

Perspective

The Role of Beekeeping in the Generation of Goods and Services: The Interrelation between Environmental, Socioeconomic, and Sociocultural Utilities

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Abstract: Honey bees and beekeeping belong to a large enterprise where the managers are the beekeepers, the workers are the bees, and the products generated are ecosystem goods and services, mostly intangible. Evidence for a reduction in the number of pollinating insects in the planet due to causes that are still being studied has put the spotlight on beekeeping activity and bees (wild and managed) due to their extraordinary capacity to contribute to pollination. The aim of the present work was to detect, identify, and analyze the set of environmental, socioeconomic, and sociocultural utilities (goods and services) generated by honey bees and beekeeping in order to identify possible interrelationships between them. The aim was to demonstrate that these utilities, far from being watertight, are interconnected, which will help to increase their value and highlight their positive externalities (genetic diversity and landscape, among others). This research begins with an overview of some seminal articles, published mainly in the last three years, which were searched following a review using keywords in major databases. After reading the seminal articles and others that were referenced, we analyzed the main utilities generated by honey bees and the possible relationships between them. The main contribution of our results is the determination that the generated utilities are interrelated, which could contribute to increasing their value. In addition, we found that, of the three interrelated dimensions, the socioeconomic dimension encompasses the environmental and sociocultural dimensions. The article ends by proposing future lines of research.

Keywords: beekeeping; honey bees; environmental utilities; economic utilities; sociocultural utilities; interrelationships between utilities



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1. Introduction

As has already been demonstrated in other studies [1–3], beekeeping is an inclusive and diverse activity. This activity, which provides multisystemic benefits to society [4,5], contributes to the sustainable development of rural areas [6,7] and helps the development of global sustainability [8,9]. This is carried out through the generation of goods and services that often lead to an increase in the per capita income of families [3], as well as important opportunities, since it contributes to the creation of jobs, both directly and indirectly, that are traditionally linked to industry [6,7].

Recent studies have shown great interest in the pollination service provided by bees [5,7,10], as they generate intangible goods and services. This increased interest in bees is due to the fact that multifactorial causes are leading to a global reduction in the number of pollinating insects, including bees of various species [4]. Although it remains difficult to prove causality and predict future consequences [11], this has raised concerns in a number of different areas related to the possible loss of crop productivity and its potential impact on food security globally. According to Patel et al. [3], pollination is crucial for the ecology, economy, and society and is of utmost importance for crop productivity.

In this context, there are still benefits generated by bees that have not been recognized [3] because they are clearly intangible and remain to be explored. It should be taken into account that understanding human needs and the uses that humans derive from things and living beings (in this case, bees) is the first step in becoming aware of the present situation [12], which is necessary for subsequent assessment and the future development of interventions by administrations, either as alternatives or complementary to market mechanisms.

The primary utilities generated by honey bees and beekeeping can be grouped into three main blocks: environmental, socioeconomic, and sociocultural [13,14]. These blocks have fundamentally been studied individually; however, it has become necessary to study them in a connected way, since some of these utilities can be considered from a triple perspective, thus increasing the synergies that they produce individually.

We conducted a review of the literature, searching for articles in the main databases on the basis of keywords; however, our starting point was a number of seminal articles [3–5,13]. Our research has two objectives: The first is to identify and analyze the utilities (goods and services) that arise from honey bees. The second objective is to analyze the manner in which honey bee utilities may be related to one another and to demonstrate that they are not watertight—rather, that they are interrelated. The consequences derived from these objectives can be used to inform the development of policy by administrations.

The rest of this article is organized as follows: First, we explain what beekeeping is. Second, we analyze in detail the utilities generated by beekeeping (environmental, socioeconomic, and sociocultural). Third, we develop a series of arguments to interrelate these utilities. Finally, we close the article with a conclusion, practical implications, and future lines of research.

2. Concept of Beekeeping

Based on our literature review, we deduced that there is no single definition of the term beekeeping. According to Masuku [15], beekeeping is an agricultural activity defined as the art, science, and/or business of managing bees for the purpose of producing honey, wax, and other bee products for personal consumption and industrial use. According to Caron [16] (p. 23), beekeeping is “the technique of keeping bees for commercial purposes, for the sale of pollination products or services, but also for hobbyists for recreational and/or lucrative purposes”. Pajuelo [17] (p. 267) defined beekeeping as “the management of honey bees as livestock, in farms (. . .)”, and Vélez et al. [18] qualified this definition and indicated that it is a “rational” exploitation. The objective of this management is for the main flowering period to coincide with the majority of the honey bee population is in its adult stage in order to maximize production of the various products and services generated by bees [16].

Spanish public administrations classify economic activities by assigning them a CNAE code (National Classification of Economic Activities). Taking into account this classification, beekeeping is included as part of the livestock activity group, in the category of “other livestock farms.” Simultaneously, this livestock activity is one of the activities that form part of the primary or agricultural sector according to Regulation (EC) No. 858/2004. However, although it generates products and income for those who practice it, beekeeping is a form of productive livestock farming of which society has little awareness, and which therefore seems alien to it [19], and although in recent years it has been receiving greater attention [20], it still receives less attention than other sectors of animal production [21] (see Figure 1).

Among livestock activities, beekeeping has some distinct peculiarities, which, according to Casanelles-Abella and Moretti [22], are due to the fact that, while other forms of livestock depend largely on the resources provided by their owners, bees can move freely, without having their movements controlled, and can exploit available resources without depending on beekeepers; they also have the particularity that they reproduce faster than other livestock, and because of the positive association between bees and pollination ser-

vinces, beekeeping may not be perceived as an exploitation of floral resources. Moreover, unlike other primary sectors, the beekeeping sector is a unique primary sector [23] and an indispensable part of the bioeconomy [9].

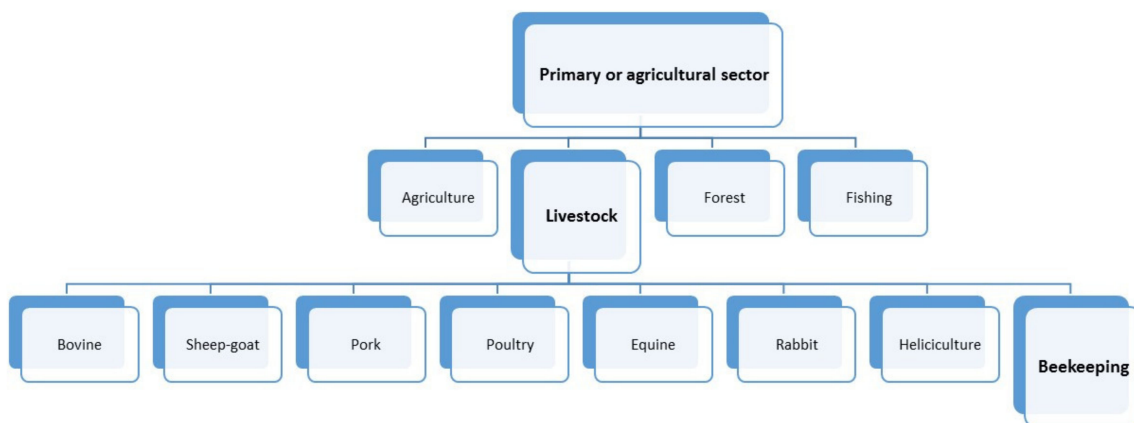


Figure 1. Beekeeping sector. Source: Own elaboration.

Beekeeping tends to be an activity that is complementary to agriculture, which allows it to generate additional income for its producers [24–26], generally without it being the main source of income. It can also be carried out simultaneously with other rural activities such as forestry (apiforestry), because these two activities have shared resources [27].

In general, the land factor is used for primary agricultural activities; however, beekeeping does not use land directly [28], rather focusing on other basic resources or capital [29]: natural (honey bees, flowering plants, and water, among other things), human (experience, skills, and knowledge), material or physical (facilities, transportation, water, and energy), social (help from friends, family, social networks, associations, marketing information, and research results), and economic (cash, accessibility to loans, and subsidies) (see Figure 2).

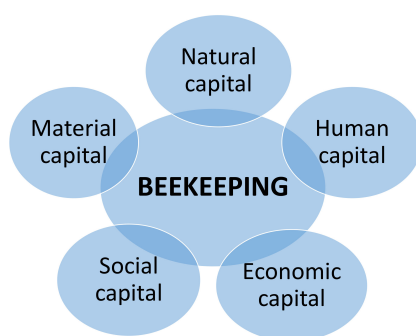


Figure 2. Types of capital needed for beekeeping. Source: Own elaboration.

Erdős [30] considered that agriculture and some livestock activities such as beekeeping possess mutual benefits or synergies, on the basis of which cooperation between the two can be favorable.

3. Utilities Generated by Beekeeping

In general, the ecosystem services associated with beekeeping include pollination and habitat conservation [31,32]. However, there is a new trend that includes economic, environmental, and cultural ecosystem services [5,10]. Despite its usefulness in attracting the interest of economists, policymakers, and the public toward environmental issues, according to Papa et al. [13], considering ecosystems as mere providers of benefits and services to humans is overly simplistic, and the (mis-)use of the concept “ecosystem services” devalues the role of nature and of humans themselves, along with their intimate

reciprocal relationship. These services can be both direct and indirect [33] and can occur at the individual/business, regional, and biological–environmental levels [34].

3.1. Environmental Benefits

Among the environmental benefits, it is necessary to distinguish pollination services and the services provided by honey bees as bioindicators of disturbances in ecosystems and the environment [24,35].

3.1.1. Pollination

Honey bees are considered one of the most important pollinating agents worldwide [4,36] due to their efficiency and wide diffusion across the globe [37]. In addition, they play a fundamental role as pollinators of agricultural crops [38–40].

Recent studies [3,5,41] have also valued the pollination work performed by wild pollinators, whereby honey bees, similar to other insects, play an important role and have a positive impact on the environment by ensuring the balance of ecosystems due to increased pollination [1,24]. This ensures the maintenance of floral diversity [5] and, therefore, a greater amount of seeds and plants [1], which are a source of food for wildlife [42] and help lessen soil erosion and degradation [43]. Pollination services thus contribute to ecological balance and biological diversity [44]. According to Vrabcová and Hájek [9], approximately 90% of the benefits of honey bees afforded to mankind lie precisely in their pollination capacity. Consequently, beekeeping and honey bees are providers of ecosystem services [31,32] and thus generate public goods (i.e., those that are characterized by being non-excludable), which means that if the product is offered to one person, it is offered to all others (e.g., a landscape of great diversity) and is non-rivalrous in terms of consumption (i.e., if one person consumes this public good, it does not prevent another from also consuming it). This gives rise to the existence of people who, without having participated in the transaction or contributed to its financing, benefit from it (free-riders), mostly derived from positive externalities (collateral effects derived from the existence of a public good). These can be positive or negative and are not a part of a market on which they can be bought or sold according to the law of supply and demand; therefore, they do not generate charges or payments for their producers and do not have an impact on the price paid by the consumer. However, normal ecosystem activities can be disrupted when populations of key species, such as honey bees and other pollinators, are significantly altered [45]. According to Majewski [46], there are several factors that further increase the importance of honey bees: (a) misuse of plant-protection products, (b) environmental pollution, (c) difficulties for pollinators in accessing food sources due to extensive areas of monoculture, (d) production technologies, and (e) limited non-agricultural land areas. However, there is currently a debate among researchers regarding the real benefits for natural ecosystems derived from the presence of managed honey bees [13]. Managed honey bees, often used for pollination services in agricultural systems, can compete with wild bees and negatively affect their communities, resulting in wild bees potentially experiencing increased stress from apiculture [47].

3.1.2. Bioindicators of Planetary Health and Climate Change

The pollination service is not the only environmental advantage or benefit offered by honey bees. The beehive is a supraorganism that is considered to be a valuable reservoir of agrochemicals present in the environment [48]. Therefore, beehives are considered one of the most accurate indicators of changing climate trends [49] and play a key role as bioindicators of disturbances in ecosystems and the environment [13]. This is mainly due to the following: (a) their high sensitivity to chemical or phytosanitary products; (b) their suitability for collecting air, vegetation, water, and soil samples due to their morphological, biological, and behavioral characteristics; (c) the fact that they are ubiquitous and can be located in any geographical area, pollinating both rural and urban areas; and (d) their lower economic cost compared to physical–chemical indicators [24,50]. Products such

as wax, honey, and pollen are the sources of information on the basis of which bees are considered bioindicators, as well as demographic variations, behavioral changes, and bioaccumulation [4]. Recent studies have shown that bees can act as collectors of microplastic pollution [51]. They can also be used as biomonitors of the heavy metal content in the air [52]. They are also recognized as indirect pest controllers, since they compete for food with phytophagous insects [53], i.e., those that consume plants or their parts (stems, leaves, flowers, nectar, pollen, fruits, and roots, among other things).

Having explained the environmental benefits of beekeeping, on the basis of Aryal and colleagues' work [5], it can be concluded that honey bees generate nutritional benefits through pollination, with directly impacting benefits.

3.2. Socioeconomic Profitability (Provisioning)

In 1982, Allen-Wardell [34] referred to beekeeping as an economically profitable activity, beneficial and appropriate for young rural people, because it does not require high initial investments, and therefore, the risk is assumed to be low. Some of these advantages are as follows: (a) beekeeping is an activity that has a low maintenance cost and generates revenues in a relatively short period of time [54]; (b) it is not necessary to have a lot of space for the location of hives, and the management of the activity allows the beekeeper to manage their time more flexibly than in other agricultural activities [55,56]; (c) beekeeping does not require a large amount of land, nor does it require that the land be owned [2,23]; and, finally, (d) beekeeping can improve the beekeeper's financial security and help create employment due to the variety of products and services that are generated, thus contributing to increasing their economic income [56]. We distinguish between those goods that honey bees produce for a specific purpose in the hive, which humans have been able to take advantage of—the so-called “honey bee products”—and those that have arisen from uses that humans have derived for honey bees themselves, i.e., “honey bees as products”.

3.2.1. Honey Bee Products

Bees produce a variety of products, including honey, pollen, royal jelly, wax, propolis, and apitoxin [5], each of which has a specific function in the hive, such as food (honey, pollen, and royal jelly), factory, storehouse, reproduction site and communication network (wax), protection (propolis), and defense (apitoxin) functions.

These products have several unique characteristics, depending on their botanical origin (local flora and nectar source) [57–59], geographical origin (climate and environmental conditions) [59–62], and beekeeping practices [63]. In addition, several nutritional and therapeutic properties beneficial to health are attributed to these products, including anti-inflammatory, antitoxic, antioxidant, anesthetic, stimulant, bacteriostatic, bactericidal, antiseptic, healing, antimicrobial, antitumor, and aphrodisiac properties [64–66]. Recent studies have reported possible benefits in the treatment of patients with diabetes, obesity, cancer, and COVID-19 [62,67]. However, based on the works of Durazzo et al. [37] and Tsuda and Kumazawa [68], more research and more clinical trials should be conducted on humans to assess the relationship between the consumption of honey bee products and benefits or treatment in health disorders. In this way, the potential use of honey bee products in phytomedicine (as an alternative to drugs) could be better substantiated by scientific evidence [37].

Honey bee products are also used to treat people with severe allergies to stings—in particular, apitoxin [69,70]. Furthermore, in the current pandemic, it is worth noting the importance of the fact that honey bee venom boosts the immune system—which has antimicrobial and anti-inflammatory capabilities—fighting against the symptoms of COVID-19 [71]. In addition, honey bee products can be used in veterinary medicine [60]. Due to the multitude of properties, honey bee products have been used since time immemorial [72,73]. Likewise, there is a growing demand for natural goods, and honey bee products are consumed as raw materials. This has led to the development of the food, cosmetic,

and medicinal industries (food, creams, and shampoos, among others) [33,74], which, according to Ocampo and Boussy [75], is fundamentally relevant for small beekeepers whose production quantities do not guarantee sufficient profitability from their beekeeping activities to be economically sustainable, but who generate extra income that influences their financial security.

As mentioned previously, honey bee products are a good source of medical and pharmacological preparations (drugs, dietary supplements, and medicated cosmetics); however, these products can be contaminated by anthropogenic chemicals from the surrounding environment or a beekeeper's management practices (e.g., with veterinary medicinal products such as antibiotics or legal acaricides) [76]. According to recent research, there are notable differences in anthropogenic contaminant residue levels under organic vs. conventional honey production conditions [59]. This is because organic beekeeping includes special rules and conditions for apiary management [14]. Possession of organic certification guarantees good beekeeping practices, which increase pollinator diversity while increasing pollinator efficiency [77]. Because of this, organic beekeeping represents an important alternative to traditional apicultural practices [14]. Nevertheless, the development of organic beekeeping is mainly threatened by the intensification of agriculture (e.g., the use of pesticides), as well as by new EU requirements for certification (3 km radius claim) [78]. Therefore, the current trend toward reducing the consumption of ultra-processed products [69] while increasing demand for products in the organic market [79] probably favors their consumption.

3.2.2. Honey Bees as a Product

Honey bees can be sold as live beekeeping materials to create a new colony [80], and in this case, they constitute a product in themselves. This is also the case when they are sold or leased to supplement pollination services performed by wild pollinators and are used to pollinate horticultural crops and fruit trees [31], thus helping to increase productivity, quality, profitability, and farmers' incomes [6,55]. In this case, pollination becomes a production practice [81]. Honey bees are known to visit 90% of the 107 most important crop types in the world [36]. In Europe, approximately 84% of major crops depend, to some extent, on insect pollination [82,83]. In Spain, 70% of the main crops depend on pollinating insects, with the fruit sector, followed by the horticultural and nut sectors, being those that receive the greatest benefits from this service [83]. Thus, the current importance of pollinators in agriculture is demonstrated, meaning that this type of service with pollinating animals is used assiduously in the intensive agriculture of certain horticultural plantations (bell pepper, tomato, and zucchini), both outdoors and in greenhouses, and fruit trees (apricots, plums, almonds, oranges, and mandarins). Another aspect to be taken into account and that has not been sufficiently explored to date is the contribution of bee pollination to the production of biofuels [3]. Thus, in addition to its ecological value, pollination has an economic value.

Likewise, honey bees (both adults and larvae) are projected/considered to be a future food source [84]. In Europe, in contrast to other regions (Africa, Asia, Australia, and tropical America), insect consumption is not yet generalized or widespread. However, due to their properties and other benefits related to environmental aspects, such as (a) having lower water consumption and greenhouse gas production than in the case of conventional livestock; (b) producing greater amounts of insects per kilogram of feed; (c) feeding on biological waste, which otherwise would not be reusable; and (d) being complementary to traditional animal feed sources [85], as of 2018, Regulation (EU) 2015/2283 of the European Parliament and of the Council of 25 November 2015 on novel foods, in which insects are included as "novel food", has entered into force in all Member States. Once the obstacle of eating habits, which is one of the major drawbacks for the Western consumer [86], is gradually overcome, insect rearing and collection can generate jobs and extra monetary income, whether it is conducted on a small scale, turning the rearing and sale of edible insects into a small business, or on an industrial scale [87]. In this context, as the honey bee is the third most domesticated species on Earth [88], reared in large-scale "mini-farming"

farms/systems worldwide [89], it has a long history compared to other insect farming candidates [5], so much so that it has been systematically explored as a source of human food [90] and has been found to constitute an excellent source of nutrition due to its higher protein and lower fat contents compared to other conventional food sources [91–93]. According to Defoliart [89], honey bees can be equated to dairy animals, which are valued not only for their milk, but also for their meat, and because of their properties could become an interesting high-priced gourmet delicacy.

Concerns about health and the environment, along with animal welfare and ethical considerations regarding animal consumption, have led to a rise in vegetarian lifestyles, primarily in high-income countries [94]. In response to this emerging trend, the food industry has developed new products and ingredients using different plant proteins, biotechnological innovations, and new animal sources, including insects [95]. This, together with the high dependence of intensive animal (ruminant) production on soybean meal and the environmental impact generated by this crop, encourages the search for alternative protein-rich foods, among which the use of insects seems promising [96].

In addition to the use of honey bees for human and/or animal consumption, in some regions, such as Africa or India, beehives are used to create natural fences to protect crops from wildlife [5]. This need for protection is due to the conflict arising from the coexistence between humans and wild animals (usually elephants). Recent studies have shown that the use of beehive enclosures is a method that can help mitigate the presence of wild animals and the damage they cause to crops [97,98]. This damage is mainly reflected in direct economic losses [99]. According to King et al. [100], the greatest deterrence occurs when hive occupancy rates are high versus low. The placement of these fences does not involve an excessive cost for the farmer [97], so it is understood that their cost is compensated by the reduction in the economic damage potentially generated by wild animals.

Another use attributed to insects and honey bees as products themselves is as a source of resources for pharmacological and biochemical research, mainly due to their possession of chemical compounds resulting from their co-evolution with plants, prey, and predators [101].

3.2.3. Ancillary Services Created around Beekeeping

In addition, beekeeping promotes the dedication of other industries to the provision of auxiliary services for beekeeping [42], such as the manufacture and repair of beehives, the commercialization of products, tools, and instruments for the maintenance of beehives and apiaries, phytosanitary products, biocides, the production of suits and protections for beekeepers, training activities, pest control services, and veterinary services, as well as generating opportunities for self-employment and wealth at the regional level [25].

3.3. Sociocultural Uses

Honey bees and beekeeping can also be linked to cultural services [13]. Beekeeping activity generates other non-material (intangible) uses that are reflected in terms of well-being and satisfaction and in the uses that beekeeping offers to societies [5,24]. Allen-Wardell [34] referred to this activity as a hobby that captivates and engages, generating enjoyment, satisfaction, and personal reward to those who practice it [16,102]. In this sense, “To exploit beehives for pleasure or to live from them is an exciting and varied occupation since it follows the transformation of the colonies together with the evolution of the seasons. It gives to those who dedicate themselves to it the joys of both manual and reflective work” [102] (p. 49). This means that urban beekeeping is booming and is becoming an increasingly widespread activity in different parts of the world (Paris, London, Berlin, New York, and Hong Kong, among others) [103]. Other reasons that may have favored its practice are the decline in the global bee population, the increasing neo-rural trend, and the consideration and idealization of rural values. Additionally, urban beekeeping can also be favored by the self-sufficiency movement and people’s planting of their own crops in

cities, which contributes to the proliferation of green terraces, the slow food movement, and gastronomy, using ingredients from people's own personal vegetable gardens.

One of the advantages that can be attributed to urban beekeeping is the improvement in the pollination of wild and cultivated plants in urban areas [104], due to the fact that urban beekeeping helps with the maintenance of honey bees in cities, which is an environment in which pesticides are not used and where there is a high potential for social awareness [4].

Despite the boom in urban beekeeping in some countries, it is not without its difficulties in terms of regulations, safety, and animal control/management. One of the major obstacles to its establishment in Spain is that the regulations make it difficult to install beehives in urban areas due to the minimum distances required. Other limitations, according to Coffman [105], are the fear that bees generate among the population because they are considered dangerous, as well as the long-term commitment required for the establishment of the activity by companies and organizations that will accept the establishment of hives on their properties because it is "an agricultural project" and not the care of "pet bees". Another potential drawback of urban beekeeping is the possible consequences of the exposure of bees to the heavy metals generated by road traffic [4]. According to Casanelles-Abella and Moretti [22], administrations should intervene to ensure adequate regulation. This idea was reinforced by Egerer and Kowarik [106], who called for transdisciplinary engagement among scientific research, urban policies, and citizens.

In addition to esthetic [9], spiritual, and religious values [42,55], among the socio-cultural benefits generally attributed to beekeeping are the following: (a) the creation of associations [55]; (b) biomimetic inspiration [5,85], which consists of taking advantage of the characteristics of natural processes and organisms to trigger innovation, such as in the design of energy-efficient software; and (c) zotherapy, which is the healing of human diseases through therapies obtained or derived from animals [107], using them to both prevent and treat physical and psychological pathologies. This practice includes treatments using the effect of an animal product or the animal itself (meat, venom, and blood, among other things). In the specific case of honey bees, the use of honey bee products is called apitherapy [108].

Finally, (d) apitourism is an alternative tourism modality that comprises emerging and innovative services that can provide added value to beekeeping [5,109]. This practice consists in the establishment of "honey routes/tours" and guided visits to apiaries to show visitors the different aspects related to the universe/nature of bees (biological aspects) and beekeeping (production model) [109,110]. More specifically, it is about showing the hives and the individuals that make them up (workers, drones, and queens), how they carry out their activities freely in their natural environment, the plants and their importance within the ecosystem and as a source of food for the bees, the processing of products and by-products, and the equipment and personalized protection materials, among other things. It may also include the possibility of courses and workshops related to the extraction and processing of products and their tasting, manufacture of other products (creams and candles), therapeutic uses, queen production, plant identification, and planting activities of important plants for bees and ecosystems [110].

Apitourism is a way of promoting local or proximity tourism and can contribute to increasing the economic livelihood of beekeepers and the knowledge of the population in general, and of students and scientists in particular, helping to increase environmental education, knowledge of the rural environment, and the relationship between beekeeping and agriculture, livestock, and human food [5].

Other sociocultural utilities related to beekeeping that López i Gelats et al. [4] regarded as social innovations include (a) honey bee highways for coping with habitat fragmentation, the purpose of which is to offer safe passage for insects crossing cities—for example, by offering them food and shelter points along the way; (b) artificial insemination, in order to create bees that are more resistant to the environment; (c) participatory science, which consists of involving citizens in the collection of certain information; (d) beekeeping

coworking, where people who want to get involved in beekeeping activities share tools, materials, apiaries, or information, which helps to increase communication and synergies among the people participating in said coworking; (e) beehive sponsorship, generally linked to corporate social responsibility, for which one of the main objectives of beehive sponsorship is to involve society in the conservation of bees and the environment; and (f) pollination as a common good and a universal right, which consists of valuing the environmental services/externalities generated by honey bees and beekeeping. These serve to increase the viability of beekeeping farms.

4. Interrelationships between Beehive Utilities

Taking into account the above, the different profits generated by beekeeping are summarized in the following graph (Figure 3).

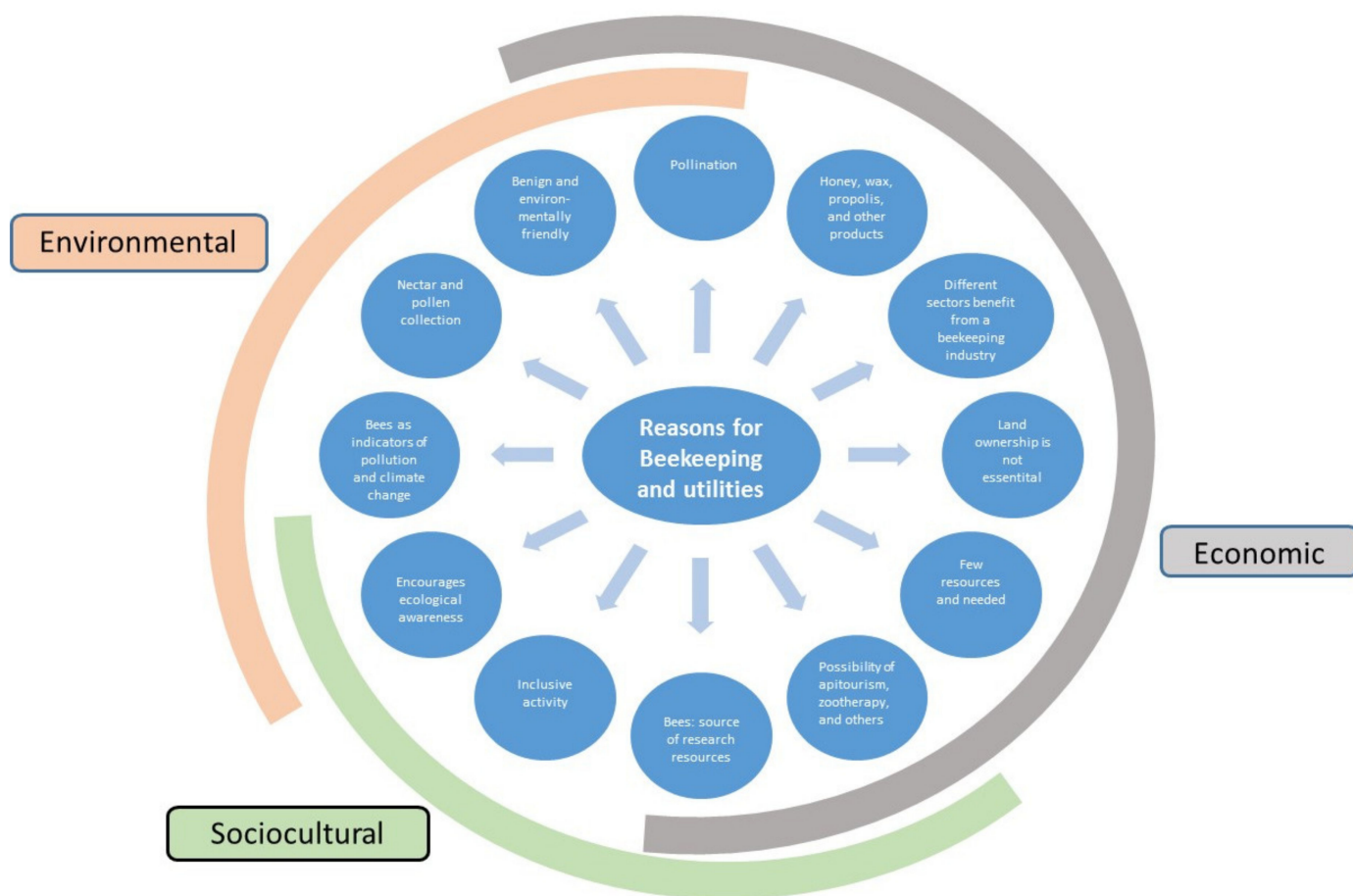


Figure 3. Reasons for beekeeping and utilities. Source: Own elaboration based on Bradbear [29].

The set of goods and services described can be considered to be products of the hive that generate a series of environmental, economic, and sociocultural utilities. These utilities do not remain static over time, since, due to new research, technologies, or cultural changes, they can give rise to other new uses; nor should they be conceived in an isolated and individualized manner, since, due to the complex system in which human beings develop, a series of interrelationships are produced among them that makes it difficult to separate them and to conceive of them as watertight compartments. This complex system generates environmental, economic, and sociocultural interrelationships, with economic utility being the one that encompasses the others. Thus, for example, the pollination service (which in this work we defined a priori as environmental) can be understood from a perspective of triple interrelated aspects: environmental (due to its contribution to biodiversity and habitat

conservation), sociocultural (since it influences the welfare of people), and economic (since it directly influences the quantity and quality of crops). With the emergence of agroecology and the search for sustainable solutions to environmental degradation, pollination has been re-evaluated as an ecosystem service with food, economic, and social importance [7,111].

On the contrary, sociocultural services are also linked to economic and ecological services. For example, in the case of beekeeping tourism, although it is conceived mainly as a sociocultural utility, it can also be considered from an economic perspective, in the sense that, being an opportunity for leisure and enjoyment, and/or a source of learning, it begins to generate income, which benefits beekeepers (through the sale of beekeeping products/services) and other groups (such as organizations organizing events and courses, hotels and rural houses, tourist guides, and others). Likewise, beekeeping tourism can also be considered from an environmental point of view, given that greater knowledge, awareness, and acquisition of values by individuals can contribute to promoting actions that help to value the importance of honey bees in ecosystems—for example, through the sponsorship of beehives. Along the same lines, the utility generated by honey bees as bioindicators is considered, by some authors, to be a sociocultural service [4].

Based on the idea that “what is not valued and not measured does not exist,” we can affirm that of the three interrelated dimensions, the economic dimension should encompass the other two dimensions. Depending on the value (economic dimension) that humans place on the benefits provided by honey bees and beekeeping, measures that benefit pollinators and, in a collateral sense, humans will be adopted and promoted. Both the environmental and the sociocultural dimensions, represented by goods and services that are more difficult to measure and value, can be extremely important, since if they did not exist, substitute resources would have to be found, which would probably entail high costs.

These systemic interrelationships are summarized in Figure 4.

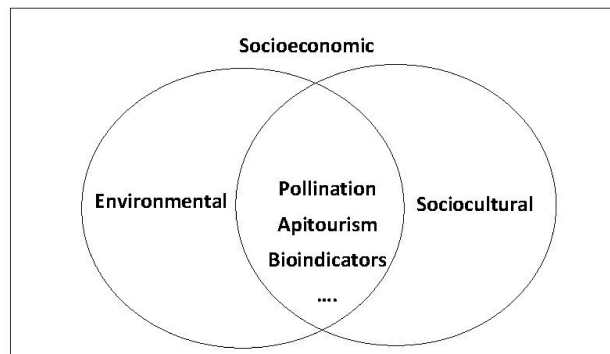


Figure 4. Interrelationships among the ecosystem benefits generated by beekeeping. Source: Own elaboration.

5. Conclusions

The aim of this article was to review the utilities generated by honey bees and beekeeping activity, and one of the main contributions of this article is the identification of the fact that there is an interrelationship between them. This article makes the following contributions: First, in line with Aryal et al. [5] and Papa et al. [13], the concept of ecosystem services is widely understood as the services and benefits that ecosystems provide to humans, and we found that honey bees and beekeeping generate a series of utilities that can be grouped into three main interrelated groups or dimensions: environmental, socioeconomic, and sociocultural. The importance of these three interrelated groups is due both to the environmental and sociocultural services generated and to the quantity and quality of the goods.

Second, in our opinion, the socioeconomic dimension should encompass the environmental and sociocultural dimensions because there is a necessity of value for all of the utilities generated by honey bees and beekeeping. Economic valuation can persuade

producers, consumers, and decision-makers to adopt measures to protect pollinators, in line with Sabbahi [112]. However, we want to underline that this economic valuation should not be understood as an undervaluation of the environmental dimension.

The third contribution is the proposition that beekeepers contribute to the generation of public goods in the form of ecosystem services, along with other environmental services demanded by societies. Pollination, which is an environmental utility that has largely gone unnoticed [19] and which has been taken for granted due to its being free of charge [13], is considered to be, to the best of our knowledge, the most important service, due to the positive externalities generated, such as its impact on biodiversity and water balance or on crops, since through food it also produces benefits with respect to nutrition and health, which is in line with the findings of Prado et al. [113] and Aryal et al. [5].

Therefore, policymakers should be redirected toward investment in public goods that have the potential to achieve sustainable growth (technologies, good practices, and good systems productions), which is in line with the report of the OECD [114].

The fourth contribution is the generation of new opportunities for diversification, and the development of new products (goods and services) different from traditional ones such as honey, wax, and royal jelly will generate new opportunities for innovation, which is related to economic profits. In this sense, Montenegro and Ortega [61] emphasized the use of these products for cosmetics and medicine. On the contrary, authors such as Neto and Ramos-Elorduy [115] and Patel et al. [116] have already intuited that honey bees themselves can be used as products, since the consumption of insects in general, and of honey bees more specifically, as an alternative food has been proposed. Obviously, the economic impact generated by beekeeping activity will be dependent on the economic structure of each region, since the use of natural resources depends on their environmental, socioeconomic, and sociocultural context.

The fifth contribution is the observation that, among the sociocultural activities, there is a tendency to use honey bees as an idle alternative and to bring the beekeeping world closer to society. This trend is demonstrated by the emergence of urban beekeepers, who seek more sustainable and responsible production and consumption models, as well as the use of beekeeping as zotherapy, apitourism, and hive sponsorship, among other things [4,61]. We understand the aim of this to be to make society aware of the importance of honey bees and to make beekeeping more economically viable.

Practical Implications

Two main practical implications can be deduced from this article. The first is that the lack of a market for many environmental and social services and the inability to pay beekeepers for the services generated creates the need to internalize externalities, since they are a clear case of market failure. This can be achieved by either implementing mechanisms (aids, subsidies, grants, etc.), demanding payments for environmental services (ecotaxes), or affecting the value and price of certain products (honey, propolis, royal jelly, etc.) through administration, which could serve as a stimulus, encouraging beekeepers to continue producing and promoting the generation of externalities.

The second practical implication is that public administrations should encourage cooperation between beekeepers, farmers, ranchers, and foresters in order to obtain mutual benefits, such as through the strategic placement of beehives as a preventive measure to mitigate damage to young crops and plantations caused by wildlife. In this way, beekeepers will have greater access to food sources for their hives when they are used as natural enclosures. All this should be kept in mind without forgetting the policies of externalities (positive and negative), compensating for the positive ones and penalizing the negative ones.

6. Limitations and Future Directions

Like all research, this study is not free of limitations. The analysis carried out was conducted from an ideal theoretical–conceptual point of view, without considering the

diverse and varied factors that condition beekeeping activity. According to Gibbs and Muirhead [23] and Kumari [56], a series of requirements must be met for beekeeping farms to be viable.

We are aware of the existence of hive depopulation collapse syndrome, which is related to multiple causalities, such as exposure to agrochemicals, habitat fragmentation, predators, or bacterial, viral, and parasitic agents, which can negatively influence the profits generated by honey bees under optimal conditions. Therefore, given the importance of these factors, we encourage future research.

Given the importance for decision making and the subsequent application of measures by administrations, the above factors require as much information as possible. In this sense, when evaluating a living being, it is important to note that the benefits generated by its existence and by its relationship with human beings are more complex than those encountered when valuing only inert assets [12]; thus, we consider it necessary to make this effort for its complete valuation.

Additionally, the COVID-19 pandemic has generated positive outcomes for honey bees and beekeeping, such as improved air quality, the reduction of insect deaths due to the impact of vehicles, and an increased demand for honey. This is important for the food chain and human health due to the immune-enhancing effect of honey bee products [117]. However, the COVID-19 pandemic has also negatively affected beekeeping, reducing apiary management due to travel restrictions [14]. A future line of research would be to study whether the positive effects outweigh the negative ones with respect to beekeeping.

Finally, beekeeping is being affected by the current conflict in Ukraine, which is the main supplier of honey to the EU [118], thus increasing the costs as a result of the increase in inputs, mainly fuel and energy. Thus, it is expected that the current conflict in Ukraine will have a significant impact on beekeeping. Therefore, another line of future research could examine this issue.

Final Conclusions

As demonstrated in this article, the complex system of environmental, socioeconomic, and sociocultural utilities must be considered in an interrelated manner unlike the manner in which it has been considered so far. It has been concluded that there is a reciprocal link between honey bees (environmental), agriculture (socioeconomic), and human beings (sociocultural), since the work of beekeepers influences public heritage through the benefits derived from their work.

Beekeeping is an economic activity, mostly private, which, together with traditional goods and services, generates public goods and, consequently, mainly positive externalities. These public goods are beneficial for the environment (less erosion and biological diversity, among other things) and affect other economic activities (e.g., agriculture) and society (landscape, health, and leisure, among others), but since there are no markets in which to buy and sell them, the externalities generated are not always converted into income and do not impact the producer. Therefore, public administrations should (1) have access to updated information on the set of utilities to which beekeeping activity contributes, due to the fact that new utilities will emerge over time, and driven by new research, technologies, and/or cultural changes, and (2) increase their efforts to make the new utilities known and to measure and value them, with the aim of developing and implementing policies and mechanisms that promote the maintenance of beekeeper activity, thus guaranteeing the generation of positive externalities.

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