APIMONDIA SCANDINAVIA 2025
SWEDEN | DENMARK | NORWAY

PP-285 [Beekeeping Technology and Quality]

Developing an Objective Scoring System for Evaluation of Sustainability of Best Beekeeping Practices

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Abstract

The sustainability value of Best Beekeeping Practices can guide beekeepers towards practices that improve the resilience and profitability of their operations. A consortium of experts from 13 EU countries participated in creating an objective scoring system based on three main criteria: (1) sustainability (including cost-benefit analysis, and scoring of the impact on honey bee health, human health, and impact on environment), (2) scientific validity, and (3) readiness for practical implementation. A total of 50 Best Beekeeping Practices (BBPs) covering the themes of Apiary and colony set up and management/maintenance (category "Good Beekeeping Practices - GBPs"), Varroosis, and American Foulbrood ("Biosecurity Measures in Beekeeping - BMBs") were analysed. The practices with the highest sustainability score in each criterion were: "Expanding the colony to give the colony space" and "Only transfer disease-free bees and/or frames to other colonies" from the GBPs category, and "Identification of the best moment for Varroa treatments according to the national climatic areas" and "Queen caging" for BMBs. A significant correlation was found between the scientific value of a practice and its reduced environmental impact. Interestingly, sustainability parameters such as "Human Health", "Scientific Value," and "Environmental Impact" varied across countries.

Introduction

The implementation of Best Practices in animal production is essential for optimising economic outcomes, improving health management, ensuring high welfare standards, and reducing environmental impact. In the context of the Horizon Europe Thematic Network B-THENET, Best Beekeeping Practices were formally defined. To support beekeepers and strengthen the EU beekeeping sector, a method was developed to assess the sustainability of these practices. Such methodology may enable cross-comparison of sustainability metrics across different countries and farmed animal sectors, particularly where theoretical frameworks are needed before practical application. This tool holds promise for integration into larger initiatives, such as the EU Farm Book project, to establish uniform sustainability benchmarks for the European agricultural sector.

Materials & Methods

The sustainability analysis was based on three criteria, assessed through seven parameters, each scored from 0 to 3 (Table 1). The median total score across all parameters determined each BBP's overall sustainability rating, classified as low (0–7), medium (8–14), or high (15–21).

Table 1. Structure of the Objective Scoring System for evaluating the sustainability of BBPs.

Criteria	Parameters	Scoring
Sustainability	Cost/Benefit analysis	0 – 3
	Bee Health	0 – 3
	Human Health	0 – 3
	Environmental impact	0 – 3
Scientific value	Assessment of scientific validity	0 – 3
Readiness to use	Required beekeepers' knowledge	0 – 3
	Availability of required tools	0 – 3

50 BBPs formally identified by the Horizon Europe Thematic Network B-THENET, were scored by experts from 13 EU countries (Austria, Belgium, Croatia, Denmark, Germany, Greece, Hungary, Italy, Poland, Slovakia, Slovenia, Spain, and Sweden). Sustainability scores of BBPs were compared across countries, with further analysis of trends between categories (GBPs vs. BMBs) and correlations among the assessment parameters.

Results

All Best Practices evaluated were rated as having medium to high sustainability values across the 13 participating EU countries. The median sustainability values derived from the analysis of best practices in each country (n = 645) are presented in Figure 1.

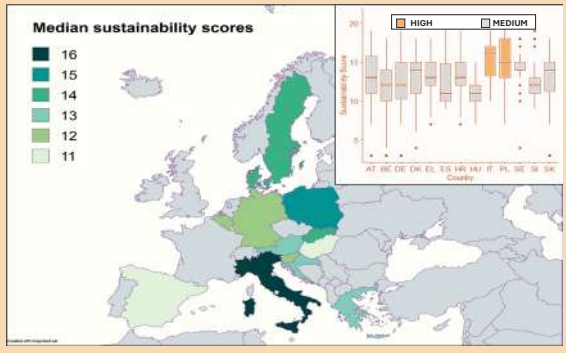

Figure 1. Map showing countries where national experts applied the Objective Scoring System for BBPs. The top-left of the figure displays median sustainability scores, with countries shaded accordingly. Boxplots at the top-right illustrate score distributions across countries, highlighting high sustainability ranges in gold and medium ranges in light grey.

The highest-scoring practices for sustainability were: "Expanding the colony to provide space" and "Transferring only disease-free bees or frames" from the GBPs category, and "Timing Varroa treatments by national climate" and "Queen caging" from the BMBs category. When comparing categories, BMBs received higher sustainability scores than GBPs. Fig. 2A shows the differences in median sustainability values between GBPs and BMBs. A significant correlation was found between the scientific value of a practice and its reduced environmental impact (Fig. 2B).

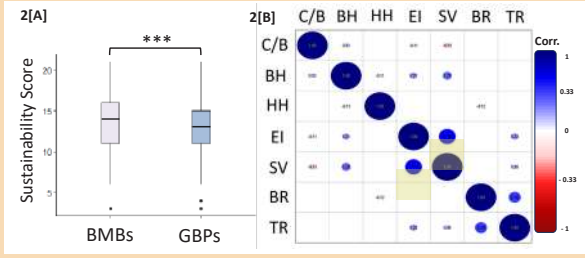

Figure 2. [A] Sustainability scores of Best Practices by category: BMBs (n=219) and GBPs (n=426). BMBs received higher scores than GBPs. (N.B. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$). **[B]** Correlation between the parameters of the sustainability analysis: C/B (Cost–Benefit), BH (Bee Health), HH (Human Health), EI (Environmental Impact), SV (Scientific Value), BR (Beekeepers' Readiness), and TR (Tools Readiness). The colour gradient indicates the strength and direction of correlations between parameters. Significant correlations are highlighted in yellow.

Conclusions

This study presents the first structured assessment of the sustainability of BBPs across 13 EU countries, applying a standardised, expert-driven Objective Scoring System. All 50 BBPs achieved medium-to-high sustainability ratings, with significant variation among countries, reflecting the diverse realities of beekeeping across the EU. BMBs scored significantly higher than GBPs. Disease prevention strategies may have a greater impact on the overall sustainability of a beekeeping operation. Scientific value and environmental impact of BBPs were significantly correlated, reflecting the prevalence of well-documented research on low-impact techniques among the practices analysed. Future assessments should broaden practice range and include more in depth evaluation concerning One Welfare (Honey Bee, Human and Environment). The scoring system shows potential as a tool to develop sustainable BBPs. This framework could also be adapted to establish uniform sustainability benchmarks for Best Practices in other agricultural and animal production sectors.

Funded by the European Union

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The implementation of Best Practices in animal production is essential for optimising economic outcomes, improving health management, ensuring high welfare standards, and reducing environmental impact. Best Beekeeping Practices were formally defined in Europe through the Horizon Europe project B-THENET. To support beekeepers and strengthen the EU beekeeping sector, a method was developed to assess the sustainability of these practices. A consortium of experts from 13 EU countries (Austria, Belgium, Croatia, Denmark, Germany, Greece, Hungary, Italy, Poland, Slovakia, Slovenia, Spain, and Sweden) participated in creating an objective scoring system based on three main criteria: (1) sustainability (including cost-benefit analysis, and scoring of the impact on honey bee health, human health, and impact on environment), (2) scientific validity, and (3) readiness for practical implementation. A total of 50 Best Beekeeping Practices covering the themes of Apiary and colony set up and management/maintenance (category “Good Beekeeping Practices, GBPs”), Varroosis, and American Foulbrood (“Biosecurity Measures in Beekeeping, BMBs”) were analysed.

The practices with the highest sustainability score in each criterion were: “Expanding the colony to give the colony space” and “Only transfer disease-free bees and/or frames to other colonies” from the GBPs category, and “Identification of the best moment for Varroa treatments according to the national climatic areas” and “Queen caging” for BMBs. A significant correlation was found between the scientific value of a practice and its reduced environmental impact. Interestingly, sustainability parameters such as “Human Health”, “Scientific Value,” and “Environmental Impact” varied across countries. The sustainability value of Best Beekeeping Practices can guide beekeepers towards practices that improve the resilience and profitability of their operations. Establishing such a framework provides a baseline, facilitating evidence-based decision-making in selecting and developing Best Practices. Additionally, a standardized evaluation tool enables cross-comparison of sustainability metrics across farmed animal sectors, particularly where theoretical frameworks are needed before practical application. This tool holds promise for integration into larger initiatives, such as the EU Farm Book project, to establish uniform sustainability benchmarks for the European agricultural sector.