JMFS
Journal of Management and Financial Sciences

Volume XVII
•
Issue 54
pp. 45–71
SGH Warsaw School of Economics
Collegium of Management and Finance

Agnieszka Kuś
Nicolaus Copernicus University in Toruń
ORCID: 0000-0003-1098-7526

Innovation management in apiaries in times of biodiversity crisis: evidence from Poland

Abstract

Beekeepers are one of the professional groups actively striving to ensure the balance of the current ecosystem. Their work affects the maintenance of an adequate level of food security, thanks to the intensification of the measures taken to protect and increase the volume of honeybee colonies. The article undertakes the niche but critical issue of innovation of apiary farms. The adopted research approach allowed us to preliminarily identify beekeepers' attitudes to innovation and the scale of implemented novelties in their farms in 2015–2020. Both the number and the scope of applied innovative solutions in Polish apiaries allow us, on the one hand, to be calm about their further expansion. On the other hand, the consequences of climate change, the uncontrolled influx of cheap honey of unknown origin, or the lack of direct financial support raise new challenges for the management of family beekeeping. Owners of Polish apiaries are far more likely to choose business process innovations than product innovations, which is related to the specifics of the process of obtaining bee products. Therefore, it is necessary to have a comprehensive approach at the level of apiary management in order to make decisions related to current operations as well as those of an investment or preventive nature, taking the chosen direction and form of further expansion into account.

Keywords: Polish beekeeping farms, apiary management, biodiversity crisis, bees, Polish beekeepers
JEL Classification: O310, Q120

Introduction

The development and management of modern business, regardless of the type of activity conducted or the entity's size, is a process characterized by significant uncertainty, in which a holistic approach to the projects implemented is necessary. As a rule, the primary goal of the activities of any business entity is to multiply its resources, capital and value, and ultimately to achieve a satisfactory profit. However, this is often done at the expense of environmental degradation to a greater or lesser extent or overlooking needs of employees and, more broadly, of society. In view of the visible and perceptible climate change and the expansion of the ecological trend, it is impossible not to consider this aspect in the pursuit of sustainable development of modern companies. Reducing the pejorative effects of environmental degradation by businesses takes work, requiring coordinated action on many levels simultaneously. As Karaczun [2018, p. 11–12] rightly emphasizes, what is required first and foremost is a change in the mindset and the evolution of the existing civilization model based on a linear economy focused on constant economic growth and optimization of material effects, in favor of new ecological business models that take into account the economy of moderation and the satisfaction of material and non-material needs to a similar degree. Despite the appearance in the literature of several heterogeneous determinants of the development of business entities, it is innovation that is mentioned among these most significant drivers [Anand et al., 2021; Bar-Am et al., 2020; Baruk, 2017; Barrichello et al., 2020; Chen, 2017; Crudu, 2019; Fu, Shi 2022; Laperche, Mignon, 2018; Maradana et al., 2017; Nicolaides, 2014; Taalbi, 2017]. Innovations form an integral part of the operating mechanism of every business, with a direct connection to the need to take them into account in the activities and processes implemented. We are talking about the adaptation of proven solutions and the creation of entirely new ideas and their implementation in the conducted business. Innovation is a susceptible matter, especially if it concerns the sectors of the economy involved in the production of safe and natural food, i.e., agriculture and its components: agronomy, horticulture, zootechnics, fishing, or beekeeping [Bębenek, 2016, p. 2].

Agriculture is identified, on the one hand, as the sector of the economy having the most significant impact on human health and the state of the environment, and on the other hand, as the sector in which violations occur, resulting in possible harmful activities. Therefore, coordinated efforts are being made, at both community[1] as well as national levels,[2] to reduce the harmful effects of agriculture on the socio-natural sphere by harmonizing agricultural and rural policies with environmental policies. This is particularly important for countries such as

[1] In 2020, the European Commission announced a new approach to agriculture in the European Union called the European Green Deal. The tools implementing the new approach in the food system are two main strategies: "From Farm to Fork" and "For Biodiversity 2030" [European Commission, 2022].

[2] In Poland, the "Framework Action Plan for Organic Food and Agriculture in Poland for 2021–2030" has been developed and implemented [Ministry of Agriculture and Rural Development, 2022].

Poland, where areas used for agricultural production account for more than 50% of the country's territory [CSO, 2021], and the agricultural sector alone generates 3% of the Polish gross domestic product, while the average value of this indicator is 1.4% of GDP in economically highly developed countries [Ministry of Agriculture and Rural Development, 2019, p. 12]. As early as 2005, the international project The Millennium Ecosystem Assessment emphasized that "every human being depends on nature and the services provided by ecosystems, which provide the conditions for a dignified, healthy, and safe life" [MEA, 2005]. Almost two decades later, the European Commission made comparable appeals to member states by, pointing out that "we need nature in our lives, not only because of its beneficial effects on our physical and mental health, but also its impact on society's ability to cope with change on various levels" [EC, Communication 2020, p. 1]. Similarly, experts of the World Economic Forum in their report [2023, p. 6], emphasize that one of the critical global threats of the present and coming decades is the loss of biodiversity. Moreover, as calculated by the OECD [2012, p. 3], these disruptions threaten the foundations of many economies in terms of the high costs of not taking corrective action, which are projected to continue to rise. For example, in Poland, annual economic losses due to unpollinated and underpollinated crops are estimated at around PLN 2.3 billion [Zych, Jakubiec, 2006, p. 295]. Besides, it is only possible to agree with Garibaldi et al. [2013, p. 1608] that the global degradation of ecosystem services will not go unchallenged in the agricultural sector's ability to meet the needs of a growing and affluent human population. The biodiversity crisis and ecosystem collapse are evident in numerous areas, but a key concern appears to be the declining volume of many pollinator insect species – most notably the honeybee [Breeze et al., 2011; Potts et al., 2016].

The existence of bees, on the one hand, depends on the biodiversity of flora and fauna, and, on the other hand, it directly affects it, ensuring the relative stability of the ecosystem. It is estimated that 87.5% of the world's plant species are pollinated by animals, among which bees are predominant [IPBES, 2019, p. 3]. The value of the honeybee's work as a pollinator is estimated to be ten times greater than the value of the bee products harvested [Carreck, Williams, 1998]. Aizen et al. [2008] point out that the scale of crop production dependent on pollinators has increased by more than 300% over the past five decades, significantly linking human life to the volume and work of bees. Statistics show that the annual value of crops received through the work of pollinators reaches 153 billion euros worldwide [Gallai et al., 2009]. In Europe, it is estimated at 15 billion euros [Dytrych, 2018, p. 15]. From the Polish economy viewpoint, bees are precious, as they increase the value and quality of crops by 4.5 billion zlotys annually. Depending on the study, it is estimated that 2.5–4 million bee colonies are needed to pollinate all insect-pollinated plants growing in Poland [Denisow, 2018, pp. 42–43; Majewski, 2011, p. 428; Pruszyński, Skubida, 2012], while according to recent data, their number is much lower, at just over 2 million bee colonies [Semkiw, 2021, p. 3]. Like the data presented, this dimension best illustrates the quantitative and qualitative importance of bees in the environment. Keeping bees, i.e., providing them with proper living and developmental conditions, is carried out by beekeepers as part of their apiaries. In Poland in 2021,

87,000 people were engaged in beekeeping activities, the average size of an apiary was 23 bee colonies, and the number of bee colonies per 1 km2 was 6.4 [Semkiw, 2021, p. 2]. However, the above figures may be underestimated due to partial information gaps in the documentation of District Veterinary Inspectorates regarding the size of operations for some entities. It is worth noting that despite the increase in the number of bee colonies in individual countries in recent years, global and long-term statistics do not look so optimistic. According to the Food and Agriculture Organization of the United Nations (FAO), on a continental basis, only Europe experienced a decline of nearly 13% in the number of bee colonies between 1990 and 2020, while for the rest of the world the balance remains positive. However, looking more closely at European directional values for the number of bee colonies, both Eastern and Western European totals show a 37% and 36% reduction in the number of bee colonies in 2020 compared to 1990 [FAOSTAT, 2022]. In addition, Potts et al. [2010] show that despite FAO estimates that do not account for bee losses, there is an apparent overall increase in managed honey bees over the past decade, which, however, is primarily occurring outside of Europe and the United States. Osterman et al. [2021] add that one of the challenges of modern economies is ensuring sustainable, integrated management of pollination in agriculture – relying primarily on honey bees and using other pollinators. It is also impossible not to agree with De la Rua et al. [2009], who conclude in their study that "European agriculture needs pollinators, and most of them are to be maintained by a relatively unknown and not always well-appreciated figure, that of the beekeeper." A similar tone is expressed by Maderson [2023], who describes the importance of beekeepers' knowledge in sustainability management. The above statistics confirm the need for a continuous review of the needs of beekeepers and of the existing barriers to the support policies adopted, as well as for the intensification of measures to stimulate the development of the number of bee colonies at the level of individual regions.

Due to the complexity of the topic of innovation, the author of this article decided to focus on an issue that has yet to be fully recognized and still requires in-depth research, which is the analysis and evaluation of innovative activities carried out in apiary farms. In connection with the above, it is worth posing the following question: How and to what extent do the innovations introduced in Polish apiary farms affect their development? By development the author means the ability of apiary farms to create new or improved innovative solutions and the actual ability to introduce them within the scope of products, processes, and organizational and technical solutions. The subject of the study covered Polish apiaries that were innovatively active in 2015–2020. The choice of domestic subjects is determined primarily by their important and constantly growing role in beekeeping community structures. Poland ranks second in the number of beekeepers and fourth in the number of bee colonies [EC, 2020, p. 8]. The article's main objective is to characterize and evaluate the implemented innovative solutions in Polish apiaries and to identify the main barriers accompanying them. The study is both theoretical and empirical. The paper reviews the literature on the subject and part of the empirical survey results conducted in 2021–2022.

Innovation management process

The theory of economic science gives innovation a unique role in developing modern societies, organizations, and economies. Numerous studies on innovation indicate the presence of many links between innovation activities and other phenomena occurring at the micro, meso and macro levels [Greenhalgh et al., 2004, p. 587; Kraśnicka, Ingram (Eds.), 2014; Kalowski, Wysocki (Eds.), 2015; Kuś 2020; O'Sullivan, Dooley, 2009; Siau, Messersmith, 2003, p. 58; Timmerman, 2009, p. 4; Zastempowski, 2019]. The peculiar popularity of innovation in many dimensions has created a reasonably widespread emphasis on the implementation of such changes that can be classified as "novelty." However, it should be borne in mind that the implementation of innovative solutions should, first and foremost, have a practical application and bring specific tangible and intangible benefits. In addition, it is worth emphasizing that the success of innovation, analogous to the implementation of other investment projects, is primarily a consequence of the process approach to a given issue. In contrast to the definitional approaches to innovation and the knowledge of the existence of interdependence of innovations at different levels, the process of innovation creation itself is not so often addressed in the literature [Hunger, Ingram, 2015, p. 53]. Therefore, it was decided to fill this gap by undertaking the present topic.

Aside from the classic Schumpeter, one of the most frequently cited definitions of innovation is the one from the Oslo Manual. According to it, an innovation is "a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" [OECD, Eurostat 2018, p. 20]. In general, innovation can be understood in two ways: as the end result of a particular process or through the lens of the entire activities of that process [Kotler, Trias de Bess, 2013; Rogers, 2003; Smith, 2009; Tidd, Bessant, 2013]. Significantly, innovation is based on the release of layers of creativity and the application of its effects in practice [Schippers et al., 2015, p. 771]. Innovation is an evolutionary mechanism of transforming knowledge into value using new or significantly improved products, systems, and processes [Ferraresi et al., 2012, p. 690]. Moreover, the economic result of the changes introduced is an increase in the efficiency of economic activity in the spheres of labor organization, management and marketing, or technology. In view of the above, the following question arises: Is there an optimal and universal framework for innovation management? The answer to such a question is ambiguous. On the one hand, the literature provides relevant theoretical constructs showing the course of the innovation process according to various models [Kline, 1978; Rothwell, 1992; Twiss, 1992; Padmore et al., 1998; Abraham, Knight, 2002; Carlsson et al, 2002; Chesbrough, 2003; Jones, 2003; Godin, 2006; Smith, 2006; Hobcraft, 2011; Tidd, Bessant 2013; Afuah, 2014; Deschamps, Nelson, 2014; Carayannis et al., 2015; Taran et al., 2015; Meissner, Kotsemir 2016]. On the other hand, organizational diversity and complexity, the context of the environment in which an entity

operates, as well as the industry factors that determine its development, result in the emergence of certain specificities in innovation management. Therefore, starting from the search for the innovation impulse, through a series of organizational and creative activities, ending with the implementation of the idea and the further discounting of value from the innovation, the process is characterized by individual determinants and requires the adaptation of the adopted methods and model tools to the prevailing intra-organizational conditions and the needs of the external environment stakeholders. It is the use of the potential inherent inside the entity (often, in the case of smaller companies, this potential is directly identified with the person of the owner), together with the opportunities arising from the adaptation, coordination, and creative activities undertaken, combined with external support mechanisms, that enable the synergy of the innovation process. As Chodyński [2021] points out, the company's pro-entrepreneurial orientation enables the continuity of the implementation of innovation processes, which is important for the creation of responsible business models.

In many business entities, there are doubts about the nature and nomenclature of the changes introduced – can each of them be called an innovation? The opinions of researchers in this area are divided since the relationship between change and innovation is not always linear [Moreira et al., 2016]. On the one hand there are authors who believe that only significant and lasting changes can be equated with innovation [Grant, 2011; Moore et al., 1997; Morris, 2011; Schumpeter, 1960; Whitfield, 1979]. On the other hand, Porter [1990], Drucker [1992], Young et al. [2001], Fagerberg [2004], Fleuren et al. [2004], oppose this view and believe that any new solution at the organizational or sectoral level that has not been used before can be classified as an innovation. This perspective relegates radical and pioneering innovations to the background and emphasizes incremental or imitative innovations. This is a legitimate approach, taking into account, first, the time, cost, and scope of resources needed to implement breakthrough innovations, and second, the structure of contemporary changes, where less spectacular but practical solutions definitely dominate [Ober, 2022].

As a rule, radical innovations are generated by large corporations and companies, which are often not found in the structure of the Polish agricultural sector [Dudek et al., 2019, p. 17]. The fragmentation of Polish farms, including Polish apiaries, implies the need to focus on measuring the innovativeness of these entities in the context of the solutions introduced, which are correlated with the creative use of beekeepers' knowledge and knowledge of the local and natural conditions of their activities. Such an approach makes the assessment of the innovativeness of apiaries not based on traditional indicators (such as the number of R&D expenditures, the number of patents filed, the extent of innovation, etc.). However, it has a descriptive nature and allows us to determine whether the activities carried out by beekeepers differ in particular dimensions from the solutions used in similar apiaries, and whether the activities undertaken contribute to the improvement of the environment or increase its resistance to the impact of the negative consequences of human activity. If the answer to these discussion threads is positive, the solution applied can be qualified as an innovation. Therefore, such a process can be effectively managed, ending with the implementation of a novelty or a significant improvement.

Innovations in apiaries: assumption and practice

Given that one of the biggest ecological threats is the decline in biodiversity of both fauna and flora, measures to stop this process should be at the forefront. One of the ways that can contribute to further actions to prevent biodiversity decline is to help bees – both in the context of creating better living conditions for them in apiaries and in terms of diversifying crops to include a greater proportion of pollen-producing plants or establishing flower meadows. Any activity in this direction should fit into the promoted idea of "Think globally, but act locally", which fits into the construct of sustainable development. In the face of these challenges, sustainable agriculture and its components have gained prominence. For example, FAO, IZSLT, Apimondia, and CAAS [2021] have prepared extensive guidelines on good beekeeping practices for sustainable apiculture, considering specifics of each region. Scientists from different parts of the world also confirm in their studies the importance of bees for sustainable development in the US [DiDonato, Gareau, 2022]; France [Kouchner et al., 2019]; Switzerland [Casanelles-Abella, Moretti, 2022]; Ethiopia [Gratzer et al., 2021]; Tanzania [Chami et al., 2022]; Iran [Rahimi et al., 2020]; or Nepal [Devkota, 2020], among others. It should be emphasized that in order to be categorized as sustainable both agriculture and beekeeping must have three complementary characteristics: be economically viable, socially acceptable – i.e., improve the quality of life of farmers/beekeepers and their families, and ecological – i.e., ensure the safety and protection of the natural resource base [Raman, 2006]. A detailed study by Patel et al. [2021] explicitly shows that "bees potentially contribute towards 15 of the 17 United Nations Sustainable Development Goals and a minimum of 30 SDG targets". At the community level, a special Focus Group was also established, resulting in nearly two years of work to identify sustainable beekeeping and agricultural practices and tools to address climate challenges and reduce bee disease invasiveness. In addition, it prioritized innovative industry activities to ensure healthy bees in a sustainable environment by the end of 2030 [EIP AGRI, 2020].

One of the instruments that can be successfully used to implement the above ideas is innovation, including eco-innovation, which is supposed to be a new or significantly improved solution that brings an environmental benefit compared to alternatives [CSO, 2009]. Besides, eco-innovations are supposed to combine the social aspect – which is to satisfy needs and provide a better quality of life – with the environmental aspect, understood as minimizing the use of natural resources and emissions throughout the product's life cycle [Kemp, Pearson, 2007]. Moreover, Carley and Spapens [2000] emphasize that eco-innovation is an intentional activity based on entrepreneurial attitudes and activities undertaken throughout the innovation process through integrated management. It should be remembered that eco-innovation, as defined by the European Commission [2011] in the Eco-innovation Action Plan, can take the form of a technical or non-technical change, implying the realization of sustainable development goals through the reduction of adverse environmental impacts and increased responsibility for the resources used. Thus, all modernization and pro-environmental innovations can also

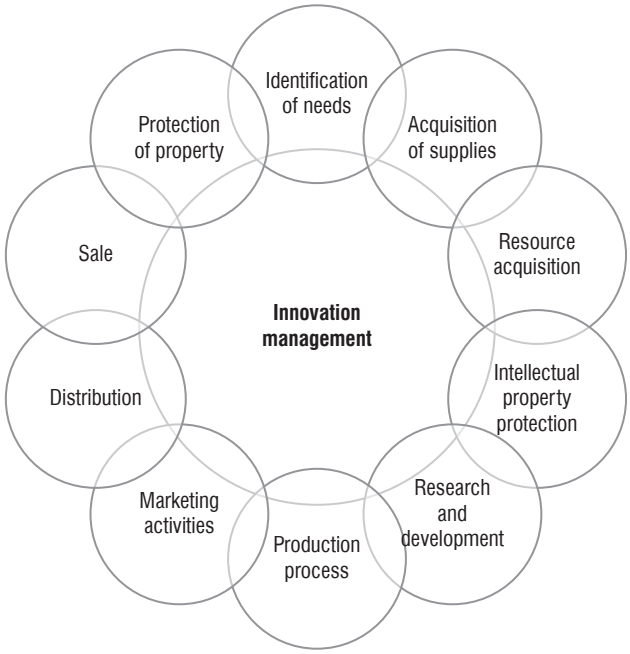
have an organizational or business dimension or concern the marketing spheres of an entity, if they fit into the above reasoning.

Contemporary developmental determinants of beekeeping and their dynamics require numerous adaptive reactions in the field of apiary management in the face of emerging changes in the environment or changes at the level of a given sector, including the sales market and buyers' preferences. As Olszewski [2021] points out, in the case of running itinerant apiaries, a kind of professionalization of the managed apiary is necessary, which refers to the mutual adaptation of the characteristics of the hive, the bee breed, and the methods of apiary management in such a way that financial, time and labor expenditures are as optimal as possible under specific environmental conditions. There are also opinions to the contrary, accusing small beekeepers in the US [Andrews, 2020] or Australia [Phillips, 2014] of excessive bio assurance and professionalization of beekeeping geared towards uncontrolled "honey chasing," which contributes to the spread of disease outbreaks in particular regions. In addition, there is the growing scale of problems related precisely to the invasiveness of parasites that prey on honeybees [Rosenkranz et al., 2010] and their resistance to the treatments used to control these mites [Benito-Murcia et al., 2022]. They are unquestionably one of the biggest problems facing the modern beekeeping industry.

It is worth emphasizing that the conduct of innovative activities is based not only on highly advanced technological solutions implemented nationally or internationally. In the case of sectors with a fragmentation of actors, new solutions that are relevant to a particular farm or apiary and that significantly contribute to improving its operation, turn out to be extremely important. There is now a need for a holistic approach to the development and management of an apiary farm, including an understanding of the decision-making process to achieve economies of scale in the business [Velardi et al., 2021]. Innovation management can be very complex and varied depending on the context, making the process somewhat unpredictable [Straete et al., 2022]. Diagram 1 shows the components of the innovation management cycle, which can be successfully implemented on apiary farms.

The various elements of the cycle from Diagram 1 are closely interrelated and can be implemented sequentially or in parallel. It is crucial to strengthen specific characteristics in the entity that build a climate conducive to the creation and implementation of innovations. These include, but are not limited to: orientation to long-term growth, alertness to emerging market opportunities, use of technology, willingness to take risks, openness to cooperation, ability to identify and adapt novelties developed outside the entity, ability to manage problems effectively, flexibility of action, and diversity of competencies and willingness to systematically expand knowledge and experience [Trott, 2012]. It should be assumed that beekeepers running apiaries in the current climatic and market realities are obliged, on the one hand, to preserve specific attributes of the traditional craft and, on the other hand, to give it an element of modernity to improve their daily work.

Diagram 1. Innovation management cycle



Source: own elaboration inspired by Gąsowska, 2014.

The innovation management process is a compilation of the activities of business entity owners with expansion opportunities created by appropriate legal regulations and the market conditions. At this level, it is also worth implementing pro-innovation regulations and programs to ensure the protection of pollinating insects not only at the local but also at the global level [Hall, Steiner, 2019]. Producer-consumer communication and taking actions to increase buyers' awareness of the health-promoting properties of natural products play an important role in creating demand and supply in the honey and bee products market. As Roman et al. [2013a, 2013b] points out, buyers of bee products usually buy honey directly from the beekeeper. However, they also sometimes buy it in a store, where they do not always check the information on the label regarding the origin of the honey. Economic factors, such as household income and the price of honey, mainly influence the amount of honey consumed. Other analyses mainly point to the organoleptic properties of honey as a decisive factor in its purchase [Brščić et al., 2017; Kopała et al., 2019; Sparacino et al., 2022; Żak, 2017]. Less attention is paid to the shape of the packaging or the pattern on the label or cap. It is worth emphasizing that consumer requirements change over time, and at the level of the bee farm, care should be taken to build a solid local brand based on the highest quality products and to be open to possible suggestions regarding the directions of potential changes in the products offered [Bratkowski et al., 2008]. Only beekeepers who build trust with their customers can count on their loyalty and practice the best form of promotion, i.e., word-of-mouth marketing. Concern for one's own and loved ones' health, interest in the natural environment, or

shortening the supply chain along with the media's affirmation of sustainable development, have changed customers' approach to the place and form of purchasing natural products and the type of food consumed.

Research methodology

The analysis and evaluation of innovative activities carried out on apiary farms is based on a part of empirical research carried out in 2021–2022 on a representative sample of owners of Polish apiaries. Based on the author's questionnaire, the CAWI method was used to obtain the primary data. The research tool, in the form of a questionnaire, was sent electronically to regional associations and beekeeping organizations in Poland and posted on the most important social networking sites associated with apiary owners. Being aware that a large percentage of people running beekeeping farms are of retirement age and may not necessarily use a computer, some of the questionnaires were delivered personally to beekeepers by the authors of the research in a traditional paper form and by courtesy of local departments of the Agency for Restructuring and Modernization of Agriculture. The representativeness of the sample was based on the following four criteria: the location of the apiary (by voivodeship), the age of the apiary owner, the form of running the apiary (individually or as a family business), and the minimum 3-year period of apiary operation. The size of the research sample was established by assuming that:

- in 2021, the number of beekeepers for whom full documentation is kept by Poviat Veterinary Inspectorates amounted to 87 096 [Semkiw, 2021],
- confidence level p = 0.95,
- fraction size is 0.5,
- the maximum error is 0.05.

With such criteria, the minimum sample size should be 382 entities [Kaczmarczyk, 2011]. A total of 435 completed questionnaires were received, but some of them contained significant gaps in the answers, resulting in their rejection. Finally, the answers of 420 owners of apiary farms in Poland were thoroughly analyzed. The detailed structure of the surveyed entities is presented in Table 1.

Table 1. Characteristics of the examined entities (n=420)

Criterion	Number	Percentage share (%)
Apiary location:		
Lower Silesia	12	2.86
Kuyavia-Pomerania	51	12.14
Lublin Province	15	3.57
Lubusz Province	11	2.62
Lodz Province	14	3.33

Criterion	Number	Percentage share (%)
Lesser Poland	7	1.67
Masovia	151	35.95
Opole Province	12	2.86
Subcarpathia	21	5.00
Podlasie Province	37	8.81
Pomerania	4	0.95
Silesia	12	2.86
Holy Cross	6	1.43
Warmia-Masuria	29	6.90
Greater Poland	32	7.62
West Pomerania	6	1.43
Age of the apiary owner:		
18–35	101	24.05
36–50	142	33.81
51–65	111	26.43
Over 65	66	15.71
Apiary management type:		
Occasional help from family members	222	52.86
Regular help from family members	195	46.43
Help from seasonal workers	3	0.71
Apiary period:		
Up to 5 years	132	31.43
5–15 years	155	36.90
16–25 years	57	13.57
Over 25 years	73	17.38
Apiary as the main source of income:		
Yes	26	6.18
No	387	91.92
Refusal to answer	7	1.66
Nature of the main sales market:		
Shrinking	21	5.00
Stable	167	39.76
Growing	232	55.24
Application of innovations in the last 5 years:		
Yes	300	71.43
No	120	28.57

Source: own elaboration.

The inference of the population of the surveyed owners of apiary farms in Poland, carried out using the criterion of the location of the apiary, allows us to conclude that the group of

beekeepers from the Masovia Voivodeship is the largest (about 36%). The second largest group of respondents runs their apiaries in the Kuyavian-Pomeranian Voivodeship (12.1%). In the next three voivodeships – i.e., Podlasie, Greater Poland, and Warmia-Masuria – the share of beekeepers surveyed oscillates between 7–9% of a given sample. The next group included representatives of beekeepers, whose share in the population surveyed is 3.3–5.0% – we are talking about the owners of apiaries located in Subcarpathia, Lublin Province, and Lodz Province. The share of the remaining eight voivodeships in the surveyed sample does not exceed 3% for a given region. In total, however, they account for 16.7% of the respondents. The smallest group of respondents are beekeepers running their apiaries in Pomerania (less than 1% of respondents).

The next criterion – the age of the owner of the apiary – shows that the age structure is quite similar in three out of four groups. The largest percentage of respondents are beekeepers between 36 and 50 years old (33.8%), who constitute 1/3 of the sample. On the other hand, the smallest share in the surveyed population of apiary owners belongs to people in the post-productive age (i.e., over 65 years old) – their share in the sample is 15.7%. The presented age range of respondents results from the dominant form of distribution of the questionnaire in electronic form.

Looking at the management structure of the apiaries surveyed, one can see a minimal advantage of running beehives individually with occasional help from family members (52.9%), over running them in the form of family businesses (46.4%). Only single respondents (0.7%) indicated that they use seasonal workers to run the apiary. None of the beekeepers surveyed employ permanent workers to help. According to the article's author, the above structure of responses may result from two reasons. Firstly, there is a significant advantage among the respondents of people running small and medium-sized apiaries, i.e., not exceeding 50 bee trunks. Secondly, the dominant stationary type of beekeeping farms enables work organization within the place of residence or available bee resources.

The analysis of the next criterion, i.e. the time of running the apiary, allows for the division of the respondents into three categories. The first, i.e., sectoral explorers, includes beekeepers who have been running apiaries for no longer than five years (31.4%). The second, i.e., sectoral transformers, includes beekeepers with work experience with bees ranging from 5 to 25 years (50.5%). Furthermore, the third, i.e., sectoral stoics, i.e., consists of the most experienced people who have been dealing with beekeeping for a quarter of a century (17.4%).

In addition to the criteria on which the sample's representativeness was based, another indicator was also used to characterize the respondents – the apiary as the main source of income. The author of the article was not surprised by the structure of the answers obtained in this area, based on her own experience and knowledge of, among other things, the number of costs associated with running an apiary or the still too low prices of honey. For the vast majority of respondents (nearly 92%), the apiary is not the main source of income. It is classified by the owners of apiaries as a source supplementing the home budget, which is usually based on professional work, a farm, or other economic activity not related to beekeeping.

However, the sample identified a percentage of beekeepers (6.2%) who live only from running an apiary. Some people (1.7%) refused to answer this question.

The largest group of beekeepers surveyed (55.2%) assesses the market on which they sell the obtained bee products as a constantly growing market in the 5-year perspective. A slightly smaller percentage of respondents define the primary sales market as a stable market (39.8%), and only 5.0% of respondents indicate that the main sales market has shrunk over the last five years.

The last criterion analyzed was the introduction of innovations in the beekeeping farm in the last five years. Extremely interesting results were obtained in this area because, given the relatively low innovativeness of Polish small business entities, which, as a rule, does not exceed 30% [Skowrońska, Tarnawa, 2022], the owners of small and medium-sized apiaries in nearly 71% declared the use of an innovative solution in the past period. According to the author of the article, the high percentage of apiary innovators in the study sample may be due to the need to:

- introduce significant improvements, especially in the organization of own work, which in the case of amateur apiaries is still associated with traditional and non-mechanized crafts;
- increase the channels and forms of promotion and distribution of bee products (especially honey) as a result of the recent pandemic market turmoil and the accompanying restrictions;
- offer new products or services in the face of constantly changing consumer preferences and expectations.
- In the further part of the article, the answers provided only by owners of apiaries active in innovation in 2015–2020 (300 in the surveyed sample) will be thoroughly analyzed.

Results

In the part of the questionnaire devoted to innovations and development prospects for their apiaries, respondents were asked to indicate the number and type of innovative solutions implemented in the last five years. The distribution of the responses obtained is presented below in Table 2. Beekeepers, despite being strongly rooted in traditional crafts, also undertake activities aimed at, firstly, improving their work and, secondly, contributing to the increase of biodiversity.

In the surveyed sample, just over half of the apiary owners implemented one innovation, every third respondent indicated using two or three solutions, and thirty-eight respondents declared the implementation of at least four innovations. This structure of responses may result, first of all, from treating beekeeping activities as an additional source of income, thus making development investments much less frequent. Secondly, the choice of a specific form of modernization involving additional financial outlays is a decision that requires appropriate knowledge, experience, and observation of the impact of specific factors on the development of bee families and the organization of the workplace. Often, apiary owners need to be sure

of the chosen direction of development and be ready to invest financial resources in new equipment and beehives or purchase land to expand their utility base. All this takes time and the ability to anticipate the actions needed.

Table 2. The structure and importance of implemented innovations in Polish apiary farms (n = 300)

Category	Range	Percentage share (%)
Number of innovations introduced in the period 2015–2020	1	53.00
	2–3	34.33
	4–5	12.67
Type of innovations introduced*	Products	21.33
	Process	47.33
	Organizational	58.00
	Marketing	23.67
	Other	31.67
Did the innovative solutions implemented in 2015–2020 contribute to the development of the apiary?	5 – Definitely YES	61.33
	4 – Rather YES	22.00
	3 – Hard to say	15.67
	2 – Rather NO	1.00
	1 – Definitely NO	0.00

* due to the possibility of indicating several types of innovations introduced, the total share of responses exceeds 100%
Source: own elaboration.

Looking at the structure of the innovative solutions introduced, it is clear that product solutions are much less popular than business process innovations. In the survey questionnaire, the classification of innovations according to the third edition of the Oslo Manual was deliberately used to make it more transparent for individual groups of respondents. It was assumed that the concept of business process innovation could be misunderstood by older owners of apiaries or amateurs of beekeeping activities, resulting in incomplete answers or disrupting the scope of changes introduced. It is worth mentioning that product innovations in the case of honey and other bee products are not so desirable and necessary because honey or pollen itself is a high-quality raw material and does not need any additional intervention. The situation is different in the case of activities organizing the work of beekeepers or the process of obtaining honey and other bee products. This is confirmed by the distribution of the responses obtained, where most of respondents indicated these categories of implemented innovative solutions (58.00% and 47.33% of responses, respectively). Almost every fifth beekeeper has undertaken marketing and sales activities in recent years, and every third respondent indicated another area of modernization activities carried out in their apiary.

In the following question, respondents were asked to rate the impact of innovative solutions introduced in recent years on the development of their apiary on a 5-point scale. The majority of respondents see a direct connection between the innovative activities carried out and the

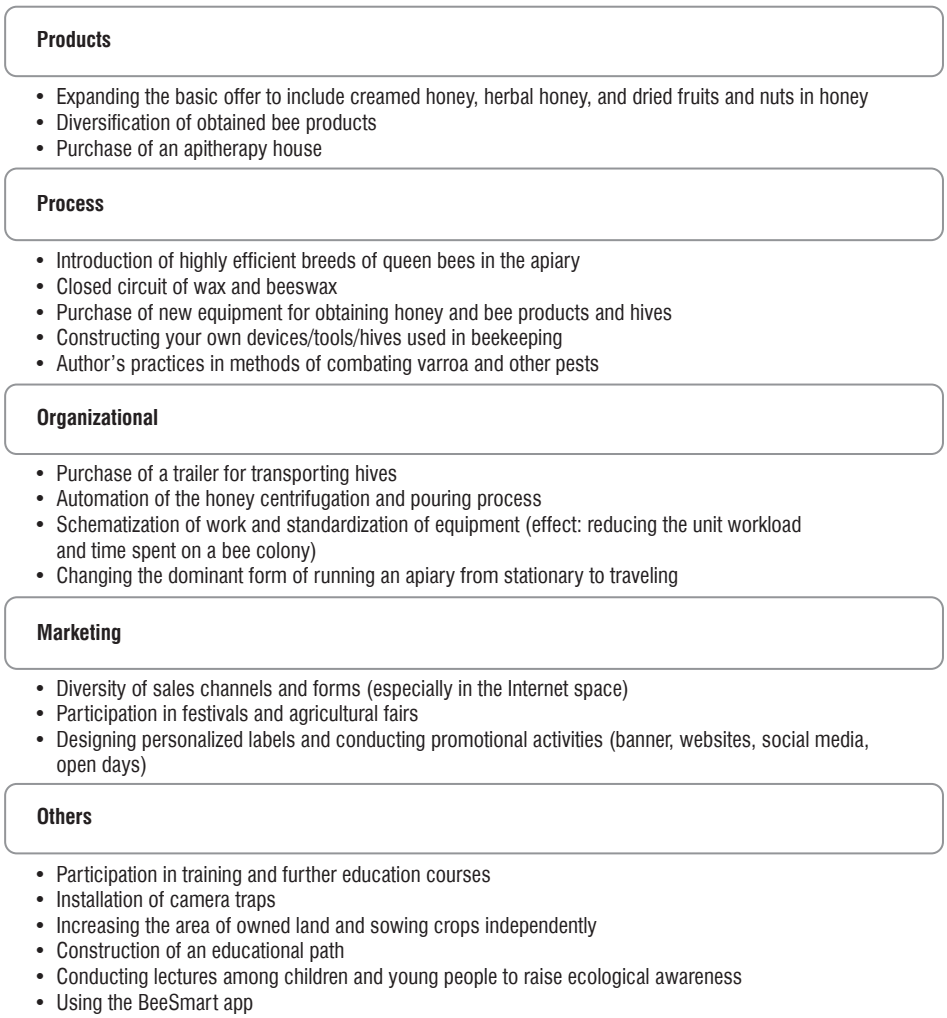
current level of development of their beekeeping activities – approximately 83% of apiary owners marked the answers *definitely YES* and *rather YES*. Less than 16% of respondents believe that it is difficult to indicate that the current level of apiary development can only be attributed to the implemented innovations – indirectly, yes, innovations contributed to the implementation of certain changes, but this is not only due to them. Only three out of three hundred beekeepers in this group of respondents do not see a direct connection between the innovations used and the current level of their business. It is worth mentioning that in the group of beekeepers conducting innovative activities, there was a significant increase in, among others, the size of apiaries, productivity per hive, the percentage of apiaries conducting nomadic farming, the number of obtained bee products, the number of sales channels, or promotional forms used, in the comparable years (2020 vs. 2015). In the same period, the dynamics of changes in the above categories were much lower among innovatively passive beekeepers. Therefore, t can, be assumed that the expansion decisions made in recent years have translated into the current situation of apiary farms and their uniform development on many levels simultaneously. Obviously, the sector technological progress and changing consumer requirements regarding the purchase of bee products have also been catalysts for changes.

In order to learn more about the nature and type of innovative activities undertaken, beekeepers were asked in the further part of the questionnaire to provide examples of the innovations introduced. The question was open and voluntary. This opportunity was used by 65.33% of the surveyed owners of innovatively active apiaries in the last period. Examples of innovations implemented in Polish apiaries, divided into specific categories, are presented below in Diagram 2.

The author of the study, based on her own experience and knowledge of the specific nature of beekeeping work and its unpredictability – resulting primarily from a strong dependence on weather conditions – is positively surprised by the multitude of changes and initiatives undertaken. Most of the innovations mentioned above, aimed at achieving a certain standardization and schematization of work, can only be implemented after several years of working with bees and testing various solutions by trial and error. Respondents' answers regarding the use of closed-loop practices and the construction of specific devices, hives, or individual components tailored to their needs should be assessed favorably. The awareness of the cyclical nature of specific processes and the readiness to implement the necessary technical, technological, or logistic solutions certainly facilitates the management of the entire project. Another critical area implemented by Polish beekeepers as part of innovative activities are educational activities addressed not only to customers but primarily to representatives of younger generations, in which pro-ecological attitudes should be developed, and their knowledge of the functioning of the ecosystem and its accompanying mechanisms and dependencies should be increased. While the connection between products directly derived from animals (such as milk or eggs) and specific species of fauna is easy for children and teenagers to identify, the importance of the role of pollinators in the availability of most vegetables and fruits is different. Therefore, grassroots initiatives such as educational trails, open days of apiaries, or school lectures are

vital. It is worth noting that the negative consequences of increased import of raw materials from unspecified sources and limited possibilities of direct honey sales during the pandemic have intensified the activity of beekeepers in the field of promotion and sales. However, the scope of these activities was closely related to the beekeepers' age and proficiency in using the Internet and social media for marketing. Interestingly, the innovative solutions being implemented also include dedicated beekeeping applications and devices used to monitor the hive's internal parameters, illustrating the bee family's situation and strength. In addition, camera traps are becoming increasingly popular, enabling continuous monitoring of the apiary and responding to emerging threats (e.g., wild animals or bystanders).

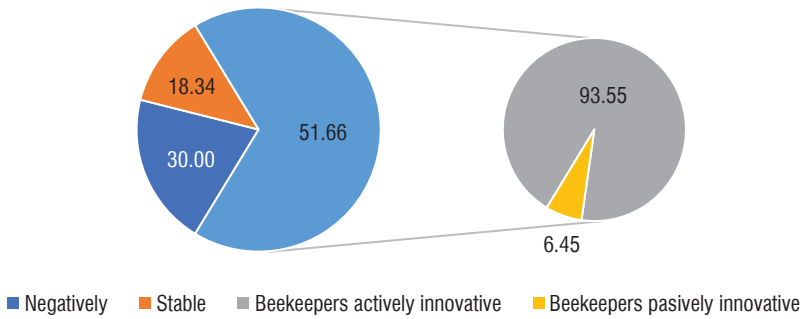
Diagram 2. Specification of innovations introduced in Polish apiaries in 2015–2020



Source: own elaboration.

At this point, it is also worth looking at the prospects for further expansion activities among the beekeepers surveyed (see Diagram 3) and the possible obstacles to their development (see Diagram 4). Every third respondent indicates a lack of development prospects for their beekeeping activity. Many responses to this question include categories of factors that inhibit the potential of family apiaries, which will be discussed in more detail in the next paragraph of this study. Just over 18% of respondents emphasize that despite the lack of planning significant investments in apiaries, their size and structure of costs and revenues will be at a similar level as in recent years. More than half of respondents indicate that the vision of the future of their apiaries should have a positive connotation. However, let us look at the structure of this answer and distinguish the group of active and passive beekeepers in terms of innovation. The first group is the leader in this category (less than 94% of responses). It is assumed that the investment outlays incurred on modernization and innovative solutions in the years preceding the study contribute to generating positive effects now and give hope for maintaining this trend in the future.

Diagram 3. Perception of the development possibilities of the apiary



Source: own elaboration.

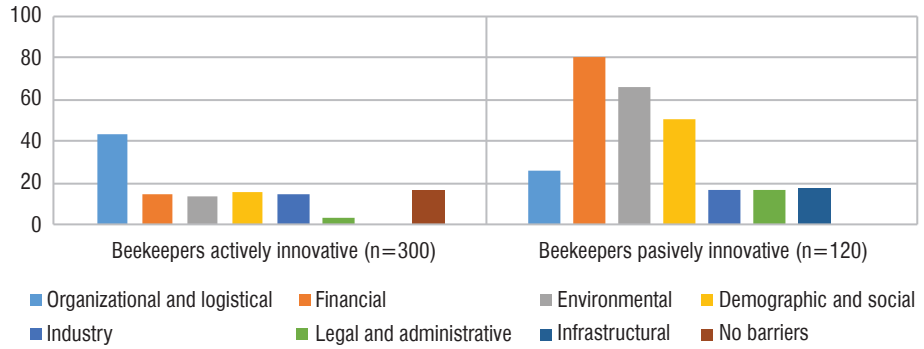
However, it should be emphasized that, as in any economic sector, including agriculture and beekeeping, several factors significantly hinder the work of respondents. Regardless of the attitude of beekeepers to conducting innovative activities, the indicated barriers have a similar meaning but differ in their significance for specific groups. The data presented in Diagram 4 below clearly indicate that significantly more groups of barriers affect to a greater extent beekeepers who have been innovatively passive in the last five years. For apiary owners implementing innovations in their activities, the most common answers to the question about development barriers were organizational and logistical ones (less than 45% of this group of respondents), mainly lack of time and problems resulting from reconciling professional work with the passion for beekeeping. In turn, for owners of apiaries who have not carried out any innovative activities in recent years, as many as three categories were indicated by at least half of the respondents in this group. They were as follows:

- financial barriers (mainly: limited profitability and production efficiency due to low honey prices on the market and production costs growing much faster than revenues),

- environmental barriers (especially: weather unpredictability, difficulty in accessing various post-harvest crops, limited ecological areas),
- demographic and social barriers (primarily: old age of people running apiaries and associated health problems, lack of family members willing to take over the apiary, and difficulty in recruiting seasonal workers).

While financial and socio-demographic barriers result directly from state policy or the organizational skills of beekeepers, some environmental barriers are random and independent of the activities of apiary owners.

Diagram 4. Development barriers of Polish passive and innovative apiary farms



Source: own elaboration.

Development barriers typical of the beekeeping industry are indicated at a similar level (approx. 15% in each respondent group). The most common answers include: the over-bearing of bees in some regions of the country and the related unfair practices of locating migratory apiaries of larger producers in the areas of smaller apiaries; farmers' resistance to cooperate and stop using of sprays or fertilizers harmful to bees, as well as the growing threat of disease outbreaks transmitted uncontrollably or resulting from gross negligence on the part of local beekeepers. The interesting fact is that none of the surveyed innovatively active beekeepers indicated a group of infrastructural barriers as limiting their further development prospects. Moreover, fifty beekeepers from this group (less than 17%) indicated that they did not see any significant factors that would limit their beekeeping activities in the future. This may prove that they are adequately prepared for the actions taken and are active in preventive measures against possible emergencies. This answer was usually given by owners who have been running their apiaries for at least ten years.

Summary

From the Polish economy viewpoint, bees are invaluable – thanks to them, the value of crops increases by approximately PLN 5 billion a year. However, this amount only covers

fields and orchards. It does not include naturally growing fruit trees, bushes, and other plants. It is estimated that at least 3.5 million bee colonies are needed to meet the demand for all insect-pollinated plants growing in our country. Currently, their number is estimated to be just over two million [Semkiw, 2021]. As with all the data above, this scale best shows the importance of bees in nature. The honey bee is the most common pollinating insect species in Poland, but its numbers have been far from the demand for many years. Unfortunately, humans themselves are responsible for the drastic reduction in the bee population. Air pollution, caused not only by spraying and pesticides but also by exhaust fumes, smog, and the emission of various chemical compounds into the atmosphere, significantly limits the bees' survival ability. The extinction of pollinating insects is worrying because the yield of up to 70% of 124 crop species depends on their work [Eilers et al., 2011]. It would be wrong to think that bees are only helpful to humans – they are an essential element of the ecosystem, and their role in the natural environment is extensive.

The article's main aim was to characterize and evaluate the implemented innovative solutions in Polish apiaries and to indicate the main accompanying barriers. The responses obtained from a representative group of Polish apiary owners clearly show that this sector actively conducts innovative activities and positively assesses further expansion prospects, despite the numerous limitations accompanying their daily activities. The answer to the research question regarding the impact of innovation on the development of apiaries is positive. A significant percentage of domestic beekeepers notice a direct relationship between innovation and the development predispositions of the apiary. The diversity and number of solutions used in such a traditional craft proves the awareness and maturity of apiary owners in business management in dynamically changing social, market, and environmental conditions. However, before gaining the appropriate level of experience and some freedom in making decisions and implementing projects, several years of active learning combined with practice must pass, preferably initially under the supervision of an experienced mentor. Unfortunately, as practice shows, there are also situations in which apiaries are set up by incompetent people who, due to their complete lack of knowledge or experience, think there is no need to make any changes. As a result, such pseudo-beekeepers lose their enthusiasm after one season or year, and, worse, they waste the bee families under their care. Society should re-learn how to use biodiversity in agriculture, breeding, medicine, and industry [Skubała, 2018, p. 9] not to deplete natural resources [Wilson, 1999] or limit their potential. The presented research approach provides a context for further analytical work on expanding the research topic. It provides the basis for formulating a policy direction to support the beekeeping sector that solves local development barriers. From the perspective of sustainable development of Polish apiaries, the affirmation of domestic products combined with educational activities to increase knowledge, undertaken by beekeepers from the bottom up and at higher administrative levels, will be of great importance.

However, the above study is not free from research limitations, especially in the context of the methodology used. Although the survey was conducted on a representative sample, some groups, such as young beekeepers or those who have introduced very few innovations, may

not be adequately covered. Attempts were made to reach a proportional number of beekeepers in certain age categories and propensities to introduce innovations, but the specificity of beekeeping, especially the treatment of it as an additional source of income and the visible generation gap, effectively limited this.

References

1. Abraham, J.I., Knight, D.J. (2002). Strategic innovation: leveraging creative action for more profitable growth. *Strategy & Leadership*, *29*(1).
2. Afuah, A. (2014). *Business Model Innovation. Concepts, Analysis, and Cases*. New York: Routlage.
3. Aizen, M.A., Garibaldi, L.A., Cunningham, S.A., Klein, A.M. (2008). Long-term global trends in crop yield and production reveal no current pollination shortage but increasing pollinator dependency. *Current biology: CB*, *18*(20), pp. 1572–1575, https://doi.org/10.1016/j.cub.2008.08.066
4. Anand, J., McDermott, G., Mudambi, R. et al. (2021). Innovation in and from emerging economies: New insights and lessons for international business research. *J Int Bus Stud* 52, pp. 545–559, https://doi.org/10.1057/s41267-021-00426-1
5. Andrews, E. (2020). The main objection to numerous small bee keepers': Biosecurity and the professionalization of beekeeping. *Journal of Historical Geography*, 67, pp. 81–90, https://doi.org/10.1016/j.jhg.2019.10.015
6. Bar Am, J., Furstenthal, L., Jorge, F., Roth, E. (2020). Innovation in a crisis: Why it is more critical than ever, https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights [accessed: 01.02.2024].
7. Barrichello, A., Santos, E.G., Morano, R.S. (2020). Determinant and priority factors of innovation for the development of nations. *Innovation & Management Review*, *17*(3), pp. 307–320, https://doi.org/10.1108/INMR-04-2019-0040
8. Baruk, J. (2017). Strategic Aspects of Innovation Management. *Marketing of Scientific and Research Organizations*, *26*(4), pp. 55–79, https://doi.org/10.14611/minib.26.12.2017.12
9. Bębenek, P. (2016). Zarządzanie procesami i innowacjami w rolnictwie. *Zeszyty Naukowe Politechniki Śląskiej*, 96, pp. 1–11.
10. Benito-Murcia, M., Martín-Hernández, R., Meana, A., Botías, C., Higes, M. (2022). Study of pyrethroid resistance mutations in populations of Varroa destructor across Spain. *Research in Veterinary Science*, 152, pp. 34–37, https://doi.org/10.1016/j.rvsc.2022.07.021
11. Bratkowski, J., Wilde, J., Miećkowska, A. (2008). Consumer Expectations Required of Honeybee Farms at Retail Trade. *Biuletyn Naukowy Uniwersytet Warmińsko-Mazurski w Olsztynie*, 29, pp. 37–43.
12. Breeze, T.D., Bailey, A.P., Balcombe, K.G., Potts, S.G. (2011). Pollination services in the UK: How important are honeybees? *Agric. Ecosyst. Environ*., 142, pp. 137–143, https://doi.org/10.1016/ j.agee.2011.03.020
13. Brščić, K., Šugar, T., Poljuha, D. (2017). An empirical examination of consumer preferences for honey in Croatia. *Applied Economics*, *49*(58), pp. 5877–5889, https://doi.org/10.1080/00036846.2017.1352079

14. Carayannis, E.G., Sindakis, S., Walter, C. (2015). Business model innovation as lever of organizational sustainability. *The Journal of Technology Transfer*, *40*(1), pp. 85–104, https:// doi.org/ doi:10.1007/s10961-015-9433-8
15. Carley, M., Spapens, P. (2000). *Dzielenie się światem*. Białystok–Warszawa: Instytut na rzecz Ekorozwoju.
16. Carlsson, B., Jacobsson, S., Holmen, M., Rickne, A. (2002). Innovation systems: analytical and methodological notes. *Research Policy*, *31*(2), pp. 233–245.
17. Carreck, N.L., Williams, I.H. (1998). The economic value of bees in the UK. *Bee World*, 79, pp. 115–123, https://doi.org/10.1080/0005772X.1998.11099393
18. Casanelles-Abella, J., Moretti, M. (2022). Challenging the sustainability of urban beekeeping using evidence from Swiss cities. *NPJ Urban Sustain 2*, 3, https://doi.org/10.1038/s42949-021-00046-6
19. Chami, C.F., Liwenga, E.T., Masao, C.A. (2022). Is Beekeeping Commercially and Environmentally viable? an assessment of the adoption of hanging frame beehives in semi-Arid Area of central Tanzania. *Tropical Conservation Science*, https://doi.org/10.1177_19400829221125393
20. Chen, G. (2017). Research on Innovation Driving Force and Industrial Upgrading under Information Technology. *Advances in Intelligent Systems Research*, 131, pp. 320–323, https:// doi.org 10.2991/icoi-17.2017.41
21. Chesbrough, H.W. (2003). *Open innovation: the new imperative for creating and profiting from technology*. Boston: Harvard Business School Press.
22. Chodyński, A. (2021). *Dynamika przedsiębiorczości i zarządzania innowacjami w firmach. Odpowiedzialność – prospołeczność – ekologia – bezpieczeństwo*. Kraków: Oficyna Wydawnicza KAAFM, Kraków.
23. Crudu, R. (2019). The role of innovative entrepreneurship in the economic development of EU member countries. *Journal of Entrepreneurship, Management and Innovation*, *15*(1), pp. 35–60. https://doi.org/10.7341/20191512
24. De la Rúa, P., Jaffé, R., Dall'Olio, R. et al. (2009). Biodiversity, conservation and current threats to European honeybees. *Apidologie*, 40, pp. 263–284, https://doi.org/10.1051/apido/2009027.
25. Denisow, B. (2018). Ekologia zapylania a bioróżnorodność. In: J. Pawłowska-Tyszko, A. Oler (Eds.), *Pszczelarstwo a zrównoważony rozwój obszarów wiejskich*. Dobrcz: Fundacja Edukacji Ekonomicznej i Rozwoju Obszarów Wiejskich.
26. Deschamps, J.-P., Nelson, B. (2014). *Innovation Governance. How Top Management Organizes and Mobilizes for Innovation*. San Francisco: Jossey-Bass.
27. Devkota, K. (2020). Beekeeping: Sustainable Livelihoods and Agriculture Production in Nepal. *Modern Beekeeping – Bases for Sustainable Production*, https://doi.org/ 10.5772/ intechopen.90707
28. iDonato, S., Gareau, B.J. (2022). Be(e)coming pollinators: Beekeeping and perceptions of environmentalism in Massachusetts. *PLoS ONE*, *17*(3), https://doi.org/10.1371/journal.pone.0263281
29. Drucker, P.F. (1992). *Innowacja i przedsiębiorczość: praktyka i zasady*. Warszawa: PWE.
30. Dudek, M., Prandecki, K., Wrzaszcz, W., Żekało, M. (2019). *Jak powstają innowacje w gospodarstwach rolnych. Analiza i przykłady*. Warszawa: IERiGŻ-PIB.

31. Dytrych, K. (2018). Pszczoły kluczowym elementem różnorodności biologicznej. In: Biznes na rzecz bioróżnorodności. *Dobre praktyki*. Kruszwica: Zakłady Tłuszczowe Kruszwica.
32. Eilers, E.J., Kremen, C., Greenleaf, S.S., Garber, A.K., Klein, A.M. (2011). Contribution of pollinator-mediated crops to nutrients in the human food supply. *PLoS One*, *6*(6), https://doi.org/10.1371/ journal.pone.0021363
33. EIP-AGRI (2020). *EIP-AGRI Focus Group Bee health and sustainable beekeeping*. FINAL REPORT SEPTEMBER 2020, https://ec.europa.eu/eip/agriculture/sites/default/files/eip-agri_fg_bee_health_sus tainable_beekeeping_final_report_2020_en.pdf, [accessed: 01.02.2024].
34. European Commission (2011). COM (2011) 899 final COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, Innovation for a sustainable Future – The Eco-innovation Action Plan (Eco-AP), Brussels, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0899: FIN:EN:PDF, [accessed: 01.02.2024].
35. European Commission (2020). *EU Beekeeping Sector*. National Apiculture Programmes 2020–2022, https://agriculture.ec.europa.eu/system/files/2020-06/honey-apiculture-programmes-overview-2020-2022_0.pdf [accessed: 01.02.2024].
36. European Commission (2022). *Common agricultural policy cap overview*, https://agriculture.ec.europa.eu/common-agricultural-policy/ cap-overview [accessed: 01.02.2024].
37. Fagerberg, J. (2004). Innovation: A Guide to the Literature. In: J. Fagerberg, D.C. Mowery, R. Nelson (Eds.), *The Oxford Handbook of Innovations*. Oxford University Press.
38. FAO, IZSLT, Apimondia, and CAAS (2021). *Good beekeeping practices for sustainable apiculture FAO Animal Production and Health Guidelines No. 25*, https://doi.org/10.4060/cb5353en
39. FAOSTAT (2022). *Statistical Yearbook. World Food and Agriculture 2022*, https://www.fao.org/faostat/en/#data/QCL [accessed: 01.02.2024].
40. Ferraresi, A.A., Quandt, C.O., dos Santos, S.A., Frega, J.R. (2012). Knowledge management and strategic orientation: leveraging innovativeness and performance. *Journal of Knowledge Management*, *16*(5), pp. 688–701, https://doi.org/10.1108/13673271211262754
41. Fleuren, M., Wiefferink, K., Paulussen, T. (2004). Determinants of innovation within health care organizations: Literature review and Delphi study. *International Journal for Quality in Health Care*, *16*(2), pp. 107–123, https://doi.org/10.1093/intqhc/mzh030
42. Fu, X., Shi, L. (2022). *Direction of Innovation in Developing Countries and Its Driving Forces*. Economic Research Working Paper No. 69, https://www.wipo.int/edocs/pubdocs/ en/wipo-pub-econstat-wp-69-en-direction-of-innovation-in-developing-countries-and-its-driving-forces.pdf [accessed: 01.02.2024].
43. Gallai, N., Salles, J.M., Settele, J., Bernard E. Vaissière, B.E. (2009). Economic Valuation of the Vulnerability of World Agriculture Confronted with Pollinator Decline, *Ecological Economics*, *68*(3), pp. 810–821, https://doi.org/10.1016/J. ECOLECON.2008.06.014
44. Garibaldi, L.A., Steffan-Dewenter, I., Winfree, R., Klein, A. (2013). Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance. *Science*, *339*(6127), https://doi.org/10.1126/ science.1230200

45. Gąsowska, M.K. (2014). The Role of Innovation in the Process of Enterprise Management in Conditions of Economic Fluctuations Based on the Example of Selected Enterprises, *Zeszyty Naukowe Politechniki Śląskiej Organizacja i Zarządzanie*, 74, pp. 513–524.
46. Głód, W., Ingram, T. (2015). Procesy innowacyjne w małych i średnich przedsiębiorstwach – studia przypadków. *Studia Ekonomiczne*, 212, pp. 52–69.
47. Główny Urząd Stattystyczny (2009). *Działalność innowacyjna przedsiębiorstw w latach 2006–2008, Notatka Informacyjna, Departament Przemysłu*. Szczecin: Urząd Statystyczny w Szczecinie.
48. Główny Urząd Statystyczny (2021). Statistical Yearbook of Agriculture, Warszawa: GUS.
49. Godin, B. (2006). The linear model of innovation: the historical construction of an analytical framework, Science. *Technology & Human Values*, 31, pp. 639–667.
50. Grant, R.M. (2011). *Współczesna analiza strategii*. Warszawa: Wolters Kluwer.
51. Gratzer, K., Wakjira, K., Fiedler, S. et al. (2021). Challenges and perspectives for beekeeping in Ethiopia. A review. *Agron.Sustain.Dev*., *41*(46), https://doi.org/10.1007/s13593-021-00702–2
52. Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., Kyriakidou, O. (2004). Diffusion of Innovations in Service Organizations: Systematic Review and Recommendations. *Milbank Quarterly*, *82*(4), pp. 581–629, https://doi.org/10.1111/j.0887-378x.2004.00325.x
53. Hall, D.M., Steiner, R. (2019). Insect pollinator conservation policy innovations at subnational levels: Lessons for lawmakers. *Environmental Science & Policy*, 93, pp. 118–128, https:// doi.org/10.1016/j.envsci.2018.12.026
54. Hobcraft, P. (2011). *Moving towards a distributed innovation model*, http://www.business-strategyinnovation.com [accessed: 01.02.2024].
55. IPBES (2019). *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Bonn, Germany: IPBES secretariat, p. 1148, https://www.ipbes.net/global-assessment [accessed: 01.02.2024].
56. Jones, O. (2003). Innovation in SMEs: Intrapreneurs and New Routines. In: O. Jones, F. Tilley (Eds.), *Competitive Advantages in SMEs. Organizing for Innovation and Change*. Chichester: John Wiley & Sons Ltd.
57. Kaczmarczyk, S. (2011). *Badania marketingowe. Podstawy metodyczne*. Warszawa: Polskie Wydawnictwo Ekonomiczne.
58. Kałowski, A., Wysocki, J. (Eds.) (2015). *Innowacje – ocena w ujęciu mikro, mezo i makro*. Warszawa: Oficyna Wydawnicza Szkoła Główna Handlowa w Warszawie.
59. Karaczun, Z. (2018). Pszczoły kluczowym elementem różnorodności biologicznej, [w:] Biznes na rzecz bioróżnorodności. *Dobre praktyki*. Kruszwica: Zakłady Tłuszczowe Kruszwica.
60. Kemp, R., Pearson, P. (2007). *Final report MEI project about measuring eco-innovation*. Maastricht: UMMERIT.
61. Kline, S.J. (1978). Innovation is not a linear process. *Research Management*, *28*(4), pp. 36–45.
62. Kopała, E., Kuźnicka, E., Balcerak, M. (2019). Survey of consumer preferences on the bee product market.Part 1. Honey. *Ann. Warsaw Univ. of Life Sci. – SGGW, Anim. Sci*. *58*(2), https://doi.org/10.22630/AAS.2019.58.2.16
63. Kouchner, C., Ferrus, C., Blanchard, S., Decourtye, A., Basso, B., Le Conte, Y., Tchamitchian, M. (2019). Bee farming system sustainability: An assessment framework in metropolitan France. *Agricultural Systems*, 176, p. 102653, https://doi.org/10.1016/j.agsy.2019.102653

64. Kraśnicka, T., Ingram T. (Eds.) (2014). *Innowacyjność przedsiębiorstw – koncepcje, uwarunkowania i pomiar*. Katowice: Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach.
65. Kuś, A. (2020). *Działalność innowacyjna małych przedsiębiorstw w Polsce*. Toruń: Wydawnictwo Naukowe Uniwersytetu Mikołaja Kopernika.
66. Laperche, B., Mignon, S. (2018). Innovation Drivers: A Multi-Scale Approach. *Journal of Innovation Economics & Management*, 25, pp. 3–8, https://doi.org/10.3917/jie.025.0003
67. Maderson, S. (2023). There's More Than One Way to Know A Bee: Beekeepers' environmental knowledge, and its potential role in governing for sustainability. *Geoforum*, 139, 103690, pp. 1–11, https://doi.org/10.1016/j.geoforum.2023.103690
68. Majewski, J. (2011). Wartość zapylania roślin uprawnych w Polsce. *Prace naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 166, pp. 426–435.
69. Maradana, R.P., Pradhan, R.P., Dash, S. et al. (2017). Does innovation promote economic growth? Evidence from European countries. *J Innov Entrep*, *6*(1), https://doi.org/10.1186/s13731-016-0061-9
70. Meissner, D., Kotsemir, M. (2016). Conceptualizing the innovation process towards the 'active innovation paradigm' – trends and outlook. *J Innov Entrep*, *5*(14), https://doi.org/10.1186/s13731-016-0042-z
71. Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-Being: Current State and Trends*. Washington: Island Press.
72. Moore, M.H., Sparrow, M., Spelman, W. (1997). Innovations in Policing: From production lines to job shops. In: A.A. Altshuler., R. Behn (Eds.), *Innovation in American government: Challenges, opportunities, and dilemmas*. Washington: Brookings Institution Press.
73. Moreira, M.F., de Aquino Guimarães, T., Philippe, J. (2016). Change and innovation: an observable relationship in services? *RAI Revista de Administração e Inovação*, *13*(2), pp. 135–144, https://doi.org/10.1016/j.rai.2016.03.001
74. Morris, M.H., Kuratko, D.F., Covin, J.G. (2011). *Corporate Innovation & Entrepreneurship*. Mason: Cengage Learning.
75. Nicolaides, A. (2014). Research and Innovation – the drivers of economic development, African Journal of Hospitality. *Tourism and Leisure*, *l.3*(2), pp. 1–16.
76. Ober, J. (2022). *Adaptacja innowacji w świetle zachowań organizacyjnych wybrane aspekty*. Gliwice: Wydawnictwo Politechniki Śląskiej.
77. OECD (2012). *Environmental Outlook to 2050: The Consequences of Inaction*. OECD Publishing
78. OECD, Eurostat (2018). *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities*. Paris: OECD Publishing/ Luxembourg: Eurostat, https://doi.org/10.1787/9789264304604-en
79. Olszewski, K. (2022). *Innowacje w gospodarstwach pasiecznych*. Wrocław: Dolnośląski Ośrodek Doradztwa Rolicznego, https://www.dodr.pl/sites/default/files/2022–07/innowacjew-gospodarstwach pasiecznych2022.pdf [accessed: 01.02.2024].
80. Osterman, J., Aizen, M.A., Biesmeijer, J.C., Bosch, J., Howlett, B.G. et al. (2021). Global trends in the number and diversity of managed pollinator species. *Agriculture, Ecosystems & Environment*, 322, p. 107653, https://doi.org/10.1016/j.agee.2021.107653

81. O'Sullivan, D., Dooley, L. (2009). *Applying innovation*. SAGE Publications, Inc., https://doi.org/10.4135/9781452274898

82. Padmore, T., Schuetze, H., Gibson, H. (1998). Modeling Systems of innovation: An Enterprise-centered view. *Research Policy*, 26.

83. Patel, V., Pauli, N., Biggs, E. et al. (2021). Why bees are critical for achieving sustainable development. *Ambio*, 50, pp. 49–59, https://doi.org/10.1007/s13280-020-01333-9

84. Phillips, C. (2014). Following beekeeping: More-than-human practice in agrifood. *Journal of Rural Studies*, 36, pp. 149–159, https://doi.org/10.1016/j.jrurstud.2014.06.013

85. Porter, M. (1990). *The competitive advantage of nations*. London: The Macmillan Press.

86. Potts, S.G., Imperatriz-Fonseca, V.L., Ngo, H.T., Biesmeijer, J.C., Breeze T.D. et al. (2016). *Summary for policymakers of the assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production*. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany, pp. 1–36.

87. Potts, S.G., Roberts, S.P.M., Dean, R., Marris, G., Brown, M.A. et al. (2010). Declines of managed honey bees and beekeepers in Europe. *J. Apic. Res*., *49*(1), pp. 15–22, https://doi.org/10.3896/ibra.1.49.1.02

88. Pruszyński, G., Skubida, P. (2012). *Ekspertyza. Dobra praktyka ochrony roślin. Ochrona zapylaczy podczas stosowania środków ochrony roślin*, https://rolnictwozrownowazone.pl/ [accessed:: 01.02.2024].

89. Rahimi, M.K., Abbasi, E., Bijani, M., Tahmasbi, G., Azimi Dezfouli, A.A. (2020). Sustainability criteria of apicultural industry: evidence from Iran. *Ecosystem Health and Sustainability*, *6*(1), p. 1818630, https://doi.org/10.1080/20964129.2020.1818630

90. Raman, S. (2006). *Agricultural Sustainability: Principles, Processes, and Prospects*. New York-London-Oxford: Food Products Press. An Imprint of The Haworth Press.

91. Rogers, E.M. (2003). *Diffusion of Innovations*. New York: Free Press.

92. Roman, A., Popiela-Pleban, E. Kozak, M. (2013a). Factors influencing consumer behavior relating to the purchasing of honey part 1. The buying process and the level of consumption. *Journal of Apicultural Science*, *57*(2), pp. 159–172, https://doi.org/10.2478/jas-2013–0026

93. Roman, A., Popiela-Pleban, E., Kozak, M., Roman, K. (2013b). Factors influencing consumer behavior relating to the purchase of honey part 2. Product quality and packaging. *Journal of Apicultural Science*, *57*(2), pp. 175–185, https://doi.org/10.2478/jas-2013-0027

94. Rosenkranz, P., Aumeier, P., Ziegelmann, B. (2010). Biology and control of Varroa destructor, *J. Invertebr. Pathol*., 103, pp. 96–119.

95. Rothwell, R. (1992). Successful industrial innovation: Critical factors for the 1990 s. *R & D Management*, *22*(3), pp. 221–240.

96. Schippers, M.C., West, M.A., Dawson, J.F. (2015). Team Reflexivity and Innovation: The Moderating Role of Team Context. *Journal of Management*, *41*(3), pp. 769–788, https://doi.org/10.1177/0149206312441210

97. Schumpeter, J. (1960). *Teoria rozwoju gospodarczego*. Warszawa: PWN.

98. Semkiw, P. (2021). *Sektor pszczelarski w Polsce w 2021 roku*. Puławy: Instytut Ogrodnictwa – PIB Zakład Pszczelnictwa w Puławach.

99. Siau, K., Messersmith, J. (2003). Analyzing ERP Implementation at a Public University Using the Innovation Strategy Model. *International Journal of Human-Computer Interaction*, *16*(1), pp. 57–80, https://doi.org/10.1207/s15327590ijhc1601_5
100. Skubała, P. (2018). Bioróżnorodnośc największym i najmniej docenianym skarbem ludzkości. Biznes na rzecz bioróżnorodności. *Dobre praktyki*. Kruszwica: Zakłady Tłuszczowe Kruszwica.
101. Smith, D. (2006). *Exploring Innovation*. New York: McGraw-Hill Education.
102. Smith, D. (2009). *Exploring Innovation*. 2nd Edition. London: McGraw-Hill Higher Education.
103. Sparacino, A., Merlino, V.M., Blanc, S., Borra, D., Massaglia, S. (2022). A Choice Experiment Model for Honey Attributes: Italian Consumer Preferences and Socio-Demographic Profiles. *Nutrients*, *14*(22), p. 4797, http://dx.doi.org/10.3390/nu14224797
104. Stræte, E.P., Vik, J., Fuglestad, E.M., Gjefsen, M.D., Melås, A.M., Søraa, R.A. (2022). Critical support for different stages of innovation in agriculture: What, when, how? *Agricultural Systems*, 203, p. 103526, https://doi.org/10.1016/j.agsy.2022.103526
105. Taalbi, J. (2017). What drives innovation? Evidence from economic history. *Research Policy*, *46*(8), pp.1437–1453, https://doi.org/10.1016/j.respol.2017.06.007
106. Taran, Y., Boer, H., Lindgren, P. (2015). A business model innovation typology. *Decision Sciences*, *46*(2), pp. 301–331.
107. The Ministry of Agriculture and Rural Development (2019). *Rolnictwo i Gospodarka Żywnościowa w Polsce*. Warszawa: Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej.
108. The Ministry of Agriculture and Rural Development (2022), https://www.gov.pl/web/rolnictwo/ ramowy-plan-dzialan-dla-ywnosci-i-rolnictwa-ekologicznego-w-polsce [accessed: 01.02.2024].
109. Tidd, J., Bessant, J. (2013). Managing Innovation: Integrating Technological, Market and Organizational Change. New York: Wiley.
110. Timmerman, J.C. (2009). A Systematic Approach for Making Innovation a Core Competency. *The Journal for Quality & Participation*, *31* (4–10), pp. 1–41.
111. Trias de Bes, F., Kotler, P. (2013). *Innowacyjność przepis na sukces. Model od A do F*., Poznań: Dom Wydawniczy REBIS.
112. Trott, P. (2012). *Innovation Management and New Product Development*. 5th Edition. Essex: Pearson Education.
113. Twiss, B. (1992). *Managing technological innovation*. 4th edition. London: Pitman.
114. Velardi, S., Leahy, J., Collum, K., McGuire, J., Ladenheim, M. (2021). „You treat them right, They'll treat you right": Understanding beekeepers' scale management decisions within the context of bee values. *Journal of Rural Studies*, 81, pp. 27–36, https://doi.org/10.1016/j.jrurstud.2020.12.002
115. WEF (2023). *WEF Global Risks Report 2023*, https://www3.weforum.org/docs/WEF_Global_Risks_Report_2023.pdf [accessed: 01.02.2024].
116. Whitfield, P.R. (1979). *Innowacje w przemyśle*. Warszawa: PWE.
117. Wilson, E.O. (1999). *Różnorodność życia*. Warszawa: PIW.

118. Young, G.J., Charns, M.P., Shortell, S.M. (2001). Top manager and network effects on the adoption of innovative management practices: a study of TQM in a public hospital system. *Strategic Management Journal*, *22*(10), pp. 935–951, https://doi.org/10.1002/smj.194

119. Zastempowski, M. (2019). *Innowacyjność małego przedsiębiorstwa*., Toruń: Wydawnictwo Naukowe Uniwersytetu Mikołaja Kopernika.

120. Zych, M., Jakubiec, A. (2006). How much is a bee worth? Economic aspects of pollination of selected crops in Poland. *Acta Agrobot*, 59, pp. 289–299, https://doi.org/10.5586/ aa.2006.030

121. Żak, N. (2017). Consumer preferences for the Polish and USA consumption of honey. *Marketing i Zarządzanie*, *2*(48), pp. 117–130, https://doi.org/10.18276/miz.2017.48-11