Liubov Mykhailova., Prof., Dr. Dr. h.c., Head department of management of foreign economic activity and eurointegration;
Viktoriia Hrytsenko, **graduate student**,
Sumy national agricultural university; Sumy, Ukraine

ASSESSMENT THE VALUE OF APICULTURE IN SPACE-TIME MEASUREMENT FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT

Abstract.
The dynamics of the development of apiculture in the world and in Ukraine is presented. The world trade in beekeeping products is described, as well as the role of Ukraine. The threats of the disappearance of bees for sustainable rural development in the space-time dimension are generalized. The importance of beekeeping is substantiated for ensuring sustainable development of the territories thanks to the multiplier effect. The methodical approach of determining the lost profit (losses) by the economy of Ukraine due to the decrease in the number of bee families was expounded and approved. Only in 2015, losses from reducing the number of bees and under-received crops for the country amounted to 10.8% of the gross added value of agriculture. The system of management of the beekeeping industry in the conditions of administrative-territorial reform and development of self-management is offered.

JEL Classification System: F14, O47, Q17, Q56
Key words: apiculture, beekeeping, gross added value, globalization, agriculture, space-time measurement, economic growth, sustainable development, Ukraine.

Introduction. Reforms that have recently occurred in Ukraine are aimed at ensuring competitive production, including agricultural production, as well as creating the basis for the development of rural territorial communities, rural development, improving the standard of living of the rural population to the level of European standards.

Taking into account the strengthening of Ukraine's relations with the EU member states, such reforms should promote the role of rural communities' self-government, transfer of powers to regulate agro-food markets and development of their territories. Among the markets one of the most market-oriented EU is the beekeeping market, more than 98% of which is produced in the households.

The development of the beekeeping market is certainly associated with rural areas, since its main product - natural honey - cannot be obtained without the interaction of bees and biological diversity. Since 2007, when Ukrainian beekeepers won 4 gold and 4 bronze medals at the prestigious Apelmondia World Apiculture Congress that was held in Australia, the rapid popularization of Ukraine in the world

as a beekeeping country began, and the honey market is characterized as one of the export-oriented ones. A definite impetus in its development, he received after Ukraine introduced from 1.01.2016 an in-depth and comprehensive free trade zone with the EU1.

It is well known that beekeeping in Ukraine has become one of the most attractive stable and exporting industries, which contributes to the formation of the country's positive balance of payments. This branch so far only strengthens its positions in the domestic and world markets, including, due to its high quality and compliance with the world standards of quality and safety of its products. The role of the beekeeping industry is also important for sustainable rural development, since the success of its operation is conditioned and supported by a balanced socio-economic-ecological system and its constituent elements.

There is a high level of competition in the world market of beekeeping products. With the purpose of integration and adaptation to the conditions of its functioning and the implementation of effective foreign economic activity, it is necessary to provide information to the subjects regarding competitors, volumes, market needs and its conjuncture. As noted by Yatsenko O.[2]., The world honey market is among the most globalized food markets. Among the five countries that were the largest honey producers in the world in 2009-2013, and produced an average of 1591 thousand tons, includes China, Turkey, Ukraine, Argentina and the United States (Table 1).

The largest producer of honey is currently China, whose average annual production was 438.2 thousand tons, which is almost five times higher than the annual production of Turkey (88.2 thousand tons) or Ukraine (71.8 thousand tons). In

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[1] Apimondia (2007). Ukrainian honey is recognized as the best in the world / *Available from Internet:* http://apimondia2013.org.ua/press-center/press-relises/135.html at date 01.10.2007 (*in Ukrainian* - Український мед визнано кращим в світі)

[2] Yatsenko O. (2011). Market conditions for the global beekeeping market / Formation of a market economy: collective sciences works / Special issue: Organizational and legal forms of agro-industrial formations: the state, prospects and influence on the development of rural areas: in 2 parts - 2011. - Part 1. - P. 435-443. (*in Ukrainian* Яценко О. М. Кон'юнктура глобального ринку продукції бджільництва / О. М. Яценко // Формування ринкової економіки: зб. наук. праць / Спец. вип. : Організаційно-правові форми агропромислових формувань: стан, перспективи та вплив на розвиток сільських територій: у 2-х ч. — 2011. — Ч.1. — С. 435–443)

recent years, such leading countries as the USA, Russia have lost their positions first, and then Argentina has gradually decreased in the rating.

Table 1

Honey production in the world, thousand tons

Country	2009	2010	2011	2012	2013	On average over 5 years	Specific weight,%
World production	1 511,1	1 546,7	1 614,0	1 616,8	1 663,8	1 590,5	100,0
China	407,4	409,1	446,1	462,2	466,3	438,2	27,6
Turkey	82,0	81,1	94,2	89,2	94,7	88,2	5,5
Ukraine	74,1	70,9	70,3	70,1	73,7	71,8	4,5
Argentina	62,0	59,0	76,0	80,0	80,0	71,4	4,5
USA	66,4	80,0	67,3	64,5	67,8	69,2	4,4
Total honey production by leading countries	691,9	700,2	753,9	766,0	782,5	738,9	46,5

Source: FAOSTAT data [3].

At the same time, China, Turkey, and Ukraine strengthened their positions. In China, during the analyzed period, honey production increased 1.1-fold or 55.9 thousand tons, in Turkey, respectively, almost 1.2-fold or 12.7 thousand tons. In Ukraine, gross production is approximately at the same level and an average of 71.8 thousand tons. It should be noted that the five leading countries account for 46.5% of the world's honey production. This indicator in comparison with 2002-2007, grew by 4.8 pp [4].

The average annual export of honey in the world for the period 2010-2015. is 563.3 thousand tons (Table 2). Leading countries, among the ten largest exporters, sell 69.7% of this amount in foreign markets. It should be pointed out that the quality of honey of China's largest exporter is estimated as low and imported as technical for the needs of the perfume, cosmetic and confectionery industries because of its lower price.

The data in Table 2 show that the annual export of honey from China over the past five years is 131.5 thousand tons, which is 2.1 times higher than the export from Argentina, which exports 62.1 thousand tons. Countries such as Mexico, Vietnam,

[3] FAOSTAT (2014). *Available from Internet:* // http://faostat3.fao.org/home/e /

[4] Cvitković D. (2009). Economic aspects of beekeeping production in croatia / D. Cvitković, Z. Grgić, Ž. Matašin[et al.] // Veterinarskiarhiv. — 2009. — Vol. 79, No. 4. — P. 397–408.

India, Germany, respectively, sell on foreign markets - 33.7; 32.5; 29.6 and 23.8 thousand tons of honey, which, as a percentage of total exports, is 6.0; 5.8; 5.3 and 4.2%, respectively, against 23.3% in China and 11% in Argentina.

Table 2

World export of natural honey, thousand tons

№	Country	2010	2011	2012	2013	2014	2015	Average for 2010-2015	
								Amount, thousand tons	Specific weight,%
	World exports	493,9	498,6	539,2	580,5	616,1	651,5	563,3	100,0
1	China	119,0	110,9	114,8	131,0	145,9	167,4	131,5	23,3
2	Argentina	59,0	71,1	77,7	66,7	54,6	43,5	62,1	11,0
3	Mexico	29,4	26,9	33,1	34,0	38,3	40,6	33,7	6,0
4	Vietnam	22,5	28,0	21,2	34,6	48,6	39,8	32,5	5,8
5	India	26,8	29,9	26,0	29,7	24,9	40,5	29,6	5,3
6	Germany	21,9	22,5	23,8	25,5	25,6	23,4	23,8	4,2
7	Ukraine	7,5	11,4	15,8	25,5	37,6	37,9	22,6	4,0
8	Spain	21,4	20,2	20,3	20,3	24,6	21,9	21,5	3,8
9	Brazil	19,6	22,9	16,9	16,2	24,5	21,7	20,3	3,6
10	Hungary	12,9	11,8	13,7	18,3	17,4	16,2	15,0	2,7
	Other	153,8	143,1	175,9	178,7	174,2	198,6	170,7	30,3

Source: data from the USDA Foreign Agricultural Service's Global Agricultural Trade System [5]

Ukraine is also approaching the leading positions, with the volume of honey exports for the period from 2010 to 2015. increased by 5.1 times and amounted to 37.9 thousand tons in 2015, which allowed Ukraine to take the sixth position in the world and the first among the countries of Europe. On average, for six years, the volume of honey exports in Ukraine was 4% of the world figure.

The trend to enter the leading positions of China, according to Yatsenko O.N. [6], due to the large area of China, its leading role in the production of fruits, which directly determines the development of the beekeeping industry as a related area of agriculture, as well as cheap labor. Germany, which is losing the leading positions of

[5] FAS (2017). - Global Agricultural Trade System (GATS) // *Available from Internet:* https://apps.fas.usda.gov/gats/default.aspx

[6] Yatsenko O. (2011). Market conditions for the global beekeeping market / Formation of a market economy: collective sciences works / Special issue: Organizational and legal forms of agro-industrial formations: the state, prospects and influence on the development of rural areas: in 2 parts - 2011. - Part 1. - P. 435-443. (*in Ukrainian* Яценко О. М. Кон'юнктура глобального ринку продукції бджільництва / О. М. Яценко // Формування ринкової економіки: зб. наук. праць / Спец. вип. : Організаційно-правові форми агропромислових формувань: стан, перспективи та вплив на розвиток сільських територій: у 2-х ч. — 2011. — Ч.1. — С. 435–443)

the exporting country, is also the leader (ranking second) in the rating of importers of natural honey with a volume of 89.5 thousand tons, or 16.5% of the world average volume of honey imports in 2010-2015 (Table 3).

Table 3

World imports of natural honey, thousand tons

№	Country	2010	2011	2012	2013	2014	2015	Average for 2010-2015	
								Amount, thousand tons	Specific weight,%
	World exports	465,6	483,6	498,1	574,5	603,1	639,7	544,1	100,0
1	USA	90,2	122,9	116,4	140,9	148,4	156,3	129,2	23,7
2	Germany	88,7	81,4	87,6	94,7	90,6	94,3	89,5	16,5
3	Japan	43,4	38,1	36,9	40,3	35,3	36,2	38,3	7,0
4	United Kingdom	33,9	37,4	35,6	41,2	37,3	42,8	38,0	7,0
5	France	26,1	28,2	26,3	31,2	36,9	32,8	30,3	5,6
6	Belgium	23,1	19,4	23,5	27,4	30,3	32,4	26,0	4,8
7	Italy	16,7	15,6	16,8	19,2	22,6	27,9	19,8	3,6
8	Spain	11,7	13,0	13,5	17,0	19,8	24,2	16,5	3,0
9	Poland	11,3	11,1	11,7	18,7	18,1	18,3	14,9	2,7
10	Saudi Arabia	9,0	11,1	10,5	14,0	18,1	11,7	12,4	2,3
	Other	111,6	105,4	119,4	130,0	145,5	163,0	129,1	23,7

Source: data from the USDA Foreign Agricultural Service's Global Agricultural Trade System[7]

The data in Table 3 show that in the first place among importers is the United States with a volume of 129.2 thousand tons, which is 23.7% of world imports. The demand for imported honey in the US is constantly growing because of problems with a sharp decline in populations of bees. Germany and the United States are the largest importers of Ukrainian honey.

Analyzing the change in the volume of honey exports (Figure 1), we see that Ukraine has a clear tendency to increase it. For the years 2000-2006 its volumes increased by 42 times (by the quantitative indicator). At the same time, the world economic crisis of 2007-2008 led to a fall in exports, and since 2009 again there was a tendency to increase it. In general, for the period from 2008 to 2016, the volume of honey exports from Ukraine increased by 17.5 times (in tons).

[7] FAS (2017). - Global Agricultural Trade System (GATS) *Available from Internet:* // https://apps.fas.usda.gov/gats/default.aspx

These dynamics of exports of Ukrainian honey (Fig. 1) in recent years indicate its rapid growth, despite the fact that the duty-free quota for import of honey in the EU until 2017 amounted to only 5,000 tons.

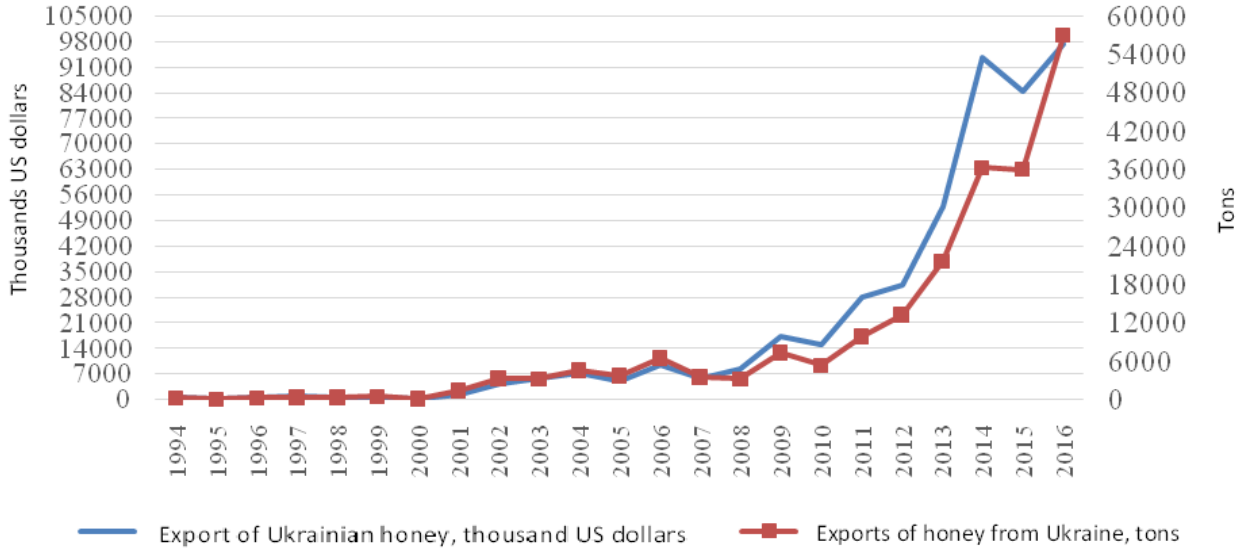

Fig.1 Dynamics of Ukrainian exports of natural honey

Source: Data of the State Fiscal Service of Ukraine [8]

The remaining quantities of honey in the EU are sold by Ukrainian companies, paying 17% duty. Only on January 1, 2017, the European Parliament supported the increase of the tariff quota on Ukrainian honey to 8,000 tons. Export of honey from Ukraine for 2016 amounted to 56988 tons, which is 58.2% more than the export volume of honey of the previous year. The main buyers of Ukrainian honey were and are Germany, Poland, the USA, but the links with Russia are lost completely. From then on, no ton of honey was delivered there (Table 4).

Traditionally, Chinese suppliers have been the leader in supplying honey to the German market, but recently, because of the poor quality and long delivery time, the Germans are increasingly giving preference to Ukrainian products, with Ukraine among the importers of Germany the third place [9].

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[8] State fiscal service of Ukraine (2017). Total volume of import and export by commodity items by codes UKTZED *Available from Internet:* // http://sfs.gov.ua/ms/f11 (*in Ukrainian* Сумарний обсяг імпорту та експорту у розрізі товарних позицій за кодами УКТЗЕД)

[9] European Commission (2017). Trade : Export Helpdesk : Statistics // *Available from Internet:* http://www.exporthelp.europa.eu/thdapp/display.htm?page=st%2fst_Statistics.html&docType=main&languageId=en

In the Polish market, Ukraine holds a leading position among importers for the past five consecutive years according to the data of the European Commission [10].

Table 1

Geographical structure and export volumes of Ukrainian honey, tons, %

№	Country	2011	2012	2013	2014	2015	Amount over 5 years	Specific weight,%
1	Germany	3845	5783	9748	11472	11826	42674	36,4
2	Poland	930	2211	4485	6976	5610	20212	17,2
3	USA	239	1022	2594	7807	7641	19303	16,5
4	Russia	3423	2290	471	19	0	6203	5,3
5	Turkey	208	515	1034	1397	1742	4896	4,2
6	Spain			358	1563	1377	3298	2,8
7	France	82		148	1783	1033	3046	2,6
8	Lithuania	21	82	416	608	1308	2435	2,1
9	Czech Republic	308	96	115	374	1069	1962	1,7
	Other	817	1340	2305	4337	4407	13206	11,3
	Total	9873	13339	21674	36336	36013	117235	100,0

Source: Calculated from the State Fiscal Service of Ukraine [11]

In the US market, 16.5% of Ukrainian honey was delivered in kind. At the same time, Ukraine is the sixth country among the main suppliers of honey to this country.

It should be noted that the import of honey in the US is increasing due to the fact that own production has a tendency to decrease. Domestic honey provides only a third of the consumption volumes, and more than 70% of the US honey is imported, and this figure only increases with time. On cheap Chinese honey in the United States introduced anti-dumping sanctions. For the American honey market, Ukraine is competing with supplies from Argentina, Brazil, Vietnam, India and Canada. According to Table 4, we see that Ukraine began to supply more honey to Turkey, Spain, France, Lithuania and the Czech Republic.

Leading importers: Germany, Poland and the USA account for 70.1% of all exported honey. Mostly Ukrainian honey is sold to member countries of the European Union, their

[10] European Commission (2017). Trade : Export Helpdesk : Statistics // *Available from Internet:* http://www.exporthelp.europa.eu/thdapp/display.htm?page=st%2fst_Statistics.html&docType=main&languageId=en

[11] State fiscal service of Ukraine (2017). Total volume of import and export by commodity items by codes UKTZED // *Available from Internet:* http://sfs.gov.ua/ms/f11 (*in Ukrainian* Сумарний обсяг імпорту та експорту у розрізі товарних позицій за кодами УКТЗЕД)

share is 71.9% of honey exported abroad. In total in the list of importers of Ukrainian honey in 2016 there were 38 countries.

It should be noted that the world market is falling prices for honey, including, and Ukrainian honey. The largest amount of honey was sold at a price of $ 2,300 to $ 2,600 / ton. To increase the price level, it is necessary to solve a number of problems related to the conformity of quality of Ukrainian honey to world standards and deliveries of non-raw materials and finished products in individual branded packaging.

The second reason, which influences the decline in the price of Ukrainian honey, is the increase in the number of exporters, that is, an increase in the supply of Ukrainian honey on the world market. According to the register of export capacities of the State Service of Ukraine on food safety and consumer protection, as of July 1, 2016, the number of registered exporters of beekeeping products was 55 subjects, although in 2015 there were 45 of them.

Ukraine is one of the few countries that provide themselves with honey on their own. But recently there has been a gradual increase in the volume of its imports (Table 2Table 2).

Table 2

Volumes of imports of natural honey to Ukraine

Indicators	2011	2012	2013	2014	2015	2016	Growth over 6 years, times
Cost, thousand dollars. USA	16	236	89	248	98	309	19,3
Weight, t	2	23	22	53	17	118	59,0

Source: State Fiscal Service of Ukraine [12].

Along with the increase in the volume of honey exports to Europe, Ukraine began to export beeswax. Volumes of export of wax are reflected in tab. 6.

Until 2015, Ukraine did not export wax abroad at all and only after the implementation of the Association Agreement with the EU gradually began to increase its exports. The largest buyer of wax is Poland, which is 85.7% of the total volume of wax exports from Ukraine.

[12] State fiscal service of Ukraine (2017). Total volume of import and export by commodity items by codes UKTZED // *Available from Internet:* http://sfs.gov.ua/ms/f11 (*in Ukrainian* Сумарний обсяг імпорту та експорту у розрізі товарних позицій за кодами УКТЗЕД)

Table 3

Volumes of export and import of wax in Ukraine

Year	Import		Export		Balance, thousand US dollars
	Cost, thousand US dollars	Weight, t	Cost, thousand US dollars	Weight, t	
2011	66	17	0	0	-66
2012	45	6	0	0	-45
2013	42	14	0	0	-42
2014	37	3	0	0	-37
2015	104	18	677	118	573
2016	73	14	1253	224	1180

Source: State Fiscal Service of Ukraine [13].

Of course, the volume of production and export of honey and wax is directly influenced by the number of bee colonies (Table 7). The largest number of beekeeping families in the world is India: 11,350 million families, which is 14,4% of their total number in the world.

Table 4

The number of bee colonies in the world, thousand families

Country	2009	2010	2011	2012	2013	On average over 5 years	Specific weight,%
World quantity	76187,9	78077,5	78565,8	80370,9	80910,1	78822,4	100,0
India	10600,0	11500,0	11500,0	11550,0	11600,0	11350,0	14,4
China	8827,2	8897,7	8953,9	8987,2	9020,0	8937,2	11,3
Ethiopia	3049,3	3250,1	4993,8	5207,3	5250,0	4350,1	5,5
Iran	3500,0	3500,0	3400,0	3250,0	3200,0	3370,0	4,3
Turkey	3400,0	3250,0	3200,0	2975,6	3047,2	3174,6	4,0
Russia	2975,6	3047,2	3049,3	3250,1	3500,0	3164,5	4,0
The total number of beekeeping families of the leaders	32352,1	33445,1	35097,0	35220,2	35617,2	34346,3	43,6

Source: FAOSTAT data [14].

Their number in the world is gradually increasing, and in 2013 amounted to 78.8 million families. Next in the ranking are China (8.9 million families or 11.3%)

[13] State fiscal service of Ukraine (2017). Total volume of import and export by commodity items by codes UKTZED // *Available from Internet:* http://sfs.gov.ua/ms/f11 (*in Ukrainian* Сумарний обсяг імпорту та експорту у розрізі товарних позицій за кодами УКТЗЕД)

[14] FAOSTAT The number of bee colonies in the world // *Available from Internet:* http://faostat3.fao.org/home/e /

and Ethiopia (4.4 million families or 5.5%). 4% fall on countries that have a little more than 3 million bee colonies - Iran, Turkey and Russia. At the same time, India, China, Ethiopia and Russia show a steady increase in the number of bee colonies.

For the years 2009-2013 the total number of beekeeping families in the world increased by 4.7 million or 6.2%.

In Ukraine in recent years, there has been a tendency to reduce the number of bee colonies, and the country is not among the leaders. So, if in 1991 there were 3,515 million beekeeping families, then until 2004 their number decreased to 2,758 million. In 2007, their number reached 3,456 million, which was equal to the level of 1991, after which again there was a trend to decrease.

At January 1, 2016, there were 2,590 million beekeeping families in all Ukrainian economies for statistical data (Fig. 2). It is worth noting and the fact that since 2012, Ukraine has entered the European market of bee's trade. Thus, according to the European Commission, in 2016, a bee was exported to Poland in the amount of 7,477 euros, while at the same time it was imported from other countries in the amount of 54,358 euros [15].

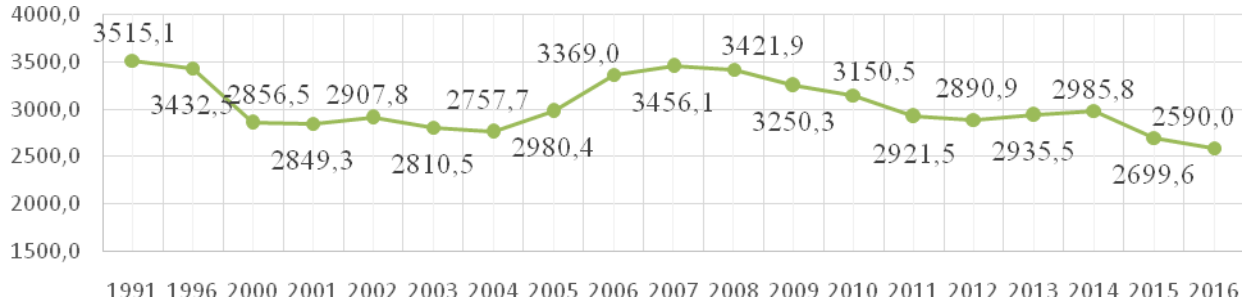

Fig. 2. Dynamics of the number of bee colonies in Ukraine as of the beginning of the year, thousands of families

Source: State statistic service of Ukraine[16].

Data on export-import of beekeeping in Ukraine are presented in Table 8. This situation with the importation into Ukraine of bees of non-ionized breeds "Buckfast",

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[15] European Commission (2017). Trade : Export Helpdesk : Statistics // *Available from Internet:* http://www.exporthelp.europa.eu/thdapp/display.htm?page=st%2fst_Statistics.html&docType=main&languageId=en

[16] State statistical service of Ukraine (2016). Livestock of Ukraine for 2015 / State statistical service of Ukraine. 2016. — P.211 (*in Ukrainian* - Тваринництво України за 2015 рік / Державна служба статистики, 2016. — С.211)

"Karnika", "Italiana" and others contradicts the legislation of Ukraine on pedigree zoning of bees and adversely affects the genetic properties of Ukrainian bee breeds.

Table 5.

Indicators of trade of families of bees of Ukraine with the European Union

Indicators	Export to ЄС, euro					Import from ЄС, euro				
Year	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
Holland						11046	2 200	23958	13499	4366
Poland	6652	8815	7256		7477					
Slovakia										49992
Total	6652	8815	7256		7477	1146	2 200	23958	13499	54358

Source: European Commission statistics [17].

This reduces their natural productivity, can cause diseases of bees, which until then did not occur in Ukraine [18].

In general, in Ukraine there is a tendency to a fall in the production of honey with a significant upward trend in its exports. In the near future, as we see, it is the volumes of honey produced that will restrain the growth of its exports. In the world, as A. Ponomarev notes[19], referring to the forecast of the consulting company Global Industry Analyst, Inc. (GIA), by 2022 the global production of marketable honey will increase to 2.4 million tons, or 1.5 times. The following factors will contribute to this: increasing the interest in the world in honey as a valuable natural product; the increasing use of honey in medicine; spreading the use of honey as a means to combat obesity as an alternative to sugar and artificial sweeteners; the growing demand for honey from the cosmetic industry; the increasing use of honey by the food industry as an ingredient in popular food products and beverages. And the most global threats to the global bee industry will remain

[17] European Commission (2017). Trade : Export Helpdesk : Statistics // *Available from Internet:* http://www.exporthelp.europa.eu/thdapp/display.htm?page=st%2fst_Statistics.html&docType=main&languageId=en

[18] Order of Ministry of agriculture (2000). On Approval of Regulatory Acts on the Development of Beekeeping, approved by the Order of the Ministry of Agrarian Policy № 184/82 approved at 20.09.2000 *Available from Internet:* http://zakon2.rada.gov.ua/laws/show/z0736-00 (*in Ukrainian* - Про затвердження нормативно-правових актів з питань розвитку бджільництва Наказ міністерства аграрної політики України № 184/82 від 20.09.2000)

[19] Ponomarev A. (2017). Prospects of the global honey market / A. Ponomarev // *Available from Internet:* http://www.apiworld.ru/1491300042.html (*in Ukrainian* - Пономарев А. (2017). Перспективы мирового рынка меда / А. Пономарев)

falsification of honey and a high level of death of honey bees. This situation confirms a decrease in the production capacity of honey with a constant increase in demand for it in European countries.

Why bees disappear, it is not known. The phenomenon of the sudden disappearance of bees, experts from the United States called Colony Collapse Disorder ("Violations that cause the death of a bee swarm") [20], but there are a number of theories:

1. Ticks, in particular Varroa mite (Varroadestructor) [21], which came from Asia to Europe. To combat the tick use insecticides, but honey after such treatment is not subject to sale because of the possibility of containing poison.

2. In honeybees detected 14 types of viruses: American foulbrood, European foulbrood, as well as the Israeli acute paralysis virus (IAPV) [22] .

3. Herbicides and pesticides that use modern agriculture, if not immediately killed by bees, make them vulnerable to mites. In the Berdichev district of the Zhitomir region, two-thirds of the bees died in a few days in the summer of 2012, this situation is associated with beekeepers spraying pesticides in the fields [23].

4. It is assumed that the cause of mass death of bees can be radio signals of cellular networks. This conclusion was recently reached by scientists from the University of Koblenz-Landau, Germany.

5. The spread of monocultures in agriculture destroys the habitat of pollinating insects. Spanish scientists from the University of Cordoba in the collapse of the colonies blame malnutrition, or rather, the monotonous food of bees, forced to pollinate large uniform fields.

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[20] Latest Penn State College Of Agricultural Sciences News (2007). HONEY BEE DIE-OFF ALARMS BEEKEEPERS, CROP GROWERS AND RESEARCHERS // *Available from Internet:* http://web.archive.org/web/20070703050700/http://www.aginfo.psu.edu:80/News/07Jan/HoneyBees.htm

[21] Anderson, D. L. & Trueman, J. W. H. (2015). Varroa jacobsoni (Acari: Varroidae) is more than one species. Exp. App. Acarol. 24, 165-189 // *Available from Internet:* https://www.researchgate.net/publication/283318630_Anderson_and_Trueman_2000

[22] Cherkasova (1989). Beekeeping, ed. Cherkasova AI .- K.: Harvest, 1989
(*in Ukrainian* - Бджільництво, за ред. Черкасової А.І. .– К. : Урожай, 1989)

[23] TSN (2012). In the Zhytomyr region mysteriously die bees // *Available from Internet:* https://ru.tsn.ua/ukrayina/na-zhitomirschine-zagadochno-umirayut-pchely.html (*in Ukrainian* - На Житомирщине загадочно умирают пчелы)

6. American scientists believe that the stress caused by the deterioration of the ecological situation on the planet, and GMOs weaken the immunity of bees and make them vulnerable to adverse environmental factors.

The consequences of the complete disappearance of bees will be catastrophic for the economy of the whole world, as well as for ensuring sustainable development.

Sustainable development is a general concept that calls for a balance between meeting contemporary human needs and protecting the interests of future generations, including their needs for a safe and healthy environment[24]. The Brundtland Commission report defines sustainable development as "a development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" [25].

Using this approach, we will characterize the conditions for conducting beekeeping, which make up the potential of rural development: the human, labor, and entrepreneurial potential of beekeepers, who are traditionally engaged in this business; natural biological potential: lands, forest plantations, honey plants, high-performance bees, etc.; the present possibility of exporting honey and increasing its competitiveness.

It is well known that due to the effect of the multiplier, the development of this industry will contribute to the effective development of crop production, livestock raising, raising the yield of agricultural crops, and the quality of animal feed. Thus, there is an increase in the resource base for processing industries and, as a result, an increase in value added, an improvement in the living conditions of not only beekeepers but also the entire population of the territorial community.

The development of beekeeping supports the biological diversity of honey plants (buckwheat, clover, alfalfa, etc.); helps to increase the green mass of the earth, provides other living organisms with plant food, replenish the atmosphere with

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[24] Hriniv L. (2001). Ecologically balanced economy: theory problems: monograph. / L. Hriniv. - Lviv: LNU them. I. Franco, 2001 (*in Ukrainian* - Гринів Л. С. (2001). Екологічно збалансована економіка: проблеми теорії: монографія. / Л. С. Гринів. — Львів : ЛНУ ім. І. Франка, 2001)

[25] Butlin J. (1989). Our common future. by world commission on environment and development. (London, oxford university press, 1987, pp.383 £5.95.) / J. Butlin // Journal of International Development. — 1989. — Vol. 1, No. 2. — P. 284–287.

oxygen, and thus improve the state of the natural environment, and develop ecotourism. In addition, beekeeping promotes the education of love for nature, the environment, because it requires people who are engaged in this activity, a philosophical view of life, accuracy in the performance of work, diligence (Figure 3).

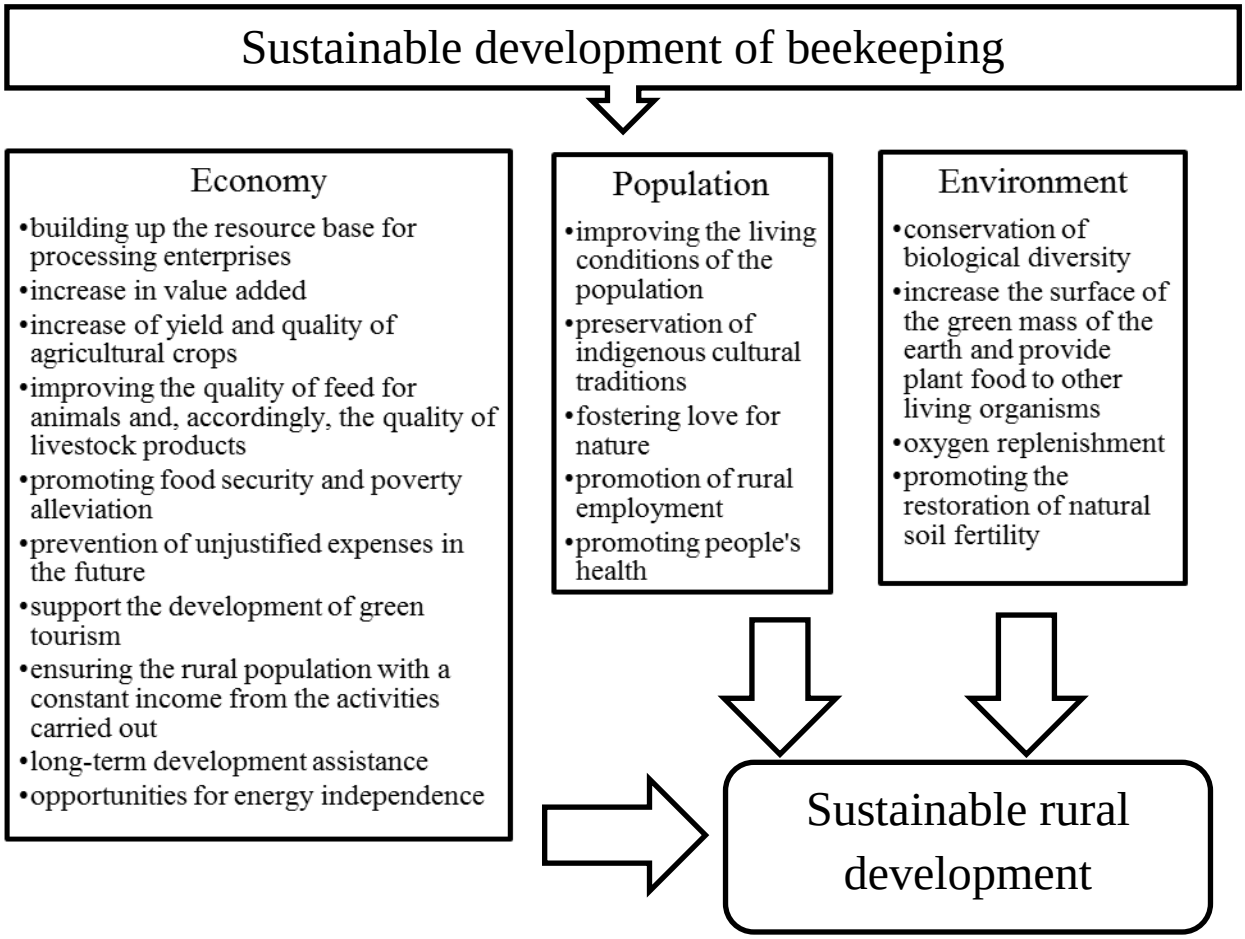

Fig. 3. The influence of beekeeping on sustainable rural development

Source: built by authors on the basis of research

The conducted researches give grounds to assert that for a long time in the development of strategies for the sustainable development of territories and administrative-territorial units, they do not take into account the natural ways of realizing the potentials of the region, including paying no attention to the losses incurred by the rural economy of the region and the country as a whole because of loss of bee colonies.

In the native literature sources known to us, we did not find a methodology that would help assess the lost or lost economic effect of the loss of beekeepers by bees because of their death.

At the same time, American researchers have long been trying to determine the value that bees bring to society[26].

Khristenko O. points out the importance of full-fledged pollination of the main entomophilous cultures with bee colonies[27]. Thus, the minimum need for beekeeping in these purposes in 2011 was provided in Ukraine as a whole only by 56.6% in the pollination of buckwheat and sunflower, which bloom in the same period. Since then, the number of bee colonies is decreasing, and the area of sunflower crops is increasing.

Only in isolated cases, agricultural producers offer payment for pollination [28], but there is no systematic approach. Therefore, given the importance of the proven role of beekeeping for the development of rural economy and sustainable rural development, we will outline our own methodological approach for quantifying the direct losses from the disappearance of bees in a certain territory.

In this case, we will distinguish between direct and indirect losses. To the indirect or those that are difficult to calculate, we attribute:

- loss from the quality of the crop;

- expenses for medicines that people could not buy, consuming high-quality products (natural, environmentally friendly), including beekeeping products that contribute to the enhancement of human health; as well as state expenditures on the health care system;

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[26] Gill R. A. (1991). The Value Of Honeybee Pollination To Society/R. A. Gill // Apiacta. — 1991.— No.4.

[27] Khristenko O. (2004). Bees - an indispensable link in the field of agricultural production / O.A. Khristenko // Bulletin of Agrarian Science of the Black Sea Region. - 2004 — Vol. 2, P. 301–304. (*in Ukrainian* - Христенко О. А. (2004). Бджоли – незамінна ланка в сфері сільськогосподарського виробництва / О. А. Христенко // Вісник аграрної науки Причорномор'я. — 2004. — №. 2. — Р. 301–304.)

[28] Zhuchenko D. (2014). Prerequisites for the establishment of a regional cooperative association of beekeepers / D. B. Zhuchenko // Effective economy. - 2014. - No. 2 // *Available from Internet:* http://www.economy.nayka.com.ua/?op=1&z=2750. (*in Ukrainian* – Жученко Д. (2014). Передумови створення регіонального кооперативного об'єднання пасічників / Д. Б. Жученко // Ефективна економіка. — 2014. — №. 2)

- losses from the impossibility of improving technologies in beekeeping, increase in production volumes, and, as a result, a decrease in the purchasing power of the population, which is the owner of bees.

We attribute to direct losses: the cost of lost bee families; the cost of lost production of beekeeping as a result of the loss of bees and the cost of less harvest of entomophilous crops. Calculations for determining the estimated losses / lost revenue will be made according to the following formula:

$$W = K_б Q_б + \sum_{i=1}^{n} K_б T_{бі} P_{пі} + \sum_{j=1}^{m} K_б S_j Y_j K_j P_{yj} + C, \quad (1)$$

Where W – loss of the region's economy from the disappearance (decrease) in the number of beekeeping families, UAH;

$K_б$ - number of dead bees, families;

$Q_б$ - market value of one family in the period of their death, UAH;

$T_{бі}$ - Productivity of 1 family in the *i*-th kind of product, kg;

$P_{пі}$ – market price of the *i*-th kind of beekeeping products in dynamics, UAH / kg;

S_j - Area of the *j*-th species of entomophilous cultures pollinated by 1 colony, ha;

Y_j– yield of the *j*-th type of agricultural crops, kg / ha;

K_j– coefficient of lost crop due to lack of pollination by bees [29];

P_{yj} – market price of 1 kg of under-received harvest, UAH / kg;

C – additional costs for the restoration of the number of bee families.

Using statistical data of the State Statistics Committee of Ukraine, we determined by this method the losses that the Ukrainian economy bears throughout 2010-2015. (Table 9).

The data presented indicate that the country's loss figures are significant. So, in 2015, for the Ukrainian economy, the losses from decreasing the number of bees and

[29] UAAS Institute of beekeeping them. П.І. Prokopovich (2004). Recommendations for the use of bee families for pollination of entomophilic cultures - Kyiv: 2004. - 12 p. (*in Ukrainian* – Рекомендації з використання бджолиних сімей для запилення ентомофільних культур / УААН Ін-т бджільництва ім. П.І. Прокоповича. — Київ : 2004. — 12 с.)

under-harvested crops, according to our methodology, constitute 10.8% of the gross added value of agriculture, and are the highest for the last 6 years.

Table 9

Calculation of losses / benefits from changes in the number of bee colonies in Ukraine (on honey production, compared to the previous year)

Year	Change in the number of bee families compared to the previous year, families	Honey production of 1 bee family, kg	Loss / benefit of beekeeping, million UAH	Loss / benefit of additional crop during pollination by bees, million UAH	Loss of the economy of agriculture, million UAH	Gross added value, million UAH	Specific weight of losses / gains in the gross added value of agriculture,%	Excess of losses (benefits) from pollination over losses (benefits) of beekeeping, times
2010	-99500	22,50	-142,4	-2406,8	-2549,2	82948	-3,07	16,9
2011	-229000	24,07	-332,9	-7592,7	-7925,6	109961	-7,21	22,8
2012	-30600	24,26	-50,7	-985,5	-1036,2	113245	-0,92	19,4
2013	+44600	25,11	+79,3	1643,9	1723,2	132354	1,30	20,7
2014	+50300	22,28	+91,3	2079,3	2170,7	161145	1,35	22,8
2015	-286200	23,56	-786,9	-24750,6	-25537,5	236003	-10,82	31,5

Source: calculated by the authors according to the State Statistics Committee of Ukraine [30].

The volume of under-received harvest for sunflower and buckwheat in the same year exceeded by 30 times the amount of the cost of under-received honey and lost families.

It should be recognized that this approach does not take into account the full accounting of all losses, since it is very difficult to estimate what additional income could be obtained from the secondary use of the sunflower harvest, buckwheat during processing, due to the lost productivity of cows through feeding low-quality feeds.

To reduce losses in the economy of the regions and the country, it is important not to allow a further decrease in the number of bees and to promote the development of beekeeping and increase its competitiveness.

Kropivko M.F. notes that the competitive production of consumer goods (including honey) that occurs in rural areas should be large-scale, that is, one that is

[30] State statistical service of Ukraine (2016). Livestock of Ukraine for 2015 / State Statistics Service, 2016 – P.211; (*in Ukrainian* – Тваринництво України за 2015 рік / Державна служба статистики, 2016. — С. 211)

capable of forming and supplying large enough (wholesale) lots of goods to the market. With this kind of production there is a "growing scale effect" [31].

At present, agroholdings are rapidly developing form in Ukraine, in which we see both positive and negative points. Negative is that they do not contribute to sustainable rural development due to many factors: they operate and use resources in the territory of one community, but actually are registered in another; there is no interest in interacting with the population, have a low socially responsible culture of doing business. But the cooperation in the countryside, including beekeeping, is undeveloped, although it could help in the development of the united communities, creating jobs and filling the budget of the community in whose territory it operates.

We believe that in the future the effectiveness of beekeeping will be largely conditioned by the development of various forms of cooperation: productive, consumer, multifunctional, and also their integration. At the same time, the mechanism of the beekeeping management system should be changed in the context of decentralization of power.

We propose a system for managing the beekeeping industry, which involves three levels: at the community level, regional, interregional and specifies the list of their main functions (Table 10).

The importance of managing the development of beekeeping is to correctly determine the number of beekeepers who work in the region, the number of families of bees they contain, by fully registering them. Improving the process of registering beekeepers and updating data in such a registry can contribute to increasing the social responsibility of society and its individual members for the results of their work. On the basis of such data, it will be possible to clearly define the veterinary and sanitary state of the apiaries, control the quality of products, and facilitate the marketing of beekeeping products.

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[31] Kropivko M. (2014). Organization and planning of complex development of agro-industrial production and rural territories in the conditions of decentralization of power authorities / MF Kropivko // Economy of agroindustrial complex. - 2014. - No. 7. - P. 109-121. (*in Ukrainian* – Кропивко М. Ф. Організація та планування комплексного розвитку агропромислового виробництва і сільських територій в умовах децентралізації владних повноважень / М. Ф. Кропивко // Економіка АПК. — 2014. — №. 7. — С. 109–121.)

Table 10

The management system of apiculture in conditions of sustainable rural development

Levels of management	Performed functions
Level of territorial community	- interaction with economic entities to regulate the processing of crops entomophilous crops and prevent loss of bees - marketing of beekeeping products - provision with means of production - quality control of bee products - introduction of advanced technologies for intensive integrated beekeeping - organization of training of sandstones - organization of veterinary and sanitary -hygienic measures - primary processing of products, storage - lending and insurance of apiaries
Regional (uniting the efforts of several territorial communities)	- processing of bee products, production of aphyphotopreparations - provision of apiaries with fixed assets and materials - - the sale of surplus bee products outside the region, the country - organization of pedigree beekeeping - sale of aphyphotopreparations and organization of their mass application in the regions - creation of a purposeful marketing company to promote honey and other beekeeping products and position them as socially significant products of organic origin with medicinal properties and protection of bees
Interregional (state)	- the organization and financing of the development of new technologies for integrated beekeeping, as well as their introduction through regional and district administrations on farms - coordination of interregional flows of apiphytic products - development and introduction of advanced technologies for mass application of aphyphotopreparations - production of progressive types of packaging for beekeeping products

Source: formed by the authors on the basis of the study**.**

It is important to carry out explanatory work and support initiatives to create cooperatives; training of beekeepers in advanced methods and technologies of beekeeping. To improve the state of the industry, it is worth using the proposed Zhuchenko D.[32] mechanism for the calculation of pollination by bees entomophilous agricultural crops and fruit and berry plantations.

The association of co-operatives into large associations will allow the creation of commodity batches of honey for export, its processing and the creation of apyfit

[32] Zhuchenko D. (2014). Prerequisites for the establishment of a regional cooperative association of beekeepers / D. B. Zhuchenko // Effective economy. - 2014. - No. 2 // *Available from Internet:* http://www.economy.nayka.com.ua/?op=1&z=2750 (*in Ukrainian* – Жученко Д. Б. Передумови створення регіонального кооперативного об'єднання пасічників / Д. Б. Жученко // Ефективна економіка. — 2014. — №. 2

products for own consumption. Management of such processes will be at the regional level. In the territory of several communities there may be a breeding apiary that will provide cooperatives with high-quality breeding material.

At the regional and national level, a purposeful marketing company should be created to promote honey and other beekeeping products and position them as socially significant products of organic origin with medicinal properties and protect bees as an essential environmental component of the development of society and the economy.

At the highest state level, coordination of work on the organization and financing of the development of new technologies for integrated beekeeping, as well as their implementation through regional and district management on farms, should be carried out; coordination of inter-regional flows of apyfit products; development and introduction of progressive technologies of mass application of aphyphotopreparations for improving the health of the population; production of progressive types of packaging for beekeeping products.

Bees can play a huge role in increasing the yield of crops by not only pollination. So, in the USA a new principle of delivery of plant protection products to the fields has already been patented. Bee Vectoring Technologies company offers to treat entomophilous plants (peaches, almonds, apple trees, watermelons and sunflowers) by biological agents of disease control by means of their delivery by bees. The press service of the company reports that the increase in yields in the fields of sunflower in 2016 when testing this method of plant protection was 31%. At the same time, no additional funds were spent on the processing of agricultural crops[33].

Conclusions. Therefore, we believe that for the development of the honey market and pollination market in the region, a beekeeping development program is needed that will take into account its own characteristics and adaptively adjusted, based on changing market conditions. Development of the program for the

[33] BVT (2017). A bee friendly dispenser system // Bee vectoring technology. Hive & bees in an inoculum dispenser system // *Available from Internet:* http://www.beevt.com/solution/hive-bees-bee-vectoring-technology/

development of beekeeping should be carried out in close cooperation between representatives of households and cooperatives with executive and legislative authorities of the region, research and training institutes.

It is assumed that the following activities should be implemented in the process of program formation: an industry development strategy will be adopted and the functional responsibilities between the participants will be distributed; specialists of scientific research institutions will jointly solve problems on the formation of a unified information system and procedures for the preparation of constituent and internal documents; support the creation of new beekeeping farms serving cooperatives; conduct seminars for beekeepers on the organization and management of production, carrying out zootechnical and veterinary activities; to provide consulting support to producers, analysis and monitoring of the development of the industry; help in the development of business plans; formulate a unified state policy on the development of beekeeping; public associations of beekeepers and agricultural beekeeping cooperatives serving beekeepers will defend the interests of business, continue to take part in the development of various regulatory and legal acts that promote the development of the industry; farms containing bees will unite material and financial resources for the formation of agricultural serving or multifunctional cooperatives, manage them, take direct part in the activities of cooperatives.