Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 25, Issue 3, 2025
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ANALYSIS OF THE BEEKEEPING PERFORMANCE OF EUROPEAN UNION COUNTRIES USING THE SAW METHOD

Tayfun ÇUKUR[1], Ferruh IŞIN[2], Figen ÇUKUR[1]

[1]Muğla Sıtkı Koçman University, Milas Vocational School, Milas, Muğla, Türkiye, E-mails: tayfunc@mu.edu.tr, figenc@mu.edu.tr
[2]Ege University, Faculty of Agriculture, Department of Agricultural Economics, Izmir-Türkiye
E-mail: ferruh.isin@ege.edu.tr

Corresponding author: tayfunc@mu.edu.tr

Abstract

The current study was conducted to analyse the beekeeping performance of some European Union countries. The data for the study were obtained from the records of the European Commission. The SAW method was used in the study and the criteria of the number of beehives, honey production, producer prices and honey export volume were used to determine the beekeeping performance of the countries. The study determined that Spain, Germany and Poland have the best beekeeping performance among the European Union countries. It is concluded that it is important to take measures to improve the production of beekeeping products in European Union countries and to ensure the long-term sustainability of beekeeping.

Key words**:** *beekeeping, European Union, SAW (Simple Additive Weighting) method*

INTRODUCTION

Beekeeping is an important supportive enterprise in small family agriculture to utilise family labour and provide additional income. In addition, beekeeping is an important activity in terms of economic, environmental and social sustainability that can be transferred from generation to generation. [12, 19]. Pollinators, including honeybees, bumblebees and wild bees, are estimated to contribute at least 22 billion Euros annually to the European agricultural industry. They pollinate more than 80% of agricultural and wild plants in Europe. Honeybees also provide honey and other beekeeping products such as pollen, beeswax used in food processing, propolis used in food technology and royal jelly, which is used as a dietary supplement and food ingredient [1].
Beekeeping activities carried out in almost all countries of the European Union provide an annual added value of approximately one billion euros in European agriculture [5]. Among the European Union countries, Germany, Romania, Italy and Greece are the countries where beekeeping is intensively practised. In 2022, the total number of beehives in the European Union was approximately 20.3 million, 285.7 thousand tonnes of honey was produced and the yield per beehive was 14.09 kilograms [2].
The EU is the second-largest honey producer in the world. Beekeeping is one of the sectors supported within the EU. In the European Union, beekeeping will be supported with a total of 610 million Euros from both national funds and EU funds between 2023 and 2027. These supports will cover investments in combating beehive diseases, adapting to climate change, restocking beehives and increasing their numbers. Promotional activities, consultancy services and training will also be financially supported [3].
For the European Union, beekeeping is an essential branch of agriculture that has recently gained special attention due to the effects of climate change and the use of pesticides in crop production. The European Union provides support through National Beekeeping Programs to improve production and support the marketing of beekeeping products [9].
There is a high level of heterogeneity within the beekeeping industry in the European Union [4]. Factors such as the climate, flora, biodiversity and colony numbers in each

country are some of the reasons for these differences.

In this regard, the purpose of the current study is to evaluate the beekeeping performance of European Union countries.

MATERIALS AND METHODS

Data collection

The data for the study were obtained from the records of the European Commission and FAO. In addition, previously published studies conducted using the SAW method on the subject were utilized.

The variables used in the study are from the year 2022. The European Union countries to be included in the study were determined by the availability of data.

The European Union countries (Spain, Romania, Greece, Poland, Italy, Hungary, Germany, Bulgaria, Czech Republic, Portugal, Austria, Croatia, Lithuania, Slovenia, Denmark, Latvia, the Netherlands, Belgium, Finland, Estonia and Ireland) that met the established criteria related to beekeeping were included in the study.

Methods used

In the study, the SAW method was used to evaluate the beekeeping performance of European Union countries. Four criteria were considered while evaluating the performances. These criteria are the number of beehives, honey production, producer prices and honey export volume. SAW (Simple Additive Weighting), which is stated to be the most widely used method in many studies, was first used by Churchman and Ackoff in a portfolio selection problem. The fundamental concept of the SAW method is to find a weighted sum of each alternative's performance across all attributes. The SAW method requires the process of normalizing the decision matrix (X) to a scale that allows comparison of all ratings of the alternatives [8].

In the SAW method, the decision-maker assigns a relative weight value to each attribute. The total value is obtained by multiplying each category's weight value by the alternative value. Calculations using the SAW method are performed solely through the input of alternative values and the normalization of the matrix containing these alternative values [6].

The stages of the SAW model can be summarized as follows:

Formation of the decision matrix (x_{ij})

The first step in the SAW method involves creating a pairwise comparison matrix for each criterion in each alternative:

$$Xij = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \quad \text{Eq 1}$$

Here, x_{ij} represents the response of the pairwise comparison matrix given by alternative j for criterion i, where n represents the criteria and m represents the alternatives.

Determination of the criteria weights (w_i)

These weights can be considered as numbers ranging from 0 to 1 and can be represented as follows.

$$\sum_{i=1}^{n} w_i = 1 \quad \text{Eq 2}$$

Here, w_i is the criterion weight, and it must be equal to 1.

Normalization of the criterion value i for alternative j (r_{ij})

r is the term used to represent the normalized value of criterion i for alternative j.

The calculation of this value depends on whether the problem is of a cost or benefit type. In cost problems, the goal is to minimize the value while in benefit problems, the goal is to maximize the value.

These differences are reflected in the calculation of r as follows:

$$r_{ij} = \frac{\min_j x_{ij}}{x_{ij}} \quad \text{if j is of a cost type} \quad \text{Eq 3}$$

$$r_{ij} = \frac{x_{ij}}{\max_j ij} \quad \text{if j is of a benefit type} \quad \text{Eq 4}$$

Determination of the alternative ranking

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \quad \text{Eq 5}$$

Here, *V* is the preference value of the alternative. A larger value of *V* indicates that the alternative is more preferred.

RESULTS AND DISCUSSIONS

Preparation of the decision matrix

In the study, firstly the decision matrix was created. This matrix contains alternatives and criteria. In the created model, there are alternatives in the rows and criteria in the columns (Table 1).

Table 1. Decision matrix

Countries	X_1	X_2	X_3	X_4
Spain	2,923	27.4	5.89	28,370.4
Romania	2,355	29.80	2.22	12,182.8
Greece	2,249	21.5	9	6,741.2
Poland	2,181	24	7.66	15,036.2
Italy	1,834	24.5	5.3	5,770.9
Hungary	1,192	25	6.39	14,483.0
Germany	996	34.1	6.22	26,943.6
Bulgaria	823	11.9	4.49	12,738.1
Czech Republic	715	6.1	8.35	972.8
Portugal	710	11.5	6.57	10,999.3
Austria	480	4.5	11	1,465.2
Croatia	461	8.3	8.21	681.4
Lithuania	230	6	6.66	2,258.8
Slovenia	213	2.4	12.05	1,169.0
Denmark	126	2.4	7	2,756.9
Latvia	105	2.3	5	560.3
Netherlands	90	0.7	12.27	4,997.0
Belgium	75	2.7	14	32,116.5
Finland	78	3.3	16.79	12.1
Estonia	55	1.6	8	17.3
Ireland	27	0.3	20	352.6

Note: X_1= number of hives (1,000 units), X_2= honey production (1,000 tons), X_3= producer price (€/kg), X_4= honey export quantity (tons)
Source: [2, 10].

Determination of criteria weights

In the study, it was assumed that the weights of the four criteria included in the model were equal to each other. Thus, the weight of each criterion was accepted as 1/4 = 0.25.

Normalization of the decision matrix and weighted decision matrix

In the first stage, since the variables represent a benefit condition, the decision matrix is normalised using the formula in Equation 4. (Table 2). Then, each variable in the normalised decision matrix was multiplied by the criteria weights to obtain a weighted decision matrix (Table 3).

The process of ranking the alternatives

In the final stage of the SAW method, the V_i values are obtained using the formula in Equation 5. The highest obtained V_i value is considered the best alternative. When Table 4 is examined, it is seen that Spain, Germany and Poland have the best beekeeping performances among the EU countries. Similarly, in the study conducted by [7], Spain is stated to be the largest honey-producing country in the EU.

Spain ranks first among European Union countries in terms of hive population, with a 15% share [5].In the study conducted by [18], it was stated that 280,000 tons of honey were produced in the EU in 2019, with 76.44% of this amount produced by the largest producer countries: Spain, Romania, Hungary, Germany, Greece, Poland, France, Italy and Bulgaria. After Spain, Romania has a good position as a honey producer in the EU and its honey is of a high quality, this being the reason why it is exported in higher and higher amounts [11, 17].

Table 2. Normalized decision matrix

Countries	X_1	X_2	X_3	X_4
Spain	1.000	0.804	0.295	0.883
Romania	0.806	0.874	0.111	0.379
Greece	0.769	0.630	0.450	0.210
Poland	0.746	0.704	0.383	0.468
Italy	0.627	0.718	0.265	0.180
Hungary	0.408	0.733	0.320	0.451
Germany	0.341	1.000	0.311	0.839
Bulgaria	0.282	0.349	0.225	0.397
Czech Republic	0.245	0.179	0.418	0.030
Portugal	0.243	0.337	0.329	0.342
Austria	0.164	0.132	0.550	0.046
Croatia	0.158	0.243	0.411	0.021
Lithuania	0.079	0.176	0.333	0.070
Slovenia	0.073	0.070	0.603	0.036
Denmark	0.043	0.070	0.350	0.086
Latvia	0.036	0.067	0.250	0.017
Netherlands	0.031	0.021	0.614	0.156
Belgium	0.026	0.079	0.700	1.000
Finland	0.027	0.097	0.840	0.000
Estonia	0.019	0.047	0.400	0.001
Ireland	0.009	0.009	1.000	0.011

Note: X_1= number of hives (1,000 units), X_2= honey production (1,000 tons), X_3= producer price (€/kg), X_4= honey export quantity (tons)
Source: Calculated by the authors.

Table 3. Weighted normalized decision matrix

Countries	X_1	X_2	X_3	X_4
Spain	0.250	0.201	0.074	0.221
Romania	0.201	0.218	0.028	0.095
Greece	0.192	0.158	0.113	0.052
Poland	0.187	0.176	0.096	0.117
Italy	0.157	0.180	0.066	0.045
Hungary	0.102	0.183	0.080	0.113
Germany	0.085	0.250	0.078	0.210
Bulgaria	0.070	0.087	0.056	0.099
Czech Republic	0.061	0.045	0.104	0.008
Portugal	0.061	0.084	0.082	0.086
Austria	0.041	0.033	0.138	0.011
Croatia	0.039	0.061	0.103	0.005
Lithuania	0.020	0.044	0.083	0.018
Slovenia	0.018	0.018	0.151	0.009
Denmark	0.011	0.018	0.088	0.021
Latvia	0.009	0.017	0.063	0.004
Netherlands	0.008	0.005	0.153	0.039
Belgium	0.006	0.020	0.175	0.250
Finland	0.007	0.024	0.210	0.000
Estonia	0.005	0.012	0.100	0.000
Ireland	0.002	0.002	0.250	0.003

Note: X_1= number of hives (1,000 units), X_2= honey production (1,000 tons), X_3= producer price (€/kg), X_4= honey export quantity (tons)
Source: Calculated by the authors.

In the study conducted by Nikolova et al [15], it is stated that the EU is the world's second largest producer of bee products and is recognised as an important role in the world beekeeping market. In the study conducted by Jarka and Trajer [14], it is stated that the beekeeping sector is supported within the framework of the Common Agricultural Policy. In this respect, it is emphasised that Spain, France, Greece, Romania, Italy and

Poland receive the most support from the EU budget.

Table 4. Ranking of V_i values

Countries	V_i	Rank
Spain	0.10554	1
Romania	0.07682	4
Greece	0.07292	5
Poland	0.08146	3
Italy	0.06339	8
Hungary	0.06767	6
Germany	0.08817	2
Bulgaria	0.04431	9
Czech Republic	0.03084	14
Portugal	0.04429	10
Austria	0.03157	13
Croatia	0.02948	15
Lithuania	0.02329	18
Slovenia	0.02769	17
Denmark	0.01945	19
Latvia	0.01313	21
Netherlands	0.02904	16
Belgium	0.06389	7
Finland	0.03410	12
Estonia	0.01651	20
Ireland	0.03643	11

Source: Calculated by the authors.

In the study conducted by Perichon et al [16], it is stated that beekeepers in Southern Europe face economic difficulties due to threats such as climate change and pests, while these same threats have not yet affected the northern countries to the same extent.

CONCLUSIONS

Beekeeping is an important enterprise in the agricultural sector, contributing to economic and ecological sustainability. It also makes important contributions to the development of rural areas. In addition, honeybee species also makes important contributions to human health and nutrition. Honeybee products such as honey, beeswax, royal jelly, pollen, propolis and bee venom are important food products used by humans. Bee products are also used as raw materials in many industries from food to cosmetics. Honeybee colonies play a crucial role in agricultural production through pollination and contribute to biodiversity [13]. The study examined the beekeeping indicators of some European Union countries. The SAW method, one of the multi-criteria decision-making methods, was used in the study. According to the results of the SAW analysis based on the number of hives, honey production, producer price and honey export amount criteria, Spain ranked first in the performance ranking, followed by Germany and Poland.

In European Union countries, beekeeping is an increasingly important production activity in agricultural economy. In addition to providing bee products, bees contribute to the pollination of plants. Therefore, beekeeping should continue to be supported in EU countries. As climate change and global warming affect every area of agriculture, they also impact beekeeping. Therefore, necessary precautions should be taken to prevent bees from being affected by climate change and global warming. Maximum care should be taken to prevent bees from being affected by pesticides.

REFERENCES

[1]Anonymous, 2025a, Honey Bees, https://food.ec.europa.eu/animals/live-animal-movements/honey-bees_en, Accessed on January 30, 2025.

[2]Anonymous, 2025b, Honey Market Presentation, https://agriculture.ec.europa.eu/document/download/c04a9774-5ba3-41f5-b256-08396b2888ec_en?filename=market-presentation-honey_spring2024_en.pdf, Accessed on January 30, 2025.

[3]Anonymous, 2025c, Clearer Rules on Origin and Composition of Honey: Commission Sets up Honey Platform, https://agriculture.ec.europa.eu/news/clearer-rules-origin-and-composition-honey-commission-sets-honey-platform-2024-06-13_en, Accessed on January 30, 2025.

[4]Bienkowska, M., Los, A., Wegrzynowicz, P., 2020, Honey Bee Queen Replacement: An Analysis of Changes in the Preferences of Polish Beekeepers through Decades, Insects, 11(544),1-13.

[5]Cavlin, M., Prdic, N., Ignjatijevic, S., Tankosic, J.V., Lekic, N., Kostic, S., 2023, Research on The Determination of the Factors Affecting Business Performance in Beekeeping Production, Agriculture, 13(686),1-22.

[6]Daniati, E., Utama, H., 2019, Clustering K Means for Criteria Weighting With Improvement Result of Alternative Decisions Using SAW and TOPSIS. 2019, 4th International Conference on Information Technology, Information Systems and Electrical Engineering, November 20-21, 2019, Yogyakarta, Indonesia, pp. 73-78.

[7]De La Rua, P., Jimenez, Y., Galian, J., Serrano, J., 2004, Evaluation of the Biodiversity of Honey Bee (*Apis Mellifera*) Populations from Eastern Spain. Journal of Apicultural Research, 43(4), 162-166.
[8]Deni, W., Sudana, O., Sasmita, A., 2013, Analysis and Implementation Fuzzy Multi-Attribute Decision Making Saw Method for Selection of High Achieving Students in Faculty Level. International Journal of Computer Science Issues. 10(1), 674-680.
[9]Dumitrescu, C.S., Salașan, C., Pet, E., Stanciu, S.M., Raul, P., 2022, Aspects Regarding the Evolution of Apiculture. 22nd International Multidisciplinary Scientific GeoConference, December 6-8, 2022, Vienna, Austria, pp.675-682.
[10]FAO, 2025. Crops and Livestock Products. https://www.fao.org/faostat/en/#data/TCL., Accessed on 02 May 2025.
[11]Grigoras, M.A., 2018, SWOT analysis in Romania's apiculture, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18(4), 129-141.
[12]Guine, R.P.F., Mesquita, S., Oliveira, J., Coelho, C., Costa, D.T., Correia, P., Correia, H.E., Dahle, B., Oddie, M., Raimets, R., Karise, R., Tourino, L., Basile, S., Buonomo, E., Stefanic, I., Costa, C.A., 2019, Characterization of Beekeepers and their Activities in Seven European Countries, Agronomy, 11(2398), 1-17.
[13]Iatridou, D., Pohl, L., Gajger, I.T., De Briyne, N., Bravo, A., Saunders, J., 2019, Mapping the Teaching of Honeybee Veterinary Medicine in the European Union and European Free Trade Area. Veterinary Record Open, 6,1-10.
[14]Jarka, S., Trajer, M., 2018, Support for the Beekeeping Sector in Poland and the European Union. Scientific Journal Warsaw University of Life Sciences, 18(4), 183-191.
[15]Nikolova, T., Dimitrova, I., Teneva, A., 2023, The Development of Beekeeping in Bulgaria and the European Union in the Last Ten Years. An Overview. Zhivotnovadni Nauki, 60(1), 37-45.
[16]Perichon, S., Adamchuk, L., Biber, L., Bozic, J., Chlebo, R., Filipı, J., Leidenberger, S., Mavrofridis, G., Ozgor, E., Pocol, C., Porporato, M., Rodriguez-Flores, M.S., Vilas-Boas, M., Zacepins, A., 2024, Perception of Threats to Bee Colonies and the Future of Local Beekeeping by Beekeepers in Various European Countries. Bulletin de la Societe Geographique de Liege, 82,19-46.
[17]Popescu, A., 2017, Bee honey production in Romania, 2007-2015 and 2016-2020 forecast, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 17(1), 339-349.
[18]Popescu, A., Dinu, D.A., Stoian, E., Șerban, V., 2021, Honey Production in the European Union in the Period 2008-2019- A Statistical Approach, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 21(2), 461-474.
[19]Popescu, C.R.G., Popescu, G.N., 2019, The Social, Economic, and Environmental Impact of Ecological Beekeeping in Romania in Agrifood Economics and Sustainable Development in Contemporary Society; IGI Global: Hershey, PA, USA, pp. 75–96.