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# Bridging research and practice: developing beekeeping knowledge and innovation systems

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This paper presents the concept of a Beekeeping Knowledge and Innovation System (B-KIS). This concept is closely related to the Agricultural Knowledge and Innovation System (AKIS) – both theoretically and methodologically. By adopting a B-KIS approach we can: a) depict the general structure and functioning of activities aiming for knowledge development, innovation and learning within the apicultural sector; b) improve understanding of how services for beekeepers are embedded into national B-KIS; and c) provide some conceptual elements to support the development of a national or regionally adapted communication strategy for improved sustainability of beekeeping. From a policy perspective, it is important that the B-KIS becomes integrated into the national strategic AKIS plans.

## KEYWORDS

beekeeping, knowledge, innovation, sustainability, apiculture

## Introduction

Beekeepers are confronted with a large amount of information through a variety of sources such as the internet, beekeeping literature and networks of fellow beekeepers. It is hard for beekeepers to know who and what is credible and trustworthy, as information is often inconsistent and contradictory. Finding the “correct” information becomes even more complex when considering that the problems are multi-scalar, and solutions often need to be based on local conditions.

Local adaptation and sharing of context-specific research results and practical experience are necessary, and generally facilitated through beekeeping formal and informal extension activities. This adapted knowledge needs to be accessible to beekeepers in a user-friendly form – ideally through a network of various supporting structures focusing on different aspects of beekeeping. These various sources of knowledge

and support for innovation in beekeeping can be defined as a Beekeeping Knowledge and Innovation System (B-KIS).

This paper presents the B-KIS approach and how it can be analyzed, developed and improved to bridge research and practice. B-KIS, as a tool of visualization, supports the co-creation of new knowledge and interventions by beekeepers, scientists, advisors, enterprises, NGOs etc., all together developing the beekeeping sector. There are significant differences between countries in terms of stakeholder involvement, existing networks, and funding. Such differences can be examined by using the B-KIS concept, which allows a quick structured overview of the beekeeping sector and relationships between stakeholders. This paper hopes to contribute to the development and sustainability of beekeeping.

## Background

The challenges facing apiculture are many today. One of the most important is related to honey bee health issues (Bruckner et al., 2023; Gray et al., 2023; Requier et al., 2024), having consequences for the rural economy, biodiversity and long-term sustainability. Increased knowledge and competence are seen as central to the possibility of reaching sustainable production systems. Innovation and collaboration among actors are seen as one of the most effective responses to existing threats and challenges (Moschitz et al., 2015; Adamson-Fiskovica and Grivins, 2022; Nettle et al., 2022). This is related to the need for a more efficient and responsible scaling up and out of new technologies, management approaches, and locally sustainable breeds of honey bees. From a policy perspective, the question is whether existing B-KIS are well suited to meet such challenges or if new configurations of the knowledge systems are needed.

## Defining a knowledge and innovation system and learning from AKIS

The concept of Agricultural Knowledge and Innovation Systems (AKIS) has been developed and explained in the literature (e.g., Klerkx et al., 2012; Knierim et al., 2015). According to the World Bank definition, an “Agricultural Knowledge and Innovation System (AKIS) indicates a system that links people and institutions to promote mutual learning and generate, share, and utilize agriculture related technology, knowledge, and information. The system integrates farmers, agricultural educators, researchers, and extensionists to harness knowledge and information from various sources for improved livelihoods. Farmers are at the heart of this knowledge triangle” (World Bank, 2012, p. 629).

A knowledge and innovation system includes all actors involved in knowledge production and accumulation within a specific sector, representing the international to the local level and belonging to different disciplines. However, a knowledge and innovation system also consist of material elements such as databases, training activities, apiaries, etc. Each national or regional B-KIS will reflect an inherited infrastructure, creating a unique network and

circulation of knowledge, which enables or hinders specific investments in knowledge development.

Advisory services, in many forms, have an important role in bridging research and practice (Knierim et al., 2017; Prager and Creaney, 2017). Within Europe, such services range from individual mediators to training centers and demonstration apiaries, where often public advisors transfer and disseminate new findings and information to beekeepers. However, in the case of the many apiaries connected to institutes or beekeeping associations, the advisors participate in the process of knowledge generation, together with researchers and other actors. In both cases, the role of the advisors is a result of a national and regional B-KIS infrastructure and institutional context, where public initiatives and funding are important to enable coordination, methodological and conceptual development, as well as novel research.

The general purpose of an AKIS is to strengthen knowledge development and communication among people involved in agriculture or adherent rural activities. Different analytical frameworks have been used to describe these knowledge and innovation systems (Klerkx et al., 2012; Toillier et al., 2022; Knierim and Birke, 2023): one of them being the infrastructural approach, making a static analysis of networks of actors and their interactions, existing research and educational infrastructure and how these aspects support or do not support knowledge development (e.g., Klerkx et al., 2012).

## Unlocking the potential of B-KIS in meeting challenges within apiculture

Over the last decades there has been increased criticism regarding the ability of knowledge and innovation systems to support sustainable development of agriculture. EU SCAR, the EU Standing Committee on Agricultural Research, describes the state of agricultural knowledge systems in Europe, as “currently unable to absorb and internalize the fundamental structural and systemic shifts that have occurred. The remaining publicly funded AKIS appear to be locked into old paradigms based on linear approaches and conventional assumptions” (EU SCAR AKIS, 2012, p 13). There is a need for renewed political attention to the effectiveness, relevance and scale of Europe’s AKIS and a redefinition of AKIS. Is this also the case for European apiculture?

## Going from AKIS to B-KIS in the Smartbees project

The Smartbees project<sup>1</sup> aimed to improve the understanding of the underlying resistance mechanisms to infectious and parasitic diseases of the honey bee in Europe. A key element of the project was to support the development of extension tools for the beekeeping community across Europe to maximize the uptake of the project outputs. To do so, the project adopted a Beekeeping

1 FP7 project 2014 to 2018, <https://www.smartbees-fp7.eu>

Knowledge and Innovation System (B-KIS) approach, which describes the existing stakeholders, arenas and information flows within a geographic area, normally a country or region. It is a snapshot that outlines who does what, with which purpose, and how. Diversity is explained by dynamics and contexts, and new initiatives can be critically analyzed, see [Figure 1](#).

While developing the B-KIS for the countries participating in the Smartbee project some general assumptions needed to be discussed. The traditional model for knowledge development within farming systems, including beekeeping, is based on the ‘technology transfer model’ ([Schot and Steinmueller, 2018](#)). In short, it means that new knowledge and innovations are developed at universities and research institutes, are tested on research stations, and taken up by advisors, who spread to the beekeepers through different written or oral methods. It is a linear model of communication, which in many respects has been successful when modernizing agriculture ([Godin, 2006](#)). However, this approach has some inherent problems such as; considering all beekeepers as a homogenous group; attempting to implement universal technologies with no regard for local context and regardless of the relative advantage; failing to manage complexity and variety; and ultimately drawing on a low level of participation and poor implementation among beekeepers.

Consequently, there is a growing need to involve beekeepers in ongoing knowledge processes, and one important way to do this is to develop and implement adapted methods for apiculture extension. It is also about creating a shared learning process, which enables the beekeepers to put forward their local knowledge and combine it with important insights from research – a collaboration which is instrumental for achieving sustainable apiculture in Europe ([Ingram et al., 2020](#)). How must new tools and

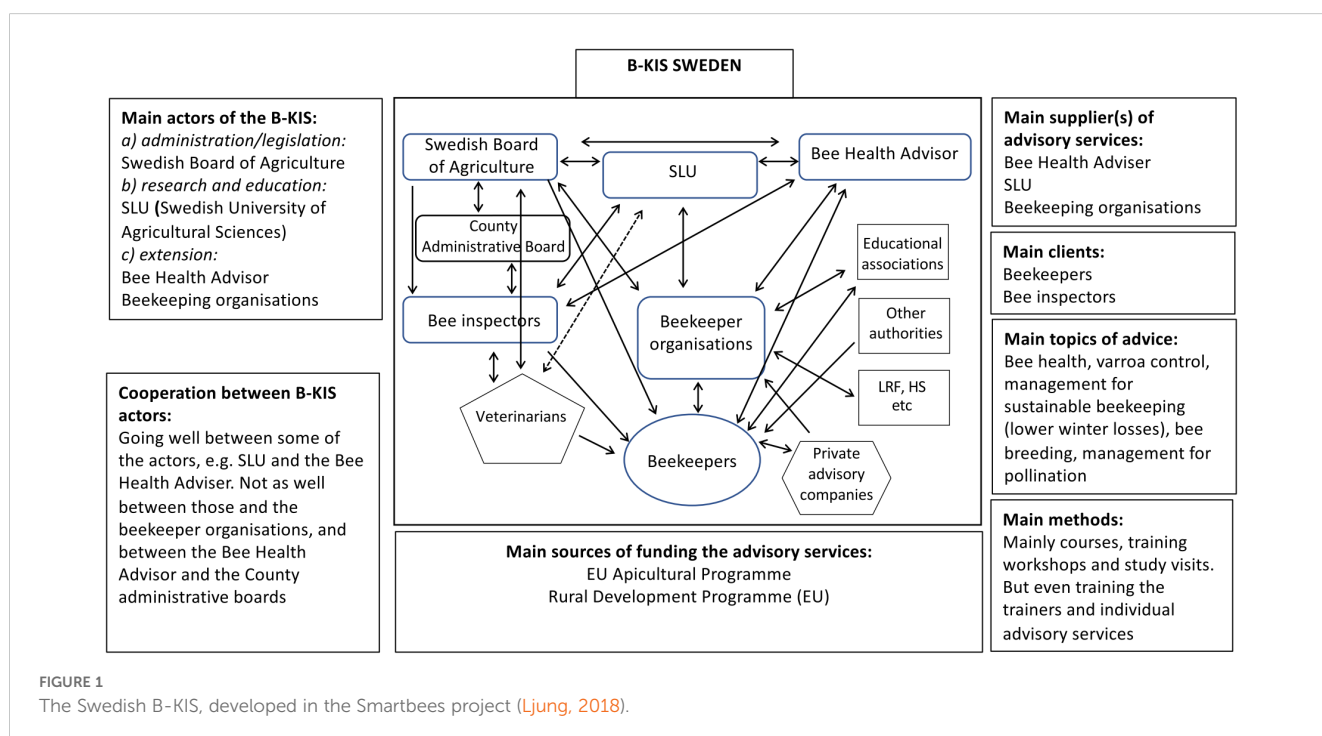
strategies function, when building on best available knowledge in extension and co-innovation science?

Beekeeping is challenging in many ways: Beekeepers are often part-time active with a small number of hives, do not belong to a long tradition of formal learning or advisory services, and often lack institutionalized structures on a local level for innovation, knowledge development, and individual learning. These features make beekeeping different from agriculture in general.

When discussing a knowledge and innovation system within the beekeeping sector, the same actors as within the agricultural fields come to mind, national authorities, research institutes, educational providers, advisory services, training centers and associations. However, there are important differences in many countries between the AKIS and the B-KIS. One important fact is that in each sub-sector of agriculture, for instance, milk production and horticulture, the configuration of existing institutions is pluralistic. That is, there is no ‘one size fits all’. Instead, each region has developed their ways to innovate and spread new information, which must be acknowledged when developing policy and recommendations on communication strategies. This is also the case for beekeeping.

## Turning to beekeeping and developing the B-KIS concept

[Rivera and Zijp \(2002\)](#) identify four main actors with an interest in knowledge development and innovation also relevant to apiculture, apart from the beekeepers themselves: Research; Extension services; Education and training; and Support systems. The latter group include all organizations providing funding and



other resources, for example, meeting places for demand articulation by beekeepers. In such a model the four sets of actors ideally act upon existing knowledge of beekeepers and generate innovations in response to challenges and new opportunities, desired outcomes (from individuals to society), system drivers and regulative policies and institutions, see [Figure 2](#).

A B-KIS is almost always composed of research, extension and some kind of educational or training organization for beekeepers. Furthermore, it is structured and governed by the government through a sector policy for agriculture in general or sometimes apiculture specifically. As for the agricultural sector in general, the main aim has historically been to make beekeepers more professional, in the meaning of efficient and competent production. The structure of this system, its organization and governance (e.g. under a public or private structure) differs greatly between countries, as does the level of centralization or decentralization. Diversity can also be found within different regions and federal states in the same country.

The AKIS in Europe has been described as highly fragmented and subject to a dynamic process of emerging new structures and actors ([EU SCAR AKIS, 2012](#)). Although being much narrower in focus, the same processes take place within the beekeeping sector in Europe, due to changes in funding, level of privatization or regionalization, emerging co-learning approaches, and the general role of government in supporting the development of the sector. Regardless of these trends, a functioning B-KIS requires various forms of knowledge brokerage such as the dissemination of applied research, farmer magazines, specialized websites, seminars, and so on.

There are universal trends in how learning and change can be achieved within rural development, agriculture and probably also apiculture. In general, more emphasis is put on networking, trans- and interdisciplinary research and other forms of cooperation between academia and practice (from beekeepers to trainers,

advisors, industry, and other knowledge brokers etc.). In most countries there are challenges in transferring results from research into practice - and vice versa - channeling practitioner demands for knowledge into research and advisory agendas.

Another universal challenge in competence development is how to support small-scale beekeepers or hobbyists. As discussed by [Labarthe and Laurent \(2013\)](#), small-scale farmers have less direct interaction with advisors which makes it more difficult to co-produce knowledge that is relevant to their needs. Due to the limited financial turnover among such actors, there is a need to develop affordable and local services. State support is often necessary to reach out to these groups. In addition, they often have no tradition of continuous education, competence development, or demand articulation, why specific measures must be taken to get them to join courses, seminars and other activities, and give voice to their needs.

To date, there has been limited systematic responsiveness to the challenges in the national agricultural knowledge and innovation systems relevant to beekeeping growth and sustainable development. In the new Common Agricultural Policy (CAP) of the EU, all member states are encouraged to develop strategies for strengthening their national AKIS [[Swedish Government, \(2023\)](#), p. 122–123]. From a policy perspective, the knowledge and innovation need of the beekeeping sector must become integrated into the national strategic AKIS plans.

### Highlighting some key differences between AKIS and B-KIS

Looking at the apicultural sector, there seem to be some important differences between the traditional AKIS and existing B-KIS in Europe.

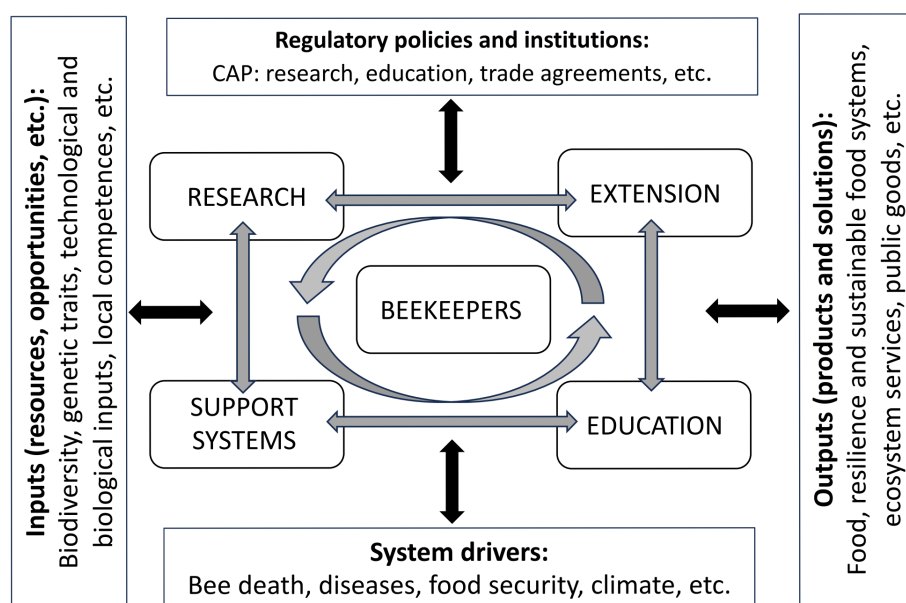


FIGURE 2  
A conceptual model of the Beekeeping Knowledge and Innovation System, adapted from [Rivera et al., 2005](#).

The first relates to the size and organization of businesses, where the beekeepers, although being many, do not usually run big agricultural businesses. This has implications for the relative economic and political power of beekeepers concerning policy and political priorities. Secondly, there are less formal educational actors within apiculture compared to agriculture in general. Thirdly, the extension and advisory services looks quite different from agriculture, which in many countries means that there are just a few formal advisors, although the sector may have several thousands of producers and fourthly, the lack of institutionalized structures.

A consequence of the above-mentioned differences is also that there is not as strong tradition of formal education and buying advisory services among beekeepers compared to farmers in general. There is a tradition of informal, adult learning within the sector, but it is often organized locally and without the intensity and/or continuity to really enable learning for innovation and change. In a situation where there is an immediate need for competence development, for instance regarding Varroa management, this might become a bottleneck in itself – just to get beekeepers to ‘the table’ can be hard enough.

There have not been many reviews of the European apicultural sector. One of the most important was completed by Deloitte in 2013 for the EC DG Agri on “Evaluations of measures for the apicultural sector” (EC DG Agri, Development, Directorate-General for Agriculture and Rural, European Commission, and Deloitte, 2014). The evaluation aimed to show how different measures within the CAP have affected the competitiveness and sustainability of the European apicultural sector. It is important to note that measures that affect beekeeping can be taken in many policy areas. The needs identified in the report were; support to the production of honey; support to the marketing of honey; fostering bee health and fight bee population decline; contribution to rural development and fostering ecological balance and pollination. The report depicted the intervention logic of bee measures taken based on the identified needs.

One important conclusion from the evaluation was that the measures taken on the European level have induced structural improvements in the sector, notably by encouraging and enabling beekeepers to produce more efficiently. These were for example technical assistance, investment support, competence development, supporting laboratories, and implementation of applied research activities. Nevertheless, a B-KIS is much more than the international policy level and the forms of state support that are linked to this level. How does an ideal B-KIS function? Are the innovation support services needed for development available (Proietti and Cristiano, 2022)?

Finally, the B-KIS must continue to support technological and management innovations, but also market and product innovations. To do so, there is a need for social and institutional innovations. In a well-functioning B-KIS, all parts are integrated, and the knowledge and innovation system are seen as a whole. An analysis of a national or regional B-KIS makes it possible for us to discuss which limitations exist and what needs to be changed (Toillier et al., 2022).

As an example of a B-KIS we use the Swedish B-KIS. What does the Swedish B-KIS (Ljung, 2018) tell us? The beekeeper organizations are central to the Swedish B-KIS (see Figure 1). They apply two main approaches to reach out to beekeepers; firstly, the long tradition of informal, adult learning through the

study circle tradition used in the whole country, especially on a basic level, and secondly the Bee Health Advisors, which becomes a knowledge hub bridging between actors within the whole B-KIS. Big efforts are today put into finding new channels and methods to reach out and engage beekeepers in learning activities.

## Discussion

Beekeepers find information about beekeeping practices in a wide range of sources and it is hard to know what information is credible and trustworthy. The knowledge and innovation systems within the beekeeping sector in Europe are unique for each country. While there may be many structural similarities, such as the presence of universities and research institutes, demonstration apiaries, beekeeping associations, and extension activities of different kinds, there are many differences, based on beekeeping traditions, governance structures, the relative power of actors, different funding mechanisms and production volumes.

Still, B-KIS across Europe face similar challenges. There is a potential to develop the system’s efficiency in supporting beekeepers to become more sustainable and to make apiculture reach its full potential in society. But there is no “one-size-fits-all”. There is a need for a “best-fit-perspective” where capacity is developed across actors in all parts of the B-KIS, from policymakers, researchers, advisors etc., to develop and implement advisory services that work within local conditions as well as political priorities in each country. From a policy perspective, the knowledge and innovation need of the beekeeping sector must become integrated into the national strategic AKIS plans.

## Future recommendations

A well-functioning B-KIS supports a high-quality and ongoing process of learning among actors involved in knowledge development. In such a situation, new findings in research quickly find their way to advisors and beekeepers, they are implemented and deliver benefits both for the individual beekeeper as well as for society. Ideally, it also works the other way around, where new issues and challenges identified by beekeepers as crucial are transformed into research questions. The latter is an example of co-learning or multi-stakeholder approaches in research and development.

An established B-KIS also supports the sector with educated people, coming from both training programs and higher education. The B-KIS supports the sector with the competencies needed to be competitive and sustainable. Of course, “no chain is stronger than its weakest link” and that is why all parts of the B-KIS need to reach a minimum level of competence to make the whole system function.

Furthermore, a B-KIS should ideally be able to innovate. This is not only a question of new inventions or management solutions, but also about developing new business models and markets and cross sectorial collaborations. Today’s increased interest in bees and beekeepers as ecosystem service providers will create new opportunities for the sector. However, for these potentials to be

realized the B-KIS must support such issues and processes more than what traditionally may have been the focus.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

## Author contributions

LFK: Writing – original draft, Writing – review & editing. ML: Writing – original draft, Writing – review & editing. LBG: Writing – original draft, Writing – review & editing. KM: Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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