5. Beekeeping records

Record keeping is the starting point for implementing a traceability system.

#### 5.1. Beekeeping level records



All hives in each apiary must be identified by numbers or letters. An identification number must be created for each hive in the apiary.

The beekeeper must be registered in the national beekeeping registry. The exact locations of the beehives should be clearly stated. Records of breeding activities such as all breeding stocks, date of birth of queen bees, date of origin and entry into the hive, insemination dates and results should be kept. Documents and certificates showing the raw materials produced by the beekeeper, supplied ready-to make and used in feeding the colonies should be kept. All movements of hives, swarms and queens should be recorded. Information about collection periods, dates and quantities of beekeeping products obtained from each apiary should be recorded.

All information about the honey bee diseases, colony deaths and decrease in the number of bees in the apiary and hives should be written. In addition, individual records of the treatments applied to the hives, the serial numbers of all the drugs administered, the dates of application, the doses, the hives treated and the washout periods should also be kept (Moritz et al. 2010, Rivera-Gomis et al. 2019, TECA 2020).

**5.2. Colony-level records**

For each colony, records of where they were procured and all commercial and health documents

should be recorded. In addition, all colonies in the apiary should be recorded. In order to ensure that the colony movements are traceable, the origin and arrival dates of each new colony and the list of certified suppliers should be noted.

All documents and certificates related to the commercial food used, all origin records of the supplements used, date of use and production procedures should be recorded.

Documents showing the bacteriological and physicochemical quality of the water given to the bees and used in food preparation and beekeeping should be kept. The history of the feeding changes made in the colonies and the records of the changes made should be kept.

Information such as the amount of colony, period, date etc. from which bee products obtained from colonies are provided should not be recorded. In addition, individual and official control documents should be kept about the health and hygienic quality of the obtained bee products. Changes made in colony management should be recorded in full detail. All laboratory reports, including bacteriological tests and antibiotic susceptibility tests, are available. (Rivera-Gomis et al. 2019, Cazier et al. 2019, TECA 2020, FAO 2021).

Good beekeeping practices recommended for bees in important diseases and pests are shown in Table-6.

**Table-7. Good beekeeping practices for important diseases and pests in honey bees\***

**Table-7. Bal arılarında önemli hastalık ve zararlılar için iyi arıcılık uygulamaları**

Disease or Pest	Recommended measures	preventive	Advantages
<b>Varroosis</b>	Hives with pollen traps should be used		Provides natural falling Varroa count
	Colonies and swarms that do not show clinical signs should be used.		Reduces the possibility of viral disease
	Good knowledge of varroosis and signs of viral infection should be		Early detection of a high level of varroa infestation ensures that necessary measures are taken in a timely manner.

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Varroa infestation levels should be monitored at the beginning of the beekeeping season or before wintering.

It is important to keep the number of varroa in the colony below the harmful threshold. It increases the efficiency, vitality and health of bees.

Colonies with high varroa resistance and hygienic behavior should be studied.

Bees can naturally control the level of Varroa in the hive with less need for beekeeper intervention.

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### Tropilaelapsosis

Hives with pollen drawers should be used

Provides natural falling mite count

The effectiveness of treatment should be increased by combining acaricide treatments with artificial incubation of the colony by removing the eggs, queen caging or artificial swarming.

Increases the effectiveness of acaricide treatment.

When disease symptoms and decreased colony productivity are observed in the colony, measures should be taken to keep the number of mites below the damage threshold.

It ensures that the hives are healthy and minimizes production losses.

To control mites, some worker or drone hatches should be opened to measure infestation levels.

Allows monitoring of infestation levels

All colonies of the apiary should be treated at the same time and in the same area.

Good and reliable information about symptoms and transmission routes should be obtained.

Prevents the risk of infection of other uninfected and untreated colonies

	The effectiveness of acaricide treatments should be monitored.	It provides the best identification and control of the parasite.
	Different and suitable acaricides should be used in treatments to prevent acaricide resistance.	Important in evaluating the control method applied
	Strong and resistant colonies should be selected.	It prevents <i>Tropilaelaps</i> spp. from developing resistance to acaricides.
		Reduces the number of treatments required
<b>Small hive beetle (SHB)</b>	Broken and cracked beehives should not be used.	Limits the number of places SHB can lay eggs and bees cannot remove from the hive
	Honey and breeding combs, and unused beekeeping materials should not be left in the apiary. Combs, food and hives belonging to collapsed colonies should be removed from the apiary as soon as possible. All organic matter that may attract SHB should be dissolved or destroyed.	Beekeeping materials such as abandoned colonies, honeycombs, and food stores are the materials that SHB will feed on and reproduce.
	Colony strength must be balanced between colonies.	
	All the frames in the hive must be filled by the bees and there must be no empty space.	Prevents weak colonies in the apiary where SHB can multiply more easily
	The hives should be properly prepared for wintering.	Reduces areas where SHB can "escape" or "hide" from an attack by bees.

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Especially in cold months, the hive entrance should be narrowed. Stronger colonies form in spring

In the hive, a separator board should be placed between the hive wall and the final frame. The bees protect the hive entrance better and SHB is less likely to enter the hive.

The hive should be well insulated against external sounds and empty frames should be removed from the hive. It facilitates the identification of SHB in the hive.

In order to diagnose honey bee diseases, hive residue and residue samples should be taken regularly from the pollen drawer. It ensures that all honeycombs and empty spaces of the hive are well-filled and covered with bees. So they can fight parasites.

If SHB is suspected, technical support should be sought from a veterinarian, technician or beekeeping specialist. Provides preclinical identification of diseases

Beekeepers should attend training programs on beekeeping and honeybee diseases in order to have information about how to identify, prevent and control diseases. It is extremely important to get help from experts for the correct diagnosis in suspected disease cases.

Hives, swarms, bees, etc., should not be transported from the areas where SHB is located. It is important for the beekeeper to be able to recognize honey bee diseases correctly.

Prevents SHB from spreading to apiaries and hives where it is absent

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Nosemosis	<p>The apiary location should be chosen correctly. Humid and windy areas should not be preferred. Areas that can get sun and have good ventilation should be chosen.</p>	<p>It reduces the likelihood of fungi multiplying.</p>
	<p>The volume of the hive should be adjusted according to the size of the colony, the number of combs should be reduced and it should be prepared for wintering. Empty frames should be removed. In cold weather, wintering should be done well and the hive should be kept warm until spring.</p>	<p>It prevents thermal stress on bees in the cold season.</p>
	<p>During the winter months, there should be enough food in the hive and quality food should be provided.</p>	
	<p>Appropriate treatments should be applied against Varroa before wintering the hives.</p>	<p>It prevents the nutritional stress of bees in the cold season.</p>
	<p>Protein-rich foods should be available in sufficient quantities for bees in late summer and autumn. Beehives should be placed in areas where pollen sources are abundant in late summer and autumn. If possible, plants with pollen should be planted in apiaries. If necessary, it should be fed with protein-rich supplements.</p>	<p>It guarantees the effectiveness of the immune system of bees.</p>
	<p>A sufficient number of combs should be used according to the colony population.</p>	<p>It prevents nutritional stress in bees.</p>

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Bees should not be disturbed during the winter months. Checks should be made only on sunny days and during the hottest hours of the day.

It prevents thermal stress in bees.

Combs obtained from depopulated or collapsed colonies should not be reused.

It prevents thermal stress in bees.

Contamination of water sources in the apiary with faeces and suffocated or dead bees should be prevented.

It reduces the possibility of contamination

Queen and adult bees should be obtained from breeders without *Nosema* spp. Resistant bees should be used.

It reduces the risk of inter-colony contamination. It reduces the risk of inter-colony contamination. A colony's depopulation often means there is a problem. Also, small colonies are more susceptible to diseases.

If there is diarrhea in the hive, the combs should be removed and burned, and the hive should be disinfected.

Samples from foraging bees or hive debris should be sent to diagnose significant infections in early fall or spring.

Bees showing genetic resistance to *Nosema* spp. are resistant to Nosemosis.

Pathogens such as *Varroa* should be controlled, the level of varroa infestation should be monitored regularly and precautions should be taken.

It reduces the infection levels of diseases in hives.

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Colonies should be strengthened with stimulating integrators or feed supplements in autumn and spring.

Early detection of diseases can prevent contamination of other colonies in apiaries.

Healthy bees have a stronger immune system and may be better at fighting pathogens.

Nutritional stress caused by a lack of food suppresses the immune system of bees and makes them susceptible to infections.

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Amoebiasis

Beekeeping tools and equipment should be cleaned and disinfected regularly.

It reduces the bacterial population in the hive.

Hives should be placed in sunny and dry areas and humid and windy areas should be avoided.

It reduces thermal stress in bees.

Colonies should be strengthened by feeding bees fortified with special herbal substances or vitamin supplements in autumn and spring.

It prevents nutritional stress in bees.

Pathogen control should be done to keep the colonies healthy, especially *Varroa*.

Honeycombs should be removed from colonies with signs of illness such as diarrhea and wax should be melted.

In particular, *Varroa* causes immunosuppression in bees.

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		Supplements should be applied to infected colonies.	It reduces the possibility of transmission of the disease to healthy colonies.
		Bees should not be fed pollen or honey from unhealthy colonies.	It reduces nutritional stress in bees.
		Comb exchanges should not be made between diseased and healthy colonies.	It reduces the possibility of transmission of the disease to healthy colonies.
			It reduces the possibility of transmission of the disease to healthy colonies.
American (AFB)	Foulbrood	Only strong colonies should be kept in the apiary.	Weak or small colonies are more susceptible and vulnerable to diseases.
		Bees should not be fed with honey or pollen of unknown origin.	Honey and pollen of unknown origin may contain AFB spores. Spores of the agent can be found in affected hives and honey that do not yet show symptoms of AFB. Healthy colonies that consume honey containing spores of the agent may become infected.
		The queen bee should be replaced at least every two years.	Well-fertilized young queens are more productive. Feeding of the brood creates a strong colony with worker bees that remove diseased broods and dead larvae.
		At least 30% of the old honeycombs should be renewed every year.	New combs contain fewer bacteria than old combs. Thus, it is an effective and preventive measure not only against AFB but also against many bee diseases.
			It is good practice to diagnose <i>P.larvae</i> in colonies before clinical signs appear. The sleeve does not need to be opened to remove debris, so there is no heat loss in the sleeve. If <i>P.larvae</i> is detected in the



	<p>Adult bees, comb, honey, hive debris, etc., at regular intervals without symptoms. The subclinical presence of AFB in colonies should be determined by sending samples for analysis.</p> <p>Hives should be cleaned and maintained regularly to prevent robbing.</p> <p>Old honeycombs and wax must be melted down to destroy the spores.</p>	<p>hive as a result of the examination, the beekeeper will have information about the infected hive. Takes necessary precautions.</p> <p>Theft causes inter-hive transmission of AFB spores.</p> <p>It prevents the transmission of infection.</p>
<p>European Foulbrood</p>	<p>There should always be enough pollen and food such as honey in the colonies, especially at the beginning of the season.</p> <p>The queen bee should be replaced at least every two years.</p> <p>At least 30% of the old honeycombs should be renewed every year.</p> <p>Honeycombs should not be transferred between hives without a health check.</p> <p>Bees should not be fed honey and pollen cakes. It should be fed only its own honey or pollen. In addition,</p>	<p>Prevents SHB from spreading to apiaries and hives where it is absent</p> <p>Well-fertilized young queens are more productive. Feeding of the brood creates a strong colony with worker bees that remove diseased broods and dead larvae.</p> <p>Bacteria and pesticides, heavy metals, etc. pollutants accumulate in old honeycombs over time.</p> <p>It prevents the transmission of pathogens from diseased colonies to healthy colonies.</p> <p><i>Melissococcus plutonius</i> can be transmitted through contaminated honey and pollen.</p>

the honey and pollen used must be completely safe and free of bacteria/viruses.

Even if no symptoms are observed, samples of adult bees, honey, and other hive debris should be taken regularly from healthy-appearing colonies and sent to the laboratory for the diagnosis of the causative agent.

Hive controls should be increased to detect European foulbrood (EFB) or other brood diseases in a timely manner. In order to check the clinical symptoms of bee diseases, a comprehensive examination should be carried out at the beginning, at the end of the active season, and after periods of lack of nectar flow or rainy periods.

Periodic cleaning and maintenance of the hives should be done regularly to prevent theft.

While melting the honeycombs, the wax must be safely processed to destroy bacteria and other pathogens.

Early diagnosis of the disease allows the beekeeper to take certain measures to prevent the spread of the disease. In the presence of stress, diseases can occur even months later. Sampling for early detection also prevents economic losses caused by production reductions and colony losses. In addition, it can prevent the careless spread of diseases by the beekeeper.

AFB and EFB infections are more common in colonies with nutritional stress due to pollen and nectar deficiency. Nutritional deficiencies can occur especially at the beginning or end of the beekeeping active season when there are few nurse bees or when flowering is significantly reduced.

Broken and cracked hives can attract robber bees from other colonies. This can increase the spread of infectious diseases.

When using wax for basic honeycomb in hives, the wax should be heated at 121 °C for at least 3 minutes to prevent contamination of pathogens and to inactivate all bacteria, including spore-forming bacteria.

	<p>EFB-resistant bees should be selected.</p> <p>Queens of infected colonies should be replaced.</p> <p>Clean beekeeping equipment should be used and tools and equipment should be disinfected regularly.</p>	<p>Colonies that have not shown EFB symptoms in the past should be used.</p> <p>Genetically susceptible queens should not be used for breeding and colony formation.</p> <p>Tools and equipment should always be cleaned after checking for infected colonies. Disposable gloves should be used in infected hives and hive tools and equipment should be disinfected.</p>
Chalkbrood	<p>The hives should be placed in suitable areas where the hive entrance is not exposed to the wind, and away from the sun and humid areas.</p> <p>Infection-resistant queens should be selected.</p> <p>There should always be enough food in the hive. Nutritional supplements should be given when necessary.</p>	<p>It reduces thermal stress on bees and minimizes exposure to moisture.</p> <p>It reduces the number of hives affected by the infection.</p> <p>Reduces nutritional stress in colonies.</p>
Stonebrood	<p>For the apiary area, preferably a sunny, moisture-free location should be chosen.</p> <p>For proper hive management:</p> <ul style="list-style-type: none"> <li>• If necessary, ventilation inside the hive should be supported by enlarging the hive entrance hole.</li> <li>• Water should be prevented from entering the hive;</li> <li>• It should be prepared in accordance with the winter by reducing the number of honeycombs;</li> </ul>	<p>It makes it difficult for fungi to grow.</p> <p>Humidity prepares a suitable environment for the reproduction of fungi.</p>

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• Empty combs should be removed, and only honey and pollen-stored combs should be left in the colony during winter months.

At least one-third of the combs should be replaced each year.

In periods when there is no nectar and pollen flow, sufficient food should be available in the colonies. Additional feeding should be given if necessary.

Only strong colonies should be kept in the apiary. Healthy but weak colonies should be combined with another stronger colony.

Especially in the spring, the number of adult bees and broods should be balanced.

Moldy pollen should not be given to bees and moldy honeycombs should not be used in hives.

It reduces the microbial population, including fungi, in the hive.

Avoiding feeding stress reduces the likelihood of bees becoming infected.

Weak colonies may be more susceptible to disease than healthy colonies.

In the spring, the number of offspring to be fed increases. If there are not enough adult bees for feeding, feeding stress occurs.

Moldy honeycombs often appear opaque whitish or greenish in color. Honeycombs in this appearance are strongly contaminated with fungi.

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\*Table-7. information is taken from (Cazier, J.A., Rogers, D., Hassler, E. & Wilkes, J.T. 2018a. A healthy colony checklist. In: Bee Culture: The Magazine of American Beekeeping [online]. [Cited 6 July 2022]. [https:// www.beeculture.com/a-healthy-colony-checklist/](https://www.beeculture.com/a-healthy-colony-checklist/), Cazier, J.A., Rogers, D., Hassler, E. & Wilkes, J.T. 2018b. A healthy colony checklist, Part 2. In: Bee Culture: The Magazine of American Beekeeping [online]. [Cited 6 May 2021]. <https://www.beeculture.com/a-healthy-colonychecklist-part-2/>, Dolezal, A.G. & Toth, A.L. 2018. Feedbacks between nutrition and disease in honey bee health. *Current Opinion in Insect Science*, 26: 114–119. <https://doi.org/10.1016/j.cois.2018.02.006>).

Stress factors such as chemical, physical, metabolic and infectious agents are predisposing factors for viral disease outbreaks. The emergence of viruses

can be reduced by applying GBPs and BMBs for Varroa and Nosema diseases.

Good beekeeping practices are essential to prevent diseases and stress factors should be kept to a minimum. The adoption of GBPs allows the beekeeper to establish and maintain strong and healthy colonies, limiting disease outbreaks. It also reduces the damage caused by diseases, and limits and prevents their spread. Adhering to the principles of good beekeeping practice, products that are safe for health, protection of the health of bee colonies and maximum economic gain are obtained. Good beekeeping practices require a responsible and trained beekeeper, a healthy environment, suitable apiculture, suitable facilities for honey extraction and storage, appropriate beekeeping pieces of equipment, regular maintenance of this equipment, healthy bee colonies and healthy food and water for bees.

In addition to maintaining good hygiene, beekeepers visiting apiaries should pay attention to biosecurity for other beekeepers or the natural environment. Pests, diseases and weeds carried by soil, beekeeping equipment, tools, clothing and shoes can introduce pests that are harmful to other apiaries, agricultural industries or local vegetation. Farm biosecurity should always be considered when entering an apiary. A "Come Clean, Go Clean" policy should be followed wherever possible.

Good beekeeping practices (GBPs) and disease-specific biosecurity measures (BMBs) in beekeeping can prevent honeybee diseases, thereby reducing the use of veterinary drugs in beekeeping and the risk of residues in hive products. BMBs have important implications for honey bee health and productivity. BMBs focus on honey bee health. It may vary by geographic area due to factors such as climatic conditions, beekeeping technology, bee breeds or breeds, and different prevalence, virulence and economic impact of pathogens. BMBs are constantly evolving and should be periodically revised depending on the introduction and spread of new diseases and pests, and changes in pathogens and stressors. Good beekeeping practices are the foundation of sustainable and resilient beekeeping. It represents a prerequisite for the application of BMBs in apiary and colony management. If GBPs are applied systematically by beekeepers, it is possible to implement BMBs and make them effective. BMBs aim to prevent both the introduction and spread of bee diseases in an apiary or colonies in a particular region. GBPs and BMBs are very important in the daily activities of beekeepers to

maintain honey bee health and reduce the incidence and prevalence of pathogens.

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## REFERENCES

- Ahmad F, Joshi SR, Gurung MB. Beekeeping and rural development. Kathmandu. International Centre for Integrated Mountain Development Khumaltar, Nepal. 2007.
- Al-Waili N, Salom K, Al-Ghamdi A, Ansari MJ. Antibiotic, pesticide, and microbial contaminants of honey: human health hazards. *TheScientificWorldJournal*, 2012, 930849. <https://doi.org/10.1100/2012/930849>.
- Andrews E. 'The main objection to numerous small bee keepers': biosecurity and the professionalization of beekeeping. *J.Hist Geogr.* 2020, 67,81-90.
- AVMA 2017. The veterinarian's role in honey bee health Honey Bees: A Guide For Veterinarians. <https://www.avma.org/sites/default/files/resources/honeybees-veterinary-medicine-guide-for-veterinarians.pdf>. (Erişim tarihi: 15.06.2022).
- Aydın, L. Kovan kaydı tutmak ve önemi, Ed. Doğanay A., Aydın L. "Bal arısı yetiştiriciliği, Ürünleri, Sağlığı" Dora Basım-Yayın Dağıtım, Bursa, 2021, p.67.
- Bogdanov S. Contaminants of bee products. *Apidologie*, 2006, .37(1): 1–18. <https://doi.org/10.1051/apido:2005043>.
- Bouga M, Alaux C, Bienkowska M, Büchler R, Carreck NL, Cauia E, Chlebo R, Dahle B, Dall'Olio R, De la Rúa, P, Gregorc A, Ivanova E, Kence A, Kence M, Kezic N, Kiprijanovska H, Kozmus P, Kryger P, Le Conte Y, Lodesani M, Murilhas AM, Siceanu A, Soland G, Uzunov A, Wilde J. A review of methods for discrimination of honey bee populations as applied to European

## DERLEME / REVIEW

- beekeeping. *J. Apic Res.*, 2011, 50:1, 51-84, DOI: 10.3896/IBRA.1.50.1.06.
- Büchler R, Andonov S, Bienefeld K, Costa C, Hatjina F, Kezic N, Kryger P, Spivak M, Uzunov A, Wilde J. Standard methods for rearing and selection of *Apis mellifera* queens. *J. Apic Res.*, 2013, 52:1, 1-30, DOI: 10.3896/IBRA.1.52.1.07.
- Cazier JA, Hassler E, Wilkes JT, Rünzel MA, Formato G, Brodschneider R. The promise of standardized data. In: *Bee Culture: 2019, The Magazine of American Beekeeping* [online]. [Cited 6 July 2022]. <https://www.beeculture.com/the-promise-of-standardized-data>
- Chauzat MP, Cauquil L, Roy L, Franco S, Hendriks P, Ribière-Chabert M. Demographics of the European apicultural industry. 2013, *PloS one*, 8(11), e79018. <https://doi.org/10.1371/journal.pone.0079018>.
- de Jongh EJ, Harper SL, Yamamoto SS, Wright CJ, Wilkinson CW, Ghosh S, Otto S. One Health, One Hive: A scoping review of honey bees, climate change, pollutants, and antimicrobial resistance. *PloS one*, 2022, 17(2), e0242393. <https://doi.org/10.1371/journal.pone.0242393>.
- Dolezal AG, Toth AL. Feedbacks between nutrition and disease in honey bee health. *Curr Opin Insect Sci*, 2018, 26: 114–119. <https://doi.org/10.1016/j.cois.2018.02.06>.
- Even N, Devaud JM, Barron AB. General Stress Responses in the Honey Bee. *Insects*, 2012, 3(4), 1271–1298. <https://doi.org/10.3390/insects3041271>.
- Eyer M, Neumann P, Dietemann V. A look into the cell: Honey storage in honey bees, *Apis mellifera*. *PLoS ONE*, 2016, 11(8): e0161059. <https://doi.org/10.1371/journal.pone.0161059>
- FAO. 2020. Good beekeeping practices: Practical manual on how to identify and control the main diseases of the honeybee (*Apis mellifera*). TECA – Technologies and practices for small agricultural producers, 1. Rome. <https://doi.org/10.4060/ca9182en>.
- FAO. IZSLT, Apimondia and CAAS. 2021. Good beekeeping practices for sustainable apiculture
- FAO Animal Production and Health Guidelines No. 25. Rome. <https://doi.org/10.4060/cb5353en>.
- Formato G, Smulders FJ. Risk management in primary apicultural production. Part 1: bee health and disease prevention and associated best practices. *Vet Q.*, 2011, 31(1), 29-7. doi:10.1080/01652176.2011.565913.
- Hayes GW. Inspections of and sanitary visits to honey bee colonies. In: *Bee health and veterinarians*. (Ritter, W., Ed.), 2014, OIE, Paris, 95-101.
- Jensen S. Predicting Honeybee Health: The Healthy Colony Checklist, Hive Scale and Weather Data. *Data & Analytics for Good*. 2022, Retrieved from <https://data-for-good.pubpub.org/pub/1thtqgb4>.
- Kyle B, Lee K, Pernal SF. Epidemiology and Biosecurity for Veterinarians Working with Honey bees (*Apis mellifera*). *Vet. Clin. North Am. Food Anim.*, 2021, 37(3),479-490. <https://doi.org/10.1016/j.cvfa.2021.06.004>.
- Moritz RFA, de Miranda J, Fries I, Le Conte Y, Neumann P, Paxton RJ. Research strategies to improve honeybee health in Europe. *Apidologie*, 2010, 41, 227–242. <https://doi.org/10.1051/apido/2010010>.
- National Bee Biosecurity Program. Australian Honey Bee Industry Biosecurity Code of Practice. July 2016, <https://beeaware.org.au/wp-content/uploads/2017/09/Australian-Honey-Bee-Industry-Biosecurity-Code-of-Practice.pdf>, (Erişim tarihi: 15.06.2022).
- Novak P, Tittl K, Pazout V, Mala G. Are the principles of biosecurity important for beekeepers? XVII International Congress on Animal Hygiene 2015, "Animal Hygiene and Welfare in Livestock Production - The First Step to Food Hygiene", Proceedings, June 7-11, 2015, Košice, Slovakia 2015 pp.377-378 ref.8.
- Plant Health Australia. Biosecurity manual for beekeepers: reducing the risk of exotic and

- established pests affecting honey bees. 2016.
- Pufal G, Steffan-Dewenter I, Klein AM. Crop pollination services at the landscape scale. *Curr Opin Insect Sci.*, 2017, 21, 91–97. <https://doi.org/10.1016/j.cois.2017.05.021>.
- Rana K, Mishra I. Adoption of Recommended Beekeeping Practices in Kumaon Hills of Uttarakhand. *IJMRA*, 2022, 5(2), 279-283.
- Rivera-Gomis J, Bubnic J, Ribarits A, Moosbeckhofer R, Alber O, Kozmus P, Jannoni-Sebastianini R, Haefeker W, Köglberger H, Smodis Skerl MI, Tiozzo B, Pietropaoli M, Lubroth J, Raizman E, Lietaer C, Zilli R, Eggenhoeffner R, Higes M, Muz MN, D'Ascenzi C, Riviere MP, Gregorc A, Cazier J, Hassler E, Wilkes J, Formato G. Good farming practices in apiculture. *Revue scientifique et technique (International Office of Epizootics)*, 2019, 38(3), 879–890. <https://doi.org/10.20506/rst.38.3.3032>
- Rose T, Kremen C, Thrupp A., Gemmill-Herren B, Graeub B, Azzu N, Antunes V, Bruteig I, Buchori D, Donaldson J, Dhyani PP, Garibaldi L, Getz Escudero A, Goss M, Iqbal J, Kasina M, Kinuthia W, Kofi K, Manetto S, Wasilwa L. 2014. Policy Analysis Paper: Policy Mainstreaming of Biodiversity and Ecosystem Services with Focus on Pollination. Food and Agricultural Organisation of United Nations, Rome, Italy.
- Smart M, Pettis J, Rice N, Browning Z, Spivak M. Linking Measures of Colony and Individual Honey Bee Health to Survival among Apiaries Exposed to Varying Agricultural Land Use. *PloS one*, 2016, 11(3), e0152685. <https://doi.org/10.1371/journal.pone.0152685>.
- TECA. Apimondia, IZSLT - Istituto Zooprofilattico Sperimentale del Lazio e della Toscana "Mariano Aleandri". 2020. Good beekeeping practices and bio-security measures in beekeeping.
- Thakur M. Bees as Pollinators – Biodiversity and Conservation. *Int. J Agric. Sci.*, 2012, 2(1): 001-007
- Tlak Gajger I, Mañes AM, Formato G, Mortarino M, Toporcak J. Veterinarians and beekeeping: What roles, expectations and future perspectives? - a review paper. *Vet. Arh.*, 2021, 91 (4), 437-443. <https://doi.org/10.24099/vet.arhiv.1444>.
- Tomljanović Z, Tlak Gajger I, Santrač V. Good Veterinary Praxis in Apiary. Bayer Animal Health, Zagreb (in Croatian) 2012.