Global Production of Maize and Ukraine's Export Capabilities During Times of War

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Global Production of Maize and Ukraine's Export Capabilities During Times of War

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Abstract.

Maize, as a grain crop, continues to maintain its leading position in the global agri-food market due to its versatile uses. It serves as a staple food for many people worldwide, a highly nutritious animal feed for livestock and poultry, and a raw material for bioethanol production. Ukraine, blessed with favorable soil and climatic conditions, has been a significant exporter of maize to the world market and held the sixth position among leading countries until 2022. However, the large-scale invasion of Ukraine by Russia has had adverse effects on all sectors of the economy, including agriculture. The occupation of territory, landmines, and other factors have resulted in a reduction of maize cultivation areas, negatively impacting Ukraine's export capabilities and potentially posing risks to global food security.

Key Words : *Maize, Food security, Global maize production, War in Ukraine, Grain yield.*

Wheat, maize (corn), and rice are among the three major cereal crops grown worldwide. These crops play a crucial role in ensuring food security for the con-

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stantly growing global population. On average, during the period from 2016 to 2018, these crops constituted the primary staple of the human diet, providing approximately 42% of the world's caloric intake and 37% of consumed protein [1, 2].

Compared to wheat and rice, maize is a more versatile multi-purpose crop. Apart from its use as a food source, it serves as animal feed in livestock farming, an energy crop, and a raw material for various industries. With the increase in energy prices, there has been a growing interest in using maize grains as the most cost-effective material for bioethanol production [2].

The rising demand for maize grains has led to a rapid increase in global cultivation areas for this crop, which grew 1.5 times between 1993 and 2019, resulting in a 2.2-fold rise in global maize production (from 521 million tons to 1137 million tons (Table 1). For comparison, during the same period in Ukraine, the cultivation areas for maize increased by 4.4 times, while maize grain production escalated by an impressive 11-fold.

Table 1. Global cereal production statistics (annual averages, for dry grain only)

Indicator	World [1]			Ukraine [3]		
	Average for 1993–1995	Average for 2017–2019	Relative change, times	Average for 1993–1995	Average for 2017–2019	Relative change, times
Area (Million ha, M ha)	135	197	1.5	1.06	4.68	4.4
Production (Million ton, M t)	521	1137	2.2	2.91	32.12	11.0
Yield ($t \cdot ha^{-1}$)	3.9	5.8	1.5	2.7	6.8	2.5

The continuous increase in maize yield is attributed to the utilization of cutting-edge advancements in agricultural science. For instance, in the United States, starting from the year 2000, maize yield has been consistently growing at an an-

nual rate of 2%. The highest maize grain yield of 10.73 tons per hectare was achieved in 2014 [4]. Modern technologies and vast expanses of land dedicated to maize cultivation have solidified the United States' leadership in maize production for many years.

As of the 2022/23 Marketing Year (MY), the top global producers of maize were the USA, China, Brazil, the EU, and Argentina (Fig. 1), together accounting for a production of 852.15 million metric tons [5].

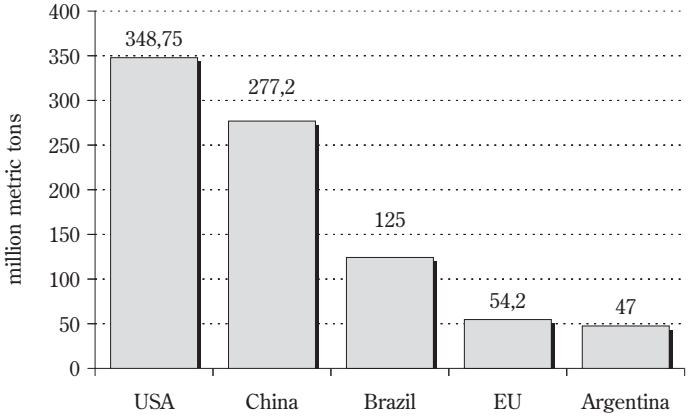


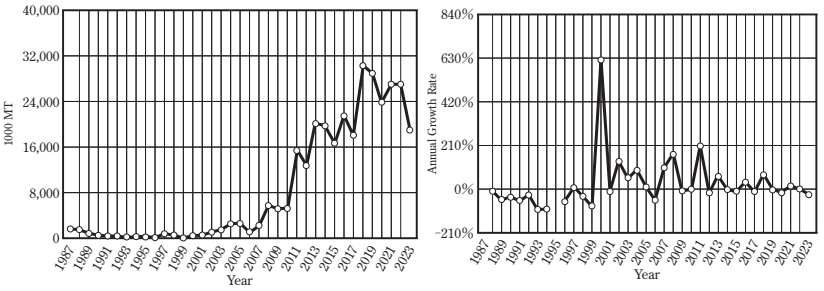
Fig. 1. Top maize-producing countries in 2022/23 MY

According to FAO data, in the 2023/24 MY, there is a projected increase of 6.3 % in global maize production, reaching 1,222.8 million metric tons, which is higher than in the 2022/23 MY (1,150.7 million metric tons) [6].

In the 2018/19 MY, Ukraine held the sixth position among major global maize producers, producing 35.5 million metric tons, accounting for 3.2% of the total global maize production [4, 7].

However, in the 2022/23 MY, Ukraine lost its position and dropped to the eighth position in the ranking of maize-producing countries, with a production figure of 27.0 million metric tons (Fig. 2). This decline was a consequence of the

large-scale war in Ukraine, the occupation of the southeastern territories, and the reduction in agricultural land areas, including due to landmines and other factors.



A) Ukraine Corn Exports by Year *B) Ukraine Corn Exports Annual Growth Rate*

Fig. 2. Dynamics of Maize Export by Ukraine [8]

Until 2022, maize cultivation areas in Ukraine had been steadily increasing. Maize ranks third in terms of cultivated land in Ukraine, following wheat and sunflower (as of 2022) [3]. This growth is driven by favorable conditions for maize cultivation in Ukraine and the global demand for high-quality Ukrainian maize products.

In 1990, the area from which maize was harvested for grain amounted to 1.223 million hectares, while in 2021, it had increased to 5.482 million hectares, a fourfold increase. Maize grain production also rose significantly by 8.9 times, from 4.74 million tons in 1990 to 42.11 million tons in 2021 (Fig. 3).

In Ukraine, the average maize grain yield has also nearly doubled compared to 1990, reaching 7.68 tons per hectare in 2021, with experts estimating significant potential for further improvement. Through the implementation of innovative developments, including modern high-yielding hybrids and next-generation plant protection chemicals, domestic agricultural enterprises can achieve maize yields on par with leading countries worldwide. Consequently, as maize yields increase, the volumes of by-products available for energy purposes also grow [9].

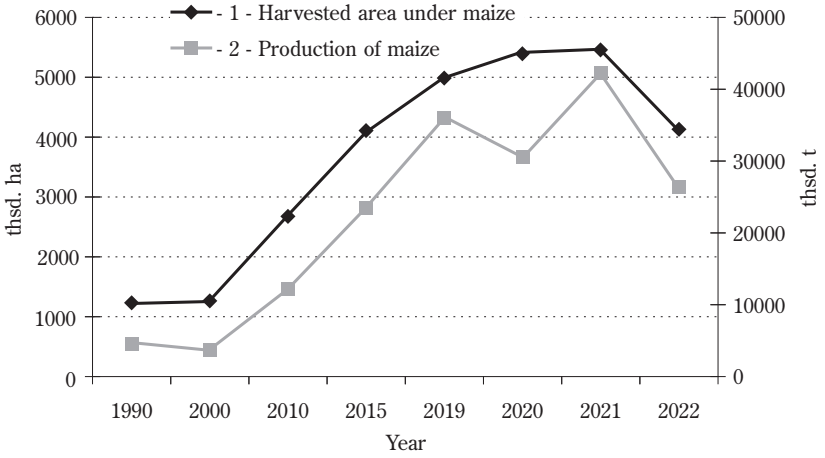


Fig. 3. Dynamics of maize production (thousands of tons) and harvested area under maize (thousands of hectares) in Ukraine, 1990-2022

Source: constructed using data from [3]

The profitability of maize cultivation is higher compared to other cereal crops, thanks to its low production costs and high potential grain productivity. Additionally, maize is characterized by its ability to thrive in continuous cropping systems due to its unique biological features [10]. These unique properties include the C4 type of photosynthesis, which is highly efficient under conditions of increased drought, a substantial assimilation apparatus, a high chlorophyll content, rapid photochemical reaction rates, active respiration, intense metabolic exchange, and a powerful root system [2, 11].

It is essential to note that in 2022 (the year the active phase of the war began in Ukraine), due to disrupted logistics, supply systems for fertilizers, plant protection products, seeds, fuel for agricultural machinery, field minings, and other factors, maize cultivation areas decreased by 22%, and the average maize yield decreased to 6.35 $t \cdot ha^{-1}$ (a 12% reduction). As a result, the gross production of maize decreased by 37.8% compared to the previous year, reaching approxi-

mately 27 million tons. This drop in production caused Ukraine to slide two positions in the global ranking of leading countries in maize production and export.

In the unstable conditions of 2023, with ongoing military actions, blockades of Ukrainian ports, and price reductions in the domestic market, maize cultivation areas have further decreased to 3.4 million hectares. It is crucial to consider that significant agricultural lands may become temporarily unsuitable for their intended purposes due to ecological issues resulting from the military situation.

The large-scale invasion of Russia into Ukraine and the active military actions have significant consequences for the agricultural sector and the economy, not only in Ukraine but also globally. The international market is trying to assess Ukraine's export potential under these war conditions, particularly for grain and oilseeds, as well as to determine the size of potential additional expenses. According to data from the Food and Agriculture Organization（FAO）, the war in Ukraine could lead to a more than 20% increase in world prices for food and animal feed［12, 13］, posing a "catastrophe on top of a catastrophe" threat to countries in the Middle East, such as Egypt, Yemen, and Lebanon, for whom Ukraine is a major supplier of wheat and maize［14］. According to Human Rights Watch, Russia's invasion of Ukraine could exacerbate the food crisis in the Middle East and North Africa［15］. Therefore, it is evident that the longer the Russian-Ukrainian war persists, the more real the danger becomes of disruptions or complete cessation of food supply not only within Ukraine and the region but also worldwide.

The estimates of experts indicate that approximately 34% of the total land area of Ukraine is within a zone where it is not possible to conduct agricultural operations or where the land is temporarily inaccessible［16］. Currently, more than 30% of all cultivated lands in Ukraine are within the risk zone of agriculture［17］.

According to assessments by a German expert in agricultural economics, Pro-

fessor M. Kaim, under the worst-case scenario, the war in Ukraine could lead to a famine affecting up to 100 million people［18］. This particularly concerns countries such as Somalia, Chad, Madagascar, and Bangladesh. Even economically developed countries in the EU are expected to experience a significant increase in food prices. The impact of the war in Ukraine extends beyond the country's borders, and there are grave concerns about the potential for hunger and food crises in vulnerable regions across the globe. The situation calls for urgent attention and collective efforts to address the underlying causes of the conflict and mitigate its devastating effects on food security and the well-being of millions of people worldwide.

Ukraine's grain exports to the EU have shown significant growth over the years. From 682,000 tons in 2010, the exports increased to 15.9 million tons in 2019, largely driven by the expansion of maize exports from 533,000 tons to 14.3 million tons. In monetary terms, the export of Ukrainian grain to EU countries grew by 23.9% in 2019, reaching over $3 billion. However, in 2020, the exports declined by 36.8% but recovered by 34.1% in 2021, amounting to $2.6 billion in monetary equivalent［19］. Ukraine became the second-largest grain supplier（including "maize," "wheat," and "other cereals, including rye, barley, and oats"）to the EU, accounting for 14% of the EU's total grain imports.

In the 2021/22 MY, the main destinations for maize exports were China, Spain, Romania, Turkey, and Egypt, valued at $1.449 billion, $745 million, $598 million, $414 million, and $412 million, respectively［4］.

During the 2020/21 MY, Ukrainian maize represented 29% of China's total grain imports, 25% of Egypt's imports, and a significant 51% share in the EU's total grain imports. These figures indicate the crucial role of Ukraine as a major exporter of maize to key markets worldwide, with the EU being one of the significant destinations for its grain products.

In the 2021/22 MY, Japan imported 108,380 metric tons of maize from Ukraine, with the majority of the imports being contracted before Russia invaded Ukraine [20]. The increase in maize prices on the global market and the overall unstable situation in the world have prompted Japan to increase its domestic production of maize for animal feed. Officials consider each ear of locally-produced corn as a step toward better national food security [21].

As of June 2023, maize remains a crucial export commodity for Ukrainian agribusiness, and approximately 25.9 million metric tons of maize have been exported since the beginning of the season [22]. However, the ongoing Ukrainian-Russian war continues to pose significant challenges to food supply stability, not only within Ukraine and the region but also worldwide. The prices of wheat and maize had already risen before the active phase of the war, and there are compelling reasons to predict their further significant increase. This situation will impact the economies of many countries worldwide, particularly the poorest African nations.

The war in Ukraine presents a real risk of a global food crisis. The escalating prices of staple grains such as wheat and maize can have severe consequences for countries heavily dependent on imports, especially countries like Japan, countries in the Middle East, and North Africa (including Egypt, Yemen, Israel, Indonesia, Bangladesh, Ethiopia, Libya, Lebanon, Tunisia, Morocco, Pakistan, Saudi Arabia, and Turkey).

The longer the Ukrainian-Russian war continues, the greater the potential for disruptions in food supply not only in Ukraine and the region but also worldwide. The situation is particularly critical for countries heavily reliant on imports, and there are concerns that it may lead to a global food crisis with far-reaching impacts on various economies and vulnerable populations worldwide.

Indeed, researchers from the USA and Uruguay have conducted a study to

model the potential impact of the conflict on wheat and maize prices over the next 12 months, considering various scenarios. The findings were published in Nature Food［23］. One model showed that if Russian grain exports decrease by half and Ukrainian exports also decrease due to the war, maize prices could increase by 4.6%, and wheat prices by 7.2%, even when accounting for other exporters. The researchers stated that price increases would persist as long as exports remain limited. The calculations revealed that to offset the supply deficit from Ukraine and other major exporters, other countries would need to significantly expand their grain areas. According to the model, if Ukraine's grain exports were completely halted, Australia would need to expand wheat cultivation by 1%, China by 1.5%, the EU by 1.9%, and India by 1.2%. This change in land use would result in emitting over one billion tons of CO_2 into the atmosphere and put immense pressure on the planet's climate system.

The war in Ukraine is a potent factor influencing the global grain market, including the maize market, and poses challenges to food security worldwide. The disruptions in grain supply from major producers like Ukraine and Russia have far-reaching implications for the global food system, commodity prices, and climate impact due to potential land-use changes in other countries. The need to mitigate these effects and address the consequences of the ongoing conflict on the agricultural sector and food security remains critical.

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