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Chapter 18

Training for beekeepers

ING.18.1 INTRODUCTION

This chapter shares the experience gained by the Beekeeping Academy of Slovenia (BAS) during its training activities. BAS was founded as a department of the Agricultural Institute of Slovenia, with the aim of raising awareness of the importance of nature and bee protection, as well as the crucial need for GBPs, informed by the latest scientific knowledge. During its activities, the main pillars of training in good beekeeping practice were described to trainees.

18.1.1 First pillar: train the trainers

Before the training courses were implemented, the first group of beekeeper mentors was selected by public invitation. We prepared some essential documents to define BAS's vision, mission and strategy. All candidates for beekeeping mentors found their roles in the BAS code of ethics. In order to impart the maximum amount of knowledge of GBPs, we selected a team of highly motivated long-term beekeepers. Not only do they have a high level of beekeeping expertise, but they also have a positive attitude and desire to pass on their knowledge and skills to the course participants. In order to fulfil the need to standardize knowledge, we have consulted all the candidates and prepared a training programme which complements the individual knowledge required to become a beekeeper.

18.1.2 Second pillar: peer-to-peer education

The key to a global view of GBPs is cooperation with international beekeeping and educational institutions. We strive to exchange knowledge between BAS beekeeping trainers and other trainers around the world and try to organize an international exchange every year. At the end of each training semester, each beekeeping trainer prepares a new topic to present to their colleagues at the BAS seminar. During peer-to-peer learning sessions, the beekeepers share their knowledge and create their own online library of Power-Point presentations, which are available to all colleagues who teach GBP training modules at BAS.

18.1.3 Third pillar: problem-based modules

BAS offers informal training courses in beekeeping – innovative courses which are innovative, topic-oriented and problem-based. The training begins with a general overview of beekeeping – this is an introductory step before the actual problem-based learning begins. The course provides

a theoretical overview of beekeeping in general, which is presented to the candidates by the BAS experts. Part of the course is dedicated to a debate on specific topics, which serves as a basis for further selection of the right level of training. The training courses are organized on several levels, both in terms of content and scope. In principle, the training can be divided into two main areas:

- General: A basic course, the duration and content of which can be adapted to the objectives and circumstances of the participants and/or their environment.
- Specialized: Courses on specific topics, including Beekeeping Technologies, Food Safety, Bee Health, Marketing of Apicultural Products, Queen Bee Breeding, Beekeepers as Promoters of Biodiversity and Beekeeping for Disabled People. The lengths of the courses vary.

Finally, we have developed a training module on bee tourism. Bee tourism is BAS's flagship module and we are very proud of it. It is the thread that connects all the specialized modules, leading to superior wellness experiences, and educational and congress tourism. Bee tourism is a further development of the well-known apitourism, which was developed by the first generation of beekeeping instructors in 2020.

Tourism is a fast-growing industry, and we are constantly surprised by its innovations. It is our shared responsibility to prepare for them, and we have to accept them. Bee tourism is much more than a traditional beekeeping activity – it also approaches beekeeping from a broader perspective, including the categories of green, sustainable, accessible, heritage, creative, educational and congress tourism. In addition to cultural and natural heritage, bee tourism is linked to traditional and contemporary world cultures, perfectly illustrating the need to reconcile economic growth with sustainable development. Our first-generation specialized instructor has created a module of the beekeeping guide intended for international students. The guidance always comes from the local environment and is based on the local beekeeping heritage, combining local beekeeping science, professional knowledge, practice and cultural heritage. It therefore enables the continuation of studies in other specific areas for beekeeping problem-oriented training modules.

18.1.4 Fourth pillar: linking practice with science

In all the BAS projects that we carry out abroad, we try to combine the practice and professional knowledge already in the pre-project phase (Figure 114). Projects are always

FIGURE 114
Connection with the Holeta bee research centre:
a fact-finding mission in Ethiopia



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divided into several phases – steps that can be carried out depending on the available financial resources and needs of the local environment. In each phase we move from the professional knowledge to practice and vice versa.

Step 1: the fact-finding mission

The first step is to prepare and to ascertain the beekeepers' knowledge needs. This requires data collection and the exchange of knowledge and experience between BAS trainers and interested customers.

Step 2: project proposal and first training group

The composition of the team that shares their knowledge and the first generation of participants the project is crucial. The BAS team always includes mentors – highly qualified trainers in the fields of practical beekeeping, biology, veterinary medicine, and heritage interpreters.

Step 3: beekeeping equipment and analysis of first beekeeping season

BAS adapts the first beekeeping season to local climatic conditions and ensures that the schedule for the equipment is properly established. After the end of the first season, a joint consultation is held between all project partners in which we decide on further procedures based on the estimated statistics resulting from analysis of the whole season.

Step 4: marketing of project goals

BAS completes the project with a special module on marketing approaches. We prepare training sessions for interested project partners with marketing knowledge. During this step, we work with successful companies that are active in the beekeeping market and have established themselves internationally. We start with their success stories and examples of good practice and also share sustainability knowledge (Figure 115). One of our guiding principles is that “it is not enough to give people the honey – they must also know how to sell it”.

FIGURE 115
An example of good marketing practice from the
Ethiopian project: selling traditional and culturally
significant bee wax products



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18.2 ROLE OF UNIVERSITIES IN APICULTURAL DEVELOPMENT

18.2.1 Relevance of training, research and education in beekeeping

Universities play an essential role in developing innovation, skills and extension services focused on the local needs of beekeepers around the world. Universities conduct research and provide education programmes aimed at informing decisions and best practice for productive, profitable, resilient and sustainable beekeeping systems. Much of this research is carried out by various national and international agricultural research bodies including public- and private-sector research institutions and universities. The outcomes of this research have impacts that are central to overcoming the continuously changing social, environmental and economic challenges of apicultural development; raising public awareness; and providing preconditions for informed decision-making, responsible behaviour and consumer choice. In seeking to strengthen beekeeping systems, research institutions and universities can:

- help adapt beekeeping systems and practice suited to local biogeographic, climatic, social and economic conditions;
- facilitate dialogue among beekeeping industry stakeholders to develop a consensus on strategic vision, goals and priorities for action;
- provide critical analysis and provision of the knowledge and skills required to meet changing needs;
- reform beekeeping education, trade and honeybee biosecurity policies;
- enhance inclusivity and gender equity in beekeeping research and development;
- develop strategies to combat new diseases and pests that are spreading globally;
- improve training, extension and educational curricula to make them more relevant and responsive to the needs of beekeepers;

BOX 11

Challenges of the near future – post-COVID-19 education modulates

The sudden emergence of COVID-19 has led to global economic turmoil with a fatal impact on tourist flows. The Organisation for Economic Co-operation and Development (OECD) stated that COVID-19 has presented the global economy with its greatest danger since the Great Recession between 2007 and 2009. According to the World Travel And Tourism Council (WTTC), the pandemic may cause the global travel and tourism sector to shrink by up to 25 percent in 2020, putting up to 50 million jobs at risk. The World Tourism Organization (UNWTO) reported that international tourist arrivals could fall by an average of 20–30 percent in 2020. Skift Research shows that 90 percent of companies have cancelled or rescheduled their international business trips (Skift Research, 2020). This is a new challenge for the Beekeeping Academy of Slovenia (BAS), which relies on international activities and educational bee tourism. During the crisis, the BAS will take three steps.

Step 1: Communicate and cooperate

We must show empathy, understanding and support. It is extremely important to support the community. During this step, we reach out to other Slovenian good

beekeeping practice (GBP) networks, for example the BeePathNet network in Ljubljana. The beekeeping tradition in Ljubljana and its surroundings dates back to the first prehistoric settlements. There are over 4 500 active beehives in Ljubljana, with the city being home to 3 percent of all beekeepers in Slovenia. Beekeeping continues to flourish in Ljubljana, bolstered by the city's Culture and Congress Centre. The Bee Path was designed in October 2015 and already has 35 members from educational and cultural institutions, health centres, economic entities and, of course, beekeepers and beekeeper associations. It is more than a path – it is a movement of like-minded people who ensure the well-being of bees in the city, with very different activities. For this reason, Ljubljana has developed new tourist products presenting the natural and cultural heritage of beekeeping in the city.

Step 2: Act and be creative

This step is the most difficult and yet the most important. We need to move away from the term “recreation” and start redefining products. Now is the time for adaptation and flexibility. Based on our training modules, BAS will expand our offering with virtual training courses and the possibility of virtually hiring a beekeeping instructor (Figure 1).

Step 3: Be proactive

We must mitigate the current situation, restart our operations and redefine our roles. BAS is well aware that projects abroad should be based on local knowledge and on local beekeepers. To demonstrate BAS's proactivity, we are planning several online promotional webinars (Figure 2) to share GBP examples in Slovenia.

FIGURE 1
Promotional webinar organized by the Beekeeping Academy of Slovenia to mark the third World Bee Day as an example of the shift towards virtual offerings



FIGURE 2
A beekeeping instructor conducting a practical beekeeping lesson online



- strengthen partnerships between other academic institutions, the beekeeping industry, the private sector, government agencies and NGOs.

Bridging research and practice should also be a key priority in beekeeping industry development activities and strategic priorities. A major challenge in improving the productivity, profitability and sustainability of beekeeping enterprises is the need for enhanced access to information, new skills and practices and mechanisms to collaborate through means of training, education and extension (Schouten and Lloyd, 2019) (Figure 116). This requires that farmers have access to what they perceive to be relevant information and knowledge. Community consultation, communication and education have thus become what many consider to be the key links between stakeholders, extension and research, for planning and implementing consensus-based development initiatives. However, it is a far too common occurrence in beekeeping research and development interventions that the stakeholders themselves have not been included in informing research, education and extension approaches and many projects have failed or had significantly reduced impact as a result (Anderson *et al.*, 2012; Schouten and Lloyd, 2019).

Beekeeping research institutes and university centres are continuously evolving and releasing new information, approaches and technology, but due to weak systems for information communication, not all the technical information is reaching those for whom it has been compiled (Asopa and Beye, 1997). More attention to effective communication could help to overcome this, with creativity and engagement, harnessing the power of publications, summary fact sheets and newsletters, short videos and podcasts, preparation and provision of simple audiovisual aids, information centres with skilled technical officers,

organization of exhibitions and beekeeping show days, organization of face-to-face and online workshops, seminars and symposiums for farmers and extension workers and rapid dissemination of activities and information via television, radio and local-language newspapers.

COLOSS, a non-profit association focused on prevention of honeybee COLony LOSSes, provides an excellent example of effective scientific communication through its core project B-RAP (Bridging Research and Practice). B-RAP activities are focused on finding ways “to ensure that learning and understanding generated reaches the beekeepers and leads to modified practice” and actively involves scientists, students, beekeepers and veterinarians in discussions, sharing best practices and communicating with beekeepers to provide “timely data that helps beekeepers to make informed management decisions” (Bee Informed Partnership, 2020).

Universities are critical in providing access to peer-reviewed data and research to inform the effectiveness of beekeeping management practices and are central to development of technical skills of value to honeybee industries. Universities should also seek to enhance the development of inclusive partnerships and the promotion of best practices suited to local conditions, which in turn effectively connect institutions to beekeepers and improve the quality of research, education and extension in beekeeping development.

Significant efforts have also been made to strengthen the agricultural research capabilities of low and middle-income countries through international agricultural research partnerships developed by FAO, the Australian Centre for International Agricultural Research (ACIAR) and the Consultative Group for International Agricultural Research (CGIAR), for example, Figure 117. While there have been mixed results, there is no doubt that these efforts have been responsible for a significant acceleration in the development of research services and agricultural development in many countries. It should not be overlooked that these research partnerships enhance honeybee research understanding, knowledge and skills for other regions, particularly in regard to informing best practice for identifying, monitoring and managing new and emerging honeybee pest and diseases and biosecurity threats.

18.2.2 Obstacles and challenges

Recent studies highlight that while honeybees and beekeeping provide significant contributions to household incomes, enhance the resilience of natural ecosystems and significantly contribute to nutrition and food security, beekeeping research and interventions should not overlook the fact that honeybees, like other livestock, require a One Health approach to their management. Specifically, this means attention must be paid to floral resources, strategic supplementary feeding and good honeybee nutrition, pest and disease management,

FIGURE 116
The knowledge triangle of research, education and extension in supporting beekeeping stakeholders and the beekeeping industry

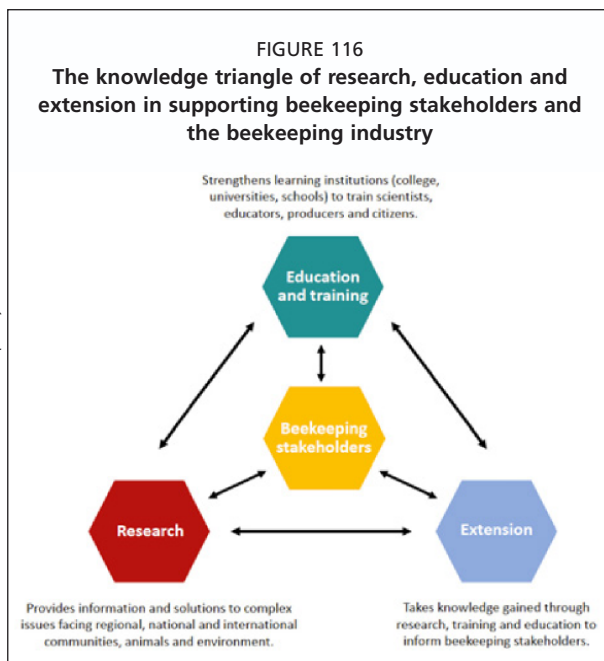


FIGURE 117

(a) Beekeeper Henao Longgar inspecting a beautiful pollen frame in the Eastern Highlands Province of Papua New Guinea. (b) Wilson Tomato, Dr Cooper Schouten and Billi Paki harvesting honey on extension visits supported by New Guinea Fruit Company Ltd., Oxfam and the Market Development Facility in Papua New Guinea. (c) Instrumental insemination of queen bees at the Agricultural institute of Slovenia where students learn valuable beekeeping research skills. (d) Prof David Lloyd training beekeepers in Labasa, a town in Vanua Levu, Fiji, as part of an Australian Centre for International Agricultural Research programme.



genetics and sound queen bee breeding, technology and importantly, appropriate education, training and extension support mechanisms in order to be successful. In many cases, the production, profitability, sustainability and resilience of beekeeping systems can be improved; however, activities which do not take into account the overall enabling environment are less likely to create systemic positive social, environmental and economic impacts.

A common challenge in creating impacts that result from the outcomes of beekeeping research and development is stakeholder engagement, and also the need for, and challenges of, implementing multidisciplinary teams. The skills required to build a supportive beekeeping value chain are cross-cutting, spanning the disciplines of livestock farming,

entomology, biology, genetics, marketing, economics and business management, agriculture, forestry, botany, food science, community development and sociology. Universities can help address these challenges through effective research and extension management and partnerships, but there is significant scope to enhance multidisciplinary approaches to beekeeping interventions, to reduce silos and to enhance social, policy and environmental research impacts.

The drivers which determine impacts on farmers and their environment can often fall outside the scope of the technical expertise employed in proposed projects, which highlights the need to encourage the use of transdisciplinary team approaches and programmes based on shared learning and joint investigation. These lead to partnerships

and engagement that draw upon diverse skillsets and knowledge to understand varied relationships, causes and solutions to problems within agricultural production systems. Beekeeping programmes continue to offer valuable opportunities for shared learning on international agricultural challenges and improving livelihood outcomes for marginalized communities in developing countries.

Below is a non-exhaustive list of several of the core challenges in providing sound research, education and extension for creating meaningful and impactful beekeeping interventions:

- Beekeeping educators often have limited applied beekeeping technical skills.
- In some countries, beekeeping extension agents tend to have little accountability for the quality and quantity of their extension efforts and little incentive to share knowledge and skills.
- Beekeeping training and education approaches often become convoluted and fail to focus on core beekeeping skills (for example, how to split a colony).
- Beekeeping training is often theory-based and short-term, rather than practical and based on long-term mentorship, which is required to gain a sound understanding of bee breeding.
- Beekeeping trainers or extension agents may have significant technical beekeeping skills but use ineffective, non-inclusive and inefficient teaching approaches.
- Researchers can fail to understand the broader context into which their research fits and more attention is needed to improve communication and stakeholder engagement and participation throughout the research.
- Researchers may not have effective capacity for scientific communication and effective dissemination of research outcomes to encourage adoption of best practices and approaches among education and extension agents and stakeholders.

18.3 STRATEGIES TO IMPROVE APICULTURAL RESEARCH, EDUCATION AND EXTENSION

Improved communication strategies and ongoing partnerships are essential to developing needs-driven research, education and extension approaches to solving problems and responding to emerging challenges. Universities, working in collaboration with professional and small-holder beekeepers and other key actors along the honey value chain, are central to taking on the threats of climate change, deforestation and land-clearing, colony collapse disorder, indiscriminate use of pesticides, and new and emerging honeybee pests and diseases.

The appropriate level and approach to research required (basic, strategic, applied or adaptive) to overcome specific

challenges depends on the nature of the problem. Particularly in many developing countries, both interdisciplinary research – involving a systems-based approach – and participatory research methods are required, with the greatest emphasis necessarily placed on taking a more applied and participatory approach.

We propose the following 16 recommendations for improving approaches to beekeeping education, extension and research at the university level:

1. Actively develop strategies for empowering women in apicultural science, education and extension to play a greater role in their nations' policy- and decision-making processes.
2. Develop an "beekeeping young leaders' programme" to identify emerging leaders in the field of apicultural research and enhance their leadership, research, extension and project management skills.
3. Ensure that educators and extension agents have sound community development, teaching and extension skills in addition to applied technical beekeeping industry skills.
4. Engage beekeeping industry stakeholders and the community to ensure that the research outcomes used to inform education and extension activities are based on their needs and priorities.
5. Promote opportunities and develop research topics for young beekeeping researchers, encouraging the development of applied beekeeping technical skills.
6. Improve beekeeping training to enhance applied learning and skills-based outcomes.
7. Adapt beekeeping curricula to local contexts to ensure the information provided is relevant.
8. Strengthen approaches to science communication among education providers and extension agents through field days, online videos and conferences.
9. Support interactive distance-learning programmes to offer new insights and collaboration opportunities to people from remote and rural areas who are involved in the beekeeping sector.
10. Develop the technical, research and communication capacity of beekeeping research specialists (social sciences, honeybee nutrition, genetics, pests and diseases, technology and quality of bee products).
11. Improve the mechanism for teachers in educational institutions to develop and peer-review the relevance and technical aspects of educational materials and practical activities.
12. Enhance partnerships to produce efficient training and research forums for all aspects of beekeeping, with greater emphasis on environmental and social impacts and sustainable development in low and middle-income countries.

13. Improve opportunities for mentorship and the quality of training and supervision of scientists, their facilities and working environment, and their motivation and rewards.
14. Develop industry representative boards which include all stakeholders and provide capacity-building for governance and management in order to develop clear goals, strategies and priorities for apicultural industries and to identify and appropriately deploy staff and research stations to investigate them.
15. Provide enabling environments for the development, critical review and evaluation of meaningful performance indicators for extension, teaching and research.
16. Develop and improve additional measures of extension and research performance indicators to include the benefits and costs of non-farm extension programmes rather than exclusively focusing on-farm productivity.

Finally, project developers should identify available experts at local or national universities and involve them in project implementation. Training at the university level: medicine (veterinarians) and agricultural sciences (agronomists)

18.4 TRAINING AT THE UNIVERSITY LEVEL: MEDICINE (VETERINARIANS) AND AGRICULTURAL SCIENCES (AGRONOMISTS)

18.4.1 Relevance of training in beekeeping

Honeybee management must be carried out by trained professionals. Educational institutions often include beekeeping-sector topics in their curricula, such as veterinary medicine, agronomy, biology and engineering, among others, covering general and specialized aspects of beekeeping. This chapter discusses the university training of veterinary medicine and agronomy students. The training of other professionals is addressed elsewhere, in chapter 18.

The One Health approach is a collaborative and interdisciplinary strategy for achieving optimal health for humans, animals and the environment. The Western honeybee (*Apis mellifera*) serves as an example of the One World, One Health concept because it is a species dependent on the environment that is currently affected by a health crisis likely to reduce human food security and well-being in the future. Therefore, honeybee colonies need and deserve veterinary care, and beekeepers need veterinarians, just as other animal farms do.

Agronomists have a long history of obtaining significant skills related to the biological, ecological and productive aspects of honeybee breeding and can play a well-defined professional role in beekeeping. Conversely, veterinary medicine stakeholders, particularly veterinary practitioners,

have yet to become significantly involved in honeybee health. There are some exceptions, like some eastern, central and southern regions of the EU, where faculties of veterinary medicine have honeybee biology and diseases as part of their core curricula, but this veterinary field, previously considered “minor” in this sector, is becoming increasingly conscious of the stakeholders involved in the current honeybee health situation. A few decades after the beekeeping sector began suffering huge colony losses, the first international research, diagnostic and epidemiological surveillance networks were developed.

18.5 VETERINARY EDUCATION AND BEEKEEPING

Role of veterinarians in beekeeping

Beekeeping is more dependent on complex environmental factors than any other animal or food production industry. This important economic sector is currently facing a health crisis. The health of honeybee colonies is a crucial factor for successful beekeeping and the production of quality food products. The influence of multiple environmental stressors, pathogens and pests has been recognized as a possible cause of the decreased strength or increased mortality of honeybee colonies. To face up to the challenges posed by the current situation, strong public- and private-sector veterinary services will be required to manage the surveillance, control, eradication and prevention of honeybee diseases within their territories in close collaboration with beekeepers. Continuous improvement in the legal framework and resources of national veterinary services are also critical to this operation, including support for establishing and maintaining honeybee research and testing laboratories. Veterinarians have an important role to play in ensuring the health, sustainability and productivity of managed honeybee colonies, public health, and ecosystem conservation. Implementing good veterinary, beekeeping and environmental practices can guarantee the safety of apicultural food products as well as environmental biodiversity.

More specifically, veterinarians can and should actively participate the evaluation and management of honeybee health, and in notifiable disease monitoring, prevention, control and eradication. This applies to all regulated areas around the world. It is now known that veterinary studies programmes throughout Europe and the rest of the world have varying levels of honeybee biology and pathology tuition in their curricula. It is an area of veterinary medicine to which undergraduate students get little exposure during their regular studies, but as veterinarians they should have knowledge and practical skills to hand for the performance of medical examinations of honeybee colonies and other veterinarian tasks at apiaries.

The main tasks and core competencies that a veterinarian must acquire in order to be qualified to practice in apiaries include:

- clinical inspection of honeybee colonies while taking the proper safety precautions;
- recognizing signs of disease on brood and adult bees;
- carrying out official sampling, and completing the formal documentation for the delivery of the sample(s) to an authorized diagnostic laboratory;
- the basics of laboratory examinations;
- performance of serious disease control, prevention and eradication measures in the regulatory framework governing the honeybee sector at the local and international level.

Veterinarians must also be able to take proper anamnestic data which is essential for making proper diagnoses and advising on disease control and prophylaxis. "Anamnesis" is the collection of an account of someone's medical history. In this case, veterinarians collect beekeeper's accounts of the bees' medical history. The data that the veterinarians collect must be as detailed as possible, including the date of first observation or occurrence of the symptoms (disease signs on brood or adult bees, changed behaviour patterns in adult bees) and an evaluation of said symptoms, the type of beekeeping (traditional, organic, extensive, intensive, primary production of honey or other bee products, or colonies reared to offer pollination services), past migratory routes in intensive beekeeping, the apicultural (density of the apiaries) and agricultural (surrounding crops) environment, water access parameters, the frequency of colony and apiary inspections, the yearly regime of Varroa mite control methods used and other (bio)technical procedures carried out at the apiary. Veterinarians should also encourage beekeepers

to keep and maintain good records of their apitechnical practices that include crucial information such as a log of dates of medical examinations of their colonies (recording the appearance and amount of brood, morphology and behaviour of adult bees, amount of stored natural food, weakening, mortality, collapse, status of debris on the hive floor), disease or intoxication, suspicious in-hive material, sampling for laboratory examinations, applications of veterinary products or other acaricides against Varroa mites (name, dose, efficiency during the first part of the treatment period), frequency and manner of colonies' supplementary feeding, sanitary audits, and veterinary inspections and interventions.

Veterinarians are able to prescribe appropriate veterinary medicine products. The public health risks that beekeeping products pose to humans mainly derive from hazardous residues of antibiotics and their degradation products, acaricides, environmental xenobiotics, and toxic and allergenic substances found mainly in honey and wax. Allergic reactions to bee stings are an additional risk.

Veterinarians must also be able to carry out in-apiairy tasks linked to epidemiological studies, surveillance or monitoring programmes.

Because of the significant economic importance of the transport and trade of honeybees around the world (especially the transport, trade or exchange of honeybee queens, adult bee packages, honeybee products, and beekeeping equipment – tools, supplies and medicines), veterinarians must take all the actions prescribed in national and international regulations to control and prevent the spread of honeybee diseases. Veterinarians and veterinary services are

FIGURE 118

As part of their clinical classes in the compulsory module "Biology and Pathology of Beneficial Insects", veterinary students from the University of Zagreb Faculty of Veterinary Medicine carry out special clinical work at an apiary in order to gain good "hands-on" skills (2019)



FIGURE 119
Group photo of students after a session of honeybee parasite monitoring at the apiary of the University of Milan Faculty of Veterinary Medicine (2019)



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responsible for advising stakeholders on the transport and trade of honeybee and bumblebee colonies in accordance with EU law and international standards and also for ensuring the enforcement of this legislation.

Veterinarians may become involved in apiary examinations and official reporting on general honeybee farm management, as well as in assessments of the sanitation level of beekeeping practices at the request of insurance companies. They can be invited to remove wild colonies from residential settings. They can also work as court experts in the field of honeybee diseases, poisoning or other disorders.

All the above-mentioned tasks require good interpersonal communication skills and experience working with beekeepers in the field. Since practical skills are of critical importance for veterinarians working at apiaries, these are also integrated into continuous professional development courses to foster professionalism in veterinary medicine.

Current situation of veterinary education in Europe

Veterinary curricula in Europe are constantly adapted to reflect scientific developments, to comply with the applicable legislation, and to meet the societal demands and the needs of the job market. This is the case of all aspects of veterinary medicine, including the teaching of honeybee biology, physiology, behaviour patterns, health, diseases and production management, and the quality of beekeeping products. A recent study, jointly conducted by the European Association of Establishments for Veterinary Education, the Federation of Veterinarians of Europe and a few experienced lecturers from faculties of veterinary medicine, looked into whether honeybee veterinary medicine

is part of the curricula in European veterinary educational institutions (faculties of veterinary medicine). According to Iatridou *et al.* (2019), the results showed that 58 of the 77 faculties of veterinary medicine included honeybee veterinary medicine in their curriculum. These honeybee veterinary medicine sessions were either obligatory (module(s) in the core curriculum that all students need to complete), elective (courses offered to students as an option), or partly obligatory and partly elective. The results also showed that 33 of the 58 faculties of veterinary medicine included honeybee veterinary medicine in the core curriculum, 17 provided it on a partly obligatory and partly elective basis, and 8 of them offered it as an option to take up if interested. Twenty-five of the 58 faculties had a separate honeybee veterinary medicine course and 33 incorporated this topic into other courses. In terms of geographical distribution, it was observed that honeybee veterinary medicine was part of the veterinary studies curricula in at least one faculty of veterinary medicine in each country in southern, central and eastern Europe, while there were a few countries in north-western Europe in which none of the faculties included honeybee veterinary medicine in their study curricula.

The veterinary profession in Europe strongly promotes the principle of continuous professional development and encourages all faculties of veterinary medicine to develop postgraduate opportunities to meet veterinarians' needs. Veterinarians certainly have a role to play in European beekeeping and therefore have to be prepared to work in this area. While most of the faculties of veterinary medicine – over 70 percent – recognize this need and dedicate a considerable part of their very comprehensive core curriculum

to the teaching of honeybee veterinary medicine, more effort is required to raise awareness of the importance of this insect species and its needs. Honeybee veterinary medicine is currently reasonably well covered in veterinary studies curricula, but it is continuing to receive the less attention in undergraduate veterinary curricula than other less popular fields of veterinary medicine. According to the study, postgraduate honeybee veterinary medicine programmes are available in 13 European countries, the level of which varies from short one-day courses to PhD programmes and national specialization programmes.

One of the main problems faced by veterinarians in beekeeping is the high level of variability in apiaries and the many colony registration requirements in the EU. Indeed, in countries where colony registration is voluntary, the total population of beekeepers and colonies is only an estimate. Chauzat *et al.* (2013) found that even in countries where honeybee colony and apiary location registration is mandatory, the total population of beekeepers and colony numbers on the register was still inaccurate in some countries. The requirement to officially declare the number of colonies in order to keep and rear bees, and fear of some monitoring duties or additional taxes, often deterred beekeepers from registering. As it is not possible to put this insect species completely into quarantine (because adult bees need to leave the hive to meet their physiological needs for natural

food supplies, mating and swarming), all apiaries must be inspected during sanitation or eradication of notifiable diseases after outbreaks (not just reported), or to ensure correct health surveillance is in place. Obtaining accurate information on the beekeeping industry is dependent on the registration of each beekeeper, apiary location and honeybee colony, and therefore, registration should be made compulsory. The record should be managed by a competent authority, which would be in charge of a centralized national database in each country. A comprehensive beekeeping record enables veterinary organizations and other health authorities to provide a rapid and efficient response in the event of a major health crisis and eventually leads to better understanding of honeybee physiology and health protection patterns.

It should also be highlighted that there is a remarkable lack of appropriate veterinary medicine products authorized for the treatment of honeybee colonies in the European beekeeping sector. In fact, acaricides to control Varroa mites are the only approved medicines in the EU. In the case of diagnosed clinical visible signs of a disease for which no available authorized product exists in the country, veterinarians are the only professionals able to select and prescribe (under the cascade system) the appropriate veterinary medicine for use in beekeeping, usually a medicine authorized for use in honeybees in another country. The use

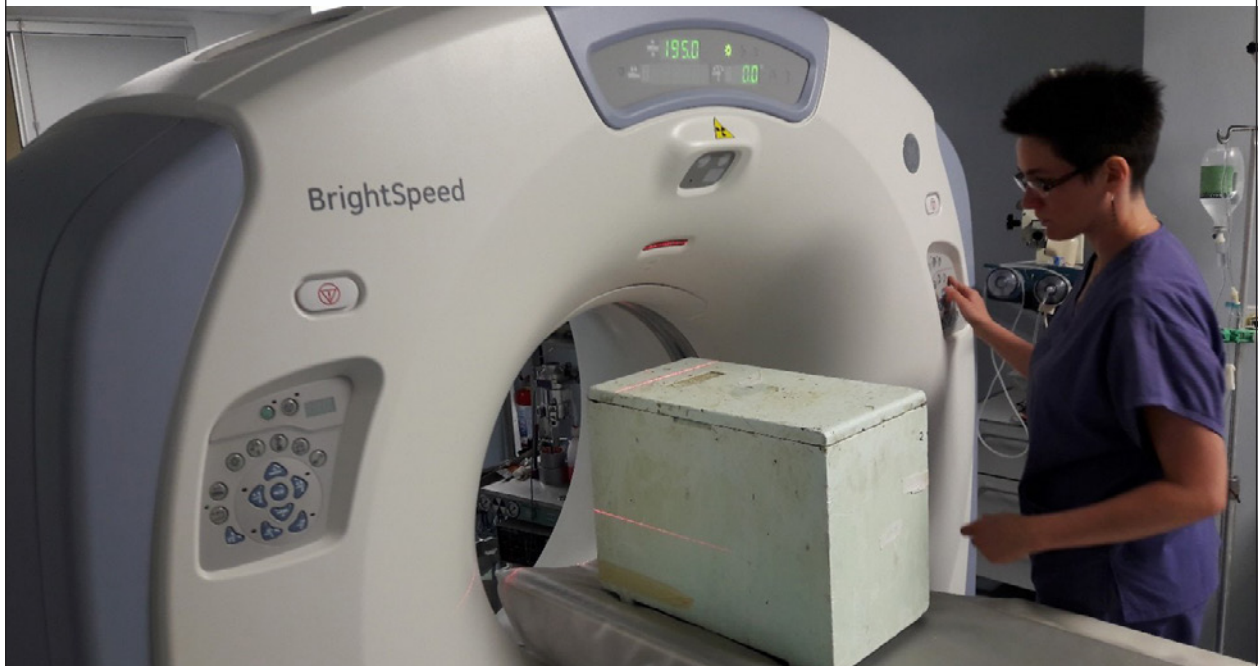
FIGURE 120

Veterinarians and beekeepers primarily collaborate on testing of official samples sent to the laboratory when a disease is suspected (in this case the Laboratory for Bee Diseases – APISlab). Veterinary students at the University of Zagreb Faculty of Veterinary Medicine learn how to detect certain diseases, how to perform a medical examination of a honeybee colony and how to submit the in-hive material for laboratory testing. They also acquire the skills necessary for proper application of veterinary medical products (2019)



FIGURE 121

Veterinary medicine students at the University of Milan Faculty of Veterinary Medicine can learn how sophisticated imaging tools like computed tomography scanners can be used for non-invasive monitoring of honeybee brood health (2018)



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of antibiotics in honeybees is practically forbidden in the EU, whereas in other parts of the world – for example, the United States of America – they can be used if prescribed by a veterinarian. Therefore, veterinarians play a key role in selecting the right veterinary medicines to treat honeybee colonies, in advising beekeepers on the responsible use of these products and in informing beekeepers about withdrawal periods, residues and risks related to the development of resistance, as well as possible adverse reactions after treatment.

Strategies to improve and support the sector

Over the last few decades, uncontrolled inter- and intra-national exchanges and trade of honeybees and other goods have led to the spread of diseases, including new pathogens, parasites, predators and pests in EU territory. This has been well acknowledged by EU policymakers, who have called for a number of supporting initiatives over the last ten years, including the education of veterinarians, for the protection of managed honeybee colonies, wild bee populations and European beekeeping.

Promotion and harmonization of honeybee veterinary medicine in veterinary studies curricula is vital to enable graduate veterinarians to acquire the necessary skills, competencies and experience to practice veterinary medicine in apiaries. This should prepare them to handle, examine, diagnose and treat honeybee colonies, as well as to ensure the safety of hive products. If they are given this opportunity, veterinarians will be able to make a greater contribution

to ecosystem sustainability and the availability of safe and nutritious food for humans in the future.

Policymakers and industry stakeholders should support the beekeeping sector by encouraging beekeepers to seek veterinary advice and to establish a good working relationship with a veterinarian. According to Vets4Bees International – a consortium to educate and inform veterinarians dealing with bees – implementing the One Health approach using good veterinary, beekeeping and environmental practices can guarantee the safety of bee products for human consumption, as well as sustainable bee health protection patterns. Public health authorities may also foster cooperation between veterinarians and beekeepers by promoting technical committees that bring together veterinary officers, academics and beekeepers' associations and by including beekeeping as a strategic objective in their animal health policies. New legislation initiatives at national and international levels can promote accreditation programmes for bee farms complying with sanitary protocols for disease detection and control under the supervision of veterinary officers. The outputs of these programmes can allow evidence-driven prioritization of hive health preclinical and clinical indicators, and modulation of the veterinary controls based on risk analysis of the accredited farms.

All the above considerations confirm that honeybee veterinary medicine must be part of the core veterinary medicine curricula. They also confirm that honeybee health must be an obligatory component of veterinary medicine studies within faculties of veterinary medicine. To achieve

this, the establishment of university chairs for honeybee health and the availability of textbooks on honeybee veterinary medicine should be promoted. All veterinary students must acquire the minimum knowledge of and training in honeybee biology, physiology, behavioural patterns, health and diseases, as well as production and trade of bee products, and the bee products market. Every veterinary student should be encouraged to work with this managed insect species, gaining hands-on experience, and, once they graduate, to become members of honeybee veterinary medicine scientific and professional associations to obtain and promote continuous professional development and training, awards and scholarships. Increased competencies among veterinarians will ensure better relationships and involvement with beekeepers. Moreover, in the long run, the establishment of geographical networks of honeybee veterinarians will provide beekeepers with effective bee health assistance and support for their activities in the field.

18.6 AGRONOMY EDUCATION AND BEEKEEPING

The practical management of social bees (Hymenoptera, Apoidea) for farming purposes is deep-rooted in the field of agricultural sciences. In the current EU landscape, university, research and technology departments dedicated to agricultural sciences mainly focus on three broad areas relevant to everyday life: agriculture, food and the environment. The practical management of social bees fits perfectly into all these areas. Firstly, maintaining social bees is crucial for agriculture as a whole because of the pollination services that both honeybees and primitive social bees like bumblebees provide. However, development of precision beekeeping for agricultural purposes and maximization of productivity, as well as pollination efficiency, is a major research challenge.

Secondly, *A. mellifera* bees are a significant source of nutraceutical foods such as honey, among other bee products. Bee venom in particular has sparked a great deal of interest in biomedical, while the nutraceutical value of royal jelly, bee pollen and bee bread has recently caught the attention of researchers worldwide. It is worth noting that honey is an ingredient used to produce niche food and beverage products of high economic value, typical in several EU areas, such as hydromel, which are also coveted by niche tourism clientele.

Lastly, bee health is closely linked to stable and safe environments and rural areas: research has long demonstrated the reliability of bees as key ecological indicators (Gilioli *et al.*, 2019; Tlak Gajger *et al.*, 2019). More recently, the topic received significant attention from both researchers and the general public, due to the negative effects of pesticide overuse on social and solitary bees worldwide (Tsvetkov *et al.*, 2017; Tlak Gajger *et al.*, 2017; Wood and Goulson, 2017). The latter issue is, in turn, linked to the

reduced safety of food products obtained from beekeeping activities (Mitchell *et al.*, 2017; Tu and Chen, 2020).

Given the above, it is unsurprising that beekeeping teaching and research has been encouraged and embraced by most agricultural science departments and research institutions in the EU, including a plethora of world-renowned centres of excellence. Top-ranking examples within the EU area include – but are not limited to – the Institute for Bee Protection at the Julius Kühn-Institut, Albersweller (Germany), the Swiss Bee Research Centre, Bern (Switzerland), the Unité de Recherche Abeilles et Environnement [Bees and Environment Research Unit] at the French National Institute of Agricultural Research, Paris (France), the Centro Agricoltura Ambiente G. Nicoli [G. Nicoli Agriculture and Environment Centre], Crevalcore (Italy), and the Institute of Biology at Freie Universität Berlin (Germany).

Beekeeping and apiology teaching are routinely delivered at the M.Sc. level. They are usually enthusiastically embraced by students, as they present a unique opportunity to combine basic insect science knowledge with the technical aspects of beekeeping, which can open the door to significant economic opportunities. The courses that agronomical science universities offer to their students can be both mandatory and elective. In comparison with the veterinary field, university education in the agronomic field places greater emphasis on educating students on the biology and ecology of bees, and on teaching them the technical aspects related to queen breeding and colony keeping. The students who successfully complete the course leave with in-depth knowledge of the honeybee's morphology, biology and ethology and the challenges they present. Moreover, they have the technical skills required to manage honeybee colonies, and to analyse and correlate the factors influencing their rearing or the use of honeybees to enhance pollination of crops. The goal is to train professionals capable of working with beekeepers on the management and environmental aspects of beekeeping. Generally, university courses in this field provide skills in the genetic selection of bees, the management of general and specific colony threats, and the production and marketing mechanisms of beehive products, as well as national and international legislation specific to the beekeeping sector. Agronomists also need to gain knowledge and understanding of the ecological role of bees and their nectariferous and polliniferous potential resulting from their interaction with cultivated and spontaneous flora. Agronomy graduates working in the beekeeping sector are primarily employed as technicians and consultants for beekeepers and their associations, as well as by companies and public and private institutions. A significant amount of this work is research-oriented. The beekeeping sector can take particular advantage of agronomists' skills in genetic selection, choosing the best breeding strategies and choosing the

right production tools based on the specific environmental, climatic and botanical conditions of the different territories.

18.7 THE ROLE OF BEEKEEPERS' ASSOCIATIONS IN PROMOTING SUSTAINABLE BEEKEEPING

Beekeepers' associations have the potential to play an important role in helping beekeepers to acquire new skills and adopt sustainable beekeeping practices.

In general, they offer a range of services and events that disseminate GBPs. Among the most common initiatives are courses and workshops. These usually involve a theoretical component followed by practical experience in the apiaries to help participants master the techniques learned. A significant amount of dexterity is required to handle the bees in an efficient and non-invasive way. These courses are offered at various age-group levels, including summer camps that allow children to familiarize themselves with hives and combs, learn to recognize different bee cells and use basic beekeeping equipment. One of the advantages of this kind of training is that it often leads to the establishment of mentoring relationships in which more experienced beekeepers assist newcomers and teach them all the tricks of the trade.

The development of beekeeping today depends on more continuous learning and on updating practices to make them more sustainable. One of the challenges of this task is that there are basically two very different prevailing approaches to beekeeping (but there are other approaches that fall somewhere in between the two). One is more commercially oriented and tends to promote the use of built hives, frames, foundations and supers; medicines and treatments; and a certain frequency of hive inspections – a more intense approach to care of the bees. The other is a somewhat softer approach, whereby the bees are kept in more rudimentary cases and are basically left to develop with minimum or even no human intervention in their reproductive and production cycles. Professional beekeepers tend to adopt the former approach whereas amateur beekeepers and bee enthusiasts tend to adopt the latter, or a version that falls somewhere in between them.

In this context, beekeepers' associations may choose to follow both approaches, explaining the differences and the relevant outcomes, or to offer only one of the two, depending on the interests of their members.

In some countries, especially those in South America, beekeeping associations encourage beekeepers to form cooperatives in which they can share common extraction rooms and equipment that would otherwise not be affordable for an individual rural beekeeper. This enables both dissemination of GBPs and broader access to beekeeping opportunities for local beekeepers. The cooperative model also creates a more integrated value chain from production to sales. Indeed, the collection and concentration of larger volumes of honey and other bee products means better

chances of selling these products. The manufacturing of some beekeeping equipment and protective clothing for beekeepers may also be included in these types of value chain. This model also promotes better quality standards in the collection, processing and bottling of honey and the recovery of discarded wax that in other circumstances may be disposed of. In this context, beekeepers tend to exchange knowledge and personal practical experiences of bee management and often take up courses to improve their skills and expertise.

Beekeepers' associations are often well connected with national or regional ministries and authorities and also with extension units, which allows public funding to be made available for staging the courses, for the provision of equipment to local beekeepers or for involving the beekeepers in national or international beekeeping projects.

18.8 THE ROLE OF FAO IN THE DEVELOPMENT OF SUSTAINABLE BEEKEEPING

The Food and Agriculture Organization (FAO) is a specialized agency of the United Nations that leads international efforts to defeat hunger. FAO's goal is to achieve food security for all and make sure that people have regular access to enough high-quality food to lead active, productive, healthy lives. Therefore, FAO's priorities are to achieve a world without hunger, malnutrition and poverty and do so in a sustainable manner – contributing to the implementation of the 2030 Agenda for Sustainable Development.

The 2030 Agenda for Sustainable Development, including the 17 SDGs, are global objectives that succeeded the Millennium Development Goals on 1 January 2016. The SDGs will shape national development plans over the next 15 years. From ending poverty and hunger to responding to climate change and sustaining our natural resources, food and agriculture lies at the heart of the 2030 Agenda.

18.8.1 Why is FAO interested in beekeeping?

For thousands of years people have kept and used bees to harvest honey and beeswax. Honey was used as a food product, for its medicinal qualities and even in cosmetics. Beeswax was used in different tools, in rituals, cosmetics, medicine, as a fuel or to make receptacles waterproof. However, beekeeping goes far beyond the production of bee products. Bees and beekeeping contribute either directly or indirectly to most of the SDGs.

The contributions of beekeeping and bees is reflected in various areas of work of FAO, and the organization is increasingly engaging in this sector.

While bees and other pollinators play a vital role in pollination, increasing agricultural yields, and contributing to biodiversity and other ecosystem services, beekeeping also provides tangible support to the livelihoods of rural communities and indigenous peoples, which leads to

a more stable food security framework. As beekeeping can be done with locally available material and limited resources, it also offers decent working opportunities and income-generation opportunities to people in extreme poverty, landless people, women, young people and disabled citizens. Beekeeping does not require land ownership and has low start-up costs, making it an ideal poverty-reduction activity.

The many bee products available help to create benefits at a nutritional level and facilitate healthier diets and life conditions.

In addition to this, beekeeping is a non-extractive, low-input-high-output activity that, unlike most other livestock sectors, does not negatively impact the environment in which it is carried out. On the contrary, it can be regarded as a positive externality for the benefits it brings. Furthermore, since beekeeping does not require land tenure rights and can be practised in agricultural areas, forests and other wild areas and urban contexts, it allows food to be produced in different environments.

Pollination is a key process in both human-managed and natural terrestrial ecosystems. It is critical for food production and human livelihoods, and directly links wild ecosystems with agricultural production systems. The vast majority of flowering plant species only produce seeds if animal pollinators move pollen from the anthers to the stigmas of their flowers. Without this service, many interconnected species and processes functioning within an ecosystem would collapse.

18.8.2 What action is FAO taking on beekeeping?

At FAO, beekeeping falls mainly – though not exclusively – under the Natural Resources and Sustainable Production stream. Pollination services and biodiversity issues are primarily assigned to the Plant Production and Protection Division (NSP) and veterinary, animal genetics and production aspects are primarily assigned to the Animal Production and Health Division (NSA).

NSP is therefore mainly responsible for pollination, working on the International Pollinator Initiative (IPI), the impacts of climate change, surveillance and management of ecosystems, plant genetics and health and the integrated pest management (IPM) programmes, the goal of which is to integrate practices for economic control of pests. The IPI is the result of effort, achievements and initiatives of people committed to the conservation and sustainable use of pollinators, around the world. IPI promotes coordinated worldwide action to monitor pollinator decline, identify practices and build capacity in the management of pollination services for sustainable agriculture, and to improve food security, nutrition and livelihoods. FAO plays a facilitatory and coordinatory role in the initiative.

It is important to mention that when FAO uses the term “pollinator”, it is not exclusively referring to bees. This is crucial to understanding the strategy adopted by FAO that is holistic in this sense.

NSA, on the other hand, is enshrining beekeeping in its Domestic Animal Diversity Information System (DAD-IS) to ensure that it now accommodates domesticated honeybees. DAD-IS is a communication and information tool supporting the development of strategies for the management of animal genetic resources for food and agriculture (AnGR).

Global policy dimensions of genetic resources are discussed and decided upon by FAO’s Commission on Genetic Resources for Food and Agriculture. This body provides a permanent forum for governments to discuss and negotiate matters specifically related to biological diversity for food and agriculture. In 2017, FAO carried out a comprehensive survey that yielded important feedback on the stock, features, perceptions and management practices of pollinators – both domesticated and non-domesticated – worldwide. Based on this information, at its seventeenth regular session in 2019, the Commission requested FAO to include fields for monitoring the diversity of managed honeybees of relevance to food and agriculture in DAD-IS. In the same year, the Commission adopted a workplan for the sustainable use and conservation of microorganism and invertebrate genetic resources for food and agriculture. It agreed to address functional groups of invertebrates and/or microorganisms, also covering pollinators, including honeybees. The Commission has a long tradition of technical work on the roles of microorganisms and invertebrates in food and agriculture, for example their use in IPM. It also facilitates and coordinates two global initiatives of the Convention on Biological Diversity in this field: the IPI (see above) and the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity. Many partner organizations collaborate with FAO on these important initiatives.

Following FAO’s Strategy on Mainstreaming Biodiversity across Agricultural Sectors, the Forestry Division of FAO has also initiated work related to pollination services. Specifically, in 2020, the FAO Forestry Division co-published with Bioversity International a Forestry Working Paper considering forest and landscape interventions to enhance pollination services for forests themselves and for surrounding agricultural landscape, contributing to local livelihoods and food security. Forthcoming in 2021 is the publication of an infographic translated in all six UN languages aimed at further disseminating the key messages of this publication.

Other FAO key activities are linked to the Emergency Prevention System for Animal Health (EMPRES-AH), the impact and spread of transboundary diseases and emergency, prevention and monitoring action. Like all living

organisms, bees can be infected with diseases and pests, some of which (for example, American foulbrood – AFB, European foulbrood – EFB and nosemosis) can be treated by antibiotics. The lack of veterinary medicines specifically registered for use in bees, together with a general lack of knowledge about bee diseases among veterinarians, may push some areas of the world towards uncontrolled or illegal use of antimicrobials at the apiary level, running the risk of residues of veterinary medicines entering bee products and stimulating antimicrobial resistance. Global concern about resistance to antimicrobial drugs is growing: the threat it poses to the health of bees, beekeepers and consumers must not be underestimated.

FAO supported a study on the responsible use of antimicrobials in beekeeping with the aim of producing guidelines on the best management practices to reduce or ultimately even eliminate the use of antimicrobials in beekeeping and offer viable and sustainable alternatives. Moreover, FAO supported a study to develop the Progressive Management Pathway (PMP) in the beekeeping sector. The PMP is a systematic framework designed to help countries plan and monitor risk reduction strategies for control of major livestock and zoonotic diseases. It aims to set out the necessary steps required to achieve sustainable, healthy and resilient beekeeping.

Another area of direct involvement is entrusted to the Research and Extension Unit (OINR) through the Technologies and Practices for Small Agricultural Producers (TECA) platform. TECA is a FAO's online platform for the exchange of agricultural practices and technologies and information for smallholder farmers. The TECA platform fills the gap in the knowledge-sharing process and makes information on proven practices and technologies available for multiple users.

The TECA platform is organized into 11 categories (crop production, livestock production, fishery and aquaculture, forestry, post-harvest and marketing, agricultural mechanization, natural resource management, nutrition and food security, capacity development, and climate change and disaster risk reduction), including one subcategory on beekeeping. The beekeeping category hosts technologies and practices that can support beekeepers around the world to maximize, in a sustainable way, the benefits they derive from beekeeping, whether it be beekeeping with fixed comb hives, top-bar hives or movable-frame hives. It covers the full value chain and all its processes: construction of beekeeping equipment, hive management, honeybee health, harvesting, processing and marketing of beehive products (honey, propolis, pollen, wax, etc.), and the use of beehive products as food and medicines. The technologies and practices available in this category mainly cover beekeeping with western honeybees (*Apis mellifera*), but the platform also contains information about technologies and practices used in beekeeping with stingless bees (meliponiculture) and giant honeybees (*Apis dorsata*).

The Beekeeping Exchange Group is another feature of the TECA platform that offers a virtual space for practitioners and experts to meet and discuss topics of interest. Regularly, the group hosts moderated discussions and/or webinars that are organized around a specific topic with a learning objective.

The technologies and practices available on the TECA platform have been developed in collaboration with partners. They come from a wide range of regions and countries and are made available in different languages (English, French, Spanish and Portuguese) to reach a wider audience. Each practice is recorded in a standard format, describing step-by-step how to implement the practice, using clear, simple language and visual aids to facilitate understanding. Those interested in replicating the practices in their local context can request more information by sending an e-mail to TECA's team: teca@fao.org.

A major area of work is FAO's Global Action on Pollination Services for Sustainable Agriculture. FAO carries out various activities to encourage pollinator-friendly practices in agricultural management. It provides technical assistance to countries on issues ranging from queen breeding and artificial insemination to sustainable solutions for honey production and export marketing.

The Global Action on Pollination Services for Sustainable Agriculture provides valuable information, helping farmers, farm advisers and land managers better understand the pollination needs of specific crops. It will include a global monitoring system that captures the diversity of domesticated honeybees, including data about products and services as well as the main threats and challenges that honeybees face.

FAO is also actively collaborating at various levels with other external partners such as the World Organisation for Animal Health, Apimondia and the network of Experimental Zooprophyllactic Institutes (I.I.ZZ.SS) for animal health and food safety to complement its action in beekeeping.

18.8.3 Where can you find out more about FAO's work on bees and pollinators?

Here is a list of interesting FAO web pages related to bees and pollinators.

- FAO's Global Action on Pollination Services for Sustainable Agriculture
- www.fao.org/pollination/en/
- TECA – Technologies and Practices for Small Agricultural Producers
- www.fao.org/teca/categories/beekeeping/en/
- Domestic Animal Diversity Information System (DAD-IS)
- www.fao.org/dad-is/en/
- Commission on Genetic Resources for Food and Agriculture – Micro-organisms and invertebrates
- www.fao.org/cgrfa/topics/microorganisms-and-invertebrates/en/