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«Київський політехнічний інститут імені Ігоря Сікорського»**THE WAR AND THE GLOBAL FOOD CRISIS:
CONSEQUENCES AND WAYS TO OVERCOME****ВІЙНА ТА ГЛОБАЛЬНА ПРОДОВОЛЬЧА КРИЗА:
НАСЛІДКИ ТА ШЛЯХИ ПОДОЛАННЯ**

Food security is the basis of national security and serves as a basis for sustainable development, ensuring food needs. Food crises that periodically arise under the influence of various factors such as crop failure, unsatisfactory climatic conditions, disruption of logistics systems and infrastructure become the cause of imbalance in both national food systems and national economic systems. Russia's military aggression in Ukraine exacerbated the already tense situation with food supply in a number of countries and demonstrated to the world a number of miscalculations in the food supply system. The purpose of the article is to identify risk-creating factors that created an emergency situation in the food safety system with the aim of evaluating them and developing scientific and methodological approaches for further substantiation of the formation of perfect and risk-resistant food systems, taking into account a number of indicators characterizing the export potential and opportunities for international trade. Since Ukraine has a strong export potential, strengthened by favourable natural and climatic conditions and the use of innovative technologies, there is every reason to consider the country a guarantor of global food security. The application of general economic methodological tools made it possible to identify the main parameters of the development of the agrarian and industrial complex of Ukraine, the world's need for the main types of food. Detailing the influencing factors and international markets' response to them made it possible to detail the entire range of risks that were realized as a result of military aggression. The assessment of each of the listed risks is of an expert nature and is based on open statistical information. The practical value of the research lies in the development of theoretical and methodological provisions of riskology that can be included in risk management programs at both the national and supranational levels and the development of the concept of a sustainable and equitable food system, which should become the basis of global food security.

Key words: food crisis, food security, military aggression, export, risks, export potential, threats, logistics chain.

Продовольча безпека є основою національної безпеки та слугує базисом сталого розвитку, забезпечуючи потреби у продовольстві. Продовольчі кризи, що періодично виникають під дією різноманітних факторів як то неврожай, незадовільні кліматичні умови, порушення логістичних систем та інфраструктури стають причиною виникнення дисбалансу як у національних продовольчих системах так і національних економічних системах. Військова агресія Росії в Україні загострила і без того напружену ситуацію з продовольчим забезпеченням у ряді країн та продемонструвала світу цілу низку прорахунків у системі продовольчого забезпечення. Метою статті є виявлення ризикоутворюючих факторів, що створили надзвичайну ситуацію у системі продовольчої безпеки з метою їх оцінювання та напрацювання науково-методичних підходів для подальшого обґрунтування формування досконалих та стійких до ризиків продовольчих систем з урахуванням ряду показників, що характеризують експортний потенціал та можливості для здійснення міжнародної торгівлі. Оскільки Україна має потужний експортний потенціал, посилений сприятливими природно-кліматичними умовами та використанням інноваційних технологій, є всі підстави вважати країну гарантом світової продовольчої безпеки. Застосування загальноекономічного методологічного інструментарію дозволило виявити основні параметри розвитку аграрно-промислового комплексу України, світову потребу в основних видах продовольства. Деталізація факторів впливу та реагування на них міжнародних ринків дозволили деталізувати весь спектр ризиків, що були реалізовані у результаті військової агресії. Оцінювання кожного з приведених ризиків носить експертний характер і базується на відкритій статистичній інформації. Практична цінність дослідження полягає в напрацюванні теоретико-методологічних положень ризикології, що можуть бути покладені в програми управління ризиками як на національних так і на наднаціональних рівнях та розробки концепції стійкої та рівноправної продовольчої системи, яка має стати основою світової продовольчої безпеки.

Ключові слова: продовольча криза, продовольча безпека, військова агресія, експорт, ризики, експортний потенціал, загрози, логістичний ланцюжок.

Introduction. Ukraine, having a powerful agricultural production potential, acts as a guarantor of global food security. The country is among the world's top five exporters of grains and pulses and has proven itself as a reliable partner during the two pandemic

years in agriculture, when supply chains were disrupted and movement restrictions were in place. In 2021, Ukraine became a member of the UN Committee on World Food Security, which reports to the UN General Assembly through the UN Economic and Social Council

and the UN Food and Agriculture Organization (FAO) conference.

With the beginning of Russia's military aggression in Ukraine, the threat of famine increased in a number of countries in Africa and the Middle East. About 20 million tons of grains and legumes were blocked in the ports, and therefore their delivery to customers was postponed indefinitely. According to UN data, in the pre-war period, 44 million people in 38 countries were on the brink of starvation, the beginning of hostilities increased this figure to 52–57 million people. A number of imperfect national systems suffer from food supply disruptions due to military action and political influence, with no alternative sources of food supply.

Thus, a number of risks caused by the war have endangered the food security of many countries. And Ukraine could not fully realize its significant potential in the production and export of agricultural products.

In the current situation, it is important for scientific research to identify the entire range of risk-creating factors that affect the process of risk realization and cause significant losses and damages to many interested parties, as well as to consider the measures that can be applied to localize the negative effects on the parameters of the global and regional food security.

Many scientific works are devoted to the problems of food safety, as well as the risks accompanying the processes of production, supply and availability of food products. And with the beginning of the military confrontation in Ukraine, their number increased significantly.

The prerequisites for the formation of the food security system were studied in the works of Irtysheva I., Ponomarova M., Dolzhykova I. The author team believes that in order to strengthen food security in Ukraine, it is necessary to improve the development of import substitution, activate the wide use of the latest technologies, and promote the rational combination of large, medium and small businesses. Food safety is the most important condition of state sovereignty, national security, social stability and independence in international relations [1].

A number of works are devoted to the impact of Russia's invasion of Ukraine on global food security. The analysis conducted in Hellegers P. study shows that Russia's invasion of Ukraine will affect food security in countries with limited coping capacity, with impacts that are anticipated to be especially concentrated in the MENA region and Sub-Saharan Africa (especially the horn of Africa), which can lead to regional instability.

Analysis by Hellegers P. shows that the Russian invasion of Ukraine will affect food security in countries with limited capacity to cope with the consequences, which are expected to be particularly concentrated in the MENA region and sub-Saharan Africa (especially in Horn of Africa), which can lead to regional instability [2].

The team of researchers Weil P. and Zachmann G. believe that world food production will be enough to feed the world's population this year. But export bans, high prices and rising transport costs can prevent vulnerable countries from buying enough food. Measures are needed to ensure global access to scarce food supplies and increase grain production [3].

They come to similar conclusions in their researches Van Meijl, H., H. Bartelings, S. van Berkum, D. Cui, Z. Smeets-Kristkova and W. J. van Zeist. Вони зазначають що there is enough food on the global level, but higher food prices could become a problem for a part of the population that has a low income and spends a large part of their food on cereals. For some countries highly dependent on imports of Ukrainian and Russian cereals like Egypt, Turkey, and the Middle East, food availability will come under some pressure. Food security impacts are very minor for the EU, as food availability is not a problem in the EU, and in general, people spend a small part on cereal-based food products [4].

A study by a team of academics concluded that the global crises are causing a decline in Kenya's GDP and employment, but these declines are not large compared to the overall size of the economy. Much of the GDP loss is caused by rising fuel and fertilizer prices, not rising food prices. This is because, despite the fact that import prices for wheat and edible oils are rising, these products tend not to occupy a significant share in the household consumption basket. Overall, national household consumption is falling. Although the global crisis will cause a modest slowdown in Kenya's economic growth, its negative impact on poverty and food insecurity is likely to be more pronounced, especially in rural areas [5].

Thus, the food crisis that arose as a result of military operations in Ukraine led to negative consequences for the food security of many countries.

The purpose of the study. The purpose of this study is to assess the impact of military actions in Ukraine on world food security and to justify proposals for overcoming them and preventing them in the future. To achieve the goal, the following tasks are solved:

1) to carry out an analysis of the export potential of Ukraine in terms of the main positions of agricultural products;

2) monitor crisis situations that have developed in the field of food safety;

3) consider measures aimed at stabilizing food exports from Ukraine and give them an assessment.

Methodology. The methodological basis of this scientific study is general economic methods of scientific knowledge and theories of international trade, risk assessment and management, which in their combination are aimed at identifying patterns of international trade transactions in war conditions, assessing the impact of a number of risk-creating factors on world food security and risk management on the whole the chain of creation of additional value in certain branches of agriculture of Ukraine.

Results. UN Secretary-General Antonio Guterres believes:

– This crisis could throw up to 1.7 billion people – over one-fifth of humanity – into poverty, destitution and hunger on a scale not seen in decades (20% from world population).

– Ukraine and the Russia provide about 30% of the world's wheat and barley, one-fifth of its maize and more than half of its sunflower oil. Together, their grain feeds the poorest and most vulnerable people, providing more than a third of the wheat imported by 45 African and least-developed countries.

– The World Food Program has warned that it faces the impossible choice of taking from the hungry to feed the starving. It urgently needs \$ 8 billion to support its operations in Yemen, Chad and Niger [6].

The start of military aggression in Ukraine stimulated the emergence of food security problems, which should guarantee the population's physical, economic and social access to food. According to statistical data, Ukraine and Russia generally account for the production and export of a number of basic agricultural products that form the basis of nutrition for citizens of many regions (Fig. 1–2). As the charts show, Ukraine and Russia are powerful producers of sunflower oil, but if we talk about the export of this product, the leading positions belong to Ukraine. In 2021, Ukraine and Russia provided 77% of the world's sunflower oil exports, of which 48% of the total share of oil sent abroad belonged to Ukraine. According to Ukrstat data, in 2021, Ukrainian producers exported 5.1 million tons of sunflower oil, which is 26% less than the result of 2020. However, according to 2020–2021 data, the share of sunflower oil in Ukraine's exports was 11%.

The geographical structure of sunflower oil exports shows that countries such as India, China and the Netherlands are highly dependent on Ukrainian imports (Table 1).

Export volumes were expected to increase in 2021–2022 MY, but due to the blocking of sea ports, exports from Ukraine practically stopped. The situation is similar with other types of products.

The military actions in Ukraine created obstacles for the full export of a number of product items. Thus, although corn stocks will not change significantly, a change in the list of main exporters is expected. Before the war, it was expected that the export of Ukrainian corn in

2021–2022 will make up 18% of world trade, and in this case, Ukraine would occupy the third position in the world among exporters.

Despite the significant potential of Ukraine in the production of corn and the presence of significant reserves of this crop, it is assumed that Brazil will be able to compensate for its supply to world markets. In Ukraine, unfortunately, there is a situation where grain stocks are growing and there is nowhere to store the new crop. Wheat stocks are also expected to increase at the end of the 2022–2023 season in China, Australia, Morocco and the Russian Federation. The limited supply of corn for importers could be critical for China, the EU, Egypt and Turkey, which provided an average of a third of their needs through Ukrainian exports. According to FAO estimates, China, the European Union, Egypt and Turkey have approximately 11.5, 3.7, 4.6 and 1.6 million tonnes, respectively, of outstanding imports for the second half of 2021/22.

The ongoing war in Ukraine is disrupting supply chains and further affecting prices of grain, fertilizer and energy. In the first half of 2022, this resulted in further food price increases. The ongoing war in Ukraine is disrupting supply chains and further affecting grain, fertilizer and energy prices. In the first half of 2022, this led to further increases in food prices. (Food security and nutrition in the world the state: repurposing food and agricultural policies to make healthy diets more affordable [7].

The grain harvest in 2022 is expected to be 2,792 million tons, which is 0.6% lower than in 2021, which is due to

Table 1

Geographical structure of sunflower oil imports

The largest importers	Share of Ukraine, thousand tons	Fraction of Ukraine in imports, %	Share of other countries, %	Share in Ukraine's exports, %
India	1569	75	Russia – 18; Argentina – 7	31
China	785	59	Russia – 38; Kazakhstan – 2	20
Netherlands	673	87	Hungary – 4; Spain – 2	10

Source: Ministry of Agrarian Policy of Ukraine

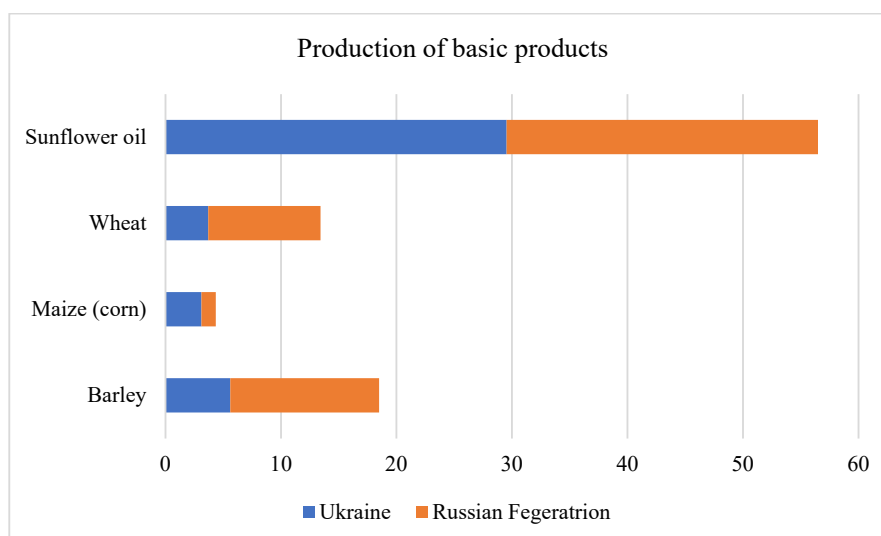


Fig. 1. Production of basic products by Ukraine and Russia in 2020

Source: FAOSTAT: <https://www.fao.org/faostat/>

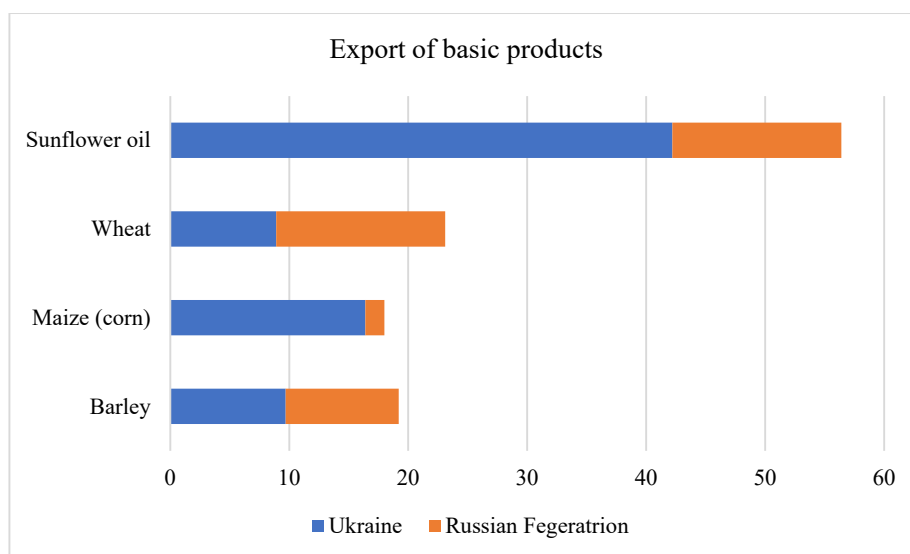


Fig. 2. Export of basic products by Ukraine and Russia in 2020

Source: FAOSTAT: <https://www.fao.org/faostat/>

the increase in grain acreage in China and India. Favorable weather conditions serve as an incentive to increase the sown area in Canada and Australia. In Ukraine, despite the military actions, a sowing campaign unprecedented in terms of its scale and level of risk was carried out, which provided an opportunity to adjust forecasts regarding the future harvest in the direction of growth. On the other hand, there is a reduction in cultivated areas in Mexico, EU countries and the Asian-Pacific area.

If to evaluate in general the volume of grain trade in 2022–2023 MY, then a number of experts predict that it will increase by 1.3–1.5% or 190–195 million tons, through the shortfall of Ukrainian exports. Alternative shipments from the country of the EU, Canada and the Russian Federation cannot be filled in the outside world. Under this situation, the largest grain importers from Ukraine may be affected (behind the 2020–2021 tax): Indonesia – \$750 million; Spain – \$645 million; Netherlands – \$552 million; Iran – \$533 million; Pakistan – \$355 million; Libya – \$342 million; Tunisia – \$306 million next to count the fall to a number of indications on the world market of grains – starting from obligatory harvesting and running out of stocks (Table 2).

Russia's military aggression in Ukraine stimulated the emergence of a number of risks for global food security: production, logistics, trade, price, social [10].

Production risks. Military aggression created grounds for uncertainty regarding the production and sale of major agricultural crops on international markets. The process of grain production in a number of regions was interrupted as a result of hostilities. As a result of the full-scale Russian invasion, Ukraine lost 22% of its arable land. According to the Ministry of Agrarian Policy and Food of Ukraine, the area of crops was 13.3 million hectares, which is 3.6 million less than last year (16.9 million hectares). In the occupied territories and in the areas of active hostilities – in parts of Zaporizhzhya, Donetsk, Kharkiv, Mykolaiv and the entire territory of Kherson and Luhansk regions – crops were destroyed.

The main risk-creating factors for agricultural production during hostilities are: rocket and artillery attacks, minefields, fuel shortages, loss of agricultural machinery, lack of mineral fertilizers, complicated logistics, and curfews. Thus, as of June 8, 2022, farmers from seven war-affected regions of Ukraine lost 2,281 units of agricultural machinery. These are farmers from Kyiv, Sumy, Chernihiv, Luhansk, Donetsk, Kherson and Mykolaiv regions [8].

Because of the war, the very structure of crops also changed. According to the Ministry of Agriculture, the farmers sowed primarily those crops that are more expensive, and the yield per hectare is lower. These are

Table 2

World cereal market

Period	Production	Supply	Utilization	Trade	Ending stocks	World stock-to-use ratio	Major exporters' stock-to-disappearance ratio
	<i>million tonnes</i>					<i>%</i>	
2018/19	2 644,7	3 501,4	2 686,3	411,1	832,2	30,7	18,8
2019/20	2 712,8	3 545,0	2 710,6	439,2	825,9	29,9	18,7
2020/21	2 778,2	3 604,1	2 761,8	479,5	834,1	29,8	18,5
2021/22	2 809,7	3 643,7	2 799,1	479,0	859,2	30,7	19,8
2022/23	2 791,5	3 650,7	2 797,4	467,6	854,2	29,8	20,1

Source: FAOSTAT: <https://www.fao.org/faostat/>

primarily rapeseed and soybeans. Farmers also reduced the amount of corn sown in favor of spring wheat. All because its value is higher on world markets. Corn acreage decreased by 40% from 5.4 to 3.2 million hectares, while spring wheat acreage increased by six percent from 188,000 hectares in 2021 to nearly 200,000 hectares in 2022.

Logistic risks. Before the war, 90% of Ukraine's agricultural exports were carried out through sea ports (Odessa, Chornomorsk, Pivdenny, Mykolaiv). Due to their blocking, 60% of transportation is currently carried out by rail transport, 25% by road transport, and by a combined method using the ports of Romania and Poland. This led to a significant reduction in the volume of exports of food items – from 6 million tons of grain every month to 40–50 thousand tons. In May 2022, only 40 thousand tons of grain were exported by trucks (4% of exports), 50% of exports were delivered by train to Poland, Slovakia and Hungary. About 45% of the total grain export was transshipped through Izmail and Reni in May. For the export of grain to the EU countries, they began to use railways and motor vehicles, which significantly increased the cost of delivery and cannot compensate for the consequences of blocked ports. With the application of all these options, Ukraine managed to export only about 1 million tons of grain per month in April and May. Ground transport is slower and more vulnerable to bureaucratic delays at the border, raising prices by at least 30%.

Trade risks. Disruptions in food exports related to military actions in Ukraine have led to unsatisfied demand and rising prices in many international and regional markets. Supply gaps are particularly vulnerable to countries in the Middle East and North Africa. In the four months since the beginning of the Russian attack, Ukraine managed to export only 5.2 million tons of agricultural products, while until February 24, the country exported 4–5 million tons of grain every month through sea ports. Among the world's largest wheat importers, Egypt, Turkey, Bangladesh and the Islamic Republic of Iran on average (2016/17 – 2020/21) import more than 60% of wheat from Ukraine and the Russian Federation. Lebanon, Tunisia, Yemen, Libya and Pakistan are also heavily dependent on wheat originating from Ukraine and the Russian Federation, importing an average of 50% of their total needs.

Price risks appeared as a response to the limited supply of a number of product items. An analysis of the FAO Food Price Index (FFPI) over a long period gives reason to claim that its growth was projected in 2020 and was caused by the Covid-19 pandemic (Table 4). At the same time, this trend intensified with the beginning of military aggression in Ukraine. If in the period from October 2021 to January 2022 it fluctuated in the range of 130–132, then in February–March 2022 the value increased to 138–156 points (Table 5). The most powerful growth of the index is observed for sunflower oil, since Ukraine, as mentioned above, occupies a leading global position in the export of this product. Therefore, the limitation of its supply caused not only an increase in prices, but also a limitation of sales to one retail buyer in certain countries. According to preliminary estimates by the FAO, the global shortage of supply could push up international prices for food and feed by 8–22%.

Social risks. The food and economic crisis worsen access to food for certain vulnerable population groups and can provoke civil unrest. The number of people in need of food aid in the West African region, including Nigeria, Mali, Burkina Faso, Chad and Niger, has increased significantly in recent years. Between 2007 and 2022, the number of food insecure people in the region increased from 7 to 27 million. If no emergency measures are taken, this figure could rise to 38 million by June 18. According to the UN, about 16 million people in this region of the Horn of Africa may face severe hunger due to persistent drought.

Measures to influence the threatening situation include a wide list of actions that were implemented both by Ukraine and by the international community. Despite the high risks, Ukraine managed to carry out sowing where possible. 20% of the territory of Ukraine is currently occupied by Russia, which makes it impossible to organize any production processes. The Istanbul agreement on unblocking the export of Ukrainian grain, which was signed on July 22, 2022, gives reason to hope for export residues of grain and oil crops, which is estimated at \$ 10 billion. The export of the 2022 harvest is estimated at another \$ 20 billion in this way, Ukraine can receive significant foreign exchange earnings that will contribute to the further development of the agricultural sector. It will also help to optimize transportation and reduce transportation costs and stabilize prices.

Table 3

Sown areas under the main agricultural crops, thousand ha

The name of the agricultural crop	2021	2022
Spring wheat	42,3	200,2
Soy	1310,1	1250,1
Sunflower	6622,4	4700,3
Corn	5500,7	4639,6
Sugar beet	227,4	182,8
Spring rape	33,4	33,6

Source: Ministry of Agrarian Policy of Ukraine [9]

Table 4

FAO Food Price Index, 2014-2016=100

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Nominal	115,0	93,0	91,9	98,0	95,9	95,1	98,1	125,7	150,4
Real	106,3	95,1	97,8	100,8	94,2	95,6	99,2	125,1	147,2

Table 5

FAO Monthly Real Food Price Indices, 2014-2016=100

Month	Food	Meat	Dairy	Cereals	Oils	Sugar
2021-01	112,9	95,5	110,7	124,4	138,2	93,7
...						
2021-05	127,5	106,8	120,5	133,0	174,0	106,2
2021-06	124,6	110,1	119,3	129,6	156,9	107,2
...						
2021-10	132,5	111,4	120,8	136,4	183,9	118,4
2021-11	134,6	111,9	125,3	140,7	183,6	119,6
2021-12	133,0	110,5	128,3	139,8	177,6	115,8
2022-01	132,7	109,7	129,8	137,6	181,9	110,2
2022-02	138,0	110,9	138,5	142,1	197,4	108,1
2022-03	156,3	116,7	142,7	166,5	246,4	115,4
2022-04	154,9	118,8	143,5	166,0	232,4	118,9
2022-05	154,0	119,4	138,6	169,7	224,3	117,7

Conclusions. Russia's military aggression against Ukraine revealed gaps in the food security system, which currently suffers from a number of negative impacts: anthropogenic (impact of military operations), economic (rising food prices), logistical (disruption of supply chains), social (threat of famine). Disruption of production processes, along with logistical limitations, irrational use of resources and growing demand for food, requires a review of the principles of global population well-being

with the involvement of leading international institutions. Any national food system should be based on sound principles of risk management, aimed at the development of the local agricultural sector with the involvement of the latest technologies, the reduction of food waste, and the prevention of military conflicts. The concept of a sustainable and equitable food system, which should become the basis of food security, needs extensive research and justification.

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