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CURRENT STATE, PROBLEMS, AND PROSPECTS OF WATERMELON PRODUCTION

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The countries that are traditionally leaders in watermelon production are China, Turkey, Iran, Brazil, and the United States. China is the main producer of this crop, accounting for 62% of the total global volume. Annual watermelon production is relatively stable with minor fluctuations in cultivation years. Only in Iran, starting in 2017, production volumes decreased by about 1.5 times, due to a decrease in cultivation areas and a decrease in yield levels. At the same time, on average from 2010 to 2022, Iran ranks second in watermelon cultivation areas after China, where 1.4–1.6 million hectares or 49% of the total global area occupied by this crop are allocated annually. However, in terms of fruit yield, China is surpassed by Turkey – 40.35 tons per hectare compared to 43.27 tons per hectare. Even higher yields are obtained in Spain – an average of 51.71 tons per hectare from 2010 to 2022. Spain is one of the main exporters of watermelon fruits to the EU and the main supplier to Germany. In Ukraine, production volumes vary significantly over the years of the study period. The highest watermelon harvests in our country were obtained in 2010–2013. Due to the annexation of Crimea and active hostilities since the beginning of Russia's full-scale invasion of Ukraine, the cultivated areas and production volumes of watermelon fruits reached their minimum values in 2022. As for yield, even during the pre-war period, it significantly lagged behind global indicators, which is determined by a number of factors, including the imperfection of existing cultivation technologies, non-compliance with deadlines and quality of agronomic measures, lack of an established sales mechanism, imperfect pricing system, inability to sell non-standard or non-marketable fruits, etc. The restoration of the melon industry in Ukraine requires support at the state, regional, and economic levels. This will allow for the establishment of stable production of high-quality watermelon fruits, their industrial processing, and ensure high competitiveness of watermelon products in the international market.

Key words: watermelon, melon industry, production volumes, planting areas, productivity.

Сидякіна О.В., Іванів М.О., Бакланова Т.В. Сучасний стан, проблеми та перспективи виробництва кавунів

Країнами-лідерами за обсягами виробництва кавунів традиційно є Китай, Туреччина, Іран, Бразилія та США. При цьому основним виробником цієї баштанної культури є Китай з часткою 62% від загального світового обсягу. Щорічне виробництво плодів кавуна є більш-менш стабільним з незначними коливаннями за роками вирощування. Лише в Ірані, починаючи з 2017 р., обсяги виробництва скоротилися приблизно в 1,5 рази, що пов'язано як зі зменшенням площ посівів, так і зниженням рівня врожайності. Одночасно, у середньому за 2010–2022 рр. за посівними площами кавуна Іран посідає друге місце після Китаю, де під кавуни щорічно відводиться 1,4–1,6 млн га або 49% загальних світових площ, зайнятих цією культурою. При цьому за врожайністю плодів Китай поступається Туреччині – 40,35 проти 43,27 т/га. Ще більший рівень урожайності одержують в Іспанії – 51,71 т/га у середньому за 2010–2022 рр. Іспанія є одним із основних експортерів плодів кавуна в ЄС та головним їх постачальником до Німеччини. В Україні обсяги виробництва досить сильно варіюють за роками вирощування досліджуваного періоду. Найбільші валові збори кавунів у нашій країні отримували у 2010–2013 рр. У зв'язку з анексією Криму та активними бойовими діями від початку повномасштабного вторгнення Росії в Україну

площі посівів під кавунами та обсяги виробництва плодів у 2022 р. досягли своїх мінімальних значень. Що стосується врожайності, то навіть у довоєнний період, вона суттєво поступалась світовим показникам, що обумовлено цілою низкою факторів, у тому числі недосконалістю існуючих технологій вирощування, недотриманням строків і якості виконання агротехнічних заходів, відсутністю налагодженого механізму збуту, недосконалою системою ціноутворення, неможливістю реалізації нестандартних або некондиційних плодів тощо. Відновлення багрянницької галузі в Україні потребує підтримки на державному, регіональному та господарському рівнях. Це дозволить налагодити стале виробництво високоякісних плодів кавуна, їх промислову переробку та забезпечить високу конкурентоспроможність кавунової продукції на міжнародному ринку.

Ключові слова: кавун, багрянницька галузь, обсяги виробництва, площі посівів, урожайність.

Problem statement. The development of the melon industry is a crucial direction in Ukraine's partnership with European Union countries. The soil and climate conditions, especially in the southern region of our country, are favorable for obtaining biologically valuable, high-quality yields of melon crops that play a leading role in the population's diet. According to established medical norms, annual consumption of vegetable products per person should be 161 kg, including 31 kg or 19% for melon crops. Based on these calculations, melon production in Ukraine should reach a level of about 1.5 million tons [1].

The most common melon crop in Ukraine is considered to be watermelon. Its fruits are in high demand not only because of their juiciness and sweet taste but also for their preventive and medicinal properties [2, 3]. In addition to consuming watermelon fruits fresh, they are used to make watermelon honey, juices, alcohol base, yeast, candied fruits, and are also pickled and marinated. Such production of watermelon products can play an important role in both agricultural and tourism businesses in the future [4].

Watermelon is a drought-resistant crop, with its root system penetrating the soil to a depth of two meters or more, and its stems and leaves covered with a thick layer of cuticle [5]. These biological characteristics, along with the nutritional, dietary, and medicinal value of this crop, indicate its significant prospects in the post-war period for the recovery of Ukraine's agricultural sector, especially in the southern region where irrigation has been destroyed, which is the main production zone for melon products. Therefore, studying the current state, problems, and prospects of watermelon production is a relevant issue today.

The analysis of recent research and publications shows that the dry matter content in the flesh of table watermelons ranges from 8 to 16%. Sugars – sucrose, glucose, and fructose – are the predominant components of the dry matter. Fructose is the sweetest, accounting for 50–60% of the total sugar content. According to estimates, one medium-sized watermelon fruit (3–4 kg) contains 200–300 g of sugars. The highest sugar content is found in the central part of the fruit, while it decreases towards the rind. The sweetness primarily determines the quality of watermelon fruits as a dessert product, but it is not the only value of this melon crop [6, 7].

Table watermelons contain vitamins B1, B2, B3, PP, pantothenic acid, folic acid, carotenoids (with lycopene being the predominant one), as well as all essential amino acids [1]. In addition to its involvement in blood formation, folic acid actively participates in protein synthesis, has anti-sclerotic effects, and regulates lipid metabolism in the human body. Significant amounts of folic acid are also found in spinach, green peas, and cauliflower, but it is destroyed during cooking. Therefore, watermelon is considered one of the most valuable sources of folic acid [8, 9].

Watermelon is enriched with iron salts and alkaline compounds that neutralize the excess amount of acids that enter the human body with basic food products (meat, fish,

eggs, bread). It also contains pectin, which binds and removes heavy metals and radionuclides from the body [5]. The easy digestibility of watermelon allows it to be recommended for people of all ages. The recommended annual consumption of watermelon per person is 16.5 kg (53% of the total volume of vegetable consumption) [1].

The therapeutic value of this melon culture is determined by its diuretic properties and activation of the processes of removing harmful substances from the human body. Therefore, watermelon diets are recommended for patients with kidney stones in most cases [10, 11]. Watermelon also plays an important therapeutic role in liver diseases [12], atherosclerosis [13], and hypertension [14]. Modern research has also shown that watermelon seeds, like pumpkin seeds, have anthelmintic properties [15].

According to reports from foreign authors [16, 17], watermelon is a highly profitable and economically attractive crop. In Ukraine, the realization of the high productivity potential of watermelon, and consequently the profitability of its production, has been limited in recent years by a number of problems, including violations of cultivation technologies, imperfections in the agricultural market, lack of developed infrastructure, etc. [18]. Therefore, solving these and other problems in the melon industry, especially in the post-war period of Ukraine's agricultural sector recovery, determines the relevance of this study.

Problem statement. The objective of the scientific research is to analyze the current state of watermelon production in Ukraine, one of the largest producers in the world; identify urgent problems in the melon industry and explore prospective solutions.

To achieve the set goal of the scientific research, the following methods were used: comparative analysis method, which involved comparing statistical data for different years and periods; graphical method – for visual representation of research results and understanding trends and dependencies between individual indicators; abstract-logical method – for formulating theoretical generalizations, conclusions, and practical recommendations based on the research results.

The FAOSTAT – Food and Agriculture Organization of the United Nations statistical database, scientific information sources, and the results of our own research and calculations served as sources of information for conducting scientific research.

Presentation of the main material of the study. The leading countries in terms of watermelon production volume are China (51.8–63.4 million tons), Turkey (3.7–4.0 million tons), Iran (1.2–4.1 million tons), Brazil (0.7–2.3 million tons), and the USA (1.5–1.9 million tons) (Table 1). China is the absolute leader in the production of this melon crop. It accounts for 61.8% of the world's production volume (Figure 1). The share of other leading countries is less significant: Turkey – 2.8%, Iran – 2.6%, Brazil – 2.2%, USA – 1.7%. The rest of the countries in the world account for 27.9%.

The production volumes of watermelons in the leading countries in growing this crop are relatively stable with slight fluctuations over the years. An exception should be noted for a country like Iran. From 2010 to 2016, Iran annually produced 3.2–4.1 million tons of watermelon fruits. Starting from 2017, production volumes decreased by approximately 1.5 times, which is due to a significant reduction in cultivation areas and a decrease in the yield level of this crop. For the period of 2010–2016, the cultivation areas for watermelons in Iran ranged from 123.2–152.9 thousand hectares, but starting from 2017, they did not exceed 70.3 thousand hectares, and in 2021–2022, they reached their minimum values for the analyzed period – 50.0–54.9 thousand hectares, which is 1.6 times less even compared to 2000 (Table 2). Despite this, on average for 2010–2022, Iran's share in the world's watermelon cultivation areas was 3.2%, making it the second-largest country after China (Figure 2).

Table 1
Dynamics of watermelon production by the largest producing countries
 (source: FAOSTAT, 2023)

Year	China		Turkey		Iran		Brazil		USA		World production, million tons
	million tons	% of world production	million tons	% of world production	million tons	% of world production	million tons	% of world production	million tons	% of world production	
2000	51.821	67.6	3.940	5.1	1.650	2.2	0.680	0.9	1.687	2.2	76.683
2010	60.736	64.9	3.683	3.9	3.208	3.4	2.053	2.2	1.893	2.0	93.531
2011	60.251	63.7	3.864	4.1	3.192	3.4	2.199	2.3	1.639	1.7	94.573
2012	60.534	63.0	4.022	4.2	3.220	3.3	2.080	2.2	1.640	1.7	96.156
2013	61.223	62.8	3.887	4.0	3.686	3.8	2.164	2.2	1.638	1.7	97.532
2014	61.702	62.2	3.886	3.9	4.011	4.0	2.171	2.2	1.509	1.5	99.218
2015	62.889	62.3	3.919	3.9	3.714	3.7	2.120	2.1	1.609	1.6	100.991
2016	62.408	60.9	3.929	3.8	4.093	4.0	2.088	2.0	1.803	1.8	102.395
2017	63.358	62.8	4.011	4.0	1.698	1.7	2.313	2.3	1.842	1.8	100.949
2018	61.758	61.2	4.031	4.0	1.460	1.4	2.244	2.2	1.771	1.8	100.960
2019	61.037	59.9	3.871	3.8	1.673	1.6	2.292	2.3	1.638	1.6	101.842
2020	60.835	59.7	3.492	3.4	1.411	1.4	2.185	2.1	1.562	1.5	101.917
2021	61.014	60.0	3.469	3.4	1.251	1.2	2.142	2.1	1.542	1.5	101.635
2022	60.542	60.6	3.395	3.4	1.200	1.2	1.913	1.9	1.493	1.5	99.958

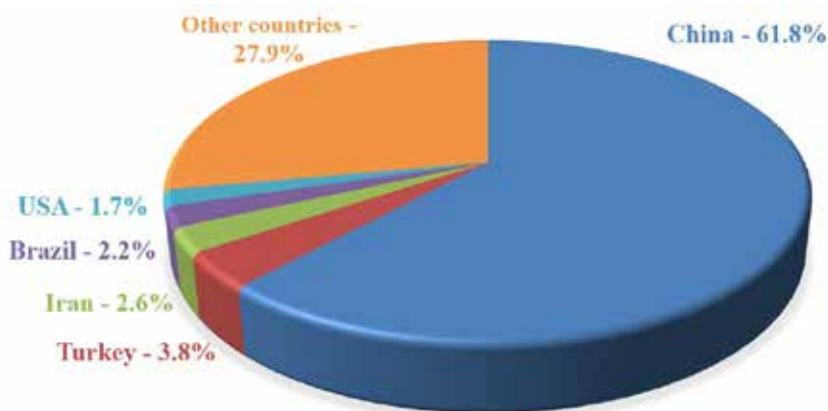


Fig. 1. The share of countries in the world production of watermelons (overall for 2010–2022) (source: FAOSTAT, 2023)

Undoubtedly, China remains the undisputed leader in watermelon cultivation areas in the world. Every year, 1.4–1.6 million hectares are allocated for this popular crop in the country, which on average for 2010–2022 accounts for 49.0%, or almost half of the total global areas occupied by watermelons. Along with its leadership in production

volumes and cultivation areas, China lags behind Turkey in terms of fruit yield, which is clearly illustrated in Figure 3. On average for 2010–2022, the fruit yield of watermelons in China was 40.35 tons/ha, while in Turkey it was 43.27 tons/ha, which is 2.92 tons/ha or 7.2% higher (Figure 4).

Table 2

Dynamics of planted areas under watermelons in the countries with the largest production volumes in the world (source: FAOSTAT, 2023)

Year	China		Turkey		Iran		Brazil		USA		World crop areas, thousand hectares
	thousand hectares	% of world area	thousand hectares	% of world area	thousand hectares	% of world area	thousand hectares	% of world area	thousand hectares	% of world area	
2000	1642.7	52.1	124.7	4.0	83.1	2.6	80.5	2.6	66.5	2.1	3151.7
2010	1652.4	51.5	95.7	3.0	130.0	4.1	94.9	3.0	54.4	1.7	3206.0
2011	1617.7	50.5	98.0	3.1	123.2	3.8	97.7	3.0	47.6	1.5	3205.3
2012	1573.2	50.3	97.7	3.1	129.7	4.1	94.6	3.0	46.9	1.5	3129.9
2013	1579.3	50.1	97.9	3.1	139.1	4.4	92.0	2.9	46.0	1.5	3153.6
2014	1567.4	49.5	95.5	3.0	152.9	4.8	94.4	3.0	45.1	1.4	3166.6
2015	1559.1	49.1	93.9	3.0	125.6	4.0	96.0	3.0	47.1	1.5	3177.0
2016	1525.8	47.6	92.4	2.9	137.8	4.3	90.3	2.8	45.5	1.4	3203.4
2017	1530.1	49.4	91.6	3.0	70.3	2.3	103.2	3.3	43.7	1.4	3098.5
2018	1528.5	49.1	90.2	2.9	60.5	1.9	102.0	3.3	45.1	1.4	3110.4
2019	1474.1	48.0	83.4	2.7	70.2	2.3	98.9	3.2	40.2	1.3	3072.3
2020	1418.0	47.2	74.0	2.5	61.9	2.1	98.2	3.3	38.3	1.3	3002.4
2021	1415.9	46.7	72.9	2.4	54.9	1.8	91.9	3.0	40.1	1.3	3031.5
2022	1391.9	47.7	69.0	2.4	50.0	1.7	85.7	2.9	37.7	1.3	2916.4

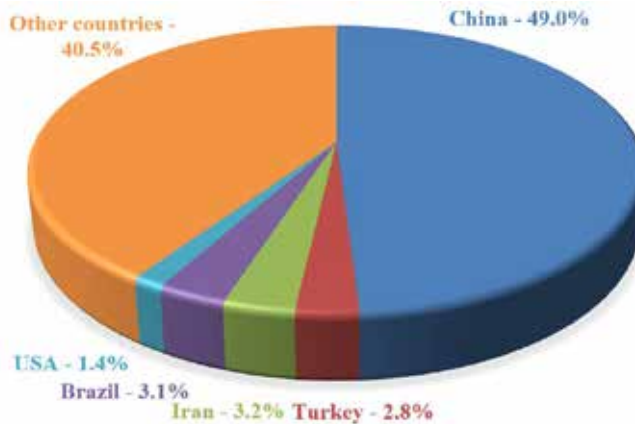


Fig. 2. The share of leading countries in the global area of watermelon crops on average for 2010–2022 (source: FAOSTAT, 2023)

An even higher level of fruit yield of watermelons than in Turkey and China is achieved in Spain, and this applies to all years of the analyzed period. On average for 2010–2022, the fruit yield of watermelons in Spain was 51.71 tons/ha, which is 8.44 tons/ha higher than in Turkey and 11.36 tons/ha higher than in China. Moreover, Spain is one of the main exporters of watermelons in the EU and the main supplier of this crop to Germany [19].

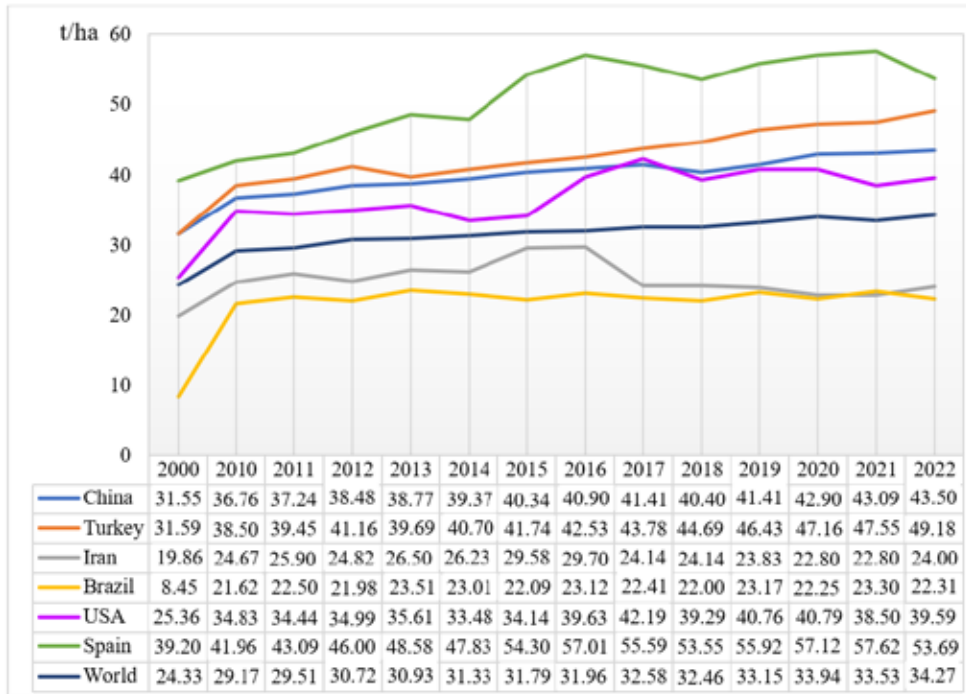


Fig. 3. The dynamics of watermelon yields in the world's leading countries in terms of production volumes (source: FAOSTAT, 2023)

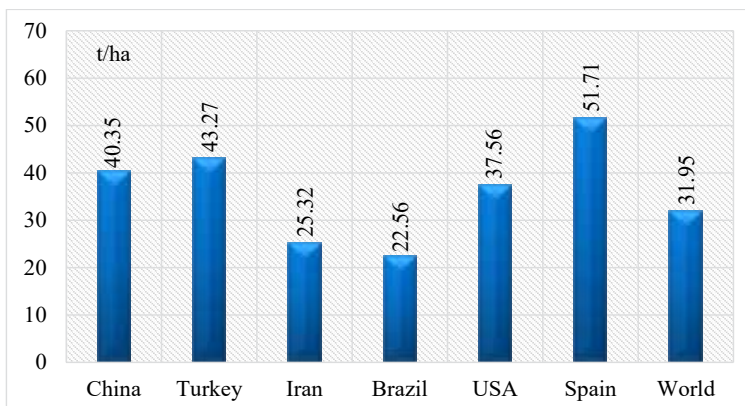


Fig. 4. The yield of watermelon fruits on average for 2010–2022 (source: FAOSTAT, 2023)

The production volumes of watermelons in Ukraine vary significantly over the years, with the highest values in 2010–2013 (Figure 5). After the annexation of Ukrainian Crimea in 2014, they significantly decreased, and since the beginning of the full-scale invasion of Russia into Ukraine, they reached their minimum values, as well as the cultivation areas of this crop (Figure 6).

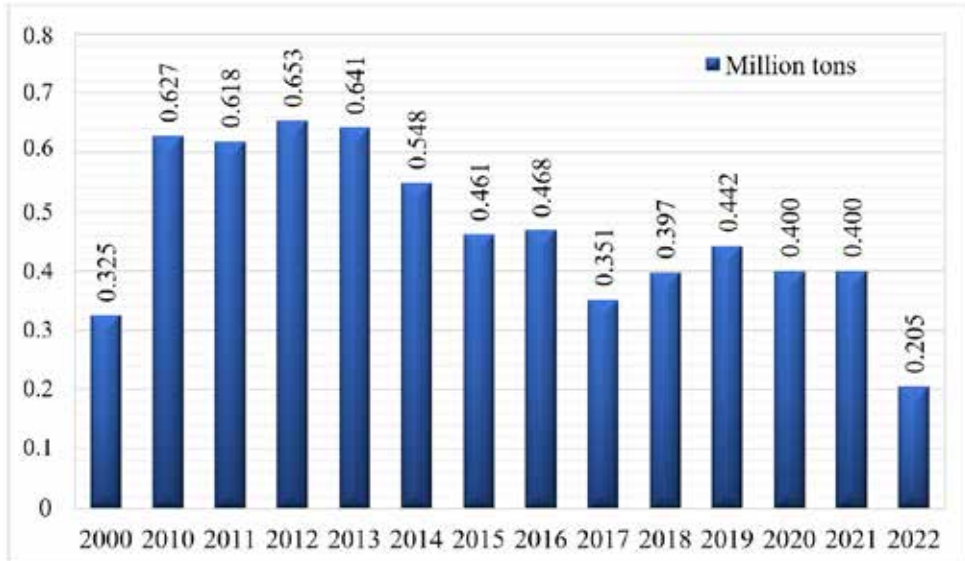


Fig. 5. Dynamics of watermelon production in Ukraine, million tons
(source: FAOSTAT, 2023)

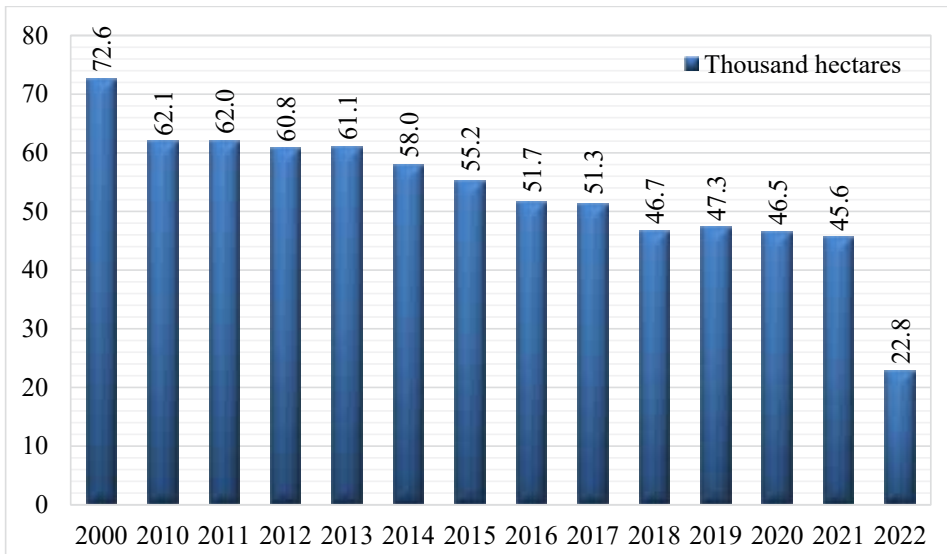


Fig. 6. Dynamics of the area of watermelon crops in Ukraine, thousand hectares
(source: FAOSTAT, 2023)

As for the fruit yield of watermelons in Ukraine, it is significantly lower compared to global indicators and much lower than in Spain, which is clearly illustrated in Figure 7. This situation is primarily due to the imperfection of watermelon cultivation technology in our country. The selection of the variety or hybrid, its potential capabilities, adaptation to adverse environmental factors (such as high atmospheric temperatures and insufficient moisture), resistance to harmful organisms, etc., have the greatest influence on achieving a high yield level. Variety resources account for about 40% of the yield. The creation of an optimal nutrient background plays a very important role in watermelon cultivation technology, as fertilizers ensure the formation of one-fourth of the yield. About 30% of the yield is determined by compliance with the timing and quality of each agrotechnical measure in cultivation [20].

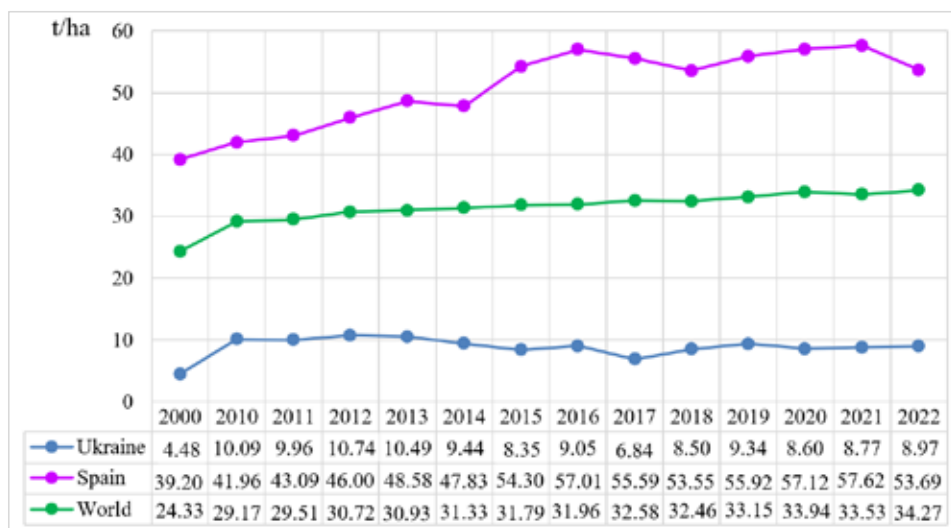


Fig. 7. Comparative diagram of the yield of watermelons in Ukraine with the yield of leading European countries and world indicators (source: FAOSTAT, 2023)

At the same time, it should be noted that the existing watermelon production system requires support at the state, regional, and economic levels. At the state level, it is necessary to provide protection for producers, create a wholesale food market, stimulate competition in the procurement, storage, and processing of watermelon fruits. The formation of integration structures and processing organizations is a priority at the regional level [18].

At the economic level, it is necessary to develop a sales concept, as a certain amount of fruit remains unsold every season. In this case, a certain portion of the unsold produce consists of non-standard or unfit fruits, making it difficult to sell them in their fresh form. Another portion of the unsold fruits remains unharvested in the fields due to imperfect pricing – the selling price does not always cover the harvesting costs [21].

At the economic level, it is also important to consider the real capabilities of farms and increase production volumes by increasing yields through the implementation of innovative and efficient elements of agrotechnology. Non-standard and unfit fruits can be used for processing into watermelon products such as pickled watermelons, juices, candied fruits, marshmallows, preserves from watermelon rinds, watermelon honey, etc.

Therefore, the development of innovative approaches to watermelon cultivation in Ukraine in the future will allow for sustainable production of high-quality fruits, which in turn will ensure the competitiveness of watermelon products in the international market.

Conclusions and recommendations. The top five countries in terms of watermelon production volumes are China, Turkey, Iran, Brazil, and the United States. China is at the top of this ranking, where annually 1.4–1.6 million hectares or almost half of the world's total watermelon cultivation area is dedicated to watermelons. Turkey surpasses China in terms of yield levels, but even higher yields are achieved in Spain – a country recognized as one of the main exporters of watermelons to the EU and the main exporter of this crop to Germany. Ukraine significantly lags behind leading countries in terms of watermelon yields due to a number of problems that require support for the watermelon industry at the state, regional, and economic levels. The development of innovative approaches will allow for the high competitiveness of Ukrainian watermelon products on the international market.

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