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The Impact of Subsidies on the Development of Beekeeping in the Czech Republic

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Abstract

Given its role in landscape sustainability and health benefits, beekeeping is supported in all EU countries. The paper focuses on the assessment of the impact of beekeeping subsidies on the number of bee colonies in the Czech Republic. Subsidies in the Czech Republic are provided from national sources (state budget), from the budgets of individual regions and from EU sources. The paper presents the development of the number of bee colonies in the Czech Republic from 1990 to 2018. Until 2008, the number of bee colonies in the Czech Republic was decreasing. A significant increase occurred only in 2013. The influence of the amount of subsidy on the number of bee colonies was analysed using a panel data model and the Pearson correlation coefficient. The results show that subsidies have a significant positive influence on the number of bee colonies in Czech Republic and also in the individual regions of the Czech Republic. In terms of the specific focus of subsidies, we can observe a significant positive dependence between the number of bee colonies per beekeeper and technical support. Subsidies for the fight against varroosis are also very important.

Keywords

Number of bee colonies per km^2; national sources of finance; EU sources of finance; technical support; fight against varroosis.

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Introduction

Many Czech and foreign authors deal with the problems of beekeeping, its development and impact on the environment and human health as well as with the sources of funding, which include subsidies from different sources. The results of their work can be divided into two areas.

The first area deals with beekeeping from the perspective of the importance of bees as important pollinators, ways of beekeeping and bee diseases and thus it addresses beekeeping rather from a biological, technical, technological and environmental point of view. These authors include, for example, Waring (2011), who focuses on the problematics of beekeeping from a complex perspective. Crane (2014) presents the historical development of beekeeping, the basic structure of beehives and recommended practices of beekeeping. Gallai et al. (2009), William (1994) and Klein et al. (2007), Goodrich (2019) emphasizes the essential importance of bees in terms of plant pollination. However, there are also authors such as Geldmann and Gonzáles-Varo (2018), who point out the fact that support for beekeeping has a negative impact on the existence of other pollinators (different insects), and that massive support for beekeeping significantly reduces their numbers.

Therefore, they understand the support for beekeeping in terms of economic interest rather than environmental. Bee diseases causing their mortality are dealt with by Haves (2007), who was mainly involved in research into the bee disease known as CCD – Colony Collapse Disorder, which spread in the USA and caused considerable colony losses.

Research into bee diseases was also done by Huang

and Solter (2013), Oliver (2010), Chauzat et al (2013) and many others. An extensive study was also conducted by Genersch et al. (2010), who investigated the causes of winter bee mortality.

The second area, which the authors focus on, is the economic area related to the quantity and price of bee products, their market application and the sources of beekeeping financing, including subsidies supporting the development of beekeeping.

Here we can mention the work of Demircan et al. (2016) which deals with the state and development of beekeeping in Turkey, comparing honey production with other states and dealing with honey consumption and types of support for this sector. In their next paper, Sert and Demircan (2018), Demircan et al. (2016), Borowska (2016) focus on the economic analysis of beekeeping, dealing with the structure of beekeeping enterprises by their size, cost, profitability and the effect of the enterprise size on its economic performance. Aksoy et al. (2018) focus on factors affecting honey production, Majewski (2017), Jarka, Trajer (2018) on the amount and types of support provided to the EU beekeepers. Karadas and Kadirhanogullari (2017) investigate factors affecting honey and wax yields as the main products of beekeeping.

The aim of this paper is to assess the benefits of subsidies provided from national and EU funds for the development of beekeeping in the Czech Republic.

Material and methods

The article is based on a summary of the current state of knowledge published by various authors in the broader context of beekeeping development. In order to characterize the basic indicators characterizing the beekeeping sector, it mainly uses publicly available data from the Czech Statistical Office and the Ministry of Agriculture of the Czech Republic databases, which are further modified for the purpose of necessary interpretation of the context considered.

As indicators of beekeeping were analyzed following variables:

- Number of beekeepers
- Number of colonies
- Number of colonies per beekeper
- Production of honey (in tonnes)
- Production of beeswax (in tonnes)

These indicators were investigated in relation to support indicators measured (in thousand CZK):

- Technical support
- Fight against varroosis
- Rationalization of movement of colonies
- Honey analysis
- Restocking of colonies
- Possibility of subsidies

In the analysis of subsidies impact included also size of the region (in hectares) and temperature (°C) as explanatory factors.

The statistical significance of relationship in the development of support and the number of bee colonies and bee products were verified using the Pearson correlation coefficient, which can be calculated according to the following formula 1.

$$\rho_{xy} = \frac{cov(xy)}{\sigma_x \sigma_y} \quad (1)$$

in which the covariance of the variables x and y is divided by the product of their standard deviations (σ_x σ_y). The Pearson correlation coefficient can take values from <-1,1>. Values close to zero mean no or weak dependence, values close to 1 strong positive dependence and values close to -1 strong negative dependence. The value of the coefficient was calculated as a sample characteristic and that is why it is necessary to verify that its value is significantly different from zero and relationship is significant. Significance is evaluated by comparing the p-value with the relevant significance level α. P-value lower than significance level α means statistical significance of the correlation coefficient, p-value higher than α means that the correlation coefficient is statistically insignificant and there is no dependency between the variables.

The impact of subsidies on the number of bee colonies was quantified using a panel data model with random effects. This type of model was chosen as way, how to include more data in the analysis, andavoid the variation of regression function parameters due to heterogeneity of cross-sectional units (regions). Model allows to estimate effect of subsidies using available data for all regions together, and express specific character of each region at the same time. Panel data for individual regions of the Czech Republiccovering period 2010-2016 were used to estimate the parameters. A logarithmic function was used to estimate the model for more convenient shape of function and easier interpretation of results. The model was estimated in the form of equation 2.

$$y_{it} = \beta_0 + x'_{it}\beta + \alpha_i + u_{it} \quad \alpha_i \sim \text{iid}(0,\sigma_\alpha^2)$$
$$u_{it} \sim \text{iid}(0,\sigma_u^2) \qquad (2)$$

Where y_{it} is a log-value of the number of bee colonies, x'_{it} is a vector of log-values of explanatory variables, β_0 is intercept, α_i is a random error specific to individual cross-sectional units, u_{it} a random error common to all cross-sectional units. The explanatory variables were: area, temperature and individual types of support: technical support, the fight against varroosis, the rationalization of the movement of honey bee colonies, honey analysis, restocking of bee colonies and the use of subsidies. Insignificant variables were eliminated from all the considered variables by stepwise elimination, also with regard to strong collinearity among the explanatory variables.

The consistency of the estimated model parameters with random effects as well as the suitability of this type of model was verified using the Hausman test.

$$m = q'(var\hat{\beta}_{FE} - var\hat{\beta}_{RE})^{-1}q,$$

where $q = \hat{\beta}_{FE} - \hat{\beta}_{RE}$ and β_{FE} are estimated parameters of the fixed-effect model, β_{RE} are estimated parameters of the random effects model, var β_{FE} is the variability in the estimation of parameters of a fixed-effect model, and var β_{RE} is the variability in the estimation of the random effect model parameters.

The resulting test statistic has a χ^2 distribution with degrees of freedom equal to the number of estimated parameters. P-value higher than the selected significance level α implies the acceptance of the null hypothesis of the consistency of the estimated model with random effects. Rejection of the null hypothesis implies inconsistency in the estimated parameters of the random effect model and the recommendation to use a fixed effect model.

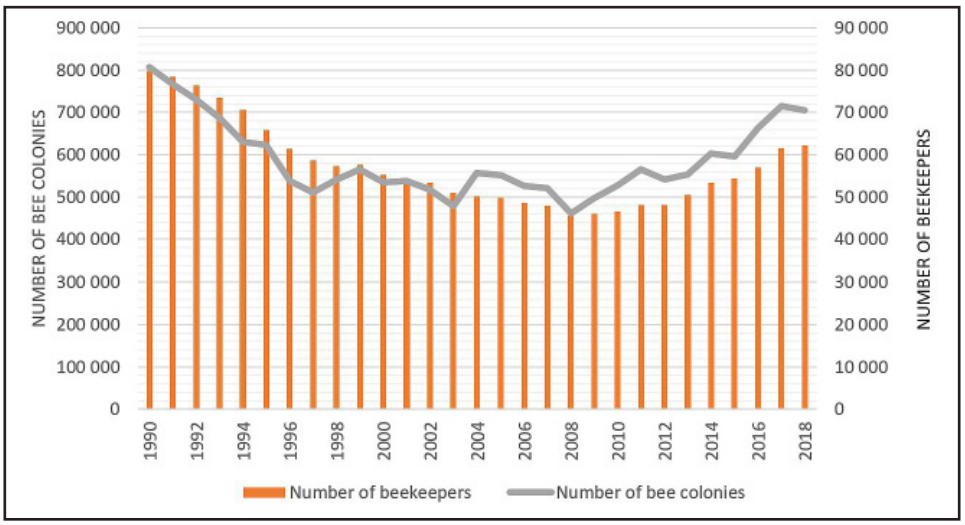
Suitability of random effect model was verified also by Breusch-Pagan test, which was used to confirm the hypothesis about different specific random error variability in regions, which is important assumption for using random effects model.

Results and discussion

The development of beekeeping in the Czech Republic

Beekeeping has a long tradition in the Czech Republic. All countries, including the Czech Republic, recognize the importance of bees for plant pollination and ecosystem stabilization. Beekeeping has been gaining importance especially in recent years as the number of other significant pollinators has decreased due to the transformation of agricultural landscapes. According to Jarka, Trajer (2018) the importance of bees for agricultural and fruit production is due to the fact, that over 70 of the 100 most important crops for humans are pollinated by bees. According to Majewski (2017) pollinating insects, especially honey bees, account for about 35% of the world´s crop production. In addition to this basic function of bees, beekeeping brings products important to human health, which include honey and other products such as beeswax, bee glue, royal jelly, bee pollen and bee venom.

The development of the number of beekeepers and bee colonies between 1990 and 2018 is shown in Figure 1.



Source: Ministry of Agriculture of Czech Republic (2017, 2018); own calculation

Figure 1: The number of beekeepers and bee colonies in 1990-2018.

As can be seen from Figure 1, there were 807 429 colonies in 2009. However, the number gradually decreased until it reached its minimum in 2008. This year, only 461 086 colonies were reported, i.e. 57% of the original number. The main reason for the decline in the number of bee colonies was considered to be the economic effects which manifested themselves in the whole agriculture, and adverse weather conditions. Chauzat et al. (2013) confirm the influence of climatic conditions on beekeeping development in the EU. Bee disease, especially varroosis, and other diseases such as American foulbrood also contributed to the decline. According to Chauzat et al. (2013) the main reason for the colony losses in the EU is the varroosis. He thinks that the reliable figures on the number of honeybee colonies and their geographical locations are the key factors required for effective control of honeybee diseases. We also think that the supports for beekeepers are able to reduce the level of diseases because of their focus. As can be seen due to different types of support, the number of bee colonies gradually increased to 704 520 in 2018. The number of bee colonies differs among regions.

Hive density in the Czech Republic, measured by the number of bee colonies per km^2, increased in 2017 compared to 2010, as can be seen in Figure 2.

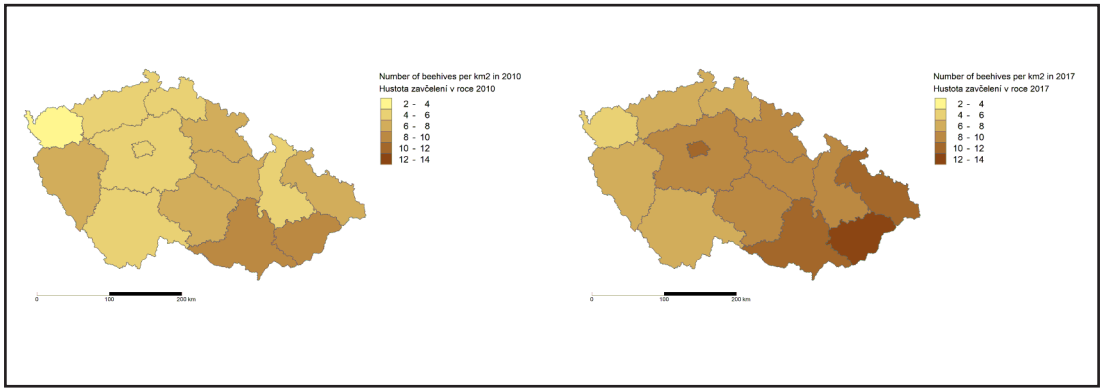
The number of bee colonies has increased in all regions of the Czech Republic, mostly in the South Moravian, Zlín and Moravian-Silesian regions. In South Moravia, it rose to 11.15 in 2017, compared to 8.25 in 2010. The district of Brno-venkov contributed most to this increase. In the Zlín region, the number of bee colonies increased from 8.61 to 12.2 colonies per km^2 in these years. The district of Vsetín contributed the most to this increase. In the Moravian-Silesian region, the original value of 7.98 in 2010 increased to 11.76. The district of Frýdek-Místek contributed the most to this increase.

Interest in beekeeping started to decline in 1990, which was reflected in the decrease in the number of beekeepers in the Czech Republic. The development of the number of beekeepers showed a similar trend as the number of bee colonies, which decreased until 2008. Significant growth started only in 2013, when the number of beekeepers rose to 50 471 and continued to reach 62 327 in 2018.

Support for beekeepers in the Czech Republic

Increase in bee colonies after 2004 and especially after 2010 was also influenced by grants to support this activity. Subsidies are provided from both national and EU sources. According to Jarka, Trajer (2018) that the support of the beekeeping sector is not only because of the economic reasons (helps to improve beekeepers competitiveness), but also because of its participation in the creation of the public goods, thus affecting the level of sustainable development of rural areas. Majewski (2017) agrees with the influence of bees on the yield and quality of crops, as well as on the biodiversity. In addition, according to him this points to the need to support beekeeping.

Support for beekeeping in the Czech Republic is based on the overall strategy of the Ministry of Agriculture of the Czech Republic, which set this task in the Strategy of the Ministry of Agriculture of the Czech Republic with a view to 2030 (Ministry of Agriculture 2016). Here the Ministry of Agriculture of the Czech Republic set the following strategic goal: Stabilization of the number of bee colonies in the Czech



Source: Ministry of Agriculture of Czech Republic (2019); own calculation

Figure 2: Number of bee colonies per km^2.

Republic, support for their even distribution in the landscape in order to ensure biological balance in pollination of cultivated and wild plants and support for sufficient supplies of bee colonies in agricultural areas. The use of national and EU funds to support both new and existing beekeepers can be considered as one of the basic measures to achieve this goal.

National subsidies are provided on the basis of Act No. 252/1997 Sb. on Agriculture, as amended, in the form of subsidy I.D – Support for beekeeping.

The aim of this subsidy program is to ensure pollination of agricultural entomophilous plants. The subsidy has been provided through the Czech Beekeepers Association and its organizational units since 1996 continuing the history of support for beekeeping in the Czech Republic.

Table 1 gives an overview of the use of this subsidy in 2010-2017.

The data clearly show that after some stagnation in 2013-2015, the total amount of subsidies used to ensure pollination of entomophilous plants increased significantly. Compared to 2015, it increased by 31% in 2016, while at the same time the average subsidy per colony increased by 15%. The slower increase in the total subsidy per colony than the increase in the total sum of subsidies is due to the growing total number of colonies, which is the intention of this subsidy policy.

Beekeeping in the Czech Republic is supported not only from the state budget through the National Subsidy Programme 1.D – Support for beekeeping but also from the budgets of individual regions. The form and amount of this support varies.

A substantial part of the funds allocated to beekeepers whose aim is to renew, expand and improve the health of bees etc., consists of subsidies from common sources of the EU and national sources in the proportion of 50% of EU resources and 50% of national resources. Since 2005, they have been provided in the form of three-year programmes on the basis of Government Regulation No. 197/2005 Sb., Regulation of the European Parliament and of the Council (EU) No. 1308/2013 and Commission Delegated Regulation (EU) No. 2015/1336. Since 2005, subsidies from common EU and Czech sources have been focused on five basic areas: Technical Support, Fight against Varroosis, Rationalization of the Movement of Honey Bee Colonies, Honey Analysis and Restocking Honey Bee Colonies. Technical Support offers subsidies for beekeeping courses, management of youth beekeepers groups and the equipment necessary for harvesting and processing apiary products. Fight against Varroosis includes financial support for all costs of medicinal products, remedies and aerosols to treat or prevent varroosis. Rationalization of the Movement of Honey Bee Colonies supports the purchase of specialist equipment to move honey bee colonies for the purpose of pollination or harvest. Honey Analysis allows to get funds for honey analysis focusing on the presence of American foulbrood spores as one of the dangerous types of bee diseases. Restocking Honey Bee Colonies supports the breeding of queen bees from a recognized breeding programme pursuant to Section 5 of Act No. 154/2000 Sb. On the improvement, breeding and registration of livestock and amending certain related acts.

Year	Total value of 1.D subsidies (in thousand EUR)	Value of subsidies paid by the Ministry of Agriculture (in thousand EUR)	1.D subsidies paid back to the Ministry of Agriculture (in thousand EUR)	Average value of subsidies per 1 colony (in EUR)
2010	3 716	2 746	3	5
2011	3 979	2 155	3	4
2012	3 799	2 807	7	5
2013	3 883	2 977	3	5
2014	4 256	2 979	3	5
2015	4 209	2 974	4	5
2016	4 675	3 896	5	6
2017	N/A	3 890	N/A	6

Source: Ministry of Agriculture of Czech Republic (2019); own calculation

Table 1: Use of subsidies from the national subsidy program 1.D in 2010-2017.

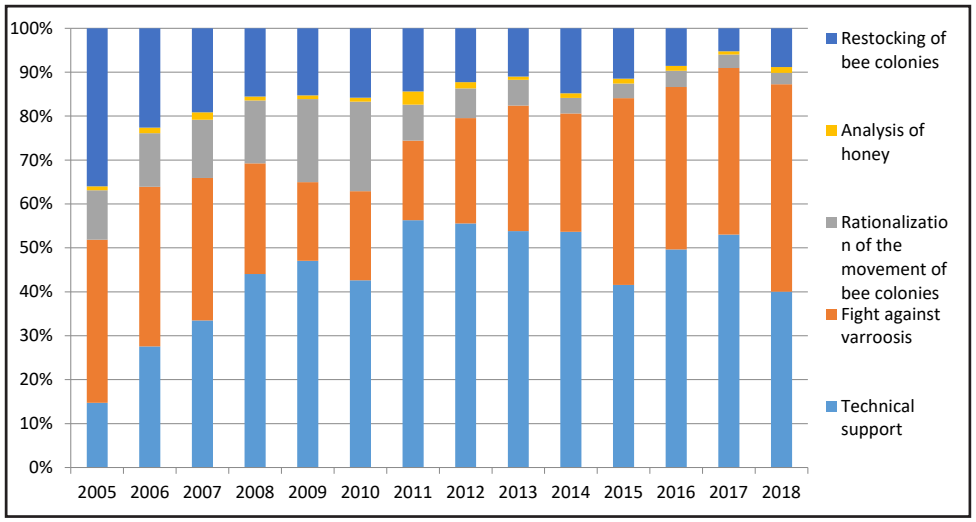
Figure 3 clearly shows the distribution of funds used in individual years.

The graph clearly shows that until 2017, the funds for beekeeping were mostly used for technical support. However, the funds allocated for the fight against varroosis increased gradually until 2018 when the total amount exceeded the amount of funds for technical support. Thus, the biggest share representing 47% of the total amount of funds was used for the fight against varroosis. The remaining areas show a decreasing share of total subsidies in the time series.

Measuring dependence between beekeeping and subsidies

Correlation coefficient values that measure the strength of dependence between the amount of subsidy and the development of the number of beekeepers, bee colonies, bee colonies per beekeeper and the production of honey and beeswax are given in Table 2.

The analysis was conducted utilizing annual data for the period 2006–2017. Due to the relatively lower number of observations, some values were statistically insignificant. However, based on the results, it is possible to conclude that the amount of subsidy had a significant positive influence on the number of colonies. In terms of the specific focus of subsidies, we can observe a significant positive dependence on the level of 0.1 between the number of bee colonies per beekeeper and technical support. Honey analysis subsidy correlates significantly with honey and beeswax production. The most significant positive effect was recorded in case of subsidies focused on fight against varroosis and number of beekeepers and colonies.



Source: Ministry of Agriculture of Czech Republic (2017); The state agricultural intervention fund (2018); own calculation

Figure 3: The structure of the use of beekeeping funds from the EU and the Czech Republic sources in 2005-2018.

	number of beekeepers	number of colonies	number of colonies per beekeeper	honey production	beeswax production
Technical support	0.39	0.47	0.51*	0.06	0.35
Fight against varroosis	0.85***	0.77***	0.30	0.26	0.56*
Rationalization of movement of colonies	- 0.71***	- 0.65**	- 0.30	-0.52	- 0.73***
Honey analysis	- 0.08	0.10	0.53	0.56*	0.51*
Restocking of colonies	- 0.68**	- 0.61**	- 0.21*	-0.46*	- 0.56*
Possibility of subsidies	0.49	0.55*	0.50	0.10	0.41

Note: *** level significance α=0.01 ** level significance α=0.05 * level significance α=0.1
Source: Ministry of Agriculture of Czech Republic (2019);own calculation

Table 2: Dependence between subsidies and bee colonies, honey and beeswax production.

Quantification of the impact of subsidies on the number of bee colonies

The influence of the amount of subsidy on the number of bee colonies was analysed using a panel data model with random effects. The model was quantified using a panel of annual data for individual regions of the Czech Republic for the period 2010-2017. The dependent variable in the model was the number of bee colonies in the region, explanatory variables were subsidies and other factors that could affect the number of bee colonies, such as the size of the area, amount of precipitation and temperature. Of the considered types of individual subsidies, it was impossible to simultaneously use more explanatory variables in the model due to the strong collinearity between these variables. In order to assess the significance of the subsidies objectively, their individual types had to be included in the model separately. Logarithmic shape, which is suitable in terms of reducing the degree of variability in the data and the interpretability of the estimated elasticities in percentage, was chosen for the model. The interpreted model was achieved as a result of the gradual elimination of insignificant variables from the original model with all the explanatory factors considered. A random effect model was used to account for individual effects in the data panel, the existence of which was confirmed by the Breusch-Pagan test. This model is more suitable owing to the higher number of cross-sectional units and the lower number of analyzed periods. Its suitability was confirmed by the Hausman test.

The results are shown in Table 3 below.

The results show that subsidies and the size of the region have a significant influence on the number of bee colonies. In the case of land, an increase of 1 % results in a 0.84 % increase in bee hives. In the case of subsidies, an increase of 1 % results in a 1.34 % increase in beehives. It can therefore be concluded on the basis of the results obtained that the subsidies have a significant effect on the number of bee colonies at the significance level α=0,05. The model was evaluated as significant despite explaining only 18 % of the variability in the number of bee colonies.

A similarly significant result would be achieved if a variable measuring a specific subsidy for the fight against varroosis was used instead of the subsidy. These variables could not be used at the same time because collinearity would always result in one of them being insignificant. An alternative model without the subsidy for the fight against varroosis is given in Table 4 below.

The impact of the size of the area on the number of bee colonies is very similar to that estimated in the previous model. The effect of the support for the fight against varroosis is highly significant. It can be concluded that a 1 % increase in funds to support the fight against varroosis results in a 0.37 % increase in colonies. The model was significant and explains 26 % variability of bee colonies.

On the basis of the results obtained, it can be concluded that subsidies have a significant positive influence on the number of bee colonies in individual regions of the Czech Republic. From different types of subsidies was recorded the most significant positive influence on the number of bee colonies and beekeepers in case of subsidies focused on fight against varroosis. Performed analysis was limited by current availability of data. To offer more complex insights

	coefficient	standard error	t stat.	p-value	significance
const	-15.256100	6.407450	-2.381	0.0191	**
l_size	0.846132	0.215268	3.931	0.0002	***
l_use of subsidy	1.339420	0.518320	2.584	0.0112	**

Source: Ministry of Agriculture of Czech Republic (2019), Czech Statistical Office (2019); own calculation

Table 3: Results of the model with random effects – using subsidies.

	coefficient	standard error	t stat.	p-value	significance
const	-4.292	2.944770	-1.458	0.1481	
l_size	0.862741	0.214746	4.017	0.0001	***
l_fight against varroosis	0.370779	0.081628	4.542	1.54E-05	***

Source: Ministry of Agriculture of Czech Republic (2019), Czech Statistical Office (2019); own calculation

Table 4: Results of the model with random effects – support for the fight against varroosis.

into effects of subsidies, would require analysis including more data, and alternative factors influencing beekeeping in Czech Republic.

Conclusion

Beekeeping is a specific sector of agricultural production which not only fulfils the production function but also contributes significantly to the sustainability of the landscape. Bees are especially important as pollinators of agricultural, forest and wild growing plants that ensure biological balance in the landscape. Gallia et al. (2009) Beekeeping also fulfils a social function as a leisure time activity. as mentioned by Aksoy et al. (2018), Borowská (2016), Demincan et al. (2016), Chauzat et al. (2013). Young people can join beekeepers groups and gain information on the social importance of beekeeping.

For the above-mentioned importance of beekeeping, this sector is supported by various measures in all states (Jarka, Trajer, 2018). The Czech Republic benefits from 5 available measures, most of which are used for the area of Technical Support that helps to acquire the tools necessary for harvesting and processing bee products, and for the area of Fight against Varroosis where beekeepers can receive funds for medicinal products, remedies and aerosol to treat or prevent varroosis. According to Borowská (2010) these are the considered important function of subsidies.

This paper proves the significant influence of subsidies on the increase in bee colonies, therefore it is clear that subsidies are one of the tools which contribute to the increase in hives in the Czech Republic. This is further documented by the number of applications for subsidies, which exceeds the total amount of funds to be allocated. The most required subsidies for Technical Support cover the cost of honey harvesting/processing tools and the cost of education programs and young beekeepers clubs management. The increasing number of beekeepers in recent years suggests that subsidies contribute to the development of beekeeping. In particular, they facilitate the restocking of lost colonies and thus the stabilization of bee colonies in the Czech Republic. By addressing young people, they also contribute to an increase in the number of beekeepers, which exceeds the natural generational replacement. Of great importance are subsidies for the fight against varroosis, which has been the cause of sizeable bee colony deaths. It is compulsory for the State Veterinary Administration of the Czech Republic to perform annual sampling from all the habitats in the Czech Republic in order to detect this disease and ensure necessary treatment in time. The increasing amount of this subsidy and the rise of beekeeping is evidence of help in fighting this disease.

The Czech Republic is one of the countries with the highest number of bee colonies per km^2, which are distributed throughout the country. This ensures uniform pollination and thus the maintenance of ecological balance and biological diversity, which also affects crop yields. However, this situation is not typical for all EU countries.

Therefore, in its report on prospects and challenges for the EU beekeeping sector of 8 February 2018, the European Parliament proposed that beekeeping be given priority in the proposals for the future agricultural policy expected after 2021, and that the EU budget be increased for national beekeeping programmes to reflect the overall importance of this sector.

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