EIP-AGRI Focus Group

Bee health and sustainable beekeeping

FINAL REPORT
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Executive summary

In the course of 2019, the EIP-AGRI Focus Group (FG) on "Bee health and sustainable beekeeping" explored and provided a state of play for different key factors that are important to honeybee health. The group of experts discussed the main drivers for change from today's situation to a sustainable future. Their goal was to answer the overarching question: **How to ensure the sustainability of beekeeping in the face of challenges linked to pests and diseases, intensification of agriculture, and climate change?**

Through a discussion about challenges, opportunities, and good practices and solutions that are available, the Focus Group has identified a set of priorities and ways forward.

Key factors to keep bee colonies healthy (priorities):

- Availability of knowledge and skills (research and practice)
- Maintaining a sustainable environment around the honeybee colony
- Determination and evaluation of the health status of honeybees
- Resilience of honeybees and improvement of their well-being
- Interpretation of data from monitoring, precision beekeeping (PB)
- Management methods adapted to local conditions
- Supporting honeybee genetic diversity
- Sublethal effects of chemicals in an environment of multiple stressors

Ways forward (solutions to the problems)

Despite the many innovations and advances of recent years, also in the fields of some of these key factors, further work is still needed to fulfil all these priorities. To address the key factors mentioned above, the Focus Group recommended to:

- Create a European platform to better connect research and practice (Research need from practice – RN)
- Develop a kind of licence for beekeepers, a pan-European standard
- Develop and implement a practical index synthetising the health status of bees (RN)
- Develop and evaluate technical methods for controlling Varroa, for sustainable beekeeping (e.g. trapping mites in workers or drone brood, queen caging and artificial swarms) (RN)
- Interpretating and sharing collected data from monitoring, both biotic- and abiotic factors
- Assess the exposure to stressors from agriculture in combination with resource quality (RN)
- Identify, implement and communicate mitigation practices among beekeepers and farmers (RN)
- Manage complexity through collaboration among relevant stakeholders
- Mapping the landscape situation around the apiary for sustainability (make monitoring results available in maps)
- Highlight the importance of genetic diversity for sustainable beekeeping, and develop programmes for local breeding (RN)

But is that enough? What activities need to be put in place, e.g. in the next 10 years, to reach the desired (long-term) goal of **healthy honeybees in a sustainable environment**? Following a theory of change model (https://www.theoryofchange.org) it can be concluded that a supporting environment for implementating and mainstreaming the listed priorities is necessary. This includes reducing the threats to honeybee health and meeting the needs of all actors involved. These actions should be supported by enabling conditions and means of implementation including financial resources, capacity and technology. Specifically, the six ways forward marked as "**RN**" are research needs from practice that have been identified by the Focus Group. These research gaps demand the specific involvement of the scientific community to be fully addressed.

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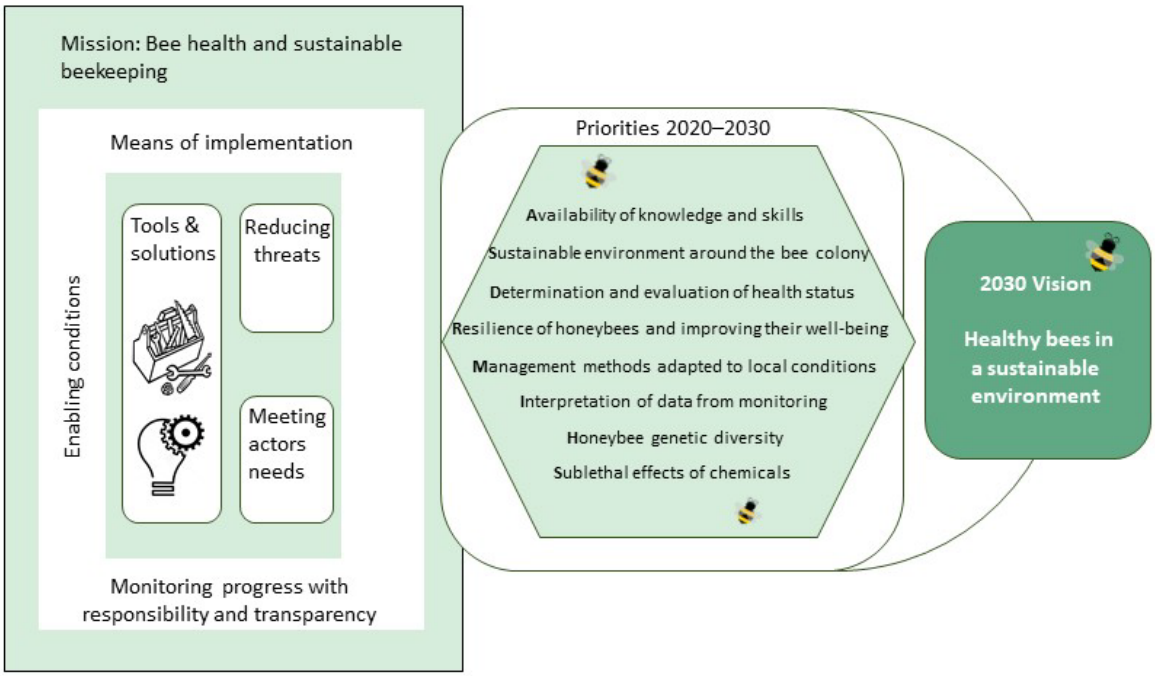

Figure 1: A framework illustrating the enabling conditions and means of implementation to support the priorities defined by the Focus Group to achieve the vision "healthy honeybees in a sustainable environment" in 2030.

In addition, with the aim of inspiring innovative actions that contribute to this framework, the Focus Group elaborated eight ideas for **EIP-AGRI Operational Groups**. The proposals for projects cover a wide range of project types, from testing solutions or management practices at hive level to ways of cooperation or knowledge exchange.

Focus Group Experts Bee health and sustainable beekeeping

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1. Introduction

Defining whether a honeybee colony is in good health or not is not easy. However, the following four points by Vidal-Naquet (2015) may provide a good indication:

- There are no clinical signs of disease
- The brood/adult ratio is in line with the expected development of the colony and the time of year (there must be enough workers to rear brood)
- There is foraging activity and production of honey and bee bread
- The total quantity of pollen and honey stored around the brood is estimated to match the need of the colony.

Therefore, it is not only diseases, pests and predators that affect honeybee health. The beekeeping practice and the environment in and around the apiary have a big impact on how the colony develops, how strong it will be and how much honey and pollen will be produced and stored.

Figure 2: Honeybee health is an issue dependent on the beekeeper as well as on the environmental situation in the forage area. It is a multi-actor and multi-factorial interaction at landscape level.

The EIP-AGRI Focus Group (FG) on Bee health and sustainable beekeeping was established in spring 2019 to identify, structure and develop answers to this main question:

How can we ensure the sustainability of beekeeping in the face of challenges linked to pests and diseases, intensification of agriculture, and climate change?

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The FG consisted of 20 experts (see **Annex 1**) from 16 different EU countries and with different professional backgrounds. The group included beekeepers, advisers, researchers and consultants coming from private businesses, universities, public authorities, NGOs and other organisations. They were selected considering their practical experience and technical knowledge on the topic. In the Focus Group, they jointly worked for a year and a half, meeting twice during this period. During the group's first meeting, discussions focused on challenges for bee health, and good practices and sources of innovation to overcome these challenges.

Based on the central question, the group explored solutions and good practices in the frame of four themes. These were collectively set, based on clusters of the main challenges of the FG topic:

- Beekeeping practices
- Agricultural practices
- Communication/collaboration
- Monitoring

The main ideas that were discussed at each table resulted in seven areas that were selected for further exploration in so called "minipapers". The list of minipapers can be found in **Annex 2**. The papers covered the following topics:

1. Knowledge transfer and capacity building. What knowledge is reliable as valuable information for beekeepers? How can we bridge best available knowledge and existing beekeeping practices?

2. Beekeeping practices to improve disease control and to ensure high efficacy without any adverse effects of the chemicals used, with the lowest costs, and ensuring the highest quantity and quality of all hive products.

3. Considering the well-being of honeybees in beekeeping. The point of view of "honeybees first", while also trying to meet the needs of the various stakeholders.

4. How to respond to the needs for training and advice that beekeepers have.

5. Monitoring of colonies and the environment to support management decisions for the beekeeping sector.

6. The impact of major stresses on honeybee health: pesticides and a lack of food resources (quality and quantity).

7. Support management decisions for honeybee breeding to maintain genetic diversity, avoid losing adaptation possibilities and secure resilient bees.

Following the work done at the first meeting and in the minipapers, the group looked at new ideas for innovation during the second meeting, where they suggested ideas for Operational Groups (OGs) and proposed possible directions for further research.

The minipapers, together with the **starting paper**, provided the basis for this final report.

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2. State of play and what we can do

What do we know about the challenges for honeybee health and what can we do to solve the problems? The FG has identified a number of "do's" or priorities to keep honeybee colonies healthy. To make the key factors and their solutions easier to understand, they are here divided into different levels of action: a) the honeybee colony; b) the apiary; c) the landscape; and d) the beekeeper.

2.1 The health status of the honeybee colony

The honeybee colony is a superorganism, an organism consisting of several individual organisms that jointly make rational decisions. On the honeybee colony level, the stress factors are e.g. pesticides, pathogens, poorly mated queens, honeybees that are not adapted to local conditions, unadapted abiotic factors like temperature and humidity, and inappropriate beekeeping practices changing the dynamics and resilience of the colony.

Framing key issues

An examination of the **health status** of a honeybee colony is not entirely simple. To get the overall picture one needs to make both an internal and an external examination.

- *Internal* means looking for clinical symptoms in the brood frames, looking for honey and pollen storage, looking for vitality signs and the colony's adaptability to stress factors, including genetic diversity, nutritional needs, Varroa (*Varroa destructor*) pressure or other diseases, pests and predators, in-hive hygrothermal climate by measuring abiotic factors (temperature/humidity) and the effect of chemicals used in the forage area.

- *External* includes the activity of the honeybees in the apiary and in front of the hive entrances, on the ground in front of the hives, the appearance of the hive, the bottom board and the entrance as well as environmental factors.

The records regarding the colony history during the seasons also need to be reviewed. In these records there should be notes of deviations from the normal actions taken and other events. However, in many cases the data are scarce and superficial.

For example, in 2016 the European Food and Safety Authority (EFSA) published a toolbox to facilitate harmonised data collection that could support the assessment of the health status of managed honeybee colonies (**https://www.efsa.europa.eu/en/efsajournal/pub/4578**). This **HEALTHY-B toolbox** (EFSA Journal 2016; 14(10): 4578) for assessing the health status is based on:

- Characteristics of a healthy, managed honeybee colony
- An adequate size, demographic structure and behaviour
- An adequate production of bee products
- Both in relation to the annual life cycle of the colony and the location
- Provision of pollination services (measured in volume of bee products)

Analysing the surrounding environment, in particular land cover/use of a honeybee colony is very important when assessing its health status. However, **good tools that could be used at apiary level are currently lacking**. Therefore, how can the beekeeper make a correct analysis of the actual health status for the colony without any proper tools? The ongoing B-GOOD project is one of the European projects addressing this question (**https://b-good-project.eu**).

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Another challenge is how to ensure high efficacy of methods used to control diseases: a) without any adverse effects of the chemicals used; b) with the lowest costs; and c) ensuring the highest quantity and quality of all hive products. There is very little knowledge regarding how the **natural behaviour of honeybees** is important for the health of a colony. Honeybees are to be looked at as semi-domesticated species. The beekeepers have changed the genetics very little but the environment has changed a lot, such as the choices of beehive construction and the location of the honeybee colony (T. D. Seeley 2019). What does the beehive construction mean for the survival of a colony? **Management methods adapted to local conditions** are known factors for good honeybee health.

Moreover, the **genetic diversity** of the European honeybee is at risk. Climate change, with altered season features is challenging the adaptation capacity of honeybees. The success factor throughout the millions of years that honeybees have existed is their ability to adapt to changes in the surrounding environment. To meet these challenges a broad genetic diversity is key. The honeybee colony breeds (the virgin queens fly out and mate with multiple drones high up in the air) with the honeybee colonies that are in the area in which the beekeeper has placed it. This is an important factor in the environment. Beekeepers should breed local resilient honeybees and this is not easy, since in most regions there are no regulations about what kind of honeybee races are allowed. The diversity of beekeeping in Europe should be the driver for regional regulations that allow sustainable conservation of varieties of local honeybees in Europe.

Key issues identified:

- Determination and evaluation of the honeybee health status
- Management methods adapted to local conditions
- Honeybee genetic diversity

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Examples of good practices

PREVENTING IS BETTER THAN CURING

American foulbrood is a brood disease caused by the spore-forming bacteria *Paenibacillus larvae*. It is considered to be one of the most destructive brood diseases on honeybees and it is a notifiable disease to the OIE (World Organisation for Animal Health). The spores, which can be dormant for decades, can be found on the honeybees, in the beeswax, in the honey and in the hive material. The spores can be present in a honeybee colony without resulting in clinical symptoms in the brood. By testing a colony for spore levels, the beekeeper gets an indication of the risk of an outbreak of the disease. By taking measures such as cleaning the equipment, frequent wax renewal and conducting general hygienic management techniques in beekeeping, the beekeeper might be able to avoid outbreaks of American foulbrood.

In New Zealand, the goal of the American Foulbrood National Pest Management Plan is to eliminate American foulbrood in managed colonies (**https://afb.org.nz**). Some New Zealand beekeepers have shown that elimination on a national level is possible. By destroying colonies with American foulbrood instead of using antibiotics and by using management techniques to avoid the spread of the disease to other hives, they have effectively eliminated the disease from their own businesses.

According to Swedish research, the beekeeping practice of testing honeybee colonies for American foulbrood spores in adult honeybees, using a systematic quarantine system, and cleaning the equipment, can eradicate the spores from the beekeeping operation (Locke et al. 2019). Analysing adult honeybees for spores is also used in conjunction with contact tracing at outbreaks of the disease in Sweden.

BREEDING PROGRAMME FOR THE PRESERVATION OF LOCAL RACES

Rather than searching for "the best bee", local adaptation will be the key to sustainable beekeeping. Preservation of local adaptation can be done by arranging bee breeding cooperatives, running regional selection programmes and promoting honey produced by regional bees. There have been several successful initiatives to conserve and/or restore original endemic bee races in Europe. The most prominent one is an Italian breeding programme to promote *Apis mellifera ligustica* and *A.m. carnica* in the native region of the subspecies. Beekeeping will need to become more regional and less global to allow for sustainable strategies to preserve honeybee diversity (R. Moritz and R. Crewe, 2018).

Sustainable conservation to improve and conserve the native or locally adapted honeybee populations or subspecies is an increasingly used breeding approach. The basic philosophy behind this is to reduce importation and instead utilise and improve the local populations in comparison to the non-local ones (A. Uzunov, E. W. Brascamp & R. Büchler, 2017). However, it is difficult to avoid crossbreeding while both local races and more commercial breeds coexist in the same area. Within the SMARTBEES project – sustainable management of resilient bee populations –, a protocol for field testing and the selection of local bee populations was produced and evaluated (**http://www.smartbees-fp7.eu/Extension/Performance/**). The data is collected in an online database at **www.beebreed.eu** (hosted by the Institute for Bee Research, Hohen Neuendorf, Germany).

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What can we do?

As described in **minipaper 2** (Disease control and emergency situations), there are several monitoring tools for each disease. However, there is still not one simple monitoring tool for all diseases, which even includes environmental factors (e.g. stressors from agriculture and nutritional quality and quantity). It is possible that an index for honeybee "Health Status" and data standardisation, if established, could be a monitoring tool for predicting the fate of a colony, under specific circumstances (EFSA AHAW Panel, 2016).

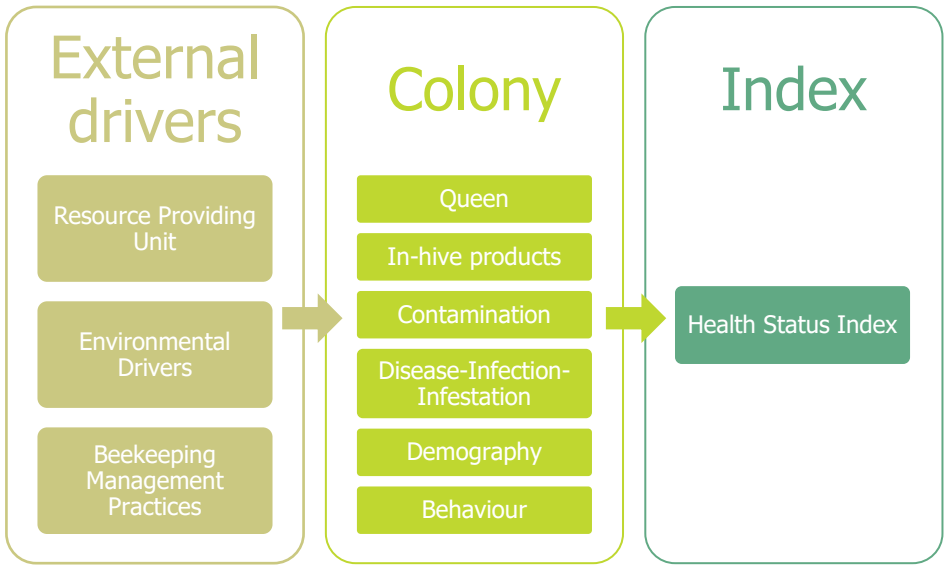

Figure 3: The Health Status Index integrates different sources of data, and it can quantify the health status of a honeybee colony based on the characteristics of each scenario (EFSA AHAW Panel, 2016, Gilioli et al 2019)

An example of disease detection is BeeScanning (**https://beescanning.com/**) which is an app that enables beekeepers to instantly diagnose Varroa infestation. Images taken of live bees on the brood frame are automatically analysed with artificial intelligence. The result is calculated in %, number of Varroa/number of bees. A factor is used to multiply the result compensating for hidden Varroa. This factor is derived from comparing results with alcohol washing. Besides finding Varroa, deformed-wing-virus and the queen, the project is developing analyses to detect another 13 classes, for instance to be possible to detect, American foulbrood for instance.

In **minipaper 7** (Sustainable honeybee breeding) the components to a holistic approach for local breeding programmes are discussed. One of these factors is the importance of communication on the value of locally bred honeybees and to provide beekeepers with technical support to monitor honeybee genetics.

Ways forward:

- Develop and implement a practical index synthesising the health status of bees
- Develop and evaluate technical methods for controlling Varroa for sustainable beekeeping
- Communicate the importance of genetic diversity for sustainable beekeeping

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Inspiration from the minipapers

MINIPAPER 2: VARROA CONTROL THROUGH MONITORING AND RESISTANCE

Management of Varroa control is key for sustainable beekeeping. Chemical control methods ('hard' or 'soft', e.g. through organic substances) may lead to Varroa resistance or weakening of the colony. Sustainable Varroa management calls for synchronised control in terms of period of the year, and type of application, which can minimise the risk of re-infestation in permanent/non-migratory apiaries. Training is also very important in Varroa monitoring or control schemes. There is a great need for innovative and cost-effective methodologies, as well as breeding efforts for resistance (see more in **minipaper 2**).

MINIPAPER 7: GENETIC CONSERVATION PROGRAMME IN BELGIUM

A new association based in Belgium was founded in November 2018. This network aims to become a tool for worldwide honeybee queen producers & breeders, a place where they can meet, exchange ideas and experiences; conservation and sustainable breeding are the main goals (**https://www.beesources.com/en/assistenza-tecnica/international-honey-bee-breeding-network-ihbbn-founded/**). Arista Bee Research is another example of local breeding for Varroa-resistant bees (**https://aristabeeresearch.org**). For more examples see **minipaper 7**.

MINIPAPER 3: QUANTITATIVE ASSESSMENT OF THE WELL-BEING OF HONEYBEES

Apicultural research is starting to embrace a "natural beekeeping" perspective and more and more results are available on the effects of such practices on the well-being of honeybees. But there is, in particular, a need to assess quantitatively with scientific studies the impact of each stress factor on the honeybee's well-being in order for beekeepers to make informed practical choices regarding for example the limitation of treatments, winter honey supplies, improvements to the beehive model, etc. (see more in **minipaper 3**). By knowing more about how honeybee colonies live in the wild, how they choose nesting sites and how they build their nest, beekeeping might find solutions on how to improve honeybee health.

Dream home for honeybees
The dream home for honeybees in the wild (T. Seeley 2010) is:

- Nest entrance height above the ground: high entrance, 5 m
- Size of entrance to the nest: small entrance, 12.5 cm^2
- Space of the cavity: spacious cavity, 40 litres
- Entrance direction: south
- Cavity dryness: the honeybees can remove wet substance and waterproof a leaky cavity
- Cavity draftiness: honeybees can caulk cracks and holes with propolis

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2.2 Bee health from the colony to the apiary

Several honeybee colonies placed in the same location are called an apiary. The stress factors at the apiary level (in-apiary stressors) are e.g. robbery (when honeybees from one colony steal honey from another bee colony), re-infestation of Varroa, transfer of brood or food frames between colonies and agricultural practices in the surrounding environment.

This section reflects on what beekeepers need to know and work with while choosing an apiary. More about the interaction with the landscape, and specifically with all the actors involved in the surrounding environment, in the following **section 2.3**.

Framing key issues

An important part of beekeeping is to keep the honeybee colonies healthy. Part of the beekeeper's job is the selection of an apiary site. But how does the beekeeper know if the location of the apiary is good or not? Part of the knowledge is of course to **know the basic needs for the bee colony** regarding food supply and access to water during the whole season. The area where the honeybees search for food is rather large, about 28 km^2 (calculated on a flight radius of 3 km). First thing is to have the possibility to **compare the development of the honeybee colonies** in one apiary with the development in another apiary over a certain period. This also includes that the colonies in the apiaries are supposed to be healthy, to be representative for the natural development. If they are not, then it is hard to evaluate to what extent other factors in the surrounding landscape actually affect the health of the honeybees. A wide range and type of variables must be monitored, such as the influence of environmental drivers, pressure of human activities and management strategies on honeybee colony health and productivity.

A helpful tool, apart from keeping records manually, is to continuously collect data through any automatic **monitoring** equipment, both at colony and environment level. Discussed in **minipaper 5** (Monitoring – from Precision beekeeping towards Decision support systems) collecting data would not solve the problems if the data collected cannot be interpreted correctly, thus translated into a practice responding to a need. By sharing information and creating tools for interpretation, beekeeping might advance and become more exact regarding doing the right thing at the right time. This can be called '**precision beekeeping**' (PB). The minipaper also discusses the need to develop standards for used hardware and open source software for monitoring colony performance.

The apiary is one component among others in the landscape, and the health of the honeybee colonies depends on the **surrounding activities**. From the honeybee's point of view, a sustainable environment is a prerequisite for survival. In most cases, the land where the apiary is located and where the honeybees forage for food is not owned by the beekeeper. Usually one or more landowners are involved with the ongoing activities of land use. This means that all activities performed in the area around the apiary have implications for the health of the honeybees. The beekeeper has very little control over the activities. How can the activities and their impact on the honeybees become visible to both the beekeeper and the land managers?

Key issues identified:

- Collaboration for collecting, sharing and interpreting data from monitoring, precision beekeeping
- Sustainable environment around the bee colony – the surrounding activities

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Examples of good practices

To choose an apiary is like choosing a home. There are a lot of demands to be fulfilled. Will the site cause a nuisance to neighbours or the general public? Is it safe from vandals? Is there forage for the honeybees? How many apiaries are nearby? Is the environment of the site suitable for bees? Is the access convenient, with minimal carrying for the beekeeper to bring in equipment and remove honey supers? Is the space suitable for the number of hives? Is the microclimate favourable? And so on.

In many books for beekeeping beginners there are instructions on how to find a good apiary site. It might be quite easy to find if you only have a few colonies, but if you increase the number of colonies then it is not that easy anymore. Establishing a good relationship with neighbours, local farmers, landowners and the general public is a major factor in finding and maintaining a successful site for the bee colonies. The beekeeper should talk to them about the value of honeybees as pollinators; inform them about swarms, flight paths etc., and try to capture their interest and cooperation, gaining respect for the honeybees and the beekeeper.

One example of a user-driven communication and coordination tool to protect honeybee health is BeeConnected (**https://beeconnected.org.uk**). It is a UK-based initiative that aims to connect beekeepers with farmers and give information on crop protection activities nearby. It is a voluntary initiative, supported by the Crop Protection Association.

Another example is provided by the **EIP-AGRI Operational Group NOMADI APP**[1], which involves remote beehive monitoring, an opportunity for migratory beekeeping. It is a regional monitoring network that consists of computerised apiaries, equipped with sensors that collect data from the hives. Hive data (humidity, brood temperature) will be elaborated and integrated with other (including historical) information, such as meteorological forecasts, or data from the nectariferous species phenology (such as flowering time) to provide useful information for apiary management. They also have an acoustic sensor outside the hive to detect frequency of *Vespa velutina*.

When honeybees fly to other hives than their own, this is called drifting. To avoid spread of disease or pests due to drifting between the colonies in the apiary, the hives can be put in different ways to help the honeybees find their way back home to the right hive. The different solutions demand a different amount of space.

What can we do?

As discussed in **minipaper 5**, electronic devices should be developed to enable new functionalities for precision beekeeping. This will be a shift from "smart" to "intelligent" hives. Intelligent hives would be able to:

- Monitor the hive for signs of trouble and send alerts before trouble hits.
- Monitor regional and national trends in real time, and make adjustments based on how these trends might affect the honeybees.
- Suggest ways to improve the production, pollination, or honeybee health.
- Prescribe the best management practices customised for a particular hive in a particular place at a particular time.
- Preventively suggest treatments before trouble manifests.
- Identify the treatments most likely to succeed given the hive characteristics, current environmental conditions, and history.

1 For further information about NOMADI APP see the EIP-AGRI Inspirational idea: **https://ec.europa.eu/eip/agriculture/en/news/inspirational-ideas-monitoring-bee-health-through**

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To find out the actual situation for the honeybee colonies in an apiary, we need to monitor the bee colony, and apart from this also measure and assess the exposure to stressors like agricultural practices and the nutritional quality and availability. The accessibility of data by mapping the landscape situation is crucial to be able to evaluate the appropriateness of an apiary.

Ways forward:

- Measure and evaluate the exposure to stressors from agriculture in combination with food resource quality and availability at the apiary level
- Interpretating and sharing collected data from monitoring, both biotic- and abiotic factors
- Mapping the landscape around the apiary for its sustainability

Inspiration from the minipapers

MINIPAPER 5: MONITORING

In **minipaper 5** examples of different national monitoring projects are listed. One that has been running since 2004 is the German Bee monitoring project, DeBiMo, administrated by a number of Apicultural state institutes in Germany (**https://bienenmonitoring.uni-hohenheim.de/en/88571**). More than 100 beekeepers are involved in the collaborative project. They provide representative, up-to-date information on colony management and overwintering dynamics of their bee colonies. In addition, samples of bees, honey and pollen are supplied by these beekeepers for the analysis of bee diseases and chemical residues. Based on the results a report of the status is delivered annually.

MINIPAPER 3: QUANTITATIVE ASSESSMENT OF THE WELL-BEING OF HONEYBEES

In **minipaper 3** a list of the stress factors with which honeybees are confronted is compiled. The table ranks them according to their scale, whether they are external factors which depend on other activities that are less controllable by the beekeepers themselves, or whether they are internal factors for which beekeeping management methods can provide opportunities for intervention. For example, materials for beehive construction and location have an impact on swarming, on the energy required for thermoregulation or on risks of infestations by bacteria or parasites. We can highly contribute to the well-being of the hives by opting for natural material (wood or polystyrene only for nuclei), no chemical wood protection, no varnish, and regular disinfection of hive material with heat and steam only.

2.3 The interaction with the landscape (involving all actors in the landscape)

The stress factors at landscape level are e.g. insufficient supply of high-quality diet (pollen and nectar), lack of sources for propolis, lack of water, exposure to plant protection chemicals, poorly coordinated land management measures and food competition or disease/parasite pressure from other beekeepers' colonies.

This chapter analyses the role of the different actors involved in the management of the landscape, in order to improve the bee health of the apiaries located in their surrounding areas.

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Framing key issues

The landscape surrounding the beekeeping practice is a complex multi-actor and multi-factorial environment.

Depending on the kind of landscape in which the beekeeping is performed, different elements have an impact on honeybee health. There are regulations that limit the **exposure of pollinators to plant protection products**. Despite this, bees are widely exposed to chemicals used in agriculture and other areas that can thus cause lethal and sublethal effects on honeybees. Due to the resilience at colony level, the effects sometimes are not easily detectable. Signs like a colony being less productive or weaker in terms of nourishment and immunity could be caused by other health problems as well. The chemicals also interact with other bee stressors like pathogens, nutritional deficiencies or adverse climatic conditions (Tosi et al. 2017). In this sense the project POSHBEE (**http://poshbee.eu/**) aims to provide the first pan-European quantification of the exposure hazard of chemicals not only to managed honeybees but also to wild bees, and to determine how chemicals alone, in mixtures, and in combination with pathogens and nutrition, affect bee health.

The exposure occurs in crops that are attractive for honeybees but also in non-attractive crops, weeds or wildflowers in the border zones of the cultivated fields (Simon-Delso et al. 2017). This makes the current risk assessment rather limited (Sgolastra et al. 2020). The mixture of different chemicals (so called 'cocktail') makes the assessment further complicated (Simon-Delso et al., 2014; Tosi et al. 2018). In 2013 EFSA published a guidance document intended to extend testing requirements for risk assessment, **https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2013.3295**.

In areas with intense land use, the plant diversity is usually low. Honeybees are vulnerable to reduced flower availability, and **nutritional stress** affects the colony health by reducing its strength and fitness. Nutritional deficiencies were identified as one of the major causes of honeybee colony losses in the USA between 2007 and 2015 (Seitz et al. 2016). Importantly, nutritional stress can also interact synergistically with pesticides amplifying honeybee mortality (Tosi et al. 2017).

There is an urgent need for **collaborations and partnerships** between the persons involved, such as farmers, other land managers and beekeepers, to create a sustainable landscape for honeybees and beekeeping. The actors in the landscape need to work together on strategies and implement mitigation measures to make the surrounding landscape fit for sustainable beekeeping. The best available knowledge about the landscape level status needs to be made available beyond beekeeping and include other actors in the forage area.

Key issues identified:

- Sublethal effects of chemicals in an environment with multiple stressors
- Sustainable environment around the bee colony and collaboration among actors involved

Good practices

"Multifunctional buffer zones" are areas of land surrounding fields on which carefully combined strips of different herbs and grasses are planted. They contribute to the farm and the environment in many ways: minimising the risk of leakage of unwanted substances from arable land, increasing biodiversity by attracting pollinators and 'natural enemies', acting as field roads for farming vehicles to avoid soil compaction, and more. A Swedish Operational Group (OG) is testing this concept, defining buffer strips with two different goals: promotion and protection (**https://ec.europa.eu/eip/agriculture/en/news/inspirational-ideas-multifunctional-buffer-zones**).

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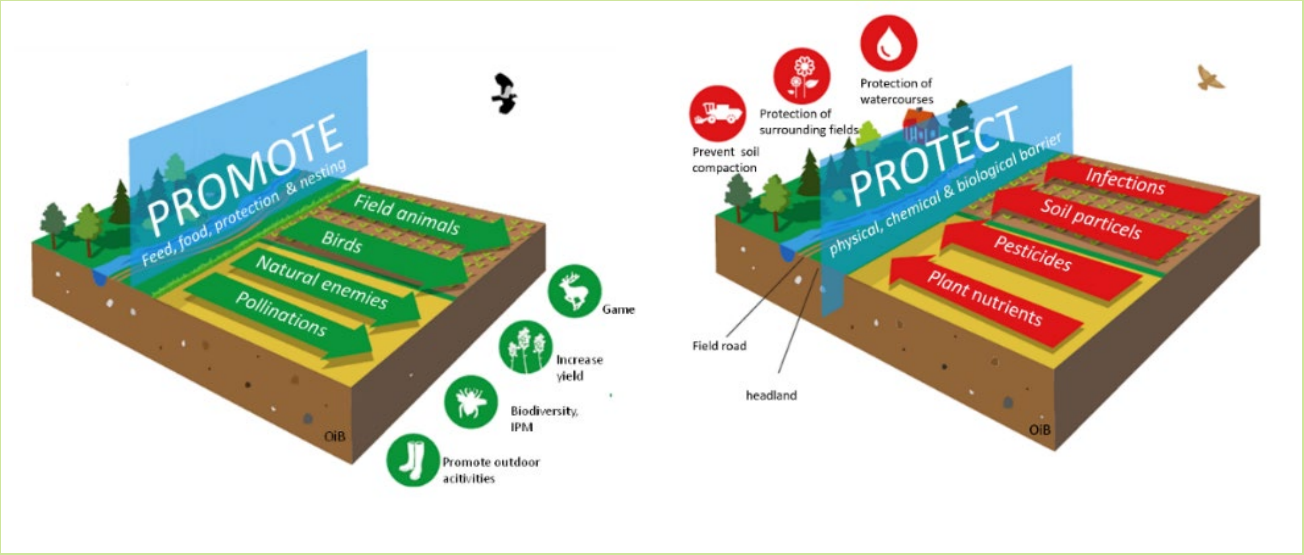

Figure 4: Multifunctional buffer zones (SamZones) by the OG, considering the two main goals: a) Promote feed, food, protection and nesting for field animals, birds, natural enemies, pollinators b) Protect (physical, chemical and biological barrier) against infections, soil particles, pesticides, plant nutrients (©odlingibalans)

What can we do?

Honeybees in agricultural landscapes need a better environment. Some ideas to achieve this goal are presented in **minipaper 6** (Developing and enhancing good practices to mitigate major bee health stressors: pesticides and lack of resources) and **Figure 5**.

The landscape level is a complex reality, and complexity should not be simplified. One solution in one area might not be applicable in another area. Each given element with its connected actor has to be identified, analysed and assigned a task in the sustainable landscape system. This calls for collaboration. But who has the responsibility in a given area to initiate and develop the collaboration?

An example of a collaborative approach on landscape level is tested in the **Interreg project BioGov** (**https://www.interregeurope.eu/biogov/**). The project is about how to improve natural and cultural heritage policies. The expected changes are more effective policies due to improved governance and broad stakeholder support. The different sub-projects are using participatory governance and/or policy instruments that actively encourage participatory governance as a new priority.

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Figure 5: Honeybees in agricultural landscapes need a better environment. Some ideas to achieve this goal are shown in the figure.

Another example is the **Research strategy of the German Agricultural Research Alliance** (DAFA) (https://www.dafa.de/wp-content/uploads/Brosch-DAFA-FF-Bienen-LaWi_en_klein.pdf). This strategy aims to provide scientific recommendations to actors in politics, research funding and economics concerning ways to improve environmental conditions for bees and foster synergistic interactions between bees and agriculture, taking into consideration the entire agricultural landscape. The long-term goal is to achieve substantial impacts for diversity-promoting and sustainable agriculture, as well as regeneration of the entire agricultural landscape. This can only succeed if all the actors are brought on board. The strategy, therefore, specifically addresses farmers, professional and hobby beekeepers, nature conservationists, NGOs, citizens and the public in general, specialist advisers and scientists. Recommendations to political decision makers complete the strategy, with the aim of improving the framework conditions for the synergistic cooperation between bees and agriculture.

Ways forward:

- Identify, implement and communicate mitigation practices among beekeepers and farmers
- Manage complexity through collaboration

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Inspiration from the minipapers

MINIPAPER 6: GOOD PRACTICES TO MITIGATE MAJOR BEE HEALTH STRESSORS

In **minipaper 6**, mitigation practices are discussed. They are essential to reduce stressors on honeybees in agroecosystems. Mitigation and support measures to honeybees must be complementary and integrated with the existing approach of Integrated Pest Management (IPM) (**Figure 5**). In this way, the development of Integrated Pest and Pollinator Management (IPPM) concept should be useful (P. A. Egan et al. 2020 and Biddinger et al. 2015). This approach promotes pollinator-friendly strategies for sustainable food production by supporting beneficial insects (with flowering strips, for example) and reducing risks from pesticides (avoiding the use of conventional pesticides and pesticide drift).

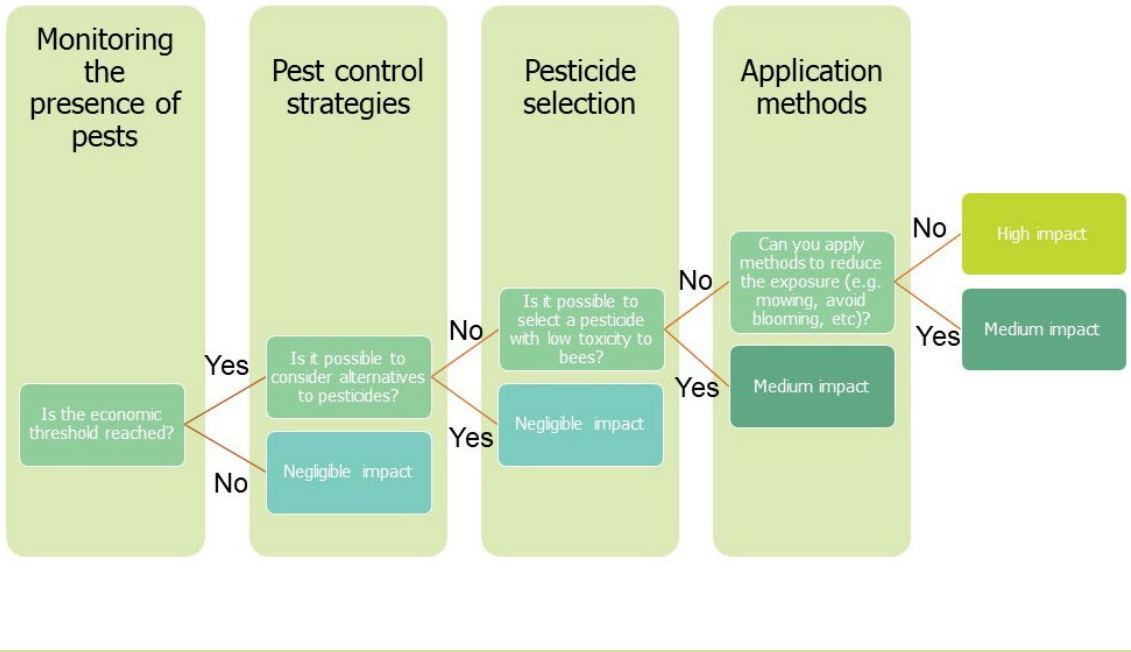

Figure 6: Decision tree in the IPPM approach and possible consequences on pollinators

These are some examples of existing collaborations between farmers and beekeepers:

- *Survey of apiaries in connection with farmers and advisers* – SURVapi – France
  - **https://nouvelle-aquitaine.chambres-agriculture.fr/agro-environnement/ecophyto/survapi/**
- *Platform for networking between beekeepers and farmers* – Beewapi – France **http://www.beewapi.com/**
- *Meeting at an apiary* – ADA NA – France **http://adana.adafrance.org/infos/Communication.php**
- *Memorandum of understanding between seed producers and beekeepers* – SEMENTI – Italy **http://www.sementi.it/comunicato-stampa/450/firmato-protocollo-intesa-per-valorizzare-colture-sementiere-e-tutelare-il-patrimonio-apistico**
- *Platform for farmers and beekeepers for pollination purposes* – Beeweb – Serbia **https://www.beeweb.co/en**
- *Increase awareness of honeybees in several cities, collaboration with farmers* – BeepathNet – Slovenia, Greece, Italy, Portugal, Hungary, Poland **https://urbact.eu/beepathnet**

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2.4 The beekeeper: knowledge and skills for healthy bees

The beekeeper has a responsibility for the well-being of his/her honeybee colonies. To practise beekeeping, knowledge and skills are crucial to be able to take the right measures at the right time, to give the colony the best conditions for a good health. How is the actual situation for knowledge development and exchange in Europe today? How is the beekeeping sector gaining access to information? Where and how can good quality knowledge and information be found?

Framing key issues

In **minipaper 1** (Platform of information at EU level) beekeeping is compared to other agricultural practices with further specific challenges within: a) a diversified target group; b) mainly micro-businesses and self-subsistence; c) rural entrepreneurs, geographically scattered; d) gender and wide age structure; e) low will or ability to pay for professional advisory services; f) lack of tradition in formalised competence development; g) trainers and educators are self-trained as instructors. Due to these challenges, the situation about how to get access to knowledge must be analysed. In **minipaper 1** three key issues are discussed:

- Diversity of beekeeping across Europe
- Access to and quality of information
- Connection between research and practice (which is also key to introduce the following point on advisers)

Beekeepers work in many different environments. Every season is unique, and the beekeepers have to adapt their management techniques. If there is more than one beekeeper in the same forage area, what one beekeeper does or does not do has an effect on other beekeeping business, especially regarding honeybee health. As discussed in **minipaper 4** (Beekeeping advising unit. Information and training for beekeepers) beekeepers need to be advised properly on how to overcome external factors in order to keep productive colonies. How can **supporting services for beekeepers** be organised in order to improve colony survival and productivity? Sustainable apiculture needs sustainable extension and advisory services. The suggestion from **minipaper 4** is that the EU platform of beekeeping knowledge (discussed in **minipaper 1**) would serve as a primary source of information and a tool for training activities. Even so, it should be noticed that the scientific and research data would need to be turned into practical information, in the appropriate format and language, useful for the beekeeping practice or training.

By using the B-KIS (**Beekeeping Knowledge and Innovation System**) approach one gets a structural overview of the main knowledge actors, their roles and relationships. It aims to:

- Describe the general structure and function of activities aiming for knowledge development, innovation and learning
- Better understand how today's services for beekeepers are embedded into the national B-KIS
- Provide some conceptual elements to support the development of a national or regionally adapted communication strategy for improved sustainability of apiculture

Key issues identified:

- Make knowledge available (from research and practice)
- Skills development

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Good practices

The "Certificate for European Consultants in Rural Areas" (CECRA) is the first European competence development programme with an international certificate, meeting the rising demand for advisory methods training. It combines practical training with tried and tested advisory techniques. The networks Internationale Akademie für ländliche Beratung (IALB) and European Forum for Agricultural and Rural Advisory Services (EUFRAS) are the providers of the CECRA Certification. This certificate is made for advisory services for farmers but could very well be applicable for beekeeping.

https://www.teagasc.ie/media/website/about/our-organisation/connected/CECRA-flyer.pdf
https://www.cecra.net/index.php/de/

Mentioned as an example in **minipaper 4**, BeeBase is the Animal and Plant Health Agency's (APHA) National Bee Unit website. It is designed for beekeepers and supports Defra, Welsh Government and Scottish Government's Bee Health programmes. The National Bee Unit, NBU has been involved in the management and control of bee pests and diseases, training and dissemination of information to beekeepers for over 60 years. NBU comprises laboratory diagnostics, programme support, research personnel and 60 home-based Bee Inspectors. A beekeeper may sign in to BeeBase on a voluntary basis. By doing this, beekeepers are able to put the details of their honeybees and apiaries onto BeeBase, including inspections information, being able to arrange an apiary visit from the local inspector who can provide the comprehensive help and advice needed. The website includes quality assured information and knowledge for beekeepers.

http://www.nationalbeeunit.com

What can we do?

As suggested in **minipaper 1** (Platform of information at EU level) we can organise a **network of credible and validated information** gathered in different regions of the European Union in order to be able to take the best possible account of local specificities linked to culture, climate, land use, and the main existing beekeeping practices. Thus facilitating the structuring and standardisation of the information received from research and practice. This information would be centralised by a European platform and made accessible to national/regional 'antennas' and/or directly to beekeepers. Another way forward could be the development of a '**beekeeping licence**', a pan-EU standard of beekeeping qualification for beekeepers, achieved through formal education, professional training and/or extension services as discussed in **minipaper 4** (Beekeeping advising unit. Information and training for beekeepers).

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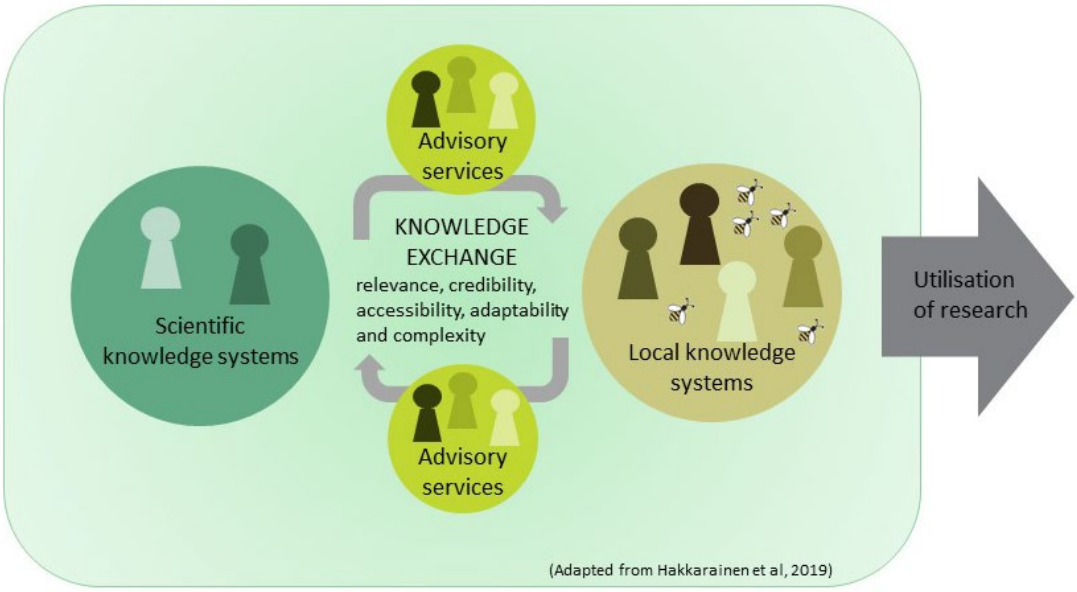

Figure 7: Bridging research and practice. A functional advisory system with the ability to make scientific knowledge available and accessible for practical use is essential and so are the knowledge and the needs generated by beekeepers, to be communicated to research through the same channels. The advisers facilitate this process.

Ways forward:

- Create a European platform for beekeeping knowledge connecting research and practice
- Licence for beekeepers, a pan-European standard

Inspiration from minipapers

MINIPAPER 4: AN ENCOURAGING STORY FROM SCOTLAND

A crisis situation in Scotland surrounding heavy levels of European foulbrood in 2009 forced a radical look at developing a strategy to deal with the situation. Initially it was felt that the beekeeping sector worked well amongst itself being kept well abreast of relevant situations. However, it quickly became apparent that this was not the case. When meetings were called to outline developing plans, it was apparent that the beekeepers were initially reticent and suspicious but as time went on the barriers broke down and a true partnership was formed.

Once the disease came under control, the strategy evolved to further improve the situation. Rather than simply have a meeting some became workshops dealing with bee health issues and then an accreditation developed where the beekeepers were tested against identification of disease and treatment. Success even resulted in a certificate acknowledging the new knowledge gained, something some had never received.

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MINIPAPER 1: SCIENTIFIC DATABASES

The International Bee Research Association, IBRA **https://ibra.org.uk** is a well-known scientific database in the field of beekeeping. It has published the Apicultural Abstracts since 1950, and continued to edit Bee World and Journal of Apicultural Research. Scientific information is structured and refers to Google scholar, PubMed, Scopus (paid) search engines, but many articles are linked to a subscription and only abstracts are accessible.

Another international non-profit association that focused on improving the welfare of honeybees worldwide is COLOSS (Prevention of honeybee COlony LOSSes **https://coloss.org/**). This association is composed of professional scientists, including researchers, veterinarians, agricultural extension specialists and students. In order to maintain cooperation and dialogue to better understand the reasons why bee populations are threatened in today's world, it maintains a website full of information, and holds regular meetings and workshops.

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3. Recommendations from the Focus Group

Following the work that was done exploring available knowledge, practices and technologies, the Focus Group experts looked at what is missing, what are the remaining needs that would need to be addressed in the future. Based on this, they have proposed new ideas for innovation, suggesting ideas for Operational Groups (OGs) and provided indications for possible directions for further research.

Most of the ideas fall into four main themes:

- Beekeeping data and their availability, management, standardisation, collection, interpretation and use.
- Beekeeper knowledge and needs in terms of training, information gaps from practice, social aspects of beekeeping.
- Beekeeping practices: health indicators, adaptation to and mitigation of climate change, dealing with farming practices with an impact on the bee's environment, cooperation with farmers.
- Bees at the centre: health and well-being, exposure to stressors, conservation of populations, genetics, breeding, effects of beekeeping practices.

3.1 Research needs from practice

Despite the many innovations and findings, still many research results are translated into practical applications very slowly, or not reaching the ground at all. On the other hand, professionals such as farmers or beekeepers may have the impression that research does not meet their needs. Therefore, the Focus Group was invited to identify remaining research needs from practice and propose possible directions for further research.

Six priority research needs from practice were highlighted by the FG. Other identified research needs can be found in **Annex 4** and are further articulated in the minipapers.

1. Create a European platform better connecting research and practice and contributing to efficiently gathering and exchanging knowledge. It should relay and be connected to local centres to properly consider context-specific issues, and ensure accessibility, credibility and visibility of the information for beekeepers. For this, specifically issues related with language and standardisation or interpretation of data from monitoring tools would need to be considered.

2. Determine and evaluate an index to synthesise the health status of individual honeybees and their colonies, which can be useful for several purposes related to honeybee health and risk assessment (effects of stressors from agriculture). Even developing an emergency tool such as the creation of the *Bee ambulance* to provide assistance in case of emergency situations (e.g. disease outbreaks).

3. Explore the effects of exposure to stressors from agriculture, including e.g.: knowledge of the effect of novel chemicals, including their sublethal effects and interactions with other chemicals or stressors such as flowering resource quality and quantity.

4. Improve technologies and methods for sustainable beekeeping, such as the use of a natural wax cell size (as would be natural for honeybees), in combination with the regular removal of drone brood or applying organic substances instead of synthetic chemicals.

5. Improve breeding efforts in all countries in order to maintain the local populations of honeybees, as well as to identify resistant populations to Varroa. Breeding local honeybees and honeybees that are well adapted to their climatic conditions will improve resilience.

6. Work on identification, communication and implementation of mitigation practices amongst beekeepers, and with farmers. Test and find out best mitigation practices in terms of effectiveness, increase farmers' awareness on the importance of honeybees and pollinators, work on agreements between beekeepers and farmers – enforced by local authorities –, etc.

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3.2 Ideas for Operational Groups

With the aim of inspiring innovative actions, seven main ideas for EIP-AGRI Operational Groups were elaborated by the FG. The proposals cover a wide range of types of projects, from testing solutions or management practices at hive level to ways of cooperation or knowledge exchange.

Theme: Varroa control

IDEA 1: TESTING THE EFFECTS OF CUTTING THE DRONE BROOD AND REDUCING THE CELL SIZE FOR VARROA CONTROL

The objective is to keep the Varroa level as low as possible during the whole season, by properly managing drone brood and choosing the most suitable comb cell size. The most common size nowadays is 5.4 mm, but it is not clear whether this is suitable to fight against Varroa. Moving to a more natural size of cells (allowing the bees to show us the exact size) might be the way forward to fight Varroa. Bees will build a different size of cells in the different climatic zones as well according to their own body size, as adaptation to the microclimate they live in. The same applies to the type and the size of the hive.

The project would require involvement from researchers, advisers and beekeepers. The outcomes – mainly for the beekeepers – would be:

- Recommendation of the best comb cell size in each area
- Recommendation of the best hive type (or size)
- Recommendations on frequency and efficiency of drone brood removal
- Low Varroa infestation levels throughout the year, increased survivability of colonies.

The activities of the project would include:

1. Testing different cell sizes of combs in 2-3 different ecotypes or conditions
2. Testing different sizes of hives in different ecotypes or conditions
3. Testing and combining the above with drone brood removal, at different frequencies
4. Monitoring Varroa levels and colony productivity together, and under all these different conditions, during the year
5. Formulating the recommendations based on all these trials.

This project could be implemented in different countries to test the differences.

IDEA 2: BETTER COLLABORATION FOR LESS VARROA

Varroa treatments are usually applied individually by beekeepers. Thus, the objective of this project is to mitigate Varroa infestation across apiaries at local level, by encouraging the cooperation of beekeepers to organise and implement a common calendar for Varroa treatment. There is some experience on this in Switzerland and Germany, thus the idea is to adapt and replicate the example in other areas.

This is a collective approach that would require the cooperation of for example 5-6 beekeepers, who would agree and coordinate the timing of the treatments. Benefits would be the decrease of the risk of Varroa, reducing chemical treatments, or better monitoring of Varroa especially in areas with high density of apiaries.

The practical outcome would be a communication tool (such as an application) for beekeepers, associations and other relevant experts (e.g. vets, advisers) which should provide info as proposed data for treatments, current levels of infestation of the different colonies in the region, localisation of apiaries, alerts, etc.

In parallel to the platform, the project would look at potential incentives that might encourage the use of the application and the coordination of treatments by the beekeepers.

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Theme: Hive construction and management methods

IDEA 3: MANAGEMENT OF APIARIES IN THE WORST/EXTREME CONDITIONS

Climate change impacts are increasing all over Europe, threatening honeybees and beekeeping activity. The objective of this project would be to contribute to maintaining the beekeeping activity focusing on protecting the apiaries against the main threats posed by climate change on a specific area. For example, helping to overcome specific adverse conditions such as very hot weather, drought or threats such as birds or *Vespa velutina*. The main topic is bee health but also how to preserve pollination activities for farmers.

The expected results are two-fold:

1. Improving the immunity of honeybees based on practices of artificial nutrition, multiplication of bee colonies, management of Varroa, etc.
2. Designing hives and apiaries to avoid adverse conditions (e.g. covers for apiaries which could help to deal with very extreme environmental conditions such as very dry and hot summers)

The idea is to run the project on a specific location. The steps towards the results would be:

1. To select the study area and identify the main climate-related adverse conditions and threats expected on the area
2. To design the apiary with the specific material and equipment to protect the apiary against the foreseen adverse conditions in the study area.
3. To define the best management practices e.g. for nutrition, multiplication of colonies or pest management.

Participants needed for the project would be some beekeepers (or an association), advisers, manufacturing companies and researchers.

IDEA 4: SMALL CHANGES, "BEEG" OUTCOMES. DIFFERENT DESIGNS OF WALLS OF THE BEEHIVE

The objective of the project is a better understanding of beekeeping and husbandry practices, looking specifically at beehive materials and techniques, depending on the climate and local situation. For example, the thickness of walls and materials of the hive have a direct impact on isolation of the hive (so affecting temperature and humidity), propolis harvest or swarming management.

The aim is to increase resilience of honeybees and improve their well-being and health, thus direct beneficiaries would be first the bees, and then the beekeepers.

The expected results would be guiding material about "Do's and Don'ts" in beekeeping, and delivering advice concerning:

1. Materials to be used in beekeeping (including feeds, etc.)
2. Practices for husbandry management

To achieve the results, the project would need to collect and study the existing beekeeping practices and materials available, e.g. designs of hives and belonging equipment. Then it would set up protocols and tests to study the performance of the different materials and practices and, if possible, under different environmental conditions. Finally, it would derive recommendations and disseminate the findings.

Specific participants needed for this project would be manufacturers and suppliers of beehive products and equipment, engineers and designers of equipment, and practitioners such as vets or advisers with knowledge on bee health.

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It should be noted that the project recognises the benefits of the standardisation of practices or equipment, thus it is not aiming to look for new developments, but it would try to deliver recommendations about what might perform better, within the wide range of existing practices and materials, depending on the local conditions.

Theme: Collaboration

IDEA 5: CREATING BRIDGES BETWEEN FARMERS AND BEEKEEPERS FOR BEE-FRIENDLY FARMING

The motivation of the project is the lack of communication and awareness of the importance of honeybees for agriculture. Do we have a common understanding about what is "bee-friendly" farming?

Expected results are:

1. Developing an app/platform to share information in real time between farmers and beekeepers. The platform would include all relevant information as for example land use, pesticide application or crops.
2. To get a common agreement on what is a "bee-friendly" strategy. For example, abundant nectar sources in the late season should not be considered a bee-friendly practice, because it shortens the life of the worker bees. These late food sources delay the overwintering of the workers. As a consequence, colonies are too weak after winter and likely too small for building up a strong colony in time for spring crops.

Participants who would be welcomed for the project are beekeeping associations, advisory services, local farmer associations, organic farming associations, among others.

IDEA 6: BRIDGES BETWEEN FARMERS AND BEEKEEPERS, TO DISCUSS AND COMMUNICATE GOOD PRACTICES AND ADAPT THE PRACTICES ON A LOCAL SCALE

Bees in agricultural landscapes need a good environment, thus the idea is to improve the implementation of bee-friendly practices by farmers. The idea for this project is to develop a communication guide to farmers and beekeepers, at a very local scale. This guide could be disseminated later on to another region with similar conditions.

The steps to follow will be, first to test and select agricultural practices to be implemented by farmers and which benefit the health of bees. Secondly the project would focus on communicating those practices amongst famers, e.g. through guidelines, visits, joint meetings with beekeepers, etc.

For this the project would need to characterise, at a very local scale:

1. The landscape (forage availability, pesticides use, etc.)
2. The colonies' health (impact of pesticides, pathogens, food quality and quantity, colony strength, etc.).

Apart from beekeepers and farmers, the project would also indirectly benefit citizens and public administration.

IDEA 7: FOOD FOR BEES

The motivation of this project is the lack of food for honeybees in some places, for example in The Netherlands, where due to the high density of apiaries, honeybees are suffering from shortage of food. Also, there is a shift in food sources due to climate change. This lack of food is affecting not only the honeybee but also wild bees and lies behind the bad reputation that beekeepers are having in some contexts.

This, as well as some other project ideas, includes a cooperation aspect amongst farmers, beekeepers and other actors, but with the main focus on increasing the availability of food for bees (not looking, for example, at reducing the impact of pesticides etc.).

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The expected results would be:

1. A better organisation and distribution of hives over the area of study
2. The description of the nutritional value of the landscape features and crops
3. An increase of the number of flowering plants and trees
4. An increase in biodiversity and building a better reputation for beekeepers

The beneficiaries would not only be beekeepers but also citizens, as the project aims to improve the quality of the ecosystems and environment.

Some of the tasks the project would carry out are:

1. Study the impact of climate change on plants which are supplying food for bees, including gardens
2. Establish "bee gardens", also for public awareness
3. Establish recommendations for landscape design (agriculture, forestry, etc.) favouring bee food sources
4. Monitor honeybee health and wild pollinators in different landscape features.

The participants of the project would be local governments in charge of landscape developments, researchers, beekeeping organisations, agricultural organisations. Additionally, "community influencers" might be a good asset to boost dissemination and raise awareness about the topic amongst citizens, farmers and beekeepers.

IDEA 8: EDUCATIONAL PROGRAMMES FOR BEE BREEDERS

Most knowledge of breeding bees lies within a few breeding organisations and not within the overwhelming majority of hobby beekeepers. For local breeding of honeybees we need to educate local bee breeders. The gain of good breeding practices by hobby beekeepers would be beneficial for all bees, and therefore for the whole beekeeping business. The development of such a programme could consist of the following steps:

1. Gathering the knowledge from different breeding organisations. This will be a mixture of different race breeders, different countries and different ecological systems.
2. Comparison of different breeding practices and mapping the practices in a scheme for different ecologies.
3. Converting the acquired breeding knowledge in locally adapted programmes.
4. Developing an implementation plan for the breeding programmes.

Step 1 would require cooperation of several bee breeding organisations like BeeBreed, Buckfast breed organisations and black bee breeders, either professional or non-professional. The gathered breeding knowledge should not focus on races, but on traits, like aggressiveness, swarm behaviour and Varroa resistance.

Step 2 and 3 require the independent assessment of the knowledge, preferably by academic researchers and/or lectures. The complete set of final specifications for the programme should be determined.

Step 4 requires the involvement or even better the participation of all local beekeeper associations or organisations. They should implement the programme at least partially in local beginner programmes or completely in educational programmes for advanced beekeeping.

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Annex 1: List of members of the Focus Group

Name of the expert	Profession	Country
Simone Tosi	Researcher	France
Fabio Sgolastra	Researcher	Italy
Marc Bock	Farmer	Finland
Florence Aimon-Marie	Adviser	France
Aleš Gregorc	Researcher	Slovenia
Stephen Sunderland	Civil servant	United Kingdom
Fani Hatjina	Researcher	Greece
Petko Simeonov	Farmer	Bulgaria
Salvador Garibay	Adviser	Switzerland
Louis Hautier	Researcher	Belgium
Ulrich Bröker	Adviser	Germany
José Antonio Ruiz-Martínez	Adviser	Spain
Frens Pries	Researcher	Netherlands
Etienne Bruneau	Working at an NGO	Belgium
Pilar De la Rua	Researcher	Spain
Ana Paula Sançana	Working at an NGO	Portugal
Anna Dupleix	Researcher	France
Constantin Dobrescu	Working at an NGO	Romania
Zeid Nabulsi	Farmer	Italy
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Facilitation team		
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You can contact Focus Group members through the online EIP-AGRI Network.
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If you want to become part of the EIP-AGRI Network, please register to the website through this link

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Annex 2: List of minipapers

No.	Topic	Contributors
MP 1	Platform of information at EU level	Etienne Bruneau (Coord), Salvador Garibay, Florence Aimon-Marie, Ana Paula Sançana, Aleš Gregorc, Ulrich Bröker, Petko Simeonov
MP 2	Disease control and emergency situations	Hatjina, Fani (Coord.), Marc Bock, Pilar De la Rua, Constantin Dobrescu, Aleš Gregorc, Zeid Nabulsi, Ana Paula Sançana
MP 3	Taking into account the well-being of honeybees in production	Anna Dupleix (Coord.), Etienne Bruneau, Ulrich Bröker, Robert Chlebo, Salvador Garibay, Petko Simeonov
MP 4	Beekeeping Advising Unit. Information and training for beekeepers	Stephen Sunderland (Coord.), José Antonio Ruiz, Louis Hautier, Zeid Nabulsi, Aleš Gregorc
MP 5	Improving the bee health status through monitoring of the colonies and the environment	Petko Simeonov (Coord.), Frens Pries, José Antonio Ruiz, Rober Chlebo, Louis Hautier, Fabio Sgolastra, Zeid Nabulsi, Simone Tosi
MP 6	Developing and enhancing good practices to mitigate major bee health stressors: pesticides and lack of resources	Simone Tosi and Louis Hautier (Coord.), Frens Pries, José Antonio Ruiz, Florence Aimon-Marie, Zeid Nabulsi, Fabio Sgolastra
MP 7	Sustainable bee breeding	Frens Pries (Coord.), Pilar De la Rúa, Ana Paula Sançana, Fani Hatjina, Salvador Garibay

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Annex 3: List of honeybee research projects and initiatives and Operational Groups

This is a list of projects (past or ongoing) related to bee health and monitoring, compiled during the second meeting of the FG, and of the main themes they're addressing (updated July 2020)

1= Pests and diseases 2= Pesticides, agricultural practice	3= bee food supply and landscape 4= Well-being of bees	5= Monitoring 6= Breeding, local races	7= Knowledge exchange, advice 8= Beekeeping practice

Project		Theme addressed							
		1	2	3	4	5	6	7	8
LIFE4POLLINATORS	LIFE 4 Pollinators (**Involving people to protect wild bees and other pollinators in the Mediterranean**) – (LIFE18 GIE/IT/000755) LIFE4Pollinators wants to improve the conservation of pollinator insects and entomophilous plants by creating a virtuous circle leading to a progressive change in the anthropogenic practices that are currently threatening wild pollinators across the Mediterranean region. Events, citizen science activities, training to key stakeholders are planned to fulfil this objective by increasing awareness in four European countries: Italy, Greece, Spain and Slovenia. **https://www.life4pollinators.eu/**		x					x	
Smarthives	Smarthives (part of FRACTAL) is an **online support system that will help beekeepers in their everyday beekeeping activities and duties**. The basis of the concept is an ERP (Enterprise Resource Planning) system customised for beekeepers to facilitate better handling and management of honeybees (sites and families), equipment, expenditures and revenues. The software is operational on itself, but, for automatisation reasons, beekeepers can connect sensors to the system as well. **http://www.r-key.eu/**	x				x	x	x	x

1= Pests and diseases 2= Pesticides, agricultural practice	3= bee food supply and landscape 4= Well-being of bees	5= Monitoring 6= Breeding, local races	7= Knowledge exchange, advice 8= Beekeeping practice

Project		Theme addressed							
		1	2	3	4	5	6	7	8
POSHBEE	PoshBee (**Pan-european assessment, monitoring, and mitigation Of Stressors on the Health of BEEs)** (Jun 2018 - May 2023) addresses the issue of agrochemicals to ensure the sustainability of bees. It will assess the exposure to chemicals and their co-occurrence with pathogens and nutritional stress for solitary, bumble, and honey bees. The info will be integrated with the MUST-B project to develop a dynamic landscape model for risk assessment of bees. https://cordis.europa.eu/project/rcn/215953/factsheet/en https://poshbee.eu/	x	x	x		x	x	x	
APENET	APENET (**Monitoraggio e ricerca in apicoltura**) (2009-2011) was a project funded by the Italian Ministry of Agriculture. The aim of this project was to monitor and study the possible causes of honey bee mortality and colony losses in Italy. The project was organised in six pillars: Bees and agrochemicals; Bees and dressed seeds; Bees and Diseases; Bees and Environment; Interaction between stressors; Monitoring. https://www.reterurale.it/apenet	x	x	x	x	x			
BEENET	BEENET (**Apicoltura ed ambiente in rete**) (2012-2014) was a project funded by the Italian Ministry of Agriculture within the European Network for Rural Development (Action 1.2.2 "Interregional Laboratories for the Development") to support the Rural Development Programme in Italy. The aim of this project was to monitor the health status of honey bees and to assess the main causes of bee mortality in Italy. Recently, BEENET (now called "BEENET: api e biodiversità al servizio dell'ambiente") (2019-2023) has been re-funded by the Italian Ministry of Agriculture within the European Network for Rural Development (2013-2020) (Action 1.1.3) with the aim to evaluate the quality of the agro-environment using honey bees and wild bees as bioindicators. https://www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/9026	x	x	x	x	x			x
POLBEES	PolBEES (**Risk assessment for honeybees and osmie bees of exposure to systemic pesticides and nutritional stresses via pollen, bee bread and osmie bread**) studies the presence of systemic pesticide residues (neonicotinoids, fungicides) and the limited diversity of food resources in Wallonia. An exposure assessment will be carried out in different landscape contexts (field crop, arboriculture, grassland, urban areas) by collecting trap pollen and bee bread from hives and nests of osmias. https://www.cra.wallonie.be/fr/polbees		x	x		x			

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Project		Theme addressed							
		1	2	3	4	5	6	7	8
BEESYN	BEESYN (**Identification of the impact of chemical products on honey bee mortality in Belgium, bearing in mind the interactions of these products with other plausible causes of mortality**) aims to answer the following questions: • What are the colonies' chemical contamination levels and what is the origin of this contamination? • To what extent may such a contamination determine the colony's fate when put in its context: its genetic, pathogen/parasite load, nutritional status, climate conditions and land use around it? • Which recommendations could be proposed to mitigate the problem of colony mortality at several levels: decision making, scientific, and practice? • Can we propose a tool box, including indicators of bee health and pesticide exposure, methods for pesticide surveillance carried out by honey bees or cost-effective surveillance programmes for colony mortality?. **https://www.cra.wallonie.be/fr/beesyn**	x	x	x		x		x	
DNA marker for VSH genes	(**Sustainable control of the Varroa mite in the Dutch beekeeping business)**. It would be ideal if bee colonies fight the Varroa mite themselves and this Varroa mite control (VSH: Varroa Sensitive Hygiene) behaviour occurs sporadically in existing bee colonies. This research project aims at a rapid cultivation of populations with this VSH behaviour. The partner Arista Bee Research breeds Varroa-resistant honeybees (buckfast, carnica, black bee) by challenging potential colonies and measuring reproducing mites in the brood. Hogeschool Van Hall Larenstein observes VSH (Varroa Sensitive Hygiene) behaviour in individual bees. Hogeschool Inholland isolates DNA from honeybees and has the DNA sequenced. With Bejo Zaden the DNA bioinformatics will be done and a marker for VSH behaviour will be established. Goal is to use the DNA marker for breeders to make apiculture possible without chemical control of Varroa. If all beekeepers will waive chemical control, in the long run all honeybee populations will be Varroa resistant, even without testing with the DNA marker. **https://www.sia-projecten.nl/project/duurzame-bestrijding-van-de-varroamijt-in-de-nederlandse-bijenhouderij**	x					x		x
GREEK QUEENS	**Conservation and genetics improvement of selected populations of Macedonian and Cecropian bees** based on performance and resistance to Varroa						x		

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Project		Theme addressed							
		1	2	3	4	5	6	7	8
BEEPATHNET	BEE PATH – Good Practice logic is very simple: bees are the best indicators of a healthy environment! The BeePathNet Transfer network aims to upgrade and transfer the BEE PATH concept, solutions and results from Ljubljana to 5 other EU cities. It will address **urban environmental, biodiversity and food self-sufficiency challenges linked to urban beekeeping** through integrated and participative approaches, build key stakeholders' capacity to influence relevant policies, develop and implement efficient solutions. **https://urbact.eu/beepathnet**				x			x	
RESCUE-B	The RESCUE B (**Risk and Exposure Survey on Chemical Use in the Environment**) research project aims at better understanding the risk that environmental stressors, especially pesticides, cause to bees. First, it aims at developing methods to estimate pesticide risk in bees, including lethal and sublethal effects of single and multiple stressors. Second, it uses several multi-year national and international honey bee health surveys that measure pesticide contamination in the environment and in bee food to identify the pesticides that pose a greater threat to bees, nationally and internationally. This work aims at laying the foundation of future integrations of bee health surveillance initiatives, guiding policy makers through refined risk assessment methods, towards a greater protection of bee health and environmental sustainability. This project is hosted by the French Agency for Food, Environmental and Occupational Health and Safety (ANSES), and was developed in the framework of the "**Make Our Planet Great Again**" research initiative, publicly funded by the President of the French Republic.		x		x	x		x	
INSIGNIA	INSIGNIA (**Environmental monitoring of pesticide use through honeybees)** is an innovative project which will build on the wide range of expertise of the applicants developed during previous projects such as the COLOSS "CSI Pollen project". INSIGNIA involves the development of a protocol for a citizen science monitoring programme using beekeepers to collect biweekly pollen samples from honeybee colonies for analysis for pesticide residues and botanical origin. In the first year, in four EU member states representing all authorisation zones, monitoring using the well-established technique for collecting pollen samples using pollen traps, will be compared with two innovative techniques: the collection of beebread using a novel sampling device, and the use of passive in-hive sampling devices. **https://www.insignia-bee.eu/**		x						

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Project		Theme addressed							
		1	2	3	4	5	6	7	8
EurBeST	EurBeSt network (**European honey Bee breeding and Selection Team**). Selective breeding is a powerful tool to improve the economic basis of beekeeping and to cope with challenges to honey bees due to parasites, diseases, climatic and environmental changes. We know that the selection progress in productivity, gentleness and resistance to the parasitic Varroa mite (*Varroa destructor*) that can be achieved by modern selection methods, and also about the development of high levels of Varroa resistance under natural infestation pressure. The establishment of mite resistance in commercial populations depends on selective breeding supported by an adaptation of colony management and treatment procedures. EurBeST would like to demonstrate how these ideas can work in practice and which technical and economical consequences derive from these. **https://eurbest.eu**				x		x	x	x
Beewood/SAPIC	Beewood studies the **influence of wood material for building beehive** from physical (insulation) and chemical (wood odours) influence on bees health with a link to personal experience knowledge of beekeepers. **http://www.lmgc.univ-montp2.fr/perso/anna-dupleix/beewood-research-projet/**				x	x			x
NO PROBLEMS	NOPROBLEMS "**Nourishing PRObiotics to Bees to Mitigate Stressors**" is a project funded by the EU under the MSCA-RISE - Marie Skłodowska-Curie Research and Innovation Staff Exchange (RISE) with the aim to define a strategy to improve honey bee health based on the use of beneficial bacteria and plant extracts. The project aims also to evaluate the impact of the developed formulation on the bee gut. **https://site.unibo.it/h2020-msca-no-problems/it** **https://cordis.europa.eu/project/id/777760**			x	x				x
BEE-RER	BEE-RER is a research project of the University of Bologna funded by the Emilia Romagna Region within the Apiculture supporting work programme. The full title is "**Analysis of honey DNA and of honey contaminants to support the apiculture sector and monitor hive pathogens in Emilia Romagna region** - (BEE-RER)". BEE-RER aims to face the problems of the beekeepers by applying genomics to the apiculture sector. The project is focused on the application of honey DNA analysis to obtain several information that could be useful to authenticate the honey, identify the Apis mellifera subspecies from this matrix and to identify pathogens **https://site.unibo.it/bee-rer/en**	x			x	x	x		x

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Project		Theme addressed							
		1	2	3	4	5	6	7	8
SURVapi	The SURVapi Project (**MONITORING environmental contamination with phytosanitary products via beekeeping matrices to improve and reduce their uses**) is part of the Ecophyto plan. It is a multi-year project which aims to set up a collaborative work between farmers and beekeepers, to improve the field practices practices taking into account the issue of protecting bees. On each site, joint facilitation by advisers from the Chamber of Agriculture and the Beekeeping Development Association will facilitate joint work. Scientific support is provided by ITSAP - Institut de l'Abeille. **https://nouvelle-aquitaine.chambres-agriculture.fr/agro-environnement/ecophyto/survapi/**		x	x				x	
BeeWallonie	BeeWallonie defines itself as the "**showcase for Walloon beekeeping and the skills developed by beekeepers**". It aims to support Walloon beekeepers and the initiative counts with the support of research organizations and the regional government. **https://www.beewallonie.be**	x	x			x		x	
B-GOOD	B-GOOD (**Giving Beekeeping Guidance by cOmputatiOnal assisted Decision making**) is an EU wide bee health and management data platform. It consist on a digital bee data logbook, a database for automated data acquisition and a web portal. The EU-funded B-GOOD project aims to create a health status index (HSI) that will be linked to apiarists, and will collect and process data from a wide range of sources. **https://www.b-good-project.eu/**				X	X		X	X
HIVEOPOLIS	Hiveopolis (**Futuristic beehives for a smart metropolis**) (2019-2024) will implement a variety of traits into this modern honey bee hive. For example, every honey bee colony will be equipped with an inbuilt dance robot. These dance robots will be able to direct forager bees to certain nectar or pollen sources. Vibrating plates built into combs will prevent colonies from foraging at harmful food sources, such as flowers treated with pesticides or dying colonies which are heavily infested by *Varroa* mites. **https://www.hiveopolis.eu/** **https://cordis.europa.eu/project/rcn/218714/factsheet/en**					X			X
BPRACTICES	BPRACTICES by ERA-NET SUSAN ((**New indicators and on-farm practices to improve honeybee health in the *Aethina Tumida* ERA in Europe**) will develop new management practices (Good Beekeeping Practices – GBPs) adopting new clinical methods, biomechanical and innovative biomolecular techniques respecting the natural behaviour of honeybees. The economic impact on beekeeping industry will be quantified and beekeepers and	x				X		X	X

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Project		Theme addressed							
		1	2	3	4	5	6	7	8
	consumers will be aware of the project results thanks to a cutting-edge traceability system using the QR-code/RFID technology https://era-susan.eu/content/bpractices								
SAMS	SAMS (**International Partnership on Innovation in Smart Apiculture Management Services**) (Jan 2018 - Dec 2020) SAMS is a multi-national, interdisciplinary project, with the goal to promote beekeeping in tropical regions by applying Internet of Things (IoT) systems and Information and Communication Technology (ICT). The solutions created by the project are accessible open source. The three-year project enhances international cooperation on ICT technology and sustainable agriculture between the SAMS partners from Ethiopia, Indonesia, Latvia, Austria and Germany. https://sams-project.eu/					X		X	X
IOBEE	IoBee (**Beehive health IoT application to fight Honey Bee Colony Mortality**) (2017-2020). The IoBee project concluded in April 2020 with the development of in-hive and in-field monitoring, as well as the implementation of satellite imagery and Spatial Decision Support Systems (SDSS). IoBee also initiated the first steps in the construction of a platform to integrate and communicate on pollinator-related data from various sources, The Bee Hub http://cordis.europa.eu/project/rcn/210011_en.html https://io-bee.eu/	x				X		X	X
WARMHIVE	WarmHive (**SMART thermotherapy solution for Varroa mite treatment**) (Jan-Jun 2019) https://cordis.europa.eu/project/rcn/220042/factsheet/en	x				X			
BEEHOME	BeeHome (**Automated beekeeping platform powered by AI that increases honey production by 50%, reduces labour use by 90%, and reduces colony loss by 80%).** (Jan – Apr 2019) BeeHome is a patent-protected modular commercial apiary that automates beekeeping powered by Artificial Intelligence. The BeeHome platform consists of a hardware and software solution that fully automates beekeeping and honey production and that optimises pollination. The platform will house up to 40 colonies (hives) and streamline their activities. https://cordis.europa.eu/project/rcn/220635/factsheet/en					X			

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Project		Theme addressed							
		1	2	3	4	5	6	7	8
FOG	FOG (**Frequency protector generator for honeybees)** (Jan - June 2019) **https://cordis.europa.eu/project/rcn/220056/factsheet/en**					X			
BeeXML	BeeXML (**Collaboration platform for the standardisation of the exchange of data about bees and beekeepers**). Governmental institutions, academic research projects as well as breeding programmes of beekeeping associations inevitably gather data about bees and beekeepers. Unfortunately these databases become data islands and the information is of limited value for the beekeeping community as a whole. beeXML is intended to be the answer to this problem. The project is not about creating a central database. Rather, XML is a self-describing data format that can allow the exchange of data. **http://beexml.org/**					X			
Hostabee	Hostabee has **developed B-Keep and B-Swarm.** These connected units enable professional and amateur beekeepers to monitor hives and their inhabitants remotely. The data, collected each hour by sensors, can be consulted via a dedicated application. This information (humidity, temperature, etc.) provides fast answers on the state of health of the bee colony. **https://youtu.be/jmVYbDXf3Fg** **https://youtu.be/-L9IBD6CDVQ** **https://hostabee.com**					x			
MUST-B	MUST-B is an initiative by the European Food and Safety Authority (EFSA). The MUST-B project draws on EFSA's expertise in areas such as animal and plant health, data collection and analysis, modelling, pesticides and environmental risk, but will also involve a range of experts and stakeholders from beyond EFSA. It comprises a number of interlinked activities that are being carried out either in-house or in collaboration with external experts, researchers and bodies such as EU Member States, the European Commission, EU sister agencies, and the European Reference Laboratory for Bee Health. **http://www.efsa.europa.eu/en/topics/topic/bee-health**	x	x	x	x	x	x	x	x

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Project		Theme addressed							
		1	2	3	4	5	6	7	8
AGROAPIS*	AGROAPIS is a project to raise the value of apiculture production by using agricultural crops beneficial to bees and pollinators in compliance with the agri-environmental conditions. The target is to test in-field conditions melliferous vegetal species that may be cultivated both for the benefit of bees and other pollinators and farmers. The testing will provide an objective assessment of the value of various plants both from the apicultural point of view and for the vegetal farming sector. The project is in its final stage of approval and will be, hopefully, financed via the Romanian National Program for Rural Development, measure 16.1.		x	x	x	x			
APISANA*	APISANA is about a mobile laboratory for sampling and conservation of the samples collected for assessment of the toxicity of agricultural cultures on honeybees. This project will explore the best methods for sampling, preservation and transport in safety conditions of the samples of bees and bee products collected from hives as well as parts of plants, soil or water in order to ensure relevant results of the lab analyses for assessment of the toxicity of agricultural crops and environment that harm the bees and other pollinators. The project is in its final stage of approval and will be, hopefully, financed via the Romanian National Program for Rural Development, measure 16.1.	x	x		x	x			
PUROWAX*	The project PUROWAX is about helping beekeepers to obtain residue-free beeswax for sustainable agriculture and for improving bees' health. The project aims to develop a method for purification of beeswax of contaminants that impact the health of honeybees and to create a scalable production process for purifying beeswax at industrial level. The project is in its final stage of approval and will be, hopefully, financed via the Romanian National Program for Rural Development, measure 16.1.	x	x						x

*Assessment in progress

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Annex 4: Full list of research needs per minipaper

This annex lists 3-4 key research needs coming from practice, which have been identified by the experts, and grouped by minipaper topic. For further details, check the minipaper.

MP 1: INFORMATION PLATFORM AT EU LEVEL

- Creating a European platform that better connects research and practice and that contributes to efficiently gathering and exchanging knowledge. It should relay and be connected to local centres to properly consider context-specific issues, and ensure accessibility, credibility and visibility of the information for the beekeepers. To do this, the platform would need to consider issues related to language and standardisation in particular.
- Better knowledge of the social perspective of beekeeping and the profile of beekeepers across Europe might contribute to a more effective and reliable platform.
- How to deal with the data collection and management and standardisation of the information at EU level.

MP 2: DISEASE CONTROL AND EMERGENCY SITUATIONS

- Determination and evaluation of the Health Status Index for honeybees as well as its applications for honeybee colonies, which can be useful for several purposes related to honeybee health and risk assessment (effects of stressors from agriculture).
- The creation of the *Bee ambulance* providing quick assistance in case of emergency situations (e.g. disease outbreaks).
- Use of natural wax cell size (as would be natural for bees), in combination with the regular removal of drone brood or applying organic substances instead of synthetic chemicals. Determine the buffer capacity of the colony – e.g. in case of intoxication or disease – and the time needed for the colony to recover.

MP 3: TAKING INTO ACCOUNT THE WELL-BEING OF BEES IN PRODUCTION

- Better knowledge of the environment around the bees, especially agriculture-related (crops, chemicals, biodiversity, etc.)
- Adaptation of beehive and apiary practices to climate change: e.g. natural wax comb production, study the effect of climate change on the thermoregulation of honeybees or influence of shape or material of the hive on its insulation.
- Effects of bees' artificial nutrition and supplementary feeding in well-being (e.g. depending on time or frequency of feeding or composition of the food, organic feed)
- Breeding and reproduction aspects and their impact on the bees' well-being, as the effect of the natural swarming process or future implications of some genetic and breeding practices (e.g. introduction of foreign queens).

MP 4: 'BEEKEEPING ADVISING UNIT'. INFORMATION AND TRAINING FOR BEEKEEPERS

- Establish an EU database of beekeeping advising and training courses, centres, and resources.
- Establishing a set of common standards for beekeepers' training
- Developing a 'beekeeping licence', a pan-EU standard of beekeeping qualification for beekeepers achieved through formal education, professional training and/or extension services.
- Knowledge on exchange opportunities amongst beekeepers, which would also be supported by the EU database on training and advising.

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These research needs are closely linked and complementary to MP1 (EU platform). Hence, the EU platform of beekeeping knowledge would serve as primary source of information and tool for training activities. Even so, it should be noticed that the scientific and research data would need to be turned into practical information, in the appropriate format and language, useful for the beekeeping practice or training.

MP 5: FROM PRECISION BEEKEEPING TOWARDS DECISION SUPPORT SYSTEMS

- Improve the interpretation of data (especially from sensors) and translate this into practical advice for the beekeeper.
- Information gap from beekeepers. What information that is not currently provided/monitored do they actually miss? E.g. swarming monitoring, time of treatments, time of feeding, etc.
- Establishing an open-source database of data (from sensors), but led by a public institution (e.g. Apimondia), rather than by private companies. It would request a standardisation of the data (the existing BeeXML project might be a start for this) so that sharing and interoperability is possible.

The FG pointed out a lack of data standardisation across Europe, and a single repository or platform to access the information. To address this issue for example, Horizon 2020 research projects are required to use open-data standards and are encouraged to cooperate concerning data management.

It was mentioned that, for beekeeping, the B-GOOD project, together with the European Bee Partnership, is also working towards the standardisation and interoperability of data.

MP 6: DEVELOPING AND ENHANCING GOOD PRACTICES TO MITIGATE MAJOR BEE HEALTH STRESSORS: PESTICIDES AND LACK OF RESOURCES

- The effects of exposure to stressors from agriculture, including e.g.: knowledge of effect of novel chemicals, including their sublethal effects and interactions with other chemicals or stressors such as flowering resource quality and quantity.

- Identify, communicate and implement mitigation practices amongst beekeepers and farmers. For example, stakeholders should investigate and develop the best mitigation practices to improve honeybee health and agricultural success, farmers' awareness on the importance of honeybees and pollinators, the development of agreements between beekeepers and farmers – enforced by local authorities –, etc.

The group mentioned that the Health Status Index proposed in MP2 could also consider effects of stressors from agriculture, in addition to pest and diseases.

MP 7: SUSTAINABLE BEE BREEDING

- Comparison of breeding practices and establishing quality indicators and criteria for breeding.

- Effective communication on how and why genetic diversity is important, to convince beekeepers that they should look for genetic biodiversity, resilient honeybees and sustainable bee breeding.

- Characterisation and conservation of local populations to increase the gene pool, also looking at feral bees, local breeding practices or studies of the relation between behaviour and ecotypes, etc.

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Annex 5: EIP-AGRI Operational Groups working on bee health

The table below compiles the Operational Group (OG) projects currently listed at the EIP-AGRI database (https://ec.europa.eu/eip/agriculture/en/eip-agri-projects/projects/). Date of consultation is July 2020. This is not an exhaustive list and more projects can be found at the national and regional databases of Operational Groups. See here the list of other available sources:

https://ec.europa.eu/eip/agriculture/en/links-existing-operational-groups

Title	Country
Control and minimiation of damage by the invasive species Vespa velutina nigrithorax (Vespa velutina) in beekeeping	Portugal
2016-008 - SOCIOECONOMIC STUDY on the impact of VESPA VELUTINA in the Apiculture of the Autonomous Community of the Basque Country	Spain
BeeOShield_An innovative biomolecular defence against bee parasites	Italy
Selection and Establishment varroa tolerant bee colonies VSH / SMR - short SETBie in BW	Germany
VarroaForm - Development of an effective formulation for the control and prevention of varroatosis in domestic bee (Apis mellifera)	Spain
Practice-research-bees: improvement of varroa management strategies for hessian beekeeper	Germany
BeeScanning 2.0 - monitoring a biological system	Sweden
Remote beehive monitoring, a new opportunity for nomadic beekeeping (NOMADI-App)	Italy
PICA: Innovative Platform for beekeeping	Spain
"Beekeeping, Agriculture and Environment" - Associate fruit growing and beekeeping for an agro-ecological and innovative management of production	France
DivInA- Diversification and Innovation in Beekeeping	Portugal
Biodivers Fruit Growing Limburg	Netherlands
Pasture for pollinators	United Kingdom
Pollinators for fruit growers and fruit growers for pollinators	Slovenia
Stimulation Pollination mix for climate adaptation	Netherlands

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eip-agri
AGRICULTURE & INNOVATION

The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as *through* the EIP-AGRI network.

EIPs aim to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- the EU Research and Innovation framework, Horizon 2020,
- the EU Rural Development Policy.

An EIP-AGRI Focus Group* is one of several different building blocks of the EIP-AGRI network, which is funded under the EU Rural Development policy. Working on a narrowly defined issue, Focus Groups temporarily bring together around 20 experts (such as farmers, advisers, researchers, up- and downstream businesses and NGOs) to map and develop solutions within their field.

The concrete objectives of a Focus Group are:

- to take stock of the state of art of practice and research in its field, listing problems and opportunities;
- to identify needs from practice and propose directions for further research;
- to propose priorities for innovative actions by suggesting potential projects for Operational Groups working under Rural Development or other project formats to test solutions and opportunities, including ways to disseminate the practical knowledge gathered.

Results are normally published in a report within 12-18 months of the launch of a given Focus Group.

Experts are selected based on an open call for interest. Each expert is appointed based on his or her personal knowledge and experience in the particular field and therefore does not represent an organisation or a Member State.

*More details on EIP-AGRI Focus Group aims and process are given in its charter on:
http://ec.europa.eu/agriculture/eip/focus-groups/charter_en.pdf

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Join the EIP-AGRI network &
register via www.eip-agri.eu

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