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Product Quality and Safety

Mathematical methods for assessment and analysis of honey yield data for Bulgaria and the European Union for the period 1961-2014

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Abstract. *The objective of this work is to assess the average yields of bee honey for the period from 1961 to 2014 for all countries of the European Union. For this purpose, a single-factor analysis of variance was used. As a result of the surveys, it was found that the highest average yield of honey in the EU is in Germany (20541.91 t) and Spain (20253.43 t), while the lowest yield is in Ireland (199.74 t) and Luxembourg (133,2 t). Data on the production of bee honey in Bulgaria by regions from 2006 to 2014 were also analyzed, and mathematical models were made, reflecting the relationship between the respective honey yields and the survey period. The data on the basis of which the study was carried out are from the FAOSTAD database and the Agro-statistical reference book for 2000-2014 of the "Agro-statistics" Department of the Ministry of Agriculture, Food and Forestry of the Republic of Bulgaria.*

Keywords: analysis of variance, mathematical model, bee honey

Introduction

Beekeeping is a traditional branch in Bulgaria. Data about its existence have been known even before the establishment of the Bulgarian state in 681. Moreover, in the distant past our country exported honey to Genoa, Venice, Dubrovnik, Byzantium. Even today the interest in beekeeping is still high. By April 2016, 17 000 beekeepers were registered, and the number of the registered bee colonies was 747 000 Mihailov (2016).

There are various reasons which have impact on the average yields of honey for the respective region. Scientists from all over the world are exploring the factors that affect the production of honey. A key factor for the number of bee colonies and the amount of the honey yield is certainly the climate. It is known that the cool and wet weather has a negative impact on these indicators. The consequences of climate change on bee honey yield are also an object of studies by various authors (Diegado et al., 2012; Paraiso et al., 2012; Switanek et al., 2017). The treatment of agricultural areas with different insecticides also has a negative effect on the quantity of bee colonies (Chauzat et al., 2009). Diseases of bees are an important factor. A study has been conducted to reduce the populations of bee colonies in seventeen European Union countries (Van Engelsdorp and Meixner, 2010). Among them are Italy, Spain, Greece, Hungary, France, etc. (Bulgaria is not included in the study). They are grouped through a cluster analysis according to the degree of mortality, both as a result of wintering and as a result of various diseases.

In 2008, about 56 million bee hives existed in the world producing about 1.2 million tons of honey, of which about 25% was commercialized. The average world honey production per bee colony was 20 kg but more in some producing countries: China 33 kg, Argentina 40 kg, Mexico 27 kg, Canada 64 kg, Australia 55 kg, Hungary 40 kg, Turkey 16 kg (Vural and Karaman, 2009). The largest top 10 producers of honey in the world are China, EU, Turkey, Ukraine, Argentina, USA, Mexico, Russian Federation, Ethiopia and Iran. China is the largest producer and exporter in the world (20% of the world overall output) as mentioned (Zhang and Hu, 2002; Popescu, 2012).

Pidek and Pohorecka (2004) explore issues related to the production and marketing of honey in ten EU countries from 1993 to 2002. The following problems were analysed: interest in beekeeping, apiary structure, number of bee colonies vs. conditions for pollination of entomofilous plants, honey production, honey market, honey import and export, honey distribution.

A study on the production of honey in Romania from 1990 to 2007 (every 5 years) and a comparison with the total production in Europe and the world were made (Pirvutoiu and Popescu, 2011). The above-mentioned studies are based on finding average values and percentage ratios.

The objectives in the present work can be classified in the following several areas:

- to assess the average yields of honey in the EU countries,
- to construct mathematical models representing the change of the average quantity of bee honey (kg) obtained from one bee colony in six regions of Bulgaria: North-west, North Central, North-east, South-east, South Central and South-west from 2006 to 2014,
- to determine the correlation coefficient between this quantity and the corresponding year of survey for each region, as well as the degree of dependence of the honey yield (kg) of a bee colony on time.

Material and methods

The analysis of the data for the obtained quantity of honey from 1961 to 2014 uses information from the FAOSTAT database

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regarding the total amount of honey (t) produced in the EU countries.

The survey is also based on data extracted from the database of the "Agro-statistics" department of the Ministry of Agriculture, Food and Forestry, Republic of Bulgaria (2000-2014). Microsoft Access provides the possibility to export tables from the corresponding database directly into the medium of MS Excel or SPSS by which the statistical processing is performed.

The tasks are achieved by:

- a comparative assessment of the average honey yields in the EU countries through applying a single-factor analysis of variance by Duncan's criterion;
- constructing polynomial regression models of second degree representing the dependence between the amount of honey and time;
- determining Pearson's correlation coefficients of the relevant indicators and time;
- calculating the degree of impact of the year on the yield.

Similar studies were carried out on the statistical data for the average amount of honey (kg) obtained from one bee colony in the six regions of Bulgaria from 2006 to 2014.

The mathematical data processing is performed through the IBM Statistics SPSS 24 (Chinna et al., 2012; Weinberg and Abramowitz, 2016).

Results and discussion

When processing the statistical data, Levene's test for homogeneity was conducted, according to which the data for the amount of honey produced in the EU countries over the considered period have equal dispersions and could be compared by the selected criterion. The overall statistical evaluation shows a level of significance less than the error α = 0.05, and this is a reason to believe that honey yields in the EU countries have statistical differences and that the common model is statistically significant.

It was found that the statistical data on the basis of which the regression analysis was performed have normal distribution. For this purpose, two independent approaches were implemented: building of the histogram of standardized residues and the Kolmogorov-Smirnov test.

The results of the single-factor analysis of variance are shown in Table 1. It was found that the highest yields are in Germany (20541.91 t) and Spain (20253.43 t), and the lowest – in Ireland (199.74 t) and Luxembourg (133.2 t). However, the high yields in Germany and Spain are not sustainable over time (given their standard deviation), while in Ireland and Luxembourg we have relatively stable quantities. We notice that Bulgaria ranks 10th in average honey production for the whole given period in the EU (7170 t).

Figure 1 shows graphically the change in the average amount of honey produced in Bulgaria and in the EU countries from 1961 to 2014. It turns out that during this period there are periods of peaks and falls both in Bulgaria and in the EU. The curves in Figure 1 show that these periods for our country and for the EU overlap to a large extent.

In general, we can divide the period under review into six sub-periods. The first one covers the time from 1961 to 1970, when we have smooth peaks and falls in the yield, but it is generally characterized by growth. From 1971 to 1976 there was a definite decline in the production of honey in Bulgaria and in the EU as a whole. The period from 1977 to 1979 is related to a sensible growth

Table 1. Assessment of the average honey yields in the EU countries by the Duncan method, a, b, c, ... – degree of proving at a level of significance α = 0.05

Country	Average yield of honey (t)	Std. Deviation
Austria	5433.94 ^{ef}	2060.04
Belgium	1977.89 ^{hij}	506.31
Bulgaria	7170.11 ^{de}	2710.18
Croatia	2457.7 ^{ghi}	1966.81
Cyprus	443.61 ^{ij}	221.69
Czech Republic	7367.32 ^{de}	1388.42
Denmark	1500 ^{hij}	0.00
Estonia	611.13 ^{ij}	259.72
Finland	1208.33 ^{ij}	667.33
France	13391.34 ^{b}	3423.44
Germany	20541.91 ^{a}	5689.28
Greece	11729.65 ^{bc}	3420.76
Hungary	13547.8 ^{b}	5164.92
Ireland	199.74 ^{j}	50.44
Italy	8115 ^{d}	2513.80
Latvia	951.09 ^{ij}	508.88
Lithuania	1418.96 ^{ij}	384.72
Luxemburg	133.2 ^{j}	38.33
The Netherlands	440.19 ^{ij}	245.44
Poland	11355.7 ^{c}	3948.29
Portugal	4141.78 ^{fg}	2012.39
Romania	13182.74 ^{bc}	4860.85
Slovakia	3582.73 ^{fgh}	615.17
Slovenia	1740.74 ^{hij}	514.17
Spain	20253.43 ^{a}	9858.90
Sweden	2537.06 ^{ghi}	809.97
The United Kingdom	4040.39 ^{fg}	2083.19

in the production of honey, this growth being more considerable in our country than in the EU. The next period ranged from 1980 to 1990 when in Bulgaria there are small peaks and falls, but in general it is a time of relatively stable yields. Unlike us, however, the EU countries show sharper changes in the yields of honey. From 1990 to 1995 there was a decline in the production of honey and we can definitely say that it was more sensible in Bulgaria than in the EU countries. This period is short and only after five years from 1996 to 2004 (respectively, 2006) for the EU (respectively, for Bulgaria) there is an increase in the production of honey, which is more sensible and longer in our country.

The last period for the EU countries is characterized by a strong decline, which lasts for a year and after 2005 we have relatively constant yields. For Bulgaria in the period since 2006, we have one significant decline, lasting for two years, followed by a period of accelerated production, compensating for the previous one, after which we have relatively constant yields of honey. The fact that after 2006 Bulgaria has the highest average yield of honey from all EU countries is optimistic. The importance of the number of bee colonies is determined by the following facts: production of bee honey, beeswax, etc., pollination of agricultural crops, provision of

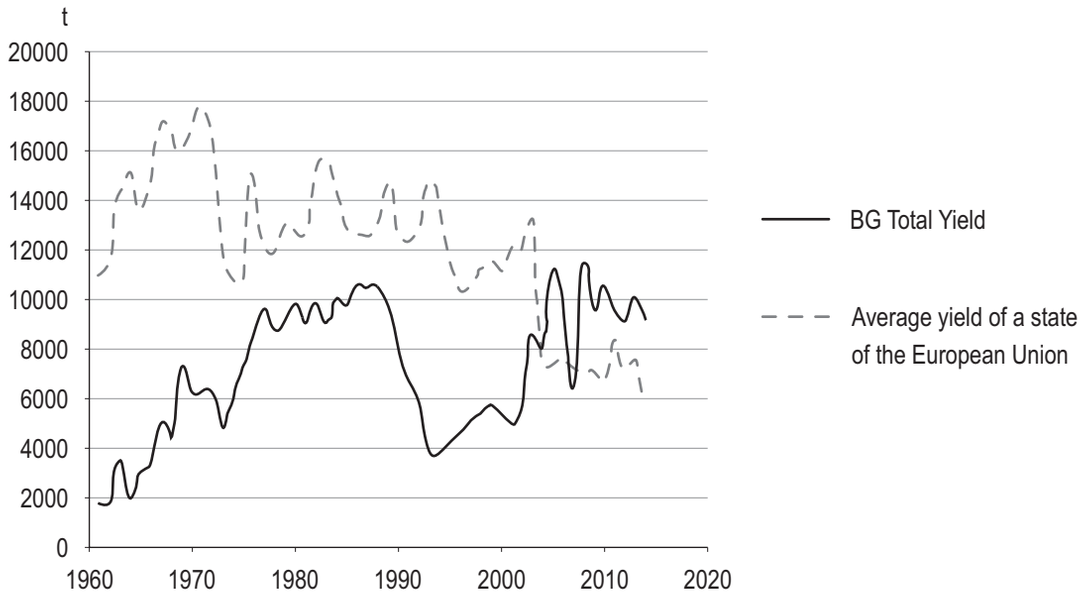

Figure 1. Graphical presentation of the change in the average honey production (t) in Bulgaria and in the European Union countries from 1961 to 2014

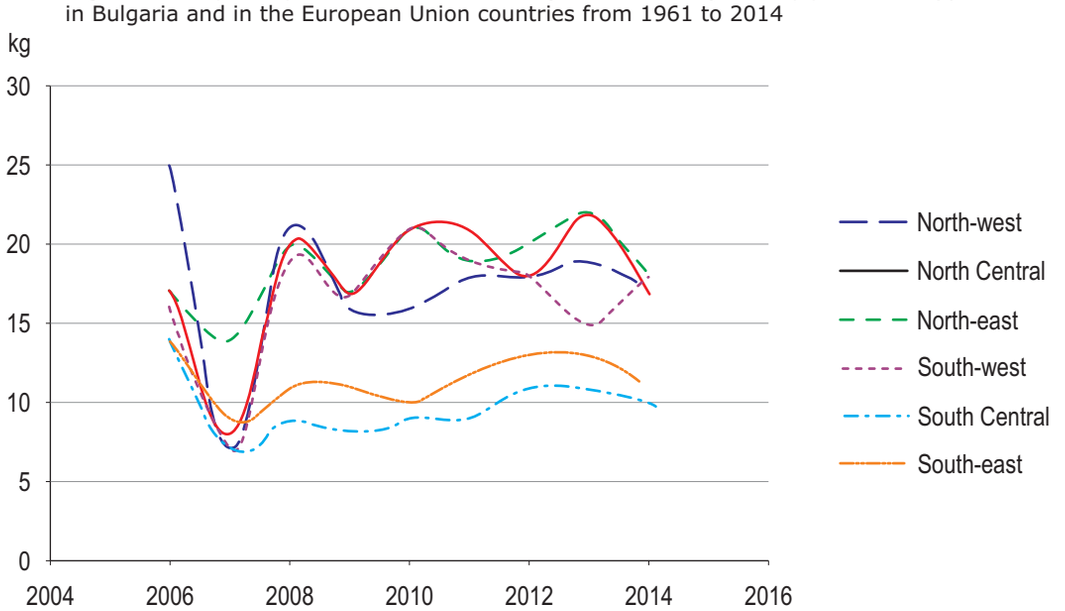

Figure 2. Graphical presentation of the change in the average honey production of a bee colony (kg) in Bulgaria by regions from 2006 to 2014

ecological balance and biodiversity (Simidchiev, 1989, 1991).

In Figure 2 can be seen that the average production of bee honey in all six regions of Bulgaria shows a decline in the period 2006-2007, and it is most significant in the North-west region.

Then there is a period of growth in the yields of honey in all regions in our country. It is the most sensible for North-west Bulgaria. In the remaining years until 2014, there are both peaks and falls that are valid for Bulgaria as a whole. These changes are the smoothest in the South Central and the South-west region, and they are the most sensible in the North-west, South-east and North Central

Table 2. Regression equations, correlation and variation coefficient with respect to the dependence of the yield of honey from one bee colony (kg) on the year in Bulgaria by regions from 2006 to 2014

Region	Regression equation	Correlation coefficient (R)	Determination coefficient (%)
North-west	-	0.2	4
North Central	$y = -0.2251x^2 + 905.64x - 910847$	-0.57	32
North-east	$y = -0.1299x^2 + 522.58x - 525674$	-0.65	42
South-west	$y = 0.0768x^2 – 308.81x + 310284$	-0.33	11
South Central	$y = 0.1829x^2 – 735.24x + 738911$	-0.56	31
South-east	$y= -0.2327x^2 + 935.87x - 941020$	-0.53	28

Region.

It was found that the highest yields from a bee family in the last six years are in Northeastern Bulgaria, and the degree of influence of the year is not particularly high (28%). The South-west region has one of the lowest yields, where, however, the influence of time is not significant (11%). The yield in Northwestern Bulgaria after 2008 is relatively constant, and the impact of the year is the lowest (4%).

Table 2 shows the regression polynomial models of second degree, which describe the statistical data for the six regions of our country. It is found that the period of time has the greatest impact on the yield of honey from a bee colony (kg) in Northeastern Bulgaria (42%), less in the North Central Region (32%) and in the South Central Region (31%) and the influence of time is the lowest on the territory of Northwestern Bulgaria (4%).

Conclusion

According to the average yield of honey for the period from 1961 to 2014 in the European Union countries, Bulgaria ranks tenth. The trends in the changes in the production of honey over the years in the EU and in Bulgaria overlap. This means that the factors affecting the yields are global. As a result of the study, it was found that the last ten years Bulgaria has the highest yields of honey compared to the average yields of the other EU countries. The characteristics of the year (climate, morbidity, etc.) have influence in varying degrees on the average yields of honey in all regions of Bulgaria. The relations between the year of study and the quantity of honey produced by a bee colony are presented in analytical form by regression polynomial models of second degree. It is well known that Bulgaria ranks first in Europe by number of bee colonies, which are biologically cultivated and it takes one of the first places by quantity of organic bee honey.

References

Chauzat M, Carpentier P, Martel A, Bougeard S, Cougoule N, Porta P, Lachaize J, Madec F, Aubert M and Faucon J, 2009. Influence of pesticide residues on honey bee (Hymenoptera: Apidae) colony health in France. Environmental Entomology, 38, 514-523.

Chinna K, Karuthan K and Choo Wan Yuen, 2012. Statistical Analysis Using SPSS, Pearson Malaysia Bhd.

Delgado D, Perez M, Galindo-Cardona A, Giray T and Restrepo C, 2012. Forecasting the Influence of Climate Change on Agroecosystem Services: Potential Impacts on Honey Yields in a Small-Island Developing State, Psyche, Article ID 951215, 10 pages, http://dx.doi.org/10.1155/2012/951215.

Jacqus A, Laurent M, Ribiere-Chabert M, Saussac M, Bougeard S, Budge G, Hendrikx P and Chauzat M, 2017. A pan-European epidemiological study reveals honey bee colony survival depends on beekeeper education and disease control, PLOS ONE, http://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0172591

Mihailov M, 2016. What is the condition of Bulgarian beekeeping, economy.bg, April 11, Bulgaria (Bg).

Ministry of agriculture, food and forestry, Republic of Bulgaria, 2000-2014. Agrostatistic reference book (Bg).

Paraiso A, Sossou A, Iz-Haquou D, Nerice and Sanni A, 2012. Perception and Adaptations of Beekeepers and Honey Hunters to Climate Change: the Case of the Communes of Natitingou and Tanguieta in Northwest of Benin. African Crop Science Journal, 20, 523-532.

Pidek A and Pohorecka K, 2004. Economical aspects of beekeeping in 10 countries ascending to European Union. Journal of Apicultural Science, 48, 43-52.

Pirvutoiu I and Popescu A, 2011. Analysis of Romania's Honey Market. Animal Sciences and Biotechnologies, 44, 500-503.

Popescu A, 2012. Research on Beekeepers Income Estimation based on Honey Production. Bulletin UASVM Animal Science and Biotechnologies, 69, 185-191.

Simidchiev T, 1989. Bee-pollination and yields. Zemizdat Publ. House, Sofia, Bulgaria, 143 (Bg).

Simidchiev T, 1991, Beekeeping and Bee-pollination, Zemizdat Publ. House, Sofia. Bulgaria178 (Bg).

Switanek M, Crailsheim K, Truhetz H and Brodscheider R, 2017. Modelling season effects of temperature and precipitation on honey bee winter mortality in a temperate climate. Science of the Total Environment, 579, 1581-1587.

Van Engelsdorp D and Meixner M, 2010. A historical review of managed honey bee populations in Europe and the United States and the factors that may affect them. Journal of Invertebrate Pathology, 103, 80-95.

Vural H and Karaman S, 2009. Socio-econometric analysis of beekeeping and the effects of beehive types on honey production. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 37, 223-227.

Weinberg S and Abramowitz S, 2016. Statistics Using IBM SPSS, An Integrative Approach, Cambridge University Press. Cambridge, UK.

Zhang G and Hu F, 2002. Analysis of the structure of honey production and trade in the world, Apiacta 2.

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Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows,IXth International Conference on Production Diseases in Farm Animals, September 11–14, Berlin, Germany.

Thesis:

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