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Food Self-Sufficiency in the Honey Market in Poland

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Abstract: Looking from the perspective of the importance of beekeeping production for agriculture, and its impact on production sustainability, biodiversity and food security, research on food self-sufficiency in the honey market is important. The aim of this article was to assess food self-sufficiency in the honey market in Poland in terms of the sustainability of production. The research covered the years 2002–2023. The research material consisted of secondary sources of information from the FAOSTAT 2024 database, reports of the Institute of Horticulture, Department of Beekeeping in Puławy, and market reports of IERiGŻ-PIB. The research used dynamic indicators, Pearson's correlation coefficient, self-sufficiency ratios (SSR) and intra-industry trade (IIT) indicators. The analysis showed that Poland is not food self-sufficient in honey production. Environmental issues and related food security will be important for a change in the model of beekeeping in Poland, as this sector plays an important role in maintaining sustainability and biodiversity; hence, the assessment of food self-sufficiency in honey production should be treated broadly, including the benefits for agriculture.

Keywords: honey market; sustainable production; food self-sufficient; food security; economic crisis

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1. Introduction

The situation on the honey market is complex and multifaceted. The honey market has always experienced problems specific to agriculture, resulting from its close dependence on and from the connection with the climate and nature, such as extreme weather events, e.g., drought, rains and, as a result, low supply of honey, favourable weather conditions and related overproduction, or bee diseases and liquidation of bee colonies, etc. The year 2020 and the following years are unique in that regard. In addition to the factors that are the standard cause of many changes in agricultural markets, there have also been external events of enormous magnitude (crisis phenomena, i.e., COVID-19, the war in Ukraine, rising inflation and interest rates) that have significantly affected the situation in agriculture and processing, including the honey market. The consequences of these two major crises may be long-lasting; hence, observation of the impact of these phenomena on the changes taking place in the honey market is important for the shaping of food security. The topic's relevance increases as the demand for honey is increasing globally [1]. In addition, pandemics and war have caused many countries to look at their food production capacity [2], although a previous significant signal of a return to the food self-sufficiency paradigm was the food price crisis of 2007–2008 [3]. Undoubtedly, ensuring physical and economic access to food (in sufficient quantity, price, quality and meeting all safety standards) will be one of the most important global challenges in the coming future.

Many studies point to the negative impact of lockdowns on bee production, and consequently, on food security, not only due to trade restrictions, reductions in purchasing power and labour supply, but also due to restrictions in pollination, and thus, in the biodiversity of the ecosystem [4]. This is because beekeeping shows a strong link with agricultural production through the pollination of plants by bees, which translates into

an increase in the size and quality of crop yields. Thus, honeybees play a huge role as pollinators maintaining the balance of the ecosystem, which is crucial for food security. Furthermore, beekeeping itself is often an additional source of income for small farms and rural populations, which translates into a global increase in income.

The demand for honeybee products, especially honey, both in the Polish and global markets is growing [1,5,6], while the beekeeping sector still faces many challenges. This is related, among other things, to the fact that in most countries, the beekeeping sector—despite technological and digital advances in the economy overall—remains traditional, so its contribution to the country's economy remains minimal. Moreover, beekeeping production is characterised by seasonality and is influenced by many factors, including climatic conditions, the scale of monoculture, the degree of environmental degradation, the number of bee colonies, bee diseases, the degree of development of apiary management, the level and structure of consumption or the profitability of production. This situation is not conducive to the development of beekeeping as a profession providing a basic source of income. The problem is exacerbated by the high fragmentation of honey production and marketing, both in Poland and in many other countries, and the imbalance between supply and demand for honey and other bee products. Despite these unfavourable conditions, the honey market has been developing dynamically since Poland's accession to the EU, although the balance of trade in this product is negative. Poland's honey production in 2004–2022 accounted for about 4–6% (depending on the year of analysis) of European production and 6–10% of the production of EU countries, giving it the 7th–9th position in the honey market in Europe and 5th–7th in EU countries. Since 2004, Poland has recorded a double-digit growth rate in imports and an even higher rate in exports. Before the outbreak of the pandemic, the exceptions were the years 2010, 2015 and 2018, in which honey trade turnover declined compared to the previous year, with the rate of decline in export turnover being greater than that of imports. In 2010, exports decreased by 15.4% with imports increasing by 26.0%, while in 2015 and 2018, both exports (down 27.3% and 7.6%, respectively) and imports (down 3.7% and 2.7%, respectively) fell. After the outbreak of the pandemic in 2020, Poland continues to record high growth in honey trade (exports increased by 48.2% and imports by 25.8%). From 2021 onwards, however, we see significant changes in trade in this product, which may be the aftermath of the COVID-19 pandemic and the war in Ukraine—deep declines in both exports and imports are evident. If we add to this the unstable, due to natural conditions, production of honey in Poland in the analysed years, this situation raises several questions, e.g., about whether and how the beekeeping sector will cope with the perturbations occurring on the market, as despite the relatively good natural and production potential and support for beekeeping production in Poland, the honey market is not self-sufficient. Furthermore, in the face of all these problems, will apiary management respond to the expectations of the agricultural environment related to, among other things, pollination of plants. If we look at the problem through the prism of the COVID-19 pandemic and the ongoing war in Ukraine, the challenge for this market will be broadly understood food self-sufficiency, which is one of the factors determining a country's food security.

The aim of this article was to assess food self-sufficiency in the honey market in Poland in terms of the sustainability of production. The structure of the article is as follows. Section 2 is divided into three sections. The first section describes the impact of the crises on the economics and—in particular—on food security, focusing on the impacts of the COVID-19 pandemic. The following section highlights the issue of food self-sufficiency as an important element to the food security system. The third section of the literature review specifically focuses on the case for the self-sufficiency of honey production. After the literature review, Section 3 follows, where self-sufficiency and intra-industry trade indices are explained. In Sections 4 and 5, calculations are presented regarding honey trade and production in Poland (as compared to the consumption rate), as well as being set not only in the broader context of the honey market in Poland, but also in other relevant countries (EU countries, China, Ukraine). Section 6, Conclusion, summarizes the whole article.

2. Economic Crisis and Food Security—Literature Review

The issue of the impact of crises on the economy is part of a broader strand of the literature relating to the economic impact of various types of crises, including natural disasters and emergency hazards [7–10]. Although economic crises are unpredictable phenomena, their existence is quite natural. They are characterised by a general imbalance between global supply and overall demand. Usually, their occurrence leads to a significant slowdown in economic activity, regardless of the source of the crisis (e.g., natural phenomena, economic and political factors). An example of one of the major and devastating crises caused by a natural factor was the so-called Black Death (1347–1351), which led to a significant reduction in population, a decrease in demand for agricultural commodities, an increase in prices and wages, and, in the long-term, a wave of famine and riots. Many studies indicate that the COVID-19 pandemic, belonging to crises caused by natural factors, led to the disruption of economic processes on a regional and national scale but also on a global scale [8,11–13]. These crises have not only had—and continue to have—wide-ranging impacts on human health and security, but also cascading effects on agri-food systems and increasing the risk of further crises across society. This was indicated by the results presented in the World Bank [14] report, which projected the deepest global recession in eight decades since World War II, and predicted that the deep recessions triggered by COVID-19 are likely to have long-lasting effects on societies and economies through multiple channels, such as lower investment, increased unemployment, and withdrawal from global trade and supply linkages.

The COVID-19 pandemic sharply reduced economic activity and thus had a negative impact on the demand and supply side of the market [15]. Looking at the demand side, demand for all kinds of services (especially tourism, entertainment, culture, catering, hairdressing, etc.) and consumer durables collapsed. In contrast, sales of food, especially long-life products, developed differently. As a result of the COVID-19 pandemic, many eating habits changed, towards so-called natural foods, and in this respect, the pandemic had a huge impact on the growth of domestic consumption in the food sector [16], including the honey market. Due to the properties of honey, there was an increase in its consumption as a potential immunity agent during the COVID-19 emergency. However, there was a marked decrease in demand for agri-food products from the HoReCa sector [15,17], one of the primary markets for small-scale honey suppliers in Poland. The COVID-19 pandemic also had negative consequences in terms of food exports, as many countries introduced restrictions on the export of certain products to ensure the availability of basic foodstuffs for their own populations [15]. Such measures are characteristic of economic crises and are aimed at ensuring food self-sufficiency. The policy of self-sufficiency was applied, among others, in the interwar period in the USA, Austria, Czechoslovakia and Italy, and its aim was to ensure independence from economic phenomena in the world or, for example, in times of warfare (Germany, Italy, Japan) or because of the system of nationalised economy with arms characteristics (USSR from 1929, satellite countries of the USSR in the years 1948–1989, China, North Korea, Vietnam).

As a result of the COVID-19 pandemic, there was also a decline in supply, which was a consequence of the epidemic restrictions on business (including production and logistics) and reduced access to markets and disrupted supply chains [18]. However, it should be clearly noted that food production is characterised by shorter supply chains, making them more resilient to disruption. There have been greater problems with imports of goods, including agri-food items, due to transport disruptions and the need to meet tighter health safety standards.

Against the backdrop of this global economic crisis, increasing catastrophic phenomena, the pursuit of economic, social and environmental sustainability should be the overarching goal of modern economies [19]. One of the sectors that can play an important role in the development of modern economies, including, among others, the realisation of the objectives of the European Green Deal (maintaining environmental sustainability, preserving welfare and improving the quality of agricultural products) or F2F (Farm to Fork

Strategy), is the honey market and the related beekeeping industry. After all, a very important aspect of beekeeping is the pollination of crops, which significantly increases their yield potential and the formation and size of the fruit, thus contributing to food production.

The importance of beekeeping not only for agriculture but also for food production drew attention in early 2020. Indeed, the COVID-19 crisis highlighted the role of honeybees in the food and feed chain and the problems of the global beekeeping sector related to environmental pollution and climate change, among others. Particular attention was paid to the fact that bee products contribute to the maintenance of human and animal health and can act not only as immune system enhancers, but also as natural antiviral agents [17]. Natural bee products are rich in active compounds that can improve the immune system of both humans and animals, and thus, used on a larger scale, can ensure more sustainable animal production and food safety. In addition, the bee, as mentioned above, is fundamental to the balance of ecosystems, plant species diversity and increased crop productivity.

Analysing the literature on the beekeeping sector and the honey market, one can identify several factors determining its state and development on different continents. These factors include: climatic conditions, traditions, habits, interest in beekeeping, and the degree of its development and specialisation itself, as well as other factors of a socio-economic nature, which depend on the level and structure of consumption [5,20] or the determination of the profitability of production [21]. Furthermore, honey production provides an additional source of household income, thus contributing to poverty reduction [22].

Taking into account the above conditions, as well as the positive impact of honeybees on the agricultural sector, food self-sufficiency in the honey market becomes important in the context of the impact of crises and the country's food security. It is important from the point of view of Poland, as the country maintains food self-sufficiency in almost every food category, except for vegetable oils and honey. The situation of vegetable oils is described in the literature, and the industrial and scientific community of agriculture and food is aware of this situation (see: [23]). The situation is similar in legumes, or the occasional deficits in pork production [24]. However, the issue of honey seems to escape scientific analysis—which may be due to the fact that Poland is self-sufficient in sugar production, which is a cheaper substitute for honey. Sugar, however, does not contain as many nutritional enzymes as honey [25], with its consumption being associated with lower nutrient intake [26,27], although its negative consequences are still a topic of scientific debate (e.g., [28]). From this perspective, the study of the honey market in terms of its self-sustainability represents a potential research gap. Moreover, interest in improving the level of food self-sufficiency tends to increase after the experience of major crises, as shown by the policies of many countries after the 2007–2008 food price crisis, which also justifies and indicates the need to look at this issue more broadly from the perspective of the current crisis.

2.1. Understanding Self-Sufficiency

The concept of food self-sufficiency can be defined differently depending on the approach. Moreover, the concept has been evolving over the years, linked to changes in the economic life of individual countries.

Self-sufficiency in an economic context refers to a situation in which a country or region is fully self-sufficient, independent of external imports, and able to meet all its needs with internal resources. The very idea of self-sufficiency assumes that a country or region can survive and develop without trading with other countries. It is a model that prioritises local production, reducing dependence on global markets and promoting self-reliance in key economic sectors. In economic theory, self-sufficiency is presented as a theoretical model in which an economy does not require external sources to function. It is a situation in which a country produces all necessary goods and services on its own. This understanding of the concept was first introduced by Fredrich List [29,30], who noted, however, that a sufficient quantity and variety of raw materials was needed to achieve such a state. Similar

views were held by mercantilists, who argued that only exports were profitable, and that bullion was the source of wealth. According to Bishop [31], implementing self-sufficiency, i.e., a complete absence of exports and imports, is very difficult, practically impossible, as no country can produce all the products needed at the competitive prices demanded by its citizens. Moreover, in the age of globalisation, trade links have been formed in the world economy because of the optimal allocation of resources, including factors of production. Hence, the concept of self-sufficiency should be considered much more broadly, considering global value chains, because of which trade linkages are formed because of cooperation between the contractors of the various elements, leading to increased profitability.

Given these strong trade links in the modern global economy, food self-sufficiency in today's understanding means that a country produces an amount of food (supply) that is equal to or greater than 100% of its internal demand [32]. With this approach, food self-sufficiency can be understood as one of the guarantors of food security [32], as the current understanding of the concept of food security is deeply embedded in the neoclassical paradigm of economics, based on institutions such as the WTO (see: [32]) and trade globalisation. Hamilton-Hart [33], on the other hand, writes of food self-sufficiency as a total or near-total break with imports, and feeding the population through domestic production. This view is a result of a lack of trust in international markets and price volatility in these markets. However, Mikuła [34] points out that food self-sufficiency can be understood in two ways: as total self-sufficiency in the production of (a particular type of) food, or in the context of the trade balance of food products, i.e., if a country sells a particular product but is thus able to supplement its domestic demand with imports of that commodity (e.g., due to its price or quality), then it is still considered food self-sufficient. Kapusta [35], in defining self-sufficiency, points to differences between countries in their comparative advantages, which determines what food a country should produce, and therefore uses the indicator of self-sufficiency as the 'balance of trade in food products', which provides an 'optimum of security'. Cango et al. [36] refer to this approach as 'agricultural complementarity', citing the operation of regional blocs such as the Common Agricultural Policy in the EU, or efforts to integrate Latin American and Caribbean countries. Similarly, Clapp [3] calls for considering self-sufficiency as a 'relative concept', excluding neither domestic production nor international trade. Clapp [3] adds that no country completely abandons trade in at least some food products. This is also noted by Hamilton-Hart [33], as well as Warr [37], who point out that self-sufficiency understood as closing markets does, admittedly, have a positive impact mainly on domestic producers, but reduces food security due to supply pressures and price increases for consumers. This particularly hits the poorest, who are most strongly affected by Engel's law [37]. However, supporting local producers without restricting imports can be helpful in achieving self-sufficiency. This is also the current EU policy on honey imports [38,39].

The reliance of economic development on international trade has been a central theme in the food security debate since the late 20th century [40,41]. However, due to the increasing incidence of so-called 'Black Swans' and unexpected trade disruptions caused by various economic crises, there are increasing calls for increasing the state of food self-sufficiency, not only in the context of countries, but even regions [42]. It is worth adding that the issue of self-sufficiency may be particularly relevant for countries that are not self-sufficient. Thus, trying to achieve food self-sufficiency in areas where the country is not self-sufficient takes on a different meaning.

The above indicates that although the closed economy model may be economically unsound, some countries are pursuing autarky. This is also noted by Svinous and Stepura [43], who point out that economic deterioration shifts the burden of food security to own production. It should also be noted that while in the past it was not profitable for a country to produce food in which it did not have a comparative advantage, the relevance of this advantage is now diminishing in favour of food security issues and risk factor mitigation.

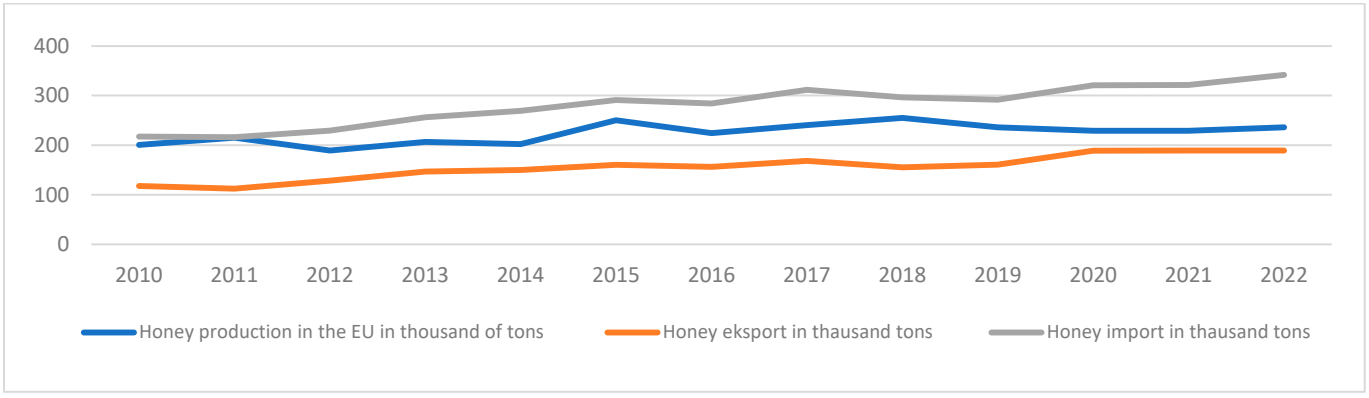
However, some scholars believe that attempts to achieve food self-sufficiency work against the assumption of food security, e.g., due to price increases [32,33]. Azoulay [44]

adds that, according to neoliberal analysis, a country's food self-sufficiency gives way to food security, which is achieved when the food supply situation matches the total demand for food commodities. This means that even countries striving for self-sufficiency will be forced to rely to some extent on imports [35,45]. From this perspective, food security is no longer entrusted to states, but is in the hands of the market. Looking also through the lens of consumer choices according to Hamilton-Hart [33], changes in consumer habits tend to work against efforts to achieve self-sufficiency. In contrast, Kallas et al. [46] consider product origin to be one of the more important determinants of consumer choices, accounting for issues such as consumer preference to consume closely produced products, consumer-perceived quality (i.e., closely produced products as those with higher quality) or potential consumer ethnocentrism—especially in the case of national, regional or cultural products. Such behaviour can create a basis and interest for countries to achieve self-sufficiency in markets for regional, high-quality, often lucrative products.

2.2. Self-Sufficiency in Beekeeping Production

Looking at the problem of food self-sufficiency from the point of view of beekeeping production, it is multifaceted and must consider its two dimensions. On the one hand, it is about ensuring security in domestic honey production, which is undoubtedly important from the point of view of meeting consumer needs, maintaining the balance of supply and demand and food security. On the other hand—and this aspect seems to be increasingly recognised in public debates—is the provision, through beekeeping production, of ecosystem services, such as pollination, which has a measurable effect on agricultural production and contributes to environmental sustainability. Bees play a very important role in the global food chain. From publicly available data by weight, 35% of global food production is due to pollinator-dependent crops, and the annual contribution of pollinators to global agriculture was estimated in 2015 to be EUR 153 bn, representing 10% of the total value of global agricultural production for consumption. (The production of fodder crops, biofuel crops, seed production of ornamental plants and pollination of wild plants were not considered for the estimate. Therefore, the total value of pollination services to the global economy may well exceed the EUR 153 billion figure). For the EU, this contribution was estimated to be worth around EUR 15 bn [47].

EU honey production in 2022 was 236 thousand tons. Which is slightly higher (2.8%) than in 2021, and higher (9.7%) than in 2010 (Figure 1). The European Union is the world's second largest honey producer (13%) after China (26%). The largest amount of honey is produced in countries located in the south of the EU, due to the most favourable climate for the development of beekeeping. These are successively Spain, Romania, Greece and France, followed by Germany, Poland and Hungary.



Sources: FAOSTAT 2010–2022.

In 2022, a total of 341.6 thousand tons of honey were imported to the European Union, of which almost 46.1 thousand tons (13.5% of total imports) came from Ukraine and 68.4 thousand tons from China (20.0% of total imports). The countries that im-

ported the most honey from outside the European Union in 2022—despite their own production—were Germany (75.1 thousand tons), Belgium (39.8 thousand tons), Spain (37.6 thousand tons), France 35.5 thousand tons) and Poland (31.8 thousand tons). Total honey exports from the European Union amounted to over 189.2 thousand tons. The largest exporters of honey from the EU in terms of quantity in 2022 were: Belgium with a share of 16.9% (32.1 thousand tons), Spain with 14.9% (28.3 thousand tons), Germany with 14.2% (26.9 thousand tons) and Poland with 7.9% (15.0 thousand tons). In 2022, the self-sufficiency rate in the EU honey market was 60.8%, which meant that the EU is not self-sufficient in food in this market and would explain the need to import honey from non-EU countries (Figure 1).

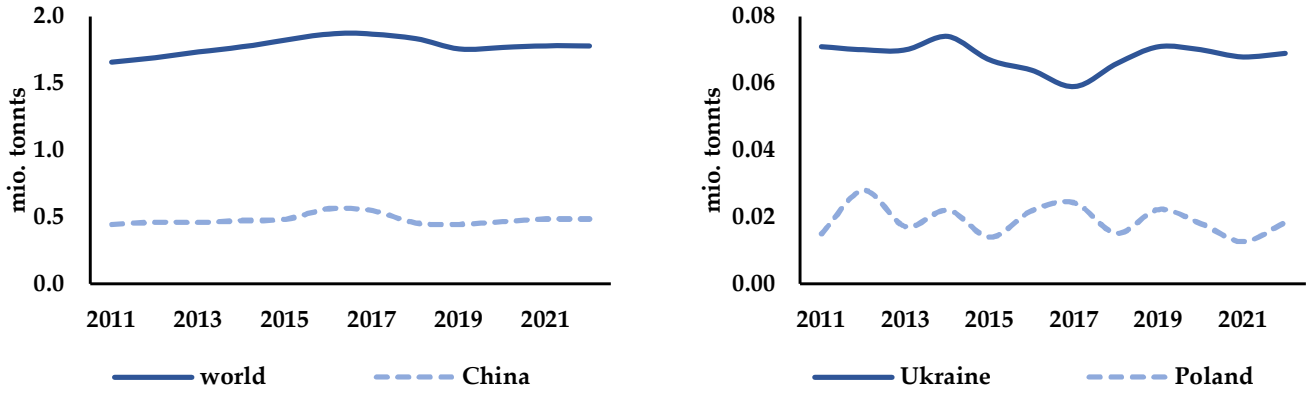


Figure 1. Honey production. Source: own compilation based on FAOSTAT data.

It is pollinators that increase the quantity and quality of food produced and ultimately secure the food supply. Thus, beekeeping is an important sector of the agricultural economy, both because of the role that bee populations play in the agricultural economy and the production of honey and other bee products. Through the pollination of plants, bees support agricultural production, ensuring food security and, through their highly nutritious products (honey, royal jelly, pollen, etc.), the nutritional security of the population.

Increasing food production by supporting beekeeping activities (subsidising ecosystem services such as pollination) is an important step towards achieving food self-sufficiency in the broadest sense [48]. Urban apiaries, whose intensive development has been evident since the beginning of the 21st century [49], may also be helpful in achieving this, although there are also claims that this is not an appropriate place to keep bees [50]. Nevertheless, urban food production can have important supplementary value for urban populations, for example, in disaster conditions, although this is also dependent on the scale of urban production, or the season [51]. The authors [51] point out that in disaster conditions, urban populations usually must rely on long-term carbohydrate-based foods that lack many nutrients. Honey, however, is one of those products that possesses these properties and can easily be produced in urban areas [52], without compromising its properties, because, like honeys extracted in rural settings, it contains many nutrients essential for human functioning: proteins, amino acids, enzymes, vitamins, minerals [25,53] and antioxidants [25,54], and has a number of antimicrobial properties [55].

It is worth noting that food self-sufficiency mainly refers to staple, low-cost and satiating carbohydrate-based foods such as rice and cereals, as indicated by the studies of Cango et al. [36], or Clapp [3]. However, it is not applied to luxury products, as honey is. Thus, self-sufficiency in honey production does not mean ensuring food security at the most fundamental levels, i.e., physical or economic availability. Indeed, domestic honey production does not mean that all citizens can afford to buy products that they would like to consume but are beyond their financial reach [3]. Research indicates that building up honey reserves for emergencies has the potential to keep economically disadvantaged citizens in relative health. The above situation is related to the non-economic dimensions of

food security, i.e., physical availability, sustainability and quality. Food self-sufficiency in honey production (beekeeping sector) must be considered very broadly, considering both the physical access to food and the economic value added to agriculture from the provision of pollination services by bees.

Thus, when analysing the issue of food self-sufficiency in the beekeeping sector, it is worth noting the strategies for developing the sector in the state of Hawaii, where there is a provision in the state's constitution to strive for food self-sufficiency. Melrose and Delparte [56], in their report on food self-sufficiency in the State of Hawaii, elaborate on the issue of beekeeping, emphasising that honeybees are crucial to Hawaii's crop pollination and food production, but the vulnerability of the Hawaiian Islands biome to invasive species could threaten food production on the island. Hence, the US Department of Commerce's 'Strategy for Enhanced Food Security and Self-Sufficiency' report [57] warns against the spread of parasites, including varroa, or Aethina tumida beetles, which are a threat to Hawaii's multi-million-dollar beekeeping industry. Indeed, the spread of varroa and beetles in 2007 led to a significant decline in agricultural production. Curbing the spread of bee diseases is a key issue for the conservation of bee populations across Europe [8].

3. Materials and Methods

Statistical data on honey production and trade came from the FAOSTAT database, market analyses of the Institute of Horticulture, the Beekeeping Department in Puławy and market analyses of IERiGŻ-PIB and covered the period 2002–2023. Similarly, an extended period to illustrate the trend in the study of self-sufficiency in the aftermath of the pandemic and the war in Ukraine was studied by Brankov and Matkovski [2]. In the analysis of world honey production, due to the lack of data availability, the year 2022 was limited. The years 2019–2023 were analysed in detail to assess the impact of the crises.

Statistical descriptive analysis was used to evaluate the collected material. Changes were compared on an annual basis. Dynamic indicators and Pearson's correlation coefficient were used to measure the reaction of the Polish honey market to changes in production, and domestic and external demand. Factors such as production, exports and imports were correlated, with particular emphasis on imports from China and Ukraine—the two largest exporters of honey to Poland.

An indicator (SRR_{food}) was used to measure food self-sufficiency, which expresses the ratio of domestic production to balance consumption (1). Self-sufficiency in the market for a given good occurs if the values of the indicator (SRR_{food}) are greater than or equal to unity ($SRR_{food} \geq 1$).

$$SRR_{food} = \frac{P_{food}}{D_{food}} * 100 \quad (1)$$

where:

SRR_{food}—self-sufficiency index;
P_{food}—domestic production;
D_{food}—balance consumption.

The balance consumption (D_{food}) expresses production (P_{food}) adjusted by the external trade balance (TB_{food}), which can be described by the following formula:

$$D_{food} = P_{food} \pm TB_{food} \quad (2)$$

where: TB_{food}—foreign trade balance.

The external trade balance (TB_{food}) is the absolute difference between exports (Ex_{food}) and imports (Im_{food}) and allows an assessment of the supply and demand situation in a given market. A positive foreign trade balance ($TB_{food} > 0$) indicates the existence of a surplus of a country's production over its domestic demand, which means that this surplus

can be sold on external markets and that the country is self-sufficient in the production of the good in question.

$$TB_{food} = Ex_{food} - Im_{food} \quad (3)$$

where:

Ex_{food}—export;
Im_{food}—import.

The balance consumption can be written as the volume of domestic production plus the volume of imports minus the volume of exports (4). This is the FAO method used in the calculation of the indicator SRR_{food} by Kapusta [35], Baer-Nawrocka and Sadowski [58], Brankov and Matkowski [2], Cango et al. [36] and Clapp [3]. According to the new FAO method, national reserves (S_{food}) are also included in Formula (5). This method has been described by Clapp [3], among others

$$D_{food} = P_{food} + Im_{food} - Ex_{food} = P_{food} \pm TB_{food} \quad (4)$$

$$D_{food} = P_{food} + Im_{food} - Ex_{food} \pm \Delta S_{food} = P_{food} \pm TB_{food} \pm \Delta S_{food} \quad (5)$$

where: ΔS_{food}—change in inventory.

In this study, due to limitations in the availability of static stock data, the indicator SRR_{food} was calculated according to the following Formula (6).

$$SRR_{food} = \frac{P_{food}}{P_{food} \pm TB_{food}} * 100 \quad (6)$$

Another method of calculating food self-sufficiency can be the production of energy from food, the so-called dietary energy production (DEP) per person method [3], but in its simplest form, it is limited to calorie consumption—like self-sufficiency studies focusing on calorie-rich carbohydrate products. In both the SSR and DEP methods, food imports and exports are considered [3]. Regardless of how it is framed, the indicator SRR_{food} expresses the extent to which the balance consumption (a country's internal demand for a given product) is covered by its domestic production. The higher the values of the indicator SRR_{food} are than unity, the greater the capacity to cover demand for the product in question with own production.

To deepen the findings, an analysis of IIT intensity was carried out based on the Grubel–Lloyd concept, which has been described and used in studies by Krugman [59], Black [60], Szajner [61] and Szczepaniak [62], among others. IIT intensity indices were calculated for the honey market in volume terms (7).

$$IIT_i = \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)} * 100 = 1 - \frac{|X_i - M_i|}{(X_i + M_i)} * 100 \quad (7)$$

where:

IIT_i—intra-industry exchange intensity;
M_i—import of a commodity (group of commodities) I;
X_i—export of a commodity (group of commodities) i.

An examination of the index (IIT_i) assesses the intensity of trade in products manufactured in the same industry. The index values (IIT_i) are in the range [0, 1]. Index values oscillating around 1 indicate IIT (in all product classes the value of exports is equal to the value of imports), and values close to 0 indicate inter-industry trade (there are no product classes that are simultaneously exported and imported).

IIT concerns differentiated products with a high degree of substitutability to each other, and to a much lesser extent, it concerns homogeneous products. The source of IIT may also be economies of scale, seasonality of production or differences in transport costs [62].

Product complementarity, on the other hand, is the basis of inter-industry trade. Product differentiation can be of a different nature and impact on IIT: horizontal (products of the same quality are traded) and vertical (products of different quality are traded, including products at different stages of the production process, e.g., semi-finished products; trade in these types of products is characteristic of economies at different stages of economic development) [61–63]. As Talar [63] notes, IIT is judged to be more beneficial compared to inter-industry trade.

4. Results

4.1. General Trends in the Global Honey Market

In 2022, world honey production accounted for about 1.7 million t and was about 1% (16.3 thousand t) lower than in 2021, having increased from 1.5 to 1.7 million t (about 9%) between 2010 and 2022. China was the world's largest producer of honey, producing about 500,000 t each in 2021–2022, accounting for about 28% of world production. Europe is the second largest (after China) honey producer in the world. In 2021–2022, Europe accounted for more than 13% of world production, dominated mainly by Turkey with a share of 6–7%. Ukraine is a significant honey producer: its share of world honey production in 2021 was 4% and declined by 0.3 p.p. in 2022. Thus, Ukraine dropped from sixth to eighth position in terms of the world's main honey producers, which was caused by a decrease in honey production by about 8.7% in the period under review (from ca. 69 to 63 thousand t). This situation should be linked to the ongoing war in Ukraine since March 2022 and the associated difficulties in running apiaries, sowing fields with honey-producing crops, esp. sunflower, and consequently, lower honey yields. However, the biggest impact on the distorted trade with Ukraine was all sorts of restrictions introduced by many countries and the associated difficulties in supplying honey abroad. In 2021, Poland was ranked 20th in the world market of honey producers, with an average production of about 18,400 t. In 2022, it was already the 15th largest honey producer in the world, with production at the level of approximately 24 thousand t.

World honey production has remained almost unchanged since 2010 with small increases (2–4% year-on-year) noticeable until 2017, and a slowdown (a decrease of about 13.7% over the period) visible from 2018 to 2022. Similar trends are noticeable in China, which, after increases between 2010 and 2016, sees production decline from 2017 to 2019 (by 20.6% in the period), with growth of just over 4% in the years 2020/2021. In 2022, production falls slightly to 474,000 tonnes (by 2.5%). Much greater variability in production is recorded in Ukraine and Poland. In Ukraine, the highest production increases are recorded in 2017–2018 (11.9% and 7.6%, respectively). Subsequent years see a decrease in production from 71 thousand t in 2018 to 64 thousand t in 2022. In Poland, on the other hand, with very high production variability throughout the analysed period, the highest increases are recorded in 2021–2022 (by 44.9 and 30.4%, respectively) (Figure 1).

Against the backdrop of world production, European honey production fluctuated in the period 2010–2022, with a declining trend since 2018 (from 274.6 thousand tonnes in 2018 to 228.3 thousand tonnes in 2021, with a significant increase to 285.7 thousand tonnes in 2022). The high variability in honey production in Europe is mainly determined by weather conditions during the growing season and the associated production risks, the number of bee colonies, the health of the apiaries, bee die-offs, production profitability and demand. The decline in European honey production between 2018 and 2022 is also attributed to the COVID-19 pandemic and the war in Ukraine, influenced by health security restrictions and consequent broken supply chains, rising inflation and the energy crisis, all of which threatened the profitability of apiaries.

4.2. Changes in the Honey Trade in Poland

While honey production in Poland showed high variability, which is related to unstable weather conditions and a short crop growing season, honey imports until 2021 clearly increased from 4.6 thousand t in 2002 to 37.6 thousand t in 2021. In 2023, they reached

27.0 thousand t and were 28.2% lower than in 2021. Since 2017, imports have clearly exceeded the value of domestic production, indicating an increase in demand for honey on the domestic and foreign markets (increase in exports and domestic consumption). Honey exports show similar trends to imports, with the value being lower or comparable to domestic production (the exception was in 2020, where, as a result of the COVID-19 pandemic, the overall demand for honey increased and exports reached the highest value of 24.9 thousand t in the entire period under review, and its dynamics until 2019 were comparable to imports. In 2023, exports reached 14,000 t and were 25.5% lower than in 2020.

The collected data show that during the beginning of the COVID-19 pandemic, Polish honey trade continued its upward trend. In 2020, honey exports (expressed in thousand t) were 48.2.0% higher than the year before, while imports were 25.8% higher. A clear deterioration in trade was recorded in 2021 and the following years, when Polish exports clearly decreased—by 24.5%, 20.2% and 6.7%, respectively, compared to the previous year. By contrast, imports decreased to a lesser extent. What is important, however, is that the downward trend in honey trade is decreasing (Figure 2).

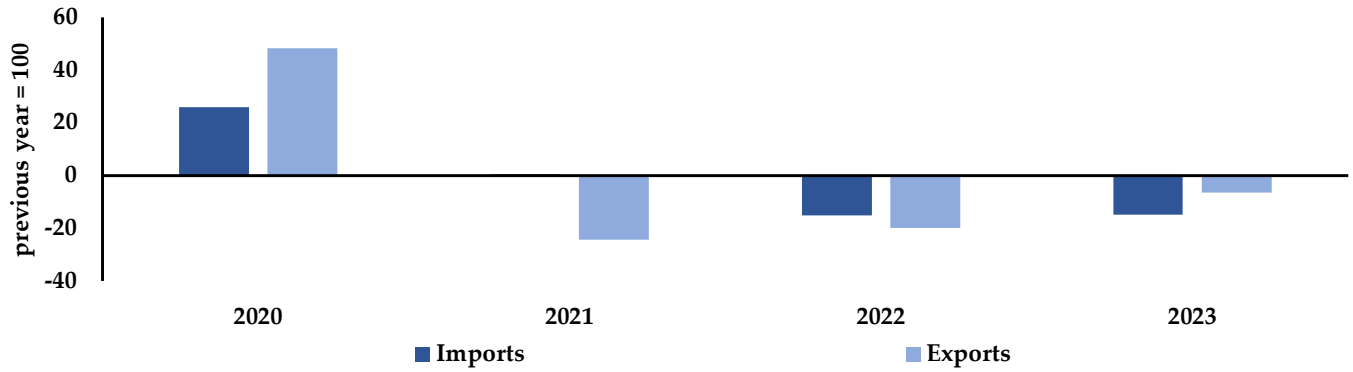


Figure 2. Changes in the volume of Polish honey exports and imports. Source: own compilation based on FAOSTAT data, market analyses of the Institute of Horticulture, Beekeeping Department in Puławy and market analyses of IERiGŻ-PIB.

Between 2002 and 2023, foreign trade in honey by volume was characterised by increasing intra-industry intensity. The values of the *IITi* indices increased from 0.02 to 0.83 (Figure 3), and their dynamics and foreign trade dynamics testify to the increasing intensity of IIT, which is a positive trend and constitutes a favourable change in specialisation of the honey industry. The analysis of IIT showed that before Poland's integration with the EU, honey was exported in small quantities, while imports took place on a slightly larger scale. This resulted in the occurrence of a large negative balance of exchange, and the intensity of trade was of an inter-industry nature, especially in the years 2002 and 2006, in which the share of intra-industry exchange was symbolic and was at the levels of 2% and 7%. In the following years, especially from 2011, there was an increase in imports of honey, which was subjected to the packaging process. Imported honey was also standardised and re-exported. Due to the differences in the quality of honey (especially price) in imports and exports, foreign trade in honey is vertically intra-industry. In the case of honey, an additional reason for IIT is the seasonality of production. From 2014 until the outbreak of the pandemic, the intensity of IIT has remained at the 0.7–0.8 level and has an intra-industry character. However, the last three years under study—in which the effects of the crises in question were known—can be considered unfavourable for the development of Poland's IIT. There has been a slight decline in the share of IIT; nevertheless, the values of the *IITi* indices do not indicate the formation of inter-industry specialisation; these indices remain at the level of 0.64 to 0.68.

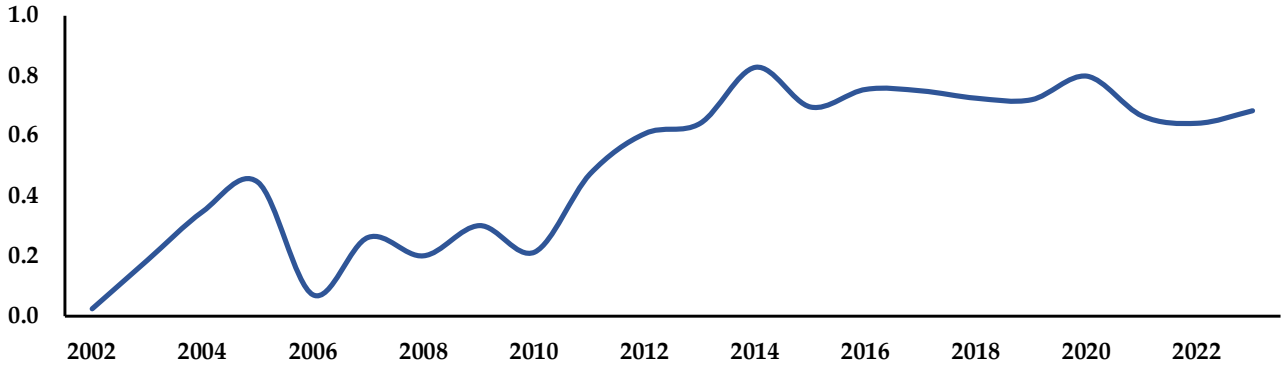


Figure 3. IITi indicators in foreign trade in honey. Source: own compilation based on FAOSTAT data, market analyses of the Institute of Horticulture, Beekeeping Department in Puławy and market analyses of IERiGŻ-PIB.

The above results are also confirmed by Pearson correlation coefficients, which indicate that in the analysed period, honey production did not show strong correlations with imports (0.3133), and the correlation between exports was even lower (0.2145), which means the dependence of production on other factors, such as weather conditions, seasonality and prices. Honey imports to Poland were strongly correlated with exports (0.9749), and this indicates that a large amount of honey is re-exported to other world markets and proves the intra-industry nature of foreign trade in honey.

Analysis of the impact of the changes of the COVID-19 pandemic and the war in Ukraine, on the other hand, showed that the crises had an impact on changing the structure of Poland's honey trade with its main suppliers and customers. A decrease in honey exports (by 10.7%) and an increase in imports (by 10.4%) were recorded between 2019 and 2022. During this period, most honey was imported from Ukraine (61.8 thousand t in total). Until 2021, Ukraine was the largest supplier of honey to Poland, with its share in imports fluctuating between 43.7% and 45.2% in 2019–2021. The war in Ukraine and problems with stopping honey at the border moved it from the leading position to second place in 2022, and its share decreased to 33.3%. Thus, China became the main supplier of honey to Poland, supplying 47.8 thousand t of honey to the Polish market in 2019–2022, with its share fluctuating between 22.3% in 2020 and 46.2% in 2022. The data for 2023 shows that these trends are strengthening. In the period I–XI 2023, the downward trend of honey imports from Ukraine continued. In the analysed period, honey imports from Ukraine to Poland amounted to 8.6 thousand t, and compared to the same period of 2022 (9.5 thousand tonnes), decreased by 0.9 thousand t. In the period I–XI 2023, China strengthened its position in the Polish market. Honey imports from this country amounted to 12.8 thousand t, almost 50% more than from Ukraine. In 2022, the main suppliers to Poland were China and Ukraine [64].

Both crises significantly changed the direction of honey imports from other countries. In 2020, honey imports from China (by 26.5% compared to 2019), Belgium and Bulgaria (by about 24–25%) and Germany (6.9%) decreased because of tighter business restrictions. However, imports from countries with less severe epidemic restrictions, i.e., Lithuania (almost four times), Romania (more than twice) and Ukraine (by 72.1%), increased markedly. In 2020–2021, more than 30% more honey (by about 8.7 thousand t) was imported to Poland than in the year preceding the outbreak of the pandemic. The economic impact of war in the Ukraine was already evident in 2022, with declines in imports from Germany (by 62.8%), Romania and Ukraine (by 39.2 and 37.7% respectively) and Lithuania (by 21.1%). In contrast, very clear increases in imports were seen in Belgium (almost fourfold) and Bulgaria (almost threefold) (Figure 4).

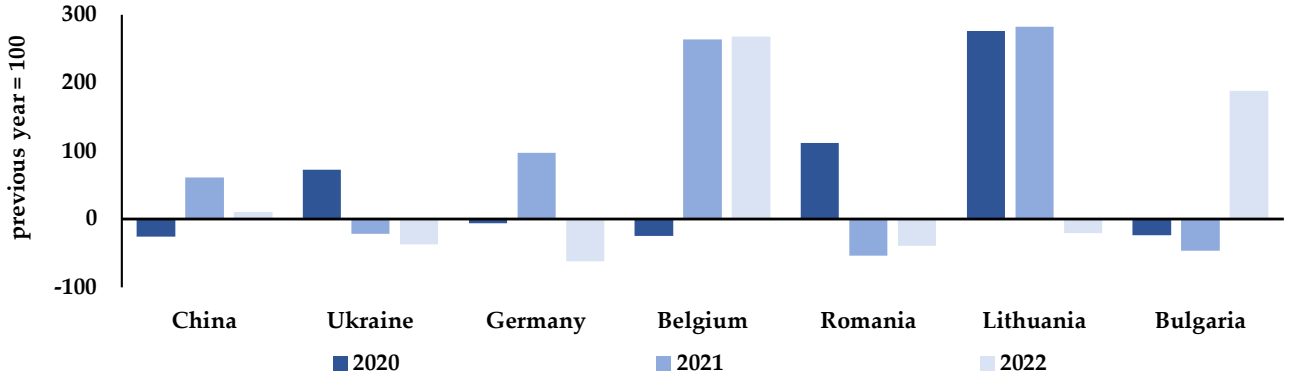


Figure 4. Changes in the volume of Polish honey imports from major suppliers. Source: own compilation based on FAOSTAT data, market analyses of the Institute of Horticulture, Beekeeping Department in Puławy and market analyses of IERiGŻ-PIB.

The largest recipients of honey in 2019–2022 were Germany (a total of about 13.2 thousand t), France (ca. 11.4 thousand t), Spain (ca. 9.7 thousand t) and the UK (ca. 6.7 thousand t). In 2020, exports showed an upward trend in all major Polish honey buyers. The largest increases were recorded in Spain and Belgium (more than twofold). This situation may have resulted from the increased demand for honey during the pandemic, when it was treated as a health-promoting, immunity-enhancing product. In most countries, exports were not affected the most until 2021, when declines to key Polish customers were in double digits. Among the most important markets for Polish honey, exports to the UK (by 71.6%), Spain (by 51.9%) and Germany (by 42.4%) collapsed the most. Exports to France proved relatively resilient, with a fall of just 2.5%. Polish exporters fared best on the Greek and Bulgarian markets, where double-digit increases were recorded (20.8 and 95.6%, respectively). In 2022, the decline in exports clearly deepened in the French (by 32.7%), Spanish (by 24.3%) and Belgian (by 27.8%) markets. Exports on the Bulgarian market also collapsed between 2020 and 2021 (down 24.7%). Clear increases in exports were recorded in four markets: Italy (up 29.4%), the UK (up 24.8%), Greece (up 14.1%) and Germany (up 5.7%). It is worth noting that throughout the period under review, Polish exporters fared best on the Greek market, where year-on-year increases in sales to this market were recorded (Figure 5).

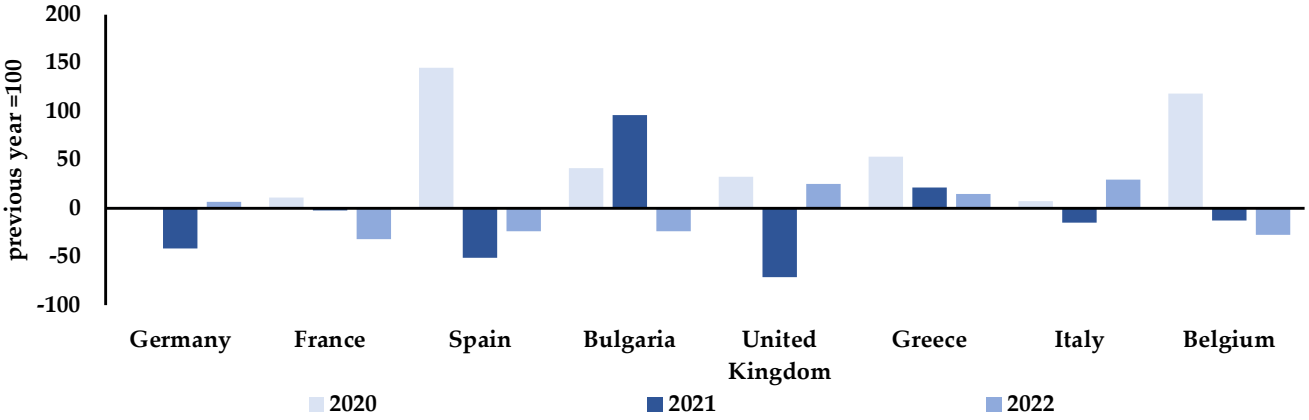


Figure 5. Changes in Polish honey exports to major customers. Source: own compilation based on FAOSTAT data, market analyses of the Institute of Horticulture, Beekeeping Department in Puławy and market analyses of IERiGŻ-PIB.

The correlation results show a very high dependence of Polish imports on imports from Ukraine (0.9136) and China (0.8287). On average, in 2019–2022, about 80% of honey imported to Poland comes from these countries. Similarly, there is a strong correlation

between Polish exports and imports from Ukraine (0.9520) and China (0.7577), which could mean that the honey is mostly re-exported. In this context, the problem with the sale of domestic honey on the Polish market should not be linked to the import of honey from Ukraine, which is often raised as an argument to reduce dependence on Ukraine.

Poland's honey production in 2019–2022 was almost double the balance consumption, justifying the need to import it. Honey demand was volatile, driven by increased demand for honey during the pandemic period (twice the domestic production) and still high but declining consumption in 2022 (about 70% higher than domestic production). SRR_{food} indicators on the honey market in 2019–2022 were 58.2–69.7%, which means that Poland was not self-sufficient in this market. In 2020, the self-sufficiency indicator worsened (a decrease of 8.2 p.p.), which was due to a decrease in domestic production compared to the previous year (by approximately 30%) and a decreasing foreign trade balance (a change of 6.2 p.p. compared to 2019). From 2021, because of favourable conditions for honey production and an improving foreign trade balance, the self-sufficiency rate increased from 49.5% in 2021 to 58.8% in 2022 (Figure 6), but this increase should be considered cosmetic.

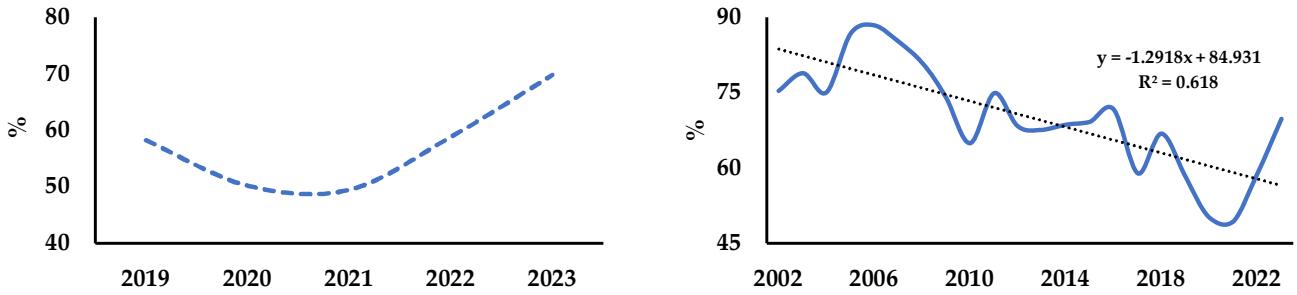


Figure 6. Self-sufficiency indicators on SSR_{food} for the Polish honey market.

Analysis of the self-sufficiency indicator in the long term (2002–2023) indicates that Poland does not achieve self-sufficiency on the honey market. Studies of this indicator indicate a downward trend, and this is determined by increasing honey imports from other countries and unstable domestic production. Climatic conditions, high weather variability and a short vegetation period of plants also do not create good conditions for competitive honey production; hence, Poland imports large quantities of honey. The lack of self-sufficiency on the honey market is not only a consequence of unstable production but also of a lack of structural change in apiaries. There is still a high fragmentation of production in Poland, with small and medium-sized apiaries (up to 20 bee families) predominating in the size structure (about 66.9%), with larger apiaries (over 80 families) accounting for just 2%. The average size of an apiary is 23 bee families. Most apiaries are hobby apiaries, managed by people over 50 years of age (61.1%), and the percentage of young beekeepers is currently 12%. Reasons for the low self-sufficiency are also seasonality, low profitability of production and bee diseases, to which most of the problems associated with the formation of national honey markets are attributed.

5. Discussion

Research conducted from the point of view of the impact of the COVID-19 pandemic and the war in Ukraine on trade, production and self-sufficiency in the honey market in Poland allows an opinion to be expressed on the prospects for its development, considering the discussion relating to the limitations on the development of beekeeping worldwide and the need to achieve food self-sufficiency in this area. The analysis shows that the Polish honey trade performed well during the COVID-19 pandemic despite the introduction of numerous movement restrictions. The good performance of the honey trade during the COVID-19 pandemic can be explained as follows.

First, honey is a long-lasting product with strengthening and immunizing properties, which was of particular importance during the pandemic. Such properties of honey

translated into an increase in consumer demand for it, especially during the first months of the pandemic. This is confirmed by Eurostat data showing that retail sales in March 2020 were over 8% higher than the year before. The increase in domestic consumption of honey during the COVID-19 pandemic due to its health-promoting properties is also indicated by research by Galanakis [16]. Several researchers have also positively evaluated the effect of honey in treating patients with COVID-19 to alleviate its symptoms or to directly counteract coronavirus [65–67].

Second, the honey market is characterised by relatively short supply chains, which had a significant impact on the risk of their rupture. Despite the strong dependence of Polish honey production on foreign markets, the disruptions in honey supply were of a temporary nature and resulted from the adaptation of the market to new, specific conditions. This is also confirmed in studies by Ambroziak [15], who indicates that in many industries in which production is highly dependent on foreign supplies of raw materials and semi-finished products (e.g., the fish industry, tobacco industry), disruptions in their deliveries to Polish plants were sporadic.

The war in Ukraine has changed the structure of honey trade in Poland. Imports of honey to Poland declined, mainly due to a reduction in imports from Ukraine, Poland's main supplier, with Poland increasing imports from China to compensate for the shortfall. The reasons for this include a reduction in the transport of raw material from Ukraine, but also pressure from Polish honey producers to limit imports. Honey imports are, however, necessary, as Poles consume more honey than domestic apiaries can produce (consumption in the last decade has risen from 0.48 to 1.1 kg/person). Production in Poland has been increasing in recent years and has fluctuated between 13,000 and 24,000 t over the last decade, but it is still unstable and does not show a long-term upward trend (see Figure 1). Moreover, Polish companies have a strong position on the foreign market, thanks to which they can resell imported raw material abroad, competing with Germany, among others. In fact, the whole community faces a similar challenge—in the EU market the demand for honey far exceeds the production capacity of domestic beekeepers [8], so importing raw material is necessary.

This is also confirmed by the SRR_{food} and IIT_i indicators, which were subject to little change due to the crises. Despite its relatively high natural-production potential, studies have shown that Poland is not self-sufficient in honey production. According to Clapp [3], most net food importing countries are not self-sufficient. Low SRR_{food} rates justify the need to import, as also indicated by crises when self-sufficiency rates do not keep up with increasing demand [3]. Clapp [3] notes that the 2007–2008 food crisis provided a reason to look at self-sufficiency from a broader perspective and recognise trade liberalisation to hedge against the effects of crises. The findings of this research are consistent with the literature indicating the important economic and social consequences of crises, which affect global and local food markets [8–10]. Our research indicated that both crises paradoxically increased Poland's self-sufficiency in honey production slightly, with—again paradoxically—decreasing diversification of supply sources. This means that Poland has a relatively strong and established position in the honey trade. Research also indicates that other factors that have been key to stabilising the honey market in Poland and minimising the negative effects of crises include increased honey production, improved infrastructure and support for beekeepers [6]. However, striving for a high SRR_{food} rate cannot be an end in itself as many countries have ratios well below 100% and have no problems securing adequate food supplies for their populations by relying on international trade. These countries include Japan, South Korea, Greece, Italy, Mexico and Kuwait, as per FAO data, 2007–2011. Low food self-sufficiency can also provide an impetus for IIT, which is seen as a factor in the comprehensive development of an economy, as opposed to inter-industry, which leads to significant foreign dependence. Changes in the direction of intra-industry specialisation and the trade based on it are easier, faster and involve much lower adjustment costs [68]. Stable markets are the basis for improving self-sufficiency and strengthening IIT.

Our research has shown that the honey market in Poland is unable to achieve food self-sufficiency due to specific production conditions (e.g., short growing season, decreasing biodiversity, overlapping flowering periods of many plants), which implies an increase in imports. Poland's increasing dependence on imports is not only a result of natural resource constraints (although they are of key importance), but depends on changes in consumer preferences (health-oriented food), greater consumption of honey (increase in consumption), availability of cheap honey on world markets and changes in export earnings. While the lack of self-sufficiency did not have decisively negative consequences for Poland's honey trade during the COVID-19 pandemic and the war in Ukraine, the high degree of concentration of import sources can result in a very fragile food system, which, as numerous studies have shown, is highly susceptible to natural and economic shocks.

Data from food-insecure countries show that the COVID-19 pandemic caused significant problems with farmers' access to inputs. The honey market was also affected, as the disruption of supply chains of inputs necessary for agricultural production, such as agricultural machinery or fertilisers, in extreme cases led to up to a 50% reduction in crop yields [8], and consequently reduced honey production. Studies also point to the negative impact of lockdowns on crop productivity and quality due to the disruption of crop pollination, which has a negative impact on ecosystem biodiversity [4]. Climate change and unfavourable weather conditions led to a significant decrease in crop yields and thus honey production not only in Poland but also in the whole of Europe.

These case studies contribute to the understanding of risk and the cascading nature of systemic risk. Climate change is increasing the frequency and intensity of natural hazards. The COVID-19 pandemic, which began as a public health crisis, increased existing risks and vulnerabilities exacerbating agricultural losses, reducing access to resources and services. African Swine Fever is a clear example of how transboundary animal diseases (TADs), that do not transmit to humans, have widespread systemic impacts, including when they occur simultaneously with other natural disasters such as the COVID-19 pandemic. In conflict situations, climate change and natural resource depletion increase the risk of disaster. Conflicts can increase a country's vulnerability and reduce its ability to cope with all types of hazards. These examples show that emergencies can have long-lasting effects on economies [8,14].

The problem of food self-sufficiency in the honey market cannot be viewed only through the prism of trade. Food self-sufficiency in the beekeeping sector needs to be considered much more broadly, as the development of this sector is crucial to ensure food security through the pollination of plants and the production of high-value agricultural and bee products [69]. Both the COVID-19 pandemic and the war in Ukraine have exposed all the contradictions in the beekeeping sector: the valuable role of bee products as immune enhancers and antiviral agents, and the impact of unsustainable human activities on bee health and survival, and thus on food security.

The literature can find both positive and negative consequences of crises on beekeeping activities. General blockades introduced as a result of crises can effectively restrict the movement of bees over long distances, which can have negative consequences for both agriculture and the earnings of the beekeepers themselves. When analysing crises through their environmental impact, one can also see their positive effects on agriculture and beekeeping. This can be confirmed by the research of Baxter-Gilbert et al. [70], which indicates that reducing the intensity of motorised transport may have had a positive impact on bee survival, as this transport kills billions of insects annually, of which approximately 95% of the insects that die in this way are pollinators. This is also indicated by the research of Attia et al. [17], which shows that the reduction in industrial and commercial activities, transport and general blockage had an immediate impact on air quality, significantly improving environmental conditions, which has a positive impact on the quality of life of honeybees and increases plant productivity.

6. Conclusions

The results of the analysis carried out show that, compared to global production, European honey production is less stable. The COVID-19 pandemic and the war in Ukraine due to health security restrictions contributed to its decline between 2018 and 2022, mainly influenced by the inability to transport apiaries over longer distances and thus reduced pollination capacity and lower honey yields, increased inflation and the energy crisis, all of which threatened the profitability of apiaries. However, the high variability in honey production in Europe has been determined primarily by weather conditions during the growing season and the associated production risks, the number of colonies, the health of apiaries, bee die-offs and demand. Against this backdrop, honey production in Poland is even more variable, resulting in a fluctuating level of the self-sufficiency index, although these changes are not as severe. Poland's honey production (at over 24,000 and 30,000 t in 2022 and 2023, respectively), gives it a position in the top twenty producers in the world. Nevertheless, the scale of honey production in Poland is not sufficient to satisfy internal demand—its self-sufficiency is at the level of about 60% on average, so in the future, Poland will have to continue to import raw material. The increase in domestic production can be attained through, e.g., the increase in support for the beekeepers' multifunctional efforts, especially ecosystem services such as pollination, which improve the level of food production overall.

The results of the research indicate that Polish honey trade did relatively well during the COVID-19 pandemic and the war in Ukraine, but a slowdown in honey trade should not be ruled out in the following years. There have been major structural changes in the foreign honey trade. From 2014 until the outbreak of the pandemic, IIT intensity remained at 0.7–0.8 and intra-industry in nature, and the pandemic did not have a significant impact on the change in trade specialisation because the indicators fell slightly to 0.64 to 0.68.

Food self-sufficiency is an element of state resilience. During the period under review, the SRRi indicators showed an upward trend. The war in Ukraine and the COVID-19 pandemic caused changes in Poland's honey trade, changing the structure of suppliers and customers, but did not affect the deterioration in the self-sufficiency index, as this was determined by the increase in domestic production and the improvement in the foreign trade balance via the increased share of imports from China.

The COVID-19 pandemic and the war in Ukraine started a debate on Poland's high dependence on imports and the importance of local production. The health-promoting features of beekeeping products was important in shaping trade in Poland during the COVID pandemic and translated into an increase in honey consumption. Environmental and related food security issues will be important for a change in the model of beekeeping in Poland, as this sector plays an important role in preserving sustainability and biodiversity; hence, the issue of food self-sufficiency in honey production should be treated broadly, including the benefits for agriculture and environmental sustainability.

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