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SUNFLOWER: CURRENT STATE, PROBLEMS AND PROSPECTS FOR PRODUCTION

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The areas of sunflower cultivation in Ukraine and Europe increased by 1.8 times, and in the world by 1.4 times during the period 2000–2022. Ukraine's share in the total sunflower cultivation areas in Europe varied between 25.2–33.7%, and in the world between 13.4–23.5% during this period. The maximum volumes of sunflower production in Ukraine, Europe, and the world were observed in 2019 and 2021. Compared to 2000, sunflower production in Europe tripled. Ukraine's share in sunflower production volumes in Europe during the period 2000–2022 varied between 26.1–39.3%, and in the world between 13.0–28.7%. Sunflower production volumes in Ukraine increased by 4.7 times during the period 2000–2021, primarily due to high yields, favorable soil-climatic conditions, and improved cultivation technology. Sunflower yields in Ukraine significantly exceed European and global levels, with modern high-yielding varieties and hybrids adapted to specific soil-climatic conditions playing a crucial role. 37% of sunflower varieties and hybrids in Ukraine are of domestic breeding, 31% are French, and 9% are Serbian. In recent years, there has been rapid growth in the cultivation of high-oleic and sulfonyl hybrids of sunflower in Ukraine. The cultivation technology, including classic, SUMO, and CLEARFIELD technologies, plays a significant role in increasing sunflower productivity. Ukraine is a leader in Europe and the world in sunflower oil production and is forecasted to remain a leader in sunflower oil exports on the global market according to USDA predictions. There are some challenges in the sunflower industry in Ukraine, including issues related to fertilizer and plant protection product markets, as well as sunflower seed supplies. However, experts predict that sunflower production in Ukraine will remain at a high level. Ukraine is expected to maintain strong positions both at the European and global levels in the future.

Key words: sunflower, sunflower oil, production volumes, crop area, yield.

Сидякіна О.В., Подрезов І.О. Соняшник: сучасний стан, проблеми та перспективи виробництва

Площі посівів під соняшником за період 2000–2022 рр. в Україні та Європі зросли в 1,8 рази, у світі – в 1,4 рази. Частка України у загальних площах посівів соняшнику в Європі за даний період варіювала в межах 25,2–33,7%, у світі – 13,4–23,5%. Максимальні обсяги виробництва соняшнику в Україні, Європі та світі спостерігали у 2019 та 2021 рр. Якщо порівнювати з 2000 р., виробництво соняшнику в Європі зросло втричі. Частка України в обсягах виробництва соняшнику в Європі за період 2000–2022 рр. варіювала в межах 26,1–39,3%, у світі – 13,0–28,7%. Обсяги виробництва соняшнику в Україні за період 2000–2021 рр. зросли в 4,7 рази, що пов'язано з багатьма факторами і, в першу чергу, з високим рівнем урожайності, завдячуючи сприятливим ґрунтово-кліматичним умовам та вдосконаленню технології вирощування. Урожайність соняшнику в Україні значно перевищує європейський і світовий рівень, і важливе значення в цьому відіграє добір сучасних високопродуктивних сортів і гібридів культури, добре адаптованих до конкретних ґрунтово-кліматичних умов вирощування. 37% від загальної кількості сортів і гібридів соняшнику в Україні відносяться до вітчизняної селекції, 31% – французької, 9% – сербської селекції. В Україні в останні роки спостерігається досить стрімке зростання площ посівів високоолеїнових і сульфогібридів соняшнику. Важливе значення у збільшенні продуктивності соняшнику відіграє технологія вирощування – класична, технологія SUMO та CLEARFIELD технологія. Україна є лідером в Європі і світі за виробництвом соняшникової олії, за прогнозами USDA і надалі залишиться лідером з експорту соняшникової

олії на світовому ринку. Наразі в Україні існують і певні проблеми в соняшниковій галузі, пов'язані, зокрема, з падінням ринку добрив і засобів захисту рослин, а також з поставками насіння соняшнику в Україну. Проте обсяги виробництва соняшнику в Україні прогнозуються експертами на досить високому рівні. Україна і надалі буде займати стійкі позиції як на європейському, так і світовому рівнях.

Ключові слова: соняшник, соняшникова олія, обсяги виробництва, площі посівів, урожайність.

Problem statement. According to FAOSTAT data (2023) [1], the volumes of global agricultural crop production from 2000 to 2022 increased by 56%, driven by the expansion of arable land, including irrigated land, and the improvement of cultivation techniques, particularly through the use of high-yielding varieties and hybrids, increased fertilizer application, and plant protection measures. During this period, production volumes of some crop groups decreased, including cereals, sugar crops, root crops, and tuber crops. At the same time, there was a significant increase in the production volumes of fruit, vegetable, and oil crops.

From 2000 to 2022, oil crop production increased by 121%. In 2022, the world leaders in oil crop production included oil palm fruit, soybeans, rapeseed or colza seed, seed cotton (unginned), and coconuts (in shell) [2]. Sunflower is not among the top five global leaders in oil crops, but its production volumes worldwide have significantly increased during the specified period, strengthening its position in the global agri-food market [3].

In Ukraine, sunflower is a leading oil crop, accounting for approximately 70% of the total oil crop planting area each year and around 85% of the total gross production volume. Over 60% of all plant-based oil in Ukraine is represented by sunflower oil, used for both food purposes and the production of cosmetic and medicinal products and many other manufacturing products [4, 5]. Therefore, researching the current state, identifying ways to address urgent issues, and outlining future prospects for sunflower production, especially in the post-war period of Ukraine's agricultural sector recovery, is a relevant issue today.

Analysis of recent research and publications. Sunflower is a versatile crop. Primarily, it is grown for seed production – a source of beneficial substances and vitamins. The seeds of modern high-oil sunflower varieties contain 50–55% oil on an absolutely dry basis and about 16% protein, while the kernel contains 65–67% oil and 22–24% protein. In terms of oil content, sunflower is a leader among oil crops, and sunflower oil is considered one of the best in terms of taste properties, nutritional value, and digestibility. Sunflower seeds contain important elements such as iron, potassium, calcium, magnesium, manganese, copper, sodium, selenium, phosphorus, zinc, and vitamins A, B3, B6, D, E [6, 7].

Most of the sunflower seeds are used for food fat production, while lower-quality seeds are processed for technical purposes [8].

An important by-product of sunflower seed processing for oil is meal or cake, which provides the livestock industry with valuable concentrated high-protein feed (protein content up to 36%). Sunflower protein contains all essential amino acids and plays a significant role not only in feed production but also in the food industry. In terms of methionine content (an essential amino acid), sunflower surpasses crops such as peanuts, walnuts, and hazelnuts [9].

For fodder purposes, the yield of green mass of sunflower can reach 60 t/ha, which is directly fed to livestock or ensiled [10].

In recent years, sunflower has gained increasing importance in the energy industry. The husk output during the processing of this crop ranges from 11% to 20%. Husks are burned or processed into fuel pellets or briquettes to generate energy. In addition

to husks, other by-products of sunflower seed production can be used as biomass for energy production [11, 12].

Burning sunflower stalks produces ash containing a significant amount of potassium, which can be used for producing potassium fertilizers or directly as a potassium fertilizer [13].

Sunflower is also a valuable honey plant, and with a yield of 2.5 t/ha, each hectare of sunflower crops can yield 35–40 kg of high-quality honey with excellent taste properties [14].

Sunflower is a highly profitable crop, very attractive economically for agricultural producers and investors, as noted by both domestic [15, 16, 17] and foreign authors [14, 18]. However, the profitability of growing this oil crop in Ukraine has significantly decreased due to the full-scale Russian invasion, which is associated with limited seed imports due to complex logistics, a substantial decline in the fertilizer and plant protection market, and a range of other serious problems that need to be addressed, especially during the post-war recovery period of Ukraine's agricultural sector.

Problem statement. The aim of the research is to analyze the current state of sunflower production in Ukraine, Europe, and globally; identify development issues in the oil and fat industry in Ukraine and promising ways to address them.

To achieve the set goal of the research, various methods were used. In particular, the method of comparative analysis was used to compare statistical data for different years and periods. The graphical method was applied to visualize research results and identify relationships between indicators. The abstract-logical method helped formulate theoretical generalizations, draw conclusions, and provide practical recommendations based on the obtained results.

For scientific research, data from the FAOSTAT statistical database (Food and Agriculture Organization of the United Nations), as well as scientific sources, results of own research, and calculations were used.

Presentation of the main material of the study. The area of sunflower plantings in Ukraine increased by 1.8 times from 2000 to 2022. The highest values were reached in 2021 – 6.665 million hectares (Table 1). Ukraine's share of total sunflower plantings in Europe during the analyzed period ranged from 25.2% in 2000 to 33.7% in 2016, and globally from 13.4% in 2000 to 23.5% in 2020, meaning that almost a quarter of the world's total sunflower plantings before the war were concentrated in Ukraine (Figure 1).

A similar increase in sunflower planting areas occurred in European countries during the period from 2000 to 2022, by 1.8 times. The war in Ukraine and high demand on the international market in recent years have contributed to further growth in sunflower plantings in Europe, especially in countries like France, the Czech Republic, and Hungary. The main EU countries with areas dedicated to organic sunflower production are Romania, France, Italy, Bulgaria, Spain, and Hungary [19].

When analyzing the scale of global sunflower plantings, they have shown a tendency to increase, but have been relatively stable over the years, increasing by 1.4 times from 2000 to 2022. At the same time, sunflower seed production has more than doubled. For example, global sunflower seed production was 26.550 million tons in 2000 and had already reached 54.286 million tons by 2022. The maximum global sunflower production volumes were observed in 2019 and 2021 at 56.027 and 57.994 million tons respectively. In the same years, maximum sunflower production volumes were also recorded in European countries at 42.481 and 44.026 million tons or 75.8 and 75.9% of global production of this crop. Comparing to the year 2000, sunflower production in Europe has tripled, with Ukraine playing a significant role. Its share in sunflower production volumes in

Europe during the period from 2000 to 2022 varied from 26.1% to 39.3% (Figure 2). This percentage was also significant on a global scale – from 13.0% to 28.7%.

Table 1
Dynamics of sown areas and sunflower production volumes in Ukraine,
Europe and the world

Year	Ukraine		Europe		World	
	area harvested, million hectares	production, million tons	area harvested, million hectares	production, million tons	area harvested, million hectares	production, million tons
2000	2.842	3.457	11.271	13.263	21.161	26.550
2010	4.526	6.772	14.302	19.922	23.074	31.457
2015	5.166	11.181	16.400	29.251	24.529	42.301
2016	6.087	13.627	18.075	34.672	26.343	47.478
2017	6.061	12.236	18.215	34.472	26.850	48.612
2018	6.167	14.165	18.756	38.469	26.796	51.914
2019	5.959	15.254	19.300	42.481	27.331	56.027
2020	6.481	13.110	19.876	36.604	27.560	50.115
2021	6.665	16.392	21.293	44.026	29.441	57.994
2022	5.238	11.329	20.061	38.325	29.258	54.286

Source: FAOSTAT, 2023

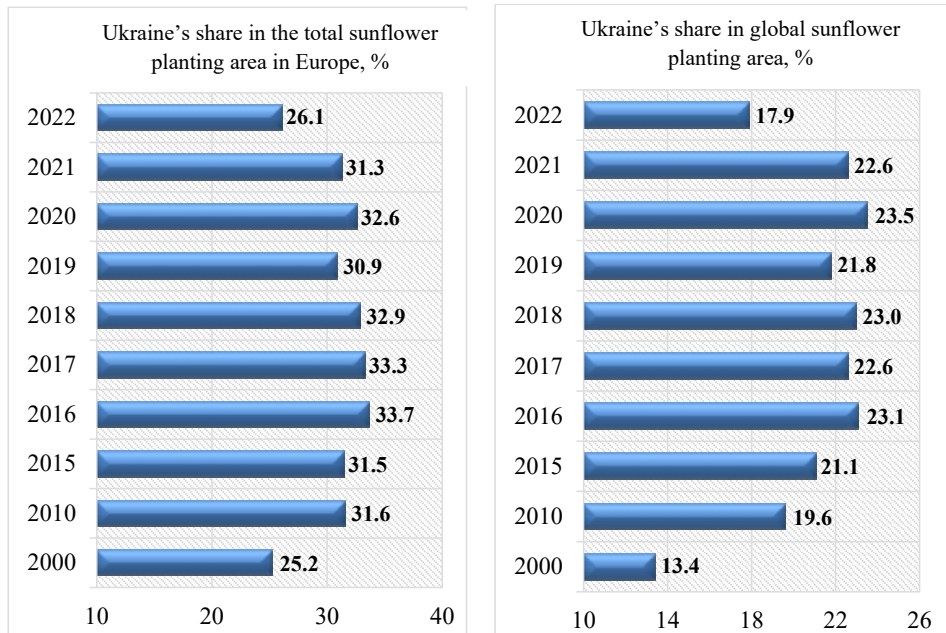


Fig. 1. Ukraine's share in the total area under sunflower crops in Europe and the world

Source: FAOSTAT, 2023

Sunflower production volumes in Ukraine increased from 3.457 to 16.392 million tons or by 4.7 times from 2000 to 2021. Due to the full-scale Russian military invasion of Ukraine, sunflower oil production in 2022 fell to the level of 2015 but still remained at a relatively high level. This rapid growth in sunflower production in our country is associated with many factors, primarily with a high level of seed yield due to favorable soil-climatic conditions and improved cultivation technology. Despite significant fluctuations in production from year to year, sunflower yield in Ukraine significantly exceeds the European and global levels, as illustrated in Figure 3.

The selection of modern high-yielding varieties and hybrids of the crop, well-adapted to specific soil-climatic conditions, plays a significant role in achieving high yields [20, 21].

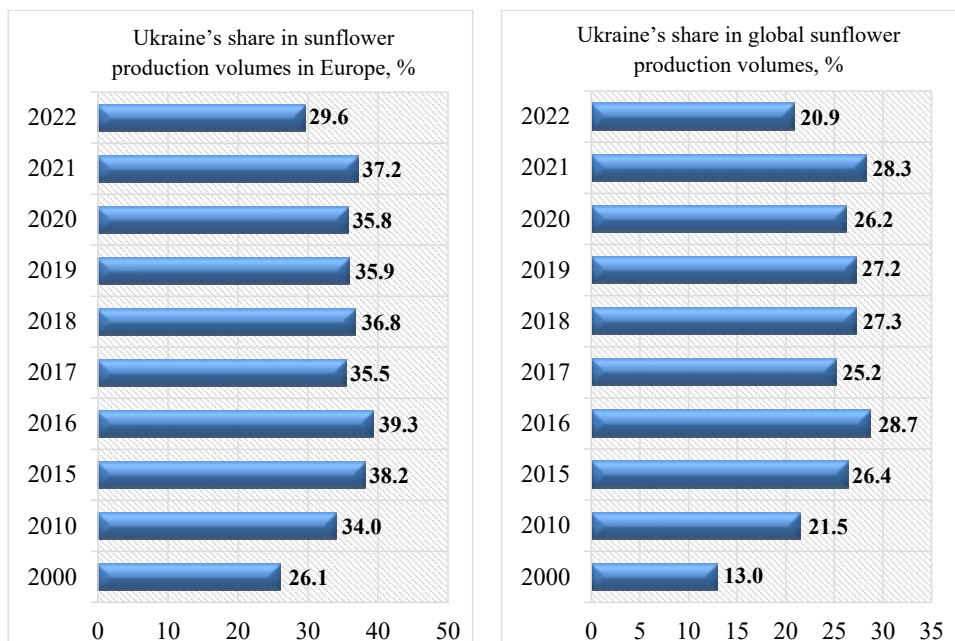


Fig. 2. Ukraine's share in sunflower production volumes in Europe and the world
 Source: FAOSTAT, 2023

The total number of sunflower varieties and hybrids in the State Register of plant varieties suitable for distribution in Ukraine, as of March 19, 2024, is 2276. Starting from 2020, 1015 varieties and hybrids have been included in the State Register, accounting for 44.6% of their total number (Figure 4).

832 sunflower varieties and hybrids, or 37% of the total, belong to domestic breeding (Figure 5), indicating a high level of breeding work with this oil crop, despite Russia's military aggression against our country. France holds the second position among countries of origin with a share of 31%, followed by Serbia at 9%. Switzerland and Romania are also among the top five countries of origin for sunflower varieties and hybrids, with shares of 8% and 3%, respectively.

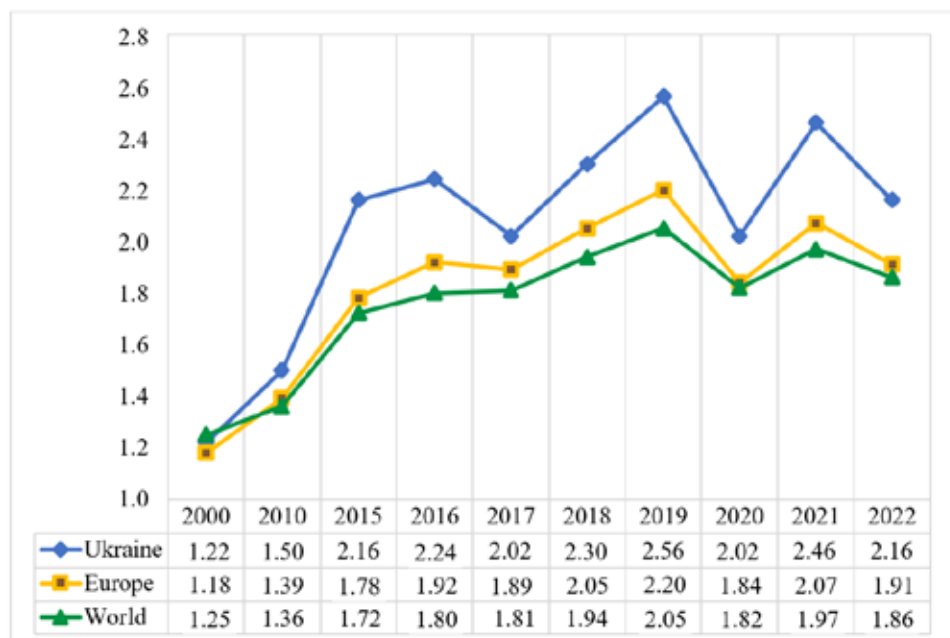


Fig. 3. Dynamics of sunflower yield in Ukraine, Europe and the world, t/ha
Source: FAOSTAT, 2023

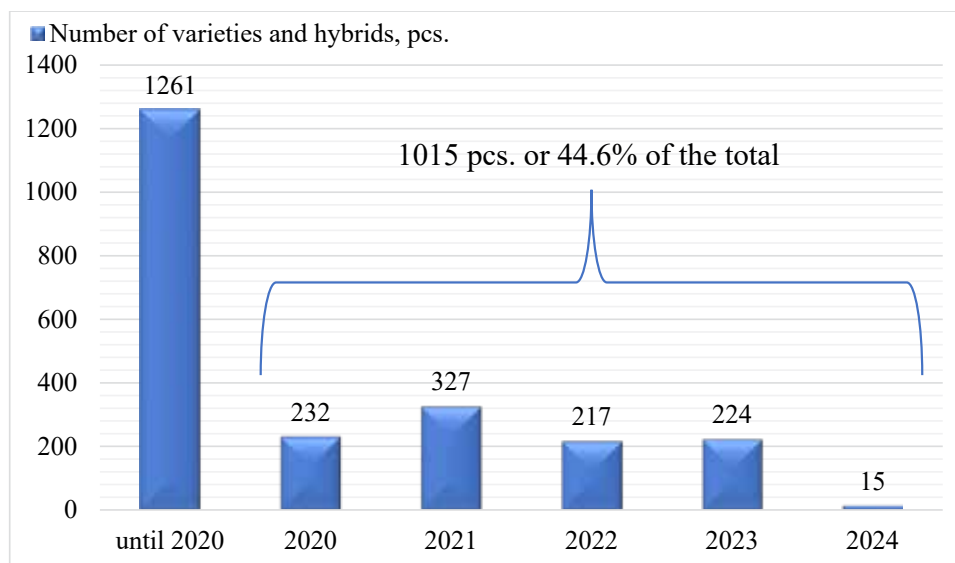


Fig. 4. Number of sunflower varieties and hybrids registered in Ukraine, pcs.
Source: State register of plant varieties suitable for distribution in Ukraine, 19.03.2024

Modern breeding work is primarily focused on creating high-oleic sunflower hybrids. The experience of French breeding in this direction is particularly interesting. Since the 1990s, France has gradually shifted towards high-oleic hybrids, with approximately 70% of all sunflower areas in the country being sown with these hybrids each year. France does not experience a shortage of high oleic planting material, supported by state payments to farmers, making the country a leading player in the international market for high-oleic sunflower [22].

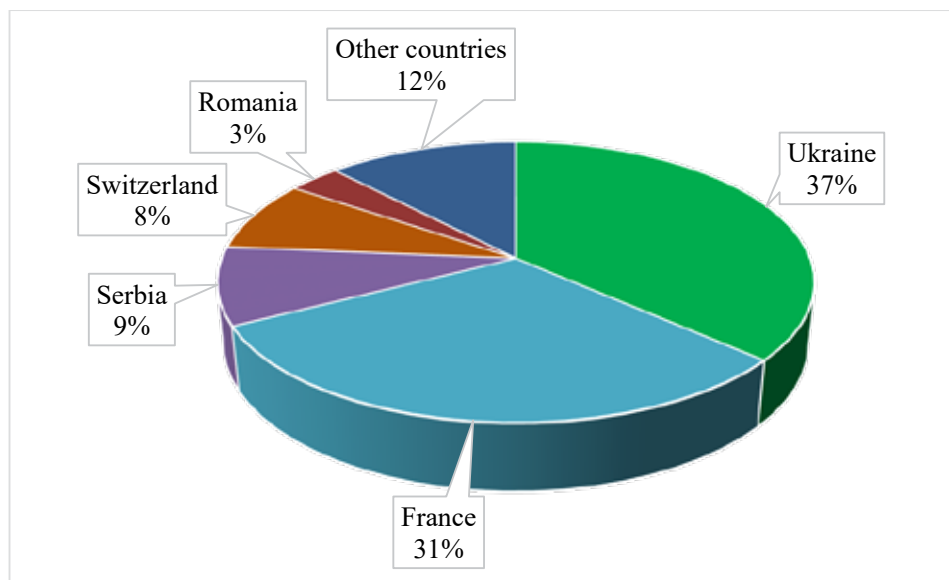


Fig. 5. Share of originating countries of sunflower varieties and hybrids included in the State Register of Ukraine, %

Source: State register of plant varieties suitable for distribution in Ukraine, 19.03.2024

In recent years, there has been a rapid increase in the cultivation area of high-oleic and sulfohybrid (HTS hybrids) sunflowers in Ukraine, capable of resisting new strains of sunflower broomrape (*Orobanche cumana* Wallr.). Cultivation technology, which depends on the choice of hybrid, plays an important role in increasing sunflower productivity. This can involve classical technology, SUMO technology (sulfohybrids resistant to sulfonylurea), and CLEARFIELD technology (hybrids resistant to imidazolinones) [23, 24].

Any technology should consider all factors affecting seed oil content. In addition to the genetic characteristics of the hybrid, sowing dates are crucial. Early sowing dates help extend the vegetative period and increase oil content in seeds. Drought during BBCH 71–BBCH 79 can negatively impact sunflower oil content. Seed quality is significantly influenced by fertilizer application rates. Each macroelement affects oil content differently. For example, nitrogen fertilization increases yield but may decrease oil content. Potassium fertilizers do not affect sunflower oil content, while phosphorus fertilizers have a positive impact on this indicator. Therefore, fertilizer application should be balanced and consider cultivation technology and soil-climatic conditions [25, 26].

The literal translation into English is: “In the production of sunflower oil, Ukraine is a leader in Europe and the world, as demonstrated by the data presented in Table 2. According to the forecasts of the US Department of Agriculture (USDA), despite active hostilities in our country, Ukraine will continue to be a leader in sunflower oil exports on the world market [27].

Table 2
Dynamics of sunflower oil production in Ukraine, Europe and the world

Year	Ukraine			Europe		World production, million tons
	million tons	% of world production	% of production in Europe	million tons	% of world production	
2000	0.973	10.0	19.0	5.134	52.6	9.763
2010	2.990	23.9	35.6	8.391	67.0	12.529
2015	3.716	24.4	33.9	10.963	72.1	15.208
2016	4.424	27.7	36.2	12.227	76.5	15.986
2017	5.277	29.1	38.1	13.846	76.3	18.141
2018	5.149	28.0	36.9	13.948	75.9	18.388
2019	5.836	29.1	37.9	15.392	76.8	20.053
2020	6.084	29.7	37.9	16.054	78.3	20.498
2021	4.929	26.7	35.1	14.053	76.0	18.495

Source: FAOSTAT, 2023

At the same time, there are certain problems in the sunflower industry in Ukraine. Primarily, they are related to the decline in fertilizer markets. Fertilizer prices are very high due to complex logistics and the inability to import them from abroad. Farmers have started to earn less, so they will cut costs on fertilizers, especially nitrogen. A similar situation can be expected with plant protection products. Ukrainian farmers have mostly started to refuse fungicide plant protection, although diseases are forecasted for the 2024 season that will pose the biggest threat to sunflower crops – white mould (*Sclerotinia sclerotiorum* de Bary.), downy mildew (*Plasmopara halstedii* Berl. & de Toni), and alternaria leaf spot (*Alternariaster helianthi*), which is a problem, especially considering the warm and wet winter. Therefore, it is crucial to plan a well-grounded strategy for fungicide protection [28]. Another problem in the sunflower industry is the issue with sunflower seed supplies to Ukraine. Therefore, a certain seed deficit should be expected.

Despite active hostilities and difficult times currently experienced by Ukraine, seed production volumes are forecasted by experts to remain at a fairly high level. Ukraine will continue to maintain strong positions both at the European and global levels.

Conclusions and suggestions. The sunflower sowing areas allocated in Ukraine, Europe, and the world are trending upward. Ukraine’s share of total sunflower sowing areas in Europe during the period 2000–2022 varied from 25.2% to 33.7%, and globally from 13.4% to 23.5%. Sunflower production in Europe during the study period tripled, while in Ukraine it increased 4.7 times, largely due to the growth in yield of this crop. Sunflower yield in Ukraine significantly exceeds the European and global levels. The use of modern high-yielding varieties and hybrids well adapted to specific soil-climatic

conditions plays a significant role in this. Ukrainian, French, and Serbian selection varieties and hybrids prevail in the State Register of Ukraine. In recent years, areas of high-oleic and sulfohybrid sunflower sowings have been rapidly increasing, SUMO and CLEARFIELD technologies are widely introduced into production. Ukraine remains a leader in Europe and the world in sunflower oil production, and according to USDA forecasts, will remain a leader in sunflower oil exports in the future. Despite certain problems in the sunflower industry, Ukraine will continue to maintain strong positions at both European and global levels.

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