

Vapa-Tankosić, J., Prodanović, R. (2026). Analysis of the organic beekeeping practice in the Republic of Serbia: beekeepers' attitudes on environmental protection and sustainable development challenges. *Agriculture and Forestry*, 72 (2): 153-176. <https://doi.org/10.17707/AgricultForest.72.2.11>

DOI: 10.17707/AgricultForest.72.2.11

Jelena VAPA-TANKOSIĆ^{*1}, Radivoj PRODANOVIĆ¹

ANALYSIS OF THE ORGANIC BEEKEEPING PRACTICE IN THE REPUBLIC OF SERBIA: BEEKEEPERS' ATTITUDES ON ENVIRONMENTAL PROTECTION AND SUSTAINABLE DEVELOPMENT CHALLENGES

SUMMARY

This study provides an empirical analysis of beekeepers' perceptions of organic and sustainable beekeeping practices in the Republic of Serbia. Utilizing data from a survey of 210 experienced beekeepers, the research applies revised multiple linear regression models to examine associations between selected environmental, social and knowledge-related factors and sustainability-related perceptions. To reduce conceptual overlap, the variable measuring the perceived contribution of organic beekeeping to environmental protection was excluded from the main regression specification and retained in the descriptive and correlation analysis. The results indicate that perceived pesticide impact, the perceived role of beekeeping in the local community and cooperation among beekeepers are associated with perceptions of organic beekeeping's contribution to sustainable development. Economic profitability and knowledge of organic beekeeping principles were not retained in the revised models due to their limited contribution to model stability and interpretation. The findings suggest that further development of organic beekeeping in Serbia requires stronger institutional, market and environmental support, including pesticide monitoring, certified ecological zones and support for beekeeping associations and cooperatives.

Keywords: organic beekeeping; Republic of Serbia; sustainable development; sustainability-related perceptions; ecosystem services

INTRODUCTION

The global apiculture sector is currently facing major challenges, primarily driven by the combined effects of habitat loss and climate change. As Singh and Deore (2025) point out, shifting phenological patterns are disrupting the vital

¹Jelena Vapa-Tankosić, Radivoj Prodanović (corresponding author: rprodanovic@fimek.edu.rs); University Business Academy in Novi Sad, Faculty of Economics and Engineering Management in Novi Sad, Cvečarska 2, 21 107 Novi Sad, REPUBLIC OF SERBIA; <https://orcid.org/0000-0001-8062-1154>; <https://orcid.org/0000-0002-7088-8506>

Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.

Received:27/01/2026

Accepted:05/05/2026

synchrony between pollinators and flora. This ecological crisis is further exacerbated by the dramatic decline in insect biomass. Hallmann *et al.*, (2017) documented a loss of over 75% in flying insect biomass, which raises serious concerns regarding the sustainability of agroecosystems. In this context, Dainese *et al.*, (2019) provide evidence that species richness of pollinators directly supports ecosystem services, independent of their abundance. Their global study demonstrates that up to 50% of the negative impacts of landscape simplification on crop yields is due to the loss of biodiversity among service-providing organisms. This underscores that protecting the 'ecological landscape' is not only a conservation goal but a functional necessity for food security. Growing consumer awareness of the health and environmental aspects of nutrition, together with the need to preserve biodiversity and pollination services, has stimulated demand for organic bee products and practices that minimize environmental impact (Filipiak, 2018; Vapa-Tankosić *et al.*, 2020a). Against this global backdrop, the beekeeping sector in the Republic of Serbia faces a critical juncture where traditional practices must align with emerging sustainability standards and market demands.

Beekeeping has become one of the most visible segments of sustainable agriculture in Europe in recent decades as bees are proven to be providers of provisioning, regulating and cultural ecosystem services (Klein *et al.*, 2018; Prodanović *et al.*, 2024). Bees play a vital role in delivering diverse ecosystem services that enhance human well-being underpinning food security and nature as a whole (Gill *et al.*, 2016; Matias *et al.*, 2017; Science for Environment Policy, 2020), potentially contributing towards 15 of the 17 United Nation's Sustainable Development Goals (SDGs) and a minimum of 30 SDG targets (Patel *et al.*, 2021).

At the same time, climate change, habitat loss, insufficient diversity of pasture resources and the pressure of diseases and parasites (e.g. *Varroa destructor*) make beekeeping a sector of increased risk, in which the organic principles of prevention, biological balance and local adaptability are increasingly important (Vapa-Tankosić *et al.*, 2020b; Vercelli *et al.*, 2021). In such conditions, organic beekeeping, in its broadest sense, is based on the principles of bee welfare, the preservation of natural ecosystems and the limited use of synthetic substances (Conrad, 2013). This aligns with the broader conceptualization of organic agriculture in the Republic of Serbia, which is defined as a sustainable food production system that maximizes the use of renewable resources, protects human health, and preserves the environment. In this context, organic beekeeping appears as a key link in maintaining biodiversity (Golijan Pantović *et al.*, 2025). In practice, this involves choosing locations with sufficiently clean pasture resources, relying on preventive and biological measures for disease control, beekeeping with varietal material adapted to local conditions and careful management of bee products without aggressive technological interventions (Wakgari and Yigezu, 2021). Unlike conventional beekeeping, in an organic system, procedures, materials and veterinary agents are strictly defined and

controlled; certification ensures traceability and consumer confidence, but at the same time carries costs and administrative obligations for producers (Vapa-Tankosić, 2025). The findings show that organic and conventional management systems performed comparably in terms of survival and honey production, suggesting that the organic system can be considered a sustainable management approach for small to mid-size stationary honey-producing operations (Underwood *et al.*, 2023).

The European Union has recently developed a comprehensive regulatory and institutional framework for organic production, including beekeeping, through general acts on organic production, a single labelling and control system, as well as instruments of the Common Agricultural Policy that support the transition to and maintenance of organic practices (Vapa-Tankosić, 2025). In addition to the regulation, support mechanisms for research, training and promotion have also been developed, which has contributed to the gradual increase in supply and stabilization of the market for organic honey products (Tadesse *et al.*, 2021). Recent findings underscore the need for integrated approaches combining education, financial incentives, and technical support to achieve widespread adoption of sustainable agriculture (Zec Vojinović *et al.*, 2025).

By contrast, the Republic of Serbia is in the process of harmonizing with European standards, while national regulations, control systems and various incentive measures are already in place. The Republic of Serbia has a long tradition of beekeeping and is considered one of the European regions with favourable conditions for this activity. A continuous increase in the number of beehives can be observed in the Republic of Serbia, reaching 977 thousand beehives in 2023 (SORS, 2023), with 12,618 hives in the organic farming system in 2021 (Willer *et al.*, 2023). Many beehive owners are also engaged in other agricultural activities, such as animal husbandry, fruit growing and vegetable production. On such farms, beekeeping is often practised as a complementary activity or as a hobby, rather than as the main source of income (Vapa-Tankosić *et al.*, 2020b).

Geographical diversity, climate and wealth of honey plants provide a good basis for the development of organic beekeeping. Traditionally, Serbian beekeepers have used natural resources for centuries, and the development of organic beekeeping is a continuation of these practices (Prodanović *et al.*, 2024), but in accordance with certification standards. Although the share of the organic segment in total honey production is still not large, the interest of producers is growing, especially in regions with clean pastures and a tradition of beekeeping. The findings show that in Romania, the beekeepers were aware of organic principles and were familiar with the concept of sustainability in beekeeping, the most important factor being the environmental aspect, followed by the economic and social components, although with a small percentage of certified organic beekeepers (Pocol *et al.*, 2012; Pocol *et al.*, 2021). Yet, in the Republic of Serbia the organic market is still at a very early stage of development. The organic

products are still perceived as a luxury (Vapa-Tankosić *et al.*, 2018). The findings show that the higher monthly household income positively influences the WTP for organic honey (Vapa-Tankosić *et al.*, 2020a). Consumers of honey in Serbia are mostly women, aged 20-39 years, highly educated with the average income of 500-2000 euros (Ignjatijević *et al.*, 2019). Consumer awareness plays a crucial role in driving change in farming practices and influencing food supply chains empowering individuals to make choices that align with their health and environmental values (Puvača *et al.*, 2024).

As a broad interpretative framework, the Theory of Planned Behavior links individual behaviour to attitudes, perceived social expectations and perceived control over action (Ajzen, 1991). In the context of organic beekeeping, environmental perceptions and awareness may be understood as attitudinal components, while the perceived role of beekeeping in the local community and cooperation among beekeepers reflect social and community-based dimensions. Knowledge of organic beekeeping principles and institutional support may be interpreted as enabling or constraining conditions for sustainable practices. In this paper, the theory is used as an interpretative lens rather than as a fully operationalised and statistically tested behavioural model.

This study examines the associations between selected characteristics, attitudes and sustainability-related perceptions among beekeepers in the Republic of Serbia. Particular attention is given to differences between conventional and organic/combined beekeepers, as well as to perceptions of the contribution of organic beekeeping to environmental protection and sustainable development. The objective is to analyse how environmental, social, economic and knowledge-related factors are associated with beekeepers' perceptions of organic beekeeping and its role in sustainable rural development.

MATERIAL AND METHODS

Due to the complexity and interrelations of factors shaping organic beekeeping practices, this research examined beekeepers' attitudes toward organic beekeeping, environmental protection and sustainable development in the Republic of Serbia. Particular attention was given to the perceived role of organic beekeeping in environmental protection, the challenges faced by beekeepers, and the differences between conventional and organic/combined beekeepers. The research focused on selected environmental, social, economic and knowledge-related factors associated with beekeepers' sustainability-related perceptions.

Data collection was carried out in the Republic of Serbia from March to December 2025 using an anonymous survey among beekeepers identified through local agricultural associations, the Union of Beekeeping Organisations of Serbia, Serbia Organica and publicly available sources, including agricultural directories and online contact information. The sample was designed to include beekeepers from different parts of the Republic of Serbia and different forms of beekeeping practice, including conventional, organic and combined beekeeping. Beekeepers were contacted individually and informed about the purpose of the research.

Table 1. Socio-demographic and structural characteristics of respondents

Research variables	Values
1. Age of respondents	-18–45 years -46–60 years -Over 60 years
2. Years of experience in beekeeping	-Numeric response (in years)
3. Number of beehives	-Numeric response (number of beehives)
4. Education level	-Primary education -Secondary education -Higher education -Academic higher degree (Master's, PhD)
5. Do you practise beekeeping professionally or as a hobby?	-Professionally -As a hobby
6. Gender	-Male -Female
7. Type of beekeeping practised	-Conventional beekeeping -Organic and combined beekeeping
8. Which types of organic honey and honey products do you produce?	-Open-ended response*
9. Have you increased the price of your honey products in the last five years?	-Yes -No
10. Do you use subsidies or other forms of state financial support for organic beekeeping?	-Yes -No
11. Do you participate in social and educational activities related to beekeeping?	-Yes -No
12. Which challenges do you consider most significant for organic beekeeping in Serbia? (select one)	-Lack of certified organic pastures -Limited availability of organic feed for bees -Complex and costly certification process -Insufficient education and professional support -Limited market and low purchase prices -Presence of pesticides and environmental pollution -Weak institutional support and incentives -Climate change
13. Do you feel that the benefits of organic beekeeping are sufficiently promoted in your community?	-Yes -No
14. What type of support would you like to receive from the state or professional organisations? (select one)	-Additional subsidies and targeted financial support for organic beekeepers -Simplified and more affordable organic certification -Free additional education and training for organic beekeeping -Support in the promotion and market placement of organic honey -Development of "clean" and certified bee pastures (organic zones) -Inclusion of organic beekeeping in national rural development strategies -Free scientific and technical support
15. Do you think it is important to establish "ecological beekeeping areas"?	-Yes -No

*Responses to the open-ended Question 8 ("Which types of organic honey and honey products do you produce?") were subsequently coded for statistical analysis. Based on response content, four categories were defined: (1) organic floral honey (acacia, linden, meadow and sunflower), (2) honeydew honey (forest honey), (3) other bee products and honey without specified type (e.g. propolis, honey for personal use), and (4) respondents who do not produce certified organic honey. Each response was assigned a numerical code (1–4).

Table 2. Attitudes on environmental protection and sustainable development challenges

Research variables	Values
1. How do you assess the economic profitability of your beekeeping activity? (X1)	-Completely unprofitable -Mostly unprofitable -Moderately profitable -Mostly profitable -Completely profitable
2. To what extent, in your opinion, does organic beekeeping contribute to environmental protection? (X2)	-Does not contribute at all -Contributes to a small extent -Contributes to a moderate extent -Contributes to a large extent -Contributes to an exceptional extent
3. How do you assess the impact of pesticides on bee health? (X3)	-Very negative -Mostly negative -Neither negative nor positive -Mostly positive -Very positive
4. To what extent are you familiar with environmental and climate-related problems affecting beekeeping? (X4)	-Not familiar at all -Familiar to a small extent -Familiar to a moderate extent -Familiar to a large extent -Fully familiar
5. Beekeeping plays an important role in the local community. (X5)	-Strongly disagree -Mostly disagree -Neither agree nor disagree -Mostly agree -Strongly agree
6. How do you assess cooperation among beekeepers in your area? (X6)	-Extremely poor -Mostly poor -Neither good nor poor -Mostly good -Extremely good
7. How well do you know the principles of organic beekeeping? (X7)	-Not at all -Slightly -Moderately -Well -Very well
8. Do you believe that organic beekeeping can contribute to sustainable development? (Y)	-Absolutely not -Mostly not -Partially -Mostly yes -Absolutely yes

The attitudinal variables were measured using five-point Likert-type scales. Although Likert-type responses are ordinal in nature, they were treated as approximately interval-level variables for the purpose of regression analysis, which is a common approach in applied survey research when scales contain five or more response categories (Norman, 2010). This methodological limitation is acknowledged, and the results are interpreted as associations rather than causal effects.

The survey consisted of 23 questions and was divided into sections covering socio-demographic and structural characteristics of the surveyed

beekeepers (Table 1), as well as beekeepers' attitudes on environmental protection and sustainable development challenges (Table 2). For questions requiring respondents to select one dominant option, categories with zero frequencies were interpreted as options not prioritised within this sample, rather than as entirely irrelevant. This applies particularly to items concerning perceived challenges and preferred forms of support for organic beekeeping. A total of 210 questionnaires were used in the analysis. Data exploration and distribution checks were performed in EViews 12, with additional statistical analyses conducted in IBM SPSS 26. Regression models were estimated separately for conventional and organic/combined beekeepers. To reduce the risk of conceptual overlap, X2 was excluded from the main regression specification and retained only in the descriptive and correlation analysis. Multicollinearity was assessed using VIF and tolerance values, while heteroskedasticity was tested using the Breusch–Pagan test (Breusch and Pagan, 1979). Since heteroskedasticity was detected, heteroskedasticity-robust standard errors were reported.

RESULTS AND DISCUSSION

Description of the sample

The sample is predominantly composed of middle-aged beekeepers, with the largest share of respondents belonging to the 45–60 age group (Table 3).

Table 3. Age structure of respondents

Age	Frequency	Percentage
18-45	41	19.52%
45-60	154	73.33%
Over 60	15	7.14%
Total	210	100.00%

Respondents differ considerably in beekeeping experience, but the mean and median values indicate that long-term practical engagement is common within the sample (Table 4).

Table 4. Descriptive statistics of years of experience in beekeeping

Statistical indicator	Value
Number of respondents (N)	210
Mean	20.07
Median	15.00
Std. Dev.	13.48
Minimum	5
Maximum	50

The number of beehives varies considerably across respondents, with the distribution indicating that a smaller number of beekeepers manage substantially larger apiaries (Table 5).

Table 5. Descriptive statistics for the number of beehives

Statistical indicator	Value
Number of respondents (N)	210
Mean	90.38
Median	50.00
Std. Dev.	120.73
Minimum	10
Maximum	530

Secondary and higher education predominate in the sample, while primary education is represented to a much smaller extent (Table 6).

Table 6. Education structure of respondents

Education	Frequency	Percentage
Primary education	14	6.67%
Secondary education	111	52.86%
Higher education	85	40.48%
Academic higher degree (Master's, PhD)	0	0.00%
Total	210	100.00%

Beekeeping is mainly pursued as a hobby, while professional engagement is present among a smaller share of respondents (Table 7).

Table 7. Distribution of respondents by type of beekeeping activity

Type of beekeeping activity	Frequency	Percentage
Professionally	42	20.00%
As a hobby	168	80.00%
Total	210	100.00%

Male respondents clearly predominate in the sample, reflecting the gender structure of surveyed beekeepers (Table 8).

Table 8. Gender structure of respondents

Gender	Frequency	Percentage
Male	170	80.95%
Female	40	19.05%
Total	210	100.00%

Conventional beekeeping is somewhat more represented than organic or combined beekeeping, although both groups are sufficiently present for comparative analysis (Table 9).

Table 9. Structure of respondents according to the type of beekeeping practiced

Beekeeping practised	Frequency	Percentage
Conventional beekeeping	119	56.67%
Organic and combined beekeeping	91	43.33%
Total	210	100.00%

Regarding product types, certified organic floral honey is the most common category among respondents who reported organic honey production (Table 10).

Table 10. Types of organic honey and honey products produced by respondents

Type of product	Frequency	Percentage
Organic floral honey	67	31.90%
Honeydew honey (forest honey)	11	5.24%
Other bee products / unspecified honey	34	16.19%
Do not produce certified organic honey	98	46.67%
Total	210	100.00%

Price increases were reported by slightly more than half of the respondents, while the remaining share indicated no price change over the last five years (Table 11).

Table 11. Price increase of honey products in the last five years

Response	Frequency	Percentage
Yes	112	53.33%
No	98	46.67%
Total	210	100.00%

Use of state subsidies or other financial support remains limited, as most respondents reported not using this type of support (Table 12).

Table 12. Use of state subsidies or financial support for organic beekeeping

Response	Frequency	Percentage
Yes	28	13.33%
No	182	86.67%
Total	210	100.00%

Participation in social and educational activities is relatively high, indicating an active level of engagement within the beekeeping community (Table 13).

Table 13. Participation in social and educational activities related to beekeeping

Response	Frequency	Percentage
Yes	140	66.67%
No	70	33.33%
Total	210	100.00%

Pesticides and environmental pollution emerged as the most frequently reported challenge, followed by limited market access and low purchase prices (Table 14).

Table 14. Perceived challenges for organic beekeeping in Serbia

Perceived challenges	Frequency	Percentage
Lack of certified organic pastures	29	13.81%
Limited availability of organic feed for bees	31	14.76%
Complex and costly certification process	26	12.38%
Insufficient education and professional support	0	0.00%
Limited market and low purchase prices	40	19.05%
Presence of pesticides and environmental pollution	56	26.67%
Weak institutional support and incentives	28	13.33%
Climate change	0	0.00%
Total	210	100.00%

Respondents unanimously indicated that the benefits of organic beekeeping are not sufficiently promoted in their communities (Table 15).

Table 15. Perception that the benefits of organic beekeeping are being sufficiently promoted in your community

Response	Frequency	Percentage
Yes	0	0.00%
No	210	100.00%
Total	210	100.00%

Additional subsidies and targeted financial support were the most preferred forms of support, followed by the development of “clean” and certified bee pastures (Table 16).

Table 16. Preferred types of support for organic beekeeping

Preferred types of support	Frequency	Percentage
Additional subsidies and targeted financial support for organic beekeepers	70	33.33%
Simplified and more affordable organic certification	29	13.81%
Free additional education and training for organic beekeeping	28	13.33%
Support in the promotion and market placement of organic honey	27	12.86%
Development of “clean” and certified bee pastures (organic zones)	56	26.67%
Inclusion of organic beekeeping in national rural development strategies	0	0.00%
Free scientific and technical support	0	0.00%
Total	210	100.00%

Establishing “ecological beekeeping areas” was considered important by the large majority of respondents (Table 17).

Table 17. Perceived importance of establishing ecological beekeeping areas

Response	Frequency	Percentage
Yes	182	86.67%
No	28	13.33%
Total	210	100.00%

The analytical model for conventional and organic/combined beekeepers

Descriptive statistics for the analysed variables are presented separately for conventional and organic/combined beekeepers. Respondents were divided into two groups based on the type of beekeeping practiced: conventional beekeeping and organic and combined beekeeping. This group variable was used to enable a structured comparison of perceptions, attitudes and estimated outcomes between beekeepers operating under different production approaches, and thus for comparative statistical analysis.

For the purposes of inferential statistical analysis, the dependent variable represents respondents' assessment of the contribution of organic beekeeping to sustainable development (Y) (Question 23 in the questionnaire).

The independent variables include seven constructs derived from selected questionnaire items: economic profitability (X1, Question 16), contribution to environmental protection (X2, Question 17), impact of pesticides (X3, Question 18), awareness of environmental and climate-related issues (X4, Question 19), the role of beekeeping in the local community (X5, Question 20), cooperation among beekeepers (X6, Question 21), and knowledge of the principles of organic beekeeping (X7, Question 22). These variables were analysed separately from other survey items. X1–X7 were included in descriptive and correlation analyses, while the revised regression models excluded X2 from the main specification due to its conceptual proximity to the dependent variable.

Descriptive statistics for the dependent variable, presented separately for conventional (CB) and organic and combined beekeepers (OC), are shown in Table 18, with higher mean values observed among organic and combined beekeepers ($M=4.40$, $SD=1.104$) than among conventional beekeepers ($M=3.46$, $SD=1.567$).

Table 18. Descriptive statistics of the dependent variable (Y)

Dependent variable	Beekeeping type	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera (probability)
Contribution of organic beekeeping to sustainable development (Y)	CB	3.46	1.567	-0.368067	1.608970	12.28109 (0.002154)
	OC	4.40	1.104	-2.222451	7.150685	140.2361 (0.000000)

The descriptive results for the independent variables are presented in Table 19. Among conventional beekeepers (CB), mean values range from 1.13 to 4.59, while among organic and combined beekeepers (OC) range from 1.32 to 4.58.

Table 19. Descriptive statistics of the independent variable

Independent variable	Beekeeping type	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera (probability)
Economic profitability (X1)	CB	2.61	0.825	-0.274815	2.578550	2.378577 (0.304438)
	OC	2.58	0.955	-0.313778	2.163925	4.143715 (0.125952)
Contribution to environmental protection (X2)	CB	3.28	1.766	0.240534	1.283220	15.76136 (0.000378)
	OC	4.33	1.155	-1.971524	5.912697	91.11916 (0.000000)
Impact of pesticides (X3)	CB	1.13	0.333	2.253345	6.077564	147.6674 (0.000000)
	OC	1.32	0.728	1.861256	4.503344	61.11081 (0.000000)
Awareness of environmental and climate-related issues (X4)	CB	4.59	0.753	-2.039848	6.805204	154.3207 (0.000000)
	OC	4.46	1.036	-1.554186	3.724279	38.62403 (0.000000)
Role of beekeeping in the local community (X5)	CB	4.26	1.045	-0.937903	2.313241	19.78516 (0.000051)
	OC	4.58	0.790	-2.110789	6.904828	125.3881 (0.000000)
Cooperation among beekeepers (X6)	CB	3.03	0.929	-0.830548	2.933934	13.70288 (0.001058)
	OC	3.11	0.752	-0.496504	2.831129	3.846954 (0.146098)
Knowledge of the principles of organic beekeeping (X7)	CB	3.38	1.033	0.259537	1.931273	6.999260 (0.030209)
	OC	3.27	0.817	0.072706	2.399573	1.447118 (0.485023)

Both groups reported high mean values for awareness of environmental and climate-related issues and for the perceived role of beekeeping in the local community. The lowest mean values in both groups were recorded for perceived pesticide impact, while organic and combined beekeepers showed a higher mean score for the perceived contribution of organic beekeeping to sustainable development (Tables 18–19; Figure 1).

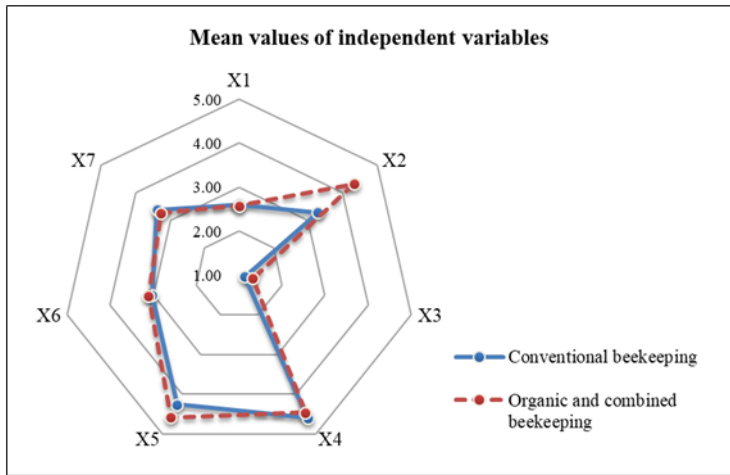


Figure 1. Comparison of mean values of independent variables between conventional and organic/combined beekeepers

Correlation analysis of independent variables

Pearson correlations are presented separately for conventional beekeepers (CB) and organic and combined beekeepers (OC).

Table 20. Pearson’s correlation coefficients for independent variables (CB)

	X1-CB	X2-CB	X3-CB	X4-CB	X5-CB	X6-CB	X7-CB
X1-CB	1.0000						
X2-CB	-0.1819	1.0000					
X3-CB	0.1788	0.3145	1.0000				
X4-CB	-0.0948	-0.0855	0.2087	1.0000			
X5-CB	0.1375	0.6677	0.1968	0.1591	1.0000		
X6-CB	-0.8015	0.1957	-0.0138	-0.3073	-0.2272	1.0000	
X7-CB	0.0736	0.0442	-0.4595	0.0494	-0.1704	-0.3311	1.0000

For conventional beekeepers, correlations were mostly low to moderate, with the strongest positive association observed between the perceived contribution of organic beekeeping to environmental protection and the perceived role of beekeeping in the local community (Table 20).

Table 21. Pearson’s correlation coefficients for independent variables (OC)

	X1-OC	X2-OC	X3-OC	X4-OC	X5-OC	X6-OC	X7-OC
X1-OC	1.0000						
X2-OC	-0.0350	1.0000					
X3-OC	-0.2537	-0.1130	1.0000				
X4-OC	-0.2072	-0.0543	0.2004	1.0000			
X5-OC	-0.1159	0.6763	0.2146	0.3604	1.0000		
X6-OC	-0.5231	-0.1317	0.5033	-0.3368	-0.1651	1.0000	
X7-OC	-0.1076	0.0089	-0.1487	0.1766	-0.0785	-0.4112	1.0000

For organic and combined beekeepers, the strongest positive association was observed between the perceived contribution of organic beekeeping to environmental protection and the perceived role of beekeeping in the local community. A moderate positive association was also found between perceived pesticide impact and cooperation among beekeepers. X2 was retained only in the descriptive and correlation analysis due to its conceptual proximity to the dependent variable and was excluded from the revised regression models to reduce conceptual overlap (Table 21).

F-test results for group comparisons

Group differences between conventional (CB) and organic and combined beekeepers (OC) were tested using one-way analysis of variance.

Table 22. F-statistics for CB–OC group comparisons

Variable	SS (between)	SS (within)	df	F	p
Y	44.9286	399.3381	1, 208	23.40	< 0.0001
X1	0.0496	162.3504	1, 208	0.06	0.8067
X2	57.1080	487.9586	1, 208	24.34	< 0.0001
X3	1.9135	60.8675	1, 208	6.54	0.0113
X4	0.8278	163.4389	1, 208	1.05	0.3067
X5	5.3438	185.0562	1, 208	6.01	0.0151
X6	0.3000	152.7666	1, 208	0.41	0.5227
X7	0.5516	186.1151	1, 208	0.62	0.4319

The ANOVA results for CB and OC groups are presented in Table 22. They were used to compare differences between conventional and organic/combined beekeepers. However, variable selection for the revised regression models was based primarily on conceptual relevance, reduced overlap with the dependent variable and methodological stability. Therefore, variables were not retained or excluded solely on the basis of statistically significant group differences.

Regression analysis by type of beekeeping: conventional and organic/combined beekeepers

Linear regression models were estimated separately for conventional beekeepers and for organic and combined beekeepers. Given the conceptual proximity between X2, which measures the perceived contribution of organic beekeeping to environmental protection, and Y, which measures the perceived contribution of organic beekeeping to sustainable development, X2 was excluded from the main regression specification. This adjustment was introduced to reduce the risk of conceptual tautology and inflated explanatory power. X2 was retained in the descriptive and correlation analysis, while the revised regression models were estimated using predictors that are conceptually more distinct from the dependent variable.

Table 23. Revised linear regression model for conventional beekeepers

Variable	Coefficient	Robust Std. Error	t-statistic	Probability
C	-2.7948	0.7070	-3.9528	0.0001
X3-CB	-1.3342	0.1700	-7.8471	< 0.001
X4-CB	-0.0249	0.1052	-0.2362	0.8137
X5-CB	1.1385	0.0535	21.2646	< 0.001
X6-CB	0.9964	0.1195	8.3360	< 0.001
Model summary				
Indicator	Value			
R-squared	0.7256			
Adjusted R-squared	0.7160			
F-statistic	75.3729			
Prob (F-statistic)	< 0.001			
Included observations	119			

Revised regression results for conventional beekeepers are presented in Table 23. After excluding X2 from the main model, perceived pesticide impact (X3-CB), the perceived role of beekeeping in the local community (X5-CB), and cooperation among beekeepers (X6-CB) remained statistically significant predictors of beekeepers' perceptions of the contribution of organic beekeeping to sustainable development. Awareness of environmental and climate-related issues (X4-CB) was not statistically significant in the revised specification. The model explains 72.56% of the variance in the dependent variable, with an adjusted R² of 71.60%, which represents a more plausible level of explanatory power for cross-sectional survey data.

Table 24. Revised linear regression model for organic and combined beekeepers

Variable	Coefficient	Robust Std. Error	t-statistic	Probability
C	-0.5498	1.4295	-0.3846	0.7015
X3-OC	-0.6175	0.1836	-3.3625	0.0012
X4-OC	-0.1984	0.1122	-1.7693	0.0804
X5-OC	1.2297	0.0535	22.9701	< 0.001
X6-OC	0.3248	0.3503	0.9271	0.3565
Model summary				
Indicator	Value			
R-squared	0.6544			
Adjusted R-squared	0.6383			
F-statistic	40.7026			
Prob (F-statistic)	< 0.001			
Included observations	91			

Revised regression results for organic and combined beekeepers are shown in Table 24. Perceived pesticide impact (X3-OC) and the perceived role of beekeeping in the local community (X5-OC) were statistically significant

predictors of beekeepers' perceptions of the contribution of organic beekeeping to sustainable development. Awareness of environmental and climate-related issues (X4-OC) and cooperation among beekeepers (X6-OC) were not statistically significant in this model. The model explains 65.44% of the variance in the dependent variable, with an adjusted R^2 of 63.83%. Compared with the original specification, the revised model provides a more cautious and methodologically defensible interpretation of the associations among the analysed variables.

Based on the revised specification, the estimated regression equations are expressed as follows:

$$\hat{Y}\text{-CB} = -2.795 - 1.334 \times X3\text{-CB} - 0.025 \times X4\text{-CB} + 1.139 \times X5\text{-CB} + 0.996 \times X6\text{-CB}$$

$$\hat{Y}\text{-OC} = -0.550 - 0.618 \times X3\text{-OC} - 0.198 \times X4\text{-OC} + 1.230 \times X5\text{-OC} + 0.325 \times X6\text{-OC}$$

The revised models are statistically significant, with $F(4,114)=75.37$, $p<0.001$ for conventional beekeepers and $F(4,86)=40.70$, $p<0.001$ for organic and combined beekeepers. These results should be interpreted as statistically significant associations rather than causal effects, given the cross-sectional design of the study.

To further assess the reliability of the revised regression models, diagnostic tests were conducted for multicollinearity and heteroskedasticity. Multicollinearity was assessed using variance inflation factor (VIF) and tolerance values, as presented in Table 25. In both models, VIF values remained below commonly used threshold values, while tolerance values were above the critical lower limit, indicating that multicollinearity was not a serious concern in the revised specifications. Heteroskedasticity was tested using the Breusch–Pagan test. Since the test indicated the presence of heteroskedasticity in both models, heteroskedasticity-robust standard errors were reported in Tables 23 and 24.

Table 25. Diagnostic tests for the revised regression models

Model	Variable	VIF	Tolerance
CB	X3-CB	1.085	0.922
CB	X4-CB	1.161	0.861
CB	X5-CB	1.101	0.908
CB	X6-CB	1.155	0.866
OC	X3-OC	1.789	0.559
OC	X4-OC	1.483	0.674
OC	X5-OC	1.221	0.819
OC	X6-OC	1.895	0.528

The Breusch–Pagan test was statistically significant for both models, indicating heteroskedasticity. For conventional beekeepers, the test result was $LM=78.23$, $p<0.001$, while for organic and combined beekeepers it was $LM=26.16$, $p<0.001$. Therefore, robust standard errors were used to improve the reliability of statistical inference.

DISCUSSION

The results of this study provide an empirical insight into the beekeeping sector in the Republic of Serbia, focusing on the intersection of traditional practices, environmental pressures and the transition toward organic sustainability. The socio-demographic profile of the 210 respondents indicates a sector strongly rooted in experience, but also marked by certain structural limitations. With an average of over 20 years in beekeeping and a dominance of individuals aged 45–60, Serbian beekeeping relies on “tacit knowledge” – information acquired through long-term practice that is often difficult to formalise. However, the fact that 80% of respondents practise beekeeping as a hobby suggests a possible “professionalisation gap”. This indicates that while the technical base for organic production exists, the economic and structural incentives are insufficient to transform this expertise into certified organic enterprises. This mirrors findings in the wider Western Balkan region, where beekeeping is often viewed as a “social safety net” or a secondary income source rather than a primary business orientation.

One of the observed patterns concerns the limited role of economic profitability in explaining sustainability-related perceptions among beekeepers. In many models of agricultural transition, the expectation of a price premium is considered an important factor in the adoption of organic standards. However, economic profitability (X1) was not retained in the revised regression models due to its limited contribution to model stability and interpretation. This suggests that beekeepers' perceptions of organic beekeeping and sustainable development cannot be explained only through economic considerations. Descriptive results also show that 19.05% of respondents identified limited market access and low purchase prices as important constraints, indicating that market conditions remain relevant, although they do not fully explain sustainability-related attitudes. In this sense, environmental and community-related factors appear to play an important role in shaping beekeepers' perceptions.

Revised regression results provide a more cautious interpretation of the relationship between beekeepers' perceptions and sustainable development. After excluding X2 from the main regression specification, perceived pesticide impact, the perceived role of beekeeping in the local community and cooperation among beekeepers remained statistically significant in the model for conventional beekeepers, while perceived pesticide impact and the perceived role of beekeeping in the local community were significant in the model for organic and combined beekeepers. These findings suggest that sustainability-related perceptions among beekeepers are associated not only with environmental concerns, but also with social and community-based dimensions of beekeeping.

Such results may be interpreted in relation to stewardship-oriented approaches, where beekeepers are seen as actors who monitor and respond to environmental pressures through their daily practice. The notion of beekeepers as “ecological sentinels” is therefore used here as an interpretative concept rather than as a separately operationalised construct. This interpretation is consistent

with the broader literature on the role of bees and beekeepers in maintaining ecosystem services and responding to environmental risks (Potts *et al.*, 2016; Brodschneider *et al.*, 2020).

Perceived pesticide impact (X3) remained negatively associated with beekeepers' perceptions of the contribution of organic beekeeping to sustainable development in both revised models. This association was stronger among conventional beekeepers than among organic and combined beekeepers, suggesting that pesticide-related risks are particularly relevant for respondents operating outside organic or combined production systems. Beekeepers in Serbia operate in an environment where intensive, chemical-based crop protection, especially in field crop production, may threaten colony health and complicate the transition toward organic beekeeping. The fact that 26.67% of respondents identified pesticide use and environmental pollution as the most significant challenge further supports the relevance of this issue. External pesticide drift from neighbouring fields may create practical barriers even for beekeepers who follow organic principles, particularly in relation to certification requirements and colony health. This points to the need for stronger spatial and regulatory measures, including better pesticide monitoring and the development of protected apicultural zones. Such an interpretation is consistent with studies showing that pesticides and related agricultural pressures represent important risks for honey bees and wild pollinators (Simon-Delso *et al.*, 2015; Goulson *et al.*, 2015; Tsvetkov *et al.*, 2017; Woodcock *et al.*, 2017).

Economic profitability (X1) and knowledge of organic beekeeping principles (X7) were considered in the initial model specification but were not retained in the revised regression models due to their limited contribution to model stability and interpretation. This suggests that sustainability-related perceptions among beekeepers cannot be explained only through economic profitability or formal knowledge of organic principles. Such a result is consistent with studies indicating that the adoption of organic and sustainable practices may also be shaped by personal values, professional identity and agroecological orientation, rather than by market calculations alone (Darnhofer *et al.*, 2021; Markoč and Krstajić, 2024; Padel, 2001).

At the same time, the role of cooperation and community-based factors remains important. Among conventional beekeepers, cooperation among beekeepers (X6) was statistically significant in the revised model, while the perceived role of beekeeping in the local community (X5) was significant in both groups. These results suggest that social relations, local networks and shared professional experience may support sustainability-related attitudes. The limited role of formal knowledge (X7) may indicate that existing educational and advisory activities are not fully aligned with the practical needs of beekeepers. Social capital, reflected in beekeeping associations and informal networks, may therefore represent an important supportive factor in sustainable transition (Borg *et al.*, 2015; Garforth *et al.*, 2003; Mizik, 2021).

The identified institutional gap is one of the more actionable aspects of this study. The consensus among respondents that the benefits of organic beekeeping are not sufficiently advocated indicates a possible weakness in institutional communication and promotion. While Romania records success in the apicultural sector through more aggressive utilisation of National Beekeeping Programmes and better institutional visibility (Popescu, 2017), beekeepers in Serbia may still face an information gap that limits the broader development of organic beekeeping. While beekeepers demonstrate sustainability-related awareness, the results indicate insufficient support from the broader social and economic environment. The identified lack of promotion and support points to a discrepancy between declarative policy goals and the real-world needs of beekeepers, which appears insufficiently aligned with the pillars of the Green Agenda for the Western Balkans (European Commission, 2020), requiring active support for the transition toward sustainable food systems. The demand for increased subsidies should not be viewed merely as a request for financial aid, but as a call for risk-sharing between the state and producers in the face of climate change and environmental degradation. This demand for institutional support corresponds to broader trends in which beekeeping is increasingly recognised as an activity of public interest that requires specific protective measures, such as the establishment of “clean ecological zones”, in order to reduce exposure to agrochemical pressures and support the achievement of sustainable development goals. This suggests that policy-making should shift from generic financial aid toward protected apicultural territories and more stringent pesticide monitoring.

When placed in relation to the Green Agenda for the Western Balkans and the EU accession process, these results have important practical implications. Serbia’s potential to further develop organic honey production appears to be constrained less by beekeeper awareness than by structural risks. The transition to a sustainable beekeeping sector requires a holistic approach:

- 1.Regulatory reform. Stricter enforcement of pesticide application protocols and the introduction of “bee-friendly” agricultural zones.
- 2.Market development. Promoting the ecological and health benefits of Serbian organic honey to create a domestic price premium.
- 3.Social capital investment. Supporting beekeeping cooperatives to reduce the “hobbyist” isolation and facilitate the high costs of organic certification through group schemes.

In conclusion, the findings suggest that Serbian beekeepers perceive organic beekeeping as closely connected with environmental protection, community development and broader sustainability goals. However, these perceptions should be interpreted with caution, since the revised models indicate statistically significant associations rather than causal effects. Beekeepers’ sustainability-related attitudes appear to be shaped by perceived environmental risks, especially pesticide pressure, as well as by social and community-based dimensions of beekeeping. Therefore, the future development of organic beekeeping in Serbia depends not only on producers’ awareness, but also on the institutional, market and environmental conditions in which beekeeping is practised.

CONCLUSIONS

This study examined beekeepers' perceptions of organic beekeeping, environmental protection and sustainable development in the Republic of Serbia, with particular attention to differences between conventional and organic/combined beekeepers. Based on survey data from 210 respondents, the analysis provides empirical insight into the environmental, social and institutional dimensions of organic beekeeping.

Revised regression models indicate that perceived pesticide impact, the perceived role of beekeeping in the local community and cooperation among beekeepers are associated with beekeepers' perceptions of the contribution of organic beekeeping to sustainable development. These results should be interpreted as statistically significant associations rather than causal effects, given the cross-sectional design of the study. The findings suggest that sustainability-related perceptions among beekeepers are shaped not only by environmental concerns, but also by social and community-based dimensions of beekeeping.

Economic profitability and knowledge of organic beekeeping principles were considered in the initial model specification but were not retained in the revised regression models due to their limited contribution to model stability and interpretation. This indicates that sustainability-related perceptions cannot be explained only through economic profitability or formal knowledge of organic principles.

From a policy perspective, the results point to the need for stronger institutional, market and environmental support for organic beekeeping in Serbia. Particular attention should be given to pesticide monitoring, the development of protected or certified ecological beekeeping zones, better promotion of organic beekeeping, and support for beekeeping associations and cooperatives. Such measures may help reduce environmental risks, improve the conditions for organic certification and strengthen the role of beekeeping in sustainable rural development.

Several limitations should be acknowledged. The research is based on cross-sectional survey data and therefore does not allow causal conclusions. Since all key variables were obtained from the same self-reported questionnaire, the findings should be understood as perceptual associations rather than objective behavioural relationships. The use of five-point Likert-type responses as approximately interval-level variables represents a methodological simplification, although this approach is commonly applied in survey-based research. Future studies could apply ordinal regression models or structural equation modelling to test the robustness of the identified relationships. In addition, response patterns such as categories with no selected responses and variables with uniform responses may reflect questionnaire design, response framing or the requirement to select only one dominant option. Future research should consider revised questionnaire design, multiple-response options, longitudinal designs and objective environmental and economic indicators, such as pesticide residues, colony health indicators and financial performance data.

In summary, organic beekeeping in Serbia can be understood as an activity closely linked to environmental protection, community development and sustainable rural transformation. Its further development depends not only on beekeepers' awareness and motivation, but also on the institutional, market and ecological conditions that shape everyday beekeeping practice.

ACKNOWLEDGEMENTS

This report is the result of the research within the project Jean Monnet Module „European sustainable values in Environmental and Agricultural policy (EUVALUESEAP)”, co-funded by the Erasmus + Programme of the European Union, Project: ERASMUS-JMO-2024-HEI-TCH-RSCH - Project:101172317-EUVALUESEAP.

REFERENCES

- Ajzen, I. (1991). The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.*, 50 (2): 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Borg, R., Toikka, A., & Primmer, E. (2015). Social capital and governance: a social network analysis of forest biodiversity collaboration in Central Finland. *For. Policy Econ.*, 50, 90-97. <https://doi.org/10.1016/j.forpol.2014.06.008>
- Breusch, T. S., & Pagan, A. R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica*, 47 (5): 1287–1294. <https://doi.org/10.2307/1911963>
- Brodtschneider, R., Gratzner, K., Carreck, N. L., Vejsnaes, F., & van der Steen, J. (2020, September). INSIGNIA: Beekeepers as citizen scientists investigate the environment of their honey bees. In Proceedings of “Austrian Citizen Science Conference (available at <https://pos.sissa.it/393/019/>)
- Conrad, R. (2013). *Natural beekeeping: organic approaches to modern apiculture*. White River Junction: Chelsea Green Publishing.
- Dainese, M., Martin, E. A., Aizen, M. A., Albrecht, M., Bartomeus, I., Bommarco, R., ... & Steffan-Dewenter, I. (2019). A global synthesis reveals biodiversity-mediated benefits for crop production. *Sci. Adv.*, 5 (10): eaax0121. <https://doi.org/10.1126/sciadv.aax0121>
- Darnhofer, I. (2021). Farming resilience: from maintaining states towards shaping transformative change processes. *Sustainability*, 13 (6): 3387. <https://doi.org/10.3390/su13063387>
- European Commission (2020, October 6): Guidelines for the Implementation of the Green Agenda for the Western Balkans. Brussels. (available at <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020SC0223>)
- Filipiak, M. (2018). A better understanding of bee nutritional ecology is needed to optimize conservation strategies for wild bees—the application of ecological stoichiometry. *Insects*, 9 (3): 85. <https://doi.org/10.3390/insects9030085>
- Garforth, C., Angell, B., Archer, J., & Green, K. (2003). Fragmentation or creative diversity? Options in the provision of land management advisory services. *Land Use Policy*, 20 (4): 323-333. [https://doi.org/10.1016/S0264-8377\(03\)00035-8](https://doi.org/10.1016/S0264-8377(03)00035-8)
- Gill, R.J., Baldock, K.C.R., Brown, M.J.F., Cresswell, J.E., Dicks, L. V., Fountain, M.T., Garratt, M.P.D., Gough, L.A., Heard, M.S., Holland, J.M., Ollerton, J., Stone, G.N., Tang, C.Q., Vanbergen, A.J., *et al.* (2016). Protecting an Ecosystem Service: Approaches to Understanding and Mitigating Threats to Wild Insect Pollinators. *Adv. Ecol. Res.*, 54, 135–206. <https://doi.org/10.1016/bs.aacr.2015.10.007>

- Golijan Pantović, J., Dimitrijević, B., Popović, V., Popović, A., Ikanović, J., & Sečanski, M. (2025). Organic agriculture in Serbia-share of barley in it. *Agric. For.*, 71 (1): 61-71. <https://doi:10.17707/AgricultForest.71.1.05>
- Goulson, D., Nicholls, E., Botías, C., & Rotheray, E. L. (2015). Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. *Science*, 347 (6229): 1255957. <https://doi.org/10.1126/science.1255957>
- Hallmann, C. A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., ... & De Kroon, H. (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PloS one*, 12 (10): e0185809. <https://doi.org/10.1371/journal.pone.0185809>
- Ignjatijević, S. D., Prodanović, R. V., Bošković, J. Z., Puvača, N. M., Tomaš-Simin, M. J., Peulić, T. A., & Đuragić, O. M. (2019). Comparative Analysis of Honey Consumption in Romania, Italy and Serbia. *Food Feed Res.*, 46 (1): 125-136, <https://doi.org/10.5937/FFR1901125I>
- Klein, A.-M., Boreux, V., Fornoff, F., Mupepele, A.-C., & Pufal, G. (2018). Relevance of wild and managed bees for human well-being. *Curr. Opin. Insect Sci.*, 26, 82–88. <https://doi.org/10.1016/j.cois.2018.02.011>
- Markóć, M., & Krstajić, J. (2024). Multicriterial Analysis of Agroecological Vineyards in Montenegro: How Motivation Affects Viticulture? *Agric. For.*, 70 (3): 173-184. <https://doi.org/10.17707/AgricultForest.70.3.12>
- Matias, D.M., Leventon, J., Rau, A.L., Borgemeister, C., & von Wehrden, H. (2017). A review of ecosystem service benefits from wild bees across social contexts. *Ambio*, 46 (4): 456-467. <https://doi.org/10.1007/s13280-016-0844-z>
- Mizik, T. (2021). Agri-food trade competitiveness: A review of the literature. *Sustainability*, 13 (20): 11235. <https://doi.org/10.3390/su132011235>
- Norman, G. (2010). Likert scales, levels of measurement and the “laws” of statistics. *Adv. Health Sci. Educ. Theory Pract.*, 15 (5): 625–632. <https://doi.org/10.1007/s10459-010-9222-y>
- Padel, S. (2001). Conversion to organic farming: a typical example of the diffusion of an innovation? *Sociol. Rural.*, 41 (1): 40-61. <https://doi.org/10.1111/1467-9523.00169>
- Patel, V., Pauli, N., Biggs, E., Barbour, L., & Boruff, B. (2021). Why bees are critical for achieving sustainable development. *Ambio*, 50 (1): 49-59. <https://doi.org/10.1007/s13280-020-01333-9>
- Pocol, C. B., Marghitas, L. A., & Popa, A. A. (2012). Evaluation of sustainability of the beekeeping sector in the North West Region of Romania. *J. Food Agric. Environ.*, 10 (3-4): 132-138.
- Pocol, C. B., Šedík, P., Brumă, I. S., Amuza, A., & Chirsanova, A. (2021). Organic Beekeeping Practices in Romania: Status and Perspectives towards a Sustainable Development. *Agriculture*, 11 (4): 281. <https://doi.org/10.3390/agriculture11040281>
- Popescu, A. (2017). Bee honey production in Romania, 2007-2015 and 2016-2020 forecast. *Sci. Papers, Ser. Manag. Econom. Eng. Agric. Rural Dev.*, 17 (1): 339-349.
- Potts, S. G., Imperatriz-Fonseca, V., Ngo, H. T., Aizen, M. A., Biesmeijer, J. C., Breeze, T. D., ... & Vanbergen, A. J. (2016). Safeguarding pollinators and their values to human well-being. *Nature*, 540 (7632): 220-229. <https://doi.org/10.1038/nature20588>

- Prodanović, R.; Brkić, I.; Soleša, K.; Ljubojević Pelić, D.; Pelić, M.; Bursić, V.; & Vapa-Tankosić, J. (2024). Beekeeping as a Tool for Sustainable Rural Development. *J. Agron. Technol. Eng. Manag.*, 7 (2): 1054-1066. <https://doi.org/10.55817/IXVM2800>
- Puvača, N.; Bursić, V, Vapa-Tankosić, J., Prodanović, R., Vuković, G., Vještica , S.Lekić, S., Vapa, I., & Gvozdenac, S. (2024). Toxicological assessment of honey for conventional and organic production and risk assessment for public health, *J. Cent. Eur. Agric.*, 25 (2): 554-566, <https://doi.org/10.5513/JCEA01/25.2.4210>
- Science for Environment Policy (2020). Pollinators: importance for nature and human well-being, drivers of decline and the need for monitoring. Future Brief 23. Brief produced for the European Commission DG Environment. Bristol: Science Communication Unit, UWE Bristol (available at https://environment.ec.europa.eu/publications/pollinators-brief-importance-nature-and-human-well-being-drivers-decline-and-need-monitoring_en)
- Simon-Delso, N., Amaral-Rogers, V., Belzunces, L. P., Bonmatin, J. M., Chagnon, M., Downs, C., ... & Wiemers, M. (2015). Systemic insecticides (neonicotinoids and fipronil): trends, uses, mode of action and metabolites. *Environ. Sci. Pollut. Res.*, 22 (1): 5-34. <https://doi.org/10.1007/s11356-014-3470-y>
- Singh, K., & Deore, C. R. (2025). Effects of Climate Change on Phenological Shifts and Pollination Dynamics in Native Flora. *Int. J. Res. Technol.*, 13 (3): 444-454.
- Statistical Office of the Republic of Serbia (SORS) (2023). Number of beehives by years - Republic of Serbia. (available at <https://data.stat.gov.rs/Home/Result/130202010207?languageCode=sr-Latn>)
- Tadesse, B., Tilahun, Y., Woyamo, W., Bayu, M., & Adimasu, Z. (2021). Factors influencing organic honey production level and marketing: evidence from southwest Ethiopia. *Heliyon*, 7 (9): e07975. <https://doi.org/10.1016/j.heliyon.2021.e07975>
- Tsvetkov, N., Samson-Robert, O., Sood, K., Patel, H. S., Malena, D. A., Gajiwala, P. H., ... & Zayed, A. (2017). Chronic exposure to neonicotinoids reduces honey bee health near corn crops. *Science*, 356 (6345): 1395-1397. <https://doi.org/10.1126/science.aam747>
- Underwood, R. M., Lawrence, B. L., Turley, N. E., Cambron-Kopco, L. D., Kietzman, P. M., Traver, B. E., & López-Urbe, M. M. (2023). A longitudinal experiment demonstrates that honey bee colonies managed organically are as healthy and productive as those managed conventionally. *Sci. Rep.*, 13 (1): 6072. <https://doi.org/10.1038/s41598-023-32824-w>
- Vapa-Tankosić J., Ignjatijević S., Kranjac M., Lekić S., & Prodanović R. (2018). Willingness to pay for organic products on the Serbian market. *Int. Food Agribus. Manag. Rev.*, 21 (6): 791-801. <https://doi.org/10.22434/IFAMR2017.0068>
- Vapa-Tankosić, J., & Vapa, B. (2025). Sustainable agriculture within the framework of the Common Agricultural Policy: organic beekeeping in the Republic of Serbia and the European Union. Scientific conference with international participation Political and economic aspects of family entrepreneurship in the context of the Green Agenda for the Western Balkans with the application of artificial intelligence. *International Academy of Sciences, Arts and Security*, Vol. 1 [pp. 153-170] (available at <https://doi.ub.kg.ac.rs/doi/manub25-153vt/>)

- Vapa-Tankosić, J., Ignjatijević, S., Kiurski, J., Milenković, J., & Milojević, I. (2020a). Analysis of consumers' willingness to pay for organic and local honey in Serbia, *Sustainability* 12 (11): 4686. <https://doi.org/10.3390/su12114686>
- Vapa-Tankosić, J., Miler-Jerković, V., Jeremić, D., Stanojević, S., & Radović, G. (2020b). Investment in Research and Development and New Technological Adoption for the Sustainable Beekeeping Sector, *Sustainability*, 12 (14): 5825. <https://doi.org/10.3390/su12145825>
- Vercelli, M., Novelli, S., Ferrazzi, P., Lentini, G., & Ferracini, C. (2021). A qualitative analysis of beekeepers' perceptions and farm management adaptations to the impact of climate change on honey bees. *Insects*, 12 (3): 228. <https://doi.org/10.3390/insects12030228>
- Wakgari, M., & Yigezu, G. (2021). Honeybee keeping constraints and future prospects. *Cogent Food Agric.*, 7 (1): 1872192. <https://doi.org/10.1080/23311932.2021.1872192>
- Willer, H., Schlatter B., & Trávníček J. (Eds.) (2023). *The World of Organic Agriculture, Statistics and Emerging Trends 2023*. Research Institute of Organic Agriculture FiBL, Frick, and IFOAM - Organics International, Bonn. (available at <https://www.fibl.org/fileadmin/documents/shop/1254-organic-world-2023.pdf>)
- Woodcock, B. A., Bullock, J. M., Shore, R. F., Heard, M. S., Pereira, M. G., Redhead, J., ... & Pywell, R. F. (2017). Country-specific effects of neonicotinoid pesticides on honey bees and wild bees. *Science*, 356 (6345): 1393-1395. <https://doi.org/10.1126/science.aaa1190>
- Zec Vojinović, M., Čehić Marić, A. & Oplanić, M. (2025). Factors influencing farmers' adoption and willingness to accept sustainable production practices in Istria County, Croatia. *J. Cent. Eur. Agric.*, 26 (2): 495-509. <https://doi.org/10.5513/JCEA01/26.2.4506>