

REVIEW

Maintaining continuity in the fruit growing sector in the context of the war in Ukraine

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Abstract

This study assesses the impact of ongoing Russian full-scale aggression in Ukraine, which started on 24 February 2022, on the fruit growing sector by examining damages, losses, and the broader consequences for the industry. The methodology of the research includes the analysis of open access reports and publications of specialized state and international institutions and expert and analytical reviews. Various aspects observed as the impacts of war actions, including the destruction of orchards, agricultural machinery, and storage facilities, are described. Indirect effects, such as market destabilization, increased production costs, and disruptions in export routes, were also explored. The study delves into the challenges faced by farmers, from shortages in labor to the decrease in the production of certified planting material. Despite these adverse factors, the Ukrainian fruit growing sector exhibits resilience and adaptability. The study also discusses ongoing recovery efforts, state grant programs, and international collaborations that offer prospects for growth, emphasizing the potential for recovery and adaptation amid the ongoing conflict.

Keywords: horticulture, war impact, damages, losses, recovery

Introduction

Ukraine is located in the south-eastern part of Europe with the majority of its agricultural land being situated in a temperate climate zone. Favorable climatic conditions and unique soil characteristics make Ukraine suitable for growing more than 50 species of fruit, berries, nut crops, and grapes. Nevertheless, in 2021, these crops only occupied approximately 250 thousand hectares, which is a small share of the total area of agricultural land, c.41.4 million hectares (The State Statistics Service of Ukraine, 2023a). However, the past two decades have seen the growth and development of the Ukrainian fruit growing industry directed toward domestic and export markets. Furthermore, during this time, Ukrainian horticulture has been moving away from the traditionally extensive methods to intensive growing technologies, involving modern cultivars, a high density of planting, and environmentally friendly plant protection schemes. The innovations have also included special garden constructions, tunnels, greenhouses, the automation of plant control, etc. Though the area occupied by orchards and grape plantations decreased between 2000 and 2015, the situation would stabilize over the next 5 years, the average yield per hectare increasing at least twice during this period (Kernasyuk, 2020). The intensification and increased efficiency of production processes compensated well for the decreased growing area. This was also

supported by the fact that the consumption of fruits and berries doubled during these years.

Review methodology

The main objective of this review was to evaluate the impact of ongoing war on the development of the fruit growing sector in Ukraine. Attention was given to the challenges and future prospects that may influence farms producing fruit and berry crops.

The review is based on an analysis of reports, official publications, and data made freely available by the Food and Agricultural Organisation (FAO), the State Statistics Service of Ukraine, the Ministry of Agrarian Policy and Food of Ukraine (n.d.), the National Bank of Ukraine, and Kyiv School of Economics (KSE). Statistical and other data presented in the study are the latest available at the time of writing (November 2023). Additionally, the authors used open access expert and analytical publications. Finally, we looked into published interviews with experts in the field and officials. This approach led to a greater understanding of the situation and the ongoing processes. Topic-oriented keywords (e.g. horticulture, war damage, losses due to war, etc.) were used to search for the relevant information.

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The personal experience of the authors and direct communication with farmers were useful when compiling information and integrating it into a global overview of the impact of the war on the fruit growing sector in Ukraine and ways of maintaining its continuity.

Damage to the fruit growing industry

Russia's full-scale invasion of Ukraine has not only taken many lives but has also severely affected the economy and infrastructure, with the agricultural sector being particularly affected. After 1 year and 6 months of ongoing war, the agricultural sector is at the end of the second growing season under such exhausting conditions. The damages and losses suffered by the agricultural sector in Ukraine continue to mount. Recent research by the Kyiv School of Economics estimates the harm caused to Ukrainian agriculture during the first year of the war at US\$40.2 billion (KSE, 2023). This number incorporates both direct damage and indirect losses.

The fruit growing sector appears to be especially vulnerable to the negative impacts of war. Production areas were lost as a consequence of occupation or the destruction of orchards. Once destroyed, these are very costly to replace as this requires large initial investments into plant material, irrigation and trellis systems, and netting protection. In addition, the destruction of agricultural machinery, equipment, storage and production facilities, and stolen or destroyed production resources and commodities add to the direct damages to the industry.

According to the State Statistics Service of Ukraine, a decrease (c.1–2% per year) in areas used for fruit crops was observed over the last decade, with 2018 being an exception (Fig. 1) (The State Statistics Service of Ukraine, 2023b). This decrease was mainly associated with the uprooting of old orchards which produced low or no profit. During the first year of the war, the area of fruit production sharply decreased by c.12%, from 253.6 thousand hectares in 2021 to 223.6 thousand hectares by the end of 2022. A similar situation occurred in 2013–2014 after the Russian annexation of the Autonomous Republic of Crimea and partial occupation of the Donetsk and Lugansk regions of Ukraine. More than 40 thousand hectares were lost in 2014 and c.30 thousand hectares in 2022 due to the occupation of territories and active hostilities. Even after territories have been liberated, time and money are needed for demining and restoration.

As a result of the occupation, the entire area used for fruit crops in the Kherson region (encompassing c.8.5 thousand hectares) became inaccessible for cultivation. In the Donetsk, nearly 4.4 thousand hectares (60% of the fruit growing area in this region) and 4.1 thousand hectares (45% of the fruit growing area) in the

Zaporizhzhia region were also lost (Fig. 2). In total, all regions of Ukraine saw a reduction of orchards, either as a result of the direct impact of war or for economic reasons.

Apple production, the most economically important and popular fruit industry in Ukraine, suffered the highest decrease in area and the highest losses. The area of apple plantations prior to the full-scale invasion was 93.7 thousand hectares or almost 40% of the total area for fruit and berry crops. Most of the apple plantations are concentrated in central and western parts of Ukraine, mainly in the Vinnytsia, Khmelnytskyi, Chernivtsi, Zakarpattia, and Lviv regions, which did not face any direct warfare. Nevertheless, the area decreases in these regions added to the decrease in the regions affected by battles and occupation. In total, 9.2 thousand hectares were lost, about 9.8% of the total apple acreage (Fig. 3).

Unlike the apple industry, the sweet cherry industry is concentrated mainly in the south and south-eastern parts of the country. Thus, the biggest sweet cherry orchards are situated in the Zaporizhzhia region, particularly around Melitopol city, which was occupied in the first days of the war. Almost 4 of the 12 thousand hectares of sweet cherry orchards (c.33% of the sweet cherry area) are under occupation. In 2022, Melitopol occupation authorities, with the support of Russian troops, forced large farms to hand over their entire yield of cherries under unclear payment conditions. Also, the facilities of cherry producers were often taken over by the occupiers. Consequently, the turnover of the Melitopol cherry cluster, which was estimated at \$25–35 million per year, has been removed from the Ukrainian fruit market (Ulyanytskyi, 2022).

Viticulture was also significantly affected by the war. Viticulture is an important commodity in the Kherson, Mykolaiv, and Odesa regions. According to official statistics, the area of vineyards decreased by at least 6 thousand hectares, c.17.5% of the area in 2021.

The greatest damages in agriculture were caused to agricultural machinery and special equipment, which were partially or totally destroyed. This damage accounts for \$4.7 billion based on the first year's estimations. The most valuable machinery that was damaged, when assessed in terms of monetary worth, were tractors. It is estimated that over 17% of all agricultural machinery and equipment in Ukraine are no longer functional, compared to 2019 (KSE, 2023).

In addition, many premises intended for the parking of agricultural machinery, and the storage of production equipment, planting material, and various postharvest production processes, etc., were also affected or totally destroyed.

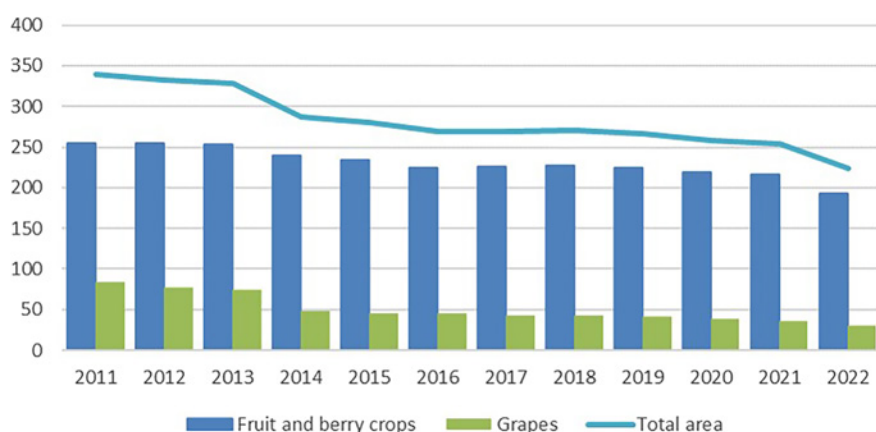


Fig. 1. Dynamics of the area (thousand hectares) of perennial horticultural crops in Ukraine, 2012–2022 (Data source: The State Statistics Service of Ukraine, 2023a).

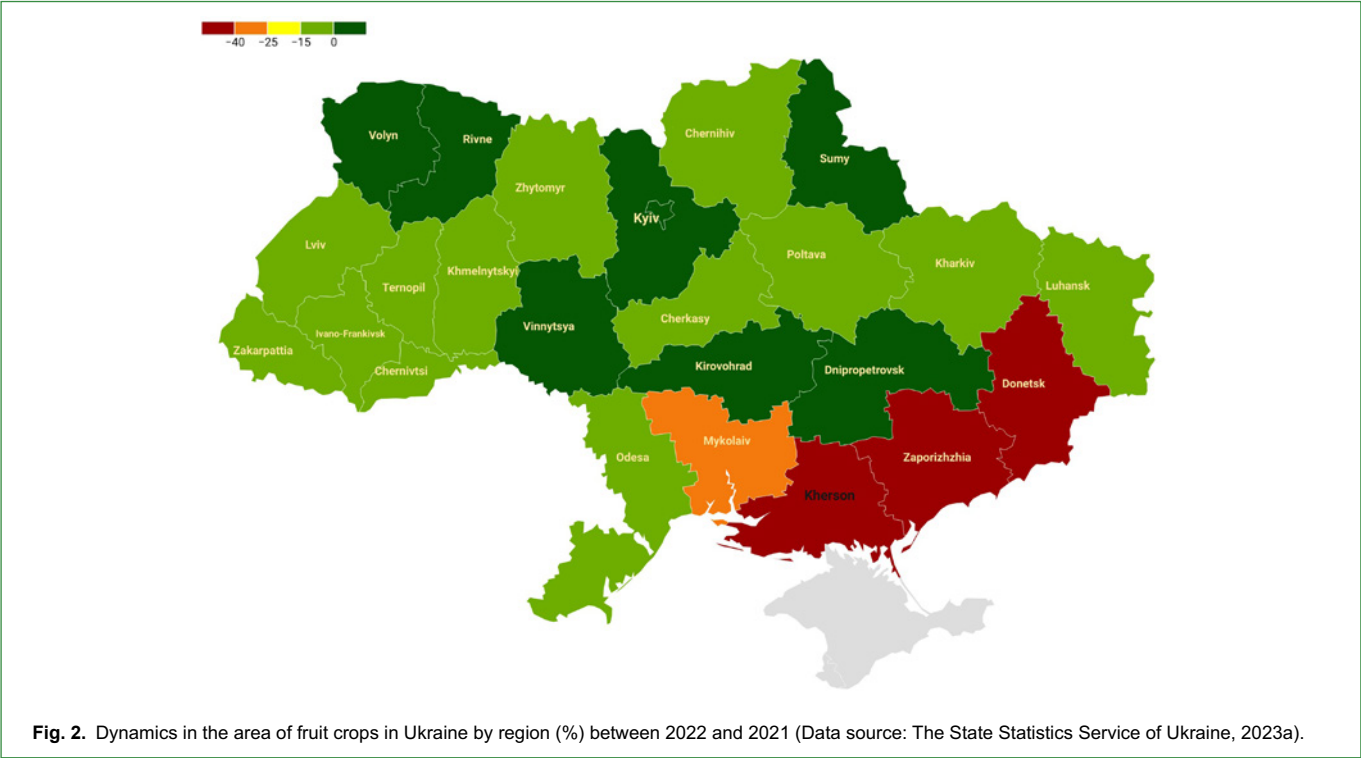


Fig. 2. Dynamics in the area of fruit crops in Ukraine by region (%) between 2022 and 2021 (Data source: The State Statistics Service of Ukraine, 2023a).

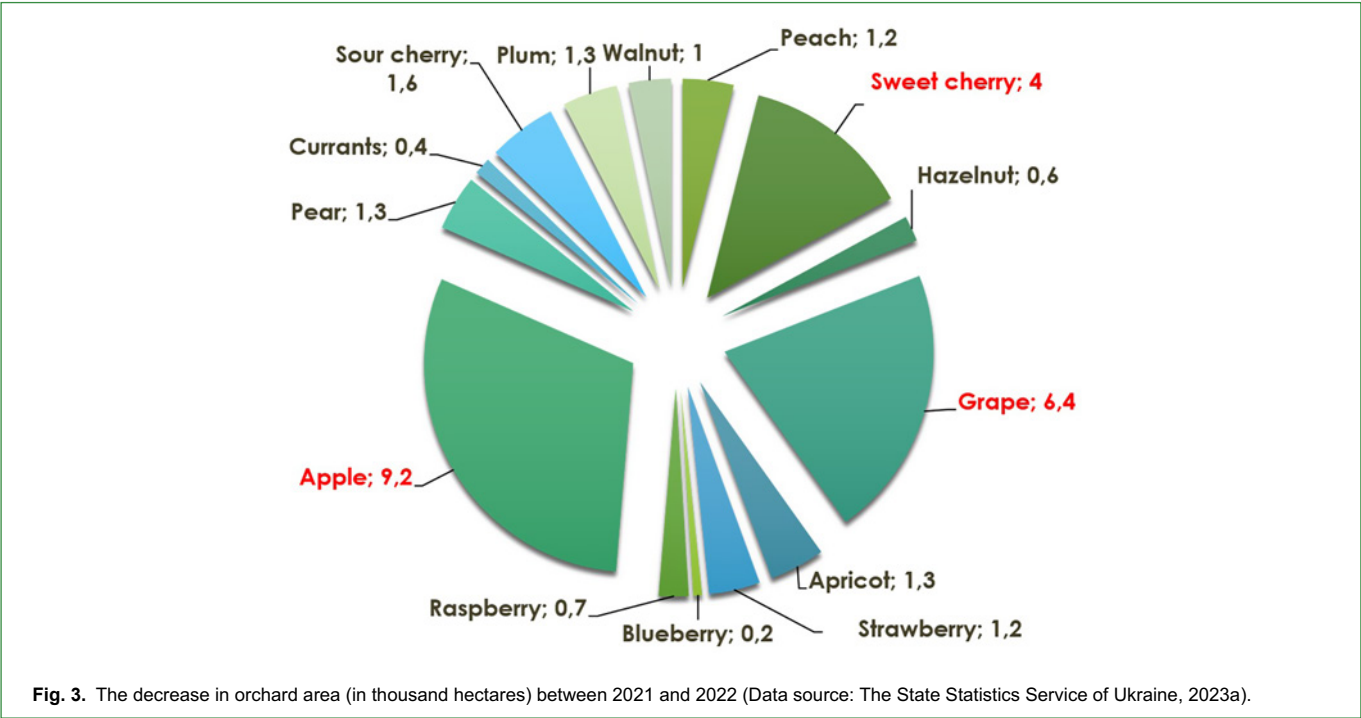


Fig. 3. The decrease in orchard area (in thousand hectares) between 2021 and 2022 (Data source: The State Statistics Service of Ukraine, 2023a).

Damage assessment and compensation

To make the sector viable in the future, farmers need financial support to sustain and restore their business. The issues of compensation are regulated by the *Resolution of the Cabinet of Ministers based on a procedure for determining the harm and damage caused to Ukraine as the result of the armed aggression of the Russian Federation* (Mudra, 2023; Cabinet of Ministers of Ukraine, 2022). The document was published less than a month after the start of the full-scale invasion. Another key document is the *Methodology for determining the harm and the amount of damage caused as a result of the armed aggression of the Russian*

Federation (Ministry of Economy of Ukraine, 2022). It was issued in December 2022 and describes in detail the procedures and damage assessment formulas for enterprises and organizations of all forms of ownership. Several state and/or internationally supported platforms, such as *Diia*, the *Interactive map of the Ukrainian agricultural sector destruction*, and *Damaged in Ua* (Ministry of Digital Transformation of Ukraine, n.d.; Interactive Map of the Ukrainian Agricultural Sector Destructions, n.d.; Damaged in UA, n.d.), have been established to collect information on the scale of destruction and damage. They help farmers to provide responsible authorities with documents,

photos, and video evidence of the damage caused. The portal for the *Interactive map of the Ukrainian agricultural sector destruction* was created to show the extent of damage caused by Russia's armed aggression and to help agricultural producers to record war crimes committed against their enterprises. Another team conducts analyses using images captured through specialized surveys of settlement damage conducted by drones, along with satellite data. This approach enables the precise determination of the extent of damage to buildings and infrastructure in cities and towns across Ukraine, leading to the generation of highly accurate damage assessment data. This valuable information will subsequently be utilized by the government, local authorities, and donors to enhance their strategies for national recovery. The Satellite Data section of *Damaged in UA* represents a distinct business intelligence module designed to visualize this information, presenting damage data categorized by region, type of damage, and specific facilities within different sectors.

Overall, it will take a lot of time, money, and effort to repair or completely replace agricultural machinery and facilities at least to the baseline level.

The indirect effect of war on the fruit growing sector

In addition to direct damage, Russia's invasion of Ukraine has had indirect effects on the entire agricultural sector. These secondary effects, as estimated by the Kyiv School of Economy, have led to losses of around \$31.5 billion within the first year of the conflict (KSE, 2023). These losses include the revenue that could not be generated because of reduced agricultural output and the extra expenses incurred by producers as a result of the war. The main reasons for these additional costs are the reduced production of fruit crops and increased production expenses due to higher prices for fertilizers, plant protection products, and fuel. Furthermore, additional costs are created by the cancellation of seasonal lending and instalment payments, labor shortages, decreased revenues for producers due to disruptions in logistics, and unstable market conditions.

Considering the amount of occupied farmland and the above-mentioned effects, losses in fruit crop production are estimated at \$429 million after 1 year of the war (KSE, 2023).

According to official statistics, the yield of fruits, berries, nuts, and grapes in Ukraine amounted to 2253 thousand tons in 2022, 10% less than in 2021. However, in 2022, 1129 thousand tons of apples, 146 thousand tons of pears, 180 thousand tons of sweet cherries, 169 thousand tons of plums, 58 thousand tons of sour cherries, and 50 thousand tons of apricots were produced. Berry production equalled 123 thousand tons, nuts 108 thousand tons, and grapes 258 thousand tons. Despite Russian military aggression, ongoing hostilities, and missile attacks on energy and transport infrastructure, Ukrainian farmers continued to supply consumers with their products. Favorable weather conditions and reserves of inputs bought in advance in 2021 partly compensated for the negative impact of the war (Ukrainian Fruits, 2023).

Farmers who continued, and still continue, their work face an extreme growth in production costs. According to the National Bank of Ukraine, consumer prices increased by 26.6% in 2022 and a further 7.1% as of June 2023 (Inflation Report, 2023a, b). The pressure of inflation increased production and logistic costs, as well as causing a limited availability of goods and services as the result of extensive destruction, damage, and disruptions in production and supply chains. These processes were compounded by the depletion of primary commodities, materials, and equipment, along with limited replenishment capabilities. Additionally, toward winter 2022–2023, a crisis in the energy sector had a noticeable impact on the cost structure of most goods and services. For example, for some fertilizers, the prices more than doubled. Furthermore, the fertilizer market in Ukraine experienced a decrease of around

40–55%, with the volume falling from 4.75 million tons to 2–2.9 million tons by the end of 2022 (Arestarkhov, 2022). The production season of 2022 relied on old stock available in storage, and the market reached its lowest point in the early summer of 2022, followed by a subsequent recovery of domestic production (The Mineral Fertilizers, 2023).

A similar situation was observed with plant protection products. An increase in product's compound costs began in 2021, and with the onset of the war, the situation further deteriorated. Comparing plant protection product prices from 2021 with those in 2023 revealed a cost increase of 30–60%. The overall decline in the market in 2022 ranged between 15 and 25% according to various estimates, with a forecast of an additional 20% decline for 2023 (The PPP Market, 2022; Borysov, 2023). Due to the increased costs of original products, there has been a trend toward the use of generic plant protection products.

The situation was aggravated by limited fuel availability, which was particularly critical at the beginning of the conflict. Immediately after the start of the armed aggression, Ukraine stopped the import of fuel from Russia and Belarus, which constituted approximately 50% of the market. Missile attacks significantly damaged the main oil refinery in Kremenchuk, and a considerable number of oil depots across Ukraine were destroyed or damaged. Later, the government managed to address the situation by arranging for supplies from other countries and ensuring fuel needs were met. Thanks to these measures, the shortage was eliminated, but prices have risen by 60% and continue to gradually increase (Fuel Prices by Years, n.d.).

Producers incurred additional expenses to sustain their operations during the continuous blackouts in the fall and winter of 2022–2023 due to Russia's extensive attacks on Ukraine's energy sector. They had to invest in electric generators and fuel to ensure the uninterrupted functioning of their equipment. Despite these efforts, operators of energy-intensive enterprises, like refrigerating and freezing sectors, faced and still face risks.

Due to the destabilization of the market, seasonal crediting and instalment payments were canceled by suppliers for fertilizers and plant protection products; only full payment was accepted in 2022. However, 2023 was marked by a gradual recovery and stabilization of the market; product suppliers seemed to become more adapted to operating under the terms of martial law and offered producers acceptable terms of cooperation. Many farmers changed their product suppliers from international companies to domestic ones which offered lower prices due to the localization of production facilities in Ukraine.

The next challenge for farmers is the shortage of labor. Approximately 6.2 million people moved abroad as refugees (Inflation Report, 2023b), around one million men have been mobilized to the Ukrainian army, three million people are residents in occupied territories, and there are also a large number of internally displaced persons (IDP) in Ukraine. In all, Ukraine has lost over 30% of its working-age population since the beginning of the war (Miroshnychenko, 2023). As a result, farmers met with a shortage or total absence of workers, including tractor drivers, operators of other machines, hydraulic engineers, seasonal workers, and others.

The fruit and berry market also experienced a significant negative impact from the war for the above-mentioned reasons. At the beginning of 2022, Belarus played a significant role in the export of fruit. This export was stopped with the onset of Russian aggression, as Russian troops attacked Ukraine from the territory of Belarus. Inflation and income instability led to a reduction in the purchasing power of domestic consumers. Additionally, the number of consumers decreased due to population migration, with a significant portion being women and children, who are normally the major consumers of fruits and berries. The fuel crisis, the disruption of traditional logistic routes, and the distribution centers of retail networks further exacerbated the situation. The occupation of the Kherson and Zaporizhzhia regions, which typically supplied

early-season fruit and berry products to the market, led to an increase in fruit and berry imports. Consequently, prices saw a significant increase compared to the 2021 season (A year of losses and hopes, 2022).

Despite all the challenges, apple exports resumed as early as April 2022. The United Arab Emirates and Saudi Arabia became the main importers of Ukrainian apples. Sweden, Turkey, Uzbekistan, Iraq, and France are also important for the export structure (Fig. 4).

2022 was also favorable for blueberry growers. The volume of export was the greatest on record, increasing to 3.0 thousand tons. The main consumers of Ukrainian blueberries were Poland, the Netherlands, the United Kingdom, and Moldova. Thus, even in the conditions of war, at the end of 2022, the market was 85% of the value of the previous year, and the value of the export of apples and berries even increased.

However, in the first 9 months of 2023, export income for fruit and berry products decreased by 30% to \$167 million. The top-selling categories were frozen fruits (\$98 million), walnuts (\$37 million), berries (\$17 million), and pome fruits (\$10 million). In terms of quantity, frozen fruits remained stable at 64 thousand tons, walnuts increased by 6% to around 15 thousand tons, and berries experienced a notable 20% rise to almost 5 thousand tons. However, there was a decline in the export of apples and pears, amounting to 27 thousand tons, 23% less than the same period in 2022 (Agro-Food Exports of Ukraine, 2023).

In addition to the mentioned above, there are likely to be numerous delayed effects which are not yet obvious.

Thus, the well-established research in many fields has been on hold or interrupted. In particular, the Institute of Horticulture of NAAS of Ukraine has a network of seven research stations located in different regions of the country, two of which, Melitopol Research Station and Bakhmut Research Station, stopped work. The Melitopol Research Station is currently under occupation. Its premises were seized by the occupation authorities; most of the scientists left, and those who stayed have no opportunity to continue their work. This station had a successful breeding program for stone fruit crops, especially sweet and sour cherries. The station's germplasm collections included 838 accessions, including 199 apple accessions, 109 pear accessions,

123 sweet cherry accessions, 114 sour cherry accessions, 157 apricot accessions, and 136 peach accessions. The accessions of the germplasm collections represented the Ukrainian and foreign gene pool from at least 35 countries.

The situation at the Bakhmut Research Station is even worse as fierce fighting continues there even today. The premises of the station have been destroyed and cannot be restored. Research plots and orchards were significantly damaged as a result of active hostilities. This institution maintained the germplasm collection for the National Bank of Plant Genetic Resources of Ukraine for cherries, which included 280 accessions. Furthermore, this station housed 426 accessions of niche crops, such as barberries – 39, sea buckthorn – 12, mulberries – 10, chaenomeles – 40, hawthorn – 32, rowan – 19, rose hip – 6, medlar – 9, and others.

Despite the partial overlap between different genetic collections in the country, it is likely that some genotypes were lost and will need to be restored from private collections or imported from abroad.

The activities of phytosanitary institutions coordinating the monitoring of diseases and pests have also been affected (Forecast of Phytosanitary Condition, n.d.; During the War, 2022). These institutions face difficulties in the implementation of the monitoring programs, both due to hostilities in certain territories and economic reasons. It is important to point out that increased production costs have forced farmers to revise spraying and fertilization schemes. Such savings may, in the long run, lead to the development and spread of pests and diseases which, in turn, will negatively affect the yield and quality of fruit and berries.

Another highly important consequence, which is already visible, is the decrease in the production of certified planting material. In Ukraine, as in many other European countries, planting material certification schemes operate according to the standards of the European Plant Protection Organization (EPPO). Therefore, to ensure a high quality of planting material, nurseries conduct additional checks to ensure the absence of harmful pathogens and pests according to certification schemes. In 2022, a sharp drop in the number of registered nurseries was observed, from 62 in 2021 to only 25 in 2022. At the same time, the production of certified planting material decreased more than four times and was totally terminated in some regions (Fig. 5). Such a reduction in production

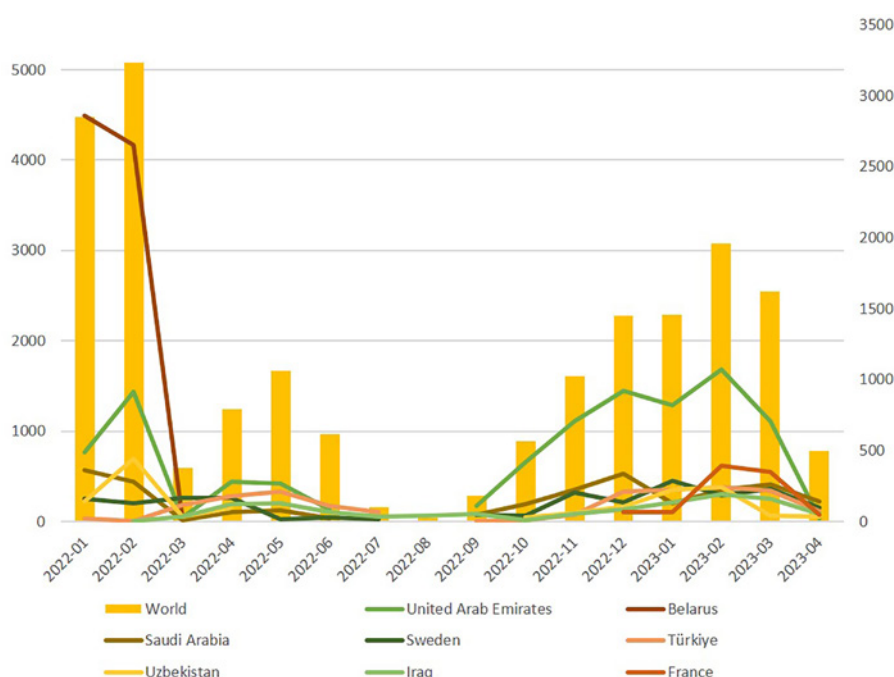


Fig. 4. The structure of apple exports from Ukraine in 2022–2023 (thousand USD) (Data source: International Trade Centre, 2023).

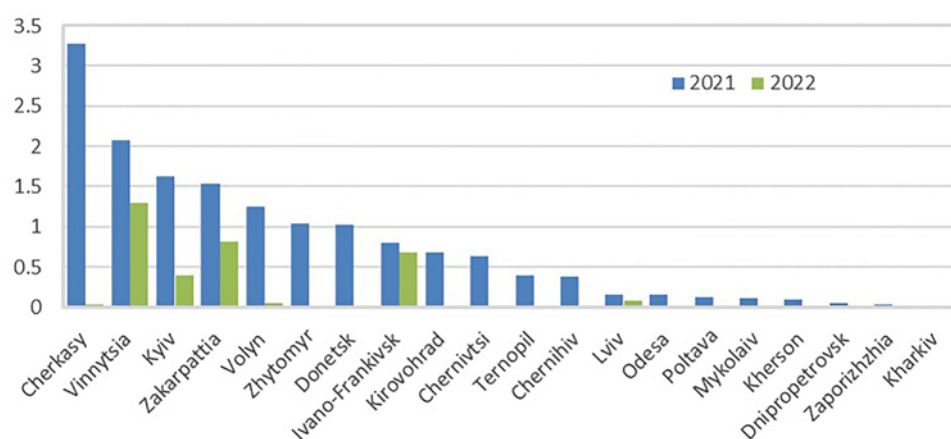


Fig. 5. The production of certified planting material of fruit crops by region in Ukraine between 2021 and 2022 (in million plants) (Data source: Ministry of Agrarian Policy and Food of Ukraine, 2023).

was expected as some of the nurseries are located in temporarily occupied territories or in war zones. Due to uncertainty about the future, producers have avoided the risk of investing in plantations, leading to a decrease in demand. Furthermore, the certification procedure itself requires additional investments for nurseries. At the same time, the import of planting material has also significantly decreased.

Future prospects and opportunities

Despite the significant negative impact of the ongoing war, Ukrainian fruit production continues to function and explore new opportunities for development and growth. In particular, several positive examples are highlighted below.

As an instrument to support the industry, the state grant program for the development of fruit, berries, grapevine orchards, and greenhouses was launched. Since the beginning of the program, 134 applications have been approved, with a total budget of almost \$16 million for plantations covering an area of 1949 ha (Ministry of Agrarian Policy and Food of Ukraine, 2023). Amendments to the law were also adopted to simplify the registration of agricultural machinery and trucks.

After the disruption of logistic routes and the closure of certain export routes, Ukrainian farmers are looking for opportunities to expand exports to European countries and the Middle East.

In 2022, farmers continued planting new orchards for fruit, berries, and nut crops. Despite a decrease in new plantings, a total of 1170 ha of orchards were established.

Some farms, in search of new profitable niches, expanded their assortment of crops and started growing vegetables like tomatoes, onions, pepper, and eggplant. Some companies from the war-affected regions managed to relocate part of their machinery and equipment to western regions of Ukraine, where they launched new enterprises.

Many industry specialists, including both producers and scientists, who were forced to leave Ukraine are currently active in production and research in Europe and other countries in the world, and will hopefully be able to return with new experience, ideas, and vision for the recovery of the industry.

Conclusion

The ongoing war in Ukraine, initiated by Russia, has significantly impacted the fruit growing sector. The conflict has resulted in damage and losses, including the occupation or destruction

of orchards, the destruction of agricultural machinery, storage facilities, and production resources. The conflict destabilized the market, causing price fluctuations, the cancelation of seasonal crediting, and disruptions in export routes, affecting overall production costs. The shortage of labor, with millions of people displaced or mobilized for military service, has presented a challenge to the continuation of horticultural activities. The war has also disrupted the work of research and phytosanitary institutions, impacting the monitoring of phytopathogens and the production of certified planting material. State grant programs, amendments to laws, and international collaboration showcase efforts to support recovery and growth, with the sector displaying resilience through successful export ventures and diversification. The challenges ahead include extensive repairs, the replacement of damaged tangibles, and addressing the long-term consequences of changes in the industry.

Although Ukrainian fruit production faces significant challenges from the war, it has demonstrated adaptability and resilience, with recovery depending on effective rebuilding and adaptation to evolving circumstances.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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