agriculture

MDPI

Article

Economic Sustainability Assessment of a Beekeeping Farm in Hungary

Aliz Feketéné Ferenczi [1,*], István Szűcs [2] and Andrea Bauerné Gáthy [3]

[1] Faculty of Economics and Business, Institute of Applied Economics Studies, University of Debrecen, Böszörményi Str. 138, 4032 Debrecen, Hungary
[2] Faculty of Economics and Business, University of Debrecen, Böszörményi Str. 138, 4032 Debrecen, Hungary; szucs.istvan@econ.unideb.hu
[3] Faculty of Economics and Business, Institute of Economics and World Economy, University of Debrecen, Böszörményi Str. 138, 4032 Debrecen, Hungary; bauerne.gathy.andrea@econ.unideb.hu
* Correspondence: ferenczi.aliz@econ.unideb.hu

Abstract: In Hungary, beekeeping is a relatively small-scale sector within the livestock sector, but it is essential for maintaining biodiversity and rural employment. In order to provide ecosystem services such as pollination by honey bees, apiaries need to be economically sustainable, and it is therefore of strategic importance that beekeepers can continue their activities. Based on this, this article's main objective is the economic analysis of Hungarian honey production, which enables the evaluation of the cost–benefit relationships, production volume and the efficiency of the operation. The authors' analysis is based on a Hungarian apiary with 300 bee colonies, which also engages in migration and produces a significant amount of acacia honey. The model farm produces several types of honey due to migratory beekeeping, and its average yield reaches 60 kg/bee colony/year, which the authors calculated based on the average purchase prices in 2021. Based on the farm model, the analysis showed that 71 bee colonies and 4253 kg of honey production reached the profitability threshold.

Keywords: beekeeping; economic indicators; honey production; Hungary; the technology of beekeeping; sustainability

check for updates

Citation: Feketéné Ferenczi, A.; Szűcs, I.; Bauerné Gáthy, A. Economic Sustainability Assessment of a Beekeeping Farm in Hungary. *Agriculture* **2023**, *13*, 1262. https://doi.org/10.3390/agriculture13061262

Academic Editors: Luboš Smutka and Karolina Pawlak

Received: 6 May 2023
Revised: 16 June 2023
Accepted: 16 June 2023
Published: 18 June 2023

1. Introduction

According to the literature, there will be around 94 million bee colonies (in this study, we use the term bee colony; the term hive is also used) worldwide in 2020, compared to 80 million in 2010. Global honey production peaked in 2017 at around 1.88 million tonnes and has since declined to around 1.77 million tonnes. China is the primary driver of international honey production (China's share of global honey production in 2021 was 27.42%) [1–3].

The EU is the second largest honey producer after China [2,3]. It is also a net importer of honey from third countries. The EU countries with the most significant honey production are Romania, Spain, Hungary, Germany, Italy, Greece, France and Poland. The amount of honey produced in the EU-27 Member States has decreased recently, reaching 215 thousand tonnes in 2021, compared to 230 thousand tonnes in 2020, 227 thousand tonnes in 2019 and 250 thousand tonnes in 2018 [2,3].

Honey production contributes approximately 1% to the gross production value of Hungarian agriculture and almost 5% of the production value of livestock production. In recent years, a significant part of the honey produced in Hungary, more than 80%, has been exported in barrels, typically to Western European countries [4]. The main export destinations for acacia honey are Germany, France, Italy and the United Kingdom. Examining export and import data has demonstrated that Hungary has a comparative advantage in the European Union for natural honey [5]. Hungarian honey sales are also characterised by the fact that 64–66% of the honey produced is sold to buyers and traders, 3–5% is packaged and sold to retailers and shops and 1% is for industrial use (food industry); moreover, 30% is sold directly to consumers [6]. Among Hungarian consumers, acacia honey is one of the best-known and tastiest, probably because acacia honey has been a Hungaricum (the term Hungaricum is a generic term that denotes a value worthy of distinction and emphasis, which, with its characteristic feature, uniqueness, distinctiveness and quality, is the peak achievement of the Hungarian nation [7]) since 2014 [8]. The European bee colony count was at its lowest in 2017 at 16.66 million, followed by a gradual increase to 17.58 million in 2018, rising to 18.21 million in 2019. The long-term trend also shows that the number of bee colonies in the EU has increased over the last decade [9]. Compared to previous years, the number of bee colonies and apiaries in Hungary has slightly decreased since 2017, but before that, the trend grew. The decline in bee colonies has accelerated recently, with 46 886 bee colonies in 2017–2019 and 43,236 bee colonies in 2019–2020 (Figure 1). This means that the number of bee colonies decreased by the same amount in one year as in the previous two years. As a result, bee density also decreased, from an average of 13.44 bee colonies/km^2 in 2017 to 12.5 bee colonies/km^2 in 2020 [10], which is still high by European standards.

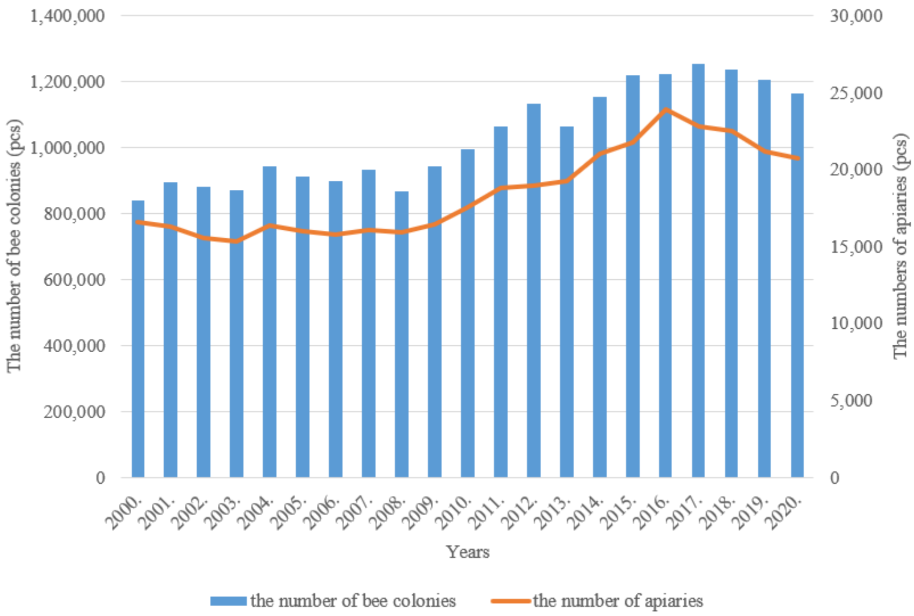

Figure 1. Trends in the number of bee colonies and apiaries in Hungary (2000–2020).

A specific feature of the Hungarian sector is that there are relatively few beekeepers with at least 150 bee colonies. In 2017, 6.8% of beekeepers and 6.82% in 2018 had at least 150 bee colonies, about 30% of the Hungarian bee population [6]. According to Chauzat et al. (2010), the proportion of professional apiaries in Hungary was 7% in 2010, and beekeepers with more than 150 colonies were classified in this category [11]. In Hungary, beekeepers typically consider beekeeping as a hobby to be 20 bee colonies, above 20 bee colonies as supplementary earnings (74.4% of beekeepers belong to this category) [12] and around 70% of beekeepers migrate to different apiaries to obtain higher yields [13].

In agricultural sectors, including beekeeping, it is essential that beekeepers have a broad knowledge of agrotechnology, economics and marketing [14]. Maintaining traditional agricultural sectors in rural areas is very important [15], as argued that rural depopulation is one of the significant problems in both developed and developing countries [16]. It is essential to maintain sectors that provide local employment opportunities. Beekeeping, as a labour-intensive sector [12,17,18], can contribute to solving this problem.

The present study investigates the possibility of economically sustainable honey production by economically modelling the economics of a large-scale apiary in Hungary. The research aims to evaluate the profitability and efficiency of Hungarian honey production through a model farm. In order to achieve the main objective, the authors aimed to answer the following research questions:

What are the type, structure and composition of beekeeping inputs (feed, medicine, beeswax, fuel and other materials) and production costs?

What output level or parameters (yield, sales price, production value) characterise production?

How does the result of beekeeping and production efficiency (income-generating capacity, profitability and efficiency) evolve in terms of a farming year? Considering the production structure, what are the quantity and the minimum number of bee colonies needed to produce each type of honey?

2. Materials and Methods

The research includes both primary data collection and secondary data analysis. Besides processing relevant literature on the subject, the data used in the analysis were taken from the Hungarian National Beekeeping Programme and statistical databases. The research results were based on the 2021 HUF/EUR exchange rate (HUF 358.52/EUR) published by the Central Bank of Hungary [19]. The primary research involved personal farm visits to develop the parameters of the sample farm, which involved collecting data and information from two professional bee farms. A farm model was created to determine the possible conditions of honey production under the given ones, using the statistical data and the individual apiaries' technological characteristics [20]. The production and economic processes were modelled from the data collected using an Excel-based deterministic simulation model similar to the one created by Szőllősi [21] and Erdős et al. [22]. In the costing, costs were first grouped according to their relationship with production volume. Yields, revenue, production value, critical production volumes per variety and the minimum number of bee colonies were determined, followed by disposable income [23]. Finally, some essential efficiency indicators were calculated [24]. The critical quantity for the break-even point shows the sales volume required to cover all variable and fixed costs. The break-even point is where total sales and costs are equal [25,26]. A higher production volume than the critical or break-even point (the output of the break-even quantities, a kind of threshold) means the farm is profitable. A lower production volume means the farm is loss-making [26,27]. The break-even point of a company or business refers to the number of products sold where the total income is equal to the total cost. In other words, the utility is zero [28]. The break-even point is defined as the production value, including subsidies and sales. The minimum number of bee colonies was determined based on the annual yield calculated from the interviews.

Finally, the results were compared with similar conclusions from some international studies. The aim of this study is not to analyse the data of a specific apiary but to evaluate the results of a farm model based on these data. The total production technology is in the form of in-kind inputs to analyse the cost side. Additional data for the study were provided by various studies related to the sector and Hungarian databases (statistical database, National Hungarian Beekeeping Association, Ministry of Agriculture) and producers' data. Yield data were obtained from beekeepers, while data on sales prices were obtained from secondary sources. All output and input prices are nets, i.e., excluding VAT, and reflect the price level in 2021. The farm-level analyses are based on technology, thus analytically presenting a model farm's characteristics and production practices.

Our research used data to analyse the annual cost–income ratios of production. The following production data had to be collected in order to assess the annual cost–income ratios: the natural quantity of inputs used (feed, medicine, queen bee, fuel, live labour); the unit prices of inputs (input prices); all other inputs related to product characteristics and their costs; specific yields; the selling prices of the different honey varieties and some available subsidies.

3. Results and Discussion

3.1. Technological Characteristics of the Model Farm with 300 Bee Colonies

The honey yields in the model farm assume an average beekeeping season, apart from severe adverse weather conditions. Yields lost due to late frosts, prolonged drought or prolonged rainfall can reduce the calculated yield by up to 50–100%.

Based on the specific yields of an apiary moving bee colonies (rapeseed honey 10 kg/bee colony; acacia honey 21 kg/bee colony; mixed flower honey 10 kg/bee colony; sunflower honey 19 kg/bee colony), the annual honey production is 18,000 kg. In the apiary, four containers with 72 bee colonies and 12 reserve bee colonies ensure the production in the bee colonies in Nagy-Boczonád. The containers can be moved quickly and efficiently so that in the event of sudden adverse weather conditions, they do not require excessive effort to transport them to other bee pastures. A good bee colony is essential for honey production, and the natural stands of plants with large surface areas, many flowers and cultivated crops are essential. The weather significantly influences bees' regular foraging activity and honey plants' nectar production [6,29]. In line with Hungarian beekeeping practice, we assume the availability of acacia (*Robinia pseudoacacia*) as a bee pasture in our model. Among the honey-producing forest trees in Hungary, acacia occupies the most prominent area and is the primary source of honey for beekeepers (459,135 hectares in 2021) [30]. Among cultivated crops, rape and sunflower are Hungary's most essential bee pastures. In 2021, the total area sown to sunflower in Hungary was 663,491 hectares and to rapeseed 261,266 hectares in 2021 [31].

The description of the model economy and our economic calculations are based on the following technological indicators, which were determined based on interviews with beekeepers (Table 1).

In spring, the bee colonies' preparation for production begins depending on the temperature (average daily temperature reaches 10 °C) and the needs of the colonies; food is given in sugar candy or sugar syrups, supplemented with pollen, vitamins and minerals. To ensure that the physiological processes of the colonies are not disturbed, feeding should be carried out during periods without nectar and pollen gathering, which can serve the purposes of food supplementation and stimulation [32]. In order to avoid bee mortality, feeding is essential during extended periods when the bees cannot collect nectar and pollen [33].

The first transport of the bee colonies is to rapeseed pasture. Once the nectar and pollen gathering is complete, the beekeeping farm can be expanded by establishing new colonies. This also serves to prevent the swarming of bees (natural reproductive instinct). During propagation, the uncapped brood is removed from the hives and placed in the other hive with pollen frames and immediate extra food. With further intensive feeding, these are kept away until the bee queens mate. Bee colonies must be kept in continuous production. The aim is to have a new queen bee in half the bee colonies yearly. The queen bee has a significant impact on the performance of bee colonies [34]. For beekeepers, the bee colonies are a fundamental means of continuing their business. Vercelli et al. (2020) have developed a unique tool for keeping economic records of honey bee colonies called the Honey Bee Colony Inventory (HBCI) [35]. Some queens come from the apiary's stock, while most queens are purchased from other beekeepers. Beekeepers mostly purchase queen bees from Hungarian bee breeders. It serves to preserve the genes of the native Pannonian bee, which has excellent production and behavioural traits suitable for exploiting Hungarian bee pastures [36]. Migration from rape to acacia follows immediately, with acacia honey harvested from early eastern acacia pastures and then from northern acacia pastures. After the acacia harvest, bee colonies carry pollen and nectar from wildflowers and other floodplain flowers. The maximum amount of honey to be removed is 10 kg per bee colony.

Table 1. Main production and technological indicators for beekeeping in 2021 *.

Specification	Unit	Value
Species	*Apis mellifera carnica pannonica*	-
Number of producing bee colonies	Bee colony	288
Number of reserve bee colonies	Bee colony	12
Average annual honey yield	kg/year	60
Colony mortality rate	%	5
The useful life of queen bees	year	2
Sales price of rapeseed honey (wholesale)	EUR/kg	1000
Sales price of acacia honey (wholesale)	EUR/kg	2300
Sales price of mixed flower honey (wholesale)	EUR/kg	1000
Sales price of sunflower honey (wholesale)	EUR/kg	1000
Average feed prices		
Granulated sugar	EUR/kg	280
Sugar candy with protein and vitamins	EUR/kg	800
Bee wax	kg	143
Comb foundation (4 pieces/bee colony)	Piece	1200
Bee health		
Oxalic acid	g/bee colony	10
Persistent carrier drug	Box/5 bee colonies	60
Anti-nozema drug	mL/bee colony	4
Purchased queen bee	EUR/piece/year	4500
Fuel—trucks	L	520
Fuel—operating machines	L	120
Average gross wage (beekeeper)	EUR/h	1850
Average gross wage (seasonal workers, family members)	EUR/h	1200

* Based on modelled farm with 300 bee colonies.

During the intervening few weeks, oxalic acid can be used to keep Varroa destructor infestation under constant control. Using organic means, a combination of different treatment protocols can ensure effective Varroa control in colonies [37]. The Varroa mite prefers drone (male honey bee) broods, which guarantees a longer development period [38,39]. The number of Varroa mites can be kept in check by removing the capped drone brood. Before bees visit sunflowers, the queen bees should be rechecked and replaced if necessary. Depending on external factors (weather, crop protection), migration to early and late-flowering sunflowers may occur. At this time, honey is no longer taken from bee colonies, as late summer and autumn flowering usually does not produce nectar.

Honey extraction (honey spinning) is carried out at the bee pasture using two electric self-turning honey extractors, a bee blower and an uncapping machine (mechanised operations). The migration to the bee pastures is carried out by its lorries. The apiary relies on family labour and, for specific tasks (transport, spinning), on casual workers.

Depending on the current crop, slow feeding with 1 L sugar syrup every 2–3 days should be applied to maximise the number of broods at the end of the honeying period. Suppose there is a large bee pasture in the area. In that case, this can be beneficial to minimise feeding and enhance the maximum overwintering development of colonies. At the end of September, the effects of climate change require an intensive winter food supply. The recent years' mild autumn and winter weather keeps the bees active for a long time, and the queen bee lays eggs for longer than necessary. In parallel with proper Varroa destructor control, feeding should stop in mid-October. At this time, the brood cells should be checked (reproduction of the colony in the frames: eggs, larvae, pupae); there are no uncapped broods (larvae), and control of the persistent carrier Varroa destructor can be started and removed it in the first days of November. At the end of the month, depending on the weather, the final treatment is either oxalic acid soaking or sublimation. Considering the weather forecast, winter blankets should be applied as late as possible to prevent further oviposition.

3.2. Operational Calculations: Yields, Production Value, Production Costs, Income, Quantity at the Break-Even Point and the Minimum Number of Bee Colonies

The most crucial technological parameter is the amount of honey a bee colony produces, which averages 60 kg/bee colony/year. For a professional apiary (over 150 bee colonies), the annual honey yield is at least double that of an average smaller apiary, with a honey yield of 60 kg per bee colony in Hungary [6]. The proportion of professional apiaries with more than 150 bee colonies at the European Union's level is only around 3% [40]. The yield of acacia honey, the most crucial domestic honey variety (6300 kg/year), contributes about 55% of the revenue and 53% of the total production value (Figure 2). The average selling price of acacia honey (EUR 6.42/kg) is more than double that of other honey varieties, including the purchase and consumer prices. The yields of rapeseed honey (3000 kg/year) and mixed flower honey (3000 kg/year) and sunflower honey (5700 kg/year) and their average selling price (EUR 2.79/kg) mean that they account for a smaller share of production value. The calculation of revenues and costs is based on the data in Table 1.

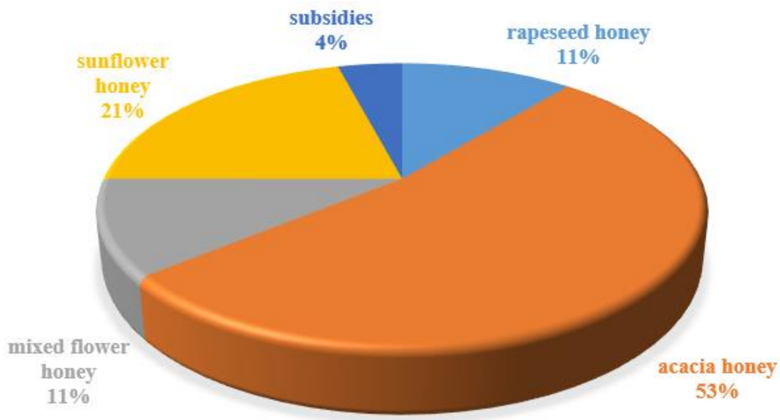

Figure 2. Distribution of the annual production value of beekeeping.

The following subsidies for 2021 have been taken into account in the calculation, linked to the number of bee colonies that are members of the National Hungarian Beekeeping Association and registered in the Breeding Information System. Aid for maintaining the health of the bee population is available at EUR 2.79 per bee colony, for maintaining the number of bees at EUR 4.46 per queen bee, for sugar and medicine at EUR 4.46 per bee colony and for hive and frame replacement at EUR 1.39 per bee colony. Kárpáti et al. (2010) have already stressed the importance of subsidies for beekeeping programmes for competitiveness and the sector's development [41]. Another ad hoc aid may be requested under the National Beekeeping Programme, such as purchasing a new honey extractor and new equipment for transport. It is assumed that the apiary is debt-free and has neither a short-term working capital loan nor a long-term investment loan.

Most of the total production value (96%) comes from the sale of honey, with subsidies accounting for only 4% (Figure 2). Most of the total production value (96%) comes from the sale of honey, with subsidies accounting for only 4%. Similar to the results of several studies [6,12,42–45], most of the total production value (96%) comes from the sale of honey, with subsidies accounting for only 4%. The model beekeeping farm produces the most acacia honey (6000 kg), which has the highest purchase price and contributes the most to production value. Next comes sunflower honey (21%), rapeseed honey (11%) and mixed flower honey (11%), with the exact purchase price for these types of honey. In the modelled farm, sunflower honey is higher (5700 kg) than rapeseed honey (3000 kg) and mixed flower honey (3000 kg).

The value of honey sales per bee colony is calculated to be over EUR 243, and the value per kg of honey is EUR 4.06/kg of honey, plus subsidies (Table 2), giving a total production value of EUR 253.93 per bee colony and EUR 4.23/kg of honey.

Annual production costs per bee colony depend largely on the technology used, the transport of the bee colonies and the ecological conditions of the environment. Some materials, tools and bee colonies used in beekeeping are purchased, and others are self-made. The beekeeper uses own beeswax in the production process. Looking at the farm's cost structure, the proportion of fixed costs (47%) and variable costs (53%) within the total production cost is almost the same. In both cases, labour costs represent the largest share (Table 3). According to several studies, the share of variables in production costs is around 60–68% [44–46]. In Croatia, material costs account for the largest beekeeping costs (36%) [47].

The wages of the beekeeper, family helpers and other workers were calculated according to the 2021 wage level. Following Feketéné Ferenczi et al. [9], the profitability of beekeeping activities was analysed by including labour as an input. Here, the authors distinguished between wages calculated for the beekeeper and for family members and casual workers, given that the beekeeper is present in the apiary as a necessary permanent worker [43,48]. The beekeeper's wage costs were calculated according to the rules for full-time farmers and included as a fixed labour cost under fixed costs. Accordingly, the personnel costs of the beekeeper represent 41% of the total fixed costs (EUR 6558/year, i.e., EUR 21.86/bee colony/year), reflecting that it is a labour-intensive activity. Studies of honey production in Serbia in 2017 found that the proportion of beekeeper wages in 200 hives was 51–52% [43,44], and in a 2010 study in Bosnia and Herzegovina it was 41% [44]. One measure of the labour intensity of honey production is the number of person-hours needed to look after a bee colony. Based on interviews with beekeepers, the average hours worked per bee colony is 10.7 h/per year, for a total of 3210 working hours per year for 300 bee colonies.

The depreciation cost reflects the amortisation of the existing assets of the apiary. The assets used in beekeeping have a long lifespan, and depreciation is relatively low [43,47]. In our calculations, we assumed depreciation of 5% for trucks, 2% for the storage building, 10% for hives, honey extractors and bee blowers, 12.5% for the aggregator and 20% for the barrels used for honey storage. This was calculated considering the winter mortality of the producer colonies (5%) at EUR 4482/year, about 28% of the fixed costs. The cost of regular replacements of queen bees (half the stock per year) is EUR 1883/year, 12% of the fixed costs. The other fixed costs charged to the sector are estimates based on the data collection. These include, among others, expenses not directly related to production, but which are permanent, such as membership fees, accounting fees, insurance premiums, participation in professional forums, travel expenses and other management costs, amounting to about EUR 3121/year.

Within variable costs, the highest (35%) is the wage of the employees (EUR 6747/year, which is EUR 21.57/bee colony/year), i.e., when the beekeeper uses seasonal (family, casual) workers to carry out the work processes of honey spinning, transporting and treating (seasonal agricultural work), according to the amount of work that is required. The feeding of bee colonies—29% of the variable costs—is based on the use of preparations containing granulated sugar, sugar syrup, vitamins and minerals, so the current price level (purchase of larger quantities) is the determining factor in the development of this (EUR 5355/year). The cost of preventive preparations accounts for about 15% of the variable costs. Maintenance, fuel, protective equipment, small tools and equipment for the repair and maintenance of trucks (other variable costs) account for 21% of the variable costs.

The model calculation shows that labour-related costs represent a significant share of variable and fixed costs. The production cost per bee colony is EUR 114.48/year, and the production cost per kg of honey is EUR 1.91/year. The calculations presented in our study are also supported by a study carried out by the Ministry of Agriculture in 2018 [5]. Compared to this analysis, the only difference is between the breakdown of fixed and variable costs. According to the Ministry of Agriculture, the cost per bee colony in Hungary in 2018 was EUR 125.95/year, based on data from migratory beekeeping with 150 bee colonies, of which fixed costs were EUR 97.43/bee colony/year and variable costs EUR 28.52/bee colony/year. For these calculations, fixed costs include amortisation, labour and other fixed costs (membership fees, insurance). The variable costs taken into account were the cost of Varroa destructor control, the price of feed sugar, the cost of transport and the costs of packaging and processing the honey. The Ministry of Agriculture calculates the cost as EUR 2.10/kg of honey in 2018.

The contribution margin, reflecting the difference between the production value and variable costs, is EUR 192.93 per bee colony, and including fixed costs, the net income per bee colony is about EUR 140/year (Table 4).

Table 2. Evolution of the annual production value in the model farm *.

Types of Revenues	Modelled Farm Total (EUR/Year)	Amount per Bee Colony (EUR/Year)	Amount per 1 kg Honey (EUR/Year)	Distribution (%)
Rapeseed honey	8368	27.89	0.47	11.5
Acacia honey	40,416	134.72	2.25	55.3
Mixed flower honey	8368	27.89	0.47	11.4
Sunflower honey	15,899	53.00	0.88	21.8
Sales revenue	73,050	243.50	4.06	96.0
Subsidies	3130	10.43	0.17	4.0
Production value	76,180	253.93	4.23	100.0

* Based on 300 bee colonies and 60 kg/bee colonies/year yield.

Table 3. Annual production costs in the model farm *.

Types of Costs	Modelled Farm Total (EUR/Year)	Amount per Bee Colony (EUR/Year)	Amount per 1 kg Honey (EUR/Year)	Distribution (%)
Feeding	5355	17.85	0.30	29.0
Bee health	2697	8.99	0.15	15.0
Maintenance	2008	6.69	0.11	11.0
Fuel	798	2.66	0.04	4.0
Seasonal workers	6747	21.57	0.36	35.0
Other variable costs	971	3.24	0.05	5.0
Total variable costs	18,300	61.00	1.02	53.0
Beekeeper's wages	6558	21.86	0.37	41.0
Cost of depreciation	4482	14.94	0.25	28.0
Queen bee	1883	6.28	0.11	12.0
Other fixed costs	3121	10.41	0.17	19.0
Total fixed costs	16,044	53.48	0.89	47.0
Production costs	34,347	114.48	1.91	100.0

* Based on 300 bee colonies and 60 kg/bee colonies/year yield.

Table 4. Evolution of the contribution margin and income in the model farm *.

Economic Indicators	Modelled Farm Total (EUR/Year)	Amount per Bee Colony (EUR/Year)	Amount per 1 kg Honey (EUR/Year)	Distribution (%)
Production value	76,180	253.93	4.23	100.0
Variable costs	18,300	61.00	1.02	53.0
Fixed costs	16,044	53.48	0.89	47.0
Production costs	34,347	114.48	1.91	100.0
Gross margin	57,880	192.93	3.21	
Net income	41,833	139.45	2.32	
EBIDTA	46,315	154.39	2.57	

* Based on 300 bee colonies and 60 kg/bee colonies/year yield.

The primary efficiency indicator of the model farm under study is the 122% profitability-to-cost ratio (net income/production costs), which is considered very good [49]. It should be noted that this depends mainly on the availability of acacia pasture for the production of acacia honey and the quality of the acacia blossom, i.e., it is often solely a function of human relations to which areas the beekeepers can deliver their bees. Furthermore, no extreme situation was assumed. Another important indicator is the net income per hour worked, which in this case is EUR 13/hour (net income/total working hours), and the feed cost per kg of honey produced, which is EUR 0.3/kg of honey (Tables 3 and 4).

The break-even points for beekeeping in the model farm were calculated separately for each honey variety, as the domestic price of acacia honey is significantly higher than that of the other honey varieties considered in the model farm. The coverage quantities for the different types of honey were determined based on the production structure, i.e., the costs were allocated to the different types of honey—as shown in Table 1 presented—in proportion to their share of turnover. The number of bee colonies required to produce the quantities covered was also determined. Based on the calculations, the break-even production is 1517 kg for acacia honey, 688 kg for rapeseed honey and 688 kg for mixed flower honey and 1360 kg for sunflower honey (Figures 3–6).

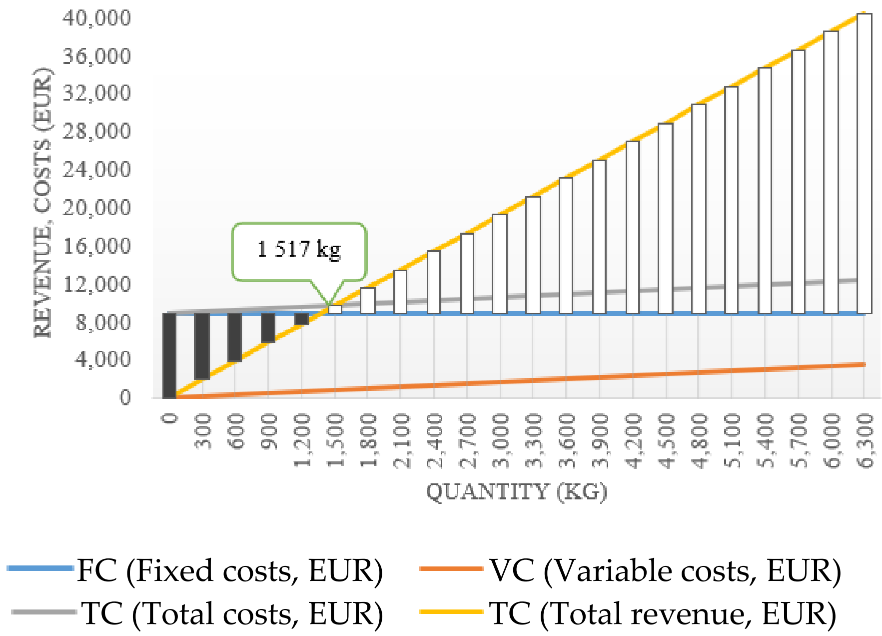

Figure 3. Evolution of quantity at break-even point by the acacia honey.

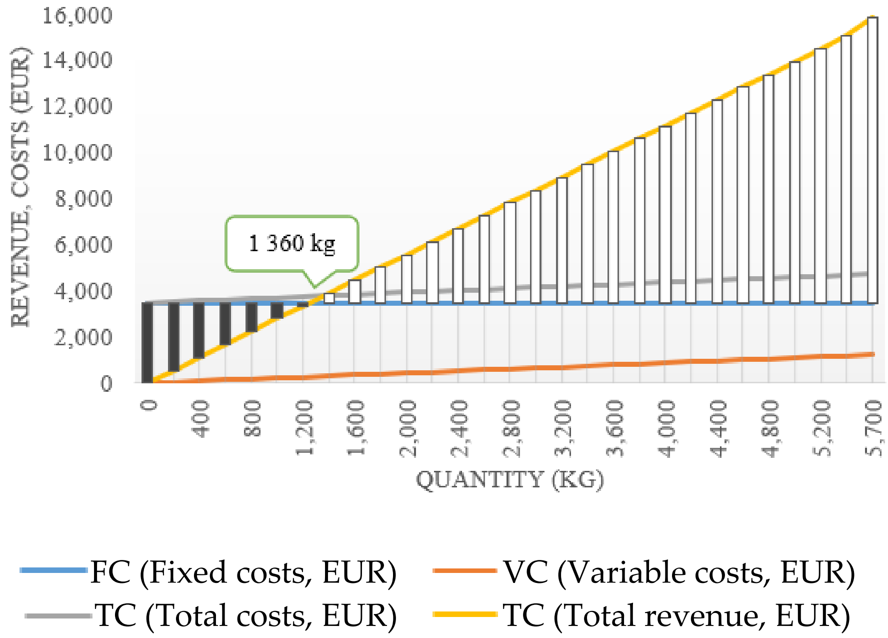

Figure 4. Evolution of quantity at break-even point by the sunflower honey.

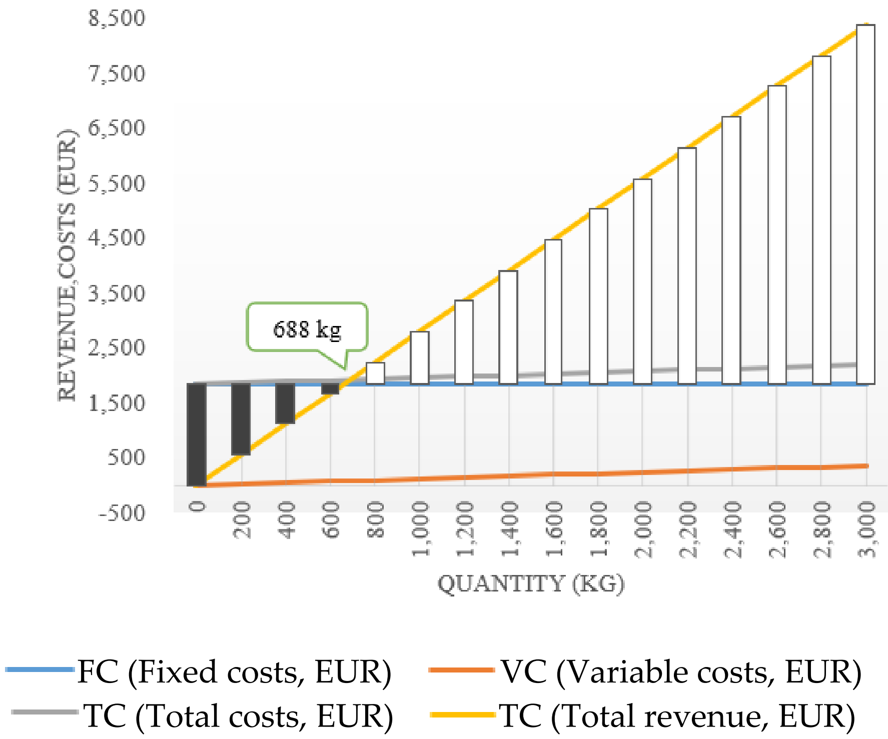

Figure 5. Evolution of quantity at break-even point by the rapeseed honey.

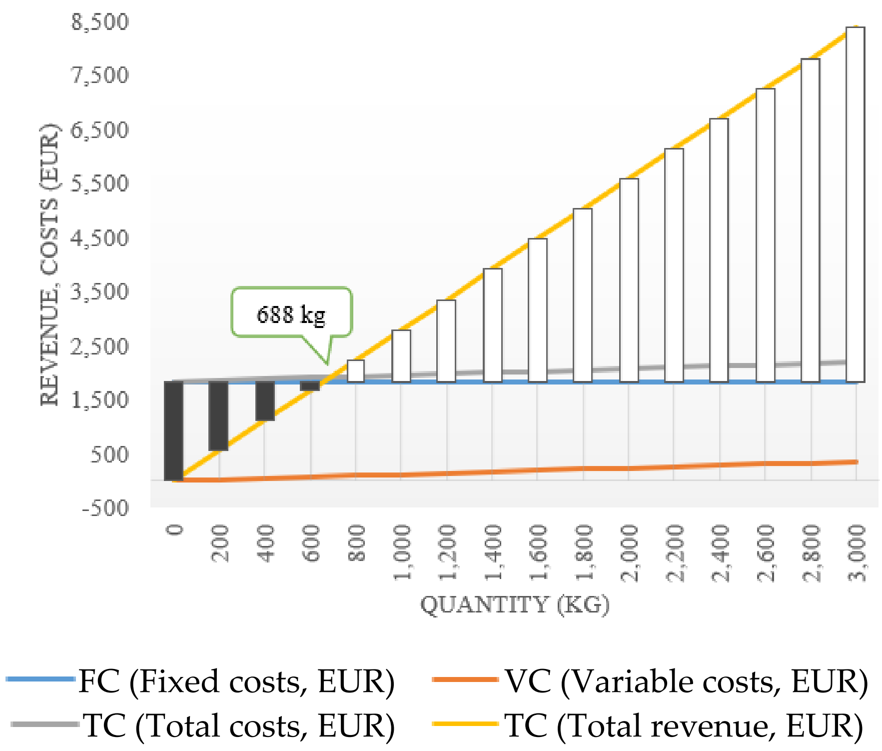

Figure 6. Evolution of quantity at break-even point by the mixed flower honey.

The average yield determined based on the primary research is 60 kg per bee colony/year on the model farm. This implies that 71 bee colonies are needed to produce the total coverage (4253 kg). The number of kilograms of honey and the minimum number of bee colonies for the break-even point are presented in Table 5 for each type of honey in the chronological order of production.

Table 5. The number of bee colonies per break-even point per type of honey *.

Type of Honey	Quantities at Break-Even Point (kg)	The Colony Needs (Piece)
Rapeseed honey	688	11
Acacia honey	1517	25
Mixed flower honey	688	11
Sunflower honey	1360	23
Total	4253	71

* Based on modelled farm with 300 bee colonies.

With more bee colonies, honey can be produced to cover all the fixed and variable costs and make a profit. The inputs and sales prices determining net income, expenditure and revenue can vary significantly between countries, regions and years. A study by Knaus and Milotić [47] and Nedić et al. [43] suggest that, in Croatia, a beekeeper must have at least 168 bee colonies to be paid the average wage in the country. In Serbia, this means 137 bee colonies or 2905 kg of honey produced, while to qualify for the minimum wage, a beekeeper must have 68 bee colonies or produce at least 1450 kg of honey. In Romania, Popescu [50] found that beekeepers must keep more than 100 bee colonies to be profitable. In Bosnia and Herzegovina, the model described by Cejvanovic et al. [42] puts the economic farm size at 200–350 bee colonies.

The 71 bee colonies needed to produce the calculated coverage point for our model farm can be explained by the fact that the selling price of acacia honey is higher than that of other honey varieties. Thus, it is considered a pull factor in the sales, so fewer bee colonies are sufficient to reach the coverage point set against international comparisons.

4. Conclusions

Our study presented how and with what technology a large-scale beekeeping enterprise in Hungary can operate to make honey production profitable. The model farm produces more honey thanks to the migration, with an average yield of 60 kg/bee colony/year based on average purchase prices in 2021. The production value of honey varies according to the current buying-in price, which has risen by around 20–40% in the last two years, primarily due to meagre national honey yields.

As the sector is highly dependent on the weather and climate change, it is paramount to carry out the activity professionally, to know the biology and behaviour of the bees and to know the quality of the available bee pasture. The two critical factors influencing the profitability of honey production, which are also interrelated, are the development of the honey yield per colony of bees (the productivity of the bee colonies) and the current purchase (wholesale) price. In the case of the model farm, it was EUR 6.42/kg for acacia honey and EUR 2.79/kg for other types of honey. These two factors are in themselves sensitive to the sectoral result. In Hungary, buying starts after honey extraction, initially at a lower price, which stagnates at a slightly higher level in the autumn and winter months until the beginning of the following year. The purchase price of acacia honey is higher than that of the other types of honey analysed, so its contribution to the production value is significant.

It can be concluded that beekeeping is a labour-intensive activity, illustrated by the high share of labour costs in production costs. Based on this, the production volume for the contribution to the break-even production was established at 1517 kg for acacia honey, 1360 kg for sunflower honey and 688 kg for rapeseed honey and 688 kg for mixed flower honey, i.e., a total of 4253 kg of honey, which requires at least 71 bee colonies. An increase in the number of bee colonies could also lead to a corresponding increase in the share of subsidies in the total income structure, indicating the importance of subsidies and their link to the financial result.

The main economic objective of honey and other beekeeping production is to provide income and livelihood opportunities for beekeepers (about 20,000 people in Hungary) and generate significant export revenues, as most of the honey is exported abroad, thus playing a role in developing macroeconomic indicators. Beekeeping contributes significantly to the pollination and ecological balance essential for agriculture, for example, by recycling the beeswax produced (for artificial bees) and by the sustainable use of many tools (hive, spinner, scrubber, storage tools). In addition, providing society with healthy, high-quality food is increasingly essential. All this contributes to strengthening the rural population's capacity to maintain and sustain itself and stabilising family farms based on beekeeping.

5. Limitations

In our study, we have presented how the revenue and cost structure and profitability of a professional beekeeping business can be developed in Hungary. It should be pointed out that a limitation of our study is that we have used one year of data and have not taken into account weather extremes, which can have a significant impact on honey yields. The model beekeeping farm described represents the professional scale of beekeeping in Hungary. We have assumed a full-time beekeeper who is only producing honey and only sells the honey produced to a wholesaler. The technology used was the Nagy-Boczonád frame type and container, which this studied was also modelled after, for migratory beekeeping.

Author Contributions: Conceptualization, I.S.; methodology, I.S. and A.B.G.; software, A.F.F.; validation, A.B.G.; formal analysis, A.F.F.; investigation, A.F.F. and A.B.G.; resources, A.F.F.; data curation, A.F.F.; writing—original draft preparation, A.F.F.; writing—review and editing, A.F.F. and A.B.G.; visualization, A.F.F.; supervision, I.S. and A.B.G.; project administration, A.F.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: The data presented in this study are available upon request from the authors.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Statista. Honey Market Worldwide and in the U.S.—Statistics & Fact. Available online: https://www.statista.com/topics/5090/honey-market-worldwide/#topicOverview (accessed on 15 February 2023).
2. Faostat. Crops and Livestock Products. Available online: https://www.fao.org/faostat/en/#data/QCL (accessed on 15 February 2023).
3. European Commission. National Apiculture Programmes. European Commission-Agricultural and Rural Development. Available online: https://ec.europa.eu/agriculture/honey/programmes (accessed on 20 May 2023).
4. Oravecz, T.; Mucha, L.; Illés, B.C. A magyar méhészeti ágazat elmúlt 20 éve–Termelési alapok. *Sci. J. Agric. Econ.* **2020**, *64*, 435–451. (In Hungarian) [CrossRef]
5. Mucha, L.; Oravecz, T.; Totth, G.; Illés, B.C. A magyar méz kereskedelmének komparatív előnyei. *Sci. J. Agric. Econ.* **2021**, *65*, 23–37. [CrossRef]
6. Agrárminisztérium. Magyar Méhészeti Nemzeti Program Értékelés 2016–2019 és Tervezés 2019–2020. Available online: https://www.mvh.allamkincstar.gov.hu/documents/20182/7906115/Magyar+M%C3%A9h%C3%A9szeti+Nemzeti+Program+2020-2022.pdf/0f4f5859-5eb7-4334-9d0d-dd301381d78a?version=1.0 (accessed on 15 February 2023). (In Hungarian)
7. On Hungarian National Values and Hungaricums Act XXX of 2012. Available online: https://net.jogtar.hu/jogszabaly?docid=a1200030.tv (accessed on 15 February 2023). (In Hungarian)
8. Vida, V.; Feketéné, F.F. Mézfogyasztási és vásárlási szokások alakulása Hajdú-Bihar megyében Honey consumption and purchasing habits in Hajdú-Bihar county. *Régiókutatás Szle.* **2022**, *7*, 88–101. (In Hungarian) [CrossRef]
9. Feketéné Ferenczi, A.; Szűcs, I.; Vida, V. Családi gazdasági keretek között működő méhészeti vállalkozás üzemtani vizsgálata. *Sci. J. Agric. Econ.* **2021**, *65*, 237–255. [CrossRef]
10. Országos Magyar Méhészeti Egyesület. Környezetterhelési Monitoringvizsgálat 2020–2021. Budapest. Available online: http://www.omme.hu/kornyezetterhelesi-monitoring-vizsgalat-2020-2021/ (accessed on 15 February 2023). (In Hungarian)
11. Chauzat, M.-P.; Cauquil, L.; Roy, L.; Franco, S.; Hendrikx, P.; Ribière-Chabert, M. Demographics of the European Apicultural Industry. Szerkesztette Dennis vanEngelsdorp. *PLoS ONE* **2013**, *8*, e79018. [CrossRef] [PubMed]
12. Nagy, I. A Méhészeti Termelés Technológiai, Gazdasági, Társadalmi Összefüggéseinek Vizsgálata. Doktori (PhD) Értekezés. Mezőgazdaság-és Élelmiszertudományi Kar, Mosonmagyaróvár, Ujhelyi Imre Állattudományi Doktori Iskola. 2007, 31, 56p. Available online: http://doktori.uni-sopron.hu/id/eprint/23 (accessed on 15 February 2023). (In Hungarian)
13. Központi Statisztikai Hivatal. A Méhészet, a Méztermelés Helyzete és Lehetőségei, Különös Tekintettel Észak-Magyarország Megyéire; pp. 4–6. 2012. Available online: https://www.ksh.hu/docs/hun/xftp/idoszaki/regiok/meheszet.pdf (accessed on 15 February 2023). (In Hungarian)
14. Kovács, K. Managerial Challenges in Hungarian Agricultural Enterprises. In *Managing Agricultural Enterprises: Exploring Profitability and Best Practice in Central Europe*; Palgrave Macmillan: Cham, Switzerland, 2018; pp. 225–239. [CrossRef]
15. Bittner, B.; Anitha, M.K.; Tibor, O.; Janos Borsos, D.S.C. Difficulties of diversification and alternative crops to tobacco in European Union. In Proceedings of the Aspects and Visions of Applied Economics and Informatics: International Congress: Proceedings II, Cáseres, Spain, 26–27 March 2009; pp. 1121–1127.
16. Tumiwa, J.R.; Tuegeh, O.D.M.; Bittner, B.; Nagy, A.S. The challenges to developing smart agricultural village in the industrial revolution 4.0.: The case of Indonesia. *Tor. Int. Stud.* **2022**, *15*, 25–45. [CrossRef]
17. Nyárs, L. Situation and perspective of the Hungarian beekeeping. *J. Apic. Sci.* **2003**, *47*, 59–66. Available online: https://apiardeal.ro/biblioteca/carti/Straine/EN_-_A_Jurnal_of_Apicultural_Science_vol.47_2003.pdf (accessed on 15 February 2023).
18. Odemer, R.; Odemer, F.; Liebig, G.; de Craigher, D. Temporal increase of Varroa mites in trap frames used for drone brood removal during the honey bee season. *J. Appl. Entomol.* **2022**, *146*, 1207–1211. [CrossRef]
19. Magyar Nemzeti Bank. HUF/EUR Átlagárfolyam. Available online: http://www.mnbkozeparfolyam.hu/arfolyam-2021.html (accessed on 25 October 2022). (In Hungarian)
20. Velardi, S.; Leahy, J.; Collum, K.; McGuire, J.; Ladenheim, M. You Treat Them Right, They'll Treat You Right: Understanding Beekeepers' Scale Management Decisions within the Context of Bee Values. *J. Rural. Stud.* **2021**, *81*, 27–36. [CrossRef]
21. Szőllősi, L. The operation of the Hungarian broiler product chain. *Appl. Stud. Agribus. Commer.* **2009**, *5*, 47–50. [CrossRef]
22. Erdős, A.D.; Molnár, S.; Szőllősi, L. Efficiency of table egg production in different housing systems and farm sizes: A case study based on three Hungarian farms. *Ann. PAAAE* **2019**, *XXI*, 116–125. [CrossRef]

23. Apáti, F. The Comparative Economic Analysis of Hungarian and German Apple Production of Good Standard. 2008. Available online: https://dea.lib.unideb.hu/server/api/core/bitstreams/824f3dd5-2620-44dd-8fad-58b1b35cacb8/content (accessed on 15 February 2023).
24. Kovács, K.; Vida, V.; Madai, H.; Szűcs, I. Jó színvonalú hazai tejtermelő üzem gazdasági elemzése. Economic Analysis of a Good Quality Hungarian Dairy Farm with Leading Technology. *Tejgazdaság* **2021**, *1–2*, 43–64. Available online: http://hdl.handle.net/2437/320962 (accessed on 15 February 2023). (In Hungarian) [CrossRef]
25. Olatubosun, T.O.; Oluwale, B.A.; Ilori, M.O. Economic Evaluation of Smallholder Honey Production Technologies in Southwestern Nigeria. *J. Econ. Manag. Trade* **2016**, *15*, 1–17. [CrossRef]
26. Nábrádi, A. *Vállalkozási Ismeretek*; Debreceni Egyetem: Debrecen, Hungary, 2019; pp. 30–48. (In Hungarian)
27. Agang, M.W.; Mauliana, H. Break Even Point (BEP) Analysis of Honey Bee Cultivation Business Trigona Sp in UPTD KPH TARAKAN. In Proceedings of the International Conference on Indigenous Knowledge for Sustainable Agriculture, Tarakan, Indonesia, 13 July 2022.
28. Chi, J.R.C.; Campeche, M.I.C.; Cauich, I.C.; Fernández, V.G.P.; Luis, D.M.; Fernández, A.P.; Chapingo, D. Social and economic characterisation of bee Honey production in the north of the state of Campeche, Mexico. *Textual* **2018**, *72*, 103–123. [CrossRef]
29. Chabert, S.; Sénéchal, C.; Fougeroux, A.; Pousse, J.; Richard, F.; Nozières, E.; Geist, O.; Guillemard, V.; Leylavergne, S.; Malard, C.; et al. Effect of environmental conditions and genotype on nectar secretion in sunflower (*Helianthus annuus* L.). *OCL* **2020**, *27*, 51. [CrossRef]
30. Központi Statisztikai Hivatal. A Faállománnyal Borított Erdőterület és az Élőfakészlet Megoszlása Fafajcsoportok és Korosztályok Szerint, December 31. (Hektár). Available online: https://www.ksh.hu/stadat_files/kor/hu/kor0004.html (accessed on 20 February 2023). (In Hungarian)
31. Központi Statisztikai Hivatal. A Fontosabb Növények Vetésterülete. 1 Június 2021. Available online: https://www.ksh.hu/docs/hun/xftp/stattukor/vet/20210601/index.html#aszntfldnbztkukorictsnapraforgtvetettekalegnagyobbterleten (accessed on 20 February 2023). (In Hungarian)
32. Ruff, J. *A Méhészmester Könyve*; Szaktudás Kiadóház: Budapest, Hungary, 2007; 153p, ISBN 978 963 973 640 5. (In Hungarian)
33. Pohl, F. *Méhészet*; Holló és Társa Könyvkiadó: Kaposvár, Hungary, 2003; 63p, ISBN 963 684 213 2. (In Hungarian)
34. Al-Ghamdi, A.A.; Adgaba, N.; Tadesse, Y.; Getachew, A.; Al-Maktary, A.A. Comparative Study on the Dynamics and Performances of Apis Mellifera Jemenitica and Imported Hybrid Honeybee Colonies in Southwestern Saudi Arabia. *Saudi J. Biol. Sci.* **2017**, *24*, 1086–1093. [CrossRef] [PubMed]
35. Al-Ghamdi, A.A.; Adgaba, N.; Tadesse, Y.; Getachew, A.; Al-Maktary, A.A. An Economic Approach to Assess the Annual Stock in Beekeeping Farms: The Honey Bee Colony Inventory Tool. *Sustainability* **2020**, *12*, 9258. [CrossRef]
36. Zajácz, E.; Donkó, K.S.; Harka, L.; Hidas, A.; Horváth, J.; Szalainé Mátray, E.; Szalay, T. A pannon méh (Apis mellifera carnica pannonica) hazai génmegőrzése. In *Génbanki Kutatások Régi Haszonállataink Védelmében*; Műhelytanulmányok a tudományos génmegőrzés tárgyköréből; Szalay, I., Ed.; Mezőgazda Lap-és Könyvkiadó: Budapest, Hungary, 2017; pp. 202–212. ISBN 978-963-286-729-8. (In Hungarian)
37. Gregorc, A.; Sampson, B. Diagnosis of Varroa Mite (Varroa Destructor) and Sustainable Control in Honey Bee (Apis Mellifera) Colonies—A Review. *Diversity* **2019**, *11*, 243. [CrossRef]
38. Evans, K.C.; Underwood, R.M.; López-Uribe, M.M. Combined Effects of Oxalic Acid Sublimation and Brood Breaks on Varroa Mite (*Varroa destructor*) and Deformed Wing Virus Levels in Newly Established Honey Bee (*Apis mellifera*) Colonies. *J. Apic. Res.* **2022**, *61*, 197–205. [CrossRef]
39. Gregorc, A.; Adamczyk, J.; Kapun, S.; Planinc, I. Integrated Varroa Control in Honey Bee (*Apis mellifera carnica*) Colonies with or without Brood. *J. Apic. Res.* **2016**, *55*, 253–258. [CrossRef]
40. European Commission. EU Beekeeping Sector. National Apiculture Programmes 2020–2022. 2020. Available online: https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/animals_and_animal_products/documents/honey-apiculture-programmes-overview-2020-2022.pdf (accessed on 15 February 2023).
41. Kárpáti, L.; Csapó, Z.; Ványi, G.Á. Current Situation and Development of the Beekeeping Sector in Hungary. *Appl. Stud. Agribus. Commer.* **2010**, *4*, 71–74. [CrossRef]
42. Cejvanovic, F.; Grgic, Z.; Maksimovic, A.; Bicanic, D. Assumptions of economic model for sustainable productions of beekeeping in the Bosnia and Hercegovina. *Nong Ye Ke Xue Yu Ji Shu* **2011**, *5*, 481–485. Available online: https://www.bib.irb.hr/800664/download/800664.America._doc.pdf (accessed on 15 February 2023).
43. Nedić, N.; Nikolić, M.; Hopić, S.E. Economic justification of honey production in Serbia. *J. Agric. Sci.* **2019**, *64*, 85–99. [CrossRef]
44. Nikolić, M.; Nedić, N.; Đorđević-Milošević, S. Cost-Effectiveness Analysis of Organic Honey Production in Serbia. *Ekon. Poljopr.* **2022**, *69*, 533–547. [CrossRef]
45. Beltrán, J.I.Z.; Santiago, M.A.L.; Alcalá, R.V.; Batalla, B.M.M. Análisis de la rentabilidad apícola por estratos en Aguascalientes, México. *Rev. Mex. De Cienc. Pecu.* **2022**, *12*, 453–468. [CrossRef]
46. Tosun, C.; Oguz, C. Determining the lowest cost of production capacity in the beekeeping enterprises. *Preslia J.* **2021**, *93*, 2–22.
47. Knaus, K.; Milotić, A. Income of family farms from bee-keeping in Istrian county. *Stočarstvo Časopis Unapređenje Stočarstva* **2001**, *55*, 227–234. Available online: https://hrcak.srce.hr/file/256680 (accessed on 15 February 2023).
48. Okpokiri, C.I.; Nwachukwu, I.N.; Onwusiribe, C.N. Determinants and profitability of honey production in ikwuano local government area. *Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural. Dev. Abia State Niger.* **2015**, *15*, 211–216.

49. Nábrádi, A.; Pető, K.; Vida, V.; Szabó, E.; Bartha, A.; Kovács, K. Efficiency indicators in different dimension. *Appl. Stud. Agribus. Commer.* **2009**, *3*, 7–22. [CrossRef]
50. Popescu, A. Bee honey production in Romania, 2007–2015 and 2016–2020 forecast. *Sci. Pap. Manag. Econ. Eng. Agric. Rural. Dev.* **2017**, *17*, 339–350.