

WAR INFLUENCE ON SUNFLOWER SEED AND OIL PRODUCTION IN UKRAINE

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Abstract. Sunflower is a high oil content seed and average yields can produce 600 pounds of oil per acre, considerably more than soybeans and some other oilseeds. There is a great deal of interest from EU market for construction of small processing facilities for sunflower biodiesel production. For more than 10 years Ukraine is known as the biggest producer of sunflower seeds worldwide. For now, sunflower seeds and oil are the most profitable branch of agricultural production in Ukraine, which has a steady demand from global farmers. Moreover, among the agrarian activities of oil crops, the segment of sunflower cultivation and processing suffered the biggest blow from military operations, since the sown areas under sunflower make up an average of 62% of the entire area of oil crops in Ukraine. The ecological consequences of hostilities for the environment are accompanied by significant destruction of natural ecosystems and environmental pollution. Each rocket or projectile explosion pollutes the air, water and soil with toxic substances. Many industrial facilities were attacked, resulting in uncontrolled emissions of pollutants. Military operations and related activities led to a significant number of violations of the natural environment and established forms of agricultural use of nature. The purpose of this study is to analyse in which way the cultivation of sunflower seeds and producing of sunflower seed oil has changed since the war in Ukraine started from February 24, 2022.

Keywords: sunflower seed, oil, crushing, biofuel, war.

Introduction

Ukraine produces a lot of grain and oilseeds which are further used for deep processing [1]. The sunflower seed and crude oil are among them. The functioning of the sunflower market is determined both by general market laws and regularities, and by its specific features during wartime. Sunflower seeds and oil are a high-calorie product that is widely used in various branches of the food industry and fuel production, and therefore the ecological status of sunflower cultivation is of great importance. According to the research bureau of the world market ISTA Mielke GmbH in Hamburg, in recent years the global consumption of oils and vegetable fats has increased by 4% every year [2]. According to FAO data published in 2014, it is expected that the demand for sunflower oil and its processing products will increase in the nearest future [3]. The increase in the production of oil crops for the last 12 years was about 3.5 million tons every year, the total consumption per season was 123.8 million tons on average, and according to forecasts, it will increase to 135-137 million tons by the end of the next decade. The reasons for the increase in consumption are the following: population growth, increase in the standard of living, and increase in the productivity of the global agricultural sector [4]. In the world production of edible vegetable oil, the first place belongs to soybean oil, the second - palm oil, the third - sunflower. A large role in the total production of edible vegetable oil is given to rapeseed, peanut, cotton, and olive oil.

Ukraine, Argentina, and Russia occupy leading positions in the ranking of world producers of sunflower seeds and oil. The specific weight of these countries in seed production is on average 47.8%, and in oil production – 53.6% [4; 5]. Ukraine has a leading position in sunflower exports, having mastered the markets of EU countries, the Middle East and North Africa.

Before the military events, sunflower cultivation increased annually, which is facilitated, first, by its high liquidity. Thus, in 2015, the average profitability of sunflower seed production in country was 80.3%. According to the structure of cultivated areas, sunflower occupies at least 15% of their total, which made it possible for Ukraine to produce a quarter of sunflower seeds in the world. Moreover, Ukraine is the largest producer of sunflower oil in the world, its share in global production is 23%. Ukraine's nationwide need for sunflower oil is only 10% of produced, the rest is exported, which requires serious quality control according to international standards and contract requirements. In Europe, sunflower oil ranks second in popularity after rapeseed and before soybean, occupying 23% of the market. So, EU is the main export market both for sunflower seed and oil for Ukraine [6].

It should be noted that a conflict between two major agricultural powers, war has various negative socioeconomic impacts that are now being felt internationally and might worsen, notably, for global food/feed/fuel security. If the war deepens, the food crisis will worsen, posing a challenge to many countries, especially those that rely on food imports. Simultaneously, the war came at a bad time for global food markets because food prices were already high due to disruptions in the supply chain caused by the COVID-19 pandemic, strong global demand, and poor harvests in some countries. Understanding how conflict-related disruptions in global food and fuel markets might affect the price and availability is critical for understanding the overall impact on global food security. Further, two years into the war, its implications for global security and safety suggest that this review is timely, urgent, and highly needed [7; 8].

Summarizing the above, it should be noted that the decreasing of land bank, the strengthening of soil degradation processes due to hostilities, problems with the production of safe food products require a detailed study of the impact of the war on the production volumes both seeds and oil. Therefore, the purpose of this study is to analyse the consequences of the war on the oil production complex in Ukraine and its dynamic in the nearest future.

Materials and methods

When conducting the research, analytical methods were used, as well as methods of causal analysis and logical generalization. Statistical data was analysed with ANOVA one factor method.

On the basis of identifying national features and factors of the food system, local and international approaches to assessing its sustainability, the conditions functioning and stability of the sunflower seed production in unstable macroeconomic environment, as well as the war influence on it was researched. The analysis of the production and yield of sunflower seeds and crude oil in Ukraine for the period from 2015 to 2023 was conducted. The comparative analysis of the gross harvest of sunflower seeds and the export of sunflower oil for the years under research was carried out. It was determined that the export of sunflower oil has increased over the years under research before the war started in 2022, which indicates a significant Ukraine's export potential. It was found that the increase in the share of exports by 15.9% was made possible by a qualitative change in yield, that was ensured by the changes in the cultivation technology and by the selection of sunflower hybrids that are better adapted to Ukrainian climate zones. The recommendations for further improvement of export and production in connection with war in the country in order to further increase yields and the export potential of Ukraine are provided.

Results and discussion

The oil and fat industry requires an appropriate level of supply of high-quality oil raw materials, which is especially relevant in the conditions of hostilities. In order to satisfy the demand for raw materials and stabilize the raw material base for oil and fat industry, it is necessary to approach the cultivation of sunflower seeds in a reasonable manner [9].

As for the beginning of 2022, Ukraine had 32 large enterprises and almost 1,000 small oil crushing operators. The oil and fat industry is characterized by a rather high concentration. In 2021, 6.936 million tons of unrefined sunflower oil were produced in Ukraine. This is stated in an official report from the association "Ukroliyprom" (oil-fat operators). Thus, the leader in the production of unrefined oil became the LLC "European Transport Stevedoring Company" ("Bunge"), which occupies 6.9% of the market. Optimusagrotrade LLC (Agrocosm, Zaporizhzhia OJK) was the second - 6.4%, and Vinnytsia OJK (Vioil) PJSC was the third. The TOP-10 producers of unrefined sunflower oil have 48.7% of the total market. At the same time, producers of refined sunflower oil produced 364.8 thousand tons of products in the season 2021-22, which is 9.1% more than the previous year. Dnipropetrovsk OEZ (Bunge) PJSC became the leader in this segment, which took 14.7% of the market. The second is "Delta-Vilmar CIS" LLC – 12.4%, the third – PrJSC "Poltava OEZ" ("Kernel") – 11.8%. The production volumes of sunflower oil in Ukraine are presented in Fig. 1.

Besides sunflower seed oil Ukraine has a significant export of corn for further processing of bioethanol and rapeseed for further processing of biodiesel. Compared with SF oil production the volumes of the mentioned products have also been decreased from 28.1 mln t to 21.7 mln t and from 4.9 to 4.2 mln t accordingly [10].

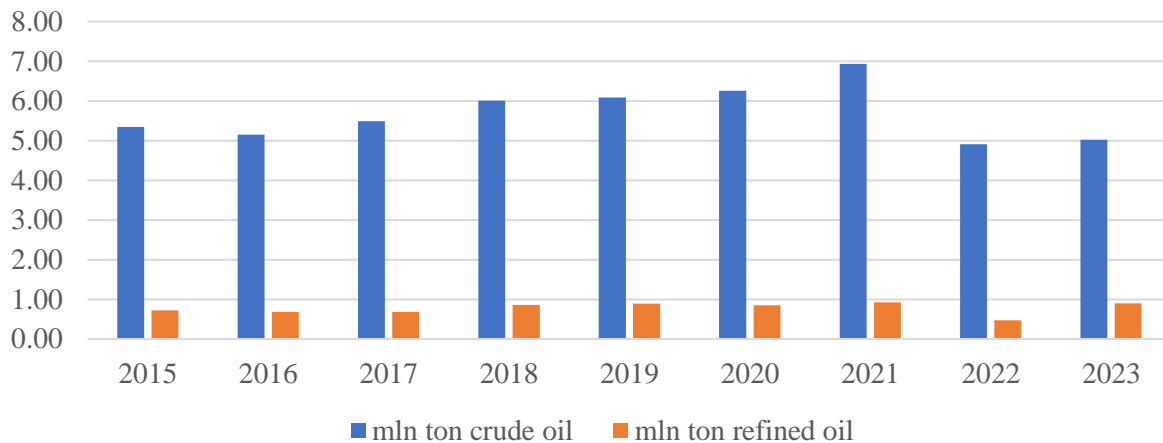


Fig. 1. **Production of sunflower oil: blue – unrefined sunflower oil and its fractions (except chemically modified), million tons; orange – refined sunflower oil and its fractions, million tons**

Since there is a constant steady demand for crude oil from the world market and within the country, oil producers compete mainly in the raw material market. As a rule, this is the area where production facilities are located and areas adjacent to it. The highest concentration of the industry is observed in Zaporizhzhia, Kirovohrad, Kharkiv, Dnipro, Kherson and Odesa regions [11]. Moreover, most of these areas are within the radius of hostilities and have been hit by artillery of varying degrees of severity. According to the data of the “Ekodiya” public association, as of November 10, 2022, 685 cases of potential damage to the environment were recorded on the territory of Ukraine. Most of them were recorded in the Dnipro (148), Kharkiv (103), Mykolaiv (82), Donetsk (58), Zaporizhzhya (57), Luhansk (47), Kyiv (37) and Sumy (36) regions. The main categories include: nuclear and energy safety, damage to industrial facilities, impact on the marine ecosystem, livestock waste, river and soil pollution, and other factors that have a catastrophic impact on the environment. It is also confirmed by other scientists dealing with the mentioned issues [12-14].

Table 1

State of sunflower cultivation in recent years, 2015-2023

Year	Cultivated area, thousand ha	Volume of production, thousand tons	Yield, tons from 1 ha of harvested area
2015	4962.0	110871.1	2.23
2016	5756.8	131905.5	2.29
2017	5779.6	119377.5	2.07
2018	5923.4	138827.1	2.34
2019	5756.9	149234.4	2.59
2020	6014.0	169876.0	2.82
2021	5999.6	175100.1	2.92
2022	4891.9	105889.7	2.17
2023	5421.3	141506.4	2.61
Average	5611.7	137635.2	2.49
LSD ₀₅	417.1	30122	0.25

Moreover, the common areas of sunflower spread mainly in the northern and central regions of the steppe zone. Its crops cover more than 4.0 million hectares, which is 64.7% of the area of all oil crops and 15.7% of the area of all agricultural crops. Somewhat smaller areas are planted with sunflowers in the forest-steppe and southern steppe zones, and completely insignificant - in Polissia and the foothills of the Carpathians. According to statistics, over the past decade in Ukraine, the area under sunflower has increased by 37% from 4.53 million hectares to 6.22 million hectares. In the world, in the last 10 years, the area under sunflower has increased by 3.97%, in 20 years – by 18.3%, and in 30 years – by 38.9%. The increase in cultivated areas under sunflower indicates a high level of its economic

attractiveness in the leading producing countries [15]. In Table 1 the trend of sunflower cultivation in Ukraine is shown.

2016 can be considered the beginning of an increase in sunflower production in the steppe zone: in Dnipropetrovsk up to 1.26 million tons, Zaporizhia – 0.99, Kirovohrad – 1.29, Mykolaiv – 1.16, Luhansk – 0.67, Odesa – 1.00, in Kherson – 0.61 million tons. Other regions, observing the growth of the profitability of this crop, began to cultivate it in the northern and western regions of Ukraine, where before its cultivation was restrained by climatic conditions, the absence of precocious and early-ripening hybrids, and the manifestation of diseases. Sunflower production in the forest-steppe zone increased significantly: in the Kharkiv region to 1.35 million tons, Poltava region - 0.82, Cherkasy region - 0.58, Vinnytsia region - 0.82, Sumy region - 0.49, Kyiv region - 0.45 million. t. It began to be grown even in some regions of the Polissia zone: 0.23 million tons of seeds were obtained in Zhytomyr, and 0.54 million tons in Chernihiv.

The sown areas and their share in the structure of sown areas by oblasts and zones of Ukraine for 2016 are presented in Table 2. The oblasts where agricultural lands have suffered significant damage from the fighting as of 2022 are highlighted in red.

The hostilities had a significant impact on both the sunflower acreage and sunflower oil production. Combat operations on the territory of Chernihiv, Sumy, Kharkiv, Kherson, Mykolaiv, Dnipropetrovsk, Zaporizhzhia, Donetsk, Luhansk, and Kyiv regions already have serious environmental consequences today. Experts from the Ukrainian nature protection group conducted an analysis where they noted that artillery bombardment of fields leads to the destruction of unique fertile lands, the restoration of which will take years. Comparing with the experience of restoring agricultural land, for example, after the First World War, we can talk about decades. The destruction of fertile lands in the south and east of Ukraine creates not only food security problems, but also poses a threat to steppe and forest conservation areas. After all, it is necessary to sow somewhere so that people can live. Land that was not used before can be transferred to agricultural use. And these can be territories of nature reserves, sanctuaries and national parks. Military actions led to burning of 100 thousand hectares of forests and steppes of Ukraine. Moreover, this is the number that the Ukrainian nature protection group calls based on the results of four months. Taking into account the active fires on the Kinburn spit and in the Kherson region, the burned area has most likely increased significantly.

Significant fires occurred in the south and east of Ukraine, which is marked on the map in Fig. 2. In addition to agricultural fields, unique nature conservation areas were damaged and may not be able to be restored.

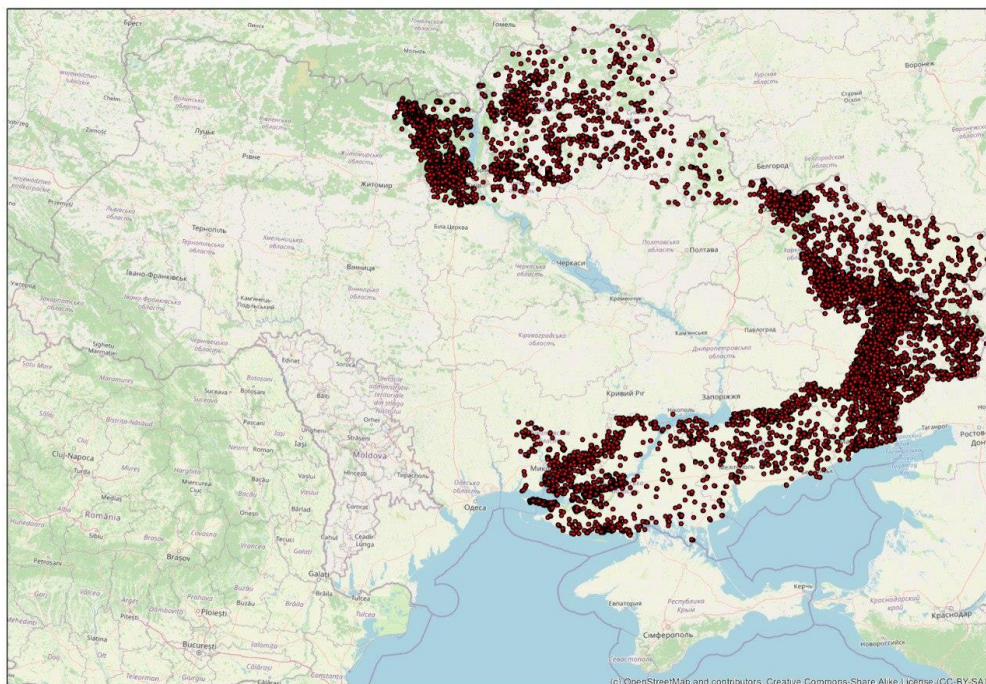


Fig. 2. Approximate map of fire sources

If you look at the map, you can see that there have always been fires where hostilities took place. Whether it is the east, south or north of the country. Unfortunately, even in those places where hostilities no longer exist, the probability of fires caused by military operations remains high. Many territories are still mined, and it may take years and decades to clear them of the consequences of hostilities.

Therefore, in connection with intensive military operations during the war, the number of fires caused by shelling, bombing, and mining increased in a significant part of the territory of Ukraine. In conditions of limited access to fires, especially in the war zone, the most accurate and reliable fire monitoring tool is the satellite remote observation method. The number of fires, fire start and end times, fire boundary detail, area and land category for each fire, and other data used to estimate fires were obtained from open information systems – the US Fire Information for Resource Management System – FIRMS) and the European Forest Fire Information System (EFFIS). The consequences of the fires and explosions are summarized in Fig. 2.

The bodies of the State Inspectorate calculated the quantitative indicator of the damage caused by the war on the territory of Ukraine in eight months. Thus, more than 180,000 m² of soil is contaminated with dangerous substances; more than 2.3 million m² of land is littered with the remains of destroyed objects and ammunition; 680 tons of petroleum products burned during the shelling, polluting the air with dangerous substances; 23 thousand hectares of forests were burned as a result of shelling; more than 7 million m² of infrastructure objects destroyed, including critical ones, the remains of which caused damage to the environment. This is far from a complete list of damages caused to the environment. The scale of military operations in Ukrainian territories leads to the fact that nature does not have time to restore itself and compensate for the destructive consequences of war, which makes it impossible to conduct agriculture in polluted territories.

Conclusions

In accordance with data analysed the overall decrease of sunflower oil production was 17,2-19,8% compared to years prior the war, the same can be conclude for the sowing area and crop yield which were decreased significantly since 2021. If the situation will not change, the further decrease can also be predicted. The most crucial thing from is that the war is not ended yet and no one can predict with what result it will happen.

Accordingly, the Russia–Ukraine war’s direct and indirect impact on sunflower seed and oil market was investigated. The paper highlights that the war resulted in immediate and far-reaching cascading consequences on, e.g.: Ukrainian crush and exports have firstly stopped and then reduced, part of sowing areas polluted, destroyed or occupied, access to seedling material, plant protection products and fertilizers restricted, and future harvests are uncertain. Firstly, Ukraine’s export capacity has been hampered. Secondly, some production facilities are destroyed or occupied. Thirdly one quarter of the sowing area is poisoned with mines and bombs or occupied. Finally, the war may jeopardize the implementation of the Sustainable Development Goals (SDGs), notably SDG 1 (No poverty), SDG 2 (Zero hunger), and DG 12 (Responsible consumption and production).

Author contributions:

Petrenko V. – methodology and manuscript preparation, Naumenko O. – statistical data and review, Nechai O. – investigation and visualization, Bondar V.– project administration.

All authors have read and agreed to the published version of the manuscript.

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