Selected Aspects of Beekeeping Sector in the Czech Republic and Switzerland

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Abstract

In this thesis the results of research conducted on selected aspects of beekeeping sector in the Czech Republic and Switzerland are presented. Considering the lack of studies focusing on the economics of small-scale beekeeping operations in the Czech Republic, Switzerland and other comparable countries, submitted dissertation might possibly (at least to a certain extent) fill this gap in the literature and contribute to clarification of economics of beginning beekeepers' operations, while providing insight into the contemporary beekeeping sector in terms of agriculture, economics, natural and urban habitats, and drawing a comparison between the beekeeping sectors in both countries. Applied methodological framework combines the use of both quantitative and qualitative methods of data collection and data analysis to obtain complex and integrated view on the beekeeping sector, including specific stakeholder (beekeepers') approach. Apart from the evaluation of the economics of the hobby beekeeping operations, Czech honey price time series is quantitatively analysed and the aspects of beekeepers' professionalization and selected initiatives promoting beekeeping within specific target groups are presented. Overall, this dissertation is a contribution to the long-term sustainability of beekeeping sector with regard to pollinator-dependent agriculture in the Czech Republic, Switzerland and other comparable countries.

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List of Abbreviations

ACF – Autocorrelation Function

AFB – Amerikanische Faulbrut

AGNI – Arbeitsgruppe naturgemässe Imkerei

AIC – Akaike’s Information Criterion

AIR – Annual Implementation Report

AR – Autoregressive

ARIMA – Autoregressive Integrated Moving Average

ARMA – Autoregressive and Moving Average

BC – Bee Colony

BFS – Bundesamt für Statistik

BGD – Bienengesundheitsdienst

BIC – Bayesian Information Criterion

BIVS – Buckfastimkerverband Schweiz

BLV – Bundesamt für Lebensmittelsicherheit und Veterinärwesen

BLW – Bundesamt für Landwirtschaft

BRC – Bee Research Centre

CAFIA – Czech Agriculture and Food Inspection Authority

CBU – Czech Beekeepers’ Union

CH – Switzerland, Swiss

CHF – Swiss franc

CL – Confidence Limit

COLOSS – Prevention of Bee Colony Losses

CZ – Czech Republic, Czech

CZK – Czech koruna

CZSO – Czech Statistical Office

ČSV – Český svaz včelařů

ČZS – Český zahrádkářský svaz

DG – Directorate-General

EC – European Commission

EFB – Europäische Faulbrut

EMA – Economically Motivated Adulteration

EPBA – European Professional Beekeepers Association

EU – European Union

FSO – Federal Statistical Office

GDP – Gross Domestic Product

GMO – Genetically Modified Organism

HA – Hectares

IBH – Institut für Bienengesundheit

ICYB – International Centre for Young Beekeepers

IMYB – International Meeting of Young Beekeepers

LCL – Lower Confidence Limit

MA – Moving Average

MAE – Mean Absolute Error

MAPE – Mean Absolute Percent Error

MLE – Maximum Likelihood Estimation

MSE – Mean Squared Error

MZe – Ministerstvo zemědělství České republiky

NAP – National Apiculture Programme

NGO – Non-governmental Organization

NUTS – Nomenclature of Territorial Units for Statistics

OECD – Organization for Economic Co-operation and Development

ÖEIB – Österreichischer Erwerbsimkerbund

PACF – Partial Autocorrelation Function

PSNV – Pracovní společnost nástavkových včelařů

RASFF – Rapid Alert System for Food and Feed

SAR – Societé Romande d’Apiculture

SBC – Schwarz Bayesian Criterion

SBIC – Schwarz Bayesian Information Criterion

SCIV – Schweizerische Carnicaimker-Vereinigung

SFGV – Schweizer Familiengärtner-Verband

SIC – Schwarz Information Criterion

SIG – Statistical Significance

SOUV-VVC – Střední odborné učiliště včelařské – Včelařské vzdělávací centrum

SPIV – Schweizerische Pollenimkervereinigung

STA – Società Ticinese di Apicoltura

STD – Standard

SVA – State Veterinary Administration

SVS – Státní veterinární správa

SVZ – Situační a výhledová zpráva

SZIF – Státní zemědělský intervenční fond

SZPI – Státní zemědělská a potravinářská inspekce

UCL – Upper Confidence Limit

USA – United States of America

VDRB – Verband deutschschweizerischer und rätoromanischer Bienenfreunde

VSBV – Verband der Schweizerischen Bienenzüchtervereine

VSMB – Verein Schweizerischer Mellifera Bienenfreunde

VSWI – Verein Schweizer Wander-Imker

WCED – World Commission on Environment and Development

WOMM – Word of Mouth Marketing

ZFB – Zentrum für Bienenforschung

1 Introduction

„You will probably more than once have seen her fluttering about the bushes, in a deserted corner of your garden, without realizing that you were carelessly watching the venerable ancestor to whom we probably owe most of our flowers and fruits (for it is actually estimated that more than a hundred thousand varieties of plants would disappear if the bees did not visit them) and possibly even our civilization, for in these mysteries all things intertwine."

Maurice Maeterlinck (1901, p. 389)

1.1 Relevance of the Topic

Although honeybees provide various bee products (honey, propolis, pollen, beeswax, royal jelly and bee venom), their crucial role lies in plant pollination. Through proper pollination honeybees along with other insects and animals enable the existence of several dozen entomophilous plant species and determine the volume of agricultural production of selected crops.

According to Tautz (2008), honeybees are considered the third[1] most valuable domestic animals in Europe. The main reason for this importance is their pollination activity that should be perceived as a crucial element in the world's food supply, since the beneficiaries include not only farmers, but also local and (inter)national consumers of the pollinated crops (Hein, 2009). As the pollinating service also affects the production, which is already used by other organisms within the nature (Cane, 2005), beekeeping contributes to the conservation of biological diversity and productivity of natural and agricultural ecosystems.

With regard to reported significant bee colony losses (Neumann and Carreck, 2010; Potts et al., 2010a,b) adverse agricultural, economic and environmental impacts of pollinator declines became of utmost interest for scientific community, as proved by numerous research works (e.g. Allen-Wardell et al., 1998; Gallai et al., 2009; Hein, 2009; Kevan and Phillips, 2001).

Bee colony losses in diverse countries throughout the world have been traceable to dissemination of pathogens and parasites (Neumann and Carreck, 2010), agricultural intensification (Groß, 2011; Richards, 2001; Ricketts et al., 2008), other miscellaneous

[1] The first is cattle, the second is pig and the fourth is poultry (Tautz, 2008).

causation (e.g. Colony Collapse Disorder – Oldroyd, 2007; van Engelsdorp et al., 2009) and combinations of these factors. Some further reasons behind the pollination crisis barring pollinators' decline are given by Westerkamp and Gottsberger (2000), who point out the drawbacks of missing know-how in proper flower handling, alien crops growing and the reliance on a single pollinator species, and criticize customers' year-round demand for certain crops.

In addition to that, contemporary European beekeeping has been facing other severe challenges, including for example climate change (Le Conte and Navajas, 2008; Menzel et al., 2006), beekeeper numbers' decline or economically motivated adulteration.

In the course of time beekeeping sector is confronted with problem of beekeeper's ageing (EC DG AGRI, 2013; Klein et al., 2007) and accordingly with declines in beekeeper numbers and a loss of incentives for beekeeping. The results of study by Potts et al. (2010a) show significant 31 % decrease in the number of beekeepers in Europe between 1985 and 2005. Such trend is driven by diverse factors, for example socio-economic conditions (agricultural policy, subsidies, taxes, prices for bee products etc.) or demands on bee diseases treatment and mite control (Potts et al., 2010a; Watanabe, 1994). Since the role of beekeepers, their professional knowledge and proper beekeeping practice are indispensable for honeybee colony survival (Jacques et al., 2017), it is essential to develop a long-term sustainable strategy to reverse this unfavourable trend and its prospective consequences.

Beekeeping affects both crop and animal farming, but its products extend beyond the agriculture and food processing industry to pharmaceuticals, chemistry, medicine etc. Honey is considered as a product of high value and quality, and therefore it becomes a frequent target of economically motivated adulteration (Everstine et al., 2013; Fairchild et al., 2003; Strayer et al., 2014). Fraudulent practices can have negative impact on the overall image of food industry, agriculture and consequently they can influence consumers' preferences. Hence, the international cooperation towards detecting adulteration and improving food safety regulations is needed.

Apart from the current threats to managed beekeeping in Europe, there are also opportunities to be used. Honeybees proved to be excellent instrument for data sampling in environmental pollution issues, where they work as promising bio-indicators monitoring environmental quality (Badiou-Bénéteau et al., 2013; Zhelyazkova, 2012). There also exists variety of multifarious projects supporting and promoting apiculture and pollinator conservation – for instance urban beekeeping is gaining popularity among public (Fenske, 2018; Lorenz and Stark, 2015; Salkin, 2012).

With respect to the attention turned to sustainable agriculture, where all three parts (ecological, economic and social) need to be balanced, the involvement of relevant actors (farmers, consumers, environmental NGOs and the like) can be of great importance to research and its results (Neef and Neubert, 2011). According to the principle of idiosyncrasy[2], putting theory into practice requires locally based information and science (Daily et al., 2000). Moreover, farmers (and beekeepers) usually rely on an extensive base of agronomic and biological knowledge, which is frequently bound to certain regions and agroecosystems (Tilman et al., 2002).

Given the aforesaid problems of managed beekeeping, fundamental role of world's ecosystems (Balmford et al., 2002, Daily et al., 2000) and critical pollinator dependence (Aizen et al., 2008; Chopra et al., 2015; Garibaldi et al., 2009; Garibaldi et al., 2011; Winfree, 2008), beekeeping remains a topical scientific issue.

There is a call for raising the attention paid to maintaining pollination services in agricultural management (Kevan and Phillips, 2001; Klein et al., 2007). Another scientific gap is identified by Allen-Wardell et al. (1998) in scientific knowledge regarding nationally coordinated efforts addressing honeybee declines, which include inter alia projects to reduce pesticide misuse and educational programs for relevant stakeholders in order to enhance agricultural management policies and practices affecting beekeepers' livelihoods. The need for international cooperation is also stressed (Neumann and Carreck, 2010; Potts et al., 2010b). Therefore, the necessity of scientific research, interdisciplinary cooperation and adequate policy to create sustainable beekeeping sector should be integrated not only horizontally across countries and regions, but also vertically from international to local levels.

In the upshot there is missing overall strategy to preserve the sector over a medium (or large) period of time. Sustaining global agriculture depends both on pollination by managed honeybees and wild insects (Hein, 2009) and the aim should not be to combat either managed or wild pollinator conservation strategies, but rather find the optimal solution to preserve both managed beekeeping and biodiversity (Geslin et al., 2017). As stated above, the scientific

[2] I.e. an unusual or unexpected feature, habit, uniqueness, distinguishing element of behaviour and/or expression (Longman, 2009).

research is essential to help develop economically viable sustainable management in introduced beekeeping and support pollinator species coexistence through successful integration of bee protection and conservation in contemporary agricultural production.

This dissertation is a contribution to the long-term sustainability of beekeeping sector with regard to pollinator-dependent agriculture in the Czech Republic, Switzerland and other comparable countries.

1.2 Objectives

The overall objective of this thesis is to evaluate the beekeeping sector in the Czech Republic and Switzerland in terms of selected aspects, identify sector's weak spots and make appropriate recommendations thereon to relevant stakeholders.

Specifically, the dissertation aims:

To compare selected theoretical underpinnings referring to contemporary beekeeping sector in terms of agriculture, economics, natural and urban habitats and to make a comparison between the beekeeping sectors in the Czech Republic and Switzerland in order to determine common traits, clarify differences and place the findings in context with existing literature.

To investigate and assess economic situation of hobby beekeeping operations in the Czech Republic and Switzerland through doing an economic simulation of variously sized hobby beekeeping operations, calculating their initial investments, annual expenditures and annual revenues, identifying potential shortcomings, and to make suggestions to improve the economics of small-scale beekeeping operations in the Czech Republic and Switzerland.

To assess the time series of Czech honey prices over time span 1995 – 2018 through indicating and measuring the change in Czech honey prices by means of growth rate and linear approximation, and constructing an ARIMA model of given time series according to Box – Jenkins methodology and on the basis of constructed model to forecast short – term future price development of Czech honey.

To assess beekeepers' professionalization as a significant aspect of beekeeping sector through data comprehension, describing the current state of beekeepers' professionalization in the Czech Republic and Switzerland on the basis of conducted expert interviews, and to determine drawbacks and recommend their possible solutions.

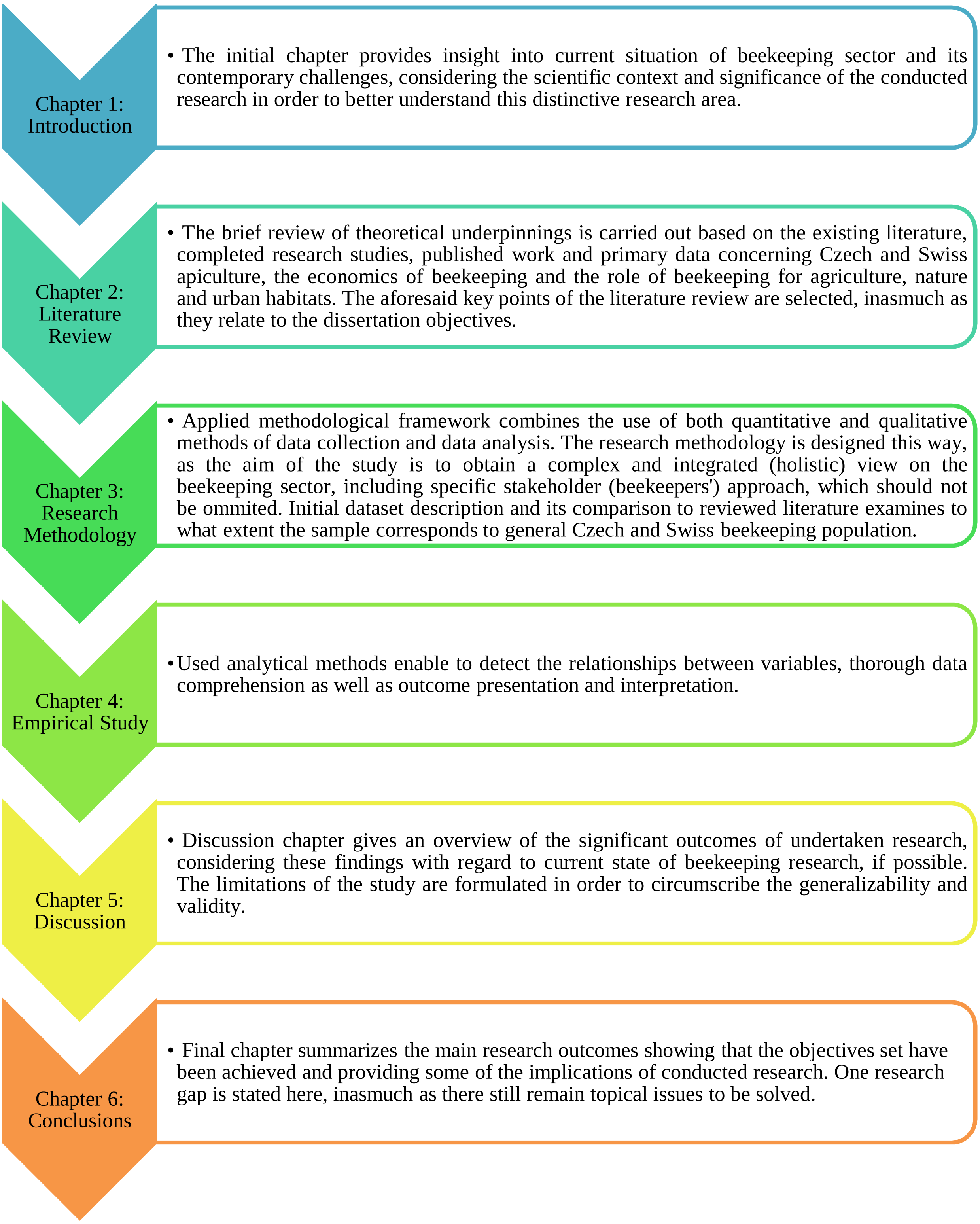
To provide insight into selected beekeeping initiatives promoting beekeeping in the Czech Republic and/or Switzerland within specific target groups, through data comprehension and placing them in context of existing literature, if possible.

Last but not least, this thesis aims to fill the gap in the literature and contribute to clarification of economics of beginning beekeepers' operations in the Czech Republic, Switzerland and other comparable countries.

1.3 Thesis Structure

Figure 1 shows an overview of the thesis' structure including rationale of each single chapter.

Figure 1: Structure of the thesis



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2 Literature Review

Beekeeping sector considerably exceeds the conceptions of honey production and pollination securing food production, since the range of its impacts is much more varied nowadays. Insect pollination is essential to crop farming and by extension to animal husbandry (through pollinating forage crops) and biofuel industry. New and/or rediscovered trends of urban agriculture and beekeeping in the city emerge all over the world. The role of bees in nature and biodiversity conservation is also significant, even for the environmental pollution assessment. Topical issue represents the economics – profitability and economic viability of beekeeping operation, the valuation of beekeeping's benefits and market competition, which are together with bee colony losses and beekeepers' ageing calling sector's long-term sustainability into question.

Reviewed theoretical underpinnings hence refer to the contemporary beekeeping sector in terms of agriculture, economics, natural and urban habitats and sustainability. The primary data on Czech and Swiss beekeeping is gathered to give a detailed description of the branch within these two countries. Czech and Swiss beekeeping has a long tradition and locally produced honey is in both countries appreciated as a high-quality product. Small scale beekeeping prevails in comparison to commercial bee farms. Top-quality bee research is integral to beekeeping sector and together with beekeepers' professionalization is the sine qua non of its success. So, it is reasonable to draw a comparison between Czech and Swiss beekeeping in order to determine their common traits and define gaps, which can be bridged by cooperation opportunities.

2.1 Beekeeping Sector in the Czech Republic

In this part the apicultural sector in the Czech Republic is presented with regard to its key features – bee colonies, beekeepers, main bee products, institutional background and research activities. According to the Sector Strategy of the Ministry of Agriculture of the Czech Republic (MZe, 2017), the main strategic priority for Czech beekeeping sector as a whole is to ensure sufficient numbers of healthy bee colonies for ample and continuous pollination of agricultural crops and satisfactory and top-quality honey production.

2.1.1 Bee Colonies

Czech Republic has relatively high bee colony density among European countries, inasmuch as more than 630 000 bee colonies are managed here and the natural conditions (particularly moderate climate and bee forage abundance) are favourable to beekeeping.

Honeybee breeds distribution to a certain extent corresponds to the linguistic regions of Europe (French-speaking, German-speaking) and individual multilingual countries (Switzerland). Regarding managed honeybee breeds, the honeybee population in the Czech Republic is relatively homogenous and the Carniolan honeybee (*Apis mellifera carnica*) prevails. In addition to that there are stocks of the Buckfast bee (*Apis mellifera buckfast*), the European dark bee (*Apis mellifera mellifera*) and of course some cross-breeds (Kašpar et al., 2016 and 2017).

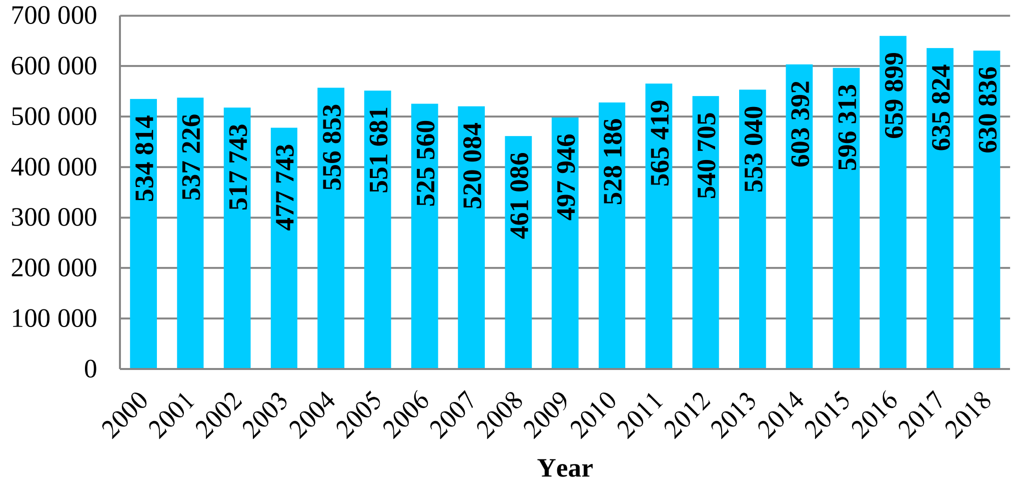
The Carniolan honeybee is listed as the animal genetic resource in the National Program for the Conservation and Utilisation of Genetic Resources in the Czech Republic (Včela, 2019). According to the Breeding Act[3], only Carniolan honeybee can be bred in the Czech Republic. Added to this, the COLOSS Association (2019a) points out the risks driven by free honeybee trade, where possible genetic threats are neglected.

The bar chart below in Figure 2 shows the number of bee colonies in the Czech Republic between the years 2000 and 2016 at year intervals. From the chart it is clear that the numbers of bee colonies were fluctuating from year to year. Since 2014 the number of bee colonies has oscillated around 600 000. In winter 2007/2008 substantial bee colony losses due to varroosis were reported (SVZ, 2009; Vláda ČR, 2008), however the results of latest studies on winter colony losses in the Czech Republic (e.g. Brodschneider et al., 2019) show favourable development. Bee colony losses driven by bee diseases are reduced through excellent cooperation between Czech Beekeepers' Union, State Veterinary Administration of the Czech Republic, and Bee Research Institute in Dol (CBU, 2008).

Apart from the bee colony losses caused by bee diseases, Czech beekeepers are from time to time confronted with bee colony thefts (e.g. Sojka, 2008) and/or vandalism (e.g. Suchoradský, 2011).

[3] Act No 154/2000 Coll., on breeding, stirpiculture and record keeping of farm animals and on amendments to some related laws, as amended. / Zákon č. 154/2000 Sb., o šlechtění a plemenitbě a evidenci hospodářských zvířat a o změně některých souvisejících zákonů, v platném znění (plemenářský zákon).

Figure 2: Bee colonies in the Czech Republic (2000 – 2018)



Source: own processing according to CBU (internal data, 2019)

The bee colony density in the Czech Republic is 8.8 bee colonies per km^2, which indicates one of the highest levels in Europe (Brodschneider et al., 2019).

With regard to bee pasture and the agriculture and forestry, bee colonies benefit from diversity of bee forage sources and they ensure the pollination of flowers (for floristry) and various agricultural crops – for example oil plants (oilseed rape, sunflowers, white mustard), forage crops (alfalfa, red clover), fruit trees (apples, apricots, cherries, peaches, pears, plums), shrub berries (currants, gooseberries), vegetable (cucumbers, squash), medicinal and aromatic plants (fennel, dill, coriander) and herbs (Zelená zpráva, 2017). In 2016, nearly 34 % of the Czech Republic was covered by forests and there was following structure of tree species in terms of volume: spruce (50.5 %), pine (16.4 %), beech (8.3 %), oak (7.2 %), larch (3.8 %) and others (Kahuda, 2018).

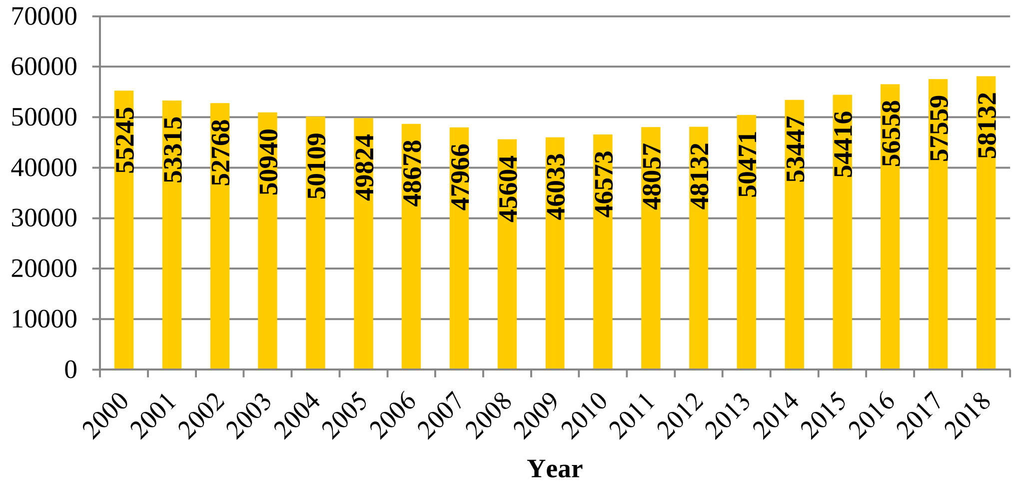
The types of beehives, which are commonly used in the Czech Republic, still vary considerably, however the two main types are the frame dimensions of 39 x 24 cm and 42 x 27.5 cm. Also the Langstroth hive type (frame dimensions of 44.8 cm, see Picture 6 in Appendices) gained in popularity among Czech beekeeping community in past decades (CBU, 2008).

2.1.2 Beekeepers

In the Czech Republic there are more than 58 000 beekeepers and almost three fourths of them are older than 46 years. In 2019, nearly nine out of ten Czech beekeepers are male and small scale (hobby) beekeeping continues to prevail.

To describe the development of the number of Czech beekeepers, the data of CBU are used, which represent the count of CBU's members. According to CBU (2019) about 98 % of all beekeepers in the Czech Republic are registered in the Czech Beekeepers' Union. The bar chart in Figure 3 illustrates the number of beekeepers united in the CBU in the Czech Republic between the years 2000 and 2018 at year intervals.

Figure 3: Beekeepers in the Czech Republic (2000 – 2018)

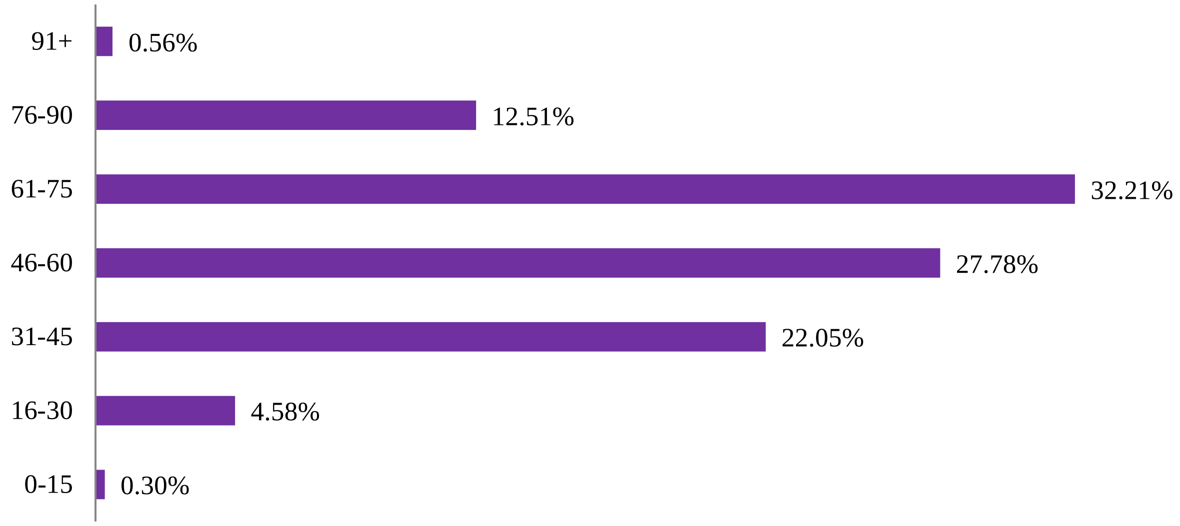


Source: own processing according to CBU (internal data, 2019)

It can be seen that the number of beekeepers had considerably declined from 55 245 in 2000 to 45 604 in 2008, closely corresponding to a trend presented by Potts et al. (2010a). Since then the figures have gradually increased. As opposed to the decreasing trend of European beekeepers indicated by Potts et al. (2010a), the amount of Czech beekeepers is steadily growing. According to CBU (internal data, 2019), men make up the vast majority (87.1 %) of Czech beekeepers.

The graph in Figure 4 depicts the age distribution of Czech beekeepers in 2019. The proportion of beekeepers up to 45 years is relatively low (in total ca. 27 %) in contrast to the majority of beekeepers older than 46 years. The chart below shows that the demographic structure in Czech beekeeping sector is highly regressive, as stated earlier by Šimpach (2012) and the age structure of Czech beekeepers matches with the general problem of beekeepers' ageing in apicultural sector in Europe, as evidenced by the EC DG AGRI report (2013). However the Czech Beekeepers' Union (CBU, 2019) aims to foster the interest in beekeeping in order to improve the unfavourable situation.

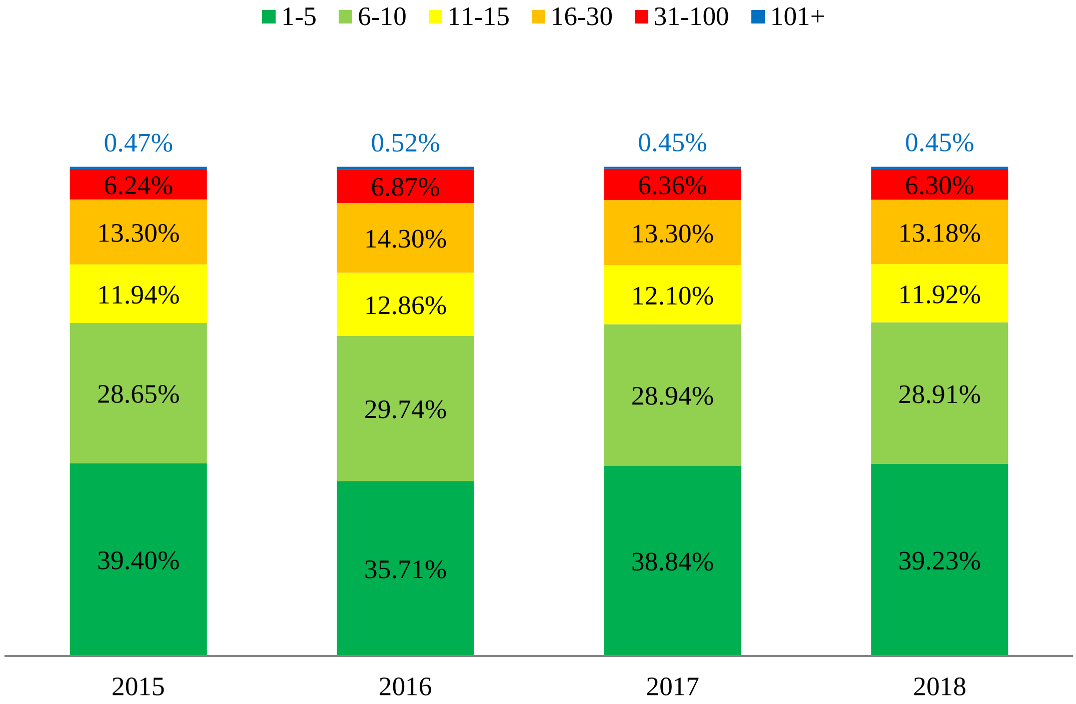
Figure 4: Age structure of Czech beekeepers (2019)



Source: own processing according to CBU (internal data, 2019)

With regard to the beekeeping operation sizes it is worked on the assumption that hobby beekeeping prevails in the Czech Republic and only a small minority of bee farms is commercial. The bar chart below (Figure 5) shows the structure of the beekeeping operations in the Czech Republic between the years 2015 and 2018 at year intervals. From the chart it is clear that the two thirds of Czech beekeepers manage the beekeeping operations up to 10 bee colonies, which confirms that the hobby beekeeping predominates here (similarly to some other European countries – see e.g. Chauzat, 2013). Little more than a fourth of beekeepers in the Czech Republic have between 11 to 30 bee colonies. There is just one to two percent difference between the two categories (11 – 15 and 16 – 30). The beekeepers, who manage more than 101 bee colonies, account for ca. 0.5 % of all Czech beekeepers. From the point of view of professional beekeeping, defined as an operation with more than 150 bee colonies, in 2018 there were 107 professional beekeepers (CBU internal data, 2019) in the Czech Republic.

Figure 5: Sizes of Czech beekeeping operations based on the bee colonies (2015 – 2018)



Source: own processing according to CBU (internal data, 2019)

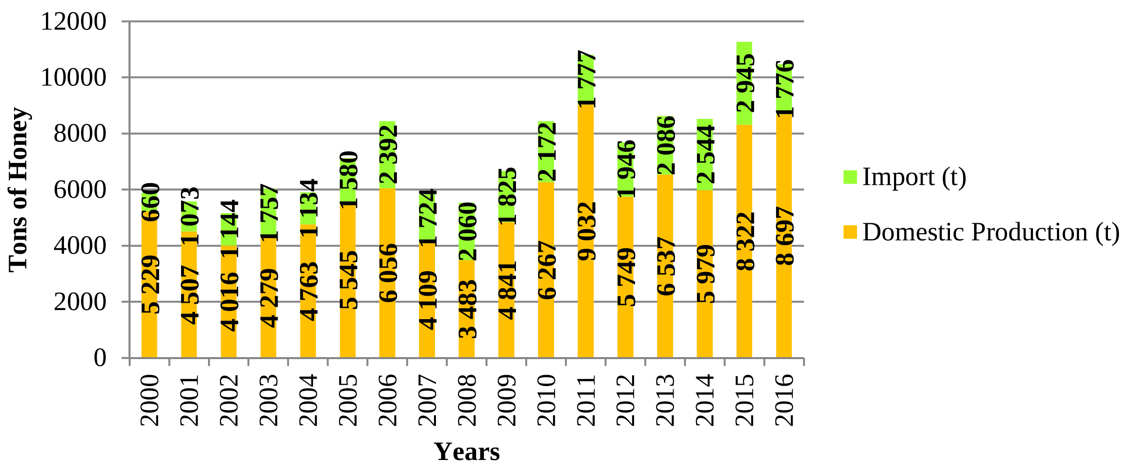
One of the objectives set by the Ministry of Agriculture of the Czech Republic in its Sector Strategy (MZe, 2017) is the professionalization of beekeepers through improvement of the current education system and supporting educational activities, including centres and training programs for beginning beekeepers and the general public.

2.1.3 Bee Products

The use of bee products (honey, pollen, propolis, beeswax, royal jelly and bee venom) is not solely limited to the food industry, but they are also used in cosmetic industry, pharmacy, chemical industry, furniture manufacturing, glass industry and so forth (CBU, 2008). With regard to their economic significance to Czech beekeeping, honey and beeswax production is presented in detail.

The best pasture for bees is provided by landscapes offering many floral species with rich nectar and pollen and blooming from early spring to late autumn. In the Czech Republic the most important floral varieties in terms of beekeeping are: oilseed rape (*Brassica napus*), false acacia[4] (*Robinia pseudoacacia*), European raspberry (*Rubus idaeus*), red clover (*Trifolium pratense*), alfalfa[5] (*Medicago sativa*), sunflower (*Helianthus annuus*), European spruce (*Picea abies*), and fruit trees (Haragsim, 2004, 2007 and 2008). On account of geographical and climatic conditions, Czech honey is predominantly multifloral (mixed), while the monofloral honey types (e.g. rapeseed honey, false acacia honey and sunflower honey) are rather rare (CBU, 2008). The bar chart below (Figure 6) shows the development of total honey supply in the Czech Republic between the years 2000 and 2016.

Figure 6: Honey supply in the Czech Republic (2000 – 2016)



Source: own processing according to SVZ (2017)

It can be seen that the amount of honey production varies greatly from one year to another and furthermore, there may be differences within the same year in various regions. From the chart it is clear that the proportion of domestic honey production to imported honey is in the Czech Republic much higher in contradistinction to Switzerland (see Figure 9). The average production of honey in the Czech Republic for the time period 2000 – 2016 was 7 837.5 tons a year, while the average honey yield per colony and year was about 15.3 kg. This corresponds to the long-term average (i.e. 15 to 18 kg of honey per bee colony and year) given by CBU (2008). The commercial beekeepers, economically dependent on revenues from their beekeeping operation, use the opportunity of the migratory beekeeping to move

[4] Locust tree

[5] Lucerne

their bee colonies into localities with abundant bee pasture, and therefore reach the average production between 35 and 50 kg per bee colony (CBU, 2008). According to CBU (internal data, 2019) the total honey production in the Czech Republic in 2018 was 8 978.7 tons, whereas the average honey yield per colony and year was approximately 14.23 kg. In terms of the international trade, the Czech Republic exported between the years 2000 and 2016 an average of 2 128 tons of honey a year and imported an average of 1 800 tons of honey a year. The average import prices for honey were 80.75 CZK/ kg in 2015 and 81.29 CZK/ kg in 2016, and the average export prices were 102.98 CZK/ kg in 2015 and 89.22 CZK/ kg in 2016. Czech honey is mainly exported to France, Slovakia, Germany and the United Kingdom. Honey imported to the Czech Republic principally originates from Ukraine, Slovakia, Uruguay, Germany, Spain, China and Argentina (SVZ, 2017; Zelená zpráva, 2017). Although the EU is the second largest honey producer (after China); it is not self-sufficient, and so the demand for honey needs to be covered by imports (Rossi, 2017).

Table 1 (below) provides more detailed description of Czech honey production and international trade indicators between the years 2000 and 2016.

Table 1: Czech honey production and international trade (2000 – 2016)

Year		**2000**	**2001**	**2002**	**2003**	**2004**
Total Production (t)		7 500	6 300	5 883	6 303	7 738
Import (t)		660	1 073	1 144	1 757	1 134
Total Consumption (t)		5 889	5 580	5 160	6 036	5 897
Export (t)		2 271	1 793	1 867	2 024	2 975
Domestic Production (t)		5 229	4 507	4 016	4 279	4 763
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total Production (t)	8 371	9 051	8 466	6 078	6 892	7 455
Import (t)	1 580	2 392	1 724	2 060	1 825	2 172
Total Consumption (t)	7 125	8 448	5 833	5 543	6 666	8 439
Export (t)	2 826	2 995	4 357	2 595	2 051	1 188
Domestic Production (t)	5 545	6 056	4 109	3 483	4 841	6 267
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Total Production (t)	11 302	7 332	8 063	7 163	9 228	10 113
Import (t)	1 777	1 946	2 086	2 544	2 945	1 776
Total Consumption (t)	10 809	7 695	8 623	8 523	11 267	10 473
Export (t)	2 270	1 583	1 526	1 184	906	1 416
Domestic Production (t)	9 032	5 749	6 537	5 979	8 322	8 697

Source: own processing according to SVZ (2017)

Domestic production (shown also in Figure 6 above) is calculated by subtracting the export from the total production. Sum of domestic production and import is then considered as a total consumption. In relation to the honey consumption in the Czech Republic between the years 2000 and 2015, the average was 0.7 kg of honey per capita and year. However, the honey consumption in 2015 was 1 kg per capita and year. Overall, the domestic honey consumption is considered relatively low (as opposed to Austria, Germany or Greece); although it matches with the EU average. And thus it should be increased (SVZ, 2017; Zelená zpráva, 2017). According to data by CZSO (Kholová, Michaela, Information Services Unit, personal communication, March 6, 2019), in 2018 the average price[6] for one kilo of honey was 205 CZK.

Beeswax is necessary for wax foundation combs production and it is also used for candles, in cosmetics and pharmacy (as a part of balms, salves and emulsions) and in glass industry (CBU, 2008). The average beeswax production in the Czech Republic for the time period 2000 – 2018 was ca. 255 tons a year. It follows that the average beeswax yield[7] per colony and year accounted for 0.454 kg (CBU, internal data, 2019). With regard to SVZ (2017), between the years 2000 and 2016 the Czech Republic exported an average of 2.6 tons of beeswax a year and imported an average of 13 tons of beeswax a year.

2.1.4 Institutional Framework

More than 58 000 members and approximately 200 beekeeping youth groups (representing 98 % of all beekeepers in the Czech Republic) are united in the Czech Beekeepers' Union, which shows strong organized character of Czech beekeepers on an international scale (CBU, 2019).

Czech Beekeeper's Union[8] (CBU) is in charge of cooperation with national authorities, governmental and non-governmental organizations in order to ensure legislation and activities to promote beekeeping, research, honeybee health, pollination and bee forage sources protection. Other tasks include professional growth and further education of its members and approaching youth in order to arouse its interest in beekeeping. CBU's excellent results of making provision for honeybee health through sophisticated methodology of uniform preventive measures against bee diseases outbreak are well regarded. Apart from its membership of two international organizations (Apimondia and Apislavia), the CBU

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[6] For detailed Czech honey price analysis see the subchapter 4.2

[7] For details about beeswax production, see Tautz (2014) or Titěra (2013).

[8] Český svaz včelařů (ČSV)

maintains many bilateral contacts, as the international networking plays an important part in knowledge transfer (CBU, 2008 and 2019).

Apimondia is the International Federation of Beekeepers' Associations and another organizations actively participating in beekeeping sector. It was established in 1949 and it aims to promote scientific, technical, ecological, social and economic apicultural development; support the stakeholders' global cooperation within the apicultural sector, and improve beekeeping practice (Apimondia, 2015).

Apislavia is the federation of beekeeping organizations in Slavic and Danube countries. It unites beekeepers' associations from 17 member countries. Apislavia's predecessor organization was a "Pan-Slavic Beekeepers' Union" founded in 1910 with intention to develop mutual relationships between beekeepers and their associations in the Slavic geographical area in order to defend their interests and support the development of rational beekeeping (Apislavia, 2016).

The ***Ministry of Agriculture of the Czech Republic***[9] provides relevant information on valid legislation and available subsidy[10] programs in beekeeping. It issues the Situation and Outlook Report of the Bees[11] and defines the strategic objectives of the beekeeping sector (MZe, 2019). The ministry, inter alia, establishes some of the administrative units listed below, whose activities directly affect beekeeping in the Czech Republic.

The ***State Veterinary Administration***[12] (SVA) is the public administrative agency and following activities come under its competence – to protect consumers from potentially harmful products of animal origin, to supervise animal health situation, to ensure high level of veterinary protection, to preserve favourable animal health situation, animal welfare and animal protection (SVA, 2019). With regard to beekeeping, SVA's website (SVS, 2019) provides a significant map output of outbreak of the American foulbrood[13] (*Pestis americana*

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[9] Ministerstvo zemědělství České republiky (MZe)

[10] The State Agricultural Intervention Fund (Státní zemědělský intervenční fond, SZIF) is an authorized payment agency – the provider of financial support from the EU and national sources (SZIF, 2019).

[11] Situační a výhledová zpráva Včely (SVZ)

[12] Státní veterinární správa (SVS)

[13] Mor včelího plodu / Amerikanische Faulbrut (AFB), Faulbrut der Bienen

larvae apium caused by *Paenibacillus larvae* ssp. *Larvae* – cf. Genersch, 2010)[14] with situation overview and protection zones in the Czech Republic.

The objective of the ***Czech Agriculture and Food Inspection Authority***[15] (CAFIA) is firstly monitoring and inspecting food and agricultural products within the production process, storage, transport, sale and import; and secondly the protection of economic interests of consumers and the state. CAFIA is the National Contact Point for RASFF[16] in the Czech Republic (CAFIA, 2019).

The Ministry of Agriculture of the Czech Republic and the Czech Beekeepers' Union established the ***Beekeeping Vocational School – Beekeeping Training Centre***[17] for adult education, organization of extracurricular beekeeping activities for children and youth and arrangements of educational and cultural-educational activities for the general public (SOUV-VVC, 2019).

Besides the institutions outlined above, there are also some other organizations devoted to beekeeping in the Czech Republic – for example Rooftop Beekeepers' Club (Klub střešních včelařů, 2017), Association of Professional Beekeepers[18] (Asociace profesionálních včelařů, 2018), Beekeeping Youth (Včelaříci, 2019), Association for beekeeping in movable frame hives (Pracovní společnost nástavkových včelařů, 2019), Mendel Society for Beekeeping Research (Mendelova společnost pro včelařský výzkum, 2019), Section of Commercial Beekeepers at CBU (Sekce komerčních včelařů při ČSV, 2019), Bee Watch (Včelí stráž, 2019), Mája – Association for Beekeeping Development (Mája, 2019), Society of Breeders of the European dark bee (Spolek chovatelů včely tmavé, 2019) and so on. Furthermore, on an international scale, the COLOSS Association[19] (2018) has its representatives of the Czech Republic too.

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[14] Not to be interchanged for the European Foulbrood (Forsgren, 2010) / Hniloba včelího plodu (*Putrificatio polybacterica larvae apium*) / Europäische Faulbrut (EFB), Sauerbrut der Bienen

[15] Státní zemědělská a potravinářská inspekce (SZPI)

[16] Rapid Alert System for Food and Feed

[17] Střední odborné učiliště včelařské – Včelařské vzdělávací centrum (SOUV-VVC)

[18] Former Professional Beekeepers‘ Guild (Cech profesionálních včelařů)

[19] See the subsection 2.2.4 for details.

2.1.5 Research

The leading power for bee research in the Czech Republic represents the ***Bee Research Institute***[20] in Dol, providing among other things services and counselling, delivering lectures and self-production of honey. Bee Research Institute has certified laboratory and its research is focused on bee diseases, genetics, bee breeding, chemical properties of bee products, toxicology of agrochemicals, botany and pollination, biology and breeding of bumblebees etc. The institute cooperates with the Czech Beekeepers' Union and the State Veterinary Administration. Its international relations lie primarily in collaboration with the European Professional Beekeepers Association (EPBA) and the Austrian Professional Beekeepers Association[21] (Bee Research Institute, 2017).

Apart from the research undertaken by the Bee Research Institute in Dol, some Czech universities[22] conduct research on bees and beekeeping as well, focusing on a broad range of topics (bee breeding, entomology, parasitology, veterinary sciences and so forth).

Czech beekeeping is nowadays facing a number of issues which have detrimental effects on an apicultural sector as a whole. Economically motivated adulteration of honey is such a problem, inasmuch as it can undermine the trust of consumers and affect their buying preferences. In spite of its relatively low incidence in the EU-28 within past years[23], the preliminary results of the European Commission control plan (2015) as well as the CAFIA report (2015) revealed that the situation on the honey market is not optimal (CAFIA, 2015; EC, 2015; Šeráková, 2016). In the Czech Republic, similarly to Europe, there is an emerging issue of beekeepers' ageing (Šimpach, 2012), continuing concerns about honeybee health and preventive measures (e.g. Kamler et al., 2016; Papežíková et al., 2017), research on honey quality (e.g. Bušová and Kouřimská, 2018; Dluhošová et al., 2018) and agricultural risks occurrence (e.g. Tihelka, 2016). A wide range of such research gaps emphasizes the need for research on beekeeping.

[20] Výzkumný ústav včelařský v Dole / Institut für Bienenforschung in Dol

[21] Österreichischer Erwerbsimkerbund (ÖEIB)

[22] E.g. Mendel University of Brno (Faculty of AgriSciences – Department of Zoology, Fishery, Hydrobiology, and Apidology), Czech University of Life Sciences Prague (Faculty of Agrobiology, Food and Natural Resources), University of Veterinary and Pharmaceutical Sciences in Brno (Faculty of Veterinary Medicine, Faculty of Veterinary Hygiene and Ecology), University of South Bohemia in České Budějovice (Faculty of Agriculture), Charles University (Faculty of Science), Palacký University Olomouc (Faculty of Science) etc.

[23] Based on RASFF database notifications (EC, 2016) between the years 2002 and 2015

2.2 Beekeeping Sector in Switzerland

In the following subchapters the beekeeping industry in Switzerland is described with respect to bee colonies and beekeepers (bee stocks, beehives, bee colony density, bee pasture, professionalization and so forth). Selected bee products (honey, pollen and beeswax) are outlined in economic terms regarding both the domestic production and international trade. Institutional framework sets forth the organizations directly linked to Swiss beekeeping and describes their activities. A very important part in Swiss apiculture plays the research, its focus on current issues and its organizational structure. However, due to the unavailability of official statistical data (on bee breeds, beehive types, beekeepers etc.), the detailed information is to a large extent obtained from personal communications (Jean-Daniel Charrière from the Bee Research Centre of Agroscope, Anita Koller from the VDRB[24]) and some older statistical data from the very last available sources is used too.

2.2.1 Bee Colonies

Switzerland is homeland of almost 170 000 bee colonies of various subspecies of the Western (European) honeybee (*Apis mellifera*). Rich flora offering also alpine vegetation provides abundant and assorted bee pasture.

With regard to managed honeybee breeds, in Switzerland there are stocks of the Carniolan honey bee (*Apis mellifera carnica*, ca. 50 %), the European dark bee (*Apis mellifera mellifera*, ca. 40 %), the Italian bee (*Apis mellifera ligustica*), the Buckfast bee (*Apis mellifera buckfast*) and many cross-breeds (Charrière, personal communication, November 28, 2016). This distribution is in accordance to approximate natural distribution of the *Apis mellifera* subspecies in Europe given by for example De la Rúa et al. (2009) or Franck et al. (1998).

The bar chart below in Figure 7 illustrates the number of bee colonies in Switzerland between the years 2000 and 2016 at year intervals. It can be seen that the number of bee colonies had remained stable between the years 2013 and 2016, oscillating around 169 000 bee colonies. In comparison to data from the year 1985 with 338 954 bee colonies (Agristat, 1995), Switzerland has lost half of its bee colonies in the past 30 years. The declines of managed honeybees and especially long-term problems with winter colony losses are possible

[24] Verband deutschschweizerischer und rätoromanischer Bienenfreunde

consequence of Varroa mite[25] (*Varroa destructor*), pathogen exposure and the combination of some other adverse factors (Charrière and Neumann, 2010).

Figure 7: Bee colonies in Switzerland (2000 – 2016)

Source: own processing according to Agristat (2001 – 2017)

According to Charrière et al. (2018), the contemporary honeybee colony density in Switzerland is estimated ca. 4 bee colonies/km^2, the highest honeybee colony density is reported in the canton Basel – City (11.8 bee colonies/km^2) and the lowest one is in canton Grisons (1 bee colony/km^2).

Concerning bee pasture and Swiss crop farming, bee colonies ensure the pollination of variety of agricultural crops – for example legumes (field beans), oil plants (oilseed rape, sunflowers), fruit trees (apples, pears, cherries, plums, apricots), shrub berries (raspberries, blackberries, blueberries, chokeberries, elderberries, currants), vegetable (squash, cucumbers) – and seed production (Agristat, 2017; Fluri et al., 2004). The pollination value of a bee colony based on fruits and berries[26] was according to Fluri et al. (2004) CHF 1 069 and rose to more than CHF 1 200 (BLW, 2008). Nowadays the value is estimated even higher. The most important tree species in Swiss forests in terms of volume are according to BFS[27] (2017) spruce (44 %), beech (18 %), fir (15 %) and larch (6 %). In some years there is only short

[25] See for example Evans and Cook (2018) for details.

[26] Not included are the pollination values for other crops such as oilseed rape, sunflowers, vegetable seeds, forage crops etc.

[27] Bundesamt für Statistik (BFS) / Federal Statistical Office (FSO)

nectar and pollen flow[28] available in the Swiss Plateau (e.g. dandelions, cherry trees, fruits, rape).[29] The migratory beekeeping to areas offering rich flows is therefore recommended primarily for beekeepers in rural areas below 800 meters above sea level (Lehnherr et al., 2001).

There are three main types of beehives in common use in Switzerland (see Appendix II) – Schweizerkasten (traditional type, ca. ⅔), Dadant (ca. ¼) and variants of Magazinbeute[30] (Charrière, personal communication, November 28, 2016).

The average Swiss beekeeping operation has ca. 9.4 bee colonies (BLW, 2008; Charrière et al., 2018), which confirms the assumption that hobby beekeeping prevails in Switzerland.

2.2.2 Beekeepers

The exact number of beekeepers in Switzerland is unknown, as these data are not collected systematically. The estimates are based on data from various regional beekeepers' associations and some cantonal veterinary offices. Some beekeepers are thus not included (BLW, 2008).

The estimated number of beekeepers in Switzerland is ca. 17 500 (Charrière et al., 2018) and their average age is ca. 57 years (Charrière, personal communication, November 28, 2016). The age structure of European beekeepers is in general rather unfavourable, as evidenced by the EC DG AGRI report (2013) stating that almost 60 % of European beekeepers are older than 55 years, whereas only ca. 6 % account for beekeepers younger than 35 years of age. Therefore the interest in beekeeping should be fostered particularly in young and middle-aged groups.

To describe the development of the number of Swiss beekeepers, only the original data of the VDRB statistics (Koller, personal communication, March 17, 2017) are used due to limited data availability from other associations. Although the VDRB accounts for ca. 77 % of all Swiss beekeepers (BLW, 2008), its data interpretation needs to be put on with caution, whereas the generalization is not possible. The bar chart in Figure 8 shows the number of beekeepers registered in VDRB between the years 2002 and 2011 at year intervals.

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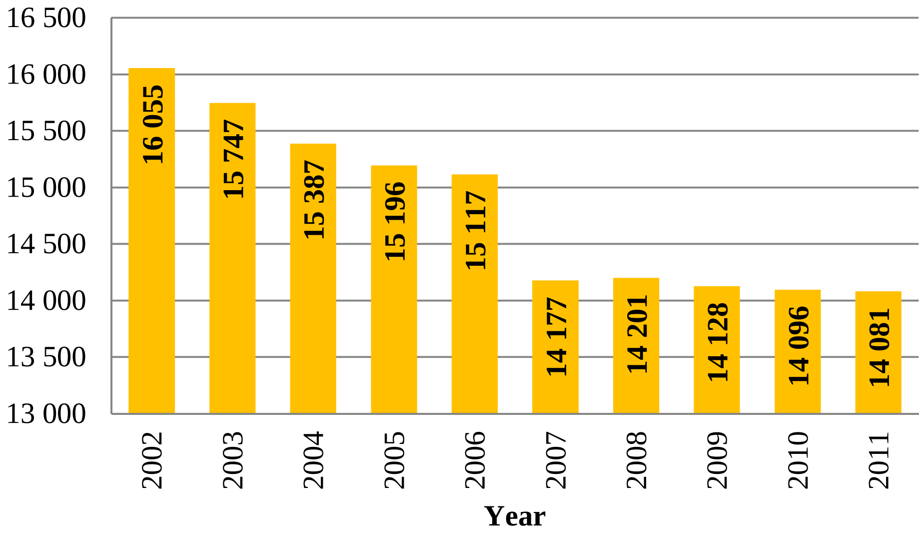
[28] Die Tracht / snůška

[29] The city areas and suburbs are an exception to this due to garden flora and extensive tree avenues, providing abundance of nectar and pollen flow throughout the summer (Fluri et al., 2004; Lehnherr et al., 2001).

[30] Movable frame hives – e.g. Zander, Deutsche Normalmass

Figure 8: VDRB Beekeepers in Switzerland (2002 – 2011)



Source: own processing according to VDRB (Koller, personal communication, March 17, 2017)

Similarly to the number of bee colonies in Switzerland, the number of VDRB beekeepers followed between 2002 and 2011 rather downward trend. However the bar chart shows that the drop slowed down noticeably since 2007. Overall in Europe there have been widespread declines of managed bee colonies and beekeepers (Fluri et al., 2004; Potts et al., 2010a), so Switzerland is no exception of this trend anyway.

The number of beekeepers, who are simultaneously farmers, has been steadily decreasing (around 3 000) and had amounted to ca. 15 % in 2008 (BLW, 2008). In terms of professional beekeeping[31], there are about 54 professional beekeepers in Switzerland (Charrière et al., 2018).

One of the challenges set forth by BLW (2008) for beekeeping sector is the professionalization of the beekeeping community, requiring new approaches to education, training, counselling and knowledge transfer. The educational framework is divided to two levels according to the target groups – beginning beekeepers and beekeeping cadres[32] (BLW, 2008).

[31] I.e. beekeepers who manage more than 80 bee colonies

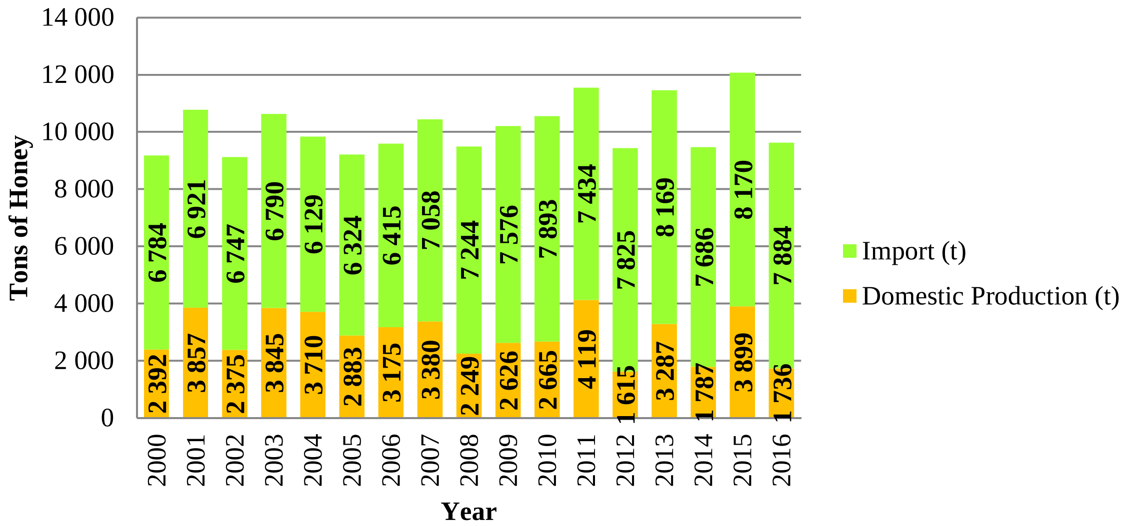
[32] I.e. beekeeping consultants (Imkerberater), breeding advisors (Zuchtberater), honey inspectors (Honigkontrolleur) and bee inspectors (Bieneninspektor)

2.2.3 Bee Products

Besides their pollination function honeybees also benefit to society through producing broad range of natural products (i.e. honey, pollen, propolis, royal jelly, beeswax, and bee venom) which are widely used in different industries and sectors. On account of diverse bee products' economic significance to Swiss beekeeping, honey, pollen and beeswax production is discussed in detail.

In Switzerland, but also in Central Europe the nectar, pollen and honeydew flow origins from following floral varieties: false acacia[33] (*Robinia pseudoacacia*), alpine roses (*Rhododendron ferrugineum*), dandelions (*Taraxacum officinale*), sweet chestnut trees (*Castanea sativa*), linden trees (genus *Tilia*), firs (genus *Abies*) and oilseed rape (*Brassica napus*). On their basis the popular monofloral honey types are produced (Matzke et al., 2001). The bar chart below (Figure 9) illustrates the development of total honey supply in Switzerland between the years 2000 and 2016.

Figure 9: Honey supply in Switzerland (2000 – 2016)



Source: own processing according to Agristat (2001 – 2017)

From the chart it is clear that the honey production varies greatly from one year to another. Moreover there may be huge differences within the same year in various regions and/or cantons (BLW, 2008). It can be seen that the proportion of imported honey to its domestic production is in Switzerland much higher in comparison to the figures given by the Czech

[33] Locust tree

Republic (presented in Figure 6). The average production of honey in Switzerland for the time period 2000 – 2016 was 3 420 tons a year. It follows that the average honey yield per colony and year in Switzerland was approximately 18.3 kg. In the same time span, Switzerland exported an average of 503 tons of honey a year and imported an average of 7 238 tons of honey a year (Agristat, 2001 – 2017). In 2011, Switzerland imported 2 357 tons of honey from the EU, which accounted for one fifth of total EU honey exports (EUROSTAT Comext, p. 25 In: EC DG AGRI, 2013). Table 2 provides more detailed overview of Swiss honey production and international trade indicators between the years 2000 and 2016.

Table 2: Swiss honey production and international trade (2000 – 2016)

Year	**2000**	**2001**	**2002**	**2003**	**2004**
Total Production (t)	2 834	4 288	2 692	4 157	4 077
Import (t)	6 784	6 921	6 747	6 790	6 129
Total Consumption (t)	9 176	10 778	9 122	10 635	9 839
Export (t)	442	431	317	312	367
Domestic Production (t)	2 392	3 857	2 375	3 845	3 710

Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total Production (t)	3 223	3 656	3 917	2 803	3 135	3 316
Import (t)	6 324	6 415	7 058	7 244	7 576	7 893
Total Consumption (t)	9 207	9 590	10 438	9 493	10 202	10 558
Export (t)	340	481	537	554	509	651
Domestic Production (t)	2 883	3 175	3 380	2 249	2 626	2 665

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Total Production (t)	4 677	2 145	3 826	2 419	4 602	2 384
Import (t)	7 434	7 825	8 169	7 686	8 170	7 884
Total Consumption (t)	11 553	9 440	11 456	9 473	12 069	9 620
Export (t)	558	530	539	632	703	648
Domestic Production (t)	4 119	1 615	3 287	1 787	3 899	1 736

Source: own processing according to Agristat (2001 – 2017)

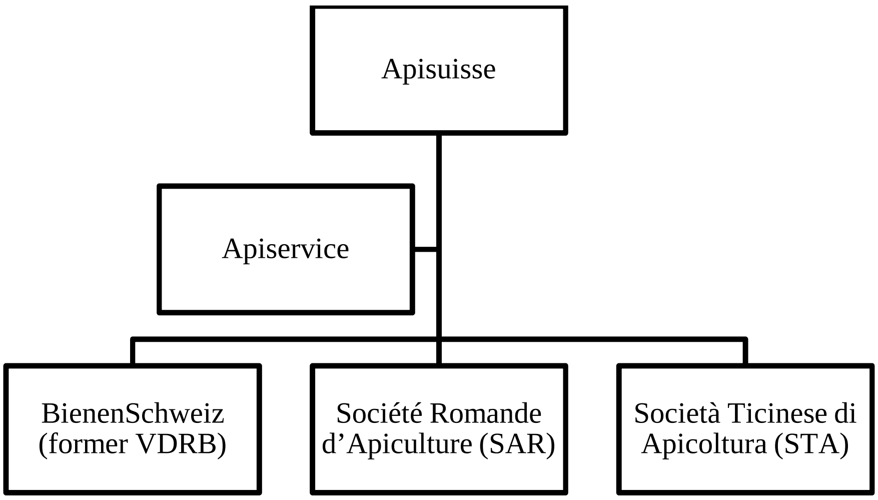
Domestic production (illustrated also in Figure 9 above) is calculated as the total production less the export. And consequently, total consumption is calculated by adding import to domestic production. With regard to the honey consumption in Switzerland between the years 2000 and 2015, the average is 1.3 kg of honey per capita and year. In addition, Swiss beekeeping managed to cover on average 34 % of domestic demand for honey through its own production (Agristat, 2001 – 2017). According to Charrière et al. (2018), the average price for one kilo of honey was 25 CHF.

Although other bee products (beeswax, pollen, royal jelly) are quantitatively less significant than honey, they have recently experienced a substantial increase in demand. Apart from the food industry, bee products are also used in cosmetics, alternative medicine, human and veterinary medicine (BLW, 2008; Matzke et al., 2001). Due to the unavailability of present data, figures and estimates from the very last available sources are used for the market description of other bee products. The approximate value of other bee products (beeswax, pollen and propolis) is estimated ca. CHF 1.5 million a year (Charrière et al., 2018). The annual pollen production of beekeepers affiliated to the Association of Swiss Pollen Beekeeping[34] was approximately 1 000 kg in 1998. The average pollen yield accounts for ca. 600 to 700 kg a year. Switzerland imports an estimated 2 to 3 tons of pollen and pollen-containing products a year. According to the data by large Swiss beeswax processors, between 60 and 70 tons of domestic beeswax are produced per year. This amount covers the domestic demand for beeswax necessary for wax foundation combs. On average, 150 tons of beeswax is imported annually (Fluri et al., 2004; Matzke et al., 2001).

2.2.4 Institutional Framework

Unlike in the Czech Republic, Swiss beekeepers' organizations are divided into three units according their geographical and language distribution – see Figure 10. The umbrella organization is Apisuisse subdividing into BienenSchweiz, Societé Romande d'Apiculture and Società Ticinese di Apicoltura. An advisory board of Apiservice is responsible for the management of the Breeding Department and the Bee Health Service.

Figure 10: Beekeepers' organizations in Switzerland



Source: own processing according to Apisuisse (2018)

[34] Schweizerische Pollenimkervereinigung (SPIV)

Apisuisse is the umbrella organization of the Swiss Beekeeper Associations[35] and its members are BienenSchweiz – Imkerverband der deutschen und rätoromanischen Schweiz (former VDRB), Société Romande d'Apiculture (SAR) and Società Ticinese di Apicoltura (STA). Apisuisse coordinates the work of three member associations and it works as a contact point of the federal agencies for bee-related issues. It safeguards common interests and maintains contact with politics and international bee organizations, such as for example Apimondia[36] – International Federation of Beekeepers' Associations (Apisuisse, 2018; Lehnherr et al., 2001).

Apiservice is consulting and competence centre founded in 2013 as a subsidiary of Apisuisse. Apart from its support to Apisuisse the organisation is involved in education, marketing (e.g. press relations) and bee breeding (the Breeding Department[37] management). Apiservice also operates the Bee Health Service[38] accountable for bee health matters – counselling, knowledge exchange, bee health monitoring and so forth (Apiservice, 2018).

BienenSchweiz represents the interests of beekeepers in German and Rhaeto-Romanian Switzerland – a total of around 14 000 beekeepers keeping approximately 140 000 bee colonies. BienenSchweiz publishes annual beekeeping calendar, Swiss Bee Book, brochures, flyers and on a monthly basis also the magazine Schweizerische Bienen-Zeitung. It is responsible for the training and further education of beekeepers, and so it organizes courses, lectures and designs educational materials. The effective networking with related associations (Apisuisse, Apiservice, Agroscope and the like) is a matter of course (BienenSchweiz, 2018).

Societé Romande d'Apiculture (SAR) unites the Vaudois, Neuchâtel, Geneva and Jura associations as well as the French-speaking associations of the cantons of Berne, Fribourg and Valais. SAR has about 3 700 members keeping circa 50 000 bee colonies. Inter alia it is responsible for publishing the magazine Revue Suisse d'Apiculture, it promotes training, supervises honey controls and bee diseases control, and deals with liability insurance concerning beekeeping and networking with other beekeeping associations (SAR, 2018).

Società Ticinese di Apicoltura (STA) unites circa 500 beekeepers from the canton of Ticino. Its members keep about 8 000 bee colonies. Some of the beekeepers are semi-professional and

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[35] Verband der Schweizerischen Bienenzüchtervereine (VSBV)

[36] See the subsection 2.1.4 for details.

[37] Die Fachstelle Zucht

[38] Der Bienengesundheitsdienst (BGD)

do migratory beekeeping, but majority of them manages about 15 bee colonies on average. By far the most common way to keep the bees is in Dadant beehives with 10 frames, but there are also apiaries with so-called Swiss boxes (Schweizerkästen). STA bimonthly publishes its own magazine L'Ape and offers advisory and honey control (STA, 2018).

Another organizations involved in Swiss beekeeping are the ***Federal Office for Agriculture***[39] (BLW, 2019) responsible for financial contributions to the training and further education of consultants and beekeeping tutors (Lehnherr et al. 2001) and also for supporting agricultural research and reviewing the effectiveness of agricultural policy (BLW, 2018); and the ***Federal Food Safety and Veterinary Office***[40] (BLV, 2019) which is in charge of legal regulation over bee diseases treatment measures and guidance for bee colonies stock control management (BLV, 2016 and 2019; Lehnherr et al., 2001).

The ***COLOSS*** Association is global non-profit organization with headquarters in Bern aiming to benefit the well-being of bees all over the world mainly through monitoring, counselling and publishing original research work (e.g. Brodschneider et al., 2016 and 2018; Crailsheim et al., 2009). Wide professional orientation of its members (scientists, vets, agronomists, students etc.) enables the cooperation, discussion between diverse stakeholders as well as the knowledge transfer from science into the practice (COLOSS, 2019b and 2019c).

In addition, according to the Concept of Bee Promotion in Switzerland (BLW, 2008) there are some various associations pursuing special beekeeping interests: Swiss Carnica Beekeepers Association (Schweizerische Carnicaimker-Vereinigung, SCIV), Swiss Mellifera Bee Friends Association (Verein Schweizerischer Mellifera Bienenfreunde, VSMB), Buckfast Beekeepers Association Switzerland (Buckfastimkerverband Schweiz, BIVS), Association of Swiss Migratory Beekeepers (Verein Schweizer Wander-Imker, VSWI), Association of Swiss Pollen Beekeeping (Schweizerische Pollenimkervereinugung, SPIV), Working Group of Natural Beekeeping (Arbeitsgruppe naturgemässe Imkerei, AGNI), Forum of Bee Inspectors (Forum der Bieneninspektoren) or Apitherapy (Apitherapie).

2.2.5 Research

In Switzerland the responsibilities for bee research are redistributed to three institutions, which are independent of one another at an organizational level, but cooperate together. Their

[39] Bundesamt für Landwirtschaft (BLW)

[40] Bundesamt für Lebensmittelsicherheit und Veterinärwesen (BLV)

wide range of activities brings benefit not only to beekeepers and beekeeping organizations, but also to federal, governmental and cantonal offices, universities and technical colleges, the EU and global organizations, consumers and general public (Bee Research Centre, 2017).

The aim of ***Swiss Bee Research Centre of Agroscope***[41] (BRC) is sustaining ecological and economical beekeeping to secure plant pollination and to provide high quality bee products through apicultural counselling (e.g. good apicultural practice and maintenance of healthy bee colonies) and applied research. Furthermore, Swiss Bee Research Centre of Agroscope focuses on national and international networking (Bee Research Centre, 2017).

The ***Institute of Bee Health***[42] (IBH) was founded in 2013 as a part of the Department of Clinical Research and Veterinary Public Health at the Faculty of Veterinary Medicine (Vetsuisse) of the University of Bern. IBH conducts fundamental and applied research to improve the health of bees. In addition to its research activities, the Institute of Bee Health concentrates on knowledge transfer to university students of veterinary medicine and biology (in bachelor, master and doctoral study programmes), beekeepers and other stakeholders (Bee Research Centre, 2017; IBH, 2019).

The ***Bee Health Service***[43] (BGD) arranges the training and further education of the beekeepers through organizing workshops, lectures and presentations on bee health topics free of charge, distribution of informational leaflets and fact sheets. Apart from the scientific knowledge exchange (in local beekeeping journals[44]) and managing the incidents of bee colony poisoning, BGD runs the beekeepers' advice hotline and offers remediation and cleaning facilities to rent. On behalf of the Federal Food Safety and Veterinary Office (BLV) the Bee Health Service prepares annual summary report on bee health in Switzerland (Apiservice, 2018; Bee Research Centre, 2017).

Swiss beekeeping faces a number of challenges and consequently many scientific gaps are identified. Unfavourable situation of bee health is documented statistically by winter colony losses (Bericht des Bundesrats, 2016; Brodschenider et al., 2018, Charrière and Neumann, 2010; Sieber and Charrière, 2016) and also by increased interest of stakeholders in bee health

[41] Zentrum für Bienenforschung (ZFB)

[42] Institut für Bienengesundheit (IBH)

[43] Der Bienengesundheitsdienst (BGD)

[44] I.e. Schweizerische Bienen-Zeitung, Revue Suisse d'Apiculture and L'Ape

(Sieber, 2014). The Asian hornet (*Vespa velutina*) as well as the small hive beetle (*Aethina tumida*) pose a serious threat to bee colonies in Europe (e.g. Eyer et al., 2009; Monceau et al., 2014; Neumann et al., 2016; Rortais et al., 2010). Further bee research issues, aside from bee health problems, are influenced by some agricultural risks[45], beekeepers' ageing (EC DG AGRI, 2013; Klein et al., 2007), stakeholders' cooperation and policy-making (Sieber, 2014) and of course new trends – for instance the concept of smart city, bee hotels (see Appendix I) or urban beekeeping.

[45] I.e. pesticides, GMO, bee losses caused by rotary mowers, spread of fire blight infection and so on (Bees and Agriculture, 2019)

2.3 Urban Beekeeping

Urban agriculture is a sector with the potential to enrich urban surroundings by means of strengthening the economic base of cities and their greening. It opens up the opportunities for small businesses, job creation, environment protection, community building, enhancing the quality of life and pastime (Ackerman et al., 2014; Smit and Nasr, 1992; Specht et al., 2016).

Urban apiculture is a specific field of urban agriculture that has grown in popularity among wide public, as proved by numerous scientific works (e.g. Bhatt and Farah, 2016; Cane, 2005; Delaney, 2018; Fenske, 2018; Kohfink, 2010; Lorenz and Stark, 2015; Peters, 2012). The recent involvement in keeping bees in the city can be ascribed both to global pollinator crisis (Moore and Kosut, 2016; Peterson Roest, 2019; Potts et al., 2010a,b) and the promotion of urban agriculture in general (Smit et al., 2001; Van Veenhuizen, 2006).

Urban and suburban sprawl modifies some features essential for honeybees and other pollinators – for example diverse plant community composition (Plascencia and Philpott, 2017; Salisbury et al. 2015; Tommasi et al., 2004), stronger pathogen pressure induced by urbanization (Youngsteadt et al., 2015), law-abiding principles (Peters, 2012; Salkin, 2012) or weather and climatic conditions. The latter relates especially to the increasing temperature[46] of urban areas, which affects floral bud phenology (Crabbe et al., 2016; Kolářová et al., 2014; Menzel et al., 2006; Švamberk, 2011), specifically periodic life cycles of bee forage plants and trees. Considering the quality of environment, the honeybees and their products often work as promising biological indicators of environmental pollution (e.g. Badiou-Bénéteau et al., 2013; Giglio et al., 2017; Jovetić et al., 2018; van der Steen et al., 2016; Zarić et al., 2015) not only in (sub)urban areas. The benefits ensuing from beekeeping and pollination provided by managed honeybees in urban areas are economic, ecological and social as well.

From an economic perspective, urban beekeeping supports agricultural yields of fruits and vegetables for gardeners and earnings from bee products sale for beekeepers (Cane, 2005; Kohfink, 2010). Davis and Cullum-Kenyon (2016) highlight larger honey yield from a wider variety of plant sources contrary to traditional rural beekeeping.[47] Moreover, urban honey is

[46] The temperature of the urban areas most likely increases on the grounds of the heat island phenomena and climate change (Li et al., 2014; Santamouris, 2012).

[47] Referring to Sponsler et al. (2015 and 2017), it is necessary to point out the fact that the landscapes might differ from one another, both within and between non/urban areas, and the agricultural landscape can also offer multifarious flora and rich bee pasture.

considered as an exceptional product, hence on the account of its relative uniqueness and low numbers of urban beekeepers it results in higher prices and considerable revenues. This aspect might further stimulate popularity of urban beekeeping within city dwellers.

In ecological terms, urban apiculture contributes to fruit and seeds yield for resident and migratory songbirds (Cane, 2005). Furthermore, the pollination might have some beneficial effects on successful preservation of revegetated wasteland and green spaces floras (Lomov et al., 2010). However some studies present some negative effects of urban beekeeping on wild pollinators. There are for instance research results showing that introduced honeybees (especially in unnaturally high densities) might cause increased competition over finite resources and/or initiate pathogen transmission (e.g. Fürst et al., 2014; Geldmann and González-Varo, 2018; Geslin et al., 2017; Graystock et al., 2016; Mallinger et al., 2017).

With respect to the society, bee colony represents an educational model for urban dwellers to observe nature and interconnections between flora and fauna (Cane, 2005; Delaney, 2018; Peterson Roest, 2019). Since nature has beneficial effects on mental and physiological health considering human links to ecosystems (Russell et al., 2013) and beekeeping in a form of leisure activity prevails in Europe (Chauzat et al., 2013; Jones, 2004), there is a potential of hobby beekeeping to be developed in order to eliminate negative impacts of stress and rush. In defiance of mentioned virtues of urban apiculture, the critics of managed beekeeping (not only in urban areas) point out some associated health risks (e.g. bee venom allergies and other allergic reactions) on beekeepers and on those living in close proximity to bee colonies (Stanhope et al., 2017).

Implementation of agriculture and managed beekeeping concepts into urban development plans might also give a direction to the design of the cities of the future. A biophilic city defined by Beatley (2011) might be illustrative of such models. Cultivated areas of allotments, gardens, hedgerows, parks and green spaces[48] should provide multifarious flora to attract the pollinators and fulfil their foraging needs (Garbuzov and Ratnieks, 2014; Plascencia and Philpott, 2017) and to support viable coexistence of diverse organisms in urban surroundings.

[48] E.g. botanical gardens (cf. Münze et al., 2006) and community gardens (cf. Pawelek et al., 2009).

2.4 Economics of Beekeeping Sector

Beekeeping sector contributes to the food supply partly by honey production and partly by pollination services to agricultural and forest crops dependent on insect pollination. However in economic terms both these parts are in stark contrast to one another. The overall benefit of beekeeping sector for all EU countries is € 22 billion, in comparison to revenues from honey sale that are € 153 million (SVZ, 2015). Despite the given figures, from beekeepers' perspective the honey sale is of greater importance as a source of income. According to Aizen and Harder (2009) the global dynamics of domesticated honeybees is presumably more affected by the economics of honey production, rather than by agricultural and biological demands on pollination.

On account of their pollinating function, honeybees are considered as an economic linchpin (Watanabe, 1994) and pollination has often exemplified the positive externality[49] (e.g. Rucker et al., 2012). Nevertheless it is important to make reference to possible negative externalities of beekeeping as well – e. g. massive introduction of managed beekeeping being detrimental to nature and ecosystems functioning (Geslin et al., 2017). Equally the overall value of pollination cannot be solely defined by agricultural economics.

Last but not least, this chapter presents some general indicators, specifically focusing on agricultural intensity, aiming to assess some structural characteristics of beekeeping sector in the Czech Republic and Switzerland.

2.4.1 Economics of Beekeeping Operation

In view of the fact, that the majority of Czech and Swiss beekeepers are hobbyists, the revenues from honey sale represent an extra income to household budget. Nevertheless in both countries there are also some professional bee farms managing hundreds of bee colonies and being able to earn a living. The economics of beekeeping operations has been described in detail for instance by Kamler (2005) and Šeráková (2012) for the Czech Republic and in work by Hunger (2004) for Switzerland.

The amount of bee colonies (considered as an input to the honey production) is determined by prices of the beekeeping operation outputs and other production inputs (Willet, 1992).

[49] Substantial attention was already given to the issue of bees and externalities by economists as well (see for example Cheung, 1973; Johnson, 1973 or Siebert, 1980).

Beekeepers usually start out by managing two to four bee colonies and in the course of time they let their business grow along their experience and management skills (Leopold Center, 2010). According to Kamler (2007), the beekeeper in Europe should be able to make a living by managing the operation of 300 bee colonies. For the Czech Republic the estimate is approximately 200 – 400 bee colonies. Considering better technology, higher honey yields and successful honey sale, the number could under certain circumstances drop to 200 bee colonies (Kamler, 2007).

The primary input of the beekeeping operation is the bee colony followed by other significant inputs – labour, bee feed, bee treatment measures, bee-products processing facilities and alternatively transportation equipment (Siebert, 1980; Willett and French, 1991). Labour is considered a crucial input from two main reasons – firstly, as the bee colony grows and develops itself, it requires regular attention; and secondly, the labour is expected by bee products processing and beehive transportation (Siebert, 1980). According to Owens and Cleaver (1973) the operating expenses include apart from the above mentioned inputs and utilities also maintenance and repairs and advertising (marketing and sales promotion). Unlike labour costs, where it is possible to save time mainly by introducing better practices and improving the equipment quality, it is not possible to save much on material cost items (Kamler, 2007). Furthermore, high-quality and accessible bee pasture (and/or supplemental feeding) is sine qua non of bees' welfare and well-being (Haragsim, 2007).

Beekeepers' income comes from the sale of bee products (honey, beeswax), queen bees and new bee colonies – established colonies, nucleus colonies, package bees (Siebert, 1980). Honey and other bee products can be marketed on farmers' markets, health food stores, roadside stands, agritourism sites and also sold directly from the yard (Leopold Center, 2010). On account of relatively high bee colony density[50], renting hives to growers for pollination[51] is extensively used neither in the Czech Republic nor in Switzerland.

A significant potential of the economy of beekeeping operation lies in underused production capacity, and consequently in increasing honey yield on the bee colony. The beekeeping operation profitability threshold is estimated 30 – 40 kg honey per colony (Kamler, 2007).

[50] CZ – 7 bee colonies per km^2 (CBU, 2017 – own communication); CH – 4 bee colonies per km^2 (Charrière et al., 2018)

[51] Such practice is common for instance in the USA (for details see Champetier et al., 2015; Nash, 2009; Rucker et al., 2012; Sumner and Boriss, 2006).

Although the supplementary activities[52] are often overlooked, they can create a new revenue stream.

2.4.2 Economic Valuation of Pollination

In contrast to any other agricultural input, the pollination service is influenced by many environmental, economic and social factors; therefore it rather needs wide-ranging approach than a one-sided policy arrangement (Breeze et al., 2014). Hence it is essential to put pollination in the broader context of agricultural productivity, consumption requirements, GDP or agricultural policies.

Complete economic effect of insufficient pollination service cannot be entirely determined by the reduction in agricultural production due to the lack of substitution among agricultural production (Gallai et al., 2009) and since the pollinator losses have diverse economic impacts both on producers and consumers as well as in exporting and importing countries. Nonetheless it is evident that pollinator deficits have been affecting agricultural productivity (Kevan and Phillips, 2001). In particular the pollinator declines might have far-reaching consequences for regions which are already hardly meeting their consumption requirements and/or which are net importers for specific crop. A case in point is the European Union where the fruit consumption had exceeded production by 20 % in 2005, whereas such deficit would most likely double considering complete pollinator loss in Europe. Similar situation would be in the EU with vegetables and stimulant crops, such as coffee and cocoa (Gallai et al., 2009).

According to Hein (2009), the economic value of pollination is considered scale dependent. At the local scale it supports the income of the cropper, while the economic value shows high variability depending on the crop and the market conditions. At the national scale the pollination secures food supply, whereas the service value estimates range between 1 % and 16 % of the market value of agricultural production (Hein, 2009).

The monetary value of global insect pollination in 2005 was estimated to be € 153 billion and it represented 9.5 % of the total economic value of global agricultural output intended for human consumption (Gallai et al., 2009).

Unlike the low overall importance of pollination benefits for the GDP (ca. 0.5 %), its significance for agriculture is much higher (ca. 10 %). And despite unvarying general

[52] For example beeswax candles production, joinery services or consultancy (Kamler, 2007).

pollination-dependency of the agricultural economy between 1993 and 2009 the growth in producer prices for pollinator-dependent crops is reported by Lautenbach et al. (2012).

From an economic perspective, pollinator declines can substantially affect commodity price, which includes costs of production, distribution, marketing and profit. Pollination crisis can therefore increase the production cost, inasmuch as the cost of pollination rises on the grounds of larger demand for pollinating service. From the market perspective, pollinator shortage brings about yield drops in production and consequently a shift in the supply function, which leads to new, higher equilibrium price and smaller equilibrium quantity. The economic impact of pollinator shortage can be identified by changes in consumer and producer surpluses, whereas the sum of these surpluses illustrates the impact on social welfare (Kevan and Phillips, 2001).

The instability of pollination services is influenced by the relative significance of crops cultivated in individual countries and their agricultural policies, world market prices and national economic and political developments (Lautenbach et al., 2012). On account of the variety of crop species and heterogeneous composition of the agricultural production, the vulnerability to pollinator losses differs significantly among countries. Subsequently, although the interdependence of agricultural market grows, the producer prices for a given crop in diverse geographical regions are different from one another and cannot be appraised by one common world price (Gallai et al., 2009).

According to Klein et al. (2007), the majority of global crops (including many fruit crops) might experience production loss due to pollinator shortage. In addition to that the costs for artificial pollination would be apparently much higher compared to ecosystem preservation through smart and environment-friendly land-use management (Lautenbach et al., 2012).

2.4.3 Economically Motivated Adulteration of Honey

As the growth in honey production between the years 1960 and 2009 corresponded to the rising trend in the human population for the same time span, so the increasing honey production has been in accordance to satisfy a fixed global demand for honey per capita (Aizen and Harder, 2009). The globalization process brings forth many positive and negative effects to various areas (Svatoš, 2006), and one of its drawbacks is economically motivated adulteration.

Economically motivated adulteration (EMA) is nowadays considered a serious growing issue propelled by the combination of globalization, economic opportunity, and often low probability and severity of penalization (Kennedy, 2013). Product counterfeiting for the purpose of financial and/or competitive advantage is reckoned as economic adulteration. Potential impacts of such phenomena include the cost of consumer deception, the cost to producers competing with adulterators, illegal profit and in extreme cases the cost of negative externalities[53]. Furthermore, undermining the trust of consumers can undesirably influence their preferences and purchasing patterns, and therefore pose a threat to producers' economic viability (Fairchild et al., 2003). Downsides of EMA thus impact both the producers and consumers.

In view of the fact that EMA is motivated by an economic profit, some specific categories of food ingredients are put at the risk of adulteration and honey has become one of such targets (e.g. Čížková et al., 2012; Everstine et al., 2013; Lipp, 2012; Strayer et al., 2014). Honey is considered exceptionally valuable and vulnerable product, inasmuch as it exemplifies a relatively high-priced commodity. The value of honey resides in its image as a natural, wholesome and pure product, and similarly its vulnerability lies also in this image, as it could be affected by negative publicity (Fairchild et al, 2003).

Czech Agriculture and Food Inspection Authority (CAFIA) considers honey to be a highly problematic commodity on the domestic market in terms of possible adulteration. The counterfeiting methods have certainly changed over time and remarkably they have relatively closely correlated with laboratory detection procedures. In its report (2015), CAFIA mentions among the honey adulteration techniques the use of sugars from plants that are not visited by honeybees, the decomposition of higher sugars[54] derived from flowering plants and passing foreign honey off as the original Czech one. Toporčák and Chlebo (2018) describe some further examples of honey adulteration methods too.

Due to the food chain complexity (sources, processors, distributors etc.) it is really challenging to instantly trace all the components (Kennedy, 2013), and therefore the international cooperation is needed to face up the intentional adulteration.

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[53] E.g. welfare reduction for fruit farming (Fairchild et al., 2003)

[54] I.e. decomposition of sucrose from sugar beet by means of enzymes, which are not inherent in honeybees (CAFIA, 2015)

2.4.4 Indicators of Beekeeping Sector

In order to assess some structural characteristics of beekeeping sector and to draw a comparison between their results of the Czech Republic and Switzerland, some particular intensity indicators of agricultural production relevant to the apiculture are presented (cf. Ruiz-Martinez et al., 2015). The framework of selected indicators proceeds from Turner and Doolittle (1978) and Erb et al. (2013), integrating three different dimensions of intensity[55] (i.e. input intensity, output intensity and some associated impacts of land-based production).

Since beekeeping directly interacts with natural resources, the structure of insect pollinated crops is considered one of the associated impacts of land-based production. The data on agricultural land[56] might be useful inter alia for comparison of various perspectives of agricultural production and/or deriving cropping intensity (World Bank, 2019). Table 3 below provides an overview of the structure of three leading entomophilous crops cultivated in the Czech Republic and Switzerland – oilseed rape, sunflower and apples.

Table 3: Structure of leading entomophilous crops cultivated in the Czech Republic and Switzerland (2016) – in proportion to agricultural land (%) and in hectares

Type	CH (%)	CZ (%)	CH (ha)	CZ (ha)
Arable land	**27.47**	**70.47**	**407 068**	**2 965 606**
Oilseed rape	1.42	9.34	20 979	393 000
Sunflower	0.33	0.37	4 885	15 600
Orchards	**2.07**	**0.32**	**30 737**	**13 400**
Apple orchards	0.26	0.16	3 854	6 900
Agricultural land	**100.00**	**100.00**	**1 481 657**	**4 208 374**

Source: own processing according to Agristat (2017) and Zelená zpráva (2017)

It can be seen that in 2016 the proportion of arable land to agricultural land is higher in the Czech Republic. According to Agristat (2017), the majority (69.09 %) of Swiss agricultural land consists of meadows and pastures. In view of this fact it needs to be highlighted that complete consistency across both countries and over time is not possible. With regard to the structure of crops, there is a considerable difference in the sowing areas of oilseed rape between both countries. The proportions of the other two crops (i.e. sunflowers and apple

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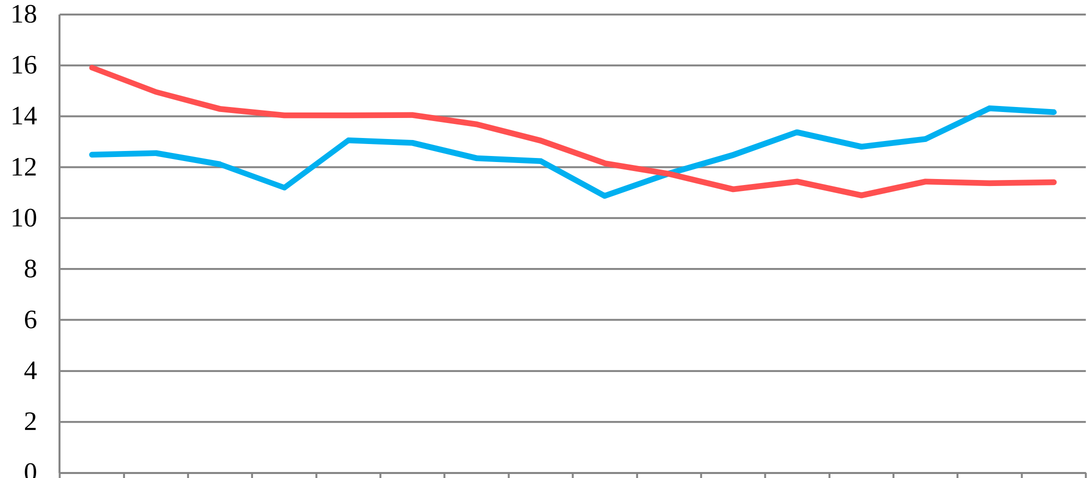
[55] Cf. Brookfield (1972, 2001) defining the intensification with regard to land and/or any other natural resource complex as a process which can be measured by inputs (i.e. capital, labour and skills) against constant land, positing that the main purpose of intensification is to substitute given inputs for land in order to gain and secure higher production.

[56] In terms of Agristat (2017) and CZSO (2014), agricultural land comprises arable land, gardens, hop-gardens, orchards, permanent grassland (including meadows and pastureland) and vineyards.

orchards) are rather similar. Other two intensity indicators are derived from the agricultural land structure[57] – firstly, the amount of bee colonies per 100 hectares of agricultural land, and secondly, number of bee colonies per 100 hectares of arable land. Their curves for the time span 2000 – 2015 are illustrated in Figure 11 and Figure 12 below.

Figure 11: Bee colonies per 100 ha of agricultural land in the Czech Republic and Switzerland (2000 – 2015)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CZ	12,5	12,56	12,12	11,19	13,06	12,95	12,35	12,24	10,86	11,75	12,48	13,37	12,8	13,11	14,31	14,16
CH	15,91	14,95	14,29	14,04	14,03	14,04	13,69	13,05	12,15	11,73	11,14	11,43	10,9	11,43	11,37	11,4

Source: own processing according to Agristat (2001 – 2017), CBU (internal data, 2019) and Zelená zpráva (2017)

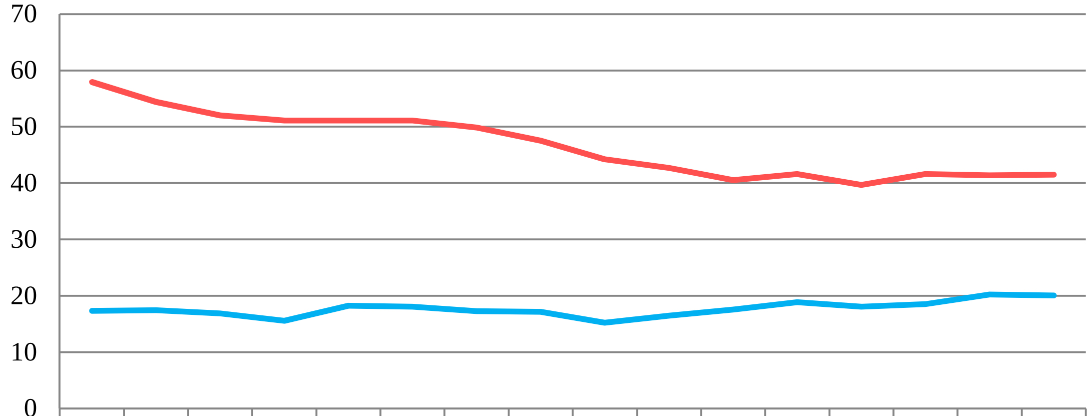
Looking at the trends over time, there are only modest differences between both countries in the numbers of bee colonies per 100 hectares of agricultural land. The lines intersect in 2009 and from then on the ratios of bee colonies to agricultural land are higher in the Czech Republic in contradistinction to Switzerland. On account of the overall bee colony density, in the Czech Republic they are 8.8 bee colonies per km^2 (Brodschneider et al., 2019) and 4 bee colonies per km^2 in Switzerland (Charrière et al., 2018). However, it needs to be emphasized that bee colony density differs from one region to another.

In Figure 12 bee colonies are proportioned to 100 hectares of arable land in the Czech Republic and Switzerland. Considering relatively low arable land share (27.47 % in Table 3 above) in overall agricultural land in Switzerland compared with the Czech Republic, the amount of bee colonies per 100 hectares of arable land in Switzerland remains almost double

[57] Cf. Herzog et al. (2006) using some land-use intensity indicators too (e.g. livestock density / ha).

in contrast to the Czech Republic. Nonetheless in the long term the lines slightly converge to each other.

Figure 12: Bee colonies per 100 ha of arable land in the Czech Republic and Switzerland (2000 – 2015)

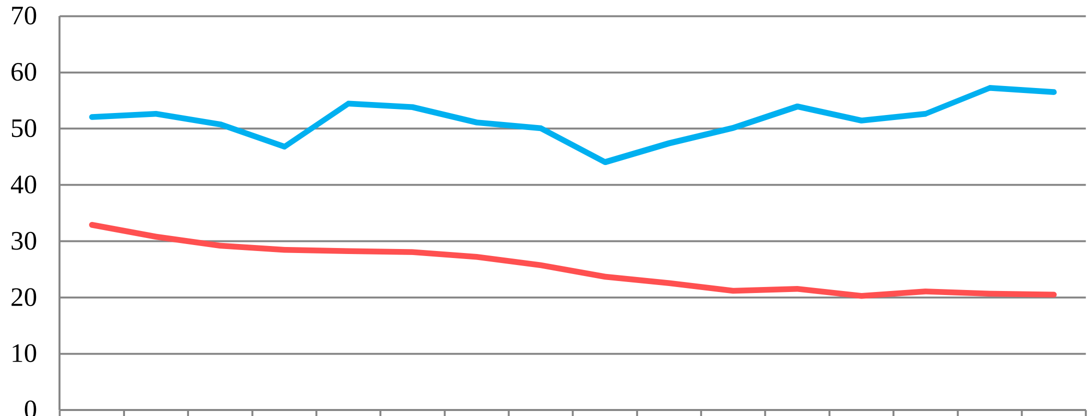


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CZ	17,35	17,47	16,87	15,6	18,23	18,1	17,29	17,15	15,24	16,51	17,56	18,84	18,06	18,52	20,25	20,06
CH	57,93	54,43	52,03	51,1	51,08	51,12	49,83	47,5	44,23	42,7	40,54	41,61	39,66	41,61	41,37	41,51

Source: own processing according to Agristat (2001 – 2017), CBU (internal data, 2019) and Zelená zpráva (2017)

Figure 13 shows the sequence chart of bee colonies per 1 000 capita in both countries between the years 2000 and 2015.

Figure 13: Bee colonies per 1 000 capita in the Czech Republic and Switzerland (2000 – 2015)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CH	32,91	30,78	29,19	28,44	28,24	28,06	27,19	25,75	23,71	22,57	21,2	21,52	20,3	21,07	20,69	20,51
CZ	52,09	52,64	50,74	46,79	54,48	53,82	51,09	50,1	44,05	47,39	50,15	53,92	51,47	52,61	57,26	56,5

Source: own processing according to Agristat (2001 – 2017), BFS (2018), CBU (internal data, 2019) and CZSO (2019a)

From the graph it is clear that there is an upward trend of increasing numbers of bee colonies per 1 000 capita in the Czech Republic since 2008, which can be ascribed to increased support of beekeeping[58] after significant bee colony losses in 2007/2008, while the numbers of bee colonies per 1 000 capita in Switzerland rather continue to decline since 2000.

Figure 14 below shows the development of output intensity indicator describing yearly changes in domestic honey production in both countries per bee colony. It can be seen that since 2005 the shape of both curves is analogous. This can be attributed to some external factors, such as climate and weather conditions in Central European region, cycles in natural phenomena and the bee colony losses changing over time (cf. Neumann and Blacquière, 2017).

Figure 14: Annual honey yield (in kg) per bee colony in the Czech Republic and Switzerland (2000 – 2015)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CH	12,02	19,35	12,71	19,98	19,61	15,49	18,02	20,26	15,57	18,04	20,09	27,61	13,29	22,59	14,36	27,24
CZ	14,02	11,73	11,36	13,19	13,9	15,17	17,22	16,28	13,18	13,84	14,11	19,99	13,56	14,58	11,87	15,48

Source: own processing according to Agristat (2001 – 2017), CBU (internal data, 2019) and SVZ (2017)

New production techniques and external inputs availability lead to changes and development of local agroecosystems (Benoît et al., 2012), and so the anthropogenic activities, such as research, infrastructure and management become indispensable to agricultural productivity (Dietrich et al., 2012). Keeping track of agricultural intensity and its relevance to beekeeping thus proves useful for applications in agronomy, efficient and sustainable land use and its planning, and/or monitoring and formulating agricultural policies.

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[58] E.g. Jalůvková (2008), Vorlíček (2008), Zlínský kraj (2007)

2.5 Beekeeping for Agriculture and Nature

"The environment does not exist as a sphere separate from human actions, ambitions, and needs and attempts to defend it in isolation from human concerns have given the very word "environment" a connotation of naivety in some political circles. The word "development" has also been narrowed by some into a very limited focus, along the lines of "what poor nations should do to become richer," and thus again is automatically dismissed by many in the international arena as being a concern of specialists, of those involved in questions of "development assistance". But the "environment" is where we all live; and "development" is what we all do in attempting to improve our lot within that abode. The two are inseparable."

Our Common Future (WCED, 1987, p. 7)

Nowadays honeybees need to adapt to changing conditions of modern agricultural landscape, to the climate change and to nature and biodiversity challenges. In spite of indisputable pollinator dependency of agriculture and mutual interconnection of beekeeping and nature, some anthropogenic activities (e. g. use of agrochemicals) have serious detrimental effects on pollinators.

2.5.1 Pollinator-Dependent Agriculture

As the three-quarters of leading food crops worldwide are reliant on animal mediated pollination, there exists well-founded argument for possible crop production limitation. Although the pollination services belong to fundamental inputs within a crop farming operations, the modern agricultural landscape has become quite restrictive with regard to its pollinators (Winfree, 2008).

On a global scale the managed honeybees are principally reared for honey production[59] in contrast to pollination, hence the relatively slow growth in bee colony numbers can neither meet the requirements of agricultural production nor moderate the native pollinator losses (Aizen and Harder, 2009). Pollinator declines may affect not only the total amount of yield, but also its quality attributes as smaller sizes or fruit distortions (Allen-Wardell, 1998; Ricketts et al., 2008).

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[59] With the exception of the USA (and few other comparable countries), where the migratory beekeeping primarily ensures pollination of valuable crops (e.g. almonds in California), rather than honey production (Morse and Calderone, 2000; Siebert, 1980).

Aizen et al. (2008) substantiate higher pollinator dependency of agriculture by a disproportionate growth in the regions of pollination-dependent crop cultivation – the amount of honeybee colonies has increased at a slower rate than the accretion of area cultivated with insect pollinated crops. The authors estimate the expansion of the global area dedicated to crop farming to be circa 23 % from 1961 to 2006, whereas its largest part might be attributed to several oil crops and a variety of fruit trees and shrubs (Aizen et al., 2008). In study across 41 European countries, total numbers of honeybee colonies rose by 7 %, however the overall acreage of honeybees-pollinated crops increased by 17 % (Breeze et al., 2014). The situation can be even aggravated in the future on account of changes in both national and international agricultural policy (Breeze et al., 2014), high cash crop production (Lautenbach et al., 2012) as well as of non-food utilization of agricultural production (Aizen et al., 2008), because some fast expanding, insect-pollinated oilseed crops have the potential for large-scale biofuel production (Groom et al., 2008; Herkes, 2014) and biofuel industry booms resulting from recent biofuel policy initiatives of the EU (Kim et al., 2012).

In order to maintain higher stability in pollination Klein et al. (2007) suggest creating a threshold level of diversity derived from crop variety and biology, landscape patterns and regional pollinator communities. So far the available data indicate the increase of pollination stability right within landscapes with abundance and variety of pollinators (Klein et al., 2007). Despite the rare occurrence of native pollinators in farms far away from natural habitats, the adequate pollination of agricultural landscapes can be secured by introduced honeybees (Ricketts et al., 2008), inter alia because of its relatively large foraging distance (Steffan-Dewenter and Kuhn, 2003) and bee breeding facilities within farm operations (Klein et al., 2007; Ricketts et al., 2008). Nevertheless the bee colonies should be placed correspondingly to the field crops, in order to avoid possible shortage in pollinating service (Breeze et al., 2014). In view of the fact that the majority of European beekeepers are hobbyists (Jones, 2004) the potential turn in migratory beekeeping seems improbable.

Stakeholder cooperation towards sustaining pollination services and food yield stability needs to focus not only on farm management practices (pesticide use, intercropping etc.), but also on associated domains. Crop breeders should take account of pollinators' interests when developing new horticultural varieties (Allen-Wardell, 1998). There is also a problem with monocultures consisting partly in insufficient nutrition (Brodschneider and Crailsheim, 2010) and partly in the so called boom-and bust cycle, where un-pollinated plants outnumber the pollinators during the few weeks of crop bloom, and subsequently starving pollinators outnumber the plants for the rest of the season (Winfree, 2008). Notwithstanding limited direct impact of the pollinator capacity decrease, the compensation for its consequences might have surprisingly significant effects. Although only scanty reduction in agricultural production is expected resulting from pollinator declines, the increased pressure on the supply of agricultural land to attend to the needs of growing global population could contribute to global environmental change, namely to accelerating deforestation and habitat destruction, pressure intensification on ecosystems, and a part of this vicious circle may involve further pollinator shortage (Aizen et al., 2009).

2.5.2 Managed Honeybees in Natural Habitats

Generally, wild insect pollinators are widely declining due to human interference with nature and environment. On that account it is essential to know how far the honeybees meet the role of the pollinator not only in fields, gardens and orchards, but also in the wild. Even in the new areas of its expansion, *Apis mellifera* faces great pressure and the beekeepers are struggling with massive declines of the bee colonies. These losses have not only impact on the yield of honeybee-pollinated crops, but also on the numerous species of wild terrestrial flora (Petr, 2018).

In defiance of significant variance in the local abundance of honeybees, their crucial importance for natural ecosystems originates from their wide distribution, generalist foraging behaviour and pollination capacity (Hung et al., 2017). According to the review by Aslan et al. (2016), the role of introduced honeybees in natural habitats is deeply context-dependent, and so the effects on native plants, non-native plants and indigenous pollinators need to be considered.

Honeybees can diversely disrupt the interactions between plants and other pollinator species, inclusive of areas of the rare occurrence of *Apis mellifera* (Hung et al., 2017). Furthermore, massive introduction of managed honeybees can have following negative effects on wild pollinators – e.g. competition with feral pollinators for floral resources (Goulson and Sparrow, 2009; Moritz et al., 2005), decreasing wild insect densities in a flowering crop (Lindström et al., 2016), hybridization leading to the loss of traits combinations given by natural selection (De la Rúa et al., 2009), disruption of native plants pollination (Goulson, 2003), homogenization of pollinator faunas and networks (Hung et al., 2017; McKinney and La Sorte, 2007) and pathogen transmission (Fürst et al., 2014; Graystock et al., 2016).

In many cases, honeybees do not pollinate a significant part of the growing flora. Even in the ecosystems where more than half of all flower visits are contributed by honeybees, these visits, on average, for approximately 16 % of the plant species, are of peripheral importance. Hence it is obvious that despite their important role as a pollinator of wild plant species, the numerousness and diversity of other insect pollinators must be sustained in ecosystems (Aslan et al., 2016; Hung et al., 2017; Petr, 2018).

However Geldmann and González-Varo (2018) stress that the crop pollination delivered by managed honeybees should not be confused with an ecosystem service, because the pollination is provided by an agricultural animal and not by the local ecosystem. For that reason the beekeeping should be considered as an agrarian activity, not an act of wildlife conservation.

2.5.3 Honeybees as Bioindicators of Pollution

Importance of honeybees for nature is not solely restricted to pollination. Notwithstanding the disputable role of honeybees in biodiversity conservation, they can serve as reliable biomarker of environmental pollution.

All the individual organisms and their environment form a complex, which needs to be considered as a whole. Case in point is the mirror-image of the living being and its biotope, whose tight interconnection enables using certain organisms as biological indicators (Celli and Maccagnani, 2003). Two main animal species – honeybees and birds (mallard, pheasant, quail and so forth) – are used in terrestrial ecotoxicology to assess harmful effects of chemicals. On the grounds of their easy rearing, effortless manipulation, worldwide distribution, well known and relatively short biological cycle, the honeybees are considered to be convenient test organisms obtained at low cost (Devillers, 2002). Results from many conducted studies (e.g. Badiou-Bénéteau et al., 2013; van der Steen et al., 2016; Zarić et al., 2015; Zhelyazkova, 2012) reveal that honeybees instantly react to various external factors in their environment, which makes them a reliable indicator and enables to use them in environmental monitoring. The honeybee as biological indicator is endowed with a range of important morphological, ecological and behavioural features. Owing to its ethogram honeybee shows to be an apt monitoring tool, while managed beekeeping assures an unlimited supply of samples (Celli and Maccagnani, 2003).

Environmental pollution is detected by means of high bee mortality rates and residues in bee organisms, bee larvae, bee products etc. (Bogdanov, 2005; Celli and Maccagnani, 2003; Conti and Botrè, 2001; Porrini et al., 2003). The content of macro and micro particles within honeybee bodies is notably different depending on a number of factors including for example beekeeping area (soil type, bee forage abundance and so forth), its ecological status, management of the beekeeping operation (supplemental feeding, preventive measures etc.), age of the worker bees, physiological and health status of bee colonies (Zhelyazkova, 2012).

In defiance of suitability of honeybees as bioindicators, some researchers highlight possible pitfalls. One of the most important aspects for the use of honeybees in biomonitoring systems is well-founded approach to the data interpretation, which must respect the specifics of the entire transfer of pollutants from the environmental compartments into honeybee organisms and bee products. It should be borne in mind that these bioindicators can provide a plausible image of the actual pollution level only in a relatively small locality determined by the honeybee flight range. Without an adequate number of control stations and knowledge of contaminants transfer in the natural environment, the findings can be hardly generalized within larger areas or regions (Bohačenko et al., 1994). Likewise, the increased volume of certain chemical elements in honey may be also caused by completely different circumstances than the presence of pollutants in soil or air. An example is inappropriateness of the material used for processing and/or honey storage (Wieczorek et al., 2006).

2.5.4 Sustainability

In view of the contemporary beekeeping problems, which were outlined in the previous sub/chapters, it is (more than ever) essential to consider the concept of sustainable beekeeping in agricultural, natural and urban conditions. The general concept of sustainability is therefore dealt with in this subchapter.

Territorial development must be consistent not only with the socio-economic development, but also with the environmentally friendly development towards the sustainable use of the landscape. Although some activities are limited in the short term, respect for these principles leads to the long-term benefit, development and advantage of those, who meet their diverse needs in the real world (Kender, 2000). In relation to the triple bottom line[60] some authors

[60] The triple bottom line is an accounting framework including three dimensions of performance (i.e. social, environmental and financial), often called the three Ps: people, planet and profits (Slaper and Hall, 2011).

speak about the fifth sustainability revolution (e.g. Elkington, 1998). From an economic perspective sustainability is linked to the problem of resource scarcity (Kuhlman and Farrington, 2010).

There are plenty of ways to define the sustainable development. Nevertheless according to its widespread use and citation frequency the definition given by the Brundtland's Commision focusing on intergenerational equity (WCED, 1987) is considered the standard one (Kates et al., 2005; Kuhlman and Farrington, 2010).

"*Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.*" Our Common Future (WCED, 1987, p. 16)

According to Svatoš (2006, 2007) the very successful human adaptation strategy has reached a critical limit given by the capacity of the Earth's biosphere and the threat to the ecological balance posed by technological and economic globalization is a key problem to be solved – possibly through the concept of sustainable development. The Brundtland Commission's report (WCED, 1987) moreover points out the limitations given by sustainable development itself – these are imposed by the current state of technology and social organization on natural resources and by the ability of the biosphere to absorb the effects of anthropogenic activities. Among other global limits (e.g. biogeochemical flows, land-system change, freshwater use, novel entities and ocean acidification) the two core boundaries are identified by Steffen et al. (2015) – climate change and changes in biosphere integrity. The latter apply to beekeeping as well – for instance through altering the floral bud phenology (e.g. Crabbe et al., 2016; Kolářová et al., 2013; Menzel et al., 2006) and changes in landscape structure (e.g. Dauber et al., 2003; Duelli et al., 1999; Hendrickx et al., 2007; Steffan-Dewenter and Kuhn, 2003; Tscharntke et al., 2005).

Agricultural sustainability incorporates principles of resilience and persistence, while addressing numerous economic, environmental and social outcomes. There is a need to develop particular technologies and practices in agriculture to approach the sustainability. These should be accessible and effective for farmers, they should lead to better food productivity, and they should not harm the environment but rather have positive side effects on environmental goods and services (Pretty, 2008). Agricultural systems are often linked to multifunctionality, inasmuch as agriculture contributes to wide range of non-food tasks that cannot be sufficiently fulfilled by other economic sectors – e.g. water management, wildlife and habitats, aesthetic appreciation, recreation and tourism (Dobbs and Pretty, 2004). Hence Pretty (2008) considers sustainability in agriculture as both relative and case dependent, while finding balance between agricultural and environmental assets. Despite the virtues of the transition towards sustainability, it is necessary to concede some possible secondary problems too – see Pretty (2008).

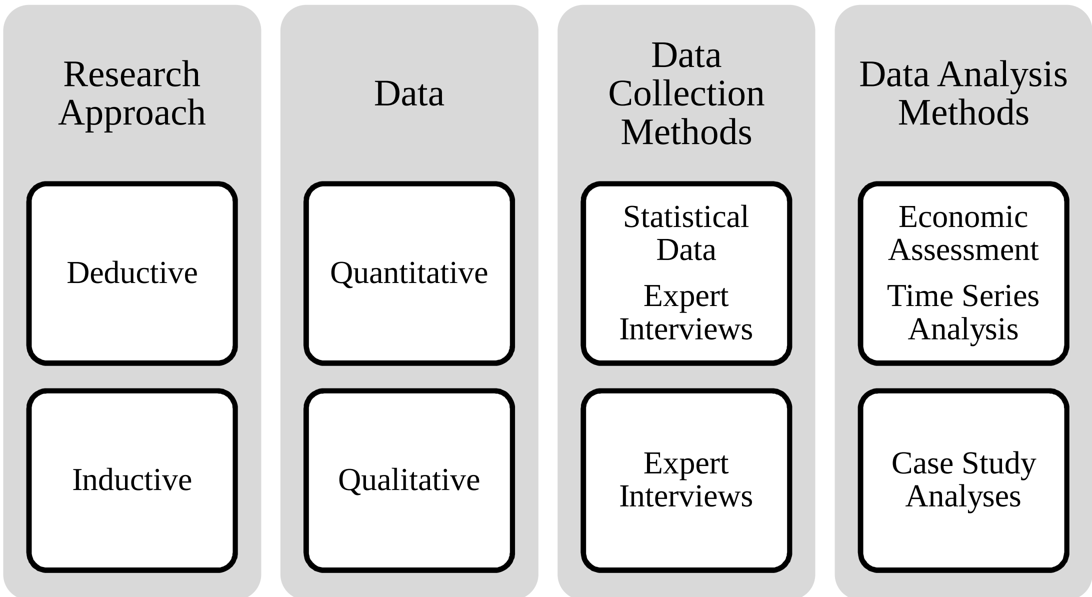
One of the accomplishments of sustainable development is its ability to symbolize a great compromise between those who are primarily concerned about environment and nature, those who esteem economic development and those who are enthusiastic about society. The particular challenges of this compromise are at least as heterogeneous and complex as the diversity of human population and natural ecosystems variety around the world. This malleability of sustainable development thus enables its adaptation to miscellaneous problems. Hence the concept has been adjusted to fit different situations, ranging from the planning of sustainable cities to sustainable livelihoods, from sustainable agriculture to sustainable fishery and so forth (Kates et al., 2005).

With respect to the European apiculture, for instance the studies from France (Kouchner et al., 2018) and Romania (Pocol et al., 2012) have focused on its sustainability. However the research on sustainable development of beekeeping sector both in the Czech Republic and Switzerland is lacking.

3 Research Methodology

The underlying research paradigm of this dissertation is the logic method of deduction and induction. Quantitative data is gathered from Czech and Swiss official statistics, beekeeping equipment retailers and expert interviews conducted with Czech and Swiss beekeepers. Firstly, the assessment of the economics of hobby beekeeping operations is made. Secondly, the statistical data on Czech honey prices is analysed using selected methods of time series analysis – growth rate, linear approximation and ARIMA modelling in particular. Qualitative data comes from expert interviews and standardized surveys of experts (hereinafter referred to as expert interviews) conducted with Czech and Swiss beekeepers and few other experts on beekeeping sector. On the bases of expert interviews and case study approach the intra-case and inter-case analyses are employed. Figure 15 presents the general overview of the research approaches, data types, data collection methods and types of conducted analyses.

Figure 15: Overview of the methodology

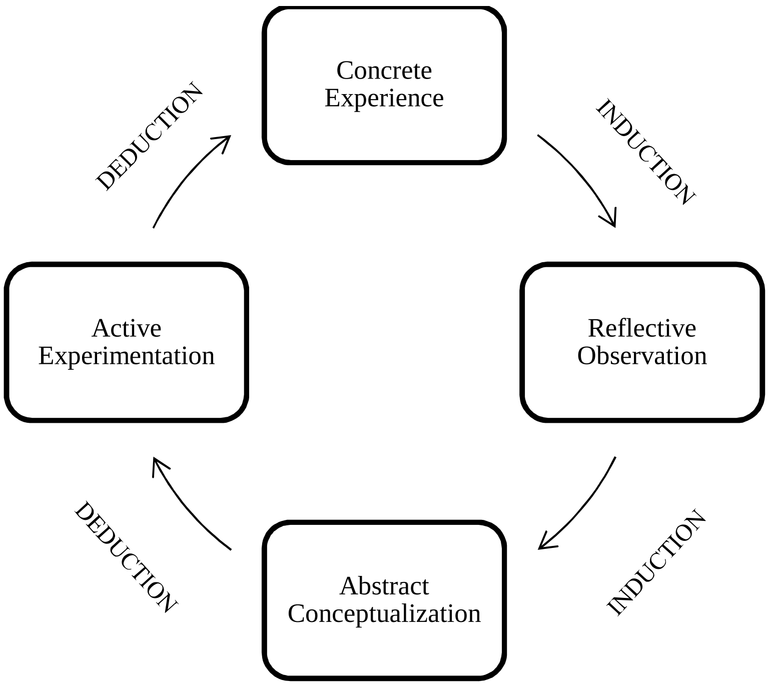


Source: own processing

3.1 Research Approach

In research reasoning both induction and deduction are being used together, as proved by Dewey (1910) in the double movement of reflection. The first (inductive) movement is from the given partial and disordered data to a proposed comprehensive (or inclusive) entire situation; and the second (deductive) movement is back from the suggested whole to the particular facts in order to link these with each other and with additional facts to which the proposal has direct relation. Such more systematic approach represents the motion towards the suggestion (or hypothesis) and the motion back to facts (Dewey, 1910). Both methods of deduction and induction are very closely related and often complement and/or combine one another in specific research. This correlation can be illustrated with an example of Kolb's experiential cycle (e.g. Kolb and Kolb, 2009) modified by Molnár et al. (2012) in Figure 16.

Figure 16: Induction, deduction and Kolb's reflective cycle



Source: Molnár et al. (2012), p. 44

Scientific inquiry is based on the inference process, which is applied to developing and testing diverse propositions through the double movement of reflection. Reflective thinking resides in sequencing of induction and deduction for the purpose of inductive explanation of abstruse condition and deduction of additional facts to confirm or deny the hypothesis (Cooper and Schindler, 2014).

3.1.1 Deductive Approach

In deduction, particular is inferred from general propositions. A deductive proof is a move toward development, application and testing. It begins with connected view of a situation and develops to particulars and their interconnection (Dewey, 1910; Whewell, 1989). Deduction is the procedure to test whether the hypothesis is capable to explain the fact (Cooper and Schindler, 2014; Thomas, 2006). Firstly, it on the basis of theory formulates hypothesis and through using logical reasoning and already known facts tests the hypothesis. Quantitative data are used for this in particular. Deductive approach follows on from positivism and it is often conducted by exploration to detect causal relationships between variables. Deduction is a way of thinking to move from general conclusions, assertions and judgements to less known, special ones. The process comes from known, validated and generally valid conclusions and applies them to individual cases, which have not been investigated. Unfortunately, impressing irreversibility of deductive evidence is achieved at the cost of not saying anything about the real world. Hence the deduction is only relevant as an element of the thought chain, in which other types of thinking apply too (Molnár et al., 2012).

3.1.2 Inductive Approach

The motion towards building up the idea is called induction and it moves from fragmentary details to a united view of a state. Scientific induction represents all the processes by which the observation and data gathering are arranged with regard to facilitate designing of explanatory conceptions and theories (Dewey, 1910). In induction, general is inferred from particular, and so a conclusion is drawn from certain fact(s) or piece(s) of evidence. On the one hand the conclusion elucidates the reality and on the other hand the facts back up the conclusion (Cooper and Schindler, 2014; Whewell, 1989). Inductive analysis is characterized as a set of approaches that fundamentally use thorough readings of raw data to derive themes, concepts, or models through researchers' interpretations. Its main objective is to let research findings emerge from prevailing or important points contained in raw data, lest being suppressed by given methodologies (Thomas, 2006). Inductive approach typical for social sciences is based on constructivism and works primarily on qualitative data. Data collection is used to retrieve several different views of the problem depending on the research purpose. On the basis of the findings, the hypothesis is formulated and then tested for the purpose of generalization and designing a "new" theory. Inductive approach addresses the "why" and "how" questions and it requires deeper understanding of the problem. Induction occurs wherever a fact is observed and a question "Why is it?" arises. In order to get the answer, a preliminary (non-binding) explanation is made and accepted only, if it explains why the phenomenon had occurred. An inductive conclusion can be considered as a hypothesis, since it provides explanation(s), although there might be more elucidations in practice. Since the conclusions of inductive processes are always influenced by subjective attitudes (experience, knowledge), their validity is limited. It is often a type of an exploration research, where there is not customary to formulate hypotheses at the beginning of the work. These may be one of the research outputs as well as a starting point for follow-up research (Molnár et al., 2012).

3.2 Data Collection Methods

In this section the applied system of data collection is described with respect to the general types of data – quantitative and qualitative. Quantitative dataset is primarily made up of Czech and Swiss national statistical information on beekeeping sector and qualitative data material consists of expert interviews carried out with Czech and Swiss experts on apiculture.

3.2.1 Quantitative Data

There exist noticeable differences between the European countries concerning statistical publications. Even the statistics produced by state institutions (e.g. ministries) varies from one to another, not just from country to country. Statistical data production and official statistics are closely related to socio-economic development and socio-economic structure of the country (Rothenbacher, 1998). The Czech Republic and Switzerland are no exception, and so the development and specific shape of their national statistical systems are determined by diverse factors. By analogy, the structure of agricultural production influences the type of statistical investigation in agriculture. In case of beekeeping, the statistical data availability is limited, for one thing as a result of its small scale position in national agricultural systems, and for another in consequence of prevailing hobby beekeepers to commercial bee farms in both studied countries. Although beekeeping is sine qua non to agriculture due to pollination services, its real importance is often underestimated.

The sources of quantitative data on beekeeping in the Czech Republic are official statistics by the Czech Statistical Office (CZSO[61]), statistical data provided by the Czech Beekeepers' Union and sectoral statistical yearbooks[62] of the Ministry of Agriculture of the Czech Republic. Quantitative data on beekeeping in Switzerland are obtained from Statistical surveys and estimates about agriculture and nutrition[63] published by Swiss Farmer Association[64], information provided by the Swiss centre of excellence for agricultural research[65] and Swiss Federal Statistical Office[66].

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[61] Michaela Kholová, Information Services Unit, repetitive personal communications (2019)

[62] Situační a výhledová zpráva Včely / Report on State of Beekeeping Sector in the Czech Republic; Zelená zpráva / Green Report (Summary Report on Agriculture)

[63] Statistische Erhebungen und Schätzungen über Landwirtschaft und Ernährung

[64] Schweizer Bauernverband

[65] Agroscope

Statistical data of beekeeping sector in the Czech Republic and Switzerland consist of time series of numbers of bee colonies, numbers of beekeepers (only in CZ), information on honey consumption, honey production and honey prices. Time span for the data is at least 2000 – 2016.

For the purpose of economic assessment of beekeeping operation the available prices are used. Initial data sources of beekeeping gear and material prices are companies Včelpo (2018), iVcelarstvi.cz (2019), Medocentrum.cz (2018) and Bee Research Institute in Dol (2017) for the Czech Republic and Bienen Meier (2018) and Imkerhof (2019) for Switzerland. However some of the quantitative data necessary for economic evaluation stem from the expert interviews (see the subsection 3.2.2.2 for details) too.

3.2.2 Qualitative Data

"*And most of all, we know that there are the people who have knowledge that we do not have, but which we nevertheless refer to and depend on as soon as we determine (voluntarily or involuntarily) problems and questions that go beyond our own competencies.*"

Ronald Hitzler (1994, p. 13 – 14, own translation)

An efficient instrument for reflection and decision-making represents a stakeholder approach, whereby interest groups are involved in the research process. Generally speaking, stakeholder participation in agricultural research can be characterized as a "*systematic dialogue between farmers and scientists to solve problems associated with agriculture, and ultimately to increase the impact of agricultural research*" (Hellin et al., 2008, p. 81). This approach may be an essential tool for beekeeping sector, as a unique stakeholder group of beekeepers can bring new innovative ideas, provide specific knowledge and experience or enhance the awareness of certain beekeeping practices. For the purpose of this thesis the conceptual framework of participatory research by Neef and Neubert (2011) is applied.

Qualitative data on beekeeping in the Czech Republic and Switzerland is gathered through expert interviews. These were conducted from May 2017 to January 2018. In total 81 experts were interviewed[67] – 46 from the Czech Republic and 35 from Switzerland.

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[66] Bundesamt für Statistik

[67] See the subchapter 3.4 for details

Due to diverse climatic, economic and social conditions within the countries themselves the spatial distribution of interviewees is taken into account. The expert interviews were carried out in territorial units NUTS 2 (Nomenclature of Units for Territorial Statistics) – cohesion regions in the Czech Republic and regions in Switzerland. Minimum number of interviewed experts per (cohesion) region is three. At the beginning of data collection process the research participants were assured that data gathering would be conducted anonymously (cf. Saunders et al., 2015). All interviewees were considered equally informative with regard to their individual expertise. For detailed information about the conducted expert interviews, see the subsection 3.2.2.2.

In order to develop an understanding of the concepts and theories held by the interviewees, a pilot study was done to smooth out the problems, modify the design of the interviewing procedure, and reformulate questions in a questionnaire. The need to undertake the pilot study is stressed by numerous authors – e.g. Blessing and Chakrabarti (2009), Maxwell (2005), McBurney and White (2010).

3.2.2.1 Sampling Methods

It is essential to point out that in qualitative research; the researcher does not know how many individuals and how many groups will be interviewed. It continues until it reaches the theoretical saturation. When the names of the experts repeat and new names no longer appear, the sample can be declared theoretically saturated (Disman, 2002; Glaser and Strauss, 2006). In comparison to statistical (random) sampling, the theoretical sampling is done to explore categories and their attributes, and to embed the interrelationships in a theory. The objective of statistical sampling is reaching the evidence on distributions of people within categories to be described and/or verified (Glaser and Strauss, 2006). For the purpose of qualitative data collection two techniques of non-probability (judgemental, non-random) sampling are used. Both of them are adopted for the expert selection due to narrowly specialized research focus on managed beekeeping in the Czech Republic and Switzerland.

a. Purposive sampling

This method is applied to very small samples such as case study research, to particularly informative cases as well as to grounded theory research strategy, and so these samples cannot be regarded as statistically representative of the total population. In case of homogeneous sampling strategy the attention is focused on one particular sub-group, where all the sample units resemble each other and the group can be analysed in great depth (Saunders et al., 2009). Sample group members might share similar traits in terms of age, culture, profession or life experience. The objective of homogeneous sampling resides in such similarity and its relation to the research (Etikan et al., 2016).

b. Snowball sampling

Snowball sampling technique (or chain referral sampling technique) as described by Bailey (2008) is used to obtain necessary sample. Disman (2002) defines the snowball technique as a selection of individuals, where some original informants lead researcher to other members of the target group. Firstly, a few beekeepers having the expert characteristics are identified and interviewed. These interviewees are then used as informants to identify others qualifying for inclusion in the sample. Secondly, through gained contacts the other beekeepers are approached, asked for an interview and for recommendation of further experts. And the sampling process carries on in the same manner few more rounds. Such procedure proves to be very useful in the study of this specific expert group where the respondents may not be easily identifiable. Snowball sampling plays an important part in theoretical sampling, since it has a validation function to some extent (Disman, 2002).

3.2.2.2 Expert Interviews

Expert interview is a qualitative empirical research method to scrutinize expert knowledge (Meuser and Nagel, 2009). The objective of this data generating instrument is to produce a dialogue of experts including some distinctive features (e.g. thematic focus, active use of professional terminology) and a unique conversational setting, where the researcher is a quasi-expert. A high degree of thematic competence of the interviewer is the mainstay of the expert interview (Pfadenhauer, 2009). According to Disman (2002), in qualitative research the boundaries between the researcher's role and the role of the investigated person disappear, both being equal partners. Bogner et al. (2009) emphasizes the fact that the interviewer and interviewee often share a common scientific background or relevance system, which might have beneficial effect on expert's willingness to participate in an interview. The main task of the expert discussion is to record the individual statements with regard to the problem to be investigated. At the same time, comparable material should be provided by a large number of respondents (Köhler, 1992). The principal difference between an expert interview and a standardized (survey) interview is that in the expert one, the interviewers do not use their questionnaires directly in order to optimally simplify the comparability of their data, but rather use it as a work aid for an informed conversation. Expert interview is primarily aimed at respondent's special knowledge stocks, their particularly comprehensive, detailed or exclusive know-how and practices (Honer, 1994).

The experts are considered as experts in a specific field. In most cases they know something that is significant or relevant to a particular domain. They have an overview of a special knowledge area and can offer within this principle problem solving or application to individual issues (Hitzler, 1994). It has to be emphasized that not only professional knowledge is regarded as the expert one, since the experts are neither identical to the professionals nor to specialists, because they have at their disposal a relatively exceptional knowledge asset that is fundamentally not freely available (Hitzler, 1994; Meuser and Nagel, 2009; Pfadenhauer, 2009). Definition of an expert works on the assumption that expert knowledge is distinguished from any other knowledge (Meuser and Nagel, 2009). Such knowledge is then the core to be discovered by the expert interview. Expert status does not have to be inevitably linked to schooling nor training in traditional educational institutions (Pfadenhauer, 2009). Expert interviews derive from the generation of domain-specific and object-theoretical statements and their subject matter is knowledge in the sense of rules of experience determining social system functioning (Meuser and Nagel, 1991). Beekeeping is a case in point of a domain, where the emphasis is rather laid on learning by doing, autodidacticism and active training the proficiency than on certificates or diplomas.

Experts associate knowledge elements and knowledge types in a multi-faceted and highly routine manner, make extensive use of the available information and organize the knowledge as a whole according to collectively proven principles (among experts). In relation to the layman, experts develop more appropriate hypotheses for a problem, use successful solution strategies, and acquire even more systematic, fundamental knowledge in the specific case (Hitzler, 1994). According to Pfadenhauer (2009), the expert knowledge indicates the knowledge necessary to investigate the roots of problems and to explore the solution principles. The subject matter is a description and discursive explanation of what they are doing and why they are doing that the way they are doing it (Pfadenhauer, 2009). Method is not apparently based on the concept of information extraction in the sense of questionnaire, but data collection rather benefits from an open interview framework providing the experts enough space to share their knowledge (Meuser and Nagel, 2009). The aim is to create a supportive environment in order to produce the scope and complexity of expressions addressing pertinent issues (Holstein and Gubrium, 1995). It should be possible for both the interviewer and interviewee to change the order of discussed topics. However the interviewer's difficult task is to keep the balance between a conversation that is too close to the guideline and a completely free conversation (Köhler, 1992).

If needed, a partially standardized survey of experts might substitute an open expert interview. It is possible, when the experts are addressed as providers of information that cannot be found anywhere else. A written survey meets the requirements likewise. On the contrary for the exclusive knowledge (e.g. rules beyond regulations, unwritten laws of expert action, tacit knowledge and relevance aspects), no alternative to open expert interview is admitted (Meuser and Nagel, 1991). Written interview per e-mail or fax is conceded by Mieg and Brunner (2001) too.

Most expert interviews were conducted in private, as it according to Holstein and Gubrium (1995) helps assure that interviewees speak directly, not in response to the presence of others. Part of the data, especially in the Czech Republic was gathered through standardized survey of experts via e-mail.

As the case studies generally include a particular exploration of a smaller unit, the definition of an "expert" is of capital importance with regard to expert's specific domain and considering research orientation of the empirical investigation (Bogner and Menz, 2009). In contradistinction to the analytic approach, which is appropriate for case studies, in the expert interviews analysis the attention is turned to thematic units interwoven with similar corresponding topics dispersed in the interview (Meuser and Nagel, 2009). The questions were grouped thematically and the compactness of the questionnaire was pre-tested during pilot study. The topics discussed in the interviews are divided into categories, as follows – economics of beekeeping operation, beekeepers' professionalization, beekeeping practice and sector's development towards sustainability. Individual categories are not strictly separated from one another, as some questions[68] relate to more than one thematic group.

In this work hobby and professional beekeepers from the Czech Republic and Switzerland are considered as the experts for beekeeping in given region. Five additional expert interviews were conducted with decision and policy makers responsible for different beekeeping initiatives – a hotel manager in Bern, initiator of beekeeping operation on a rooftop of city

[68] The question of queen bees is such a case in point, since the difference between rearing own queen bees and buying them belongs partly to economics, partly to beekeeping practice and partly to beekeepers' professionalization.

restaurant, project manager of railway beekeeping exposition, expert on rooftop and urban beekeeping and an under-secretary of the Ministry of Justice of the Czech Republic. Personal communications from these additional five interviews are cited in subchapter 4.4 according to APA (2017), using letters and roles to identify the participants.

Interviews conducted with beekeepers included ca. 80, mostly unstructured questions focusing on various topics (e.g. beekeeping practice, economics of beekeeping operation, professionalization and beekeeping sector's development). The interviews followed the structure of semi-standardized interview, introduced by Berg (2009). Flexible wording of questions as well as the possibility to make necessary clarifications and answering potential respondent's questions enabled the interviewer to tailor particular questions to specific situations and made every interview unique.

With regard to the type of individual questions, interviews comprised (according to Berg, 2009) identification and/or demographic questions (e.g. age, gender, place of residence), essential questions (i.e. questions directly related to the problem under study), and validating and/or extra questions to control the reliability of responses (cf. Disman, 2002).

On account of the structure of potential answers, following types of questions were formulated (in accordance with the categorization provided by Reichel, 2009) – open-ended questions (e.g. origin of beekeeping, local sources of honey yield), semi-opened questions (e.g. the ways of marketing bee products, volumes of sold honey pots) and closed questions (e.g. membership in local beekeeping organization, attending the course for beginning beekeepers). In addition to that, Reichel (2009) divides questions according to the number of answer-options into dichotomous questions (e.g. yes/no question) and polytomous questions (e.g. selective, enumerative and/or order of options).

In terms of politically definable interaction situations the expert has the position of the third. In such an actor configuration not only the layman does not exist without the expert, here also the expert does not exist without the decision maker (Hitzler, 1994). The stakeholder approach and the interviews with experts are therefore considered very important part of this research, as they might bring specific experience, different points of view and/or new ideas.

3.3 Data Analysis Methods

This sub-chapter comprises of the explication and justification of analytical methods, which are intended for analysis of both quantitative and qualitative data. Firstly, selected quantitative methods are described, and secondly, applied techniques of qualitative analysis are characterized.

3.3.1 Quantitative Methods

In order to quantitatively assess the economics of beekeeping sector, the economic data on hobby beekeeping operations and the Czech honey price time series is analysed. On the grounds of the expert interviews, knowledge of good beekeeping practice and available normal prices the assessment of small-sized beekeeping operations in economic terms is made. The aim is to modify theoretical assumptions of given categories through real data integration[69]. It is found out that the honey price is an important factor not only for beekeepers (Aizen and Harder, 2009), but also specifically for Czech honey buyers (Šánová et al., 2017). Hence the analysis and forecast of Czech honey prices (including elasticity of demand for honey) can provide insight into the development of this economic time series. So as to analyse given time series, the methods of growth rate, linear approximation, and Box-Jenkins methodology (i.e. autoregressive integrated moving average model in particular) are employed.

3.3.1.1 Assessment of the Economics of Hobby Beekeeping Operations

For the purpose of this thesis, economics is defined according to Longman (2009) as an observation of the way to produce and make the use of money and goods. Neither hobby beekeepers in the Czech Republic nor in Switzerland keep the books, so the data on economics of beekeeping operations mainly proceeds from conducted expert interviews and normal prices. The calculations of initial investment, annual expenditures and annual revenues are subsequently put in context of the data obtained from the respondents and/or from the review of literature in order to draw a comparison between the theoretical underpinnings and reality, and therefore to assess to what extent the computation is reflective of real data. The individual items of some basic necessary beekeeping equipment are listed on the grounds of

[69] Case in point is the assumption that the transport costs entirely arise from migratory beekeeping, neglecting the possibility that the apiary is located outside beekeeper's immediate vicinity.

good beekeeping practice, providing that the list is not exhaustive, since a variety of additional tools is available.

Firstly the initial investment in a beekeeping operation of a beginning beekeeper is calculated, taking into consideration not only tangible assets, but also the education and knowledge. Although the importance of beekeeper's knowledge is highlighted by several contemporary research works (e.g. Jacques et al., 2017; Maderson and Wynne-Jones, 2016), some economic evaluations of beekeeping operations (e.g. Hunger, 2004; Kamler, 2005; Šánová and Benda, 2014) omit the education as a significant factor.

Secondly the expenditures are described and calculated including time requirements, annual investments, packaging material, beeswax processing, queen bee breeding, varroa mite treatment, transport costs, membership fees and charges and insurance. The other way around the structure of revenues proceeds from the analysis of bee products sale, from the potential of selling products for beekeepers and in case of the Czech Republic from the role of subsidies.

In the end the recommendations for cutting the costs and increasing the revenues in the beekeeping operation are made.

3.3.1.2 Selected Methods of Time Series Analysis

Time series is considered a set of observations taken sequentially at different points of time (Box et al., 1994; Priestley, 1991). Another definition by OECD (2007) describes time series as a sequence of regular time-ordered records of a quantitative characteristic of an individual or collective phenomenon over time. Observing the change of economic variables in the course of time, results from numerous interests of various interest groups – e.g. stock market analysts, policy-makers, business owners, consumers (Lewis, 2012).

Time series methods provide new insights into commodity prices patterns and revise some assumptions of traditional approaches. In contrast to structural models, modern time series techniques are often employed to data sets collected at high frequencies (Tomek and Myers, 1993). The main purpose of compiling high frequency series is to observe their development and volatility over time (OECD, 2007). To explain the volatility in agricultural prices the original cobweb model was developed.

Provided an original state of equilibrium between demand and supply of a commodity, the cobweb theory presumes the occurrence of a disturbance, which elicits a discrepancy in given equilibrium and ensuing examination of price and production movements (Åkerman, 1957). For some commodities where the production cycle takes a certain stretch of time (e.g. agricultural products[70]) the given period might not suffice to the modification of supply. There might be a noticeable delay in a production change in response to price change. Hence the cobweb theorem demonstrates the complexity of possible market reactions to newly-emerged disequilibrium (Ezekiel, 1938; Brčák and Sekerka, 2010). Due to the above stated condition, the principle of cobweb theory is applicable only to a very limited range of industrial production, as Åkerman (1957) declared. Although the cobweb theorem explains fluctuation in production and price in consecutive production periods, it does not exhaustively clarify the long cycles detected in some commodities (Ezekiel, 1938).

By an example of agriculture and suchlike beekeeping can be illustrated that farmers can do very little to influence future production, since natural and climatic conditions represent serious limitation. Referring to Ezekiel (1938) the combination of cobweb processes with such occasional incidents (natural variations, weather changes, animal diseases etc.) may suffice to create repetitious cyclical transitions in production and prices. On the contrary Åkerman (1957) does not consider unusual weather and changes in prosperity and income of consumers applicable, as such demand variations affect all agricultural products and, therefore should not justify the cobweb reasoning.

Time series analysis is comprised of extensive and diverse range of ideas and approaches that make it a fascinating field of study. Its scientific relevance is proved by the substantial growth in its use as well as its wide application scope in natural science (Priestley, 1989). In view of the fact that several techniques describing various types of change over the time were developed (Lewis, 2012); the core of this part is to examine some of those quantitative methods to empirically estimate short-term changes in Czech honey prices. Three methods are proposed to assess the course of given variable in time series over time – growth rate, linear approximation and ARIMA model in particular. IBM® SPSS Statistics® Software and specifically its module Time Series Modeller, which enables ARIMA modelling, are used to model given time series and forecast its future values. Additionally, price elasticity of the

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[70] For majority of agricultural production there is a lag between the initial moment of making decisions regarding the input and point in time when the output reaches the market. As a consequence, supply response functions work on the assumption that produced quantity depends on available input prices and the expectations of producers concerning output prices. However the expectations often originate from past prices (Antonovitz and Green, 1990; Tomek and Myers, 1993).

demand for honey and income elasticity of expenditures of product category including honey are computed in order to assess consumers' behaviour in the market.

3.3.1.2.1 Growth Rate

Growth rates indicate the change in value (or magnitude) of a time series between two or more different time intervals. Consequently the analyses of economic activities (for instance movements in prices, GDP or unemployment) often utilize the growth rates (OECD, 2007).

According to Hendricks (2016), the growth rate *r* might be defined as:

$$r = \frac{x(t+1) - x(t)}{x(t)} \quad (1)$$

And/or alternatively as:

$$x(t+1) = (1+r)x(t) \quad (2)$$

In case the multiple periods are employed, the equation transforms to:

$$x(t+n) = (1+r)^n x(t) \quad (3)$$

The average growth rate indicates the constant growth rate, which would change y_t to y_{t+n} in *n* years. Based on the given equation (4):

$$y_{t+n} = y_t(1+r)^n \quad (4)$$

It is being solved for *r*:

$$(1+r)^n = \frac{y_{t+n}}{y_t} \quad (5)$$

And then the equation is converted in following form:

$$1 + r = \left(\frac{y_{t+n}}{y_t}\right)^{\frac{1}{n}} \quad (6)$$

In case the equation of the average growth rate (4) is considered in logs (where *ln* is the natural log[71]), the shape of equation is as follows:

$$\ln(y_{t+n}) = \ln(y_t) + n\ln(1+r) \tag{7}$$

Then for small growth rates the linear approximation is applicable in the form presented by Hendricks (2016) and Sydsæter et al. (2016):

$$\ln(1 + \mathrm{r}) \approx r \tag{8}$$

And consequently from (5) the equation takes the form:

$$r = \frac{\ln(y_{t+n}) - \ln(y_t)}{n} \tag{9}$$

In this thesis, the growth rates are calculated as monthly average and represented as percentage. Growth rates of values are computed from constant Czech honey price series in CZK per month. Due to the interconnection of growth rates and linear approximation, the latter is also used.

3.3.1.2.2 Linear Approximation

In large part the modern economic analysis is contingent on numerical calculations, nearly always only approximate. Consequently, rather than work with a complicated function, it is better to approximate it by a simpler one. In view of the fact that linear[72] functions are mainly simple, using a linear approximation seems to be a possible alternative (Sydsæter et al., 2016).

Pflueger (2013) expounds linear approximation through local linearity, where a tangent line to a function lies in close proximity to the function (near the point of tangency), and so it evinces simply computable and conceptually uncomplicated approximation of the original function.

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[71] I.e. $\ln(e^x) = x$

[72] Womack and Matthews (1972) revisited the linearization technique of non-linear variables through the expansion of the Taylor's series using agricultural time series data and Bera (1984) studied the use of linear approximation to non-linear regression analysis.

According to Stopple (2003), all of the differential calculus is based on an idea presented above, where complicated functions can frequently be approximated[73] by straight lines. For instance, it is given a function *y = f (x)* and the graph of this function increases at point *x = a* if the derivative *f' (a)* is positive. The truth of this statement is confirmed by the proposition of the linear approximation, as follows. The function rises at the time, when the straight line approximating its graph rises (in other words it increases, in case its slope is positive). Therefore for the function *y = f (x)*, the line through point *a (f (a))* with the slope *f' (a)* is:

$$y = f(a) + f'(a)(x - a) \tag{10}$$

When *x* is close to *a*, then:

$$f(x) \approx f(a) + f'(a)(x - a) \tag{11}$$

Where ≈ signifies approximately equal in some sense not yet specified (Stopple, 2003).

Although linear approximation of the growth rate represents a quick calculation of the growth rate, it is necessary to stress, that there exists a possible impact of any irregular (OECD, 2007).

3.3.1.2.3 ARIMA Model

The original use of time series analysis consisted in forecasting the time path of a variable. Providing insight into the dynamic course of a time series leads to the improvement of forecasts, because of the extrapolation of predictable components of the given sequence into the future (Enders, 2015). A forecast represents a prediction that foresees where a time series is heading towards. Forecast is an anticipation of a time series future value extrapolating from historical figures (Stine and Foster, 2014). Using time series to forecast future values can serve to economic, business and production planning, inventory and production control, as well as management and optimization of industrial processes (Box et al., 1994). Even though forecasting has constantly been the mainstay of time series analysis (cf. Brandt and Bessler, 1983), the growing significance of economic dynamics has generated alternative utilization of time series analysis, hence the objective of modern time series analysis is not only to develop

[73] On a small scale

appropriate model capable of forecasting, but also a model suitable for interpreting and testing hypotheses regarding economic data (Enders, 2015).

Priestley (1989) indicates that the classical methods of time series analysis work on following two assumptions. Firstly, all time series are considered stationary, or they can be transformed to stationarity (e.g. through differencing), the autoregressive integrated moving average (ARIMA) models likewise. Secondly, all models are considered linear, and so the sequence can be depicted as a linear function of present/past values of an independent white noise process.

A stochastic process (a time series) is described as stationary, when its parameters (mean and variance) do not change in the course of time and the covariance of two random variables depends on their distribution in time, not on the finite moment, when the covariance is measured (Ramík, 2007). Nevertheless, Priestley (1989, 1991) claims that ***stationarity*** is, similarly to other mathematical concepts, an idealization, which can be practically examined as an approximation.

White noise (as a stationary stochastic process) represents a sequence of independent random variables, which are assumed normal and having a mean of zero and a constant variance, and their autocorrelation function is identically zero (Box et al., 2016; Enders, 2015; Ramík, 2007).

Autocorrelation function (ACF) depicts the chart of the autocorrelation coefficient ρ_k as a function of the lag k, while being independent of measurement of given time sequence and consequently, ***partial autocorrelation function*** (PACF) plots the partial autocorrelations φ_{kk} as a function of the lag k (Box et al., 2016).

Although the ***random walk*** is a non-stationary stochastic process with highly positively correlated adjacent values, its first-order difference is stationary, as it is white noise. For random walk series the mean value equals to Y_0 (constant, usually $Y_0 = 0$), but the variance increases directly proportional to growing t (time), and is therefore not constant and the time series is not stationary (Cowpertwait and Metcalfe, 2009; Ramík, 2007).

The approach of Box and Jenkins focuses on a particular type of non-stationary series – in case the $\{X_t\}$ process is differenced d times, a stationary ARMA[74] process $\{Y_t\}$ is generated, while model's non-stationarity can be demonstrated as the result of white noise process modification. Such patterns are called ***autoregressive integrated moving average (ARIMA) models*** (Priestley, 1991).

The autoregressive integrated moving average (ARIMA) process is generally represented by the equation (12) given by Box et al. (1994, p. 181) on condition that φ *(B)* and Θ *(B)* correspond to operators in B of degree p and q, respectively:

$$\Phi(\mathrm{B})(1-\mathrm{B})^{\mathrm{d}}\mathrm{z}_{\mathrm{t}} = \Theta_0 + \Theta(\mathrm{B})\mathrm{a}_{\mathrm{t}} \qquad (12)$$

In the equation (12) there is an autoregressive operator φ *(B)* of order p; B represents the backward shift operator; z_t describes the values in the current time t and the values of previous periods (z_{t-1}, z_{t-2}, z_{t-3}…); the dth difference is taken and there are moving average operator Θ *(B)* of order q and random shocks a_t.

For the purpose of the given economic time series a special case of the ARIMA (1, 1, 1) model is employed according to Box et al. (1994, p. 98) in the equation (13). It is the process, where $p = 1$, $d = 1$, $q = 1$, and consequently the coefficients correspond to $\varphi(B) = 1 - \varphi_1 B$ and $\Theta(B) = 1 - \Theta_1 B$.

$$(1-\varphi_1 B)\nabla z_t = (1-\theta_1 B)a_t \qquad (13)$$

In the equation (13) there is an autoregressive operator φ *(B)* of order *1*; ∇ represents the backward difference operator; z_t describes the values in the current time t and the values of previous periods (z_{t-1}, z_{t-2}, z_{t-3}…); the *1st* difference is taken and there are moving average operator Θ *(B)* of order *1* and random shocks a_t.

According to Box et al. (1994) an ARIMA process of order (*p, d, q*) indicates a category of models capable of representing time series which are homogenous and in statistical equilibrium, but do not have to be necessarily stationary. As the non-stationary ARIMA processes are not found in statistical equilibrium over time, they cannot be presumed to reach

[74] ARMA (*p, q*) is mixed autoregressive (AR, *p*-th order of difference) and moving average (MA, *q*-th order of difference) process (Box et al., 1994, 2016; Enders, 2015; Priestley, 1989, 1991).

infinitely to the past, and consequently an infinite representation is impossible (Box et al., 1994).

In order to build an ARIMA model a three-stage iterative strategy is applied. The stages are according to Box et al. (1994, 2016) identification, estimation and diagnostic checking.

I. IDENTIFICATION

It represents the use and the origin of the data, in order to suggest a subcategory of models potentially worthy of further investigation. The objective of identification is to get an idea of *p*, *d* and *q* values and to acquire initial estimates for the parameters. There are two general steps in the identification procedure. Firstly, it is necessary to difference the time series as many times to generate stationarity, while curtailing the process to the mixed autoregressive-moving average (ARMA) model. Secondly, the resulting ARMA process should have been identified. The analyses of sample autocorrelation function and sample partial autocorrelation function are used to carry out both stages in the identification approach. Since the graphical methods are employed here, the judgement has to be exercised carefully (Box et al., 1994).

II. ESTIMATION

Both the first and the second stage necessarily overlap, because sometimes part of the identification needs to be accomplished through the estimation procedure whereby the data is used to make deductions about parameters proceeding from appropriateness of the model considered (Box et al., 1994, 2016).

Although R^2 and the average of the residual sum of squares are used as goodness-of-fit measures, Enders (2005) and Hindls et al. (2004) emphasize that their suitability usually improves, when the model embraces more parameters. Hence the use of Akaike's Information Criterion (AIC, see formula 14 below) and/or Bayesian Information Criterion[75] (BIC, see formula 16 below) is recommended on the grounds of more appropriate interpretation. Schwarz (1978) and Aho et al. (2014) claim that both AIC and BIC provide a mathematical formulation of the parsimony principle for model building.

[75] It is also known as Schwarz Bayesian Criterion (SBC), Schwarz Bayesian Information Criterion (SBIC) or Schwarz Information Criterion (SIC).

Akaike's Information Criterion (AIC) is defined by Burnham and Anderson (2002) as

$$AIC = n \log(\widehat{\sigma^2}) + 2K \tag{14}$$

where n is the number of observations, σ^2 is variance, k is the total number of estimated parameters and the maximum likelihood estimation (MLE) of σ^2 is

$$\widehat{\sigma^2} = \frac{\sum \widehat{\epsilon_i^2}}{n} \tag{15}$$

while $\widehat{\epsilon_i}$ represents estimated residuals for a particular candidate model (Burnham and Anderson, 2002).

Bayesian Information Criterion (BIC) differs from AIC in multiplication by ½ log (n), and so the BIC is according to Schwarz (1978) defined as

$$BIC = n \log(\widehat{\sigma^2}) + K \log(n) \tag{16}$$

where n is the number of observations, σ^2 is variance, k is the total number of estimated parameters and the maximum likelihood estimation (MLE) of σ^2 follows the formula (15) mentioned above.

For both criteria (AIC and BIC), smaller values posit better model fit (Aho et al., 2014).

In IBM® SPSS Statistics® Software package, the normalized BIC (Normalized Bayesian Information Criterion, 2013) is employed as a goodness-of-fit measure and calculated using the formula with Mean Squared Error (MSE)

$$Normalized\ BIC = \ln(MSE) + k\frac{\ln(n)}{k} \tag{17}$$

where MSE is defined as

$$MSE = \frac{\sum(Y_{(t)} - \widehat{Y_{(t)}})}{n-k} \tag{18}$$

and $\widehat{Y_{(t)}}$ represents the deviations of model values from real values (Mean Squared Error, 2013).

III. DIAGNOSTIC CHECKING

The last stage demonstrates the control of the fitted model in its relation to the given data in order to reveal possible shortcomings for the purpose of model improvement (Box et al., 1994). One of the standard practices of diagnostic checking is ***plotting the residuals*** in order to visually inspect the periods of time concerning data-model fit. Autocorrelation function and partial autocorrelation function of the residuals of the estimated model are constructed to examine potential correlation (Enders, 2015). Other diagnostic checking methods are the cumulative periodogram of the residuals or ***Ljung-Box test*** proceeding from the Portmanteau Lack-of-Fit test (Box et al., 2016). The latter was modified by Ljung and Box (1978) into the following form:

$$Q = n(n+2)\sum_{k=1}^{K}\frac{r_k^2(\hat{a})}{n-k} \tag{19}$$

In the equation (19) *n* is the sample size, $r_k^2(\hat{a})$ represents the estimated autocorrelations of residuals and *K* is autocorrelations' constant (*k = 1, 2, 3, … , K*), as claimed by Ljung and Box (1978) and Box et al. (2016). IBM® SPSS Statistics calculates Ljung-Box statistic algorithm based on the above stated formula (cf. Box-Ljung Statistic, 2013).

ARIMA models themselves showed up as a very successful tool in forecasting and in seasonal adjustment methods (Espasa, 2004) and various scientists recommend its application (e.g. Bessler and Kling, 1989; Tomek and Myers, 1993), since the approach performs well especially in short-term forecasting. Nevertheless, Box et al. (2016) emphasize that all models are just an approximation, and thus no model can entirely manifest the truth anytime.

Model's reliance on past values of the series being forecast is for one thing an advantage and for another a disadvantage. Its virtue lies in data availability as well as avoiding possible extrapolation difficulties associated with two-sided filtering methods like centred moving averages (Beveridge and Nelson, 1981). Contrarily the drawback shows the limitation, where not all relevant information are taken into account, for example the economic structure of the market (Tomek and Myers, 1993). And finally, to paraphrase Bessler and Kling (1989), the attainment at past predictive performance at one time or under given circumstances does not secure future success at prediction, because nothing necessarily links the past with the future.

3.3.1.2.4 Elasticity of Demand

Mankiw (2015) defines elasticity as a measure of the responsiveness of quantity demanded (or supplied) to changes in its determinant/s. ***Price elasticity of demand*** (E_d) hence measures how much the quantity demanded reacts to price change (Mankiw, 2015; Sydsæter et al., 2016).

There are various methods to compute price elasticity of demand and two of them are applied in this thesis. Firstly, by the means of percentage change, according to Mankiw (2015):

$$E_d = \frac{\%\ change\ in\ quantity\ demanded}{\%\ change\ in\ price} \tag{20}$$

And secondly, through the midpoint method (Mankiw, 2015):

$$E_d = \frac{\frac{Q_2 - Q_1}{\left(\frac{Q_2 + Q_1}{2}\right)}}{\frac{P_2 - P_1}{\left(\frac{P_2 + P_1}{2}\right)}} \tag{21}$$

And/or alternatively as:

$$E_d = \frac{\frac{Q_2 - Q_1}{Q_2 + Q_1}}{\frac{P_2 - P_1}{P_2 + P_1}} \tag{22}$$

In the equations (21) and (22) Q describes the quantity and P indicates the price.

Referring to Holman (2007) and Mankiw (2015), price elasticity of demand can be:

a. Perfectly elastic, when $|E_d| = \infty$
b. Elastic, when $|E_d| > 1$
c. Unit elastic, when $|E_d| = 1$
d. Inelastic, when $|E_d| < 1$
e. Perfectly inelastic, when $|E_d| = 0$

Since the elasticity of an individual demand depends on consumers' preferences, type of goods (luxuries versus necessities), availability of substitutes, definition of the market, time horizon and consumers' income (Holman, 2007; Mankiw, 2015), the income elasticity of demand is additionally computed.

Income elasticity of demand (E_i) posits the situation, when demand is considered as a function of income (Sydsæter et al., 2016). It measures how the quantity demanded reacts to a change in consumer's income (Mankiw, 2015).

The computation is done according to Sydsæter et al. (2016) demonstrating the general rule that elasticities are equal to logarithmic derivatives, and so whenever x and y being both positive variables (where y is a differentiable function of x), a proof proceeding from the repetitive use of the chain rule shows that:

$$E_i = \frac{x}{y}\frac{dy}{dx} = \frac{d(\ln y)}{d(\ln x)} \tag{23}$$

In addition to that, Sydsæter et al. (2016) determine an income density function and cumulative distribution function, using definite integral and providing insight into real income distribution. A function approximating actual income distribution to a considerable extent (especially for large incomes) is called the Pareto distribution (Sydsæter et al., 2016).

3.3.2 Qualitative Methods

The case study approach as a selected method for qualitative data analysis is closely related to expert interviewing as data collecting technique. Qualitative data is obtained from expert interviews, where the researcher represents a quasi-expert endowed with particular knowledge and experience necessary to achieve certain level of theoretical sensitivity. With regard to individual case studies, data analysis is accomplished through intra-case study and inter-case study techniques. Simultaneously to the data collection a framework is developed to enable manual coding of the data entries and field notes.

3.3.2.1 Case Study Analyses

Case study is a research approach concentrated on comprehension of single setting dynamics (Eisenhardt, 1989). Case study represents a research strategy, which undertakes an investigation of a phenomenon under real-life circumstances. This research strategy can be carried out through using either qualitative or quantitative data, which can originate in archival records, fieldwork, observations, verbal reports or any combination of these methods (Yin, 1981b). Subsequent analytical framework proceeds from intra-case (within-case) and inter-case (cross-case) patterns characterized and applied in several scientific works (Ayres et al., 2003; Eisenhardt, 1989; Yin, 1981a,b).

a. *Intra-Case Analysis*

This analytical method lies in the integration of individual case's facts and using the single case data. Within every single case, the similarities and/or discrepancies can be identified among the given facts (Yin, 1981a). Intra-case approach helps researcher cope with excessive data frames and gain familiarity with data, and so careful reading of interview transcripts is necessary (Ayres et al., 2003; Eisenhardt, 1989). The procedure involves detailed case study reviews enabling the unique patterns of every single case to emerge in advance any generalizations across the cases are made (Eisenhardt, 1989). In particular, the purpose of intra-case analysis is to explore data coherence to describe different beekeeping operations.

b. *Inter-Case Analysis*

Inter-case technique indicates either the categories selection, search for intra-group commonalities coupled with inter-group differences, or a selection of pairs of cases with subsequent listing their similarities and differences between each other. The third option is dividing the data by data source (Eisenhardt, 1989). If there is sufficient amount of case studies for synthesis and if some critical factors and attributes are identified, cross-case analysis can be comprised of quantitative tabulations. Unless these conditions are met, an alternative possibility should be applied, whereby the explication from each one case is taken and compared with another case explication (Yin, 1981a,b). Through inter-case procedure the changes across the individual beekeeping operations are investigated in order to identify resemblance and potential patterns. Findings of inter-case analysis can be presented as a combination of descriptive and explanatory evidence in a form of inter-case synthesis.

3.4 Material

In following subchapters the datasets of interviewed Czech and Swiss beekeepers are separately described with respect to the geographical location of the interviewees, their average age and their average experience (in years) with beekeeping. There is detailed information about data collection, the size of each one dataset and several selected characteristics of interviewed experts, their beekeeping operations and beekeeping practice (e.g. size of beekeeping operation, honeybee stocks, beehive types, bee pasture, honey yield, cooperation with farmers, engagement in environmental issues, bee colony thefts and vandalism). After straightforward presentation of the data, some features are compared with underpinnings introduced in literature review in order to examine to what extent the sample size corresponds to general beekeeping population in given country.

3.4.1 Dataset Czech Republic

Data collection was carried out from November 2017 to January 2018 in the Czech Republic.

Figure 17: NUTS 2 (Cohesion Regions) in the Czech Republic

Source: Vozenilek, Pavel. 16-07-2006. Map of the Czech Republic as divided into NUTS level 2 areas. [Picture].

Overall 44 expert interviews and standardized surveys of experts (hereinafter referred to as expert interviews) with Czech beekeepers were conducted within all 8 Cohesion Regions (see

Figure 17), representing all 14 NUTS 3 regions (see Table 4). The minimum targeted sample size was 3 experts per NUTS 2 region. Moreover, two experts were interviewed on topics concerning urban rooftop beekeeping and prison beekeeping (see subchapter 4.4). These additional interviews are not included in the Table 4, where the groups of respondents are characterized with regard to their geographical distribution, average age in years, and average beekeeping experience in years. Given the numbers of interviewed experts, their highest proportions are in three geographically largest Cohesion Regions (i.e. Southwest, Northeast and Southeast).

Table 4: Identification of Respondents in the Czech Republic

CODE	COHESION REGIONS (NUTS 2)	CODE	REGIONS (NUTS 3)	RESPONDENTS		
				Amount	Average Age	Average Experience
CZ01	**Prague**	CZ010	Prague	**4**	**61**	**32**
CZ02	**Central Bohemia**	CZ020	Central Bohemian Region	**3**	**67**	**52**
CZ03	**Southwest**	CZ031	South Bohemian Region	**8**	**63**	**26**
		CZ032	Plzen Region			
CZ04	**Northwest**	CZ041	Karlovy Vary Region	**4**	**70**	**38**
		CZ042	Usti nad Labem Region			
CZ05	**Northeast**	CZ051	Liberec Region	**10**	**62**	**39**
		CZ052	Hradec Kralove Region			
		CZ053	Pardubice Region			
CZ06	**Southeast**	CZ063	Vysocina Region	**7**	**58**	**32**
		CZ064	South Moravian Region			
CZ07	**Central Moravia**	CZ071	Olomouc Region	**4**	**61**	**16**
		CZ072	Zlin Region			
CZ08	**Moravian-Silesian Region**	CZ080	Moravian-Silesian Region	**4**	**58**	**24**

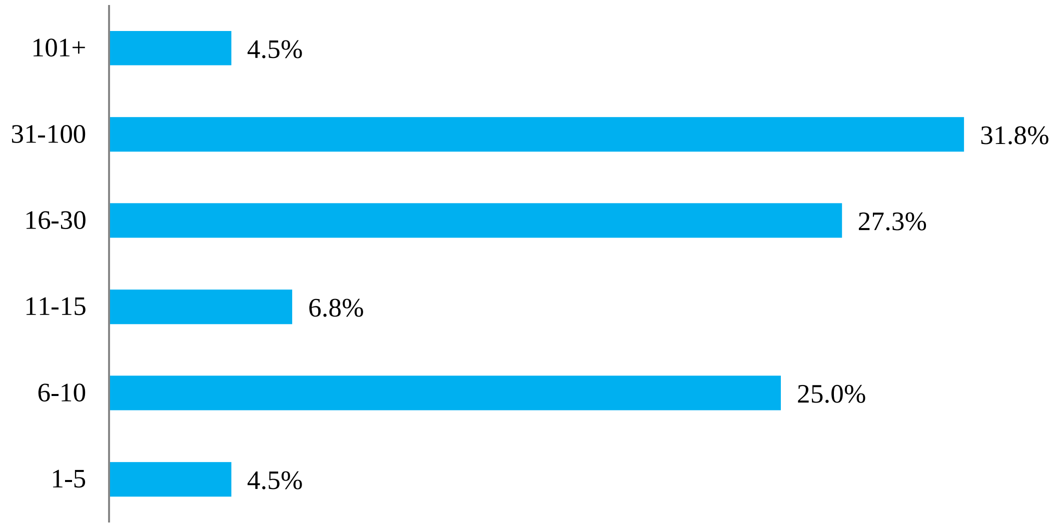
Source: own processing according to the conducted expert interviews

The average age of beekeeping experts interviewed in the Czech Republic is 62 years and their age structure matches to the age distribution of Czech beekeepers given in Figure 4 (see subsection 2.1.2), inasmuch as the majority of interviewees comes from age groups 61 – 75 years and 46 – 60 years, and no respondents were in the youngest (up to 15 years) nor oldest (over 91 years) age categories. The youngest interviewee was 18 years old and the oldest one was 82 years old. With regard to gender, 5 female and 39 male experts participated.

With regard to interviewees' experience in beekeeping, the average is 32 years. Only 3 beekeepers from the sample group have been keeping bees less than 5 years and there are 19 mentors giving classes to beginning beekeepers and those interested in apiculture. In addition to that, 11 professionals are actively engaged in youth beekeeping clubs (e.g. their establishment, management and supervision, organization, lecturing and other forms of help and support).

On account of the sizes of beekeeping operations, from Figure 18 it is clear that the hobby beekeepers prevail in the interviewed sample, since ca. 63.6 % of respondents manage less than 31 bee colonies. As seen in Figure 5 (see the subsection 2.1.2) the proportion of bee farms up to 31 bee colonies amounts to ca. 93.24 % of all beekeeping operations register in CBU. Considering potential enlargement of their beekeeping operations, only 13.63 % of all interviewees plan to increase the numbers of their bee colonies. The lack of time, and age reasons are considered as the main expansion barriers. However slightly less than a quarter (22.73 %) of all interviewed beekeepers is satisfied with the amount of bee colonies they keep.

Figure 18: Sizes of respondents' beekeeping operations – Czech Republic



Source: own processing according to the conducted expert interviews

Concerning the honey bee stocks, all interviewed experts keep the Carniolan honey bee (*Apis mellifera carnica*) in a broad variety of ecotypes[76] and two respondents admitted having former experience with the European dark bee (*Apis mellifera mellifera*) too. This is in accordance with the legislation of the Czech Republic, defining exclusive breeding of the Carniolan honey bee.

Interviewed beekeepers keep their bees mostly in movable frame hives (ca. 88 %), predominantly in frame measurement 39 x 24 cm (corresponding to the commonly used types all over the Czech Republic – regarding to the subsection 2.1.1). Apart from that type, Dadant, Langstroth and other frame measurements (e.g. 37 x 30 cm; 39 x 27.5 cm; 39 x 30 cm) are also used within the sample group. Regarding older and traditional beehives (accounting for ca. 12 %) the following types can be found – Gerstung, budečák and univerzál.

With regard to bee pasture, in most cases the interviewees enumerated following bee forage sources – oilseed rape, fruit trees, linden, maple, raspberry, dandelion, locust tree and willow.

The cooperation between beekeepers and farmers is rather rare, as only 7 interviewees (mainly from Southeast Region) put such collaboration in context of beneficial flowering strips for insects, individual private farmers, local agriculture cooperatives or pollinating oilseed rape fields. In view of the fact that the demand for the pollinating services is derived from the spatial distribution of crop production, and considering relatively high bee colony density in the Czech Republic (see subsection 2.1.1), the potential cooperation is not a topical subject for beekeepers, nor the crop farmers. The other way around, great importance is attached to the issue of agricultural spraying on account of bee toxicology (cf. Modrá and Svobodová, 2009). More than a half (61.36 %) of respondents complains about the lack of information about spraying. However some interviewed beekeepers (29.55 %) confirm receiving the necessary information.

Regarding the engagement in environmental issues and/or contact with environmental organizations, three fourths of respondents do not actively engage in this area, unlike the interviewees who are at least in indirect contact with some institutions focused on the environment.

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[76] There are two major ecotypes of the Carniolan honey bee in the Czech Republic - Alpine (Singer, Sklenár, Peschetz, Troiseck) and Carpathian (Vigor, Vučko) ecotypes (Honeybee Kingdom, 2019).

Referring to the data from conducted expert interviews, the average honey yield is 32.2 kg per bee colony and year. With regard to the individual regions, the highest annual honey yields are in Central Bohemia (51.7 kg/ bee colony) and Southeast Region (41.7 kg/ bee colony) and the lowest annual yields of honey are in Moravian-Silesian Region (22.5 kg/ bee colony) and Northeast Region (26.4 kg/ bee colony). Average amounts of honey yields originating from respondents' beekeeping operations are higher compared with the overall data given by CBU (see subsection 2.1.3).

Half of the respondents have an experience with bee colony thefts. This problem is no longer common only in border areas, but occurs in inland too. Besides the bee colonies, the queen bees and mating nucs are thieves' targets. Same proportion of interviewees (22 out of 44) has experienced vandalism in their beekeeping operation. In one case the apiary was burnt to the ground. One of the rationales for these negative social phenomena might lie in location of the apiary, as the aggrieved party often does not keep the bees in the place of residence (15 cases out of 21 by thefts, 13 cases out of 22 by vandalism). With regard to the honey fraud, almost all (43 out of 44) respondents are informed about the problem of honey adulteration.

Interviewed experts perceive the public awareness of beekeeping and bee products rather low (36.36 %) or average (21.21 %), and thus the vast majority (84.09 %) of all respondents actively participates and/or organizes various events[77] for public aiming to raise public awareness about apiculture and its products.

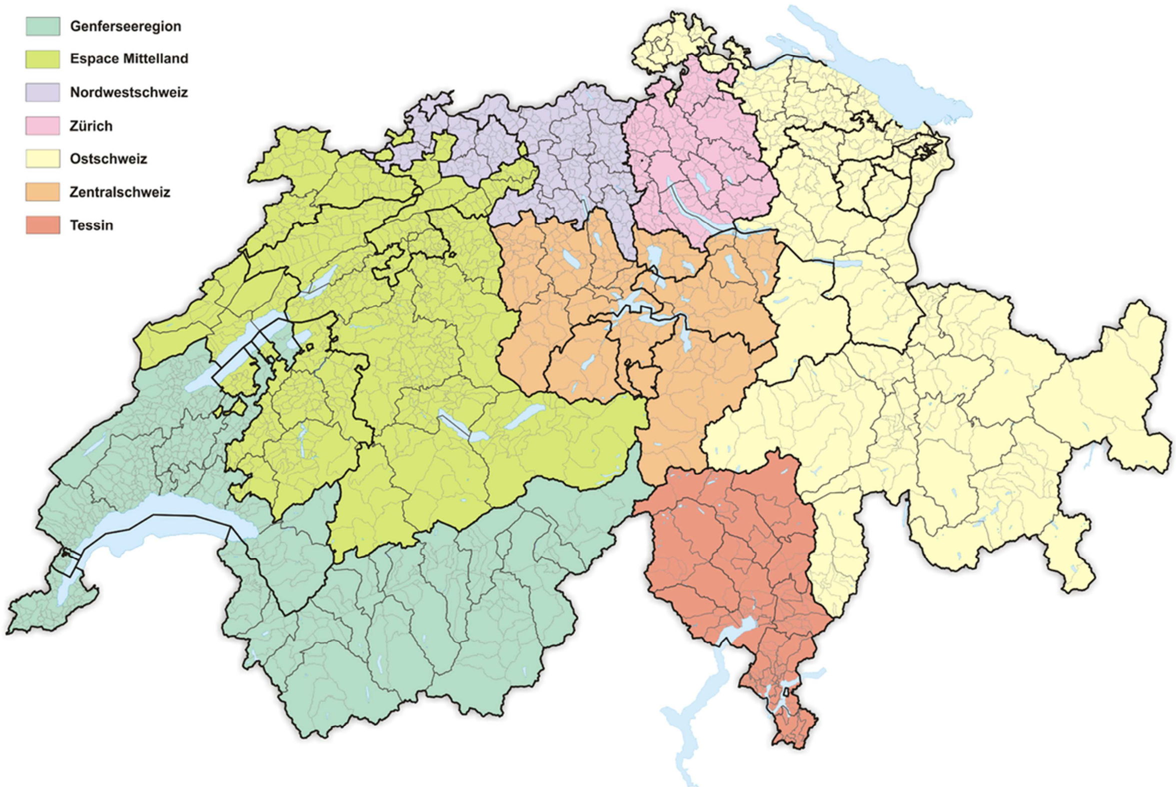
3.4.2 Dataset Switzerland

The data collection[78] was realized within May and June 2017 in Switzerland. In total 31 experts on Swiss beekeeping were interviewed within all 7 NUTS 2 regions (see Figure 19), representing 15 (out of 26) cantons (see Table 5). The minimum targeted sample size was 3 experts per region. However the Table 5 doesn't include data by four additional expert interviews, which were conducted on topics related to beekeeping promotion (i.e. urban beekeeping in a hotel and restaurant and the railway exposition – see subchapter 4.4).

[77] For example beekeeping exhibitions, honey days with public honey extraction, Easter craft fair, traditional beekeeping pilgrimage to Svatý Hostýn, lecturing for schools and the like.

[78] Through conducted expert interviews and standardized surveys of experts (hereinafter referred to as expert interviews).

Figure 19: NUTS 2 (Regions) in Switzerland



Source: Tschubby. 01-01-2014. Grossregionen der Schweiz 2014. [Picture].

As seen below, Table 5 shows the brief identification of respondents regarding their geographical distribution, average age in years and average beekeeping experience in years. Considering the counts of respondents, their highest proportions are in two geographically largest regions (Espace Mittelland and Eastern Switzerland) and also in Northwestern Switzerland, where the Canton Basel – City with the highest bee colony density (according to Charrière et al., 2018) is situated.

The average age of interviewed Swiss beekeepers is 57 years, which matches up with the average given by Agroscope (Charriére, personal communication, November 28, 2016) and the collected data also match with the report by the EC DG AGRI (2013) stating that almost 60 % of European beekeepers are older than 55 years. Similarly to the dataset of the Czech Republic, most respondents are from age categories 46-60 years and 61-75 years, and no respondents from the youngest (up to 15 years) nor oldest (over 91 years) age group. The youngest interviewee was 27 years old and the two oldest experts were both 76 years old. Concerning the gender, 2 female and 29 male experts participated.

Table 5: Identification of Respondents in Switzerland

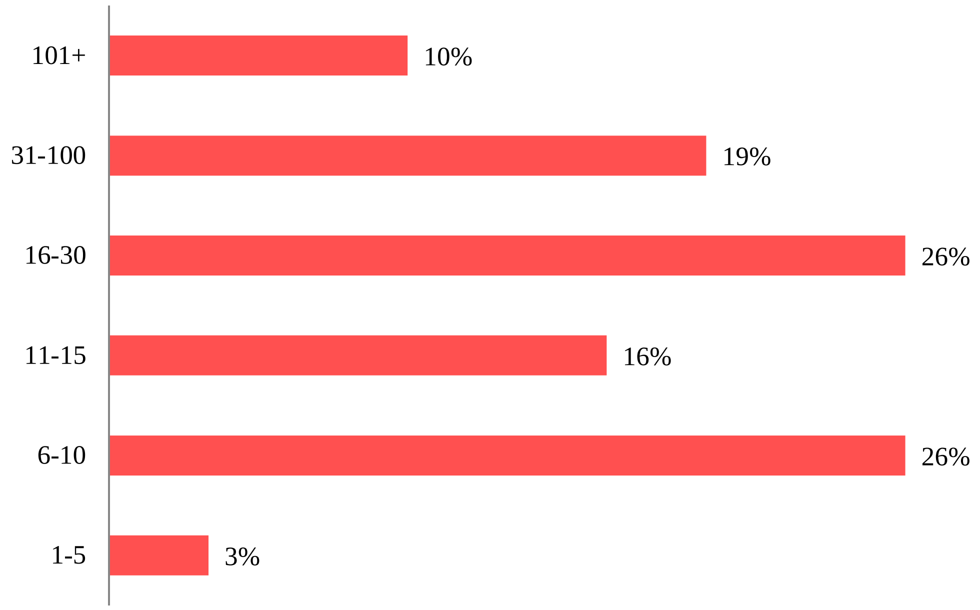
CODE	REGIONS (NUTS 2)	CODE	CANTONS (NUTS 3)	RESPONDENTS		
				Amount	Average Age	Average Experience
CH01	**Lake Geneva Region (Genferseeregion)**	CH011	Vaud	**4**	**45**	**14**
		CH012	Valais			
		CH013	Geneva			
CH02	**Espace Mittelland**	CH021	Bern	**6**	**59**	**26**
		CH023	Solothurn			
CH03	**Northwestern Switzerland (Nordwestschweiz)**	CH031	Basel - City	**6**	**59**	**29**
		CH032	Basel - Country			
		CH033	Aargau			
CH04	**Zurich**	CH040	Zurich	**4**	**57**	**22**
CH05	**Eastern Switzerland (Ostschweiz)**	CH055	St. Gallen	**5**	**56**	**27**
		CH056	Grisons			
CH06	**Central Switzerland (Zentralschweiz)**	CH061	Lucerne	**3**	**64**	**39**
		CH063	Schwyz			
		CH066	Zug			
CH07	**Ticino (Tessin)**	CH070	Ticino	**3**	**62**	**42**

Source: own processing according to the conducted expert interviews

On account of respondents’ experience in beekeeping practice, the average is 27 years. There were 5 beginning beekeepers (with experience up to 5 years) interviewed and 13 professionals, who give tuition to candidates enrolled in a beekeeping course and lectures on beekeeping to general public.

With regard to the size of beekeeping operations, as seen in Figure 20, the hobbyists prevail in the sample group (71 % of interviewed beekeepers manage maximally 30 bee colonies). In Switzerland just 2 % of all beekeepers manage more than 40 bee colonies and only ca. 0.4 % of all Swiss beekeepers have the beekeeping operation larger than 80 bee colonies (Charrière et al., 2018). There were 3 beekeepers owning more than 40 bee colonies each and 4 beekeepers with the apiary larger than 80 bee colonies in the interviewed sample. Regarding possible expansion of the beekeeping operations, only 23.33 % of interviewees plan increasing the number of bee colonies. The main rationales of non-expansion (i.e. keeping the amount of bee colonies stable and/or their reduction) are workload and lack of time and energy.

Figure 20: Sizes of respondents' beekeeping operations – Switzerland



Source: own processing according to the conducted expert interviews

On account of the honeybee stocks, the respondents keep mostly the Carniolan honey bee (*Apis mellifera carnica*, 35 %), cross-breeds[79] (30 %), the European dark bee (*Apis mellifera mellifera*, 22.5 %) and the Buckfast bee (*Apis mellifera buckfast*, 12.5 %). In comparison with the structure of honeybee breeds given in subsection 2.2.1, there is no Italian bee (*Apis mellifera ligustica*) in the sample. However the proportions of stocks correspond to a certain extent to the distribution presented in literature review. One of the beekeeping experts keeps Primorski bees and Elgon bees (cf. Forsman et al., 2004). In view of the great variability of honeybee stocks and their cross-breeds in Switzerland, it is necessary to highlight potential risks resulting from uncontrolled hybridization and breeding activities. Apart from the negative features of hybrids, such as aggressiveness, predispositions to excessive swarming and the decline in productivity after first generation, the uncontrolled cross-breeding leads to hybrid genes introduction into the environment and conceivable problems for biodiversity and indigenous honeybee breeds (Lodesani and Costa, 2003).

With regard to the beehives, the Schweizerkasten type prevails (48.57 %), followed by variants of Magazinbeute (25.71 %; Deutschnormalmass, Schweizermass and Zander),

[79] E.g. Carniolan honey bee mixed with the Buckfast bee; Carniolan honey bee mixed with the European dark bee; Carniolan honey bee mixed with the Italian bee and the like.

Dadant (17.14 %) and Langstroth (5.71 %). Structure given in the sample is in accordance with data provided by the Agroscope. One of the interviewees keeps the bees in Klotzbeute, Trogbeute and Warré hives.

Regarding bee pasture, the interviewees most frequently enumerated following nectar, pollen and honeydew sources – dandelion, linden, fruit trees (apples, pears, and cherries), oilseed rape, locust tree, chestnut, maple, blackberries, raspberries, clover, forest flora and fir.

The cooperation between beekeepers and farmers is considered relatively low, admitted only by 29 % of respondents, particularly for fruit trees pollination. However the spatial distribution of crop production (and consequently the demand for pollinating services) differs significantly from canton to canton. Hence for the majority of interviewees such cooperation is not a topical issue. By contrast, many of interviewed beekeepers expressed their concerns about agricultural spraying and its harmful effects on honey bees. About one third (10 out of 31) of respondents receives in advance the information about agricultural spraying through text message or local beekeeping organization. In general, controversy arose over the use of agrochemicals on crops. Some concerns have been expressed (e.g. Balbuena et al., 2015; Herbert et al., 2014; Motta et al., 2018) about potential detrimental impacts of glyphosate (*N-phosphonomethylglycine*) on honeybees, considering that this particular broad-spectrum systemic herbicide is still used in Switzerland. Moreover, one respondent shared past negative experience with fast rotary mowers, which had caused some severe bee colony losses in summer (cf. Fluri and Frick, 2002).

Concerning the engagement in environmental issues and/or contact with environmental organizations, slightly more than a third (35.48 %) of interviewed experts confirms indirect contact on an occasional basis. Nevertheless the majority does not actively engage in this area.

According to the data from conducted expert interviews, the average honey yield is 18.6 kg per bee colony and year. With regard to the geographical distribution, the highest annual honey yields are in Ticino Region (28.3 kg/ bee colony) and Espace Mittelland (21.8 kg/ bee colony) and the lowest annual yields of honey are in Lake Geneva Region (9.3 kg/ bee colony) and Zurich Region (12.8 kg/ bee colony). Compared with the data[80] given by Charrière et al. (2018), only the records of average honey yields obtained from expert interviews in Ticino Region are higher than the figures from the time span 2008 – 2015. In Espace Mittelland the difference accounts for ca. 2 kg of honey/ bee colony. It needs to be stressed that the quantity of honey yield depends on a broad variety of circumstances (see the subchapter 4.1).

Two thirds of respondents have no experience with bee colony thefts so far, while some of them ascribe it to the broad use of Schweizerkasten apiaries. As reported by the beekeepers that lost their bee colonies, these were mostly movable frame beehives (Dadant, Magazin), mating nucs, queen bees and some equipment. Regarding vandalism, 12 interviewees (out of 31) experienced various forms of vandalism (e.g. poisoned bee colonies, covered entrance hole to the beehive, damaged material, apiary burnt to the ground). Significant factor in cases of thefts and vandalism is the apiary location, because aggrieved party mostly (in 8 cases out of 9 by thefts, in 11 cases out of 12 by vandalism) does not have the apiary in the place of residence and the preventive control is therefore more difficult for them than for beekeepers managing their bee colonies in immediate neighbourhood. With regard to the honey adulteration, approximately 43.33 % of respondents have noticed such issue in Switzerland – partly for imported honey and partly for incorrectly labelled Swiss honey (declared as monofloral).

More than a half of interviewees (58.33 %) find the public awareness of beekeeping and bee products good and some of them claim credit for this to a document[81] by Markus Imhoof providing insight into contemporary beekeeping and its problems. In addition to that the majority (77.42 %) of respondents promotes apiculture and bee products through numerous activities[82] and efforts.

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[80] Average honey yields per bee colony and year (2008 – 2015): Ticino Region (25 kg/ bee colony), Espace Mittelland (23.7 kg/ bee colony), Lake Geneva Region (22.6 kg/ bee colony), Zurich Region (20.2 kg/ bee colony) – own processing according to Charrière et al. (2018)

[81] *More Than Honey*. Directed by Markus Imhoof, Zero One Film, Allegro Film, Thelma Film & Ormenis Film, 2012. [Film].

[82] For instance exhibitions, bee trails, open days in apiary, stands at diverse markets, lecturing, apitherapy etc.

4 Empirical Study

In this part the data is processed and interpreted according to the analytical tools used. Firstly, the quantitative data analysis proceeds from applied mathematics (economic calculations, growth rate, linear approximation) and time series analytical methods (Box-Jenkins methodology) using some standard statistics. These follow on from positivism and the deductive reasoning to provide insight into causal relationships between variables and to straightforwardly present the outcomes. Secondly, the qualitative data analysis (case study patterns) based on constructivism and the inductive approach is conducted to retrieve sundry views of the issue. Since the qualitative data feature specific phenomenological character, it is not possible to strictly detach the results from the analysis, and so the key objective is data comprehension, getting to the heart of the matter and placing it in context of both existing literature and real life.

4.1 Assessment of the Economics of Hobby Beekeeping Operations

In spite of the rising popularity of beekeeping, there still persists an information shortage of small beekeeping operations economics. Particularly beginning beekeepers might attach great importance to the economics before they enter the beekeeping business. Although honey is the main product and its sales are substantial source of beekeepers' income, the operating costs and initial investment remain high. In order to place the calculations in context, they are assessed regarding the outcomes of conducted expert interviews and standardized surveys of experts (hereinafter referred to as expert interviews) and compared with findings of some existing studies.

When the respondents were asked to evaluate their own business in terms of profit and/or loss, 60 % of Czech beekeepers and 34.62 % of Swiss beekeepers found their beekeeping operations profitable; not only from an economic point of view, but also with respect to joy and social benefits it provides them. One in ten of Czech interviewees had a loss-making business, whereas in Swiss sample the proportion was nearly twofold. Nevertheless these beekeepers go on keeping the bees, because their hobby brings them self-realization, joy, bee products and so forth. Remaining 30 % of Czech respondents managed beekeeping operation able to cover its costs, in contrast to Switzerland, where the majority of respondents (46.15 %) stated balanced budget without any profit.

With regard to the question of earning one's living solely out of beekeeping, addressed Czech beekeepers are more optimistic than Swiss respondents, as the majority of them (84.62 % in contradistinction to 60.71 % of Swiss interviewees) finds it possible to make a living by beekeeping, although it is considered difficult and feasible under certain circumstances, such as affiliated production (e.g. joinery), higher amount of bee colonies, enough experience in beekeeping, realizing the potential of other bee products and supplementary activities (e.g. beeswax candles production, queen bees and nucleus colonies sales) and so forth. In this part however the hobby beekeeping operations are examined in economic terms, regardless momentous dependence of earning one's living upon beekeeping.

Following subchapters provide insight into the initial investment in beekeeping operation of a hobby beekeeper and structures of year-round expenditures and revenues.

4.1.1 Initial Investment of Beginning Beekeeper

There are various motives for starting own beekeeping operation – family tradition, interest in nature and environment, own honey production and so forth. Beginners getting to the apiculture from a family tradition might have material, equipment and own mentor at their disposal. The other way around, there are beginning beekeepers starting from zero. Since the initial costs are relatively high, it is recommended to visit an apiary of an experienced professional and see the pros and cons before investing money in own beekeeping operation. Apart from material and necessary equipment, an enormous input of knowledge is needed to begin and succeed in beekeeping in the long term. The overall calculation of the input investment, annual expenditures and annual revenues of the beekeeping operation is presented in Table 21 for the Czech Republic and in Table 22 for Switzerland (see subsection 4.1.4).

4.1.1.1 Beehive and Bee Colony

On account of the comparability between both countries, only movable frame hives (Dadant, Langstroth and Zander – see Appendices II) are selected for the calculation of beehive equipment. However it is necessary to emphasize that the dimensions of these types may slightly differ from one country to another. The calculation in Table 6 presents local costs on one beehive in CZK and CHF without bee colony.

Buying a complete beehive seems to be cheaper, however the hive usually does not include all the spare parts or material (especially the beehive frames or wax foundation combs) and the beekeeper needs to buy them separately, which consequently increases the price.

Table 6: Costs of the Beehive and its Equipment

Type of the beehive →	Dadant			Langstroth			Zander		
Complete beehive →		2 590	250		2 590	285		2 399	266
Beehive equipment ↓	Pieces	CZK	CHF	Pieces	CZK	CHF	Pieces	CZK	CHF
hive cover (roof)	1	210	25	1	259	18	1	259	55
inner cover	1	315	18	1	359	24.5	1	379	74
super	4	360	59	4	190	33	3	439	59
beehive frames (not wired)	75	20	1.8	60	20	1.8	60	20	1.8
wax foundation combs (kg)	1	389	23.5	1	389	23.5	1	389	23.5
queen excluder	1	185	15.5	1	169	20.5	1	149	11.5
brood body / chamber / box	1	490	50	1	490	37	1	439	84
floorboard (varroa diagnosis)	1	10	3.5	1	10	3	1	10	9.8
bottom board + slatted rack	1	499	32.5	1	519	45	1	499	105
Equipment in total →		5 038	539		4 155	411.5		4 642	647.8

Source: own processing according to normal (consumer) prices by Včelpo (2018), Medocentrum.cz (2018) and Bienen-Meier (2018)

Costs for beehive frames vary according to their amount as well as in the way of their completeness – assembled, but not wired beehive frames without beeswax foundation combs are listed in the Table 6 as the budget-wise option. Already wired beehive frames are available at the market for higher prices (i.e. 30 CZK or 2.7 CHF for 1 beehive frame[83]). According to the reckoning by Sláma[84] (2019), strong bee colony of ca. 60 000 – 80 000 honeybees (i.e. quantity around summer solstice) needs a movable frame hive with 3 – 4 supers.

Possible option for Dadant beehive type hence might be to have one brood body super for 13 frames (dimensions 39 x 30 cm) and 3 – 4 supers each for 13 frames (dimensions 39 x 15 cm). It is recommended to have some beehive frames as spare parts, so the sum is 75 frames (13 for brood box, 52 for supers and 10 as spare parts). In case of Langstroth hive, the assumed optimum is having one piece of Jumbo super (i.e. brood box) for 10 frames (dimensions 48.2 x 28.5 cm) and 3 – 4 supers of type 2/3 Langstroth each having space for 10 frames (dimensions 48.2 x 15.9 cm). Total number of frames amounts to 60 – i.e. 10 for

[83] In Switzerland the wired beehive frames with beeswax foundation combs are sold too (ca. 6.5 CHF/piece).

[84] Originally considering Czech beehive with frame dimensions 39 x 24 cm – one such frame for 1 500 – 2 000 honeybees.

Jumbo, 40 for 2/3 type and 10 frames as spare parts. Zander beehive type has brood chamber for 20 frames (dimensions 42 x 22 cm), the recommended optimum is 3 supers each for 10 frames (dimensions 42 x 22 cm), and so the beekeeper would need ca. 60 beehive frames (including 10 spare parts).

In accordance with the number of beehive frames, the beeswax foundation combs need to be purchased. It is worked on following assumptions – firstly, that 1 kg package includes ca. 12 beeswax foundation combs, and secondly, that bee colony can annually produce ⅓ of beeswax combs (Kamler et al., 2007), which is crucial for regular beeswax renewal. One bee colony can produce ca. 0.8 kg of beeswax per year, whereas it needs between 5 and 10 frames with beeswax foundation combs (considering that beekeepers already have some empty beeswax combs[85] at their disposal). In case of beginning beekeepers it is assumed that they need more beehive frames with beeswax foundation combs, and so 1 kg package is used as default for calculation.

The price of nucleus[86] bee colony is ca. 2 000 – 3 500 CZK in the Czech Republic and ca. 250 – 300 CHF in Switzerland. The established[87] bee colonies are more expensive and vice versa, the packaged[88] bees are cheaper.

4.1.1.2 Beekeeping Gear

On a one-time basis the following gear and tools (Table 7) are bought for daily operation of beekeeping business. The list is not exhaustive, as there are other forms of equipment in various price ranges – e.g. digital beehive weight, creamed honey mixer, aerosol generator and so forth.

Similarly to the beehive equipment, the prices of beekeeping tools may differ according to the type, technology and so on. This relates in particular to the investment in honey extractor and beeswax melter, which are the most expensive items. Honey extractor can be purchased for 3 490 CZK or 415 CHF, but also for up to ten times higher costs (i.e. 32 900 CZK or 4 350 CHF). The prices of beeswax melter can eventually hit the level 30 000 CZK in the Czech Republic or 1 500 CHF in Switzerland.

[85] souš

[86] Jungvolk

[87] Wirtschaftsvolk

[88] Kunstschwarm

Table 7: Costs of the Beekeeping Gear and Tools

Gear and tools ↓	Pieces	CZK	CHF
beekeeping veil[89]	1	139	24.1
beekeeping gloves	1	199	28.9
beekeeping suit	1	770	76.5
bee smoker[90]	1	349	12
hive scraper / chisel	1	89	19.5
frame lifter	1	69	29.5
nuc box	1	399	12
mating nuc	1	359	20
swarm box	1	449	84.9
beekeeping brush	1	57	12
bee feeder	1	110	10
honey extractor	1	3 490	415
uncapping tank	1	880	35
uncapping scratcher fork	1	110	17.5
honey strainer / sieve	1	258	28.5
beeswax melter	1	4 990	190
solar wax melter	1	1 170	310
frame assembly tool[91]	1	260	34
beehive frame hole puncher[91]	1	500	19
wire (500 g)[91]	1	139	16.5
wax foundation wire embedder	1	730	108
Total →		**15 516**	**1 502.9**

Source: own processing according to normal (consumer) prices by Včelpo (2018), Medocentrum.cz (2018) and Bienen-Meier (2018)

[89] Beekeeping veil might be a part of some beekeeping suits.

[90] In Switzerland the beekeeper's pipe (ca. 53 CHF or 1 166 CZK) is commonly used instead of the smoker.

[91] Frame assembly tool, beehive frame hole puncher, wire and nails are necessary only in case the beekeepers assemble their own beehive frames and do not buy already prepared ones.

4.1.1.3 Knowledge

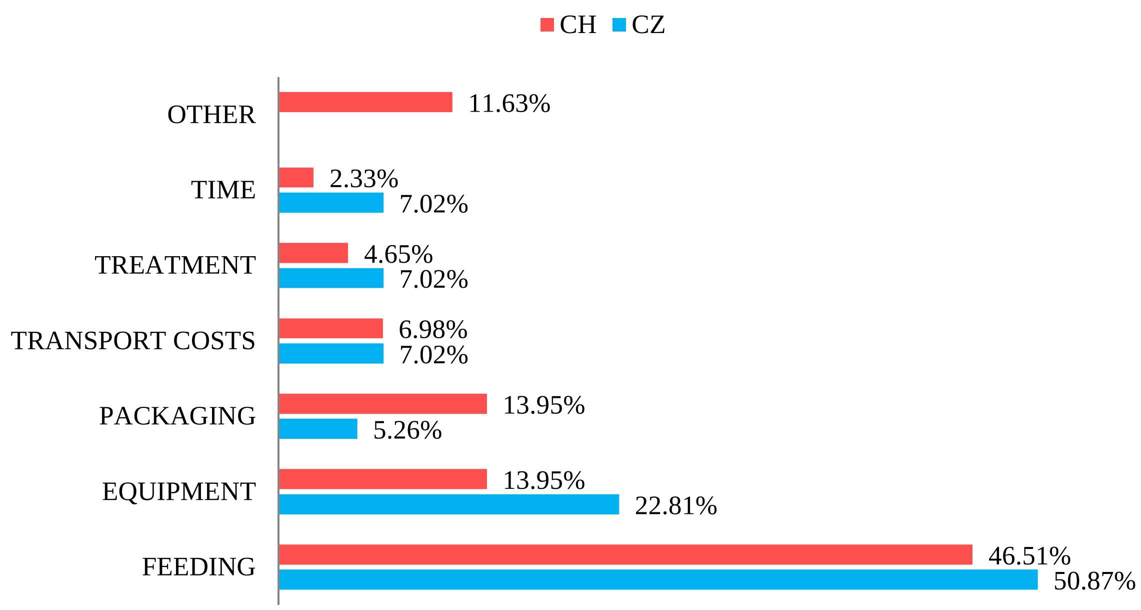
In addition to that, beekeepers should in advance get to know the basics of beekeeping practice. They can try self-learning (i.e. autodidacticism) through reading professional books and journals and studying numerous available sources (e.g. websites, articles), visiting training course organized by local beekeeping organization, having a mentor (more experienced beekeeper) or combine two or more activities. Probably the most comprehensive book about beekeeping in the Czech Republic is “Včelařství” by Veselý (Začínáme včelařit, 2019) for ca. 300 CZK. In Switzerland, ”Das Schweizerische Bienenbuch“ (Das Schweizerische Bienenbuch, 2019) for ca. 100 CHF is considered good information source not only for beginning beekeepers. Many thematic publications as well as professional journals archives are usually available in libraries of local beekeeping organizations. Regarding the training courses for beginning beekeepers, the Beekeeping Vocational School – Beekeeping Training Centre offers a basic course (4 days, ca. 2 300 CZK) and a retraining programme (270 hours, ca. 31 000 CZK) in the Czech Republic (Akce SOUV – VVC, o.p.s., 2019). Swiss basic courses (18 half days spread over two years – 9 half days a year) are offered for ca. 650 CHF (Imkerkurse, 2019). Apart from the basic courses stated above, there are plenty of private courses and specific workshops available.

4.1.2 Structure of Expenditures

Operating expenses in beekeeping operation are specified according to Synek (2011) and they include the costs of material, feeding, beeswax cycle, queen bees exchange, treatment, product packaging, transport costs, membership fees in local beekeeping organization, charges for kept bee colonies and insurance.

From an economic point of view, the expenditures on feeding the bee colonies are considered the second highest (after labour costs) in the beekeeping operation. According to the size of the bee farm, these costs can reach about 15 – 20 % of the total costs (Kamler, 2005; Šánová and Benda, 2014). As seen in Figure 21 the majority of respondents find feeding costs in the beekeeping operation the highest. These are followed by expenditures on necessary equipment (i.e. beehive frames, beeswax foundation combs, tools and gear), packaging material (i.e. jars, lids, labels and buckets), transport and treatment costs, time and personal costs. Other costs were identified only in Swiss sample and they include certification of organic beekeeping, rent, fees and charges.

Figure 21: Highest cost items according to the interviewees



Source: own processing according to the results of expert interviews

In following subsections individual categories of expenditures in hobby beekeeping operations are described with regard to good beekeeping practice and expert interviews.

4.1.2.1 Time Demands

Time demands in beekeeping operation can be hardly quantified, since they are strictly individual and depend on a broad range of factors (e.g. amount of bee colonies kept, beekeeper's experience and age, type of beehives, beekeeping practice and used techniques, and length of season).

According to the expert interviews, the small-scale beekeepers (up to 30 bee colonies) usually need 1 – 2 days[92] a week (ca. from 8 hours on) on average in high season (i.e. approximately from March to October) to manage their beekeeping operation and ca. 1 – 2 days a month (ca. 2 hours weekly or 4 hours on a fortnightly basis) in winter break (i.e. from November to February) to do the necessary maintenance, cleaning, control and to prepare for new beekeeping season. In middle-sized beekeeping operations (from 30 to 59 bee colonies) the time demands are higher, as the interviewed beekeepers state that the average time requirements for their bee farms are around 2 – 3 hours a day (ca. from 18 hours a week on) in

[92] So-called "Weekend-Beekeeping" (cf. Weiß, 2013)

season and approximately 1 day a week (ca. 8 hours) in off-season. In terms of professional and commercial beekeeping operations (more than 60 bee colonies kept), the interviewed beekeepers assume to spend at the minimum 5 – 6 days a week (ca. from 40 hours a week on) on average in season with beekeeping. During the off-season they usually dedicate themselves to apiculture between 1 and 3 days a week. However, it is necessary to emphasize that the given figures remain indicative, because each beekeeping operation is different.

Except for the bee products sale, beekeepers in both countries use the off-season to process and melt the beeswax and exchange it for beeswax foundation combs, to prepare beehive frames (disinfection, assembling, wiring etc.), to clean and repair the bee hives, some tools and material, if needed. Some beekeepers widen their expert knowledge through reading and visiting the courses and lectures. Experienced professionals often organize workshops and give lectures about various topics on beekeeping practice, queen bee rearing, bee products and the like. Few of the respondents are voluntarily engaged in local beekeeping organization and its activities (e.g. administration, running websites, organizing courses and exhibitions) and some write articles for professional beekeeping journals.

4.1.2.2 Annual Investments

Apart from the feeding costs, annual investments in one bee colony are categorized in the following way. One sixth of Swiss interviewees annually invest in one bee colony less than 50 CHF. The majority of respondents (41.67 %) pay between 51 CHF and 100 CHF per bee colony a year, whereas annual investment in one bee colony of slightly more than a fifth (20.83 %) of respondents in Switzerland amounts to the sum between 101 CHF and 150 CHF. The same proportion of interviewed beekeepers (20.83 %) yearly invests in one colony more than 151 CHF. These amounts of money are mainly intended for purchase of beehive frames, equipment and hives replacement and to cover costs on maintenance, rent and so on.

A half of Czech respondents do not invest more than 500 CZK per bee colony a year, ca. 30.77 % of interviewed beekeepers pay between 501 CZK and 1000 CZK per bee colony a year, while annual investment in one bee colony of ca. 11.54 % respondents amounts to the sum between 1 001 CZK and 1 500 CZK. Nearly 8 % of interviewees in Czech sample annually invest in one bee colony more than 1 501 CZK. This money goes to equipment and hive replacement, beehive frames, maintenance, literature and seeds of plants intended for outdoor sowing to provide additional nectar sources and to enhance local bee pasture.

Since the majority of Czech and Swiss beekeepers are hobbyists, they do not keep the books, and so the tangible assets (such as beehives, honey extractor, other equipment and gear) are not depreciated for tax purposes. However due to the risk of potential pathogen transmission (American foulbrood in particular), regular thorough disinfection of the material as well as its complete replacement from time to time are recommended.

4.1.2.3 Packaging Material

Table 8 and Table 9 show the expenditures on honey packaging in the Czech Republic and Switzerland, providing that the beekeeper manages 5 bee colonies and maximum annual honey yield amounts to 100 kg. Packaging material intended for honey storage has to fulfil the requirements given by the legislation on safe storage of the foodstuffs.

Table 8: Expenditures on honey packaging in the Czech Republic (100 kg of honey)

HONEY PACKAGING	UNIT	CZK/UNIT	AMOUNT	CZK TOTAL
plastic honey pail (25 kg volume)	1 piece	92	4	368
glass jar (for 1 kg of honey)	1 piece	6	100	600
lid	1 piece	2.9	100	290
jar label	100 pieces	159	1	159
proof seal label	100 pieces	50	1	50
TOTAL				**1 467**

Source: own processing according to normal (consumer) prices by iVcelarstvi.cz (2019), Medocentrum.cz (2018) and Včelpo (2018)

In Switzerland, honey is mainly sold in 500 g volume pots (see Figure 27), and so the twofold amount of jars, lids and labels is needed in contradistinction to Czech honey, commonly sold in 1 kg volume jars.

Table 9: Expenditures on honey packaging in Switzerland (100 kg of honey)

HONEY PACKAGING	UNIT	CHF/UNIT	AMOUNT	CHF TOTAL
plastic honey pail (25 kg volume)	1 piece	13.5	4	54
glass jar (for 500 g of honey)	1 piece	0.63	200	126
lid	1 piece	0.38	200	76
jar label	100 pieces	11.3	2	22.6
proof seal label	100 pieces	16.2	2	32.4
TOTAL				**311**

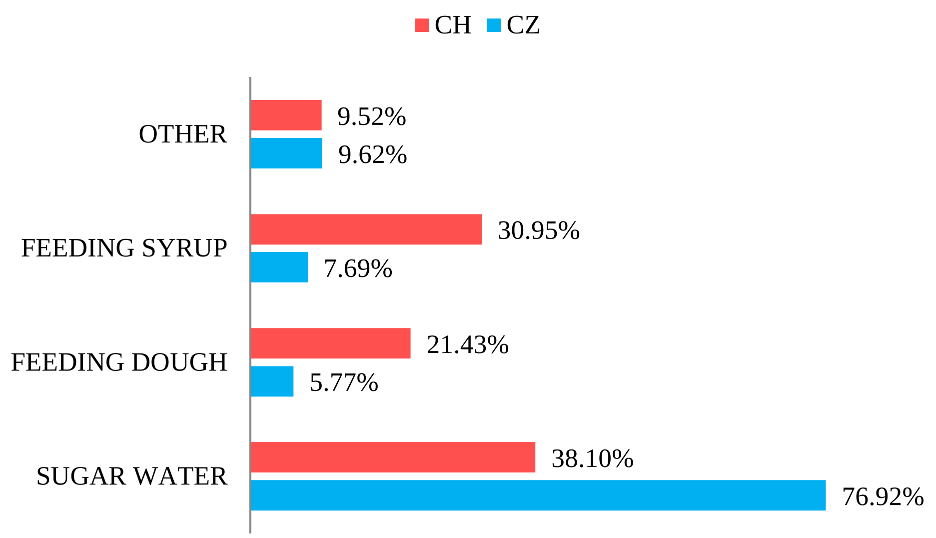
Source: own processing according to normal (consumer) prices by Bienen-Meier (2018)

Except for the packaging material enumerated in Tables 8 and 9, beekeepers might use other honey pot volumes and offer honey in gift-wrapped packaging as well. Some small-scale beekeepers also sell other bee products (e.g. propolis tincture, mead, salves), and so they need to purchase special phials, bottles and boxes.

4.1.2.4 Feeding

To replenish bee colony stocks before overwintering, it is recommended to use a sugar solution of 3 sugar parts and 2 water parts or 5 sugar parts and 3 water parts (Lehnherr et al., 2001; Titěra, 2007), since denser solutions are more difficult to be processed by the bees (Toporčák and Chlebo, 2018), and the other way around less concentrated (than the proportion 1:1) solutions are susceptible to fermentation and they may not be attractive enough to bees (Somerville, 2014; Titěra, 2007). In addition to sugar water, there are numerous types of other feed material (e.g. Semkiw and Skubida, 2016; Titěra, 2018) and nutritional supplements (cf. Charistos et al., 2015). The chart in Figure 22 illustrates the types of feed material used by beekeepers in the Czech Republic and Switzerland before overwintering and to support spring development of a bee colony.

Figure 22: Types of feed material



Source: own processing according to the results of expert interviews

According to the results proceeding from the interviews, it can be seen that the sugar water prevails in both countries, particularly in the Czech Republic. Besides sugar solutions (in varying proportions) the respondents have stated assortment of supplementary feed material including feeding dough (or paste), feeding syrup and other alternatives (e.g. honey, granulated sugar, fruit juice). Although feeding syrups and doughs are quite popular in Switzerland, their use in Czech beekeeping operations is rather low.

The amount of feed material needed to supply one bee colony before winter varies inter alia regarding climatic conditions and health of a bee colony. Annual honey consumption per bee colony in the Czech Republic is estimated by Titěra (2007) to 60 – 120 kg. Sufficient sugar stock replacing honey before winter season therefore ranges from 15 to 22 kg per bee colony, depending on geographical and climatic conditions (Toporčák and Chlebo, 2018). Table 10 provides an overview of expenditures on feeding according to different types of feed material.

Table 10: Costs of different feed material

TYPE OF FEED MATERIAL	UNIT	PRICE PER 1 KG		CONSUMED	COSTS PER BC	
	PACKAGE	CZK	CHF	BC/YEAR	CZK	CHF
Granulated sugar	1 kg	15	1	15 kg	225	15
Apifonda™ (feeding dough)	15 kg	44	3.20	15 kg	660	48
Apiinvert™ (feeding syrup)	28 kg	40	1.90	15 kg	600	28.50

Source: own processing according to normal (consumer) prices by Bienen-Meier (2018) and iVcelarstvi.cz (2019)

From the Table 10 it is clear that sugar has the most favourable price rate in contradistinction to feeding dough and syrup. Surprisingly the difference between the unit price of granulated sugar and feeding syrup is substantially lower in Switzerland than in the Czech Republic. In view of this fact, the differences in proportions of both feed materials used in both countries (see Figure 22) are partially clarified.

With regard to Czech expert interviews, one fifth of interviewees (20.51 %) reckon the feeding costs up to 199.99 CZK per bee colony, whereas one third of respondents assume the total sum between 200 and 299.99 CZK per bee colony. For 17.95 % of interviewed Czech beekeepers the sum of feeding costs is higher than 300 CZK, but lower than 399.99 CZK. The same proportion of interviewees estimates the expenditures on feeding between 400 CZK and 499.99 CZK. Every tenth pays for feeding one bee colony a year more than 500 CZK.

Slightly more than one sixth (17.39 %) of respondents in Switzerland estimate their feeding costs to be lower than 20 CHF per bee colony, nearly 30.5 % assume their costs to be less than 30 CHF per bee colony and the same proportion reckons the expenditures on feeding up to 40 CHF per bee colony. For more than a fifth of Swiss interviewees the sum of feeding costs is higher than 40 CHF per bee colony. In accordance with the results presented in Figure 22, the majority of interviewed beekeepers use besides the sugar water some supplementary nutrition (i.e. honey, dough, syrup). Furthermore, the crucial role of sugar in beekeeping is also highlighted by Šeráková and Svatoš (2019).

4.1.2.5 Beeswax Processing

In case of beeswax processing, for hobby beekeeper is the budget-wise option the exchange of own melted beeswax[93] for beeswax foundation combs in beekeeping shops or by beeswax processors. Sometimes the commercial beekeepers have at their disposal equipment for beeswax processing and beeswax foundation combs production, offering this service to small-scale beekeepers in region. Beekeeper brings own melted[94] beeswax to a processor, the beeswax is weighed and the final value is adjusted on account of some impurities (e.g. pollen). Then on the basis of the weight, the beeswax foundation combs are sold to the beekeeper for lower price. The exchange rates vary according to the impurities between ca. 40 CZK to 60 CZK per kg in the Czech Republic and between ca. 8 CHF to 10 CHF per kg in Switzerland (cf. Imkerhof, 2019; iVcelarstvi.cz, 2019; Včelpo, 2018). One kilogram of new beeswax foundation combs (without exchange for own beeswax) can be bought for approximately 350 – 400 CZK in the Czech Republic and 20 – 25 CHF in Switzerland (cf. Imkerhof, 2019; iVcelarstvi.cz, 2019; Včelpo, 2018). Some processors in the Czech Republic make a purchase of the surplus of beeswax for ca. 170 – 220 CZK/kg, without any exchange for foundation combs.

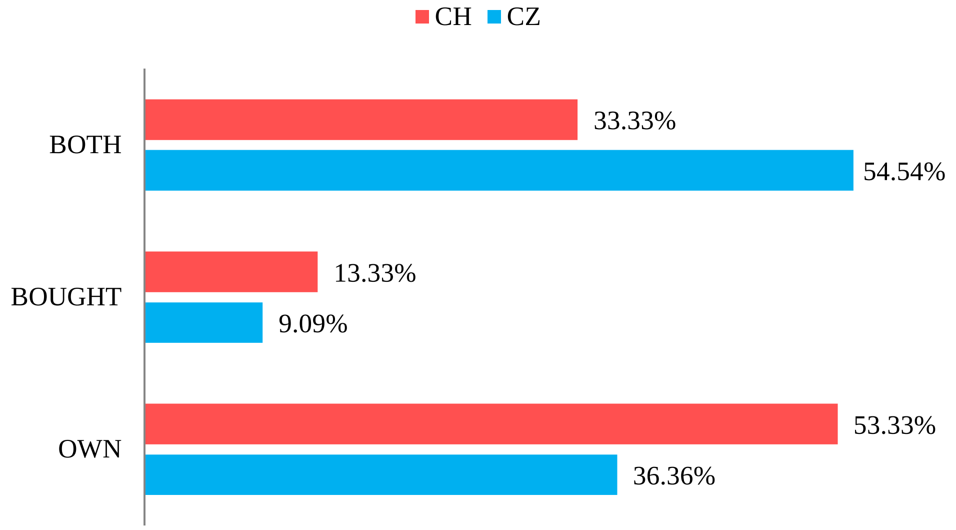
4.1.2.6 Queen Bee

The queen bee lives 3 – 5 years, but in beekeeping operation her exchange is recommended every 2 – 3 years (Toporčák and Chlebo, 2018; Veselý, 2007). Beekeepers might rear their own queen bees and/or they can buy them from professional breeders. Figure 23 illustrates the origin of queen bees in the Czech Republic and Switzerland according to the results proceeding from conducted interviews.

[93] In beeswax melter or solar wax melter

[94] Some processors might accept honeycombs too.

Figure 23: Origin of queen bees



Source: own processing according to the results of expert interviews

The groups of beekeepers who only buy queen bees do not consist solely of beginning beekeepers or beekeeping operations of small scale. For instance in Swiss sample, there are experienced beekeepers (from 40 to 60 years of experience) managing bee farms of various sizes (from 9 to 300 bee colonies) who do not breed own queen bees. According to the interviews, in Switzerland the usual price of queen bee is between 35 and 50 CHF (in some cases even higher – ca. 85 CHF). Concerning the queen bee sale[95] in the Czech Republic, there are unfertilized queen bees (ca. 100 – 200 CZK/ queen bee), fertilized queen bees (ca. 300 – 500 CZK/ queen bee) and inseminated queen bees (ca. 850 – 2000 CZK/ queen bee) for sale (cf. Bee Research Institute, 2017).

4.1.2.7 Varroa Mite Treatment

With regard to beekeeping treatment against varroa mite, two completely different approaches are used in both countries. There exist several ways to treat honeybees for varroa mites and accordingly related research studies assessing the efficacy of single methods (e.g. Giacomelli et al., 2016; Gunes et al., 2017; Kamler et al., 2016; Rademacher and Harz, 2006). On account of the great importance of bee colony health, always new medicines and treatments are

[95] Stated prices of queen bees are only indicative and they can vary depending on various conditions (lineage, insemination, fertilization, queen bee breeder etc.).

introduced (cf. Giusti et al., 2017). Referring to Beyer et al. (2018), the weather conditions and perfect timing of the treatment are important factors in varroa control strategies.

On the basis of the conducted interviews, in the Czech Republic the mainstay of varroa control and treatment consists in application of Formidol™, Gabon™ and Varidol™ medications. Other methods include use of products containing thymol (e.g. Apiguard™), spring brood coating, aerosol evaporation (M-1 AER™) and drone brood removal. As seen in Table 11, the medication is partially subsidized by the EU[96] (i.e. combating varroosis).

Table 11: Costs on Varroa Treatment in the Czech Republic

VARROA TREATMENT	AMOUNT	SUBSIDIZED (70 %)	
		YES	NO
Formidol™ (20 pieces – 20 bee colonies)	1 package	177	590
Gabon PF™ 90mg (50 strips, 2 – 3 strips / bee colony)	1 package	203	675
Thymovar™ (10 evaporation strips – 5 bee colonies)	1 package	156	519
Varidol™ (5ml) + 50 fumigation strips (1 piece / bee colony)	1 package	31	102
TOTAL →		**567 CZK**	**1 886 CZK**

Source: own processing according to normal (consumer) prices by Bee Research Institute (2017)

In Switzerland varroa treatment mainly consists in application of organic acids – formic[97] acid and oxalic[98] acid. According to the expert interviews, few beekeepers also use lactic[99] acid, essential oils, products containing thymol and/or they remove drone brood. Table 12 shows the costs on varroa mite treatment in Switzerland. Referring to the respondents, some cantons (e.g. Basel – City, Grisons, Schwyz) have covered the costs for formic and oxalic acids.

Table 12: Costs on Varroa Treatment in Switzerland

VARROA TREATMENT	AMOUNT	COSTS
Formic acid (70 %) / Formivar™ (2 – 3 ml / frame)	1 litre	11.2
Oxalic acid (5,7 %) / Oxuvar™ (5 – 6 ml / frame)	1 litre	28
Thymovar™ (10 evaporation strips – 5 bee colonies)	1 package	32.9

[96] Regulation (EU) No 1308/2013 (NAP, 2016) – Nařízení vlády č. 197/2005 Sb., o stanovení podmínek poskytnutí dotace na provádění opatření ke zlepšení obecných podmínek pro produkci včelařských produktů a jejich uvádění na trh

[97] Ameisensäure / kyselina mravenčí

[98] Oxalsäure / kyselina šťavelová

[99] Milchsäure / kyselina mléčná

TOTAL →	**72.1 CHF**

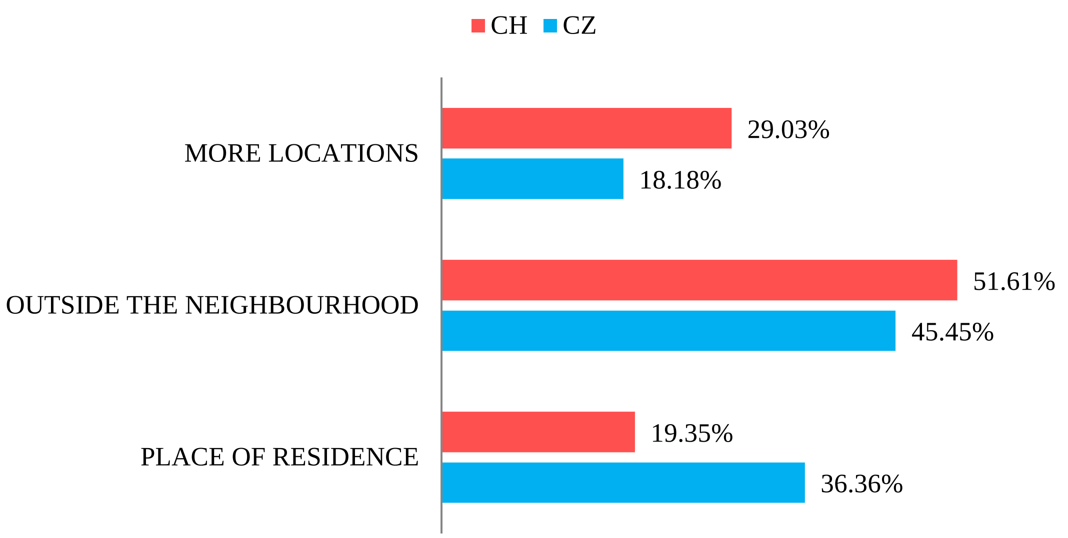
Source: own processing according to normal (consumer) prices by Bienen-Meier (2018)

Regarding the precautions, interviewees both in the Czech Republic and Switzerland emphasize particularly the importance of hygiene (regular disinfection of hives and tools, cleanliness, not to mix the contents of different hives), in-time treatment (keeping the deadlines), thorough year-round colony monitoring, regular exchange and renewal of honeycombs and beeswax foundation combs, strong and well-fed bee colonies and last but not least good beekeeping practice.

4.1.2.8 Transport Costs

Concerning the transport costs, it is necessary to take two aspects into the consideration. For one thing it is the location of the apiary (see Figure 24) and for another the migratory beekeeping.

Figure 24: Location of the apiary



Source: own processing according to the results of expert interviews

From the chart it is clear that the majority of Czech and Swiss interviewees need to allow for some additional transport costs, as their apiaries are situated either outside their neighbourhood or in two or more different locations (e.g. in the garden, in the yard, in forest, in the mountains or valleys, at the cottage). In case of larger operations, spatial distribution of apiaries works well as one of precautionary measures against potential pathogen transmission. Bee colony thefts and/or vandalism nevertheless belong to its drawbacks.

According to Lehnherr et al. (2001) migratory beekeeping offers among other things additional forage in summer, significantly larger honey yields on average, positive effects on colony development and possible bee density reduction in the region during lean flow period. Its shortcomings are for instance extra work for preparation, the transhumance itself, difficult colony control, transport costs, physically demanding work and high-risk given by potential leaving the flow out unused due to bad weather (Lehnherr et al., 2001). In defiance of its indisputable virtues mentioned above, migratory beekeeping is not very popular among hobby beekeepers due to several reasons.

Migratory beekeeping is not common between Czech respondents, as only 4 of them (out of 44) carry it out for better bee forage and varietal honey. They manage middle-sized beekeeping operations (from 21 up to 59 bee colonies). By contrast, frequently mentioned arguments against migratory beekeeping are the lack of equipment, threat of pathogen transmission, small-scale beekeeping, stress for the bees, time and age reasons. Almost one fourth (23.25 %) of the interviewees is satisfied with the available bee pasture and they see no need to practice migratory beekeeping.

In Switzerland, 9 respondents (out of 31) use the opportunity of migratory beekeeping to provide bees with better pasture sources and richer nectar and pollen flow, to secure queen bee breeding, to increase the honey yields and to harvest varietal honey. Frequent destination is therefore the mountain area. They are middle-sized and professional beekeepers, managing beekeeping operations between 15 and 1000 bee colonies. The other way around, the mentioned arguments against migratory beekeeping are high expenditures, lack of time, threat of pathogen transmission, extra workload, stress for the bees and keeping bees in Schweizerkasten hives.

4.1.2.9 Membership in a Beekeeping Organization

The vast majority of interviewed experts both in the Czech Republic (95.45 %) and Switzerland (96.77 %) are members of local beekeeping organization. One of the duties of a member[100] is to pay membership fee (per person a year) and a charge for each kept bee colony. In the Czech Republic in 2019 the membership fee is 200 CZK and a charge for colony amounts to 16 CZK (Oběžník č. 1/2018, 2018). In Switzerland all cantons and local organizations have their own schedules of charges. According to the respondents, membership

[100] In the Czech Republic the Beekeeping Clubs for Children and Youth are exempt from the payment.

fees are usually between 25 CHF and 50 CHF per person a year and charges for colony range from 0.50 CHF to 3 CHF per bee colony and year, but they can be lower/higher depending on local beekeeping organization and cantonal requirements.

4.1.2.10 Insurance

Insurance is considered as optional item of the expenditures. Nearly a third of Swiss interviewees confirm paying private insurance (accident insurance, liability insurance, household insurance and the like). Respondents from the Czech Republic who are members of the Czech Beekeepers Union have general accident insurance (by private insurance company[101]) as well as property insurance (by Self-help[102] fund of the CBU) and they might rely on the legal assistance[103] provided by the CBU.

4.1.3 Structure of Revenues

The profitability of beekeeping operation depends on various factors. With regard to Eiblmeier (2016), the aim should be the highest honey yield as possible in proportion to time requirements and capital investment. That depends on following circumstances: pollen availability in the region, nectar and honeydew flow, year-round weather, microclimate of the apiary, hives' temperature, beekeepers' knowledge and skilfulness, the ability to exchange experience, ideas and impulses, state of bee colonies' health, queen bee and her genetic (familial) features and beekeeping practice – interventions and the system of treatment (Eiblmeier, 2016; Kamler, 2005).

4.1.3.1 Honey Sale

Regarding honey sale, there are various possibilities to market honey (as well as other bee products). The results of conducted interviews illustrated in Figure 25 present the mainstay of them. In both observed countries, the direct sale (from the front yard) prevails. It can be seen that the place of honey sale is more diversified in Switzerland in contradistinction to the Czech Republic, where for instance the proportion of sales realized during events (e.g. Christmas market, local fair) or in other stores (e.g. pharmacy, restaurant, hotel, own e-shops) is much lower. An interesting seasonal opportunity to sell honey is to offer special Christmas packaging of honey pots to companies as a giveaway.

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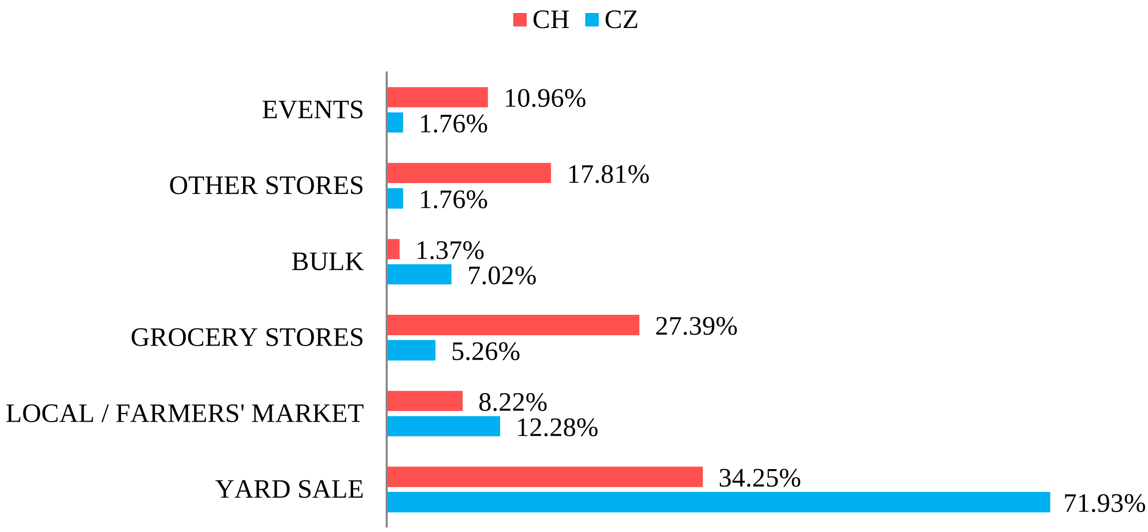
[101] Úrazové pojištění (Úrazové pojištění členů ČSV, 2019)

[102] Svépomocný fond (Statut Svépomocného fondu ČSV, z.s., 2016)

[103] Právní pomoc (Směrnice ČSV, z.s. o právní pomoci, 2016)

Figure 25: Common ways to market honey in the Czech Republic and Switzerland



Source: own processing according to the results of expert interviews

However, it is necessary to state that there exists a group of beekeepers not selling honey, since they use it just for own consumption, as a gift and/or they leave (some or all) honey to the bees to avoid artificial feeding with sugar syrups.

Potential honey sale revenues in beekeeping operations of various sizes in the Czech Republic and Switzerland are stated in Tables 13 and 14. On the basis of the structure of respondents[104] and beekeeping operations[105], the hobby beekeeping operations up to 30 bee colonies (BC) are selected. The average honey yield is considered 15 kg per bee colony a year for bee farms with 5, 10 and 15 bee colonies, and 20 kg per bee colony a year for operations with 20, 25 and 30 bee colonies. It is supposed that the difference stemming from higher honey yield is used for own consumption of the beekeepers and their families. Overall calculation works on the assumption that with the exception of beekeeping operations up to 10 bee colonies, the honey yield is not completely sold directly from the yard. Given the results in Figure 25, the honey can be marketed for higher (Group 1) or lower (Group 2) prices. Group 1 (150 CZK/kg and 26 CHF/kg) includes the direct sales such as sale from the yard, local and/or farmers' market, events (fairs, exhibitions, Christmas markets etc.) and own shop. Group 2 (120 CZK/kg and 22 CHF/kg) consists of honey pot distribution to local grocery stores, restaurants and other shops as well as to bulk.

[104] See Figure 18 in subsection 3.4.1 and Figure 20 in subsection 3.4.2

[105] See Figure 5 in subsection 2.1.2

Table 13: Revenues of various hobby beekeeping operations in the Czech Republic

Operation Size	Average Honey Yield	Amount of Honey	Sale		Price		Revenues	
			Group 1	Group 2	Group 1	Group 2	Total	Per BC
∑ BC	kg/BC/year	BC x Yield	kg	kg	150 CZK/kg	120 CZK/kg	∑ CZK	∑ CZK/BC
5	15	75	75	0	11250	0	11250	2250
10	15	150	150	0	22500	0	22500	2250
15	15	225	193.5	31.5	29025	3780	32805	2187
20	20	400	344	56	51600	6720	58320	2916
25	20	500	430	70	64500	8400	72900	2916
30	20	600	516	84	77400	10080	87480	2916

Source: own processing

Taking into consideration the results from Czech expert interviews in Figure 25, the multiplication coefficient for the Group 1 is 0.86 (i.e. yard sale[106] 71.93 % + market sale 12.28 % + events 1.76 %) and for the Group 2 is 0.14 (i.e. grocery stores 5.26 % + other stores 1.76 % + bulk 7.02 %). Consequently, the beekeeper managing 20 bee colonies, having an average honey yield of 20 kg per bee colony a year sells 344 kg of honey for 150 CZK/kg and 56 kg of honey for 120 CZK/kg. However such calculation is indicative, inasmuch as the honey sale is strictly individual and depends on the structure of beekeepers' customers, their preferences, networking, honey yield, promotion and many other factors. In case of small-scale beekeepers having full-time job it is not supposed that they all have a stand on a weekly farmers' market, but it might be an alternative for retired beekeepers.

In spite of the fact that the majority of Swiss honey is sold in 500 g volumes (see Figure 27 below), the calculation is in order to draw a comparison between Switzerland and the Czech Republic carried out for 1 kg volumes. Similarly to the calculation in Czech conditions, the multiplication coefficients for the Group 1 and Group 2 in Swiss terms also stem from the results given in Figure 25. Total amount of honey is multiplied by 0.53 in Group 1 (i.e. yard sale 34.25 % + market sale 8.22 % + events 10.96 %) and is multiplied by 0.47 in Group 2 (i.e. grocery stores 27.39 % + other stores 17.81 % + bulk 1.37 %). And thus the beekeeper managing 25 bee colonies, having an average honey yield of 20 kg per bee colony a year sells 265 kg of honey for 26 CHF/kg and 235 kg of honey for 22 CHF/kg. Also in this case it is

[106] In the Czech Republic the honey sale from the front yard is limited up to 2 tons of honey a year (Prodej ze dvora, 2019)

necessary to accentuate the individual character of honey sale and potential revenues, which both are conditional on numerous factors – some of them are described below.

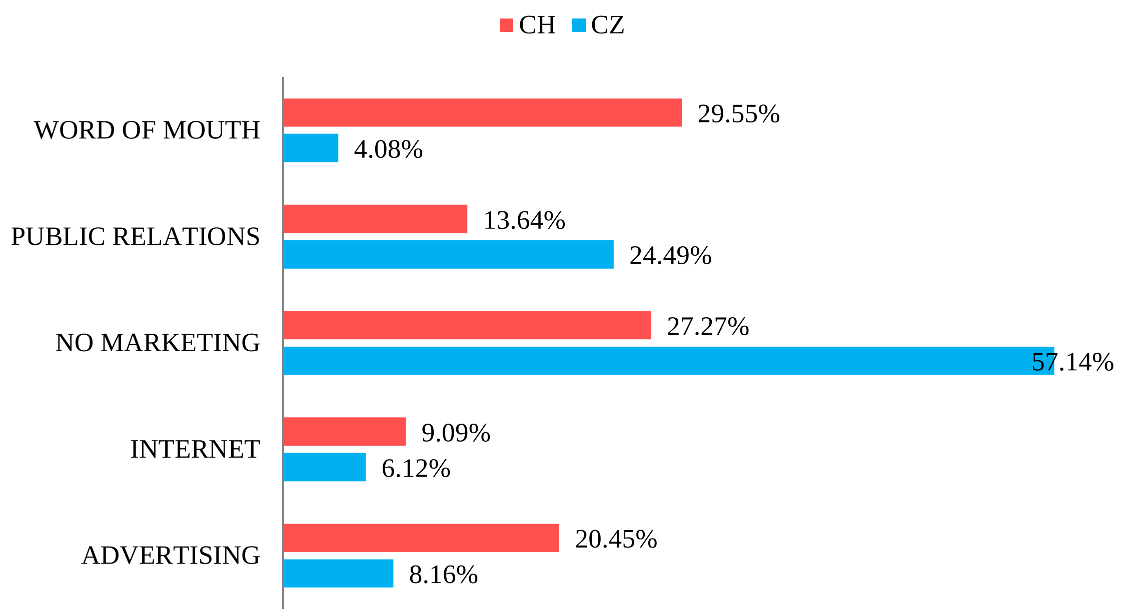
Table 14: Revenues of various hobby beekeeping operations in Switzerland

Operation Size	Average Honey Yield	Amount of Honey	Sale		Price		Revenues	
			Group 1	Group 2	Group 1	Group 2	Total	Per BC
∑ BC	kg/BC/year	BC x Yield	kg	kg	26 CHF/kg	22 CHF/kg	∑ CHF	∑ CHF/BC
5	15	75	75	0	1950	0	1950	390
10	15	150	150	0	3900	0	3900	390
15	15	225	119.25	105.75	3100.5	2326.5	5427	361.8
20	20	400	212	188	5512	4136	9648	482.4
25	20	500	265	235	6890	5170	12060	482.4
30	20	600	318	282	8268	6204	14472	482.4

Source: own processing

In terms of marketing bee products, fairly high proportions of beekeepers do not use any promotion channels to improve their bee products sales. Figure 26 shows the results originating from conducted expert interviews.

Figure 26: Bee products sales promotion in the Czech Republic and Switzerland



Source: own processing according to the results of expert interviews

In Switzerland, according to the respondents the most popular way to promote honey sale is word of mouth marketing[107] (WOMM), whereas almost similar amount of interviewees finds advertising and marketing efforts utterly unnecessary, since there is an excess of demand over supply[108] on the market with honey. Neither in the Czech Republic, more than a half of respondents promote their bee products, as they prefer the direct contact with customers on public events according to good public relations[109] principles to word of mouth marketing. Category advertising includes various signs (on the car, in the front yard – see Appendices III), business cards, advertisements in local newspapers, flyers and leaflets distribution, honey sale in small local shops (e.g. organic food shop, wine shop, cheese shop, pharmacy). For the time being, the promotion through internet websites and social networks is not extensively used.

Concerning the structure of honey purchasers, there are three different groups (family and friends, regular customers and irregular clients). The results of both countries are very similar, since the category of family and acquaintance prevails (43.37 % in the Czech Republic, 42.46 % in Switzerland), being followed by categories of regular clients (33.73 % in the Czech Republic, 36.99 % in Switzerland) and irregular customers (22.89 % in the Czech Republic, 20.55 % in Switzerland).

Honey origin is the most important deciding factor for consumers both in the Czech Republic and Switzerland, when buying honey. Local product is considerably preferred to foreign one (Ebener, 2015; Šánová et al., 2017).

With regard to the honey consumption features in both countries, the average honey consumption over a 15-year period from 2000 to 2015 is higher in Switzerland (i.e. 1.3 kg honey per capita and year; Agristat, 2001 – 2017) than in the Czech Republic (i.e. 0.7 kg honey per capita and year; SVZ, 2017). Although some former marketing campaigns have

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[107] Mund-zu-Mund-Propaganda, defined by Thorne (2008) as a marketing tool of indisputably powerful influence, when customers have a good reason to talk about the product and share their own opinions, experience and recommendation to promote the product.

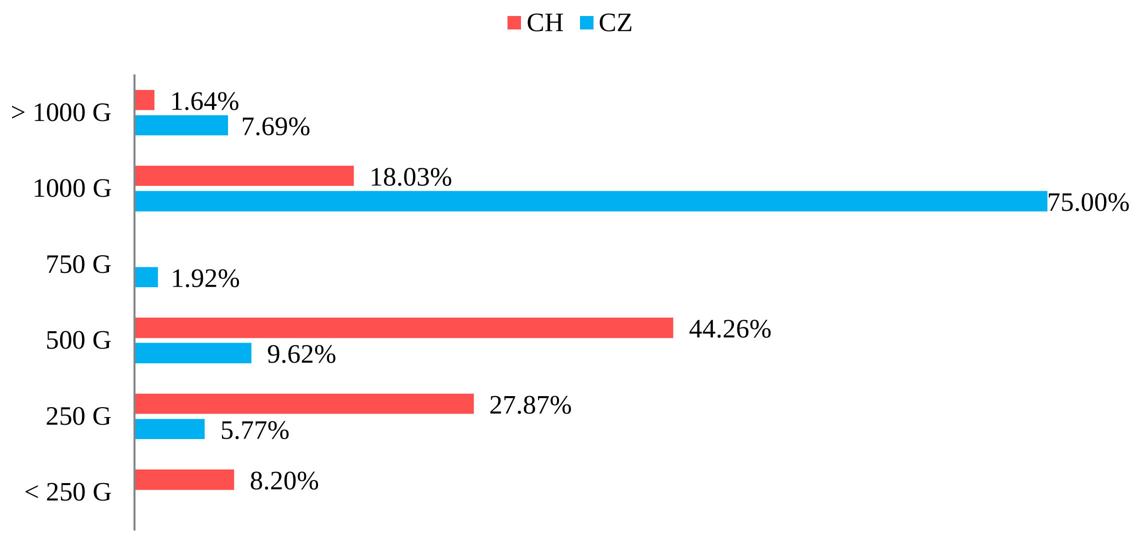
[108] See the subsection 2.2.3 for details.

[109] Public relations are here defined according to Longman (2009) as building the relationship between a beekeeper (who is selling variety of bee products) and the local public. It contains direct sale talks with customers, participation on public events (such as markets, exhibition stands, public honey harvesting), lecturing and having the honey quality confirmed by an authority and/or certification (Siegelimker in CH, Český med in CZ).

already focused on honey promotion (e.g. Bez medu to nejde, 2008; Medové snídaně[110], 2019), more advertising strategies are needed to increase domestic consumption of honey in the Czech Republic.

As seen in Figure 27, there are huge differences between both countries in volumes of the honey pots commonly sold.

Figure 27: Honey sale – volumes of the jars sold in the Czech Republic and Switzerland



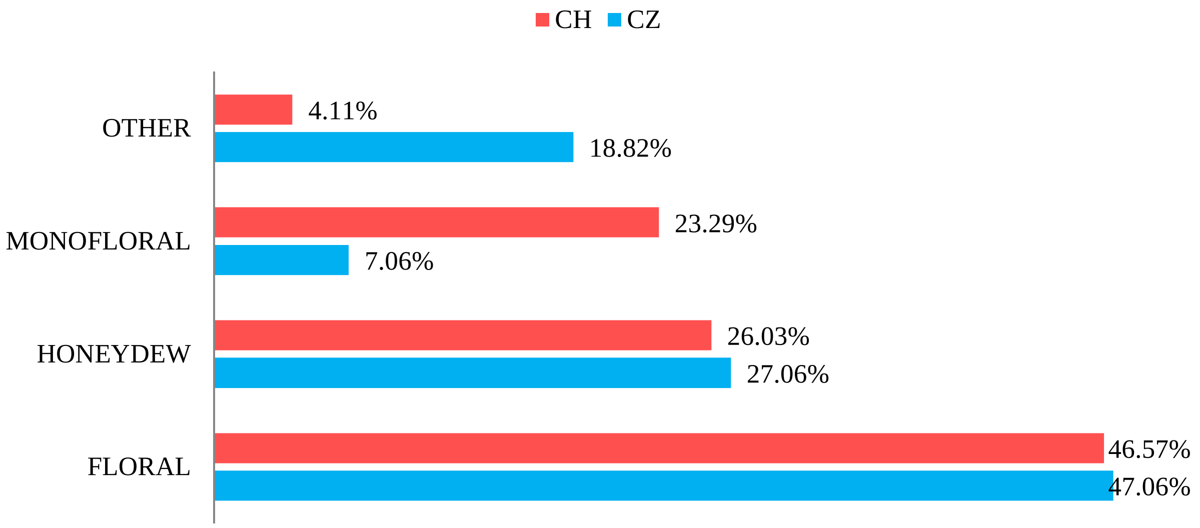
Source: own processing according to the results of expert interviews

The results of the expert interviews in Switzerland correspond to the results of the consumer survey by Ebener (2015), stating that the sale of honey jars sized 500 g prevails, followed by 250 g packaging. The bar chart shows that there are no values for category 750 g in Switzerland or for category under 250 g in the Czech Republic. The latter includes in Switzerland the volumes of 125 g (1.64 %), 100 g (4.92 %) and 50 g (1.64 %). In the Czech Republic in contradistinction to Switzerland the honey pots of 1 kg are commonly sold, followed by volumes of 500 g and volumes larger than 1 kg (specifically the 5 kg packaging). One interviewed Swiss beekeeper sells few 20 kg containers of honey to children’s homes and canteens.

According to marketed honey varieties, there are four categories identified – floral honey, honeydew honey, monofloral honey and some other types (see Figure 28).

[110] Honey Breakfasts

Figure 28: Honey types sold in the Czech Republic and Switzerland



Source: own processing according to the results of expert interviews

Floral honey category includes spring, summer and mixed flower honey. The proportions of floral and honeydew honeys in both countries match up with each other. However there is considerable difference between categories for monofloral and other honey types. In Czech dataset the false acacia[111] honey, oilseed rape honey, linden honey and chestnut honey are considered varietal and they correspond to unifloral honeys presented by Titěra (2013). Reported Swiss monofloral honeys are linden honey, erica honey, false acacia[103] honey, fir honey, chestnut honey and alpine rose honey. They match up with types of Swiss varietal honey proposed by Bogdanov et al. (2008). Group called "Other" is comprised of creamed honey and comb honey.

On the basis of the conducted interviews, the average price for 1 kg of honey is 145.375 CZK in the Czech Republic and 25.76 CHF in Switzerland. According to Šimpach (2012), the honey price has its own, market-independent development. A half of Czech respondents set the price based on a comparison between the market prices, whereas more than a fifth of interviewed experts (21.43 %) carry out neither estimations nor calculations to specify their bee product prices. For 14.29 % of Czech respondents a stable price affordable to customers, proceeding from own consideration and estimation is important. Nearly every tenth out of the Czech dataset finds crucial that revenues from honey sales cover the expenses of beekeeping

[111] Locust tree

operation and approximately 4.76 % of respondents allow for the amount of yield and demand for honey. The majority of Swiss respondents (40.74 %) sets the price according to the rate suggested by VDRB, almost one fifth (18.52 %) of interviewed experts draws a comparison between the market prices, while only 7.41 % of interviewees do price calculation in relation to expenses. Ca. 14.81 % of Swiss respondents keep stable honey price and 18.52 % of interviewees do not make substantial efforts to calculate own bee product prices.

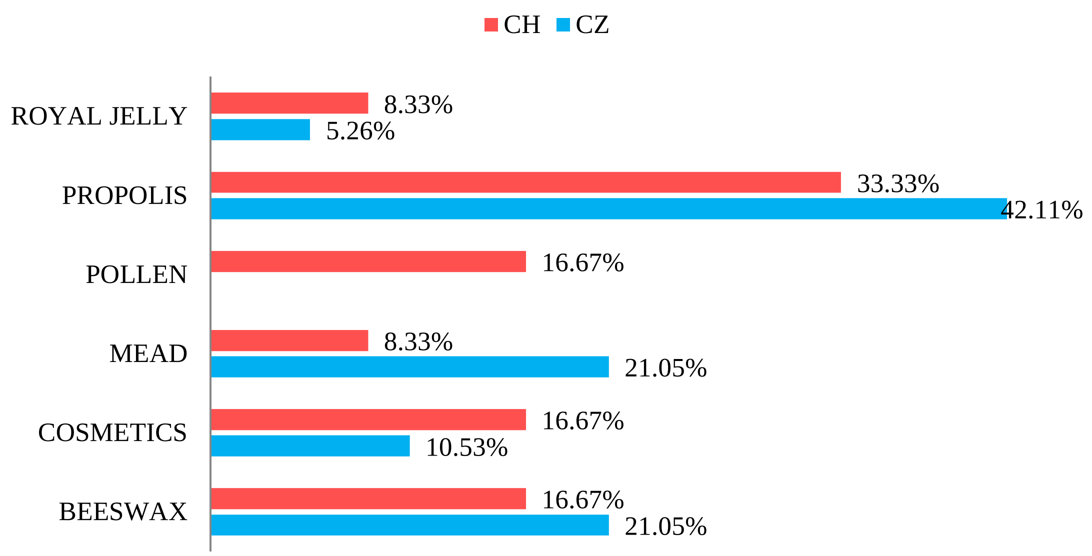
Considering the honey price, the majority of Swiss consumers is ready to pay higher prices for inland (domestic) product and the price is considered as the least important aspect of honey purchase (Ebener, 2015). For Czech honey buyers, price is the second most important deciding factor in honey selection (Šánová et al., 2017).

4.1.3.2 Other Bee Products Sale

The expert interviews both in the Czech Republic and Switzerland confirmed that for the vast majority of interviewees honey sale is the key income source of their beekeeping operation. The sale of other bee products (e.g. propolis, beeswax) and processed goods (e.g. mead, cosmetics) ranges from 25 % (in the Czech Republic) to 30 % (in Switzerland). However 54.84 % of Swiss respondents and 34.09 % of Czech respondents confirm that besides honey they also produce other bee products. Some of them make it just for family, friends and acquaintance, not for commercial purpose.

Figure 29 below provides closer insight into the sale of other bee products. From the chart it is clear that the propolis is quite frequently marketed in both countries. The category is comprised of raw propolis, its tinctures, chewing gums and the like. For example 20 ml of propolis tincture sold from the yard approximately costs in the Czech Republic more than 40 CZK, in Switzerland between 11 CHF and 20 CHF. In the Czech sample unlike the Swiss one there was no beekeeper selling pollen (in capsules or granulated). Price of pollen might range from 20 CHF to 24 CHF for 200 g. On account of mead, the price for a bottle in 0.5 l volume is ca. 11 CHF in Switzerland and from ca. 100 CZK in the Czech Republic, considering the direct sale (from the yard). Regarding cosmetics, there exists broad portfolio of products, varying from salves and creams to lip balms and likewise. Beeswax category includes candles and the indicative price of 1 kg beeswax is 20 CHF in Switzerland and 300 CZK in the Czech Republic.

Figure 29: Sale of other bee products in the Czech Republic and Switzerland



Source: own processing according to the results of expert interviews

4.1.3.3 Sale of Products for Beekeepers

Concerning the sale of products for beekeepers, only a small minority of all respondents produces for instance beeswax foundation combs, wired frames and other equipment. Three interviewees from Swiss sample group rear queen bees for sale (price ranging from 25 CHF to 60 CHF for a queen bee) and two of them regularly sell nucleus colonies (price varying from 180 CHF to 220 CHF per colony). One Czech respondent sells own beehive frames, beeswax foundation combs and other small beekeeping equipment. Only a small amount of beekeepers offers queen bees and nuc colonies for sale, while managing (with a few exceptions) more than 50 bee colonies. Moreover, referring to Kamler (2005), some commercial and large-scale beekeeping operations often run affiliated production (e.g. joinery, beeswax processing) and/or counselling.

4.1.3.4 Subsidies

Regarding the subsidies, in Switzerland there is no general state support of beekeeping and such competences are distributed within the cantonal scope. Each canton has its own policy and tools to support beekeeping – with regard to the conducted interviews, some beekeepers receive varroa treatment agents (formic acid and oxalic acid) free of charge or partially subsidized (e.g. Basel – City, Grisons, Schwyz), their contributions to disease fund might be covered by canton (e.g. Lucerne, Zug) and cantonal tax policy is adjusted to hobby beekeepers (e.g. no imposition of a tax up to certain income from beekeeping and/or certain number of bee colonies kept). Furthermore, some municipalities directly pay beekeepers a contribution ranging from 10 CHF/ bee colony to 30 CHF/ bee colony. According to the interviews, beekeeping in the Czech Republic is supported from the EU[112] (technical aid, combating varroosis, rationalisation of migratory beekeeping, honey analysis, hive renewal), from the state (programme 1.D.[113], income tax relief up to 60 bee colonies and the income up to 30 000 CZK[114]), from regions (support of beginning beekeepers) and from some municipalities as well.

4.1.4 Summary

This subsection provides an annotated overview of the economics of small-scale beekeeping operations in the Czech Republic and Switzerland regarding the initial investment, annual expenditures and annual revenues including recommendations to improve their economic activities.

According to Table 15 it can be seen that the input material costs for the beekeeping operation of 5 bee colonies (BC) in Langstroth beehives (see Table 6) are in the Czech Republic ca. 53 891 CZK and in Switzerland ca. 5 560.5 CHF, as seen below in Table 16.

Table 15: Initial investment of beginning beekeeper – the Czech Republic

INITIAL INVESTMENT	SIZES OF BEEKEEPING OPERATIONS (∑ BEE COLONIES)						REMARKS
	5	10	15	20	25	30	
Beehive	20775	41550	62325	83100	103875	124650	4 155 CZK/ piece
Bee colony	15000	30000	45000	60000	75000	90000	3 000 CZK/ BC
Gear and tools	15516	15516	15516	15516	15516	15516	see Table 7
Education	2600	2600	2600	2600	2600	2600	book, course
TOTAL	**53891**	**89666**	**125441**	**161216**	**196991**	**232766**	sum in CZK

Source: own processing

[112] Regulation (EU) No 1308/2013 (NAP, 2016) – Nařízení vlády č. 197/2005 Sb., o stanovení podmínek poskytnutí dotace na provádění opatření ke zlepšení obecných podmínek pro produkci včelařských produktů a jejich uvádění na trh

[113] 149 CZK for overwintered bee colony for the year 2018 (Ministry of Agriculture of the Czech Republic – National Subsidies according to the Act on Agriculture)

[114] Act on Income Taxes – § 10 (3) a) zákona č. 586/1992 Sb., zákon o daních z příjmů, v platném znění

With regard to the education, it is assumed that beginning beekeeper visits at least the basic beekeeping course (i.e. 2 300 CZK and 650 CHF) and buys recommended literature (i.e. 300 CZK and 100 CHF), as outlined in 4.1.1.3.

According to the data obtained from the expert interviews, nearly one third of Czech respondents (32.26 %) finds it possible to begin keeping the bees with initial investment up to 20 000 CZK. The majority of interviewed experts (45.16 %) expect the input costs to range between 20 001 and 40 000 CZK. Slightly more than a fifth (22.58 %) of the Czech interviewees assumes that the beginning beekeeper needs more than 40 001 CZK to start a hobby beekeeping business.

Table 16: Initial investment of beginning beekeeper – Switzerland

INITIAL INVESTMENT	SIZES OF BEEKEEPING OPERATIONS (∑ BEE COLONIES)						REMARKS
	5	10	15	20	25	30	
Beehive	2057.5	4115	6172.5	8230	10287.5	12345	411.5 CHF/ piece
Bee colony	1250	2500	3750	5000	6250	7500	250 CHF/ BC
Gear and tools	1503	1503	1503	1503	1503	1503	see Table 7
Education	750	750	750	750	750	750	book, course
TOTAL	**5560.5**	**8868**	**12175.5**	**15483**	**18790.5**	**22098**	sum in CHF

Source: own processing

The majority of Swiss respondents (57.89 %) supposes the input costs of the beekeeping operation of beginning beekeeper to be up to 6 000 CHF. More than a fourth (26.32 %) of interviewed experts estimates the expenditures to be between 6 001 and 12 000 CHF. Remaining respondents (15.79 %) assume the initial investment to be higher than 12 001 CHF.

On account of high input costs, it is worked on the assumption that the beginning beekeeper starts the beekeeping operation with 5 bee colonies at the maximum and after gaining some experience increases the number of colonies. In case of rooftop urban beekeeping operation[115], 10 bee colonies are usually considered as maximum, preferably to an experienced beekeeper.

[115] See the subsection 4.4.2 for details

Interviewed experts from both countries naturally take into consideration the possibility of buying second-hand gear[116], but the beekeeper needs to bear in mind the importance of hygiene and thorough disinfection of older equipment to prevent potential pathogen transmission. Hence the replacement of inappropriate equipment once in a while is recommended.

With regard to annual expenditures in beekeeping operation, it is necessary to emphasize that their proportions are strictly individual, inasmuch as they mainly depend on beekeeping practice. Every beekeeping operation is different and the costs cannot be generalized. The structure of expenditures is derived from subsection 4.1.2, whereas some further remarks might be added.

For both countries it is considered that the beeswax foundation combs are purchased through exchange of beeswax (1 kg per bee colony) and that the beekeeper replaces one fifth of queen bees yearly through buying new queen bees. The labour costs are calculated according to the outcomes of the interviews presented in 4.1.2.1, where season[117] hours account for 256 hours (8 months, 4 weeks monthly, 8 hours weekly), off-season[118] is ca. 32 hours (4 months, 4 weeks monthly, 2 hours weekly) and there are 12 extra hours (i.e. 300 hours a year in total). The hourly wage differs according to the country. Transport costs are considered equal for beekeeping operations of various sizes. Membership fees are adjusted regarding the results described in 4.1.2.9. The item insurance is not included, as it is considered optional.

In case of Czech Republic (see Table 17), it is estimated that feeding costs per bee colony do not exceed 300 CZK and the investment is not higher than 500 CZK per bee colony. The cost of varroa treatment proceeds from calculating the expenditures on diverse medicaments[119] per bee colony.

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[116] E.g. Včelařské inzertní noviny (2019) in the Czech Republic and Inserate-Übersicht (2019) in Switzerland

[117] From March to October

[118] From November to February

[119] Formidol (9 CZK/BC), Gabon (12 CZK/BC), Thymovar (31 CZK/BC), Varidol (2 CZK/BC) – see Table 11

Table 17: Expenditures in the beekeeping operation – the Czech Republic

EXPENDITURES	SIZES OF BEEKEEPING OPERATIONS (∑ BEE COLONIES)						REMARKS
	5	**10**	**15**	**20**	**25**	**30**	
Feeding	1500	3000	4500	6000	7500	9000	300 CZK/ BC
Beeswax	250	500	750	1000	1250	1500	50 CZK/ kg (exchange)
Queen bee	300	600	900	1200	1500	1800	300 CZK/ queen bee
Varroa treatment	270	540	810	1080	1350	1620	54 CZK/ BC
Packaging	1467	2934	4401	5868	7335	8802	see Table 8
Investment	2500	5000	7500	10000	12500	15000	500 CZK/BC
Labour costs	45000	45000	45000	45000	45000	45000	300 hours, 150 CZK/ h
Transport costs	1000	1000	1000	1000	1000	1000	1000 CZK/ year
Membership fees	280	360	440	520	600	680	200 CZK + 16 CZK/ BC
TOTAL	**52567**	**58934**	**65301**	**71668**	**78035**	**84402**	sum in CZK
Minus labour	**7567**	**13934**	**20301**	**26668**	**33035**	**39402**	

Source: own processing

From the Table 17 it can be seen that the assumption of Kamler (2005) and Šánová and Benda (2014) is right, and so the feeding costs in given beekeeping operations range from 19.82 % to 22.84 % of the total costs (excluded labour costs).

Table 18: Expenditures in the beekeeping operation – Switzerland

EXPENDITURES	SIZES OF BEEKEEPING OPERATIONS (∑ BEE COLONIES)						REMARKS
	5	**10**	**15**	**20**	**25**	**30**	
Feeding	175	350	525	700	875	1050	35 CHF/ BC
Beeswax	45	90	135	180	225	270	9 CHF/ kg (exchange)
Queen bee	40	80	120	160	200	240	40 CHF/ queen bee
Varroa treatment	23.6	47.1	70.7	94.2	117.8	141.3	4.71 CHF/ BC
Packaging	311	622	933	1244	1555	1866	see Table 9
Investment	400	800	1200	1600	2000	2400	80 CHF/BC
Labour costs	9000	9000	9000	9000	9000	9000	300 hours, 30 CHF/ h
Transport costs	300	300	300	300	300	300	300 CHF/ year
Membership fees	40	45	50	55	60	65	35 CHF + 1 CHF/ BC
TOTAL	**10335**	**11334**	**12334**	**13333**	**14333**	**15332**	sum in CHF
Minus labour	**1334.6**	**2334.1**	**3333.7**	**4333.2**	**5332.8**	**6332.3**	

Source: own processing

In Switzerland (see Table 18) the average cost of varroa treatment measures is estimated 4.71 CHF[120] per bee colony. Feeding costs are considered 35 CHF per bee colony at the maximum and it is assumed that Swiss beekeeper annually invests in one bee colony ca. 80 CHF. Regarding the feeding costs, in beekeeping operations stated above in Table 18, the proportion of expenditures on bee feeding ranges from 13.11 % to 16.58 % of the total costs, while the labour costs are excluded. Even though the given proportions in Swiss bee farms are lower than the results within Czech beekeeping operations, it still corresponds to the interval (15 – 20 %) defined by Kamler (2005).

Some costs can be saved through good beekeeping practice (using own beeswax, rearing own queen bees and keeping bee colonies healthy), shopping in bulk, assembling and wiring beehive frames and repairing the equipment on one's own. Customers might bring their own pots to be refilled with honey, and so the beekeeper might cut down some costs of packaging material. Small-sized beekeeping operations might share varroa treatment agents[121] and/or some equipment (e.g. honey extractor). Several beekeeping organizations offer their members specific tools to rent (e.g. aerosol generator). In addition to that, for the purpose of cutting back on costs within beekeeping operations Owens and Cleaver (1973) suggest sharing honey house and the equipment by two or more beekeepers, which might be suitable especially for hobby beekeepers in neighbourhood. For larger bee farms and professional beekeepers authors recommend using labour-saving equipment (e.g. automatic uncappers, beehive loaders), reducing labour by proper equipment arrangement, process-oriented facilitation, better organization, time management and planning (Owens and Cleaver, 1973).

According to the revenues in Czech hobby beekeeping operations, except for the honey sale the subsidy from the Ministry of Agriculture of the Czech Republic (1.D.) is taken into consideration (see Table 19 below). Moreover the subsidies for beginning beekeepers from the EU and/or the regions of the Czech Republic are an important tool to support new beekeepers in order to fight against the beekeepers' ageing and to secure sufficient pollination services in the future.

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[120] Formic acid (0.30 CHF/BC), Oxalic acid (1.12 CHF/ BC), Thymovar (3.29 CHF/ BC) – see Table 12

[121] For one thing varroa treatment agents are limited by their expiration date, for another some of these medicaments are sold in large volumes (e.g. Formidol™ for 20 bee colonies, Varidol™ for 50 bee colonies).

Table 19: Revenues in the Beekeeping Operation – the Czech Republic

REVENUES	SIZES OF BEEKEEPING OPERATIONS (∑ BEE COLONIES)						REMARKS
	5	**10**	**15**	**20**	**25**	**30**	
Honey sale	11250	22500	32805	58320	72900	87480	see Table 13
Subsidy (1.D.)	745	1490	2235	2980	3725	4470	149 CZK/ BC
TOTAL	**11995**	**23990**	**35040**	**61300**	**76625**	**91950**	sum in CZK

Source: own processing

However for the time being such financial support is according to the conducted interviews not available to beekeepers in Switzerland. Therefore it is worked on the assumption that honey sale is the only revenue stream of Swiss hobby beekeeping operations (see Table 20).

Table 20: Revenues in the Beekeeping Operation – Switzerland

REVENUES	SIZES OF BEEKEEPING OPERATIONS (∑ BEE COLONIES)						REMARKS
	5	**10**	**15**	**20**	**25**	**30**	
Honey sale	1950	3900	5427	9648	12060	14472	see Table 14
TOTAL	**1950**	**3900**	**5427**	**9648**	**12060**	**14472**	sum in CHF

Source: own processing

Even though the honey sale is considered as the main revenue source of the beekeeping operation, there exists a potential to extend or diversify the range of products and/or services, which might be of interest to hobby beekeepers too. Case in point is production of propolis tincture and/or creamed honey as well as mentoring of newbies.

From the following two Tables (21 and 22) it is clear that the labour costs have a significant share in the economics of beekeeping operations, nevertheless interviewed hobby beekeepers do not regard their bee farms as businesses, but rather as a form of pastime bringing them joy and at least some extra income to household budget (cf. Garnett, 2000). Although the results of simulated Czech beekeeping operation with 30 bee colonies support findings by Šánová and Benda (2014) proposing that beekeeping becomes economically feasible for operations managing more than 30 bee colonies, in Swiss beekeeping operation of the same size (see Table 22) the results are not absolutely unequivocal, as the expenditures still exceed the revenues. Compared with the results presented in 4.1, for 30 % of Czech respondents and 46.15 % of Swiss respondents, their beekeeping operations are able to cover their costs, nevertheless 10 % of interviewed Czech experts and 19.23 % of their Swiss counterparts admit to have a loss-making business. Contrary to Willet (1992) working on the economic assumption that all producers are profit maximizers and that such notion leads their market decision, the accomplished expert interviews with beekeepers revealed that not all honey producers (beekeepers) are profit maximizers, inasmuch as their decisions are likewise influenced by other motives than strictly the economic one.

On account of the variability of factors having an influence on profitability of beekeeping operation, it is nearly impossible to predict values or development in the years to come. In addition to that, beekeepers as well as agricultural crop growers cannot simply reckon on future revenues (cf. Winfree, 2008).

Table 21: Calculation of the Economics of the Beekeeping Operation – the Czech Republic

OVERVIEW	SIZES OF BEEKEEPING OPERATIONS (∑ BEE COLONIES)					
	5	10	15	20	25	30
Initial investment (CZK)	53891	89666	125441	161216	196991	232766
Expenditures (CZK)	52567	58934	65301	71668	78035	84402
Expenditures* (CZK)	7567	13934	20301	26668	33035	39402
Revenues (CZK)	11995	23990	35040	61300	76625	91950

without labour costs

Source: own processing

Unfavourableness of expenditures to revenues ratio within small-scale beekeeping operations might restrict necessary investments in beekeeping operations and their potential expansion too.

Table 22: Calculation of the Economics of the Beekeeping Operation – Switzerland

OVERVIEW	SIZES OF BEEKEEPING OPERATIONS (∑ BEE COLONIES)					
	5	10	15	20	25	30
Initial investment (CHF)	5560.5	8868	12175.5	15483	15790.5	22098
Expenditures (CHF)	10334.55	11334.1	12333.65	13333.2	14332.75	15332.3
Expenditures* (CHF)	1334.55	2334.1	3333.65	4333.2	5332.75	6332.3
Revenues (CHF)	1950	3900	5427	9648	12060	14472

without labour costs

Source: own processing

Great importance is attached particularly to high initial investment of beekeeping operations not only in case of beginning beekeepers, but also in cases, when the bee colonies are lost due to thefts, vandalism and/or infections. For instance, when the bee colonies get infected with

American foulbrood (see Genersch, 2010), the majority of material and equipment needs to be burnt and the beekeeper has to start over again. Accordingly the high input costs can impose serious limitation on follow-up beekeeping activities.

Kamler (2007) emphasizes, that it is possible to save time and consequently the labour costs through introducing better practices and improving the quality of equipment, but it is not possible to save much on material cost items. Hence the austerity measures should not be taken to the detriment of the health of bee colonies. Furthermore, the beekeepers should bear in mind their own education and professionalization, inasmuch as their bee colonies depend on their knowledge and disease control (Jacques et al., 2017).

In spite of the information shortage of small-scale beekeeping economics and the fact that the economics of hobby beekeeping operations is often neglected, the findings show that the economic terms might play an important part in further development of beekeeping sector, where the hobbyists prevail. Apart from the high input costs and significant amount of expenditures, the lack of financial support (particularly in Switzerland) together with regressive demographic structure of European beekeepers and relatively low domestic consumption of honey (especially in the Czech Republic) might have adverse effects on long-term sustainability of beekeeping sector both in the Czech Republic and Switzerland.

In comparison to the statistical data[122] on average honey yield, the outputs[123] from the expert interviews show the underused potential of honey yield, especially in the Czech Republic. Referring to Eiblmeier (2016) and Kamler (2005, 2007), the profitability of a beekeeping operation is influenced by the amount of honey yield harvested per bee colony and year. Kamler (2005, 2007) posits that the profitability threshold of professional beekeeping operations lies on average between 30 and 40 kg of honey per bee colony a year, on condition of contemporary level of beekeeping and bee colony treatment. It is advisable to make efforts to reach higher honey yields through enhancing bee colony health (proper nutrition, hygiene and treatment measures), improving the breeding quality of queen bees (Kamler, 2005), good beekeeping practice and own professionalization (Jacques et al., 2017) and the like. Beekeepers should provide their bee colonies with abundant and multifarious pasture and

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[122] 15.3 kg/ bee colony/ year in the Czech Republic (SVZ, 2017) and 18.3 kg/ bee colony/ year in Switzerland (Charrière et al., 2018)

[123] 32.2 kg/ bee colony/ year in Czech dataset (see 3.4.1) and 18.6 kg/ bee colony/ year in Swiss dataset (see 3.4.2)

therefore support honeybee nutrition (cf. Garbuzov and Ratnieks, 2014; Majewska and Altizer, 2018). The potential of cooperation with other related organizations might be realized as well. For example having an affiliation with local allotment and leisure gardeners' associations[124] appears to be beneficial to both groups – beekeepers and gardeners. In addition to that, one of the interviewed beekeepers in Switzerland highlighted the virtues of adopting permaculture practices (cf. Holmgren, 2006) to honeybee forage.

On the grounds of the results of the expert interviews (Figure 26), the weak part of bee products sales promotion was identified, so improving the marketing performance might be useful. Apart from the advertising (e.g. signboards, flyers distribution, reselling honey in local shops), the power of internet and social networks remains undervalued. The report by the Leopold Center (2010) also emphasizes the importance of successful marketing comprised of outstanding honey quality, packaging, advertising and customer service.

Furthermore, it is recommended to increase domestic honey consumption (through building the trust of consumers in inland honey by its top-quality and/or certification) and to raise public awareness of beekeeping and bee products (by lecturing or organizing various public events – e.g. public honey harvesting, honey tasting/ degustation, open days in apiaries, exhibitions and markets). Some of the campaigns might be realized under the auspices of a public institution as well as private entity. In subchapter 4.4 several initiatives to promote beekeeping are described.

[124] Czech Union of Allotment and Leisure Gardeners / Český zahrádkářský svaz, z.s. (ČZS, 2011) and Schweizer Familiengärtner-Verband / Fédération suisse des jardins familiaux (SFGV, 2019)

4.2 Czech Honey Price Time Series Analyses

The aim of these time series analyses is to assess how the Czech honey price (as an economic variable) varies over time, and thus some quantitative methods are selected to empirically estimate the changes in economic variables. Firstly, the methods of growth rate and linear approximation are examined to measure the short-term changes in Czech honey prices. Secondly, the Autoregressive Integrated Moving Average (ARIMA) model of Box-Jenkins methodology is applied in order to analyse given economic time series and to forecast its short-term future values. In response to price volatility of agricultural commodities, accurate price forecasting is gaining in importance for several interest groups and stakeholders. Hence the purpose of Czech honey price analysis is to moderate the presented lack of price clarity for both beekeepers and consumers, and to forecast future price development of honey in the Czech Republic.

4.2.1 Growth Rate and Linear Approximation

As seen in Table 36 (Appendices), the price for 1 kg of Czech honey in January 1995 (y_t) equalled 80.34 CZK and according to CZSO (2019b) the honey price in January 2019 (y_{t+n}) was 204.52 CZK. The question is, which constant growth rate (r) had changed the Czech honey price in January 1995 to the price in January 2019 within 289 months (n).

The growth rate (r) is calculated based on the definition expressed by Hendricks (2016):

$$1 + r = \left(\frac{y_{t+n}}{y_t}\right)^{\frac{1}{n}} \tag{24}$$

And after the application of this formula to given data series:

$$1 + r = \left(\frac{204.52}{80.34}\right)^{\frac{1}{289}} \tag{25}$$

$$r = 0.003238444 \tag{26}$$

From January 1995 to January 2019 the Czech honey price has grown by 0.3238 % p.m. As the r is considered very small (close to 0), the linear approximation is according to Hendricks

(2016) and Sydsæter et al. (2016) applicable as well[125]. The linear approximation equation has the shape as follows:

$$r = \frac{\ln(y_{t+n}) - \ln(y_t)}{n} \tag{27}$$

And consequently:

$$r = \frac{\ln(204.52) - \ln(80.34)}{289} \tag{28}$$

$$r = 0.003233212 \tag{29}$$

The examination shows that computed results from growth rate calculation (26) and linear approximation (29) are nearly identical, which confirms that for very small growth rates the mathematical technique of linear approximation can be applied.

4.2.2 ARIMA Model

The ARIMA model is applied to analyse, estimate and forecast the time series of Czech honey prices. IBM® SPSS Statistics software is used for data processing and performing analyses. Original dataset is available in Table 36 in Appendices. Using Box-Jenkins methodology requires sufficient amount of observations (Hindls et al., 2004) and the original dataset consists of 288 records obtained from CZSO (Kholová, personal communication, March 6, 2019) representing average monthly prices of 1 kg Czech honey in CZK over the period from 1995 to 2018 (see Figure 30).

The sequence plot in Figure 30 illustrates the development of Czech honey prices (for 1 kg of honey, in CZK) between the years 1995 and 2018 at month intervals. From the graph it is obvious that the time series is non-stationary. The non-stationarity is also examined by the correlogram analysis (see the subsection 4.2.2.1 for details). Espasa (2004) works on the assumption that the long-term development of a time series is eliminated by differencing its data, resulting in both a stationary transformation of the original data set and creating the unit root condition for an ARIMA model.

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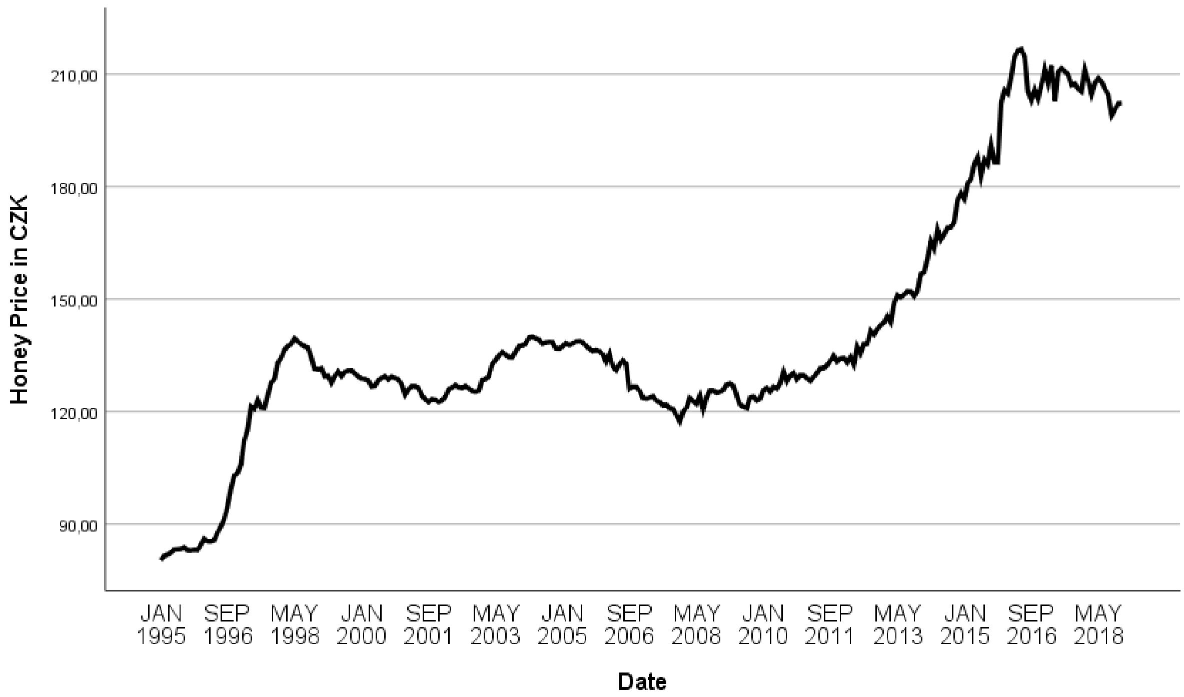
[125] In the following form: $\ln(1 + r) \approx r$

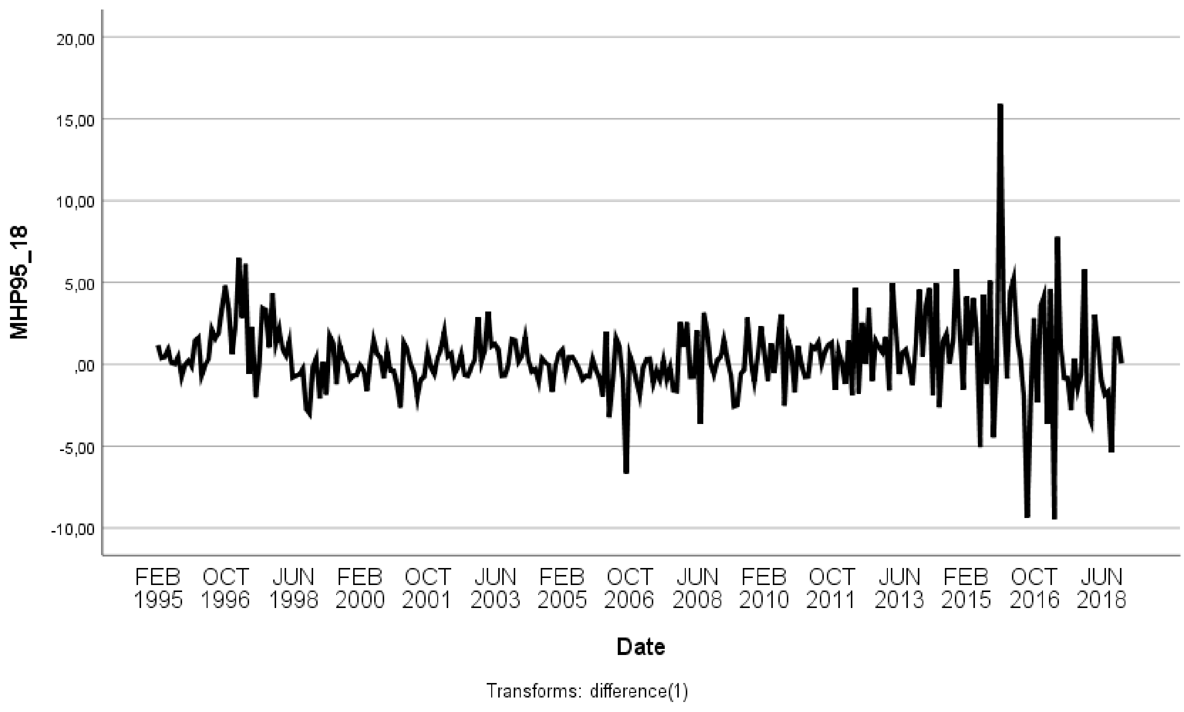
Figure 30: Monthly sequence of the Czech honey prices in CZK (1995 – 2018)



Source: own processing in IBM® SPSS Statistics according to CZSO (2019)

Non-stationarity of the time series needs to be removed by differencing the data (Figure 31).

Figure 31: Sequence plot of differenced time series data (1st difference)



Source: own processing in IBM® SPSS Statistics

From the chart it can be seen that after simple transformation accomplished by differencing, the new sequence plot is stationary and the mean of differenced time series data is around zero, as proved by its calculation in IBM® SPSS Statistics in Table 23, giving that the mean equals to 0.4249.

Table 23: Descriptive statistics on differenced time series data (1st difference)

TIME SERIES DIFFERENCE	N	MEAN		STD. DEVIATION	VARIANCE
		STATISTIC	STD. ERROR		
1ST ORDER	287	0.4249	0.13954	2.36393	5.588

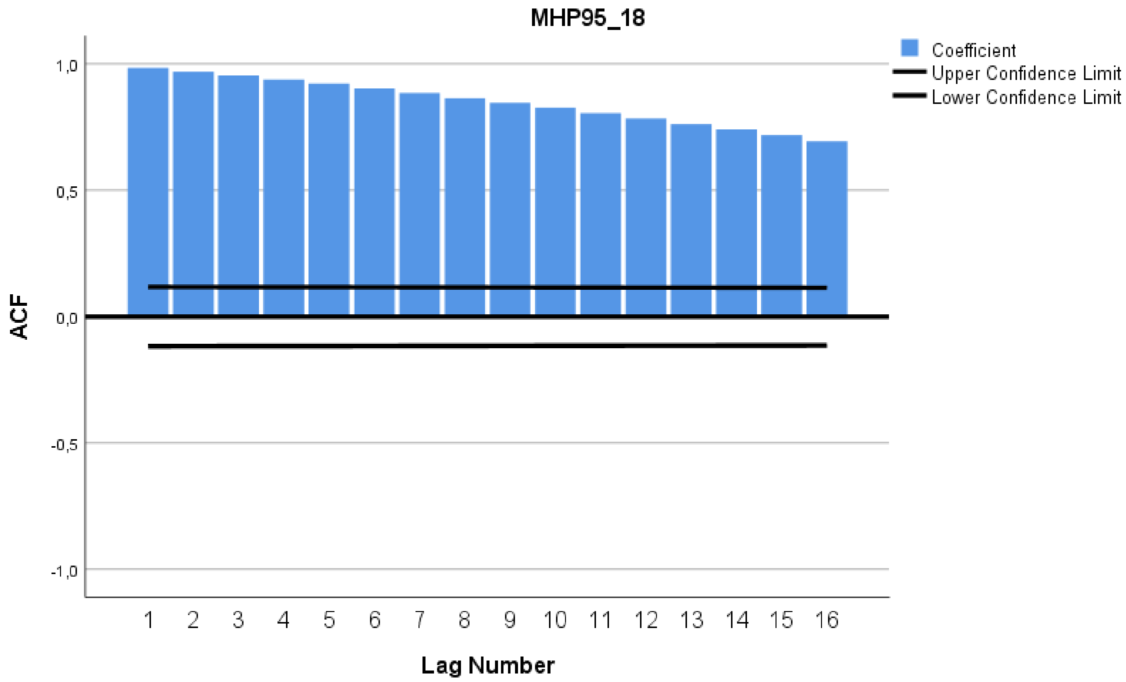
Source: own processing according to IBM® SPSS Statistics

In order to assess the suitability of the first difference of the time series, inasmuch as the chart of the second difference also shows eliminated non-stationarity (see Figure 39 and Table 37 in Appendices), the variance of both plots is used. With regard to the calculation in IBM® SPSS Statistics, the variance of first differenced data equals to 5.588, while the variance of the second differenced data amounts to 11.366. In view of the fact that the variance of the first-order differenced data is lower than the variance of the data differenced by higher order, the differencing by the first order seems to be appropriate.

4.2.2.1 Model Identification

The model is identified through the use of the autocorrelation (ACF) and partial autocorrelation (PACF) functions analysis, as recommended by Box et al. (1994). The ACF correlogram of original time series (in Figure 32) shows a slow downward trend. The first value (0.985) is close to 1 and the following values gradually decline with increasing lag numbers on the horizontal axis. Therefore, given time series is considered a special non-stationary stochastic process, called random walk without a drift. This assumption can be verified through differencing the random walk series. In case the sequence follows a random walk, the differenced series exemplifies white noise (Cowpertwait and Metcalfe, 2009; Ramík, 2007). With regard to the correlogram in Figure 40 (Appendices), the sequence is considered a white noise, although some of the values slightly overlap upper 95 % confidence interval.

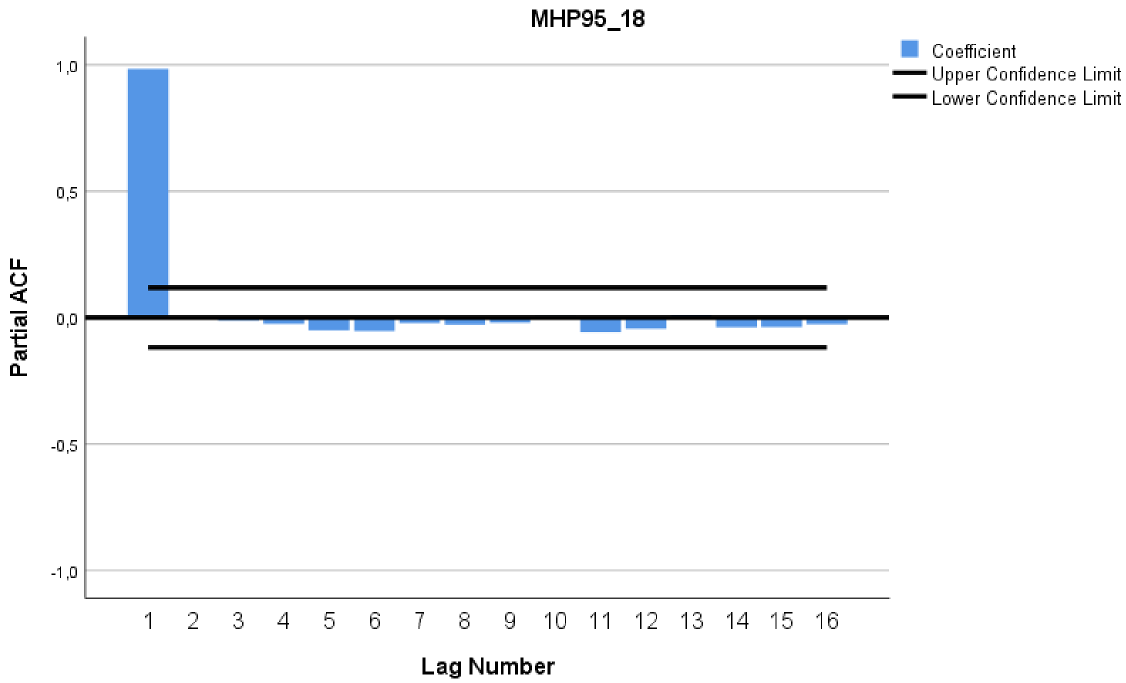
Figure 32: ACF of the original time series data (no differencing)



Source: own processing in IBM® SPSS Statistics

Figure 33 below shows the PACF correlogram of original time series and Figure 41 (see Appendices) depicts the sequence after differencing the original data.

Figure 33: PACF of the original time series data (no differencing)



Source: own processing in IBM® SPSS Statistics

Overall, according to Ramík (2007), the downward sequence of ACF values and the shape of PACF (i.e. high first value followed by statistically non-significant values) indicate the non-stationarity of the first order, i.e. type I(1), referring to ARIMA model. The first differencing of the given time series is therefore needed. After data transformation (see Figure 31), subsequent ACF and PACF correlograms are carried out (Figures 40 and 41 in Appendices).

4.2.2.2 Model Estimation

In order to determine the appropriate model, different ARIMA types in various orders are tested, because sometimes the model cannot be unequivocally identified simply on the basis of ACF and PACF analysis, and therefore more criteria (e.g. Normalized BIC, Stationary R^2 and Ljung-Box Statistic) need to be employed in the model selection. The results of model selection are available in Table 24. In case of non-seasonal time series the situations where *p*, *d* or *q* need to be greater than 2 are rare. Often, for one or more of these parameters the values of zero or unity seem to be apt (Box et al., 1994).

Table 24: Model selection criteria and their values for individual types

MODEL TYPE	NORMALIZED BIC	STATIONARY R^2	LJUNG-BOX (p>0.05)
ARIMA (0,1,0)	1.766	0.001	0.000
ARIMA (1,1,0)	1.790	0.001	0.000
ARIMA (0,1,1)	1.790	0.001	0.000
ARIMA (1,1,1)	**1.791**	**0.030**	**0.053**
ARIMA (2,1,1)	1.808	0.043	0.206
ARIMA (1,1,2)	1.808	0.050	0.224
ARIMA (2,1,0)	1.812	0.013	0.011
ARIMA (0,1,2)	1.815	0.010	0.008
ARIMA (2,1,2)	1.887	- 0.026	0.000

Source: own processing in IBM® SPSS Statistics

For Normalized BIC lower values indicate better fit and contrarily the larger values of R^2 indicate better fit. Even though the first three models have shown lower Normalized BIC levels, their Stationary R^2 is low and also the diagnostic check by Ljung-Box Statistic prevents from using them, as they include some neglected structures that should be taken into consideration. According to the ACF and PACF analysis and testing of diverse model types, the ARIMA (1,1,1) is selected as the most suitable model to given time series of Czech honey prices. In Table 25 model's parameters obtained from IBM® SPSS Statistics are stated.

Table 25: Parameters of the ARIMA (1, 1, 1) for the Czech honey prices time series

PARAMETER	ESTIMATE	STAND. ERROR	T-STATISTIC	P-VALUE
AR (1)	0.959	0.054	17.877	0.000
MA (1)	0.933	0.068	13.689	0.000
CONSTANT	0.159	0.499	0.319	0.750

Source: own processing according to IBM® SPSS Statistics

If the estimated parameters are compared with twice the amount of the standard error, it is ascertained that both parameters significantly differ from zero, and thus the model cannot be simplified by parameter removal. Hence both AR (1) and MA (1) parameters are considered as statistically significant, which is confirmed by p-values and t-test results too. In accordance with the estimated parameters in Table 25, the model has the following form:

$$y_t = 0.959y_{t-1} + \varepsilon_t + 0.933\varepsilon_{t-1} \qquad (30)$$

For the purpose of checking model's goodness-of-fit measures, primarily the normalized BIC is employed. The results of normalized BIC, R^2, Stationary R^2, MAPE (Mean Absolute Percentage Error) and MAE (Mean Absolute Error) are in Table 26.

Table 26: Model's goodness-of-fit measures – ARIMA (1, 1, 1)

MODEL FIT	NORM. BIC	R^2	STATION. R^2	MAPE	MAE
ARIMA (1,1,1)	1.791	0.995	0.030	1.074	1.574

Source: Source: own processing according to IBM® SPSS Statistics

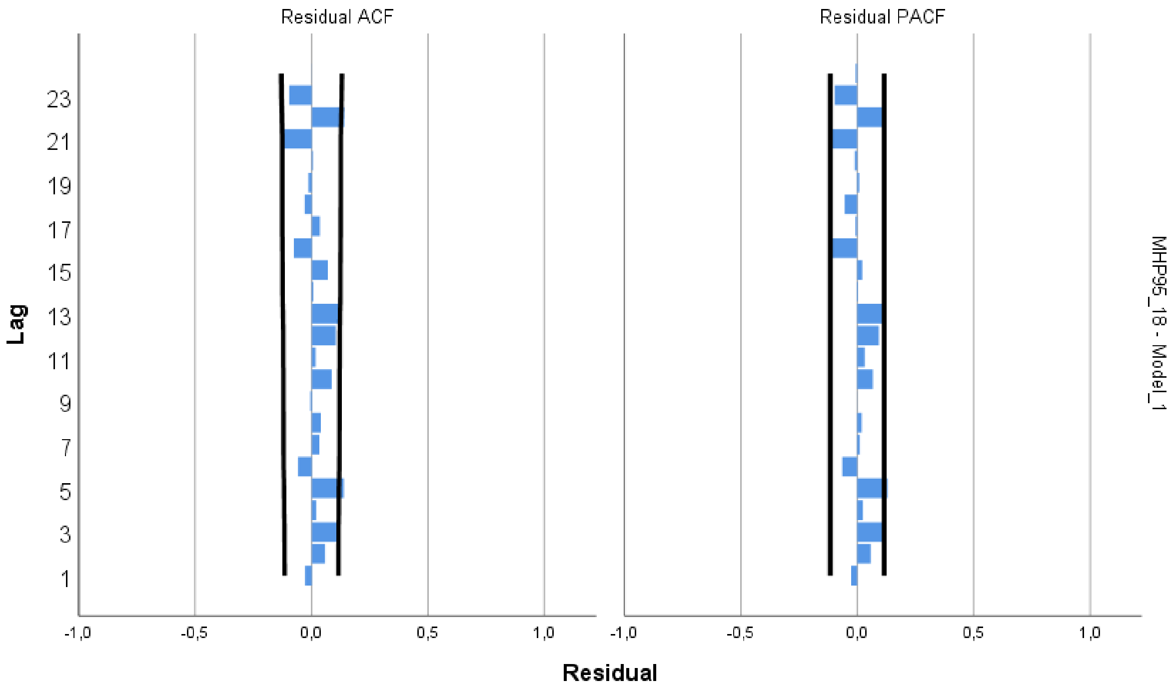
In case of Bayesian Information Criterion smaller values indicate better model fit, and therefore the ARIMA type (1,1,1) is identified as the appropriate one.

4.2.2.3 Diagnostic Checking

For the purpose of model's diagnostic check, the residuals are plotted in ACF and PACF to visually inspect potential autocorrelation and the results of Ljung-Box statistics are discussed. It is important to stress here that all three stages of stochastic model building described by Box et al. (1994, 2016) necessarily overlap and cannot be separated from each other. So, the model's fit is also verified in previous subsection (4.2.2.2) through analysing the significance of its parameters.

From the residual autocorrelation and partial autocorrelation functions in Figure 34 it can be seen that there are few larger values approaching the borderline of the 95 % confidence interval.

Figure 34: Residual ACF and PACF of ARIMA (1,1,1) model



Source: own processing in IBM® SPSS Statistics

Box et al. (2016) posit that correspondingly to the increase of the series' length, the residuals approximate to the white noise and accordingly, Ramík (2007) claims that the built model is correct, just when the residuals are white noise. In conclusion, on account of the correlograms in Figure 34 and the results in Table 39 (in Appendices) the residuals are assessed as a white noise, despite some values at the margin of the 95 % confidence limit. In addition to that, Table 27 below shows the results of Ljung-Box statistic verifying model's correct specification.

Table 27: Ljung-Box statistic results

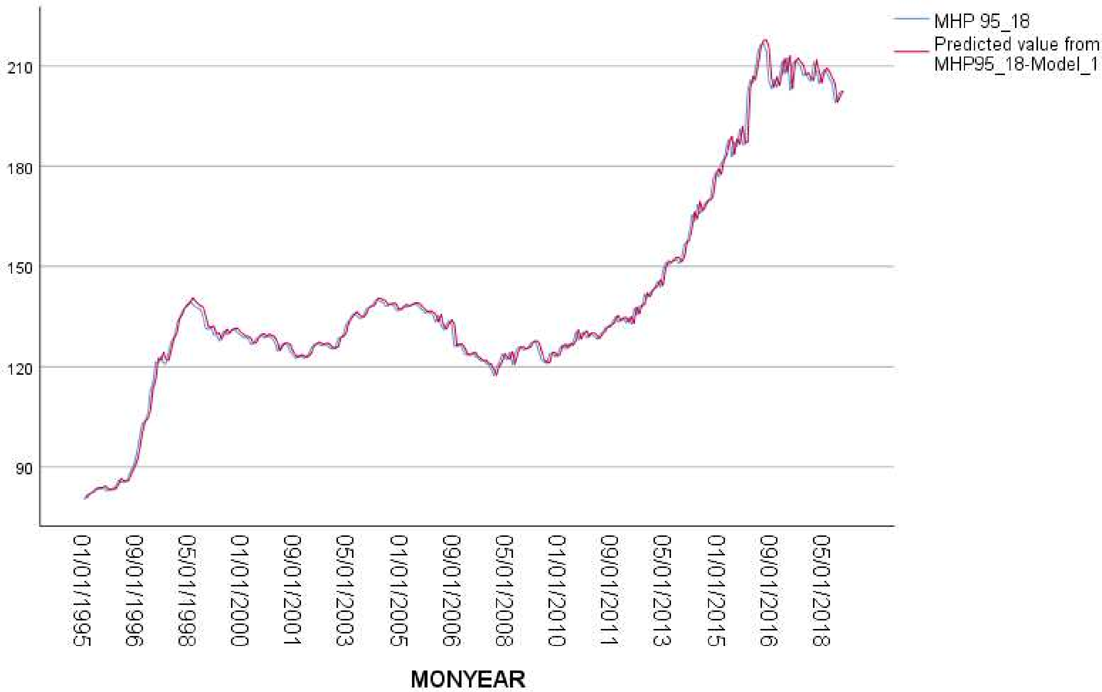
MODEL	STATISTICS	DEGREES OF FREEDOM	SIGNIFICANCE
ARIMA (1,1,1)	26.065	16	0.053

Source: Source: own processing according to IBM® SPSS Statistics

The significance value lower than the 0.05 level indicates that within the inspected time series there exists a structure which is omitted in the model (IBM, 2010). Although the value shown above (0.053) is close to being statistically significant, it is concluded that the model is correctly specified and there are no statistically significant structures overlooked within the given model.

In order to summarize the suitability of built model, the graph of predicted and real values is created in Figure 35.

Figure 35: Sequence plot of the predicted values and their fit to original time series



Source: own processing in IBM® SPSS Statistics

From the Figure 35 it is clear that the sequence chart development of the predicted values is analogous to the original data run. Although the slight delay is spotted in detail view, the model is with regard to both accomplished diagnostic checks considered adequate.

4.2.2.4 Forecasting

The last step in present time series analysis is to predict short-term future development of given sequence and to compare forecasted values with real data.

Box et al. (2016) claim that the forecast is not significantly affected by parameters' estimation errors, in case the sequence is long enough. The original time series is comprised of 288 values, and thus meets such requirement.

Besides model's predictions for certain periods of time, Table 28 (below) includes lower and upper 95 % confidence intervals for the forecasted values. And even though the width of a confidence interval seems to be large, it matches up with data variability.

Table 28: Comparison of the ARIMA (1,1,1) forecast with real data (2019)

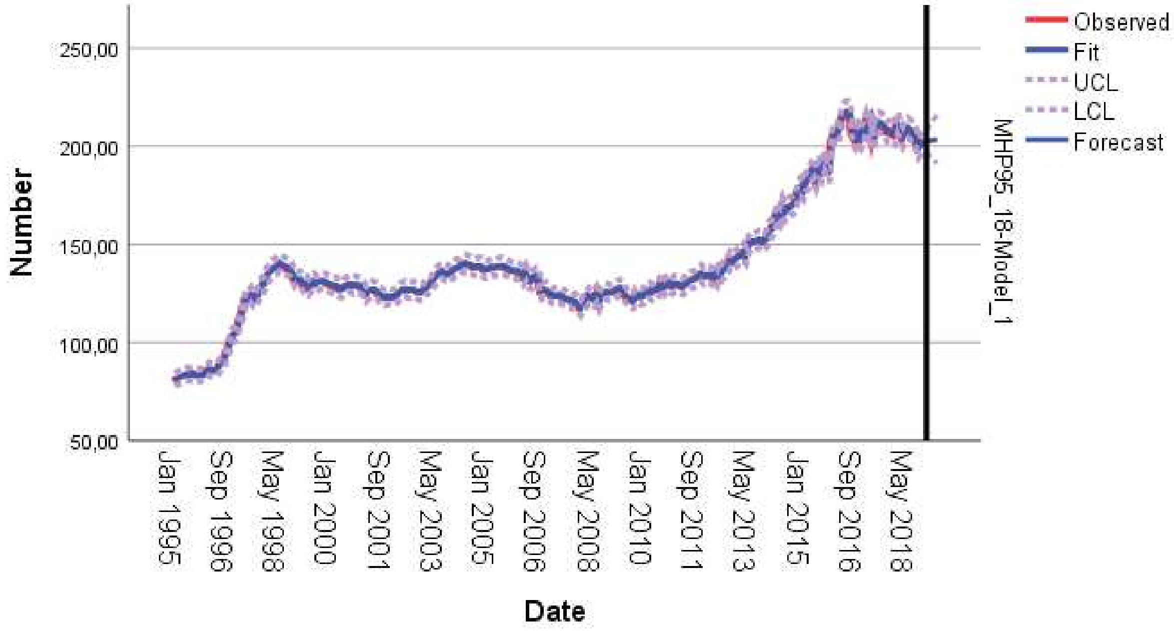
TIME	FORECAST	LOWER 95 % CL[126]	UPPER 95 % CL[126]	REALITY
January 2019	202.53 CZK	197.37 CZK	207.73 CZK	204.52 CZK
February 2019	202.76 CZK	195.39 CZK	210.24 CZK	207.55 CZK
March 2019	203.01 CZK	193.87 CZK	212.30 CZK	203.45 CZK
April 2019	203.25 CZK	192.58 CZK	214.14 CZK	201.98 CZK
May 2019	203.51 CZK	191.45 CZK	215.84 CZK	203.40 CZK

Source: own processing according to IBM® SPSS Statistics and CZSO (2019b, internal data)

Apart from the five new values of future forecasts (from January 2019 to May 2019), the predictions for original time span (from January 1995 to December 2018) are automatically generated (see Table 41 in Appendices) and their fit to the original dataset is visualized in Figure 36, including the confidence intervals and new values.

[126] CL = Confidence Limit

Figure 36: ARIMA (1, 1, 1) forecast and model's fit to original data



Source: own processing in IBM® SPSS Statistics

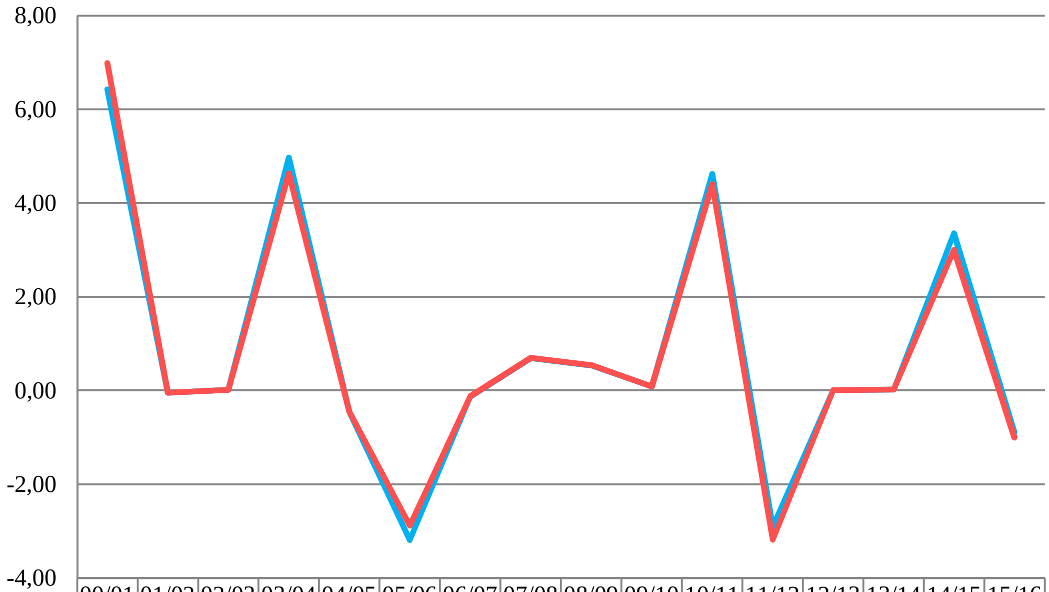
Overall, according to the Figure 36, the forecast values seem to fit the original dataset well. However it is necessary to beware of the generalization from the diversity of empirical results, inasmuch as it appears that no single modelling technique is convenient for all agricultural commodities and/or research problems (Tomek and Myers, 1993). Although the honey price is more (Roman et al., 2013) or less important (Ebener, 2015; Šánová et al., 2017) economic factor for its buyers, it still remains crucial variable for beekeepers' income generated from honey sale, enabling them not only making investments, but also motivating them to continue running their beekeeping operation.

4.2.3 Elasticity of Demand for Honey

Several studies (e.g. Fairchild et al., 2000; Guerrero-López et al., 2017; Ward, 2014) have focused on the elasticity of demand for honey, providing various results. Mankiw (2015) thus emphasizes that the price elasticity of demand does not have to inevitably be the same at all points on a demand curve and that some general estimates might not apply to the real world.

Price elasticity of demand for honey is here calculated by means of the midpoint method and a percentage change. Resulting short-term elasticities are presented in line graph in Figure 37.

Figure 37: Price elasticity of demand for honey



	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16
Midpoint	6,42	-0,04	0,01	4,97	-0,45	-3,19	-0,13	0,70	0,54	0,08	4,62	-2,91	0,01	0,02	3,36	-0,90
%	6,98	-0,04	0,01	4,64	-0,45	-2,88	-0,12	0,70	0,54	0,09	4,40	-3,18	0,01	0,02	3,01	-1,00

Source: own processing according to CZSO (2019b), Kholová (personal communication, 2019) and SVZ (2017)

The results of short-term elasticities are ambiguous, since both values of inelastic demand for honey and very high values of elasticity can be observed. The average price elasticity of demand for honey between the years 2000 and 2016 is 0.82 (midpoint method) and 0.79 (percentage change). Ward (2014) obtained very similar result of price elasticity of honey (0.765 in absolute value), indicating honey to be price inelastic commodity. The results of calculated long-term[127] elasticities also imply that product's price is more likely inelastic.

In addition to that, the income elasticity of expenditures on sugar, jam, honey, chocolate and confectionery[128] is calculated in order to provide the insight into consumers' behaviour in the market with regard to the features of Engel's law[129].

The chart in Figure 38 illustrates so called Engel's curve (Chai and Moneta, 2010), demonstrating how household expenditures (vertical axis) on a particular product (i.e. sugar,

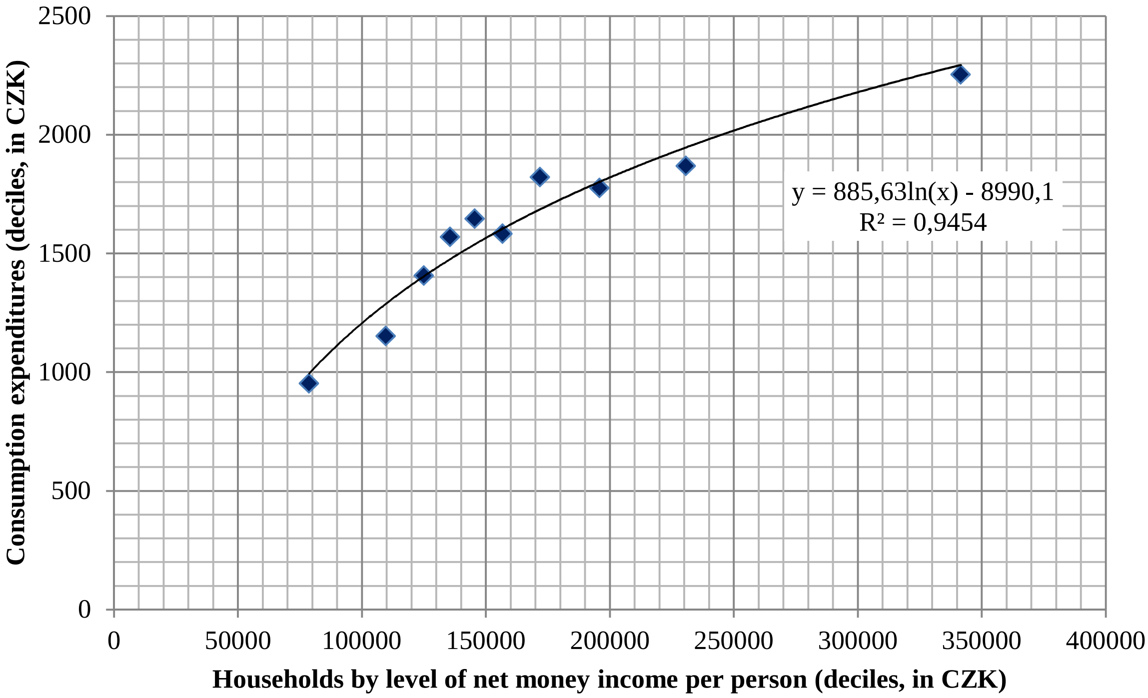
[127] I.e. 2009/2016 (0.504) and 2000/2016 (0.899)

[128] According to CZSO (2016b), honey is not categorized as a separate food product, but within the group 01.1.8 Sugar, jam, honey, chocolate and confectionery.

[129] Engel's law (Engel, 1895) posits that with rising income the proportion of expenditures on food drops, even if the absolute expenditures on food grow. Hence the income elasticity of demand for food ranges between 0 and 1.

jam, honey, chocolate and confectionery) vary with household income (horizontal axis, in deciles).

Figure 38: Consumption expenditures on sugar, jam, honey, chocolate and confectionery in households to the net money income per person (deciles) in 2015 – Engel curve



Source: own processing according to CZSO (2016a,b)

From the graph it can be seen that given product category indicates normal goods, particularly the necessities (cf. Holman, 2007). The results of income elasticity of expenditures on sugar, jam, honey, chocolate and confectionery in households (in deciles) in 2015 provided in Table 29 show the downward trend. As the income elasticity (E_i) is higher than 0 and lower than 1, the curve is considered inelastic, which is typical for food (cf. Mankiw, 2015).

There are some small differences between the theoretical values of expenditures[130] and real data of a given product category. However the R-square (0.9454) indicates an exceptional fit. The quotients resulting from dividing the annual expenditures on sugar, jam, honey, chocolate and confectionery by annual net money income per person show according to Engel's law decreasing trend, and so the proportion of expenditures on food reduces simultaneously with rising income.

[130] They are calculated by means of the trend equation provided in Figure 38.

Table 29: Income elasticity of annual expenditures on sugar, jam, honey, chocolate and confectionery in households in CZK (deciles) in 2015

2015	Deciles				
	1	**2**	**3**	**4**	**5**
Net money income, total (in CZK)	78697	109625	124988	135623	145520
Sugar, jam, honey, chocolate etc. (in CZK)	953	1152	1407	1569	1646
Theoretical values of expenditures (in CZK)	993.93	1287.48	1403.63	1475.95	1538.33
Income elasticity of expenditures (E_i)	0.891042	0.68788	0.630957	0.60004	0.575709
Engel's law[131]	0.01211	0.010509	0.011257	0.011569	0.011311
2015	**6**	**7**	**8**	**9**	**10**
Net money income, total (in CZK)	156718	171850	195874	230669	341511
Sugar, jam, honey, chocolate etc. (in CZK)	1583	1822	1776	1868	2254
Theoretical values of expenditures (in CZK)	1603.99	1685.62	1801.50	1946.31	2293.83
Income elasticity of expenditures (E_i)	0.552143	0.525404	0.491606	0.455029	0.386092
Engel's law[131]	0.010101	0.010602	0.009067	0.008098	0.0066

Source: own processing according to CZSO (2016a,b)

On account of the fact, that honey could not be assessed here as an individual product, but within a specific group, the generalizability of presented results is therefore strictly limited and they hold true only for the analysed product category as a whole. In case of honey, Fairchild et al. (2000) propose that it is considered extremely sensitive to consumers' income fluctuations, while having strong positive correlation with levels of income and being rather a luxury good than a necessity.

[131] I.e. the amount of annual expenditures (in CZK) on given product category (sugar, jam, honey, chocolate and confectionery) divided by annual net money income per person (in CZK).

4.3 Professionalization of Beekeepers

"Professionalization is the process by which a socially significant occupation organizes itself to ensure its practitioners perform their services well and thereby earn a larger share of societal respect and reward."

Ann Pederson (2005, p. 52)

Beekeeping is an activity requiring in-depth knowledge about various disciplines of natural sciences, such as biology, botany, veterinary science, phenology, entomology and the like. On a long-term basis it is not feasible to successfully keep bees, while having only rudimentary knowledge of apiculture. In their pan-European study Jacques et al. (2017) revealed that the bee colony survival is dependent on beekeeper's knowledge and disease control, which makes the professionalization of beekeeping sector topical key issue. Beekeepers are responsible for the state of health of their bee colonies and except for the good beekeeping practice they should regularly acquire new professional skills and knowledge, inasmuch as new threats constantly emerge (cf. Monceau et al., 2014; Mutinelli, 2011; Neumann et al., 2016) and timely action must be taken. Beekeeper has to be able to recognize the outbreak of different diseases[132] and consequently make provision for preventing their transmission. Tilman et al. (2002) highlight the reliance of farmers and beekeepers on an extensive base of agronomic and biological knowledge, which is frequently bound to certain regions and agroecosystems. On account of the importance of beekeepers' lifelong learning, the part of the undertaken research was focused on beekeepers' professionalization.

Regarding the origin of beekeeping activity, the majority of respondents in the Czech Republic (68.18 %) and Switzerland (64.52 %) have a beekeeper in family, among friends, neighbours or acquaintance. Less than a fifth of interviewed experts (18.18 % in the Czech Republic and 16.13 % in Switzerland) started beekeeping from own interest, while the rest of interviewees had other reasons (e.g. own honey production, free time in retirement, interest in apitherapy). In view of the fact, that the family tradition prevails in both samples, it is obvious that direct knowledge exchange and experience sharing might apply to these particular respondents. A half of Czech respondents (50.73 %) admit acquiring early knowledge from

[132] Such as American foulbrood (Genersch, 2010), European foulbrood (Forsgren, 2010) and varroosis (Boecking and Genersch, 2008). Moreover, the latter might specifically influence the occurrence of severe virus infections of honeybees – e.g. Deformed Wing Virus, Acute Bee Paralysis Virus and Kashmir Bee Virus (e.g. Staroň et al., 2009; Tantillo et al., 2015).

family member/s and/or experienced beekeepers. More than a fourth of interviewed experts (26.08 %) in the Czech Republic visited beekeeping course and ca. 23.19 % relied on autodidacticism (literature in particular). In Switzerland, ca. 42.59 % of interviewees had a mentor and 38.89 % attended training organized by local organization. Nearly a fifth of Swiss respondents (18.52 %) studied beekeeping as autodidacts. There is a significant difference between respondents in both countries concerning attending courses for beginning beekeepers. Only 39.53 % of interviewed Czech beekeepers in contradistinction to 61.29 % of Swiss interviewees attended the course for beginning beekeepers.

Pretty (2008) posits that the lack of information and management skills is the major barrier to the adoption of sustainable agriculture. In defiance of the costs of making mistakes, it is necessary to acquire new knowledge and information (Pretty, 2008). The vast majority of all interviewed beekeepers in both countries find further education very important and they confirm effective learning not only through practice, but also through studying various sources – e.g. professional journals (CH 26.87 %; CZ 30 %), literature (CH 20.89 %; CZ 27.27 %), internet (CH 29.85 %; CZ 24.55 %) – and visiting various lectures (CH 10.45 %; CZ 12.73 %) or sharing own experience with other beekeepers (CH 11.94 %; CZ 5.45 %). In terms of courses availability, majority of Swiss respondents (70.97 %) find the offer sufficient, but only nearly a half of Czech interviewees (48.78 %) is satisfied with the quantity of offered trainings and lectures.

More than 40 % of interviewed experts in the Czech Republic (43.18 %) and Switzerland (41.94 %) are lecturing in courses organized by local beekeeping organizations. During the interviews it was found out that nowadays a certain amount of beekeeping newbies quits their beekeeping efforts within few years from the starting point. Some of the lecturers see the problem in unrealistic expectations, time demands and requirement of continuing education. Even though the official statistics on this phenomenon do not exist, it is estimated that the numbers of quitting beginning beekeepers account for tens of percent. In the Czech Republic the vast majority of beekeepers are members of the CBU, which keeps statistical records of Czech beekeepers and their bee colonies. Nevertheless, in Switzerland such data are lacking, and therefore the problem of gradual beekeepers' decline might be overlooked. In the context of beekeepers' ageing (cf. EC DG AGRI, 2013), great importance needs to be attached to this issue not only for the purpose of preserving certain level of bee colony density (providing pollination, securing agricultural production and so on), but also on account of economic efficiency (i.e. costs on lecturing, equipment, time).

In conclusion, gaining new knowledge, building new skills and learning something new belong to beekeepers’ reasons to keep bees. According to conducted interviews, there is a broad range of motives to start own beekeeping operation. Beekeeping is in both countries considered as meaningful and beneficial activity bringing joy, fulfilment and linking humans to nature and environment. Apart from bee products and additional income it offers an opportunity to stay active, spend time outdoors and meet new people who share the same passion. Hobby beekeeping has a long tradition in Europe (Chauzat et al., 2013; Jones, 2004) and as a leisure or therapeutic activity it can contribute not only to stress moderation (Coleman and Iso-Ahola, 1993), but also to reduction of pathological phenomena (Kunecký, 2015; Tierney, 2012) – see subsection 4.4.3.

4.4 Selected Beekeeping Initiatives

In following sections some successful beekeeping initiatives from the Czech Republic and Switzerland are presented. Their overall objective is to promote apiculture not only to general public, but also to more specific target groups (e.g. children and youth, urban dwellers, stakeholders in the hospitality industry, prisoners), and therefore raise their awareness of beekeeping. In spite of the supplementary character of beekeeping to these initiatives (as they cannot make their living solely out of apiculture), their indisputable social virtues (e.g. fostering social interactions in community, knowledge exchange, education) and positive environmental effects (e.g. supporting bee populations in their local indigenous territories) can compensate for the economic burden (cf. Garnett, 2000). Each of the presented case studies (youth beekeeping clubs, urban beekeeping in a hotel or restaurant, beekeeping behind bars and railway exposition) can thus serve as an inspiration and stimulus to encourage active community participation as well as local entrepreneurship.

4.4.1 Beekeeping Clubs for Children and Youth

One of the key issues of contemporary European beekeeping is beekeepers' ageing (EC DG AGRI, 2013; Šimpach, 2012). In order to achieve change for the better in the age structure of Czech beekeepers, there are various educational programmes (supported by the EU[133]) not only for adults, but also for young people. These activities depend both on financial support and professional staff. On account of content, the education is primarily focused on systematic and long-term training to acquire the professional knowledge. The courses intended for young people and beginning beekeepers include broad range of topics – for instance general assumptions about apiculture and the significant role of bees, honey bee stocks and their anatomy, beehive systems and apiaries, beekeeping tools and gear, preventive measures and fighting diseases (AIR, 2018; NAP, 2016).

About one fourth of interviewees from the Czech Republic are actively engaged in beekeeping clubs (i.e. supervision, lecturing, support and so on). The help of local beekeeping organizations is of great importance to beekeeping clubs too, because they often provide these clubs with material and support them in terms of staffing. Beekeeping club(s) can be established by local beekeeping organization, elementary and secondary schools etc. Given the CBU internal data (2019), there are more than 230 beekeeping clubs in the Czech

[133] National Apiculture Programmes 2017 – 2019 (EC, 2019)

Republic. The importance of international cooperation and networking is emphasized by activities of the ***International Centre for Young Beekeepers®*** (ICYB, 2019), which also focuses on young beekeepers and the coordination of the ***International Meeting of Young Beekeepers®*** (IMYB, 2019).

According to the expert interviews, in Switzerland some beekeepers cooperate with schools (cf. Bienen in der Schule, 2019), inasmuch as they offer visits of their apiaries and/or install observatory hives to school classes. One third of respondents has own experience with such local educational events for young people, which are usually organized on a volunteer basis. Besides these initiatives there are few private campaigns funded by business and some spontaneous social occasions. In addition to that, there are regional projects such as ***Railway Beekeeping Exposition***[134] or ***Bee Trails*** (Bienenlehrpfad, 2019; Bienenpfad, 2019) targeting young people (as well as general public) and attracting their interest in beekeeping. In the upshot, an initiative such as beekeeping club for children and youth is considered valuable for future development of Swiss apiculture too.

4.4.2 Urban Beekeeping Operations

In the Czech Republic as well as in Switzerland there are many urban beekeeping operations. In this subsection the initial part focuses on rooftop beekeeping phenomena, and consequently two case studies of urban beekeeping within hospitality industry (restaurant and hotel) are presented.

A key to successful integration of urban beekeeping (and urban agriculture alike) into present-day city development lies in attaining the knowledge on the suitability and specifics of the urban surroundings. One of such particularity is the fact that many of the apiaries are placed at the rooftops of the buildings; hence the expert interview was conducted with Czech professional in rooftop and urban beekeeping (Interviewee A, in-person meeting, 1.12.2017), hereinafter referred to as Interviewee A.

The main specifics of ***rooftop urban beekeeping*** consist in limited number of bee colonies (maximum of 10 bee colonies), experienced beekeeper, beekeeping practice (non-aggressive honey bee stock, animal welfare, measures to prevent swarming, adopting hygienic and veterinary measures), building maintenance (rooftop accessibility, fire safety, information

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[134] See the subsection 4.4.4 for details.

signboard, rooftop fall protection railing), communication with stakeholders (building owner, occupants, neighbours) and so on (Interviewee A).

Although the rising interest in urban beekeeping (Delaney, 2018; Fenske, 2018) is often attributed to a popular trend of urban agriculture and preventing pollinators' decline, there are some practical reasons too. On account of the lack of space in the cities, rooftops demonstrate a suitable location for bee colonies, because they can provide satisfactory conditions for keeping bees. These are for instance not bothered by rodents or other pests (Interviewee A).

Behnke (2017) emphasized the advantages of urban beekeeping within hospitality industry and its significant role in marketing and PR. There is a broad range of strategies to promote rooftop beekeeping – for example public honey harvesting, organizing honey brunch, installation of information signboards, social networking, in-house honey at hotel breakfasts, honey sale for the guests/customers at the hotel reception desk and so forth (Interviewee A).

One of the virtues of urban beekeeping is larger honey yield from a wider variety of sources (Davis and Cullum-Kenyon, 2016) as well as exclusivity attributed to urban honey for its relative uniqueness given by small number of beekeepers and higher prices. With regard to the bee pasture, urban areas offer abundance of floral resources throughout the season, which is partially caused by heat island phenomena (Interviewee A).

Considering the public awareness, there is both positive and negative feedback. Irresponsibility and imprudent actions of some beekeepers pose a serious threat of damaging the reputation of conscientious urban beekeepers and the rooftop apiculture as a whole. Although there is always something to improve (e.g. technology, communication), rooftop beekeeping remains an avocation offering amazing city views and opening new horizons (Interviewee A).

For the case study of ***urban beekeeping operation in a restaurant***, local bistro in Basel was addressed an inquiry for an expert interview. The interview was conducted with a hobby beekeeper working full-time as a cookery instructor in the restaurant's social enterprise (Interviewee B, in-person meeting, 31.5.2017), hereinafter referred to as Interviewee B.

Bistro specializing in regional and seasonal dishes gave rise to its own beekeeping operation on the restaurant's rooftop 6 years ago. Interviewee came up with the initial idea, as he had though over sustainable products concept and missed closer linkage between social enterprise, agriculture and pollination. Nowadays there are 7 bee colonies of the Carniolan honey bee and the Buckfast bee cross-breed in Langstroth beehives. Bee pasture includes linden, buckeye, locust tree blossoms, herbs, berries, fruits, vegetable and honeydew. Honey yield (ca. 15-20 kg per bee colony a year) is for sale in the bistro, is processed in cold kitchen and given away to family and friends of the staff. Furthermore, honey serves here as a subject of barter trade too, when the agricultural goods from local producers (e.g. pears) are exchanged for honey. Such transaction notably reduces food waste and enhances social networking within the community. Even though the advertising is creative, it is not too intensive, because it only consists of some information flyers and websites. They rather promote urban beekeeping than honey sale, which would lead to the pressure on higher production. Urban agriculture is in this case tightly interconnected with public engagement and volunteering. Bistro as a social enterprise employing people with mental disability is funded by city resources (Interviewee B).

In order to collect data for the case study of ***urban beekeeping operation in a hotel***, firstly, the expert survey was accomplished with hotel representative (Interviewee C, e-mail communication, 6.6.2017) to obtain information on project initiation, implementation and development from business and managerial perspective. And secondly, the data about beekeeping management was gathered from an external beekeeper hired by hotel (Interviewee D, e-mail communication, 20.6.2017), hereinafter referred to as Interviewee C and Interviewee D.

The original idea came from a visit to another hotel, where a similar project is running. Their interest in urban beekeeping originates in concerns about bees' crucial role in natural and agricultural ecosystems, about drawing attention to bee mortality, about promotion of urban apiculture and ecological balance (Interviewee C). There are three bee colonies on the hotel's rooftop kept in Schweizerkasten and Dadant beehives. Regarding honey bee stock, they are the Carniolan honey bees and some cross-breeds bringing average honey yield ca. 15 kg per bee colony a year. Urban surroundings offer diverse and abundant bee pasture including locust tree, buckeye, maple, linden, rape and honeydew sources (Interviewee D). As the in-house honey yield satisfies hotel's needs so far, there is no reason for increasing the number of bee colonies. Despite its exclusivity, honey is not sold, but processed within the hotel restaurant and spa, and given away as a gift to hotel guests instead. In order to raise public awareness of hotel's beekeeping activities, information is published on the websites, in press releases and through social media channels. In addition to that, project's successful marketing and promotion strategy led to nomination for innovation price (Interviewee C).

In conclusion, urban apiculture is a simple and feasible way to get involved in present-day environmental issue, boost brand identity and enrich customer/guest/visitor experience. In case of hotels and restaurants the on-property beekeeping is an opportunity to make a good impression on clients, enhance their stay, surpass their expectations through transcending the ordinariness and conduce to repeat visits. These operations are aimed not only at tourists seeking experiential travel, but also members of local community and general public (Behnke, 2017). Interviewed experts from Basel restaurant and Bern hotel affirmed positive reactions of public and own staff to their urban beekeeping activities. However they are not only hotels and restaurants taking the positive action in establishing urban apiculture business, but also museums, theatres, city halls, hospitals, schools, universities and the like. Kohfink (2010) states the Palais Garnier in Paris as a case in point.

4.4.3 Prison Beekeeping

„Our combined efforts aim to help rehabilitate people living behind bars and enrich their future lives." Carri J. LeRoy (LeRoy et al., 2012, p. vi)

Beekeeping has a potential for a broad range of social services, as there exist numerous practical applications of beekeeping in social work activities. It might represent a way of zootherapy and/or it can be meritorious activity that can be also carried out after social service release (Kunecký, 2015; Tierney, 2012). Moran and Jewkes (2014) present an alternative interpretation of "green" prison in a form of nurturing environment, preferring rehabilitative milieu to retributive one. Progressive and more experimental penal practices are exemplified in prison services in Northern Europe, where the system has the potential to interconnect parallel agendas (Moran and Jewkes, 2014).

In the Czech Republic currently runs a long-term project of beekeeping in prisons "Dobrá (v)úle" managed by the Ministry of Justice of the Czech Republic. The expert interview was conducted with Deputy Minister for Prisons and Criminal Policies, project's author and a person in charge of project operation (Interviewee E, in-person meeting, 26.10.2017), hereinafter referred to as Interviewee E.

The initiative originated from the visit in Oslo[135] prison and the project has been a result of cooperation between the Ministry of Justice of the Czech Republic and the Czech Beekeepers Union since 2016 (Interviewee E).

The aim of this initiative is to let prisoners find out that beekeeping can help them change their life philosophy, values and their way of life after the release. Looking into the bee community functioning can be inspiring for own life. Keeping bees places high demands on beekeepers and their bee colony management. Hence it has to be highlighted that beekeepers need to remain level-headed, stay calm, respect bee community as a whole and perceive its needs. These values can go beyond the life behind bars to the life on release. In addition, beekeeping is beneficial free time activity that mixes business with pleasure (Interviewee E).

With respect to the "green" prisons' sustainability, Moran and Jewkes (2014, 2015) bring forward two central themes: reducing intensive use of resources through modification of physical structures of prison facilities; and providing "green" interventions for inmates in order to increase their future employability after release and consequently decrease the level of recidivism. The initiative 'The Sustainability in Prisons Project' is based on similar principles, as its goal is to bring nature and science behind the bars (LeRoy et al., 2012).

Project draws on voluntariness of both the provider (individual prisons and their professional staff) and the prisoners who are interested in beekeeping. Since apiculture is too specific activity, it cannot be ordered, even though it is a part of a wide range of activities fulfilling one of the main tasks[136] of the Prison Service of the Czech Republic (Interviewee E).

The implementation of the project was preceded by arrangements and preliminaries to motivate the employees of the Prison Service of the Czech Republic and creating technical, material, organisational and personal conditions. Following steps were to establish relations with the Czech Beekeepers Union and to evaluate legislative requirements for beekeeping behind bars (Interviewee E).

According to the Interviewee E, there were 52 bee colonies in 8 Czech prisons in September 2017 and the average number of bee colonies per individual prison oscillated from 3 to 11 bee colonies. Moreover there are 4 prisons where final preparations are made for successful

[135] Specific Scandinavian penal practices are in detail described by Scharff Smith and Ugelvik (2017) or Lund Shammas (2012).

[136] Cf. §2 Act on the Prison Service and Judicial Guard of the Czech Republic

implementation of beekeeping operation. Mostly movable frame hives are used, which are being manufactured for internal use in some correctional facilities. Only the Carniolan honeybee (*Apis mellifera carnica*) is bred on account of its spatial distribution, breed's docility and relatively high honey yield. In 2017 those 8 prisons made total honey yield of 438 kg. Concerning other bee products, the beeswax is processed in order to be exchanged for beeswax foundation combs. For the time being, the queen bees are bought not bred (Interviewee E).

The beekeepers behind bars make use of off-peak season for theoretical preparation, studies for the examinations in Vocational School of Beekeeping in Nasavrky, frames assembling, preventive measures, and bee colony treatment etc. In collaboration with CBU headquarters and local beekeeping organisations the participants have the use of professional journal Beekeeping[137]. As a part of project funding, necessary study materials and teaching aids were bought (Interviewee E).

The staff had completed training course in Beekeeping Vocational School in Nasavrky to gain necessary knowledge and experience. Moreover there are available lectures delivered by beekeeping instructors and supervisors from CBU, who are remunerated for lecture (Interviewee E).

Exact numbers of inmates actively engaged in the project are not monitored, but there are between 3 – 12 prisoners in each jail and 1 – 2 employees responsible for internal beekeeping operation. Those interested in participation in the project are usually shortlisted through the prison's officers, but it is undeniable that anyone can freely join the project after preliminary agreement. Participants' initial reactions to beekeeping are favourable up to now. Furthermore there are positive responses of inmates' relatives and friends, who appreciate person's involvement with such beneficial and meaningful activity (Interviewee E). Also Kunecký (2015) in his work confirmed that beekeeping is an attractive activity for both the "clients" and the "staff".

The project has been realized with financial support of Czech crime prevention programme. The costs have amounted to hundreds of thousands CZK since 2016 up to now, which is appropriate to high costs of beekeeping equipment. On account of initial stage of the project,

[137] Včelařství

the vast majority of resources has gone to beekeeping tools, literature as well as treating agents and feeding material (Interviewee E).

Prison beekeeping in the Czech Republic is currently not focused primarily on making a profit, since the operations are not run in the form of mass factory farming. Honey yield is not intended for sale, but for giving away to inmates' relatives and friends, for processing in correctional facilities, for project's promotion (as a gift items) and for charitable purposes instead (Interviewee E).

There is no feedback from released prisoners so far, as the project is a long-term matter. However the Ministry of Justice of the Czech Republic assesses this initiative as a meaningful use of prisoners' free time, which is beneficial not only to prisoners, but also to their relatives, friends, society and nature. The project is considered successful, and therefore it is planned to continue in its future support and further development. The public reaction to the project is also very positive (Interviewee E).

4.4.4 Railway Beekeeping Exposition

In Canton of Grisons special beekeeping project "Grischa Biena uf da Schiena" is run. The exposition is situated in a railway carriage which travels from April to October round the canton and offers interactive educational program for children and youth. An expert interview was conducted with member of Jungimkerprojekt "Flugschnaisa" – project's establishing and administrating organisation (Interviewee F, in-person meeting, 22.5.2017), hereinafter referred to as Interviewee F.

The idea developed from a smaller initiative organising beekeeping courses for youth. Motives for such beekeeping propagation were for one thing environmental concerns and for another the exclusivity of Grison's environs. The search for partners providing the railway carriage and financial support preceded the project. Thanks to the sponsors, the visit remains free of charge for schools (Interviewee F).

Beekeeping exposition targets children from 9 to 13 years old, but younger visitors (e.g. kindergartens) can also actively participate, even though they might need some help. Project covers wide range of topics regarding apiculture – i.e. bees' life, bees' work, pollination, biodiversity and nature, wild bees and the threats for bees in form of insecticides and pesticides. The aim is to bring topic's connections together. There can be two visiting groups (one of maximum 26 children) in the morning and two groups in the afternoon. Till June 2017 more than 1 400 children had seen the exhibition and there were 2 300 more registered for the rest of the tour (ending in October 2017). Their average age was 10 – 11 years. Original estimate for project's first year was 3 000 visitors (Interviewee F).

The visit is organized in an interactive and entertaining manner – at first the pupils have to complete a crossword and afterwards they are making a beeswax lip balm as a souvenir. The reactions are very positive, as the children are fascinated and excited (Interviewee F).

Initial outlay of beekeeping exposition was 120 000 CHF. This was the price for rebuilding the old discarded railway carriage. Some extra equipment was bought for 10 000 – 20 000 CHF. Supporting services cost 40 000 CHF for two years. In addition some material costs (e.g. lip salve, beekeeping tools, consumables), advertising (e.g. websites, social networking, banners) and necessary maintenance service increased total costs up to 240 000 CHF. The revenues come from direct sale of honey, salves and sweets (1 000 CHF), and financial donations (800 CHF), which does not include material donations like t-shirts for staff (Interviewee F).

Due to train's technical parameters (narrow-gauge railway[138]) it is not possible to travel across canton's border. However, according to the Interviewee F, it had travelled through Grisons more than 300 km until June 2017.

The number of project's staff members has increased from 6 to 15 people. As the train travels round the canton, the external support (usually 3 paid local co-workers a day) is necessary. There are 20 stops on the tour, and so the external assistance is comprised of 60 people per year (Interviewee F).

The initiative is commercialized through social networks, teachers' newspapers and conferences, media release, regional print media (Interviewee F). For example it had been widely promoted in local newspapers (e.g. Bündner Woche[139], Südostschweiz[140]) and radio.

[138] Úzkorozchodná dráha / Schmalspurbahn

[139] Sprecher (2017)

[140] Dirnberger (2017)

5 Discussion

This chapter provides an overview of the significant outcomes of carried out research, considering these findings with respect to current state of research. Lastly, research limitations possibly affecting the generalization and validity of obtained results are discussed.

In spite of numerous research studies (e.g. Brodschneider et al., 2016, 2018, 2019; Neumann and Carreck, 2010) pointing out significant bee colony losses, Ghazoul (2005) called global pollinator crisis into question. Referring to COLOSS survey (Brodschneider et al., 2018) the bee colony losses differ within regions. Between 1985 and 2005 Potts et al. (2010a) reported 25 % decrease in bee colonies and 31 % decrease in the number of beekeepers in Europe. According to statistical data (CBU, internal data, 2019; SVZ, 2017), there was 20.8 % decrease in the number of beekeepers in the Czech Republic between 1993 and 2018, but only 7.95 % decrease in the number of bee colonies for the same period. In case of Switzerland, due to unavailability of official statistical data on numbers of beekeepers, only the situation of bee colonies is presented. Regarding Agristat (1995 – 2017), Switzerland had lost half of its bee colonies in the past 30 years (from 1985 to 2015). However contemporary average Swiss bee colony density (4 bee colonies per km^2) can be considered satisfactory, although the Czech one is more than double (8.8 bee colonies per km^2), indicating one of the highest bee colony density levels in Europe.

Although there might exist some intents according to the rule "the more, the better", sometimes rather "less is more" holds true, appropriately when applied to numbers of managed bee colonies. Hardin (1968) in his essay illustrated this approach to using resources with an example of the commons:

> "*Each man is locked into a system that compels him to increase his herd without limit – in a world that is limited.*"
>
> Hardin (1968, p. 4)

The problem of the capacity of the Earth's biosphere is also highlighted by Svatoš (2006), who points out the increasing negative impact of degraded ecosystems on the economic growth and prosperity. The objective is to decrease resource degradation and the associated disturbance, to a level where the nature and agro-ecosystems can counterweight them and preserve overall sustainability (Barbier, 1987).

Massively introduced managed beekeeping can bring some conceivable biodiversity risks to feral bees and other native pollinators (e.g. Geldmann and González-Varo, 2018; Geslin et al., 2017; Graystock et al., 2013, 2016; Mallinger et al., 2017). The risk of disease emergence works on the presumption that managed and/or imported honeybees mix with wild bees (Graystock et al., 2016) and that various pollinators share diverse foraging sites (Fürst et al., 2014). Considering pathogen transmission threat that managed honeybees pose to wild pollinators, it is important to mention that the spillover might be bidirectional, since both managed and native populations can work as parasite reservoir (Graystock et al., 2016; McMahon et al., 2015). Concerns over massive introduction of managed species are not only relevant to high biodiversity ecosystems and protected habitats, but also to urban places, where the density of *Apis mellifera* colonies is nowadays sharply increasing (Geslin et al, 2017). The case in point is canton Basel – City, where the highest bee colony density (i.e. 11.8 bee colonies per km^2) in Switzerland was reported by Charrière et al. (2018).

On account of honeybee stocks, conducted expert interviews revealed presence of Primorski bees and Elgon bees in a Swiss bee farm, although they are not indigenous to Switzerland. Moritz et al. (2005) concede the difficulties in discussion with beekeepers (and other stakeholders) concerning bee breeding, as the work with endemic populations is recommended rather than risky introduction of foreign stock possibly leading to irreversible changes to both feral and managed animals and plants. The original distribution of honeybee stocks in Europe has been significantly modified by anthropogenic activities like importations of non-indigenous honeybee stocks or their relocations throughout Europe (Lodesani and Costa, 2003). Bee breeding has been dominated by introducing "exceptional" honeybees from various areas of Europe and Africa into managed beekeeping (Laidlaw and Page, 1996 In: Moritz et al., 2005), even though this practice frequently omits the significance of local adaptation as well as the need for local subspecies preservation and biodiversity conservation (Morizt et al, 2005). Even the COLOSS Association (2019a) highlights the risks driven by free honeybee trade, where possible genetic threats might be neglected. Miscellaneous honeybee populations are consequent upon extensive hybridization aiming more productive bee colonies and/or better disease resistance to the detriment of genetic diversity of native stocks. In the case of the Czech Republic, the Carniolan honey bee is listed as the animal genetic resource, and thus protected against uncontrolled cross-breeding. As opposed to that, the stock variability in honeybees bred in Switzerland enables the hybridization, which might pose a serious threat both to beekeeping (negative features of cross-breeds) and biodiversity (affecting indigenous populations).

Organized character of beekeepers in unions[141], associations and societies[142] is considered as strength, because they can negotiate with authorities as a community, they can also implement procedures and forms of good practices and as they often collect data, they are usually in charge of providing statistical results and current legislation regarding the beekeeping sector. Membership of beekeeping organization offers numerous benefits – e.g. professional training courses to satisfy beekeepers' educational and training needs (Androulidakis and Harizanis, 1996; Pocol et al., 2014), administrative support in accessing subventions (Pocol et al., 2014), library facilities, cooperation and assistance in bee disease prevention and financial contribution (disease funds) after bee colony losses (CBU, 2008; SAR, 2018; STA, 2018). In Switzerland, in contradistinction to the Czech Republic, however not all statistical records of beekeeping variables are kept. The shortage on numbers of beekeepers might lead to omitting some adverse developments, such as malfunctioning generation exchange. In addition to that, no official document identifying long-term strategy of Swiss beekeeping sector was found, where the strategic objectives would be set and the long-range intentions and course of the beekeeping sector would be formulated (cf. MZe, 2017).

In spite of the assumption, that beekeeping becomes economically feasible for operations managing more than 30 bee colonies in the Czech Republic and Switzerland, the statistical data from both countries show that the vast majority of their beekeepers are hobbyists, each having less than 30 bee colonies. This implies that there must be further deciding motives to keep the bees apart from the economic one. Low profitability of beekeeping sector was already proposed by Zehnalová (2009), comparing honeybees and the pollination service in light of positive externalities and ensuring public goods to Coases' lighthouses[143] (cf. Coase, 1974). The current state of beekeeping sector in Switzerland, where there is (with a few exceptions) no state support, however casts doubt upon leaving the beekeeping sector, which is traditionally dependent on hobby beekeepers, solely to the market powers.

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[141] Czech Beekeepers‘ Union (CBU)

[142] Societé Romande d'Apiculture (SAR), Società Ticinese di Apicoltura (STA), BienenSchweiz – Imkerverband der deutschen und rätoromanischen Schweiz (former VDRB – Verein deutschschweizerischer und rätoromanischer Bienenfreunde)

[143] On the example of lighthouses in the 18^{th} and 19^{th} century in the UK, Coase (1974) refuted the necessity of securing these public goods bringing positive externalities by the state, since the lighthouses were effectively managed by the private sector.

On account of close interconnection between beekeeping and other scientific fields (agriculture, biology, botany, ecology, entomology, phenology, veterinary medicine and the like), the multidisciplinarity[144] is indispensable not only in the light of international cooperation, but also regarding the knowledge transfer and linking local science with beekeeping practice. Fazey et al. (2012) stress the importance of knowledge transfer, exchange and sharing to improve environmental management and sustainability. An example of such international cooperation in beekeeping research is represented by COLOSS – a global initiative to monitor bee colony losses and sharing specific data with individual stakeholder groups (COLOSS, 2018). Furthermore, Daily (2000) emphasizes that putting theory into practice also requires locally based information and science and Pretty (2008) claims, that successful transition towards a more sustainable agriculture can only result from external and financial support.

Concerning the beekeeping and agriculture, bee pasture and agrochemicals are supposed to be crucial aspects. Since there is a problem with agricultural spraying, authorities overseeing detrimental agricultural activities play crucial role in bee protection too. According to the investigations by Ramseier et al. (2016) the flowering strips provide good food supply in critical low-season and they are attractive both for honeybee and wild bee target species. Flower strips also attract other agriculturally beneficial insects such as *Syrphidae* (hoverflies) and *Reduviidae*, which do pest control in adjacent annual crops (Ramseier et al., 2016). Although flowering strips increase both animal and plant diversity, they cannot solve all the problems with pests, thus it is necessary to combine this approach with common pest management techniques (Holý et al., 2016). In addition to that, Klein et al. (2007) suggest applying crop rotation particularly to intensified uniform agricultural landscapes, which may alongside lead to soil improvement, erosion control as well as to better pest management. The attention should be paid to suitability of seed mixture and plant composition for different soil and climate conditions as well as to operational cutting management optimization (Holý et al., 2016; Pérez-Marcos et al., 2018). Fast rotary mowers might cause severe bee colony losses in summer, as reported by one interviewee.

In spite of the assumption that the agriculture is only detrimental to honeybees, problem‘s reciprocity needs to be taken into consideration. Without agricultural fields, pastures and

[144] For the purpose of this thesis, multidisciplinarity is understood as defined by Youngblood (2007) as a cooperation of two or more scientific disciplines through using their tools and knowledge in new ways in order to consider multi-faceted issues that have at least one link to different field of study.

meadows the abundance of bee pasture would diminish, and so would the productivity of honeybees as well as the honey yield. Hence the aim ought not to be to take a stand against either agriculture or managed beekeeping, but rather secure optimal conditions for viable coexistence of diverse organisms and preserve both agricultural production and managed beekeeping.

Although the research employed thorough and time-consuming data collection and analyses, the generalizability of presented findings is due to several following reasons strictly limited. In case of the economic assessment of hobby beekeeping operations, the calculations work on certain assumptions (defined in the subsection 4.1), which do not necessarily apply to every single beekeeping operation in the Czech Republic and Switzerland. Despite the apparent conformity of predicted values to real Czech honey prices, it needs to be emphasized that one cannot absolutely rely on the forecast, since no model complies with all agricultural commodities (cf. Tomek and Myers, 1993) and nothing inevitably links the past with the future (cf. Bessler and Kling, 1989). Similarly, the qualitative analysis posits at least to a certain extent a lack in validity, because each investigated case is regarded as unique. Nevertheless the expert interviews revealed a rich diversity of opinions, hints and experience with regard to Czech and Swiss beekeeping, being instrumental in accomplished evaluations of beekeeping sectors in the Czech Republic and Switzerland.

6 Conclusions

The assessment of selected aspects of beekeeping sector in the Czech Republic and Switzerland resulted in following key findings:

With regard to the investigation and assessment of economic situation of hobby beekeeping operations in the Czech Republic and Switzerland, some suggestions are made to improve the economics of small scale beekeeping operations (i.e. to increase the revenues from bee products sale and to decrease the expenditures). Inter alia, initial knowledge has been identified as a significant input of beginning beekeeper’s operation. The results of the economic assessment revealed a paradox. Despite the assumption that apiculture becomes economically feasible for operations managing more than 30 bee colonies in the Czech Republic and Switzerland, the vast majority of beekeepers in both observed countries are hobbyists managing the beekeeping operations smaller than 30 bee colonies. This indicates that hobbyists’ reasons to keep bees are other than purely economic. In the light of conducted expert interviews, the motives for keeping bees in both countries are rather social (pastime, enthusiasm, enjoyment, active relaxation, education) and environmental (pollination, role of the bees in ecosystems, nature conservation and biodiversity) than economic. Beekeeping operations also contribute to local economy (additional income for hobbyists, jobs of professional beekeepers, complementary service, and securing crop production).

Carried out analysis of Czech honey prices over time span 1995 – 2018 confirmed the assumption that for very small growth rates the mathematical technique of linear approximation is applicable. Forecast values proceeding from constructed ARIMA model (1,1,1) seem to fit the original dataset with real data well and the model is regarding both diagnostic checks considered adequate. The purpose of time series analyses was to moderate the presented lack of price clarity for both beekeepers and consumers, and to forecast future price development of honey in the Czech Republic, inasmuch as the honey price is considered as significant factor for honey buyers.

On account of indisputable correlation between the numbers of bee colonies and beekeepers, the pollinator crisis should not be determined solely by decreasing amounts of bee colonies, but the important role of beekeepers should be taken into consideration too. In view of the professionalization of new generation of beekeepers, the drawback was identified. The expert interviews with beekeepers lecturing in beekeeping courses disclosed that a certain amount of beekeeping newbies quits their beekeeping efforts within few years from the starting point, while these figures are roughly estimated to be in tents of percent. Due to non-existing statistics on this phenomenon and beekeepers' ageing, the future of beekeeping sector remains to be of utmost interest. Even though the statistical records of Czech beekeepers and bee colonies are kept by the CBU, in Switzerland such records of Swiss beekeepers are lacking. Hence the thorough monitoring of beekeepers' numbers is recommended in order to keep a good track of its development and to be able to take necessary measures against beekeepers' numbers declines.

In conclusion, research outcome affirms positive impacts of beekeeping and it reveals the potential of managed beekeeping not only for hobby and commercial beekeepers, but also for specific target groups, such as children and youth, urban dwellers, stakeholders in hospitality industry and prisoners. In order to offset the negative impacts of beekeepers' ageing, the beekeeping clubs for children and youth are run in the Czech Republic and other comparable countries. In the upshot, such initiative might be considered valuable for addressing new generation of Swiss beekeepers too. On the contrary, in Switzerland a special project on railway beekeeping exposition is run, offering interactive educational program for children and youth. Despite the fact that urban beekeeping does not appear to be economically viable in terms of making a profit its unquestionable social virtues can balance out the economic burden. Existing economic models for financing contemporary urban apiculture projects intersect either in social enterprise or straight commercial patterns. From business perspective such projects might help stakeholders co-create competitive advantage and potential revenue streams. By contrast the beekeeping behind the bars is a non-profit project aiming to offer the inmates meaningful use of their free time.

Considering the lack of economic studies focusing on small-scale beekeeping operations in the Czech Republic, Switzerland and other comparable countries, presented research might possibly fill this gap in the literature and contribute to clarification of economics of beginning beekeepers' operations.

The scientific gap lingers on concerning the way to secure sufficient numbers of bee colonies and/or ample bee colony density for the purpose of both agricultural production and ecosystems functioning. The question is, whether (and if so, how) the state should take centre stage through interventions or if the beekeeping sector traditionally based on hobby beekeepers should be left to the market powers.

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Appendices

I Examples of Bee Hotels

Some scientists (Geslin et al., 2017; Plascencia and Philpott, 2017) see the anthropogenic contribution as a possible conservation practice to improve the current state of pollinators and foraging plants. The artificial nest for wild bees (MacIvor and Packer, 2015) – bee hotel – is considered as such intervention. However despite its large public promotion, the effects of such installations remain disputable (Bortolotti et al., 2016; Fortel et al., 2016; MacIvor and Packer, 2015).

Picture 1: Bee hotel in Botanical Garden Bern

Source: Šeráková, Petra. 22-06-2017. Bee hotel in Botanical Garden Bern. [Photograph].

Picture 2: Bee hotel in Botanical Garden Basel

Source: Mosimann, Carla. 07-06-2017. Bee hotel in Botanical Garden Basel. [Photograph].

Picture 3: Bee hotel in Locarno

Source: Šeráková, Petra. 25-06-2017. Bee hotel in a hotel in Locarno. [Photograph].

II Types of Beehives

Picture 4: Dadant beehive

Source: Dumat, Maja. 02-04-2011. Dadantbeute mit Honigräumen. [Photograph].

Picture 5: Magazin beehive (Deutsche Normalmaß)

Source: Šeráková, Petra. 20-05-2017. Magazin beehives in Bottmingen. [Photograph].

Picture 6: Langstroth beehive

Source: Lenz, Leonhard. 12-06-2018. Langstroth hive on a meadow next to the Laßzinssee 03. [Photograph].

Picture 7: Apiary – Schweizerkasten

Source: Šeráková, Petra. 18-05-2017. Apiary in Naters. [Photograph].

Picture 8: Schweizerkasten beehives in apiary

Source: Šeráková, Petra. 18-05-2017. Schweizerkasten beehives in Naters. [Photograph].

Picture 9: Schweizerkasten beehive (a)

Source: Šeráková, Petra. 08-06-2017. Schweizerkasten beehive in Steinhausen. [Photograph].

Picture 10: Schweizerkasten beehive (b)

Source: Šeráková, Petra. 03-06-2017. Schweizerkasten beehive in Grossdietwil. [Photograph].

Picture 11: Migratory beekeeping in Switzerland (a)

Source: Šeráková, Petra. 08-06-2017. Migratory bee wagon / caravan in Zug. [Photograph].

Picture 12: Migratory beekeeping in Switzerland (b)

Source: Šeráková, Petra. 03-06-2017. Migratory bee wagon / caravan in Grossdietwil. [Photograph].

III Bee Products Sales Promotion

Picture 13: Signboard on the front yard

Source: Šeráková, Petra. 03-06-2017. Signboard on the front yard in Grossdietwil. [Photograph].

Picture 14: Signboard on the house wall

Source: Šeráková, Petra. 03-06-2017. Signboard on the house wall in Grossdietwil. [Photograph].

Picture 15: Stick-on label on the car

Source: Šeráková, Petra. 08-06-2017. Information label on the car in Steinhausen. [Photograph].

IV Statistics

Table 30: Bee colonies and beekeepers in the Czech Republic (2000 – 2018)

<table>
<tr><th colspan="2">Year</th><th>2000</th><th>2001</th><th>2002</th><th>2003</th><th>2004</th><th>2005</th></tr>
<tr><td colspan="2">Bee colonies</td><td>534 814</td><td>537 226</td><td>517 743</td><td>477 743</td><td>556 853</td><td>551 681</td></tr>
<tr><td colspan="2">Beekeepers</td><td>55 245</td><td>53 315</td><td>52 768</td><td>50 940</td><td>50 109</td><td>49 824</td></tr>
<tr><th colspan="2">Year</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th></tr>
<tr><td colspan="2">Bee colonies</td><td>525 560</td><td>520 084</td><td>461 086</td><td>497 946</td><td>528 186</td><td>565 419</td></tr>
<tr><td colspan="2">Beekeepers</td><td>48 678</td><td>47 966</td><td>45 604</td><td>46 033</td><td>46 573</td><td>48 057</td></tr>
<tr><th>Year</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th></tr>
<tr><td>Bee colonies</td><td>540 705</td><td>553 040</td><td>603 392</td><td>596 313</td><td>659 899</td><td>635 824</td><td>630 836</td></tr>
<tr><td>Beekeepers</td><td>48 132</td><td>50 471</td><td>53 447</td><td>54 416</td><td>56 558</td><td>57 559</td><td>58 132</td></tr>
</table>

Source: own processing according to CBU (internal data, 2019)

Table 31: Sizes of beekeeping operations in the Czech Republic (2015 – 2018)

Bee Colonies ↓	2015	2016	2017	2018
1 – 5	19 396	18 314	19 852	20 011
6 – 10	14 102	15 254	14 794	14 745
11 – 15	5 878	6 595	6 185	6 080
16 – 30	6 547	7 337	6 800	6 723
31 – 100	3 073	3 523	3 253	3 215
101+	231	267	230	232
TOTAL	**49 227**	**51 290**	**51 114**	**51 006**

Source: own processing according to CBU internal data (2019)

Table 32: Honey supply in the Czech Republic (2000 – 2016) in tons

Year	Domestic Production (t)	Export (t)	Domestic Production minus Export (t)	Import (t)
2000	7 500	2 271	5 229	660
2001	6 300	1 793	4 507	1 073
2002	5 883	1 867	4 016	1 144
2003	6 303	2 024	4 279	1 757
2004	7 738	2 975	4 763	1 134
2005	8 371	2 826	5 545	1 580
2006	9 051	2 995	6 056	2 392
2007	8 466	4 357	4 109	1 724
2008	6 078	2 595	3 483	2 060
2009	6 892	2 051	4 841	1 825
2010	7 455	1 188	6 267	2 172
2011	11 302	2 270	9 032	1 777
2012	7 332	1 583	5 749	1 946
2013	8 063	1 526	6 537	2 086
2014	7 163	1 184	5 979	2 544
2015	9 228	906	8 322	2 945
2016	10 113	1 416	8 697	1 776

Source: own processing according to SVZ (2017)

Table 33: Bee colonies in Switzerland (2000 – 2016)

Year		**2000**	**2001**	**2002**	**2003**	**2004**
Bee colonies		235 801	221 573	211 780	208 008	207 945
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Bee colonies	208 091	202 839	193 355	180 026	173 814	165 045
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Bee colonies	169 391	161 447	169 391	168 415	168 965	169 916

Source: own processing according to Agristat (2001 – 2017)

Table 34: VDRB Beekeepers (2002 – 2011)

Year	2002	2003	2004	2005	2006
VDRB Beekeepers	16 055	15 747	15 387	15 196	15 117
Year	**2007**	**2008**	**2009**	**2010**	**2011**
VDRB Beekeepers	14 177	14 201	14 128	14 096	14 081

Source: own processing according to VDRB (Koller, personal communication, March 17, 2017)

Table 35: Honey supply in Switzerland (2000 – 2016) in tons

Year	Domestic Production (t)	Export (t)	Domestic Production minus Export (t)	Import (t)
2000	2 834	442	2 392	6 784
2001	4 288	431	3 857	6 921
2002	2 692	317	2 375	6 747
2003	4 157	312	3 845	6 790
2004	4 077	367	3 710	6 129
2005	3 223	340	2 883	6 324
2006	3 656	481	3 175	6 415
2007	3 917	537	3 380	7 058
2008	2 803	554	2 249	7 244
2009	3 135	509	2 626	7 576
2010	3 316	651	2 665	7 893
2011	4 677	558	4 119	7 434
2012	2 145	530	1 615	7 825
2013	3 826	539	3 287	8 169
2014	2 419	632	1 787	7 686
2015	4 602	703	3 899	8 170
2016	2 384	648	1 736	7 884

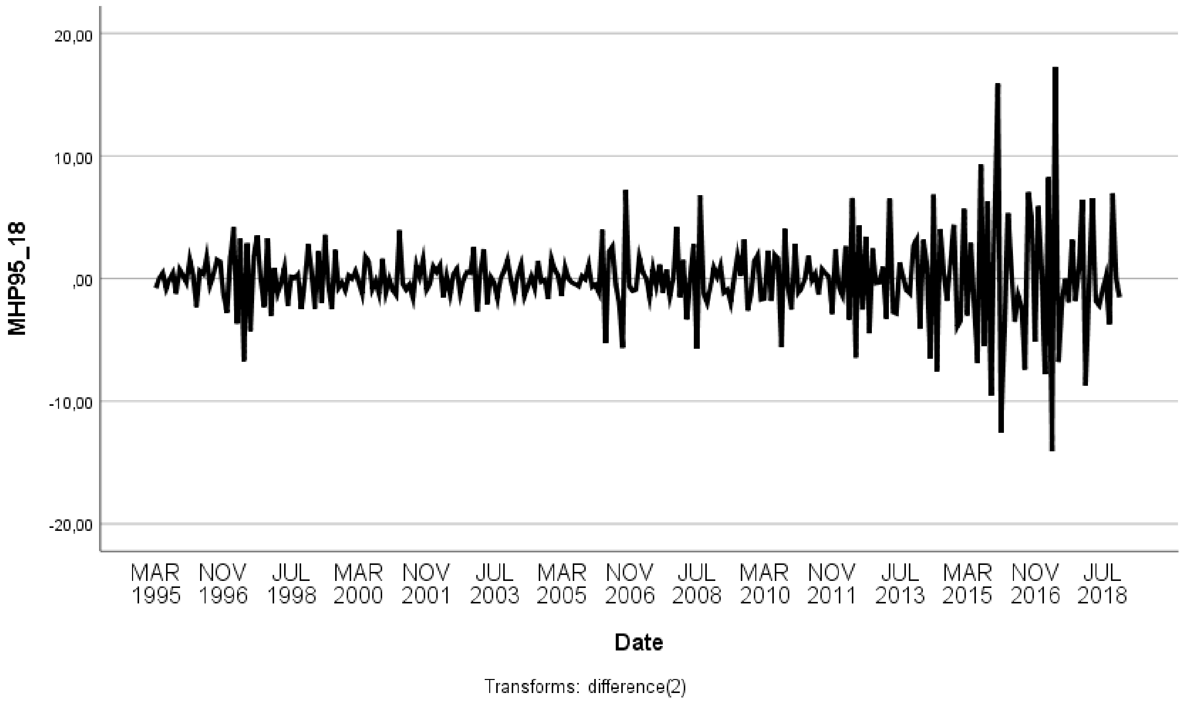
Source: own processing according to Agristat (2001 – 2017)

Table 36: Original dataset – Czech honey prices time series (1995 – 2018)

CZ-PRICE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1995	80,34	81,51	81,9	82,34	83,23	83,31	83,33	83,79	83,01	82,98	83,19	83,07
1996	84,49	86,12	85,45	85,39	85,71	87,81	89,39	91,3	94,74	99,55	102,98	103,62
1997	105,92	112,42	115,25	121,37	120,77	123,05	121,04	120,96	124,4	127,73	128,76	133,1
1998	134,4	136,55	137,5	138,06	139,49	138,69	138,01	137,39	137,11	134,37	131,37	131,18
1999	131,55	129,47	129,61	127,76	129,48	130,74	129,52	130,63	130,99	131,02	130,1	129,43
2000	128,77	128,70	128,34	126,73	126,88	128,38	129,01	129,43	128,58	129,33	128,96	128,57
2001	127,26	124,63	125,93	126,82	126,82	126,32	124,28	123,34	122,57	123,35	123,19	122,61
2002	123,01	123,95	125,95	126,43	127,09	126,49	126,28	126,86	126,21	125,51	125,33	125,61
2003	128,47	128,62	129,44	132,64	133,75	134,99	135,90	135,20	134,52	134,51	136,04	137,50
2004	137,66	138,14	139,77	139,98	139,53	139,22	138,13	138,48	138,57	138,54	136,87	136,79
2005	137,43	138,31	137,79	138,23	138,68	138,8	138,48	137,55	136,84	136,1	136,44	136,11
2006	135,29	133,34	135,34	132,11	131,08	132,65	133,71	132,71	126,06	126,64	126,6	125,57
2007	123,67	123,47	123,78	124,11	122,97	122,6	121,67	121,88	120,92	120,7	119,09	117,44
2008	120,01	121,07	123,63	122,87	122,12	124,19	120,55	123,7	125,66	125,68	125,06	125,32
2009	125,75	127,2	127,52	126,92	124,36	121,88	121,3	120,96	123,8	124,02	122,99	123,4
2010	125,72	126,34	125,35	126,63	126,11	127,53	130,58	128,05	129,58	130,36	128,63	129,73
2011	129,71	128,94	128,20	129,31	130,27	131,59	131,60	132,38	133,58	134,91	133,36	134,19
2012	134,32	133,12	134,57	132,67	137,34	135,55	138,09	138,12	141,58	140,58	142,01	143,07
2013	143,81	145,48	143,90	148,85	151,08	150,48	151,20	152,09	152,04	150,77	152,17	156,74
2014	157,20	160,80	165,45	163,56	168,50	165,88	167,28	169,13	169,18	170,62	176,44	178,33
2015	176,79	180,93	182,07	186,11	187,94	182,89	187,15	185,93	191,02	186,57	186,56	202,45
2016	205,79	204,92	209,37	214,63	216,36	216,71	214,76	205,41	203,12	205,92	203,58	207,15
2017	211,32	207,69	212,31	202,84	210,62	211,61	210,78	209,93	207,14	207,49	206,02	205,38
2018	211,18	208,24	204,73	207,77	208,96	207,97	206,12	204,46	199,09	200,66	202,24	202,3

Source: own processing according to CZSO (2019)

Figure 39: Sequence plot of differenced time series data (2nd difference)



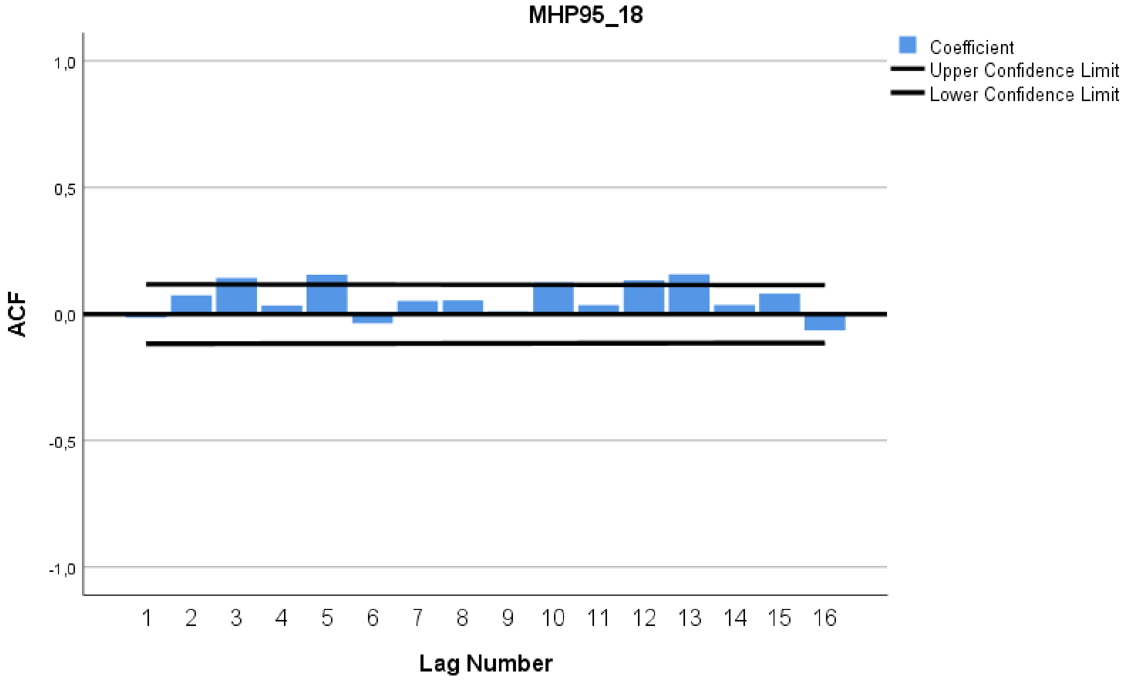
Source: own processing in IBM® SPSS Statistics

Table 37: Descriptive statistics on differenced time series data (2nd difference)

TIME SERIES DIFFERENCE	N	MEAN		STD. DEVIATION	VARIANCE
		STATISTIC	STD. ERROR		
2ND ORDER	286	- 0.0039	0.19935	3.37132	11.366

Source: own processing in IBM® SPSS Statistics

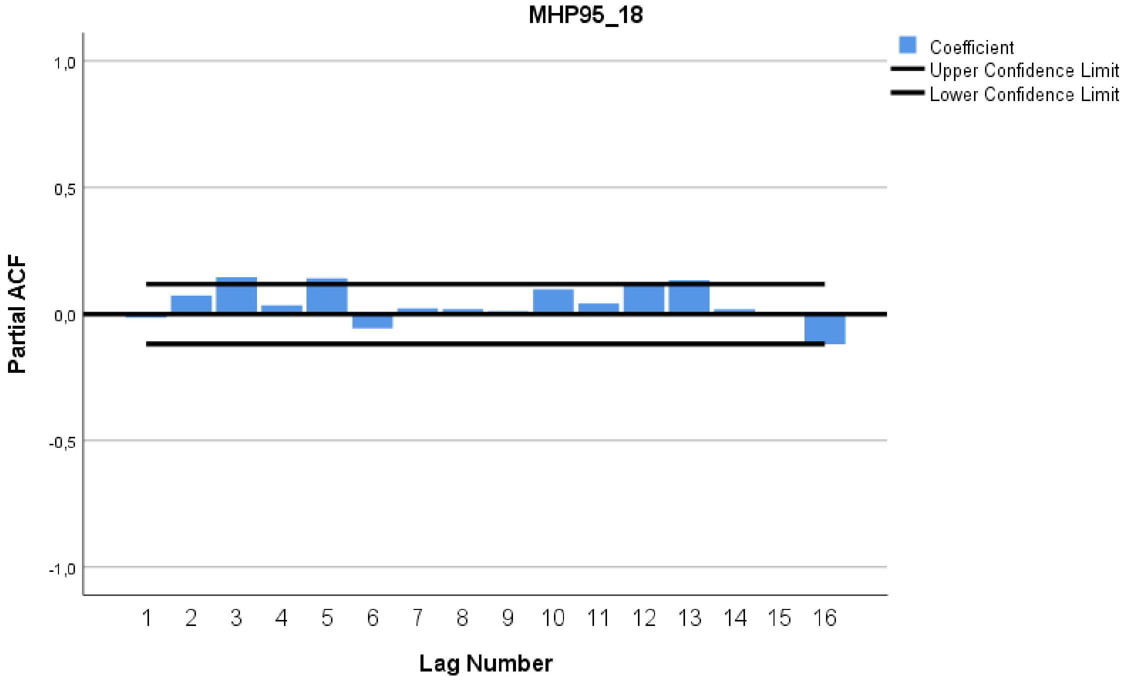
Figure 40: ACF of the original time series data (1st difference)



Source: own processing in IBM® SPSS Statistics

Given sequence is considered a white noise, even though the correlogram shows that some of the values slightly overlap upper 95 % confidence interval. Table 38 (below) presents the autocorrelation results in detail. In addition to that, according to Ramík (2007), the random walk can be transformed from the white noise through accumulating the white noise data.

Figure 41: PACF of the original time series data (1st difference)



Source: own processing in IBM® SPSS Statistics

Table 38: ACF of differenced random walk – results

AUTOCORRELATIONS					
Lag	Autocorrelation	Std. Error[a]	Box-Ljung Statistic		
			Value	df	Sig.[b]
1	-0,014	0,059	0,054	1	0,817
2	0,073	0,059	1,614	2	0,446
3	0,142	0,059	7,52	3	0,057
4	0,033	0,058	7,843	4	0,098
5	0,157	0,058	15,056	5	0,01
6	-0,037	0,058	15,45	6	0,017
7	0,053	0,058	16,271	7	0,023
8	0,055	0,058	17,161	8	0,028
9	0,012	0,058	17,204	9	0,046
10	0,126	0,058	21,932	10	0,015
11	0,035	0,058	22,298	11	0,022
12	0,133	0,058	27,635	12	0,006
13	0,158	0,057	35,19	13	0,001
14	0,036	0,057	35,575	14	0,001
15	0,081	0,057	37,57	15	0,001
16	-0,064	0,057	38,809	16	0,001
a. The underlying process assumed is independence (white noise).					
b. Based on the asymptotic chi-square approximation.					

Source: own processing in IBM® SPSS Statistics

Table 39: ACF and PACF residuals

RESIDUAL ACF		RESIDUAL PACF	
LAG	**MEAN**	**LAG**	**MEAN**
Lag 1	-0,02695	Lag 1	-0,02695
Lag 2	0,058123	Lag 2	0,057438
Lag 3	0,107961	Lag 3	0,111433
Lag 4	0,020243	Lag 4	0,023561
Lag 5	0,138938	Lag 5	0,129591
Lag 6	-0,05773	Lag 6	-0,06502
Lag 7	0,032737	Lag 7	0,010304
Lag 8	0,039486	Lag 8	0,018014
Lag 9	-0,00596	Lag 9	0,000305
Lag 10	0,086974	Lag 10	0,067473
Lag 11	0,017601	Lag 11	0,032464
Lag 12	0,104286	Lag 12	0,092528
Lag 13	0,119478	Lag 13	0,108235
Lag 14	0,008596	Lag 14	0,003434
Lag 15	0,069542	Lag 15	0,020414
Lag 16	-0,07679	Lag 16	-0,10636
Lag 17	0,035069	Lag 17	-0,00726
Lag 18	-0,02869	Lag 18	-0,05443
Lag 19	-0,01323	Lag 19	0,008162
Lag 20	0,006027	Lag 20	-0,01005
Lag 21	-0,12724	Lag 21	-0,10595
Lag 22	0,140312	Lag 22	0,118407
Lag 23	-0,09633	Lag 23	-0,09625
Lag 24	-0,00089	Lag 24	-0,0062

Source: own processing in IBM® SPSS Statistics

Table 40: Time series model algorithms in IBM® SPSS Statistics

TIME SERIES MODEL ALGORITHMS IN IBM® SPSS STATISTICS	
MAE (Mean Absolute Error, 2013)	$MAE = \frac{1}{n}\sum \lvert Y_{(t)} - \widehat{Y_{(t)}} \rvert$
MAPE (Mean Absolute Percent Error, 2013)	$MAPE = \frac{100}{n}\sum \frac{\lvert Y_{(t)} - \widehat{Y_{(t)}} \rvert}{Y_{(t)}}$
MSE (Mean Squared Error, 2013)	$MSE = \frac{\sum (Y_{(t)} - \widehat{Y_{(t)})}}{n-k}$
Normalized BIC (Normalized Bayesian Information Criterion, 2013)	$Normalized\ BIC = \ln(MSE) + k\frac{\ln(n)}{k}$
R^2 (R-Squared, 2013)	$R^2 = 1 - \frac{\sum (Y_{(t)} - \widehat{Y_{(t)}})^2}{\sum (Y_{(t)} - \bar{Y})^2}$
Stationary R^2 (Stationary R-Squared, 2013)	$Stationary\ R^2 = 1 - \frac{\sum_t (Z_{(t)} - \widehat{Z_{(t)}})^2}{\sum_t (\Delta Z_{(t)} - \overline{\Delta Z})^2}$

Source: own processing according to IBM® SPSS Statistics

$\widehat{Y_{(t)}}$ are deviations of model values from real values

$\overline{\Delta Z}$ is the simple mean model for modified (differenced) sequence, which is analogue of ARIMA (0,d,0)(0,D,0)

Table 41: Comparison of the ARIMA (1,1,1) forecast with real data (1995 – 2018)

YEAR	MONTH	REALITY	FORECAST	LCL	UCL
1995	JAN	80,34	N/A	N/A	N/A
1995	FEB	81,51	80,75	77,49	84,06
1995	MAR	81,9	81,95	78,67	85,28
1995	APR	82,34	82,34	79,05	85,68
1995	MAY	83,23	82,78	79,48	86,12
1995	JUN	83,31	83,68	80,37	87,05
1995	JUL	83,33	83,75	80,44	87,11
1995	AUG	83,79	83,76	80,44	87,12
1995	SEP	83,01	84,22	80,9	87,59
1995	OCT	82,98	83,4	80,1	86,75
1995	NOV	83,19	83,36	80,06	86,71
1995	DEC	83,07	83,57	80,26	86,92
1996	JAN	84,49	83,43	80,13	86,79
1996	FEB	86,12	84,89	81,55	88,27
1996	MAR	85,45	86,55	83,19	89,97
1996	APR	85,39	85,85	82,5	89,25
1996	MAY	85,71	85,78	82,43	89,18
1996	JUN	87,81	86,1	82,74	89,5
1996	JUL	89,39	88,25	84,85	91,7
1996	AUG	91,3	89,86	86,44	93,34
1996	SEP	94,74	91,82	88,35	95,33
1996	OCT	99,55	95,34	91,81	98,92
1996	NOV	102,98	100,27	96,65	103,94
1996	DEC	103,62	103,77	100,09	107,51
1997	JAN	105,92	104,4	100,7	108,14
1997	FEB	112,42	106,73	102,99	110,52
1997	MAR	115,25	113,39	109,54	117,29
1997	APR	121,37	116,26	112,36	120,21
1997	MAY	120,77	122,52	118,52	126,58
1997	JUN	123,05	121,84	117,85	125,89
1997	JUL	121,04	124,14	120,11	128,22
1997	AUG	120,96	122,02	118,02	126,06
1997	SEP	124,4	121,89	117,89	125,93
1997	OCT	127,73	125,39	121,34	129,49
1997	NOV	128,76	128,77	124,67	132,93
1997	DEC	133,1	129,78	125,66	133,96

YEAR	MONTH	REALITY	FORECAST	LCL	UCL
1998	JAN	134,4	134,2	130,01	138,45
1998	FEB	136,55	135,49	131,28	139,75
1998	MAR	137,5	137,65	133,41	141,95
1998	APR	138,06	138,58	134,32	142,89
1998	MAY	139,49	139,1	134,83	143,42
1998	JUN	138,69	140,53	136,23	144,87
1998	JUL	138,01	139,65	135,37	143,98
1998	AUG	137,39	138,91	134,64	143,22
1998	SEP	137,11	138,23	133,97	142,54
1998	OCT	134,37	137,91	133,66	142,21
1998	NOV	131,37	135,05	130,85	139,31
1998	DEC	131,18	131,94	127,79	136,15
1999	JAN	131,55	131,73	127,58	135,93
1999	FEB	129,47	132,09	127,93	136,3
1999	MAR	129,61	129,94	125,81	134,11
1999	APR	127,76	130,07	125,94	134,25
1999	MAY	129,48	128,16	124,06	132,3
1999	JUN	130,74	129,92	125,79	134,09
1999	JUL	129,52	131,2	127,06	135,4
1999	AUG	130,63	129,94	125,81	134,11
1999	SEP	130,99	131,07	126,93	135,26
1999	OCT	131,02	131,43	127,28	135,63
1999	NOV	130,1	131,45	127,3	135,65
1999	DEC	129,43	130,5	126,36	134,68
2000	JAN	128,77	129,8	125,68	133,97
2000	FEB	128,7	129,12	125,01	133,28
2000	MAR	128,34	129,04	124,93	133,2
2000	APR	126,73	128,67	124,56	132,82
2000	MAY	126,88	127,01	122,93	131,14
2000	JUN	128,38	127,17	123,08	131,3
2000	JUL	129,01	128,71	124,6	132,86
2000	AUG	129,43	129,35	125,23	133,52
2000	SEP	128,58	129,78	125,66	133,95
2000	OCT	129,33	128,9	124,79	133,06
2000	NOV	128,96	129,67	125,55	133,84
2000	DEC	128,57	129,29	125,17	133,45

YEAR	MONTH	REALITY	FORECAST	LCL	UCL
2001	JAN	127,26	128,88	124,77	133,04
2001	FEB	124,63	127,53	123,45	131,67
2001	MAR	125,93	124,83	120,79	128,93
2001	APR	126,82	126,17	122,11	130,29
2001	MAY	126,82	127,09	123,01	131,22
2001	JUN	126,32	127,09	123,01	131,22
2001	JUL	124,28	126,58	122,51	130,7
2001	AUG	123,34	124,48	120,45	128,57
2001	SEP	122,57	123,52	119,5	127,59
2001	OCT	123,35	122,74	118,73	126,8
2001	NOV	123,19	123,55	119,53	127,62
2001	DEC	122,61	123,39	119,37	127,46
2002	JAN	123,01	122,8	118,79	126,86
2002	FEB	123,95	123,21	119,2	127,28
2002	MAR	125,95	124,18	120,15	128,27
2002	APR	126,43	126,24	122,17	130,36
2002	MAY	127,09	126,73	122,66	130,86
2002	JUN	126,49	127,41	123,32	131,54
2002	JUL	126,28	126,79	122,71	130,91
2002	AUG	126,86	126,57	122,5	130,69
2002	SEP	126,21	127,17	123,09	131,3
2002	OCT	125,51	126,5	122,43	130,62
2002	NOV	125,33	125,78	121,72	129,88
2002	DEC	125,61	125,59	121,54	129,7
2003	JAN	128,47	125,88	121,82	129,99
2003	FEB	128,62	128,82	124,71	132,97
2003	MAR	129,44	128,97	124,86	133,13
2003	APR	132,64	129,8	125,68	133,98
2003	MAY	133,75	133,09	128,91	137,31
2003	JUN	134,99	134,22	130,02	138,46
2003	JUL	135,9	135,48	131,26	139,74
2003	AUG	135,2	136,4	132,17	140,68
2003	SEP	134,52	135,66	131,45	139,93
2003	OCT	134,51	134,95	130,75	139,21
2003	NOV	136,04	134,93	130,73	139,19
2003	DEC	137,5	136,49	132,27	140,77

YEAR	MONTH	REALITY	FORECAST	LCL	UCL
2004	JAN	137,66	137,98	133,73	142,28
2004	FEB	138,14	138,13	133,88	142,44
2004	MAR	139,77	138,61	134,35	142,92
2004	APR	139,98	140,28	135,99	144,61
2004	MAY	139,53	140,48	136,19	144,82
2004	JUN	139,22	140	135,72	144,33
2004	JUL	138,13	139,67	135,39	144
2004	AUG	138,48	138,54	134,28	142,85
2004	SEP	138,57	138,89	134,62	143,2
2004	OCT	138,54	138,97	134,7	143,29
2004	NOV	136,87	138,93	134,67	143,25
2004	DEC	136,79	137,21	132,97	141,5
2005	JAN	137,43	137,12	132,88	141,41
2005	FEB	138,31	137,78	133,53	142,07
2005	MAR	137,79	138,67	134,41	142,99
2005	APR	138,23	138,13	133,88	142,44
2005	MAY	138,68	138,58	134,32	142,89
2005	JUN	138,8	139,04	134,77	143,36
2005	JUL	138,48	139,16	134,89	143,48
2005	AUG	137,55	138,82	134,56	143,14
2005	SEP	136,84	137,86	133,61	142,16
2005	OCT	136,1	137,13	132,89	141,42
2005	NOV	136,44	136,37	132,14	140,64
2005	DEC	136,11	136,72	132,49	141
2006	JAN	135,29	136,38	132,15	140,65
2006	FEB	133,34	135,54	131,32	139,8
2006	MAR	135,34	133,53	129,35	137,77
2006	APR	132,11	135,59	131,38	139,86
2006	MAY	131,08	132,28	128,12	136,49
2006	JUN	132,65	131,23	127,08	135,42
2006	JUL	133,71	132,85	128,67	137,07
2006	AUG	132,71	133,94	129,75	138,18
2006	SEP	126,06	132,91	128,74	137,14
2006	OCT	126,64	126,09	122,03	130,2
2006	NOV	126,6	126,7	122,63	130,82
2006	DEC	125,57	126,67	122,6	130,8

YEAR	MONTH	REALITY	FORECAST	LCL	UCL
2007	JAN	123,67	125,63	121,57	129,73
2007	FEB	123,47	123,69	119,67	127,77
2007	MAR	123,78	123,5	119,48	127,57
2007	APR	124,11	123,83	119,81	127,91
2007	MAY	122,97	124,19	120,15	128,27
2007	JUN	122,6	123,03	119,01	127,09
2007	JUL	121,67	122,66	118,65	126,72
2007	AUG	121,88	121,72	117,73	125,76
2007	SEP	120,92	121,95	117,95	125,99
2007	OCT	120,7	120,97	116,99	125
2007	NOV	119,09	120,76	116,79	124,79
2007	DEC	117,44	119,12	115,17	123,12
2008	JAN	120,01	117,44	113,52	121,41
2008	FEB	121,07	120,1	116,13	124,11
2008	MAR	123,63	121,19	117,21	125,23
2008	APR	122,87	123,83	119,8	127,91
2008	MAY	122,12	123,05	119,04	127,12
2008	JUN	124,19	122,29	118,29	126,34
2008	JUL	120,55	124,42	120,38	128,5
2008	AUG	123,7	120,68	116,71	124,71
2008	SEP	125,66	123,92	119,89	128
2008	OCT	125,68	125,94	121,88	130,05
2008	NOV	125,06	125,96	121,89	130,07
2008	DEC	125,32	125,32	121,27	129,42
2009	JAN	125,75	125,58	121,53	129,69
2009	FEB	127,2	126,02	121,96	130,13
2009	MAR	127,52	127,51	123,42	131,65
2009	APR	126,92	127,83	123,74	131,98
2009	MAY	124,36	127,21	123,13	131,34
2009	JUN	121,88	124,58	120,54	128,67
2009	JUL	121,3	122,04	118,04	126,08
2009	AUG	120,96	121,45	117,46	125,48
2009	SEP	123,8	121,1	117,12	125,13
2009	OCT	124,02	124,03	120	128,1
2009	NOV	122,99	124,25	120,22	128,33
2009	DEC	123,4	123,19	119,18	127,26

YEAR	MONTH	REALITY	FORECAST	LCL	UCL
2010	JAN	125,72	123,62	119,59	127,69
2010	FEB	126,34	126	121,94	130,11
2010	MAR	125,35	126,64	122,56	130,76
2010	APR	126,63	125,61	121,56	129,72
2010	MAY	126,11	126,93	122,85	131,05
2010	JUN	127,53	126,39	122,32	130,51
2010	JUL	130,58	127,85	123,75	131,99
2010	AUG	128,05	130,97	126,83	135,16
2010	SEP	129,58	128,36	124,26	132,51
2010	OCT	130,36	129,93	125,81	134,11
2010	NOV	128,63	130,72	126,59	134,91
2010	DEC	129,73	128,94	124,83	133,1
2011	JAN	129,71	130,06	125,94	134,24
2011	FEB	128,94	130,04	125,91	134,21
2011	MAR	128,2	129,24	125,13	133,4
2011	APR	129,31	128,48	124,37	132,63
2011	MAY	130,27	129,61	125,49	133,78
2011	JUN	131,59	130,59	126,46	134,78
2011	JUL	131,6	131,94	127,79	136,15
2011	AUG	132,38	131,95	127,79	136,15
2011	SEP	133,58	132,74	128,57	136,96
2011	OCT	134,91	133,97	129,78	138,2
2011	NOV	133,36	135,32	131,11	139,58
2011	DEC	134,19	133,72	129,53	137,95
2012	JAN	134,32	134,56	130,36	138,81
2012	FEB	133,12	134,69	130,49	138,94
2012	MAR	134,57	133,45	129,26	137,68
2012	APR	132,67	134,93	130,73	139,18
2012	MAY	137,34	132,97	128,8	137,19
2012	JUN	135,55	137,76	133,51	142,06
2012	JUL	138,09	135,91	131,69	140,18
2012	AUG	138,12	138,51	134,25	142,82
2012	SEP	141,58	138,53	134,27	142,84
2012	OCT	140,58	142,07	137,76	146,44
2012	NOV	142,01	141,03	136,73	145,38
2012	DEC	143,07	142,49	138,16	146,86

YEAR	MONTH	REALITY	FORECAST	LCL	UCL
2013	JAN	143,81	143,56	139,22	147,95
2013	FEB	145,48	144,3	139,95	148,7
2013	MAR	143,9	146	141,63	150,43
2013	APR	148,85	144,36	140,01	148,76
2013	MAY	151,08	149,43	145,01	153,91
2013	JUN	150,48	151,7	147,24	156,21
2013	JUL	151,2	151,06	146,61	155,56
2013	AUG	152,09	151,78	147,32	156,29
2013	SEP	152,04	152,67	148,2	157,19
2013	OCT	150,77	152,6	148,12	157,12
2013	NOV	152,17	151,27	146,82	155,77
2013	DEC	156,74	152,69	148,22	157,21
2014	JAN	157,2	157,37	152,83	161,96
2014	FEB	160,8	157,82	153,27	162,41
2014	MAR	165,45	161,49	156,89	166,14
2014	APR	163,56	166,24	161,57	170,96
2014	MAY	168,5	164,26	159,62	168,95
2014	JUN	165,88	169,31	164,6	174,08
2014	JUL	167,28	166,58	161,91	171,31
2014	AUG	169,13	167,99	163,3	172,73
2014	SEP	169,18	169,86	165,14	174,63
2014	OCT	170,62	169,88	165,16	174,65
2014	NOV	176,44	171,33	166,59	176,12
2014	DEC	178,33	177,28	172,46	182,16
2015	JAN	176,79	179,19	174,34	184,09
2015	FEB	180,93	177,56	172,74	182,44
2015	MAR	182,07	181,79	176,9	186,72
2015	APR	186,11	182,92	178,02	187,87
2015	MAY	187,94	187,03	182,08	192,04
2015	JUN	182,89	188,87	183,89	193,9
2015	JUL	187,15	183,63	178,73	188,59
2015	AUG	185,93	187,98	183,01	193
2015	SEP	191,02	186,69	181,74	191,69
2015	OCT	186,57	191,89	186,87	196,96
2015	NOV	186,56	187,27	182,32	192,28
2015	DEC	202,45	187,23	182,28	192,24

YEAR	MONTH	REALITY	FORECAST	LCL	UCL
2016	JAN	205,79	203,54	198,37	208,76
2016	FEB	204,92	206,92	201,71	212,19
2016	MAR	209,37	205,97	200,77	211,22
2016	APR	214,63	210,5	205,24	215,8
2016	MAY	216,36	215,85	210,53	221,22
2016	JUN	216,71	217,57	212,22	222,96
2016	JUL	214,76	217,86	212,51	223,26
2016	AUG	205,41	215,8	210,48	221,17
2016	SEP	203,12	206,13	200,93	211,39
2016	OCT	205,92	203,75	198,58	208,97
2016	NOV	203,58	206,6	201,4	211,86
2016	DEC	207,15	204,17	198,99	209,4
2017	JAN	211,32	207,82	202,59	213,09
2017	FEB	207,69	212,08	206,8	217,4
2017	MAR	212,31	208,31	203,08	213,59
2017	APR	202,84	213,04	207,75	218,37
2017	MAY	210,62	203,28	198,11	208,49
2017	JUN	211,61	211,26	205,99	216,57
2017	JUL	210,78	212,25	206,97	217,58
2017	AUG	209,93	211,37	206,1	216,69
2017	SEP	207,14	210,48	205,22	215,78
2017	OCT	207,49	207,59	202,37	212,86
2017	NOV	206,02	207,94	202,71	213,21
2017	DEC	205,38	206,41	201,21	211,67
2018	JAN	211,18	205,75	200,55	210,99
2018	FEB	208,24	211,7	206,43	217,02
2018	MAR	204,73	208,66	203,43	213,94
2018	APR	207,77	205,05	199,86	210,28
2018	MAY	208,96	208,16	202,93	213,44
2018	JUN	207,97	209,38	204,13	214,67
2018	JUL	206,12	208,35	203,12	213,63
2018	AUG	204,46	206,44	201,23	211,7
2018	SEP	199,09	204,73	199,55	209,97
2018	OCT	200,66	199,22	194,1	204,38
2018	NOV	202,24	200,84	195,7	206,02
2018	DEC	202,3	202,46	197,31	207,67

Source: own processing according to IBM® SPSS Statistics and CZSO (2019, internal data)