Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 20, Issue 3, 2020
PRINT ISSN 2284-7995, E-ISSN 2285-3952

BEE HONEY PRODUCTION CONCENTRATION IN ROMANIA IN THE EU-28 AND GLOBAL CONTEXT IN THE PERIOD 2009-2018

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Abstract

The paper analyzed honey production concentration in Romania in the period 2009-2018 using the specific indicators: number of beekeepers, bee hives, honey production and yield per bee hive, and methods like: trend equation, Herfindhal-Hirschman concentration index (HHI), regression models, correlations and determination coefficients to examine the gains in comparison with the period 2007-2016. The results pointed out that both the number of bee colonies and honey production increased in a high measure, only honey yield remained stable (20 kg/year). In 2018, Romania came on important positions in the EU-28 top honey producing countries as follows: 2nd position for 1,689.5 thousand bee hives, 1st position for 30,000 tons honey production, 3rd position for 80 average number of bee hives per apiary, and 18th position for 20 kg honey yield per bee hive. In 2018, the distribution of the bee hives and honey production in the territory was: 18.5% South West Oltenia, 16.2% South East, 14.6% North West, 13.6% South Muntenia, 13.3 % North East, 12% Center, 10.6% West and 1.2% Bucharest-Ilfov. Compared to 2009, honey production increased in 2018 in almost all the micro-regions, except North East, where it remained stable. HHI indices had values below 0.15 reflecting a low concentration. Compared to the period 2007-2016, in the interval 2009-2018, the mean for the number of bee hives and honey production increased, the correlation and determination coefficients recorded higher values for the pair of indicators: honey production and the number of bee hives and for the honey production and yield, while for the average yield and the number of bee hives the values were smaller. Regression equations attested that honey production is about 50% determined by the number of bee hives and in smaller proportion by honey yield. Beekeeping has to continue to develop for assuring the pollination of the agricultural crops, the preservation of biodiversity and environment and for providing healthy products for consumers, jobs and incomes for the rural population. The EU and National Programmes for Apiculture will strengthen this sector keeping pace with the increased competitiveness on the EU honey market.

Key words**:** *bee hives, honey production, concentration, Romania*

INTRODUCTION

Having in mind the landmark scientific treatise "On the Origin of Species" by Charles Darwin (1859) who mentioned "The life of man would be made extremely difficult if the bee disappeared.",
"The Life of the Bee" written by Maurice Maeterlinck (1901) and quotes such as: "Remove the bee from the earth and at the same stroke you remove at least one hundred thousand plants that will not survive", attributed to Albert Eistein (1941), as mentioned in the "Canadian Bee Journal", and "If all bees disappeared off the earth, four years later all humans would also have disappeared", also attributed to Albert Eistein who made this calculus, as mentioned in 1965 in "Abeilles et Fleurs", we can not deny the importance of bees and beekeeping on the Earth [38].
Bees give and preserve life, produce healthy products for humans (honey, propolis, royal jelly, beewax, bee venom etc), help farmers pollinating their cultivated crops and preserve biodiversity and environment.

In their hard activity to collect nectar and pollen to nourish the family, bees are flying for kilometers from a flower to another. About 77% of the existing plants on the Earth are pollinated by bees. Grace to bees fruit trees and bushes, agricultural crops (sunflower, rape, linen, mustard, various leguminous plants, melons, strawberries, etc) are pollinated and assure a high production and food for people, the production gain exceeding more than 15 times the value of the apicultural products [40, 43].

Beekeeping is an important activity in the rural areas but also in the surroundings of the urban ones, offering a pleasant job outdoor and bringing important incomes to beekeepers.

Romania is the first among the top honey producing countries in the EU: Spain, Hungary, Germany, Italy, Greece, France, and Poland. Beekeeping has a long tradition in Romania for more than 2,500 years and its performance is due to the good geographical position, variety of relief forms, a temperate continental climate, a large range of wild flora and cultivated agricultural crops, experienced beekeepers and first of all *Apis Mellifera Carpatica*, the most valuable bee able to produce honey and pollen of an exceptional quality. Beekeeping is practiced in all the eight micro-regions of development which prove that the country has a high potential for producing honey and other apicultural products. This activity is practiced fulltime or part-time, it is a healthy job being run outdoors and brings satisfactions and incomes to the apiculturists. Honey production is high in Romania covering the internal market needs and also assuring deliveries to export representing more than 60 % of output. Romanian honey is well appreciated in the Western European countries Germany, United Kingdom, Nordic countries, Italy being the most important beneficiaries [29, 32,34, 36].

In the EU, all the countries are practicing apiculture in various breeding systems and production conditions. Bee products are well appreciated by consumers that is why the EU would like to produce more honey to cover consumers' demand. Despite that the EU comes on the 2nd position in the world as a honey producer after China, internal production is not enough and this oblige the EU to import honey from China, Ukraine, Argentina etc. [4, 21, 23].

According to the EU programmes of apiculture development for the near future, a more and more importance is given to honey production growth and quality which needs important funds to help beekeepers to increase the number of bee hives and apiary size, to improve bee family power and apiary endowment, to make innovation and modernization and assure a high quality of honey, even to extend organic honey production and increase efficiency along honey chain.

In this context, the purpose of the paper was to analyze the number of bee hives, honey production and yield per bee hive in order to assess the concentration degree of honey production in Romania at the national and territorial level in the period 2009-2018 compared to the period 2007-2016 and other EU-28 top producing countries.

This research continues the investigations started in the earlier studies [21, 23, 34, 36] in order to bring more arguments in terms of correlations and regression models which reflect the increase of honey production concentration in the two periods mentioned above.

MATERIALS AND METHODS

Data collection

The data used in this research were collected from various sources such as: National Institute of Statistics Tempo Online, Eurostat, Faostat, Knoema and others. The period includes the last decade 2009-2010 [3, 4, 5, 6, 15].

The following specific indicators used in this study have been the following ones: (i) number of beekeepers; (ii) number of bee hives at the national level and in the territory by micro region of development; (iii) number of bee hives per apiary; (iv) extracted honey production at the national level and in the territory by micro region of development; (v) honey yield per bee hive at the national level and in the territory by micro region of

development; (vi) concentration of the number of bee hives; (vii) concentration of honey production; (vii) efficiency in honey production at apiary level.

Methodological aspects

In this study, there were used the following methods:

Index method, based on the Index with fixed basis, whose formula is: $I_{t/t0} = (X_t/X_0)100$, where X_t is the level of the indicator X in the last year of the analysis, 2018, and X_0 is the level of the same indicator X in the first year of the analysis, 2009;

The trend method based on various mathematical models suitable to the distribution of the values of each analyzed indicators in the graph; the models used in this study were the linear regression equation, $Y = bx + a$,

and polynomial equation,

$Y = ax^2 + bx + c$.

Descriptive statistics including mean, standard deviation and coefficient of variation was determined for number of bee hives at the national level, honey production and honey yield in the period 2009-2018 versus 2007-2016;

The comparison method destined to identify the similarities and discrepancies between Romania and the other top honey producing countries in the EU-28, and also between various regions of development in the country;

The structural index (SI%) reflecting the share of an item in the total level of an indicator. This index was used to analyze the dispersion of the number of bee hives, honey production and honey yield in the territory by micro-region, and also to establish the market share of Romania among the EU-28 top 10 honey producing countries.

Herfindahl-Hirschman Index, HHI, was used to express the concentration of the number of bee families and honey production, using the formula:

$$HHI = \sum_{i=1}^{n} (g_i)^2$$

where: $g_i = \frac{X_i}{\sum_{i=1}^{n} X_i} = \frac{X_i}{X_j}$

i = the micro-region of development, i = 1,2,....8;

X_i = the value of the analyzed variable in the micro-region i;

X_j = the value of the variable at the country level;

g_i = the share of the micro-region i in the value of the variable at the country level, X_j.

The correlation coefficient as well as *R square* were used to assess in what measure the variation of the dependent variable is determined by the change of the independent variable. For this purpose the following three pairs of indicators were studied: honey production and honey yield, honey production and number of bee hives, honey yield and number of bee hives. The values of the correlations coefficients were compared between the two periods 2009-2018 and 2007-2016.

Regression models were established for the three pairs of indicators mentioned above and then they were compared in the two period of time taken into consideration 2009-2018 and 2007-2016.

The results were explained and commented and presented in tables and graphics, and the corresponding interpretations and comments were added. The main ideas resulting from this research were presented at conclusions.

RESULTS AND DISCUSSIONS

Number of beekeepers

During the last decade, the number of beekeepers in Romania increased grace to the National Programme for Apiculture for the period 2011-2013 approved in 2010 by the EU based on CE Regulation no.1234/2007 [1, 13].

Also, the National Programme for Apiculture for the period 2020-2022 is destined to continue the improvement of honey and other bee products output in Romania and their commercialization by offering financial support to the apiculturists to assure the apiary inputs and sustaining the marketing of the bee products [14].

This reflects the interest on the development of apiculture in Romania as a recognition of its tradition and performance in beekeeping

across the time and of its importance in agriculture and rural areas.

The need to grow honey production in the EU is one of the objectives of the Common Agricultural Policy, because honey demand is higher than the internal supply and, to assure consumption, it is needed to import honey. More than that, bee colonies are important for pollination of the agricultural crops and are a component of biodiversity which must be preserved.

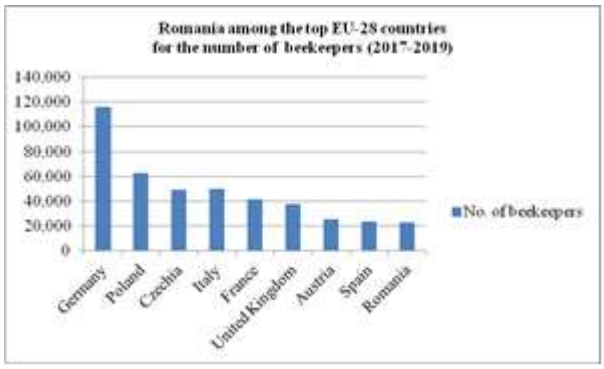

Fig. 1. Romania's position in the EU-28 for the number of beekeepers, 2017-2019
Source: Own design based on the data from [3, 4].

In 2018, Romania had 22,930 apiculturists placing the country on the 9th position in the EU after Germany, Czech Republic, Italy, France, United Kingdom, Austria and Spain. The share of Romania in the total number of 606,082 beekeepers existing in the EU-28 was 3.8 %. All these nine countries summed 70.7 % of the total number of apiculturists in the EU (Fig.1).

The number of apiculturists is expected to reach 23,161 meaning a surplus of 1 % in the period 2020-2022 compared to 2017-2019. At the EU level, in the period 2020-2022 it is expecting that the number of beekeepers to be 652,305, by 7.62% more than in the last three years.

Number of bee hives

A general ascending trend was noticed regarding the bee colonies whose number accounted for 1,689,500 in the year 2018 compared to 1,057,186 in 2009, meaning by 59.8% more than at the beginning of the studied period. The average annual growth rate in the analyzed period was 5.98% (Fig. 2). This aspect was stimulated by the interest of beekeepers to enlarge the apiary size in order to improve the extracted honey production and its efficiency, and also to benefit of the financial aid offered by the Government by means of the National Programme for Apiculture 2020-2022 which provides the conditions that the beekeeper to own at least 75 bee hives, to have certified competences in apiculture, the hives to be identified and registered by the National Agency for Zootechnics.

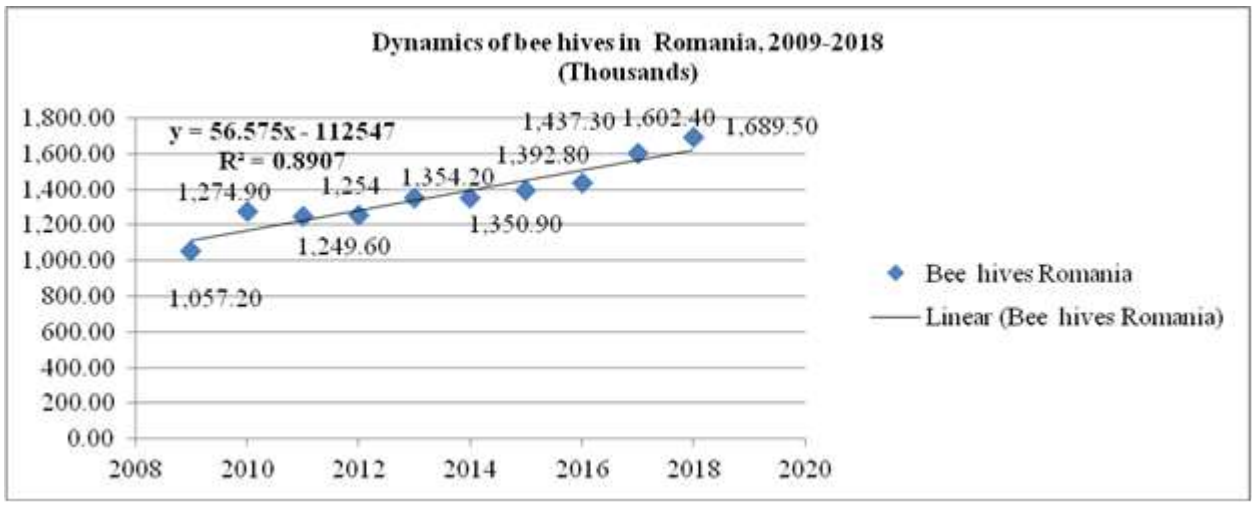

Fig. 2. The evolution of the number of bee hives in Romania, 2009-2018 (Thousands)
Source: Own design based on the data from [15].

According to Eurostat, for the number of bee hives, Romania came on the 4th position in the EU-28 in the year 2009, when there were 998,000 bee hives and on the 2nd position in

the EU after Spain for 1,849 thousands in the year 2018 (Table 1).

The data from Table 1 showed that in almost top 10 countries dealing with apiculture the number of bee hives increased in order to stimulate bee honey production, to better satisfy honey demand and grow the amount of honey destined to export.

Table 1. Romania's position among the top 10 EU-28 countries for the number of bee hives in 2018 versus 2009 (%)

2009			2018		
	EU-28	11,327,699 bee hives		EU-28	17,577,000 bee hives
Crt. No.	Country	%	Crt. No.	Country	%
1	Spain	21.09	1	Spain	16.84
2	Poland	12.80	2	Romania	10.52
3	Greece	11.82	3	Poland	9.29
4	Romania	8.81	4	Italy	8.50
5	France	7.81	5	France	8.27
6	Germany	6.13	6	Greece	7.74
7	Bulgaria	5.76	7	Hungary	7.03
8	Italy	4.41	8	Germany	5.00
9	Czech Republic	4.40	9	Bulgaria	4.45
10	Hungary	3.72	10	Portugal	4.36

Source: Own calculation based on [3].

The growth rate of the number of bee hives in the analyzed decade was the following one: 298.8 % in Italy, 293.82 % in Hungary, 240 % in Portugal, 85.2 % in Romania, 64.43 % in France, 26.50 % in Germany, 23.8% in Spain, 19,98 % in Bulgaria, 12.62 % in Poland, and 1.56 % in Greece. As a result, in 2018, all these 10 countries kept 82 % of the EU-28 number of bee hives.

Also, it is important to mention that the EU-28 reached 18.5 million bee hives representing 75 % of the number of bee hives existing in Europe.

This is a recognition of the importance allotted by the EU to beekeeping which is a very important sector in agriculture for assuring the pollination of the cultivated crops, for maintaining biodiversity, offering jobs and incomes for the rural population and for covering better the requirements in honey and other bee products on the EU-28 market where self-sufficiency in honey is only 60%.

Also, for its number of bee hives, in 2018, the EU-28 represented 22.65% of the 81.06 million bee hives worldwide.

The distribution of bee hives in Romania's territory

A relatively large variation regarding the dispersion of bee hives from a region to another is specific to Romania as there are many factors of influence such as: the local tradition in beekeeping, the existence of the floral resources for pickings, the floristic structure of the cropped and wild area, climate conditions etc.

In 2018, the number of bee hives by micro region of development was the following one: 324.4 thousands (19.2%) in South West Oltenia, 282.4 thousands (16.7%) in South East, 230.6 thousands (13.6%) in North West, 228.9 thousands (13.5%) in South Muntenia, 219.3 thousands (13%) in North East, 221.2 thousands (12.5%) in the Central part, 176.1 thousands (10.5%) in West and 16.5 thousands (1%) in Bucharest-Ilfov area. These figures show the existence of some discrepancies regarding the distribution of the bee hives in the territory.

In the period 2009-2018, the number of bee hives increased in all the micro regions as follows: +78.5% in the North West, +37.1 % in the Center, +52.7% in the North East, + 107.35% in South East, +38.9% in South Muntenia, +2.4% in Bucharest - Ilfov, +86.55 in South West Oltenia, and + 26.4% in the West.

During the analyzed decade, it was also noticed a change regarding the share of the region in the total number of bee hives at the country level as follows: either an increase of

the share of the number of bee hives like in North West, South East and South West Oltenia regions or a decline like in the Central part, North East, South Muntenia, Bucharest-Ilfov and West areas (Table 2).

Table 2. The distribution of bee hives by micro region in Romania in 2018 versus 2009 (%)

	2009	2018
Romania's number of bee hives (Thousands)	1,057.2	1,689.5
North West	12.2	13.6
Center	14.6	12.5
North East	13.6	13.0
South East	12.9	16.7
South Muntenia	15.6	13.5
Bucharest – Ilfov	1.5	1.0
South West Oltenia	16.5	19.2
West	13.1	10.5

Source: Own calculation based on the data from [15].

The number of bee hives per apiary

Romania comes on the 3rd position in the EU for the number of 80 bee hives per apiary after Greece (147 bee hives) and Spain (103 bee hives). Compared to the EU-28 average apiary size, Romania has in average a 4 times larger apiary (Fig. 3).

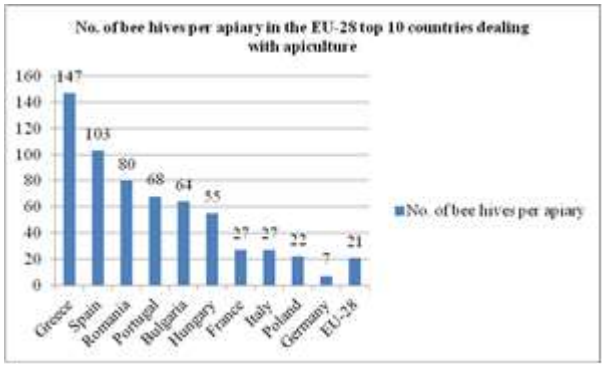

Fig. 3. Romania's positing among the EU-28 top 10 countries dealing with beekeeping
Source: Own design based on the data from [3].

If in 2004, the average apiary size was smaller than 50 bee hives, in a period of 14 years, Romania succeeded to raise its dimension to 80 bee hives, meaning an increase of 60 %. A higher size of the apiary is specific to a commercial company whose purpose is to produce more and increase the owner's profit [18, 19].

However, at present, in Romania there is a large variety of apiaries regarding the number of bee hives, ranging between 20 bee families in case of the beginners in beekeeping and about 600 bee families in case of the oldest apiculturist with an experience of more than 50 years. The structure of the apiary size is still dominated by the smaller apiaries having less than 100 bee families.

The research results in the counties of the South Muntenia region of Romania proved that apiary size is closely connected to economic efficiency in beekeeping, knowing that the higher the number of bee families per apiary, the higher honey production and apiculturist income and profit [26, 27, 28, 30, 31, 32].

Extracted honey production

Honey production registered a general increasing trend in Romania despite that during the studied interval there were noticed peaks and declines caused by the climate change which affected pickings. in spring season, usually cold rains appear when *Acacia* trees are in bloom, then in summer season long droughts diminish pickings at rape and sunflower also having a negative impact on honey production, as happened in 2009, 2014 and 2016 [44].

In 2018, honey production reached 29,162 tons being by 46.3% higher than in 2009 when it accounted for 19,937 tons (Fig. 4).

As mentioned by Eurostat, for the record of 30.9 thousand tons honey output, Romania came on the 1st position in the EU-28, being followed by Spain, Germany, Hungary, Italy, Poland, France, Greece, Bulgaria and Portugal. All these top 10 countries together produced 217.7 thousand tons representing 76.9% of the EU-28 honey output in 2018,

which accounted for 283 thousand tons [39, 42] (Fig. 5).

Fig.4. Dynamics of extracted honey production in Romania in the period 2009-2018 (tons)
Source: Own design based on the data from [15].

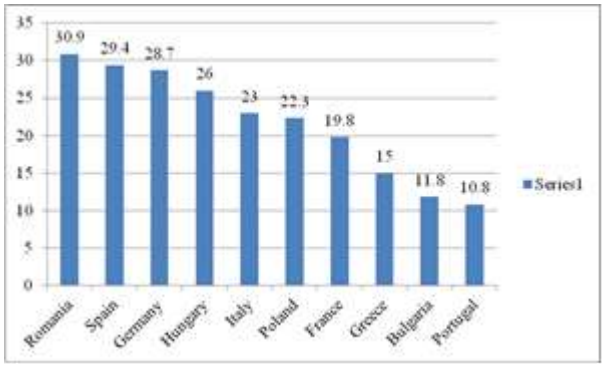

Fig.5. Romania's position among the EU-28 top 10 honey producing countries (Thousand tons)
Source: Own design based on the data from [3].

For its market share in the EU-28 honey output, Romania passed from the 3rd position in 2009 on the 1st one in 2018, and also other countries passed on higher positions such as Germany, Poland, Italy, France, and Greece (Table 3).

In 2018, all these top 10 countries produced 218.7 Thousand tons honey representing 77.27% of the EU-28 honey output.

Table 3. Romania's market share among the top 10 EU-28 honey producing countries in 2018 versus 2009 (%)

2009			2018		
	EU-28	204,725 Tons		EU-28	283,000 Tons
Crt. No.	Country	%	Crt. No.	Country	%
1	Spain	15.79	1	Romania	10.92
2	Hungary	11.00	2	Spain	10.38
3	Romania	9.74	3	Germany	10.14
4	Germany	8.04	4	Hungary	9.18
5	Greece	7.81	5	Poland	8.23
6	France	7.58	6	Italy	8.12
7	Poland	6.84	7	France	7.00
8	Italy	4.99	8	Greece	5.30
9	Bulgaria	4.65	9	Bulgaria	4.17
10	United Kingdom	4.01	10	Portugal	3.82

Source: Own calculation based on [3].

In the same year, the EU-28 contributed to the world honey production by 283 thousand tons, representing 15.28% of the global honey production which accounted for 1,851 thousand tons.

If we compare with the situation in 2009, when the EU-28 market share in the global honey output was 13.54 %, we may affirm that in 2018 the EU contribution to the world honey production was much higher.

However, at the global level, honey production is dominated by China with a share of 24%, followed by the EU - 28 with 15.2%, and then by other countries: Turkey 6%, Argentina 4%, Iran 4%, USA 4%, Ukraine 4%, Russia 4%, India 4% [5].

Distribution of honey production in the territory of Romania

It is a relatively large variation regarding the dispersion of honey production from a micro region to another and this is in close relationship with the number of bee hives distribution and also with the possibilities to assure the pickings of the bee colonies which depends in a high measure not only of the agricultural crops structure, the floristic composition of the wild flora, but also on the climate conditions.

In 2018, the contribution of the regions to the national honey production was the following one: 18.5% South West Oltenia, 16.2% South East, 14.6% North West, 13.6% South Muntenia, 13.3 % North East, 12% Center, 10.6% West and 1.2% Bucharest-Ilfov area. These figures are almost similar with the weight of the number of bee hives by region in the total number of hives existing in the country.

In the period 2009-2018, honey production increased in all the micro regions as follows: +75.5% in the North West, +8.9% in the Center, +52.5% in the North East, + 85% in South East, +47.1% in South Muntenia, +13.1% in Bucharest - Ilfov, +55.5 in South West Oltenia, and + 13.5% in the West.

During the analyzed decade, 2009-2018, it was also noticed a change regarding the share of the region in the total honey production at the country level as follows: either an increase like in North West, North East, South East, South Muntenia and South West Oltenia regions or a decline like in the Central part, Bucharest-Ilfov and West areas (Table 4).

Table 4. The distribution of honey production by micro region in Romania in 2018 versus 2009 (%)

	2009	2018
Romania's honey output (tons)	19,937	29,162
North West	12.1	14.6
Center	16.1	12.0
North East	12.8	13.3
South East	12.8	16.2
South Muntenia	13.5	13.6
Bucharest – Ilfov	1.5	1.2
South West Oltenia	17.4	18.5
West	13.8	10.6

Source: Own calculation based on the data from [15].

Honey yield per bee hive

A sinuous trend from a year to another was registered by honey yield for many reasons. First of all due to the higher growth rate of the number of bee hives in the analyzed interval, 59.8%, compared to 46.3% growth rate in honey production.

It is known that about 50 % of honey production depends on the number of bee hives as proved by [10].

Also, the picking opportunities were deeply influenced by the change in the climate conditions mainly in spring season when the trees in bloom were damaged by huge rainfalls or low temperatures and in summer season the hot weather and long and severe drought diminished the floral resources. In this way, the power of the bee hives was affected and the apiculturists had to make efforts to offer feed supplements.

The diseases caused by bacteria, viruses, parasites and fungi as well as bee intoxication and death determined by the chemical treatments (pesticides, insecticides, neonicotonoides) applied to cultivated crops have diminished the number of bee families by the so called "colony collapse disorder" and their production as well [34].

The year 2015 was the most favorable for apiculture and honey yield per apiary reached the highest level, 20.03 kg/bee family, compared to the previous year 2014 when the pickings were deeply affected by the unfavorable conditions and Romania

registered the lowest honey yield, only 13.35 kg/bee hive.

In 2018, the average honey production per bee hive accounted for 17.24 kg, being by 8.44% smaller than 18.83 kg achieved in 2009 as attested by the statistical data provided by National Institute of Statistics (Fig. 6).

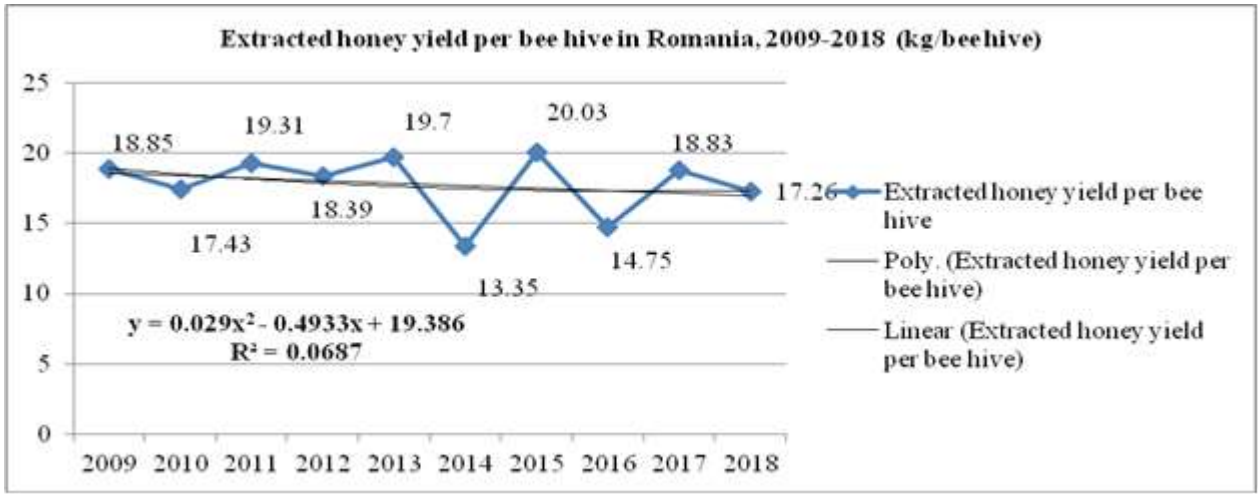

Fig. 6. Romania's honey yield in the period 2009-2018 (kg/bee hive)
Source: Own calculation based on the data from [15].

However, if we take into consideration Eurostat data, Romania registered 20 kg honey per bee hive, performance which placed it on the 18th position in the EU-28 (Table 5).

Table 5. Honey yield per bee hive in 2018 versus 2009 in the EU-28 top 20 producing countries (kg/bee hive)

2009			2018		
	EU-28 Average	18 kg/bee hive		EU-28 Average	22 kg/bee hive
Crt. No.	Country		Crt. No.	Country	
1	Finland	36.6	1	Finland	47.0
2	Germany	23.7	2	Germany	35.0
3	Estonia	23.2	3	United Kingdom	34.0
4	Portugal	21.6	4	Lithuania	30.0
5	Italy	20.4	5	Austria	30.0
6	Romania	20.0	6	Sweden	30.0
7	France	17.5	7	Estonia	26.0
8	Austria	16.9	8	Luxembourg	26.0
9	Sweden	16.6.	9	Belgium	25.0
10	Lithuania	15.8	10	Italy	25.0
11	Bulgaria	14.6	11	Latvia	22.0
12	Slovenia	14.3	12	Netherlands	22.0
13	Czech Rep.	13.8	13	France	21.0
14	Spain	13.5	14	Hungary	21.0
15	Hungary	13.4	15	Denmark	20.0
16	Latvia	12.6	16	Ireland	20.0
17	Greece	11.9	17	Croatia	20.0
18	Cyprus	9.8	18	Romania	20.0
19	Poland	9.7	19	Slovenia	19.0
20	Belgium	7.3	20	Bulgaria	17.0

Source: Own conception based on [3, 4].

However, compared to other EU countries whose honey yield per bee hive increased in the analyzed interval, in Romania yield performance remained unchanged at 20 kg per

bee hive. This is explained by the unfavorable conditions Romania was facing in many of the last years due to the climate change.

Distribution of honey yield per bee hive in the territory of Romania

Honey yield is different from a region to another depending on the local conditions which reflect the real situation regarding the impact of climate change on production performance.

The highest average production per bee hive was 20.8 kg, recorded in Bucharest-Ilfov region, where there is the lowest number of bee hives, and the lowest honey production per bee family was 16.5 kg, registered in the Central region, where both the number of bee hives and honey production is decreasing. Therefore, it is a difference of 4.3 kg honey per bee hive between these two regions.

In the other micro regions of development, honey yield per bee colony was the following one in the decreasing order: 18.4 kg in North West, 17.7 kg in North East, 17.7 kg in West, 17.3 kg in South Muntenia, 16.7 kg in South East, and 16.6 kg in South West Oltenia.

In the period 2018 compared to 2008, honey yield per bee hive increased only in South Muntenia and Bucharest - Ilfov areas, while in the other regions: North West, Center, South East, South West Oltenia, and West decreased and in North East it remained constant (Table 6).

Table 6. Distribution of honey yield per bee hive by micro region of development in Romania in 2018 versus 2009 (kg/bee hive)

	2009	2018
Romania's honey yield (kg/bee family)	20.0	20.0
North West	18.7	18.4
Center	20.8	16.5
North East	17.7	17.7
South East	18.7	16.7
South Muntenia	16.4	17.3
Bucharest – Ilfov	18.9	20.8
South West Oltenia	19.9	16.6
West	19.7	17.7

Source: Own calculation based on the data from [15].

The concentration degree of the number of bee hives and honey production in Romania

All the indicators which have been presented above proved that in Romania it is a general trend of concentration regarding the bee hives and bee production, but a stagnation in honey yield justified by the negative impact of climate change and chemical treatments applied in agricultural crop cultivation.

However, using the well known Herfindahl-Hirschman Index, HHI, the results proved that in Romania the level of concentration of the number of bee hives is low as HHI was < 0.15 in almost all the years of the last decade, except the year 2017 when the index exceeded a little this threshold. In case of honey production, HHI was also < 0.15 reflecting a weak concentration in most of the years, except 2016 and 2017 when HHI was a little higher than 0.15 (Table 7).

Table 7. Dynamics of Herfindahl-Hirschman indices for the number of bee hives and honey production in Romania in the period 2009-2018

	HHI for the number of bee hives	HHI for honey production
2009	0.1399	0.14.10
2010	0.1393	0.1429
2011	0.14.04	0.1501
2012	0.1409	0.1492
2013	0.1446	0.1414
2014	0.1459	0.1491
2015	0.1437	0.1418
2016	0.1463	0.1515
2017	0.1535	0.1516
2018	1.2353	0.1436

Source: Own calculation.

For the EU-28, based on Eurostat data, the calculated values of this index for the number of bee hives was HHI = 0.0831 and for honey production HHI = 0.1342. If we compared these values with the ones registered in

Romania, we may conclude that in this case it is a little higher concentration in Romania than at the EU level.

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Comparatively concentration in the period 2009-2018 versus 2007-2016

Continuing the research started in 2017 regarding honey production in Romania, in this study the concentration of honey production was also approached based on the dynamics of the correlations coefficients, determination coefficients and regression equations in order to point out the differences achieved in the interval 2009-2018 compared to the period 2007-2016 [34].

The growth of honey production in the period 2009-2019 was proved by the higher ***values of the correlation coefficient*** between honey production and honey yield r = 0.603 compared to r = 0.585 in the period 2007-2016, and between honey production and the number of bee hives, r = 0.688 compared to 0.580 in the reference period.

But, between honey yield and the number of bee hives, it was found a lower value of the correlation coefficient, r = 0.161 in the period 2009-2018 compared to r = 0.314 in the interval 2007-2016. This reflected that the number of bee hives increased with a higher rate during the last ten years in comparison with honey production growth rate, which diminished honey yield (Table 8).

Table 8. Comparison regarding the correlation coefficients in the period 2009-2018 versus 2007-2016 for the three pairs of the main indicators characterizing honey production

Correlation between:	Correlation coefficient, r	
	2007-2016	2009-2018
-Honey production and honey yield	0.587	0.603
-Honey production and the number of bee hives	0.580	0.688
- Honey yield and the number of bee hives	0.314	0.161

Source: Own calculation.

The values of the determination coefficient were in general low reflecting a weak influence of the variation of the independent variable on the change of the dependent one.

In case of honey production as dependent variable on honey yield, R square showed that 34.5% of the variation of honey yield influenced honey production in the period 2007-2016, and in the period 2009-2018 it was noticed a slight increase at 36.3%.

The variation of honey production was also influenced in a small proportion by the change in the number of bee families, more exactly only 33.6% in the period 2007-2016, but in a higher proportion, 47.4% in the interval 2009-2018.

The determination degree of honey yield by the change in the number of bee families was the smallest one, In the period 2007-2016, only 31.4% of the variation of honey yield was caused by the change in the number of bee colonies, and in the period 2009-2018, the proportion declined to 2.61% (Table 9).

The regression equations also proved the evolution of the impact of the change in the independent variable on the change of the dependent one.

In case of honey production as dependent variable on honey yield, the regression equations showed that in the period 2009-2018 a change with one unit in honey yield could increase honey production by 1,129.31 units compared to only 913.66 units in the period 2007-2016.

The regression equations for honey production depending on the number of bee families reflected that in the period 2009-2018 a change with one unit in the number of bee hives could produce an increase by 15.515

units in honey production compared to 12.466 units in the period 2007-2016.

Finally, the regression equations for honey yield reflected the negative impact of the number of bee hives in the both analyzed periods. In 2007-2016, an increase by one unit in the number of bee hives led to a decline by 0.0043 units in honey yield, while in the period 2009-2018 the decrease is a little smaller, 0.0019 units (Table 9).

Table 9. Comparison regarding regression equations and R square in the period 20092-108 versus 2007-2016 for the three pairs of the main indicators characterizing honey production

Regression of:	Period	Regression equation	R square	F	Sign. F
- Honey production depending on honey yield	2007-2016	Y = 913.66X + 5,647.44	0.345	4,213	0.0741
	2009-2018	Y = 1,129.31 X + 4,159.54	0.363	4,574	0.0648
- Honey production depending on the number of bee hives	2007-2016	Y = 1.466 X + 6,598.04	0.336	4,056	0.0787
	2009-2018	Y = 15.515X + 3,051.79	0.674	7,221	0.0276
- Honey yield depending on the number of bee hives	2007-2016	Y = - 0.00434X + 23.25	0.314	0.8769	0.3764
	2009-2018	Y = -0.00194X + 20.446	0.0261	0.2146	0.6555

Source: Own calculation.

How efficient is honey production in Romania compared to the EU-28 main producing countries?

Based on the data provided by Eurostat [3] for the top honey producing countries in the EU-28, we used the average production cost and average honey price for polyfloral honey in the period 2017-2018 at the apiary gate and calculated the profit or loss per kg of honey and the profit or loss per bee family in the year 2018. The results are presented in Table 10.

Romania has the lowest honey producer price at the apiary gate, Euro 2.25/kg ranking the country on the 28th position. To produce one kg of honey, an apiarist spent Euro 2.58 per kg, and for this level of production cost Romania occupied the 22nd position in the EU-28.

As a result, making the difference between price and cost it resulted a loss of Euro 0.33/kg, reflecting that honey production in Romania is not efficient, and for this result, the country came on the 24th position in the EU-28 [20, 22, 33].

In the period 2017-2018, at the EU level, average price for polyfloral honey varied between Euro 19.25/kg in Ireland, the highest level, and Euro 2.25/kg in Romania, the lowest one. Therefore, in Romania, average honey price is 3 times less than the EU average price which accounts for Euro 6.46/kg.

The average production cost varied at the EU level between Euro 10/kg in Belgium, the highest level, and Euro 2.58 in Romania, the lowest one, while the EU average production cost was Euro 3.90/kg.

Table 10. Profit/loss per kg honey and profit/loss per bee family carried out in the year 2018 by the beekeepers of EU-28 top honey producing countries

	Honey yield (kg/bee hive)	Average production cost (Euro/kg)	Average honey price at the apiary gate (Euro/kg)	Profit/Loss pe honey kg (Euro/kg)	Profit/Loss per bee family (Euro/bee hive)
Romania	20.0	2.58	2.25	-0.33	-6.60
Spain	9.92	2.73	6.50	+3.77	+37.40
Germany	32.08	6.90	6.22	-0.68	-21.81
Hungary	21.02	2.10	5.16	+3.06	+64.32
Italy	15.39	3.88	5.08	+1.20	+18.47
Poland	13.65	3.15	5.81	+2.66	+36.31
France	13.62	5.27	9.40	+4.13	+56.25
Greece	11.02	5.40	9.00	+3.60	+39.67
Bulgaria	15.07	1.31	3.52	+2.21	+33.30
Portugal	14.06	5.15	4.06	-1.09	-15.32

Source: Own calculation based on [3].

Profit per kg honey recorded the highest level in Ireland, accounting for Euro 12.25 and the lowest level was found in Italy, Euro 1.20.

Three EU countries registered losses. It is about Romania: Euro -0.33 per kg, Germany Euro -0.68 and Portugal Euro -1.09 per honey kg (Table 10).

However, this calculus is a hypothetical one, considering that profit comes exclusively from marketed polyfloral honey. But, we know that bee families produce carious types of honey depending on the flora variety they collected the nectar.

In Romania, about 25% of honey production is *Acacia* honey which has the highest price compared to polyfloral honey.

Many of the apiculturists are accustomed to practice direct delivery to loyal clients and in this case the price per honey kg could rage between Euro 5.15- 6.18, therefore 2-2.5 times higher than the average price of the polyfloral honey.

Only considering this solution, we could consider that beekeeping in Romania is a good deal and apiculture could be an attractive activity.

But, the climate change, extreme meteorological phenomena affected pickings, the treatments applied to agricultural crops killed a part of the number of bee families and reduced their power, with a negative impact on the honey production, honey yield per bee hive, in other words diminished the economic efficiency in beekeeping.

But this tragedy happened not only in Romania, other EU countries such as: France, Hungary, Italy, Greece were complaining of the damages recorded in beekeeping due to the factors mentioned above [41].

That is why subsidies and financial support by beekeeping development programmes are compulsory to sustain this sector to help apiculturists to procure powerful and high breeding value queens, new bee hives, bee swarms, modern equipment for honey extraction and honey bottling, to open shops and sell their products under local labels and trademarks. Innovation in apiculture has to be sustained like in all the other sector of agriculture in order to assure the sustainable development [8, 9, 10]. Romania has a high-quality honey which explains why Romanian honey is so much required on the EU market. But bulk sale at a price of about Euro 2-2.5 per kg is not efficient and it is not correlated with the exceptional quality of the product.

Table 11. Honey food balance sheet in Romania compared to the EU-28 top producing countries in 2017 versus 2016 (Thousand tons)

	Years	Production	Import quantity	Stock variation	Export quantity	Domestic supply quantity
Romania	2016	21	3	2	10	16
	2017	25	4	0	12	17
Spain	2016	31	29	-1	27	33
	2017	29	32	0	25	36
Germany	2016	22	84	-4	24	86
	2017	20	93	3	24	86
Hungary	2016	24	2	0	17	9
	2017	24	1	-2	22	5
Italy	2016	10	23	7	8	18
	2017	10	24	9	7	18
Poland	2016	19	24	0	14	29
	2017	17	26	0	16	27
France	2016	11	36	5	5	37
	2017	12	36	6	5	37
Greece	2016	21	3	4	2	18
	2017	22	6	6	3	19
Bulgaria	2016	10	2	2	9	1
	2017	12	2	- 1	13	2
Portugal	2016	14	6	4	7	9
	2017	11	7	2	7	9

Source: [6].

The insufficient promotion of honey, honey price higher than sugar price per kg in close relationship with the average income per household are factors which affect domestic consumption which is enough low compared to the one in the Western EU countries [36].

This is proved by Honey food balance sheet in Romania compared to the EU-28 top producing countries (Table 11).

The supply per inhabitant varies in the EU-28 top producing countries between 0.12 kg/capita/year in Poland and 1.59 kg in Greece. In Romania, honey supply is 0.75 kg/year/inhabitant (Fig. 7).

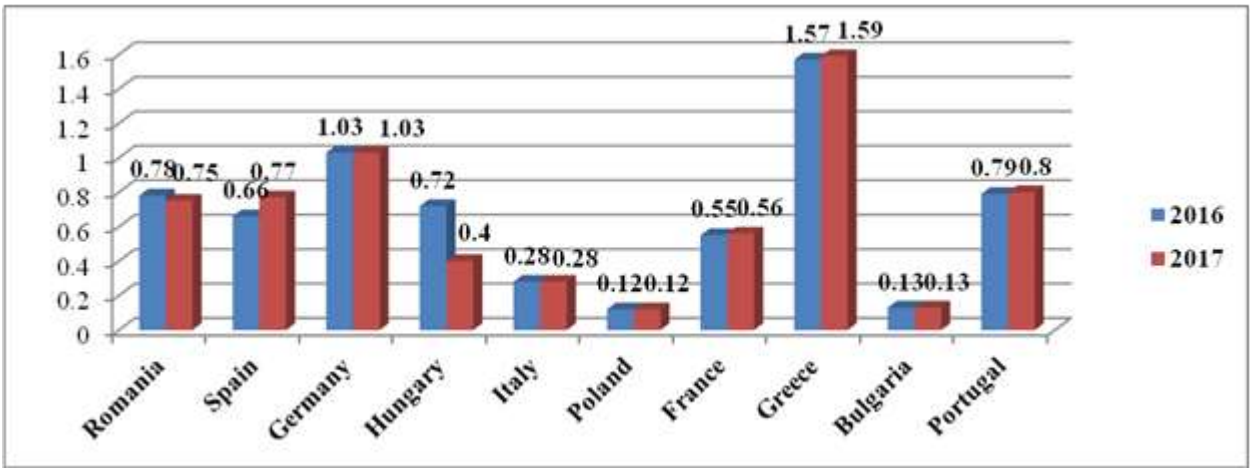

Fig. 7. Average honey supply per inhabitant and year in the EU-28 top producing countries (kg/capita)
Source: [45].

For this reason, the EU is an important honey importer from various countries, in 2018 the import value of the 208 thousand tons imported honey from outside of the EU was Euro 452 millions, being by 25 % higher than in 2013. The main importing countries are the ones where consumption is high and the offer is not balanced such as Germany, United Kingdom, Belgium, Poland and Spain. Despite that it has a higher production than consumption, Romania started to import honey a few years ago, but the quantities are enough small being around 3 tons. The main honey suppliers are China, Ukraine, Argentina, Mexico and Chile [7].

Also, the EU-28 exports honey, the amount sold in other countries accounting for 137,000 tone in 2018. The highest exporting countries being Hungary (14.5%), Belgium (13.8%), Spain (13.1%), Germany (11.6%), Poland (10.9%), Romania's export represent about 12 thousand tons (8.7%) meaning about 15 % of its production [11, 16, 17].

The export of honey is compulsory because of the impossibility as the Beekeepers Associations to pay the supermarket taxes and increase honey price at the shelf level which could affect in a higher proportion domestic consumption. The main beneficiary of the Romanian honey is Germany, and the increased competitiveness with honey provided by China, Ukraine, Argentina at a lower price causes major difficulties to the Romanian Beekeepers' Associations to export honey at a higher price corresponding to its high quality [2, 12]. Honey trade balance is a positive one, honey being among of the agricultural products for which exports are higher than imports and increase the efficiency of agro-food trade.

The access of Romania into the EU in 2007 had a beneficial impact on the whole economy, including agriculture and in beekeeping as well [24, 25, 29, 35, 36].

All these aspects reflect why beekeeping in Romania and in the EU has to be financially supported, first of all to cover the domestic market requirements and then to stimulate export.

CONCLUSIONS

The research results proved that in Romania the number of bee hives and honey production

have substantially increased in the last decade, 2009-2018, while honey yield per bee family remained relatively at the same level of 20 kg/year.

In 2018, Romania had 1,689.5 thousand bee hives, for which the country is placed on the 2nd position in the EU-28, about 30,000 tons honey production for which it comes on the 1st position, the average number of bee hives per apiary is 80, for which the country is ranked the 3rd and 20 kg honey yield per year for which it is ranked the 18th.

Both the number of bee hives and honey production followed the same distribution in the territory: 18.5% South West Oltenia, 16.2% South East, 14.6% North West, 13.6% South Muntenia, 13.3 % North East, 12% Center, and 10.6% West. The only exception is Bucharest-Ilfov area with a share of 1.2%.

The highest honey yield per bee hive was achieved in Bucharest-Ilfov (20.8 kg), while the lowest one was registered in the Central area (16.5%).

In the period 2018 compared to 2009, honey yield per bee hive increased only in South Muntenia and Bucharest - Ilfov areas, while in the other regions: North West, Center, South East, South West Oltenia, and West decreased and in North East it remained stable.

However, it is important that honey production raised in all the regions.

Herfindahl-Hirshman indices reflected a low degree of concentration in Romania both for the number of hives and honey production.

The values of the mean for the number of bee hives and honey production were higher in the period 2009-2018 compared to the period 2007-2016. Also, the correlation and determination coefficients registered higher values for the pair of indicators: honey production and the number of bee hives and for the honey production and yield, while for the average yield and the number of bee hives the values were smaller.

Regression equations attested that honey production is in about 50% determined by the number of bee hives and in smaller proportion by honey yield.

Concentration of honey production is slowly running, but it is compulsory for better satisfying consumption of a healthy product, for maintaining beekeeping as an important sector for the pollination of the agricultural crops, the preservation of biodiversity and life on the Earth.

Beekeepers have to efficiently use the EU funding for strengthening this sector in the future in Romania's agriculture keeping pace with the increased competitiveness on the EU honey market.

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