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Research article

Challenges and opportunities of sustainability, certifications and traceability in the Italian beekeeping sector

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Abstract: The impact of beekeeping on agricultural activity is significant in environmental and economic terms, supporting biodiversity through pollination and contributing to rural livelihoods. However, in recent years, this activity has been increasingly threatened by climate change, competition from imported products, and widespread honey fraud, which undermine the sector's sustainability and profitability. This study explores the perceptions of Italian beekeepers and their associations with sustainability, certification, and traceability in the sector. The aim was to identify the challenges and the opportunities for the Italian beekeeping sector in sustainability, traceability, and certification. To this end, two types of analysis were applied to combine the results of the focus groups with three association/consortia and a survey of 360 beekeepers. Through this combination, the research highlights the challenges facing the sector, particularly those related to climate change and biodiversity loss. Associations emphasized the critical role of technical support and legislative measures in promoting sustainable practices, including improved regulation of hive products imports and combating honey fraud. Beekeepers showed strong awareness of their environmental and social role, particularly in pollination and biodiversity conservation, but less engagement with broader systemic issues such as certified production and climate change mitigation. Amateur beekeepers showed greater sensitivity to sustainability issues than professionals. The findings highlight the importance of collaboration between associations, policy makers and stakeholders to address immediate operational needs and promote long-term sustainability in the beekeeping sector.

Keywords: focus group; SWOT analysis; beekeepers; TOWS; local economy; Italian market; associations

Abbreviations

BDN, Data Bank of the Livestock Register; SWOT, strengths, weaknesses, opportunities, and threats; TOWS, threats, opportunities, weaknesses, strengths; CONAPI, Consorzio Nazionale Apicoltori (National Beekeepers' Consortium); A.R.A.S, Associazione Regionale Apicoltori Siciliani (Sicilian Regional Beekeepers' Association); SO, strengths–opportunities strategy; ST, strengths–threats strategy; WO, weaknesses–opportunities strategy; WT, weaknesses–threats strategy; ISO, International Organization for Standardization; PDO, Protected Denomination of Origin; PGI: Protected Geographical Indication; TSG, Traditional Specialty Guaranteed; MA, main activity; SA, secondary activity; AA, amateur activity

1. Introduction

Beekeeping represents a significant sector that extends beyond honey production to encompass environmental, economic, and sustainability issues. In an increasingly globalized world, where product traceability and food quality play a central role, beekeeping stands at the crossroads of numerous challenges and opportunities. Honey production and trade, in fact, are influenced by international dynamics, highlighting the need to strengthen product control and authenticity processes, as well as to ensure the sustainable management of natural resources.

World honey production stands at around 1.8 million tonnes, up for the third consecutive year (+5.6% compared with 2021). Europe contributes 23% of world production.

In Italy, despite the crucial challenges of the sector, in 2023, more than 75,000 beekeepers were registered in the National Data Bank of the Livestock Register (BDN). However, in 2023, the market closed in a negative situation, with decreased demand, increased prices, and numerous stocks remaining in beekeepers' warehouses. This is coupled with increasingly fierce competition with the foreign market, especially with other honeys whose price is lower. Adulteration and fraud in the market threaten the economy of Italian honey [1].

Bees provide a crucial ecosystem service, playing an essential role in the pollination of a wide range of crops and wild plants [2]. However, their survival is increasingly threatened by pollution and the use of chemical substances in agricultural fields, which compromise their health and ability to perform this role. Beekeepers are working to safeguard bees by adopting more sustainable practices that protect them and ensure optimal conditions for honey production [3]. Furthermore, honey production offers a source of economic sustainability for many local communities, particularly in rural areas, where beekeeping contributes to both biodiversity and the local economy [4]. Pesticides, particularly neonicotinoids, and environmental pollution, along with climate change, have negative impacts on bee populations and other pollinators. In addition to the risk of extinction for certain species, the decline in bee populations, which also affect the presence of new fauna, has serious implications for global food security, as many crops rely on pollination [5]. Bees play a crucial role as bioindicators of biodiversity conservation, helping in habitat restoration and providing vital ecosystem services. Their presence and health can indicate environmental quality, as they are sensitive to changes such as

pollution and the availability of floral resources [6]. Some published studies advocate for the adoption of agroecological approaches to mitigate these threats [7], such as implementing regenerative agricultural practices and creating habitats for wild pollinators within agricultural landscapes [8].

Various associations and consortia support the honey supply chain. Collaboration among businesses offers multiple advantages in the marketplace. These nonprofit organizations often not only provide technical support to their members but also help reduce perceived market risks, protect the rights of small businesses such as beekeepers, and tackle the challenges posed by new technologies through collaborative efforts [9]. The development of a community makes everyone feels like an active part can help the business itself through the exchange of opinions, advice, and knowledge [10].

With growing interest in the honey market, and faced with the challenges by climate change and an increasingly competitive environment, industry stakeholders are seeking practical, concrete solutions to address the challenges and opportunities that the sector and these changes present.

Different study have investigated consumers' behavior [11–13], others have explored beekeepers' marketing and communication [14,15], and others the economic market situation [16–18].

No studies to date have explored the strategic aspects of the honey market with a focus on the current challenges and opportunities in Italy. This research provides an overview of the sector's strengths, weaknesses, opportunities, and threats through a strengths, weaknesses, opportunities, and threats (SWOT) analysis, followed by a threats, opportunities, weaknesses, strengths (TOWS) analysis to explore potential strategies. Additionally, a questionnaire, submitted through an online survey to beekeepers, offers an insight into actual challenges in the beehive production chain. The objective is not limited to an overview of the sector, aiming to propose practical solutions and actions to positively contribute to knowledge growth. To this end, four research questions were formulated:

RQ1: What approaches are associations and consortia within the beekeeping sector adopting in relation to traceability, sustainability, and certification?

RQ2: What role do associations play, and which strategies can they implement to advance the sector in terms of sustainability, traceability, and certification?

RQ3: What is, according to beekeepers, their role in social and environmental issues?

RQ4: What are the current challenges in beekeeping activity and which support tools would be effective to deal with them?

2. Materials and methods

2.1. Design of focus groups

The focus group methodology was selected to investigate opinions, ideas, and perceptions of sustainability in the honey supply chain, with a focus on the roles of certification and traceability. This qualitative method is based on group dynamics, where the participants interact with each other under the guidance of a moderator who conducts the sessions [19]. The choice of this methodology was driven by its advantages: the ability to stimulate discussion on topics that require collective opinions and to encourage active interaction among participants [20,21]. During the interview, exploratory questions are posed to clarify and understand the phenomena related to the issue under analysis. The topic's arguments are presented in Table 1.

Table 1. Questions and topics used for beekeepers' focus groups.

Topics	Questions
General topics	What are the main problems in the honey supply chain (e.g., in relation to including technology, support from public institutions, and other productive activities)?
Biodiversity topics	What is your awareness of environmental issues and what is the link between biodiversity and climate change (e.g., impact on pollinators in nature, effects of temperature and seasonal changes, reduction in pollen quality)?
Sustainability topics	What are the sustainability issues of beekeeping?
Future challenges	Compared with the current situation, in which direction is the beekeeping sector heading?
	What do you see as the main opportunities/challenges for the sector in the coming years?

2.2. Data collection

To achieve the aims of this study, three focus groups were designed as previously described, but considering three different geographical areas: the national level, the northwest of Italy (Piedmont), and the south of Italy (Sicily). The choice of two geographical regions (Piedmont and Sicily) was dictated by the fact that they are the most important regions in terms of bee consistency and production in northern and southern Italy (Figure 1). Two associations and one consortium of beekeepers were selected through a rolling sample method. The three experiments were conducted at three different times. The focus group with the consortium CONAPI (Consorzio Nazionale Apicoltori (National Beekeepers' Consortium)) was carried out on September 26, 2023. For the second focus group, the Association of Honey Producers of Piedmont (ASPROMIELE) was involved. The experiment took place at the association's headquarters on April 11, 2024. Finally, the third focus group was conducted via an online video call with the Sicilian Regional Beekeepers' Association (ARAS) on May 13, 2024.

Prior to holding the sessions, all interviewees gave their consent to have the sessions recorded. They were also assured that their responses would be kept confidential and fully anonymized to ensure they could not be traced back to them.

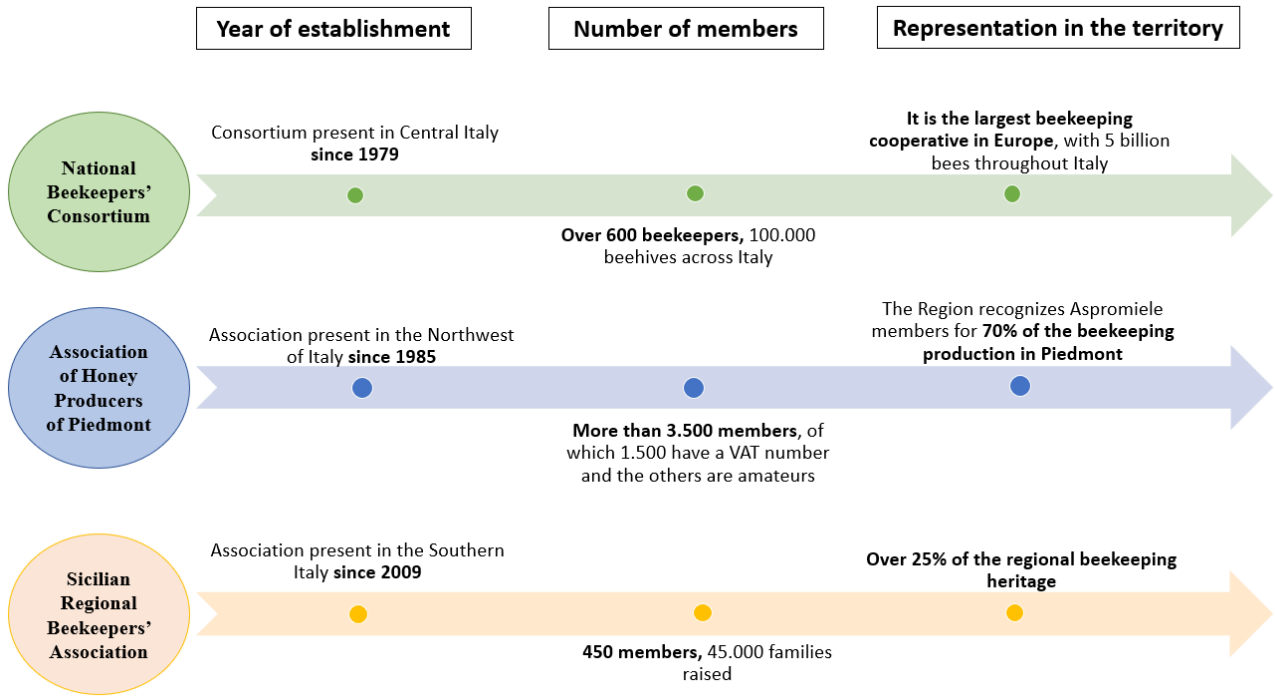

Figure 1. Information about the characteristics of the associations/consortium.

2.3. Data analysis—SWOT and TOWS analysis

Using SWOT analysis, which has already been used in similar research [22–24], it is possible to support and organize the decision-making process while analyzing the resource's internal strengths and weaknesses and the opportunities and threats from the external environment [25]. With this method, differences and similar approaches among the sample were highlighted. Following the creation of the SWOT matrix, the TOWS matrix was developed to offer alternative strategies, especially on the external environment, based on the relationships among the threats, opportunities, weaknesses, and strengths identified in the SWOT analysis [23]. Additionally, TOWS analysis can be used to maximize strengths and opportunities and, in the meantime, minimize weaknesses and threats, looking to identify practical actions that support it, as developed for other food supply chain [23,26]. In this way, it is possible to identify alternative strategies for development of the honey supply chain and overcome weaknesses and threats. In detail, the TOWS matrix identified four groups of strategies following the framework introduced by [27]:

- Strengths–opportunities (SO) strategy: Leverage internal strengths to exploit opportunities arising from the external environment;
- Strengths–threats (ST) strategy: Exploit internal strengths to mitigate or defeat external threats, with the aim of protecting against external risks by focusing on key strengths;
- Weaknesses–opportunities (WO) strategy: Minimize internal weaknesses by maximizing opportunities, with the aim of reducing vulnerability and improving performance by exploiting these opportunities;
- Weaknesses–threats (WT) strategy: Minimize both internal weaknesses and external threats.

2.4. Design of the survey

An online questionnaire was designed to directly involve beekeepers in defining the problems and opportunities related to their profession and business. The study was conducted using an online questionnaire based on the Lime Survey web app. Data collection was carried out in Italy in April–May 2024, thanks to the beekeepers, recruited through social networks, newsletters, and word of mouth, voluntarily participating in the survey. In order to achieve the research aims, the questionnaire topics related to sustainability and traceability were organized into seven different categories (Table 2).

Table 2. Questions and topics proposed in the online survey of beekeepers.

Topic	Questions	Options
Q1) Social and environmental role of beekeeping	In which of the following issues does beekeeping play a role?	• Environmental protection • Pollination and agricultural production • Production of healthy food • Productive activities in marginal areas • Safeguarding biodiversity (animals and plants) • Safeguarding natural resources • Mitigation of the impact of climate change • Promotion of the local economy • Environmental education • Development of equal employment opportunities • Protection of local production • Rational use of pesticides • Certified food production
Q2) Issues and threats	How do you evaluate the impact of these potential negative issues on your activity?	• Use of pesticides • Climate change • Unpredictability of production • Loss of biodiversity • Pollution • Competition with imported products • Lack of knowledge of the sector by consumers and stakeholders
Q3) Support strategies	How effective are these support strategies from your point of view?	• Development of legislation to control imports • Development of agricultural practices that support the environment (e.g., agroecology) • Development of a regulation to protect quality • Education and information programs for consumers, institutions, and farmers • Environmental monitoring • Financial support for beekeepers (grants, financing) • Development of technologies to monitor hives

Continued on the next page

Topic	Questions	Options
Q4) Communication tools	How important do you evaluate the relevance of these communication strategies to be?	• Description of the product's properties • Description of the territory • Description of the production process • Description of the use of the product • Description of the company's history • Description of supply chain relationships • Description of the reference community • Description of the degree of innovation of the product and/or process
Q5) Packaging	How important is this label information for consumer choice?	• Name of the company • Logos and symbols • Sustainable packaging • Price • Tradition • Environmental sustainability certification • Social sustainability certification • Product innovation • Quality certification (e.g., ISO) • Presence of a QR code
Q6) Sustainability topics	How important do you evaluate these sustainability issues to be for beekeeping?	• Carbon footprint reduction • Waste management • Responsible use of pesticides • Care of bees and their habitat • Agriculture preserving soil and water • Preserving biodiversity and habitats • Ensuring decent working conditions • Involving local communities
Q7) Traceability issues	How important do you evaluate these issues to be for certification and traceability of bee products?	• Transparent information about the production process • Indication of local/regional origin • Adherence to environmental certification standards • Adherence to ethical certification standards • Product origin and quality certification (PDO, Protected Denomination of Origin; PGI: Protected Geographical Indication; TSG, Traditional Specialty Guaranteed) • Organic Production Certification (Organic Farming) • ISO Quality Certification: ISO 9001 ISO 14000

The question addressing the social and environmental role of beekeeping (Q1) was designed as a binary (yes/no) response and was analyzed statistically through correspondence analysis (CA). For the subsequent questions, a 5-point Likert scale was employed to assess the perceived impact (Q2), efficacy (Q3), and importance (Q4–7) of each proposed option. One-way and two-way analyses of

variance (ANOVAs) were performed on the questionnaire response data, and Tukey's post hoc test was used to test the differences between different issues and topics. Differences were considered significant at $p < 0.05$. Building on prior research suggesting that beekeepers can be segmented according to the size of the apiary [28], participants were asked to indicate if beekeeping corresponded to their main professional activity (MA), to a sideline working activity (SA), or just to an amateur activity (AA). The respondents were segmented according to these three beekeeping outlines. All data analysis was performed by using the R programming language, ver.4.3.1[29] and SensoMineR: Sensory Data Analysis for R package version 1.2.

3. Results

3.1. SWOT analysis

In the SWOT analysis, the parameters considered in this study were categorized into two general categories: internal and external factors [25,30]. The identified strengths (internal factors) represent the advantages of the honey supply chain, as revealed in the discussion with beekeepers, over which they have direct control. Conversely, the internal weaknesses represent obstacles that beekeepers face in enhancing their production. Among the external factors, the opportunities identified in this study represent the potential benefits of the Italian beekeeping sector, while the threats include issues that could limit the development and improvement of the supply chain, creating issues for beekeepers.

In our SWOT analysis framework, the common and the different elements of each association/consortium are represented for all internal and external factors (Figure 2).

3.1.1. Internal factors

Strengths

The three contexts (Figure1) analyzed in this study are active in providing technical support to beekeepers to facilitate their activities through measures such as guidelines, training courses, and technical assistance. They are also involved in collaboration with schools and universities to increase knowledge and awareness of the bees' world. Regarding current issues in the world of apiculture, members of the associations/consortium are insured against declines in the production of their hives and are inclined towards the development of research into biomonitoring and the adoption of sustainable policies.

The strengths of the association based in Northwest Italy are also based on efficient communication through different channels and interactions with institutions and regional bodies. In addition, this association demonstrates a high level of cooperation among its members. For the national consortium, an additional strength is the increased awareness of animal welfare. Finally, for the association in the south of Italy, the additional benefits are communication and information activities aimed at consumers and students through interactive activities.

Weaknesses

The main weaknesses common to all three cases are the decline in hive production and the increase in bee diseases and mortality. Furthermore, imported honey is subject to weak controls, and counterfeiting is difficult to fight. In addition to these problems, the association in northwest Italy faces

rising costs associated with the need for nomadism and emergency feeding to ensure proper nutrition for the bees. The association in the south of Italy struggles with access to credit, while the national consortium faces challenges in developing new technologies.

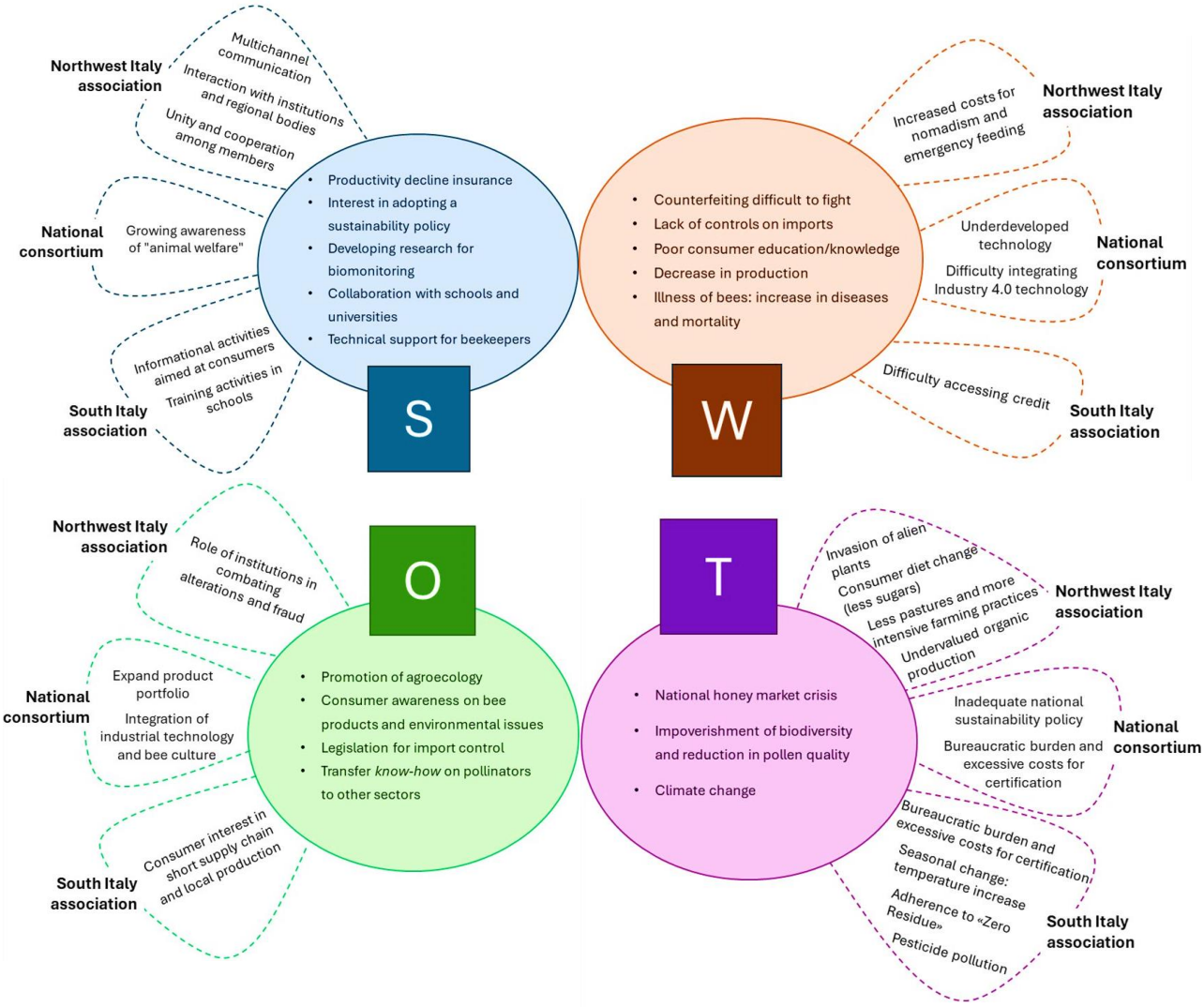

Figure 2. Framework of the SWOT analysis with the common and the different elements across the three contexts considered. S, strengths; W, weaknesses; O, opportunities; T, threats.

3.1.2. External factors

Opportunities

Opportunities for this sector include increasing consumer awareness of growing environmental issues and the crucial role of bees in the ecosystem. There is also a growing interest in promoting agroecology and developing regulations to control imports of beekeeping products. Another common opportunity between the three contexts is the commitment to transfer knowledge about pollinators and their contribution to other food sectors.

Considering the different opportunities among the associations/consortium, the entity based in northwest Italy believes that institutions could play an important and active role in fighting adulteration

and fraud. The national consortium sees the expansion of its product portfolio as an opportunity to increase market competitiveness and profitability, while the integration of traditional techniques with technological innovation is seen as an opportunity to optimize production and improve bee health. Conversely, the southern Italian association is looking to consumer interest in short supply chains and local products.

Threats

Recent environmental challenges represent a significant threat for all three sectors of the beekeeping sector. Among these, climate change carries numerous risks to bee health, including extreme temperatures, increased adverse weather events, and the spread of pests and diseases. In addition, these environmental changes are contributing to a loss of biodiversity and a reduction in the quantity and quality of pollen available to bees.

The association in northwest Italy identified further threats related to the invasion of alien plant species, which are also linked to climate change, and the decline of native plants due to decreased pastures and intensified agricultural practices. Furthermore, in Italy, organic production is undervalued, and consumers are increasingly shifting towards low-sugar diets. The national consortium highlighted the risk of inadequate national policies to promote sustainability and the excessive costs and bureaucracy involved in certifying products. This challenge of access to certification is also faced by the southern Italy association, which has to deal with additional threats due to rising temperatures, such as the spread of the *Vespa orientalis*, and increased pesticide pollution.

3.2. TOWS analysis

The results of the TOWS analysis led to the identification of four key strategies, each highlighting future potential for the beekeeping sector. This analysis not only identified the strengths and weaknesses within the sector but also opportunities for development and threats that need to be managed. These strategies provided a comprehensive roadmap for increasing sustainability and resilience in the beekeeping community:

3.2.1. SO Strategy: Enhancing agricultural sector sustainability through agroecological practices

Aligning the common strengths observed within the analyzed beekeeping sector with the opportunities that emerged from the discussion, we identified a dynamic strategy aimed at promoting sustainable agricultural practices, harmonized and integrated across different agricultural systems, based on the principles of agroecology. Through these practices, promoting beekeepers' know-how in biomonitoring can serve as a tool for measuring loss of biodiversity in order to revise agronomic practices towards greater environmental sustainability.

3.2.2. ST Strategy: Innovative bee colony management strategies

This strategy aims to develop innovative colony management methods in collaboration with research centers and universities to meet the challenges associated with climate change, such as the impoverishment of biodiversity and reductions in pollen quality impacting on production and on incidence of bee diseases.

3.2.3. WO Strategy: Consumer awareness campaigns

This informational strategy could include the implementation of educational and promotion campaigns aimed at consumers, the final actors in the supply chain, to raise awareness of the health benefits of bioactive compounds in bee products and to promote the quality of local production. Such efforts would increase interest in a local and, at the same time, short supply chain, while encouraging more sustainable consumer choices that support local economies.

3.2.4. WT Strategy: Strengthening relationships with institutions

Strengthening relationships with local and national institutions is essential to develop targeted actions to support and protect the national beekeeping sector. These initiatives could include improving existing import control regulations and introducing new certification tools to ensure the quality and promote the value of Italian bee products.

3.3. *Survey outcomes*

A total of 360 beekeepers, aged between 18 and 77, filled in the questionnaire, aimed at understanding the needs of the beekeeping sector. The participants, segmented according to the features of their beekeeping activity, indicated 29% of them addressed it as their main activity (MA), managing more than 200 beehives; 37% of the interviewed beekeepers considered it a secondary activity (SA), while 34% of them were amateur activity (AA).

3.3.1. Social and environmental role of beekeeping (Q1)

The role of beekeeping most cited by respondents (81%) was pollination and agricultural production, while four more options were indicated by more than 70%: environmental protection, production of healthy food, safeguarding biodiversity, and environmental education. On the other hand, certified food production (33%) and climate change mitigation (24%) were among the less cited, with the development of equal employment opportunities in last place (19%). Relevant differences were observed among the three identified groups of beekeepers, with CA Dimension 1 (accounting for 86% of the variance) effectively distinguishing them (Figure 3). The SA group recorded intermediate results, according to CA Dimension 1, while CA Dimension 2 indicated that the interests of this group were primarily focused on local production and the related economy. For MA, the main correlations were with certification, climate change mitigation, production in marginal areas, and protection of local products. Differently, AA were closer to environmental issues and also to the less cited social issue of equal employment opportunities.

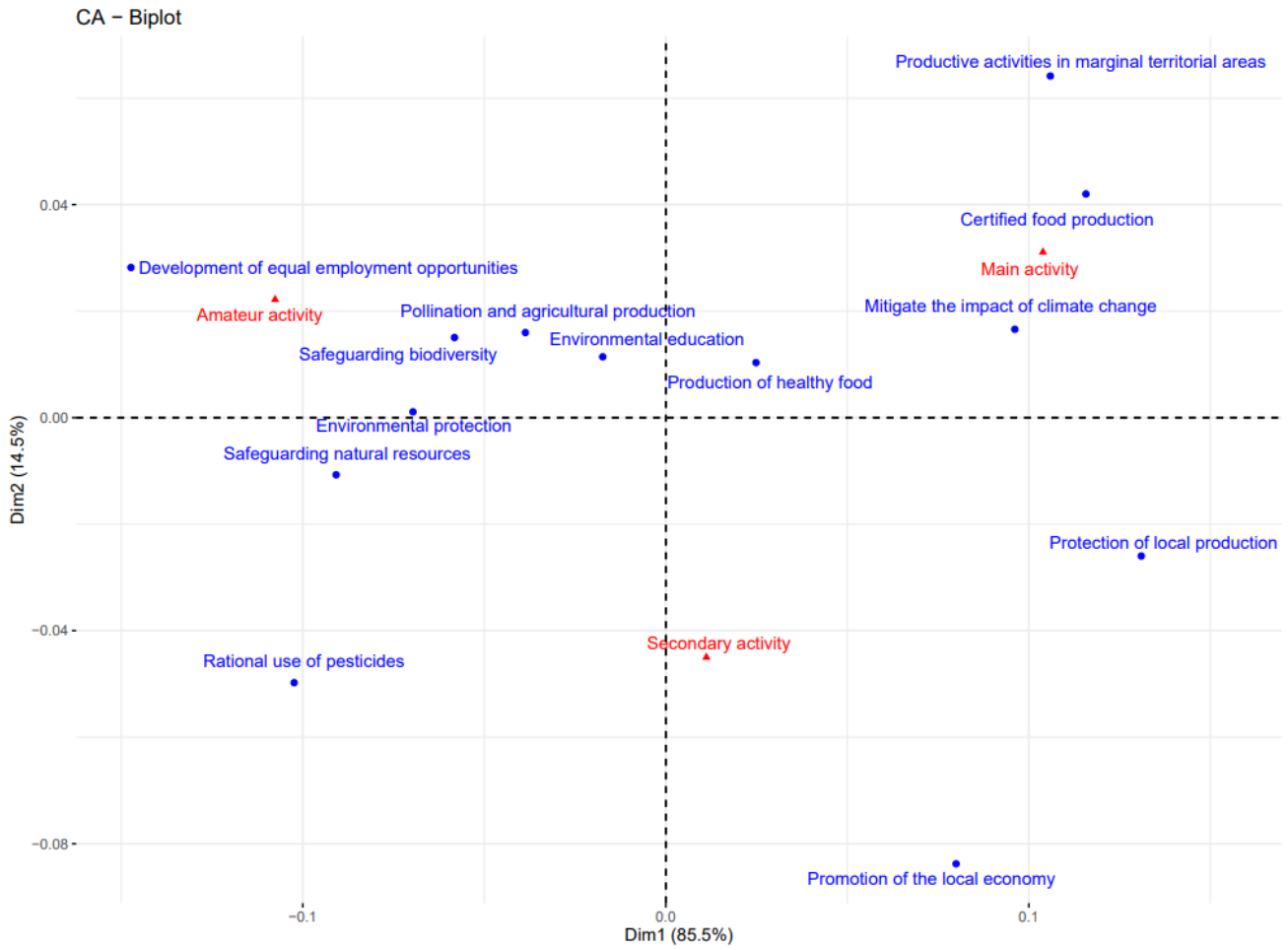

Figure 3. Correspondence analysis of beekeeping's role, as expressed by three beekeeper groups.

3.3.2. Issues and threats (Q2)

Climate change, use of pesticides, and the unpredictability of production were indicated by beekeepers as the major threats for their activity, while loss of biodiversity, pollution, and lack of knowledge of the sector by consumers and stakeholders were less feared (Table 3). The only difference among groups was recorded for pesticides, with AA indicating the highest impact for this threat.

3.3.3. Support strategies (Q3)

As the most effective strategies for supporting beekeeping, beekeepers indicated legislation to control imports, agricultural practices supporting environmental care, and regulations to protect quality. On the opposite hand, financial support and development of technologies to monitor hives recorded a lower score (Table 4). Regarding positive expectations for the application of environmental and hive monitoring technologies, AA were the most confident in these approaches.

Table 3. Beekeepers' evaluation of environmental and sustainability issues.

Issues and threats	Importance°	Beekeeper profile°°		
		Main activity	Secondary activity	Amateur activity
Climate change	4.63 ^{A}	4.57	4.73	4.69
Use of pesticides	4.62 ^{AB}	4.51 b	4.62 ab	4.73 a
Unpredictability of production	4.45 ^{ABC}	4.55	4.46	4.41
Competition from imported products	4.43 ^{BCD}	4.57	4.42	4.4
Pollution	4.34 ^{CD}	4.28	4.27	4.52
Loss of biodiversity	4.29 ^{CD}	4.27	4.29	4.43
Lack of knowledge of the sector	4.26 ^{D}	4.3	4.14	4.36
Factors	Mean Sq	F value	Pr (>F)	
Issue	7567	11.028	3.72e−12 ***	
Firm profile	3586	5.226	0.00544 **	
Issue × profile	1031	1.502	0.11590	

Statistical differences recorded in the responses were calculated by using one-way and two-way ANOVAs and Tukey's post hoc test (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). Likert scale: 1 (no impact)–5 (very high impact). °Different uppercase letters in columns correspond to different means among impacts. °°Different letters in rows correspond to different means among beekeeper profiles.

Table 4. Beekeepers' evaluation of strategies to support beekeeping.

Support strategies	Importance°	Beekeeper profile°°		
		Main activity	Secondary activity	Amateur activity
Development of legislation to control imports	4.49 ^{A}	4.51	4.56	4.40
Development of agricultural practices that support the environment (e.g., agroecology)	4.41 ^{AB}	4.36	4.40	4.45
Development of a regulation to protect quality	4.29 ^{ABC}	4.29	4.31	4.25
Education and information programs for consumers, institutions, and farmers	4.23 ^{BC}	4.15	4.18	4.34
Environmental monitoring	4.12 ^{CD}	3.92 b	4.06 ab	4.35 a
Financial support for beekeepers (grants, financing)	3.93 ^{D}	4.02	3.87	3.91
Development of technologies to monitor hives	3.43 ^{E}	3.12 b	3.43 ab	3.68 a
Factors	Mean Sq.	F value	Pr (>F)	
Issue	44.12	44.409	<2e−16***	
Firm profile	4.71	4.737	0.00885***	
Issue × profile	2.15	2.162	0.01125*	

Statistical differences recorded in the responses were calculated by using one-way and two-way ANOVAs and Tukey's post hoc test (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). Likert scale: 1 (no importance)–5 (very high importance). °Different uppercase letters in columns correspond to different means among impacts. °°Different letters in rows correspond to different means among beekeeper profiles.

3.3.4. Communication tools (Q4)

The most important aspects of communication were the description of product's properties, of the territory, and of production process, while degree of innovation and details about the community, resulted in lower importance. The only difference among groups was for the latter, with AA providing a higher score (Table 5).

Table 5. Beekeepers' evaluation of aspects of their company's communication strategy.

Communication tools	Importance°	Beekeeper profile°°		
		Main activity	Secondary activity	Amateur activity
Description of the product's properties	4.23 ^{A}	4.31	4.09	4.28
Description of the territory	4.13 ^{A}	4.17	4.18	4.03
Description of the production process	4.02 ^{AB}	4.10	3.97	4.00
Description of the use of the product (e.g., combination with other agrifood products)	3.85 ^{BC}	3.79	3.85	3.88
Description of the company's history	3.65 ^{CD}	3.80	3.65	3.53
Description of supply chain relationships	3.65 ^{CD}	3.68	3.54	3.71
Description of the reference community	3.41 ^{DE}	3.20	3.48	3.48
Description of the degree of innovation of the product and/or process	3.25 ^{E}	3.05 b	3.20 ab	3.43 a
Factors	Mean Sq.	F value	Pr (>F)	
Issue	41.34	37.79	<2e−16***	
Firm profile	1.05	0.962	0.3824	
Issue × profile	1.79	1.640	0.0617	

Statistical differences recorded in the responses were calculated by using one-way and two-way ANOVAs and Tukey's post hoc test (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). Likert scale: 1 (no importance)–5 (very high importance). °Different uppercase letters in columns correspond to different means among impacts. °°Different letters in rows correspond to different means among beekeeper profiles.

3.3.5. Packaging (Q5)

As the most important factors for the packaging of the products, beekeepers indicated the name of their company followed by logos and symbols. Use of sustainable materials and the price of the products are also important factors considered by beekeepers. On the opposite hand, quality certification and the presence of a QR code recorded lower scores (Table 6). Differences among the groups were related to sustainable packaging; the presence of environmental, social, and quality certification on their packaging; and the QR code, with AA being more favorable to these factors. Tradition and innovation in the product are important factors for the MA group too.

Table 6. Beekeepers' evaluation of factors related to the packaging of their products.

Packaging	Importance°	Beekeeper profile°°		
		Main activity	Secondary activity	Amateur activity
Name of the company	3.88 ^{A}	3.90	3.92	3.78
Logos and symbols	3.79 ^{A}	3.92	3.84	3.60
Sustainable packaging (e.g., recyclable/recycled, compostable materials)	3.76 ^{AB}	3.54 b	3.68 ab	3.99 a
Price	3.74 ^{AB}	3.66	3.74	3.80
Tradition	3.47 ^{BC}	3.51 ab	3.20 b	3.71 a
Environmental sustainability certification	3.44 ^{CD}	3.33 b	3.30 b	3.68 a
Social sustainability certification	3.16 ^{DE}	2.93 b	3.04 b	3.47 a
Product innovation	3.16 ^{DE}	3.01 ab	2.98 b	3.45 a
Quality certification (e.g. ISO)	3.01 ^{E}	2.71 b	2.90 b	3.37 a
Presence of a QR code	2.66 ^{F}	2.39 b	2.60 ab	2.97 a
Factors	Mean Sq.	F value	Pr (>F)	
Issue	54.66	37.81	<2e−16***	
Firm profile	31.64	21.89	3.57e−10***	
Issue × profile	3.61	2.50	0.000439***	

Statistical differences recorded in the responses were calculated by using one-way and two-way ANOVA and Tukey's post hoc test (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). Likert scale: 1 (no importance)–5 (very high importance). °Different uppercase letters in the importance column correspond to different means among importance scores. °°Different letters in rows correspond to different means among beekeeper profiles.

3.3.6. Sustainability topics (Q6)

Among the most important aspects of sustainability in beekeeping are the responsible use of drugs in hives and fertilizers first and foremost, followed by preserving the biodiversity of plants, insects, and the natural habitat, and by care and wellbeing of bees and their habitat. Carbon print reduction recorded a lower importance score (Table 7). The differences among the groups were related to the preservation of biodiversity and the care and wellbeing of bees and their habitat, with AA being more favorable toward these aspects. However, it is important to note that SA also demonstrated a high sensitivity to these issues, particularly waste management and carbon print reduction.

Table 7. Beekeepers' evaluation of aspects of sustainability in beekeeping.

Sustainability topics	Importance°	Beekeeper firm profile°°		
		Main activity	Secondary activity	Amateur activity
Responsible use of pesticides and fertilizers	4.84 ^{A}	4.84	4.81	4.88
Preserve the biodiversity of plants, insects, and natural habitat	4.75 ^{A}	4.72	4.73	4.80
Care and wellbeing of bees and their habitat	4.72 ^{A}	4.66 b	4.67 b	4.86 a
Responsible use of drugs in hives	4.52 ^{B}	4.37 b	4.46 b	4.72 a
Adoption of farming practices that preserve soil and water	4.42 ^{BC}	4.33	4.40	4.53
Ensure fair wages and decent working conditions	4.28 ^{CD}	4.19	4.29	4.34
Involving local communities	4.12 ^{D}	4.04	4.09	4.23
Responsible waste management	4.11 ^{D}	3.86 b	4.06 ab	4.37 a
Carbon print reduction	3.90 ^{E}	3.72 b	3.86 ab	4.09 a
Factors	Mean Sq.	F value	Pr(>F)	
Issue	36.68	53.83	<2e−16***	
Firm profile	14.22	20.87	9.9e−10***	
Issue × profile	0.69	1.018	0.434	

Statistical differences recorded in the responses were calculated by using one-way and two-way ANOVA and Tukey's post hoc test (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). Likert scale: 1 (no importance)–5 (very high importance). °Different uppercase letters in columns correspond to different means among impacts. °°Different letters in rows correspond to different means among beekeeper profiles.

3.3.7. Traceability issues (Q7)

As the most important aspects of the traceability of bee production, beekeepers indicated transparent information about the production process and an indication of the origin of the products. In contrast, ISO Quality Certification demonstrated lower sensitivity among beekeepers (Table 8). Additionally, of the differences among the groups of beekeepers, aspects related to the products' origin and quality and organic certification are considered more important for the traceability of beekeeping products, especially for the AA group.

Table 8. Beekeepers' evaluation of aspects of the traceability of bee products.

Traceability issues	Importance°	Beekeeper firm profile°°		
		Main activity	Secondary activity	Amateur activity
Transparent information about the production process	4.42 ^{A}	4.45	4.36	4.46
Indication of local/regional origin	4.28 ^{A}	4.28	4.23	4.33
Adherence to environmental certification standards	3.79 ^{B}	3.70	3.70	3.96
Adherence to ethical certification standards	3.68 ^{B}	3.66	3.55	3.83
Product origin and quality certification (DOP, IGP, STG)	3.68 ^{B}	3.46 b	3.61 ab	3.90 a
Organic Production Certification (organic farming)	3.33 ^{C}	3.07 b	3.18 b	3.66 a
ISO Quality Certification: ISO 9001 ISO 14000	3.05 ^{D}	2.80 b	2.82 b	3.40 a
Factors	Mean Sq.	F value	Pr (>F)	
Issue	80.52	61.678	< 2e-16***	
Firm profile	24.94	19.106	5.87e-09***	
Issue × profile	1.84	1.409	0.154	

Statistical differences recorded in the responses were calculated by using one-way and two-way ANOVAs and Tukey's post hoc test (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). Likert scale: 1 (no importance)–5 (very high importance). °Different uppercase letters in columns correspond to different means among impacts. °°Different letters in rows correspond to different means among beekeeper profiles.

4. Discussion

The study aimed to explore the current state of beekeeping in Italy from the point of view of beekeepers' associations/consortia, integrated by an overview of individual beekeepers' specific needs, expectations, and interest in sustainability, certification, and traceability. The findings underscore how the sustainability of beekeeping activity is particularly challenged by the increasing environmental and climatic threats [31]. Associations emphasized the significant impact of adverse climatic conditions on bee health, alongside a perceptible reduction in pollen's availability and quality. These challenges highlight an increasing risk of biodiversity loss and the spread of alien plant species. Beekeepers showed a high level of awareness of the threats due to climate change, particularly concerning the growing unpredictability of production outcomes. These results from the sample analyzed are in line with previous studies that have highlighted Italian beekeepers' concerns about the impact of climate changes on bee health and honey production [32,33].

In addition to the environmental issues, pesticide exposure emerged as a significant concern [34–36]. Previous research conducted in Belgium [37] reported a relevant concern of beekeepers as related to exposure to pesticides, either agricultural or beekeeping-related, because of the health impacts on bee colonies and humans. Similarly, our participants expressed apprehension about the inappropriate use of harmful pesticides. Associations highlighted the critical need for implementing measures to reduce pollution in beekeeping areas, as suggested by [38], to enhance the sustainability of apicultural practices.

Associations/consortia were identified as key players in guiding beekeepers towards more sustainable practices. These include not only providing technical support and educational resources, but also advocating for policies that address biodiversity conservation, climate adaptation strategies,

and the responsible use of hive treatments and fertilizers. Beekeepers, particularly those involved in amateur beekeeping, showed the highest sensitivity to sustainability concerns, focusing on biodiversity conservation and the overall wellbeing of bees and their habitat. This highlights the potential for targeted interventions and educational campaigns tailored to different beekeeper profiles.

Survey outcomes showed that beekeepers are highly aware of their key role in pollination dynamics, which are crucial for maintaining agricultural productivity, as reported in previous studies [39–41]. They also recognize the wider environmental benefits of beekeeping, such as biodiversity preservation, environmental protection, and contributions to food security [42,43]. In addition, many beekeepers see their work as playing a social role in environmental education, raising public awareness of environmental challenges. Conversely, the findings revealed a gap in their involvement in wider system issues such as certified food production, climate change mitigation, and the development of equal employment opportunities. This suggests a potential area for further engagement and capacity-building where associations could play a facilitating role.

The focus group conducted with beekeepers' associations showed the relevance of up-to-date technical support to assist apiculturists in their activity and actual decision-making, with opportunities to foster the transition toward intelligent agricultural management and digital advances [44]. Beekeepers indicated the importance of adopting agricultural practices supporting environmental care and the necessity of implementing legislation regulating the importation and quality valorization of beehive products. The same issues were cited also by associations, reporting their activity in disseminating agroecology culture and developing adequate protocols for regulating imports and combatting adulteration, mislabeling, and fraud. Honey is heavily affected by fraud [45,46], with relevant economical setbacks for honey producers, undermining honey prices and reducing the market space for authentic honey [47].

Effective communication emerged as a critical area where associations can contribute, particularly by working with schools, universities, and stakeholders to disseminate knowledge. According to beekeepers, the most relevant information for effective communication is the specific description of a product's properties, of the territory, and of the production process. These results are in line with consumer expectations and highlight the growing demand for transparency in the labelling of beekeeping products. Consumers prioritize references to the territorial and botanical origin of honey, combined with an increased focus on sustainability aspects [11,48,49].

As related to the information to be communicated through the packaging/label, beekeepers evaluate the company name, logo, and symbol as having major importance, suggesting that beekeepers focus on their company's reputation to raise customers' loyalty and strengthen their brand reputation. Association and consortia could be of help in valorizing this information through the broader concept of sustainability. Additional indications on label with relevant importance for beekeepers are the composition of packaging and product price.

Results also revealed consistent differences between amateur and professional beekeepers. Amateurs placed greater emphasis on environmental issues, probably because of the lower impact on their lives of beekeeping incomes, while their satisfaction deriving from the intrinsic values attached to beekeeping activity. This observation aligns with findings from other studies, such as [37], which identified similar patterns among amateur beekeepers in Europe.

This study illustrates a clear consensus among beekeepers and associations on the importance of addressing sustainability challenges through legislative measures, technical innovation, and improved communication strategies. Associations, by their collective influence, can guide beekeepers and the

wider agricultural sector in adopting environmentally responsible practices and thus contribute to mitigating the broader impacts of climate change on the beekeeping sector. This dual approach—combining operational needs with long-term sustainability goals—highlights the critical role of collaboration and adaptation strategies in ensuring the resilience of beekeeping in Italy and beyond.

5. Conclusions

This study provides insights into the perceptions and challenges of Italian beekeepers and their associations regarding sustainability, certification, and traceability. The results highlight significant environmental challenges facing the sector, such as the effect of climate change, the loss of biodiversity, and the inappropriate use of pesticides. In this context, beekeepers are aware of the important role of their activity in pollination and biodiversity conservation, as well as their contribution to environmental education and public awareness through activities in schools and universities. However, a gap was identified in their engagement with broader systemic issues such as certified food production and climate change mitigation, indicating potential areas for capacity building and policy development.

Associations play a crucial role in supporting beekeepers, in particular by providing technical assistance, promoting sustainable practices, and advocating for legislative improvements to address environmental and market challenges. Their efforts to combat honey fraud and promote agroecological principles are key to ensuring the resilience and sustainability of the sector. The findings also highlight the importance of communication strategies, including the effective use of product labelling and packaging to build consumer trust and loyalty.

There were notable differences between amateur and professional beekeepers, with the former showing greater sensitivity to environmental and sustainability issues, probably due to different motivations and economic dependencies.

Overall, the results highlight the importance of collaboration among beekeepers, associations, policymakers, and other stakeholders. To secure the resilience of the Italian beekeeping sector, it is vital to adopt a dual strategy that simultaneously addresses the urgent challenges and sustainability issues in the long term. Furthermore, ensuring a fair market and effective promotion of Italian beekeeping products has highlighted the crucial role of working with policymakers to enforce stricter regulations on the import of beekeeping products, combat fraud, and improve traceability.

The limitations of this study include the relatively small sample of associations and beekeepers involved. However, the sample can be considered representative for this supply chain.

Future research should explore the integration of innovative technologies, the role of digital advances, and the potential for international cooperation to further strengthen the sustainability and adaptability of the sector. In addition, this type of analysis could be extended to cover larger European geographical areas and take into account different regional contexts.

Use of AI tools declaration

The authors declare they have not used artificial intelligence (AI) tools in the creation of this article.

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Conflict of interest

Simone Blanc is an editorial board member for AIMS Agriculture and Food and was not involved in the editorial review or the decision to publish this article. All authors declare no conflicts of interest.

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