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Svitlana Cheremisina[1]
Volodumur Rossokha[2]
Olena Mazurenko[3]
Mykhailo Selinnyi[4]
Olha Tomashevska[5]

THE GRAIN MARKET OF UKRAINE: ACTUAL STATE, CURRENT PROBLEMS, AND DEVELOPMENT PROSPECTS[6]

The article is devoted to the current problems occurring in the grain industry as a result of Russia's armed aggression and active hostilities in a large area of Ukraine. The purpose of the article is operational monitoring of the current state of the grain market in Ukraine and the calculation of forecast parameters of its stabilization and further development in the conditions of military aggression.

The research used the information database of the Ministry of Agrarian Policy and Food of Ukraine, the State Statistics Service of Ukraine, and the information and analytical materials of the NSC Institute of Agrarian Economics regarding the forecast indicators of the production of agricultural products in Ukraine in 2022 year. The production forecast is made taking into account losses of cultivated areas, damage to crops, violations of production technologies and a decrease in the yield of grain crops.

The total production of grain crops in 2022 is forecast to be 53.6 million tons, which is almost 40% lower than in 2021. The area under harvest is expected to decrease by 4.7 million hectares (from 15.9 to 12.3 million hectares). The actual losses of products of the grain market of Ukraine in the current 2022 are estimated at 204 billion UAH, or almost 7 billion EUR. The biggest losses will be experienced by the production of corn – EUR 3 billion, wheat – EUR 2.7 billion, barley – EUR 0.9 billion.

To determine the extent of destructive shifts occurring in the grain market of Ukraine, the actual (for 2020 and 2021) and forecast for 2022 balances of grain products were made. The main factors that will affect the functioning and further stabilization of the grain market in Ukraine have been established.

Keywords: grain market; production forecast; losses of sown areas; crop losses; production balance; domestic consumption; total demand; total supply
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[1] *Svitlana Cheremisina, Doctor of Economics, Associate Professor, Leading Researcher, National Research Center "Institute of Agrarian Economics", e-mail: cheremisinasvitlana@gmail.com.*
[2] *Volodumur Rossokha, Doctor of Economics, Professor, National University "Kyiv-Mohila Academy", e-mail: rossokha@ukr.net.*
[3] *Olena Mazurenko, Doctor of Economics, Leading Researcher, National Research Center "Institute of Agrarian Economics", e-mail: mov@iae.kiev.ua.*
[4] *Mykhailo Selinnyi, Phd in economics, Associate professor, Chernihiv Polytechnic National University, e-mail: selm@meta.ua.*
[5] *Olha Tomashevska, Phd in economics, Associate professor, National University of Life and Environmental Sciences of Ukraine, e-mail: tomashevska2011@ukr.net.*
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1. Introduction

The grain industry is the flagship of the domestic agricultural market and the entire economy of Ukraine. The level of development of grain production and the stable and efficient functioning of the grain market has acquired the importance of priority levers for solving the problem of food and the national security of the state in modern conditions.

The Ukrainian grain market meets the needs not only of domestic consumption but also of many countries around the world. Ukraine annually increases the volume of production and export of grain crops and is among the main players in the international market.

The tendency to increase the volume of grain production remained quite stable for a lengthy period, however, Russia's armed aggression and the conduct of active hostilities in a significant territory of Ukraine caused several large-scale problems that had a destructive effect on the current state and prospects for the further functioning of the grain market.

The number of cultivated areas is declining, the technological discipline of cultivation is unobserved, the yield levels of grain crops are decreasing, the export of grain products has fallen catastrophically, transport logistics have been extensively injured, and many agricultural and processing enterprises have been destroyed or significantly damaged.

Problems and prospects for the development of the Ukrainian grain market remained a priority for N. Golomsha (2017), V. Lagodienko et al. (2019), V. Mesel-Veselyak (2018) and M. Ilchuk et al. (2019). The result of the scientific research of the scientists obtains a statement of the need to stabilize the domestic grain market, as well as the priority of the state in these regulatory processes.

A. Hyrka, V. Kompaniets, and A. Kulyk (2019) are engaged in improving the processes of standardizing production costs and forecasting indicators of winter wheat cultivation efficiency. The authors emphasize the importance and necessity of the further development of grain farming, in particular, the producing of high-quality food grains of winter wheat. Simultaneously, scientists focus their research on the development of differentiated norms of monetary, material, labour, and energy costs for the production of wheat grain, the analysis of technological aspects of the formation of costs by articles, and periods of fieldwork.

The problems of scientific and technological modelling of increasing the efficiency of grain production were considered in the works of V. Cherchel, M. Shevchenko (2020), V. Kolodiychuk (2016). O. Skrypnyk, N. Klymenko, K. Tuzhuk (2021), S. Zaika, R. Romanova (2018) and others are engaged in substantiating the prospects of sustainable development of grain production in Ukraine. N. Kovalenko, V. Kovalenko, T. Hutsol (2021) devoted their scientific works to evaluating the efficiency of growing grain crops and developing road maps for making management decisions when planning a production program.

Actual problems of increasing the efficiency of grain production in Ukraine are outlined by Y. Grynchuk, E. Tkachenko, A. Dragan (2018), I. Solovey (2017). Y. Dolgikh (2019) evaluated the dynamics of changes in the net technical efficiency of the production of grain and leguminous crops in Ukraine using the DEA method.

Problems of increasing the economic efficiency of the production of grain industry products in the conditions of European integration were investigated by O. Kotykova, T. Oliynyk, and D. Kichuk. (2018). Methodical aspects of determining the efficiency of grain production in modern conditions were studied by T. Lositska (2019). R. Miroshnyk and I. Baglay (2022) are engaged in researching the problems of the grain market in Ukraine in modern conditions of armed aggression.

Among foreign scientists, the following authors made a significant contribution to the study of the problems of increasing the economic efficiency of grain production and the development of the grain market.

O. Zhaltyrova (2019) considered the practical mechanisms of improving competitiveness and increasing the export potential of the grain market. Youzhu Zhao, Qiuxiang Jiang, and Zilong Wang (2019) studied the dependence of grain production in conditions of limited water and land resources. Luiz Gustavo Garbelini, Henrique Debiasi, Alvadi Antônio BalbinotJunior studied the influence of crop rotation diversification on increasing yield and economic efficiency of grain production (2022).

Preeti Kapuria and Roshan Saha (2020) worked on the development of parameters for ensuring the food security of the grain market. K. Tireuov. S. Mizanbekova, B. Kalykova (2018) investigated the effect of increasing the efficiency of the grain industry on the level of food security and sustainable development of the country's economy. John Baffes and Peter Nagle (2022) are engaged in studies of global problems of reducing the risks of the impact of the war in Ukraine on world commodity markets.

However, the peculiarities of the functioning of the Ukrainian grain market in the conditions of Russia's armed aggression and the world crisis require further analysis and research for the successful development of effective organizational and economic measures to stabilize and increase efficiency.

The purpose of the article is to conduct an operational monitoring of the current state of the grain market in Ukraine and the calculation of forecast parameters for its stabilization and further development in the conditions of armed aggression.

2. Research Methodology

We will present a step-by-step algorithm for determining the forecast parameters of the grain market in Ukraine under conditions of military aggression by Russia.

1. The forecast of grain production was determined by the formula:

$$\Pr = \sum_{i=1}^{n} S_i \times Y_i * K_i \quad (1)$$

where:

Pr is the aggregate forecast production of grain crops, taking into account losses of cultivated areas, damage to crops, violations of production technologies, and a decrease in the yield of grain crops by region of Ukraine, thousands of tons;

S – sown areas of grain crops in **i** region of Ukraine, thousands of hectares;

Y – yield of grain crops in **i** region of Ukraine, t/he;

K – approximate coefficient of loss of cultivated area in another region of Ukraine;

N – the number of regions in Ukraine.

2. Losses of grain crops are determined by the formula:

$$Lsabs = \sum_{i=1}^{n} S_{i\,2022} - S_{i\,2021} \quad (2)$$

$$Lsrel = \sum_{i=1}^{n} \left(S_{i\,2022} / S_{i\,2021} \right) * 100 \ \% \quad (3)$$

where:

Liabs is the absolute loss of grain crops, thousands of hectares;

Lirel – the relative losses of grain crops, %;

S_{i2022} – the area of grain crops in **i** region of Ukraine in 2022, thousands of hectares;

S_{i2021} – the sown area of grain crops in **i** region of Ukraine in 2021, thousands of hectares;

3. Crop yield losses are determined by the formula:

$$Lprabs = \sum_{i=1}^{n} \mathrm{Pr}_{i\,2022} - \mathrm{Pr}_{i\,2021} \quad (4)$$

$$Lprrel = \sum_{i=1}^{n} \left(\mathrm{Pr}_{i\,2022} / \mathrm{Pr}_{i\,2021} \right) * 100 \ \% \quad (5)$$

where:

Lprabs is the absolute loss of grain crops, thousands of tons;

Lprrel – relative loss of crop yield, %;

Pr – production of grain crops in another region of Ukraine in 2021-2022, thousand tons.

Similarly, forecast indicators of production, losses of cultivated areas and harvest separately for wheat, corn, and barley were calculated.

4. The calculation of the gross output of the grain market of Ukraine for 2022 is determined by the formula:

$$GP = \sum_{j=1}^{n} \mathrm{Pr}_{j} \times FP_{j} \quad (6)$$

where:

GP is the total forecasted volume of gross production of the grain market, UAH million;

Pr – the predicted production of the **j** type of grain crop in Ukraine in 2022, thousand tons;

FP – the constant price of 2016 of the j type of grain crop, UAH/ton;

N – the number of types of grain crops grown in Ukraine.

5. The calculation of actual losses of products of the grain market of Ukraine in 2022 is calculated according to the formula:

$$AL = \sum_{j=1}^{n} \mathrm{Pr}_{j\,2021} \times P_{j\,2021} - \sum_{j=1}^{n} \mathrm{Pr}_{j} \times P_{j\,2021} \quad (7)$$

where:

AL is the expected amount of actual losses of grain market products, million UAH/ million EUR;

Pr_{j2021} – the actual production of the j type of grain crop in 2021, million tons;

P_{j2021} – the average price of the j type of grain crop in 2021, UAH /ton.

6. Determining the parameters of grain market product balances were carried out according to the following formulas:

$$TS_j = \mathrm{Pr}_j + \mathrm{Im}_j \quad (8)$$

$$TD_j = Dd_j + Ex_j \quad (9)$$

where:

TS is the total offer on the market of the **j** type of grain crop, thousands of tons;

TD – the total market demand of the **j** type of grain crop, thousand tons;

Dd – the aggregate domestic demand on the market of the **j** type of grain crop, thousands of tons;

Im – the import of the **j** type of grain crop, thousands of tons;

Ex – export of the **j** type of grain crop, thousands of tons.

$$Dd_j = Ip_j + Cf_j + Sf_j + Af_j \quad (10)$$

where:

Ip is the volume of industrial processing of the **j** type of grain crop, thousands of tons;

Cf – consumption fund of the **j** type of grain crop, thousand tons;

Sf – costs of seeds for sowing the **j** type of grain crop, thousands of tons;

Af – use of the **j** type of grain crop for animal feed, thousand tons.

$$Sch_j = TD_j - TS_j \quad (11)$$

$$\mathrm{Pr}\,P_j = \frac{\mathrm{Pr}_j}{Pop} \quad (12)$$

where:

Sch_j is the index of changes in stocks of the **j** type of grain crop, thousands of tons;

Pop – the population of Ukraine, millions of people.

3. The Research Results

The economy of Ukraine in 2022 suffered catastrophic destruction and losses. Russia has seized territories, is ruining cities and villages, destroying enterprises, roads, bridges, stealing and taking away machinery, equipment, and grain from elevators. All components of the country's economy suffered colossal losses, including the agricultural sector.

After Russia invades Ukraine, almost the entire agricultural sector of the country is in the zone of total risk, and the issues of the sowing campaign in 2022 have become the most problematic. According to the Ministry of Agrarian Policy and Food of Ukraine, this year only 75% of Ukraine's acreage was sown. Accordingly, a significant decrease in the level of production of grain yields is expected compared to 2021.

As a result of hostilities, Chernihiv, Sumy, Kyiv, Kharkiv, Luhansk, Donetsk, Zaporizhzhya, Kherson, and Mykolaiv regions turned dangerous regions for the sowing campaign, and Zhytomyr, Poltava, and Dnipropetrovsk regions became high-risk regions. Taking into account the military danger, agro-climatic influence, and long-term dynamics of the yield of agricultural crops in the regions, the forecast of the production of farmed products in Ukraine in 2022 (June 2022) developed by specialists of the NSC "Institute of Agrarian Economy" (Lupenko, Nechiporenko et al., 2022), predictive conclusions were made regarding the future harvest of grain crops (wheat, corn, and barley) by regions of the country and the general state of the grain market of Ukraine in wartime conditions.

Data on the actual production and sown areas of grain crops for 2015-2021 were used to carry out forecast calculations. The percentages of losses of the sown area under grain crops by regions of warlike operations and those affected by occupation were predicted (Table 1).

The production forecast is made by taking into account losses of cultivated areas, damage to crops, violations of production technologies, and a decrease in the yield of grain crops.

A significant share (more than 40%) of the production of grain crops in Ukraine is formed by winter crops of wheat, barley, and rye, formed before the war.

Over the past 3 years, in the structure of grain crops, winter crops occupied an average of 51%, and their area ranged from 7.6 to 8.2 million hectares. For the 2022 harvest, 7.6 million hectares were sown with winter grains, which is 7% lower than the figure for 2021 (8.2 million hectares) and practically the same as the area in 2020 (Kupchenko, 2022).

The region under winter wheat in 2022 is 6.5 million hectares (-5% compared to the indicator of 2021), under winter barley – 969.0 thousand hectares (-15%), and under rye – 108.5 thousand hectares (-39%). However, the armed actions in Ukraine will most likely lead to a significant reduction in the areas available for harvesting. A leading part of the land was beyond the limit of the physical possibility of its cultivation. Foremost, these are the territories of Kherson, Donetsk, Luhansk, Zaporizhzhia, Mykolaiv, Kharkiv, Sumy, Chernihiv, and Kyiv regions.

Table 1

Approximate losses of cultivated areas and harvest of grain crops by regions of Ukraine in 2022 (%)

Regions of military operations		Regions affected by the occupation	
Region	Losses of sown areas and production of grain crops, %	Region	Losses of sown areas and production of grain crops, %
Donetsk	80	Kyiv	5
Zaporizhzhya	80	Sumy	10
Luhansk	100	Chernihiv	10
Mikolayiv	30		
Kharkiv	50		
Kherson	80		
Other regions of the country			
Vinnytsya	0	Odesa	20
Volyn	+20	Poltava	+5
Dnipropetrovsk	5	Rivne	0
Zhytomyr	1	Ternopil	0
Zakarpattya	7	Khmelnytskiy	0
Ivano-Frankivsk	1	Cherkasy	0
Kirovohrad	5	Chernivtsi	+7
Lviv	3		

Source: The result of the authors' research.

The total production of grain crops in 2022 is forecast to be 53.6 million tons, which is almost 40% lower than in 2021. The area under harvest is expected to decrease by 4.7 million hectares (from 15.9 to 12.3 million hectares). The most massive losses of area and harvest of grain crops are expected in Luhansk, Donetsk, Zaporizhzhia, Kherson, Kharkiv, and Mykolaiv regions (Table 2).

A more detailed regional analysis of the distribution of the land area under the main crops shows that almost 51% of the total acreage of the yield has been sown with winter wheat for the 2022 harvest in the currently most dangerous regions. Therefore, the projected losses of areas under winter crops are significant. According to the results of spring wheat sowing in the previous season, the total share of crops in dangerous parts is estimated at 30%.

Accordingly, there are prospects for expanding the area under spring wheat in relatively safe regions. First of all, this applies to Zhytomyr, Ternopil, and Vinnytsia regions (Table 3).

The forecast reduction in the area of wheat crops is set at 2 million hectares (or 28.4%), a yield loss of 12.7 million tons, or 39.5% less than the level of 2021. An analysis of the distribution of corn crops according to the data for 2021 shows that in the areas that became dangerous as a result of the war in 2022, 36% more area was planted with corn. The most critical are the Chernihiv, Sumy, and Kyiv regions, where more than 25% of corn crops have been planted. Obvious that these regions will not be leaders in corn production this year. And taking into account the low market incentives and the high-energy intensity of the production of this crop in relatively safe areas, there will be no expansion of crops to compensate for areas unavailable for cultivation.

Table 2

Forecast of production and crop loss by regions of Ukraine, 2022

Regions of Ukraine	Grain area, thsd.ha		Grain production, thsd. t		Losses of cultivated areas, compared to 2021		Crop yield losses compared to 2021	
	2021	2022 (forecast)	2021	2022 (forecast)	thsd.ha	%	thsd. t	%
Vinnytsya	890,3	890,3	6535,5	5031,8	0,0	0,0	-1503,7	23,0
Volyn	327,1	396,8	1509,3	1426,8	0	0	-82,5	5,5
Dnipropetrovsk	1150,2	1095,8	4948,8	3534,0	-54,4	4,7	-1414,8	28,6
Donetsk	596,3	120,3	2227,6	346,8	-476,0	79,8	-1880,8	84,4
Zhytomyr	552,0	544,3	3356,7	2581,3	-7,7	1,4	-775,4	23,1
Zakarpattya	83,2	77,7	362,8	254,1	-5,5	6,6	-108,7	30,0
Zaporizhzhya	1013,8	197,2	3838,0	590,6	-816,6	80,5	-3247,4	84,6
Ivano-Frankivsk	154,7	152,6	1009,5	776,1	-2,1	1,4	-233,4	23,1
Kyiv	676,0	632,5	4567,4	3206,8	-43,5	6,4	-1360,6	29,8
Kirovohrad	899,6	855,4	4981,1	3743,7	-44,2	4,9	-1237,4	24,8
Luhansk	392,0	0,0	1391,1	0,0	-392,0	100	-1391,1	100,0
Lviv	315,3	306,4	1827,9	1403,9	-8,9	2,8	-424,0	23,2
Mikolayiv	950,5	616,5	3925,5	2011,4	-334,0	35,1	-1914,1	48,8
Odesa	1238,1	951,5	5105,4	3096,9	-286,6	23,1	-2008,5	39,3
Poltava	1010,7	1058,1	5979,6	4917,2	0	0	-1062,4	17,8
Rivne	318,9	318,9	1727,0	1345,7	0,0	0,0	-381,3	22,1
Sumy	722,1	641,2	4260,7	2913,2	-80,9	11,2	-1347,5	31,6
Ternopil	487,1	487,0	3303,7	2542,4	-0,1	0,0	-761,3	23,0
Kharkiv	1061,3	508,9	4936,9	1822,1	-552,4	52,0	-3114,8	63,1
Kherson	813,8	155,4	3528,8	485,6	-658,4	80,9	-3043,2	86,2
Khmelnytskiy	626,1	626,1	4830,8	3770,1	0,0	0,0	-1060,7	22,0
Cherkasy	708,1	706,1	5150,3	3850,0	-2,0	0,3	-1300,3	25,2
Chernivtsi	120,5	129,1	728,9	609,2	0	0	-119,7	16,4
Chernihiv	840,7	803,1	5977,1	3351,2	-37,6	4,5	-2625,9	43,9
Ukraine	**15948,4**	**12271,2**	**86010,4**	**53610,9**	**-3677,2**	**23,1**	**-32399,5**	**37,7**

Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022.

Table 3

Forecast of wheat production and crop losses by regions of Ukraine, 2022

Regions of Ukraine	Wheat area, thsd. ha		Wheat production, thsd. t		Losses of cultivated areas, compared to 2021		Wheat harvest losses compared to 2021	
	2021	2022 (forecast)	2021	2022 (forecast)	thsd.ha	%	thsd. t	%
Vinnytsya	317,4	351,5	1767,2	1431,0	34,1	+10,7	-336,2	19,0
Volyn	165,4	181,3	718,0	726,9	15,9	+9,6	8,9	-1,2
Dnipropetrovsk	561,1	561,1	2468,9	2222,0	0,0	0,0	-246,9	10,0
Donetsk	380,8	70,6	1548,6	228,0	-310,2	81,5	-1320,6	85,3
Zhytomyr	162,1	162,1	754,0	650,0	0,0	0,0	-104,0	13,8
Zakarpattya	24,2	28,9	81,5	92,4	4,7	+19,4	10,9	-13,4
Zaporizhzhya	706,7	133,6	2716,6	481,0	-573,1	81,1	-2235,6	82,3
Ivano-Frankivsk	47,4	70,3	235,8	282,6	22,9	+48,3	46,8	-19,8
Kyiv	208,3	181,2	1053,9	793,7	-27,1	13,0	-260,2	24,7
Kirovohrad	383,6	383,6	1868,9	1503,7	0,0	0,0	-365,2	19,5
Luhansk	281,5	0,0	1080,7	0,0	-281,5	100,0	-1080,7	100,0
Lviv	167,1	180,6	824,4	756,7	13,5	+8,1	-67,7	8,2
Mikolayiv	480,3	343,3	2029,9	1253,0	-137,0	28,5	-776,9	38,3

Regions of Ukraine	Wheat area, thsd. ha		Wheat production, thsd. t		Losses of cultivated areas, compared to 2021		Wheat harvest losses compared to 2021	
	2021	2022 (forecast)	2021	2022 (forecast)	thsd.ha	%	thsd. t	%
Odesa	678,5	547,6	2642,8	1796,1	-130,9	19,3	-846,7	32,0
Poltava	249,5	260,5	1203,9	932,6	11,0	+4,4	-271,3	22,5
Rivne	114,6	114,6	539,2	467,6	0,0	0,0	-71,6	13,3
Sumy	195,5	187,7	928,9	756,4	-7,8	4,0	-172,5	18,6
Ternopil	205,5	229,5	1139,4	941,0	24,0	+11,7	-198,5	17,4
Kharkiv	589,4	299,3	2830,9	1062,5	-290,1	49,2	-1768,4	62,5
Kherson	503,7	98,3	2073,4	333,4	-405,4	80,5	-1740,0	83,9
Khmelnytskiy	219,3	233,9	1317,0	933,3	14,6	+6,7	-383,7	29,1
Cherkasy	227,8	227,8	1228,9	945,4	0,0	0,0	-283,5	23,1
Chernivtsi	34,6	49,6	173,9	191,5	15,0	+43,4	17,6	-10,1
Chernihiv	185,9	182,2	924,3	685,0	-3,7	2,0	-239,3	25,9
Ukraine	**7090,2**	**5079,1**	**32151,0**	**19465,6**	**-2011,1**	**28,4**	**-12685,4**	**39,5**

Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022.

A reduction in the region under corn is predicted in the amount of 0.7 million hectares (by 12%), and crop losses are estimated at 14.4 million tons, which is 34.3% lower than in 2021. (Table 4).

Table 4

Forecast of corn production and loss by region of Ukraine, 2022

Regions of Ukraine	Corn area, thsd. ha		Corn production, thsd. t		Losses of cultivated areas, compared to 2021		Corn harvest losses compared to 2021	
	2021	2022 (forecast)	2021	2022 (forecast)	thsd.ha	%	thsd. t	%
Vinnytsya	456,7	449,5	4279,4	2638,6	-7,2	1,6	-1640,8	38,3
Volyn	58,2	40,7	501,1	307,7	-17,5	30,1	-193,4	38,6
Dnipropetrovsk	303,5	290,2	1574,4	1282,6	-13,3	4,4	-291,8	18,5
Donetsk	56,1	11,8	238,8	41,5	-44,3	79,0	-197,3	82,6
Zhytomyr	273,9	225,8	2261,0	1655,2	-48,1	17,6	-605,8	26,8
Zakarpattya	53,0	47,3	267,6	228,5	-5,7	10,8	-39,1	14,6
Zaporizhzhya	36,9	6,7	278,5	39,2	-30,2	81,8	-239,3	85,9
Ivano-Frankivsk	70,6	48,6	635,8	361,6	-22,0	31,2	-274,2	43,1
Kyiv	357,9	359,7	3104,2	2111,2	1,8	-0,5	-993,0	32,0
Kirovohrad	353,5	394,2	2483,8	1801,5	40,7	-11,5	-682,3	27,5
Luhansk	55,9	0,0	161,0	0,0	-55,9	100,0	-161,0	100,0
Lviv	83,4	66,4	755,0	517,9	-17,0	20,4	-237,1	31,4
Mikolayiv	121,4	79,9	634,4	305,1	-41,5	34,2	-329,3	51,9
Odesa	137,4	125,4	838,1	584,2	-12,0	8,8	-253,9	30,3
Poltava	642,8	599,4	4362,2	2925,1	-43,4	6,8	-1437,1	32,9
Rivne	109,9	78,4	892,1	591,1	-31,5	28,7	-301,0	33,7
Sumy	459,9	441,3	3116,3	3221,5	-18,6	4,0	105,2	-3,4
Ternopil	176,0	144,0	1737,3	1061,3	-32,0	18,2	-676,0	38,9
Kharkiv	286,8	167,4	1475,0	852,1	-119,4	41,6	-622,9	42,2
Kherson	59,0	9,4	533,3	84,0	-49,6	84,1	-449,3	84,3
Khmelnytskiy	303,1	261,3	3117,2	1701,3	-41,8	13,8	-1415,9	45,4
Cherkasy	406,1	420,2	3634,5	2344,6	14,1	-3,5	-1289,9	35,5
Chernivtsi	64,0	56,6	477,8	357,7	-7,4	11,6	-120,1	25,1
Chernihiv	555,8	499,8	4751,1	2653,8	-56,0	10,1	-2097,3	44,1
Ukraine	**5481,8**	**4823,8**	**42109,9**	**27667,1**	**-658,0**	**12,0**	**-14442,8**	**34,3**

Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022.

As for barley, the situation in this segment is also rather complicated. The distribution between winter and summer crops was formed in the ratio of 45% to 55%, respectively. At the same time, a significant share of both winter and spring crops is located in dangerous areas. Thus, the total share of winter grain crops for the 2022 harvest in dangerous regions is estimated at almost 44% of its total area. The key regions where expansion is possible are Poltava, Ternopil, Vinnytsia, and Khmelnytskyi regions, which traditionally produce sufficiently high yields of spring barley. The reduction in the area under barley is estimated at 0.8 million hectares or 32%, and crop losses will amount to 4.4 million tons, which is almost 50% below the level of 2021 (Table 5).

Table 5

Forecast of production and loss of barley harvest by regions of Ukraine, 2022

Regions of Ukraine	Barley area, thsd. ha		Barley production, thsd. t		Losses of cultivated areas, compared to 2021		Barley harvest losses compared to 2021	
	2021	2022 (forecast)	2021	2022 (forecast)	thsd.ha	%	thsd. t	%
Vinnytsya	93,8	88,6	433,0	275,5	-5,2	5,5	-157,5	36,4
Volyn	32,8	33,4	111,6	104,2	0,6	+1,8	-7,4	6,6
Dnipropetrovsk	249,3	228,4	810,9	701,1	-20,9	8,4	-109,8	13,5
Donetsk	116,6	22,7	350,4	60,2	-93,9	80,5	-290,2	82,8
Zhytomyr	35,5	29,2	141,0	78,3	-6,3	17,7	-62,7	44,5
Zakarpattya	1,9	2,3	5,6	6,3	0,4	+21,1	0,7	-12,5
Zaporizhzhya	194,7	39,4	684,5	124,8	-155,3	79,8	-559,7	81,8
Ivano-Frankivsk	25,3	27,9	109,8	86,2	2,6	+10,3	-23,6	21,5
Kyiv	70,4	63,0	284,7	200,9	-7,4	10,5	-83,8	29,4
Kirovohrad	132,4	117,6	535,4	370,4	-14,8	11,2	-165,0	30,8
Luhansk	40,7	0,0	112,8	0,0	-40,7	100,0	-112,8	100,0
Lviv	38,4	39,8	183,5	129,0	1,4	+3,6	-54,5	29,7
Mikolayiv	307,2	179,2	1159,3	510,8	-128,0	41,7	-648,5	55,9
Odesa	370,3	264,8	1498,9	683,1	-105,5	28,5	-815,8	54,4
Poltava	89,5	84,9	325,9	288,7	-4,6	5,1	-37,2	11,4
Rivne	45,2	45,4	172,6	142,6	0,2	+0,4	-30,0	17,4
Sumy	32,5	35,2	127,2	107,3	2,7	-8,3	-19,9	15,6
Ternopil	83,6	99,6	374,1	293,8	16,0	+19,1	-80,3	21,5
Kharkiv	136,1	85,8	502,3	260,0	-50,3	37,0	-242,3	48,2
Kherson	209,8	33,4	813,0	107,5	-176,4	84,1	-705,5	86,8
Khmelnytskiy	71,5	69,6	319,6	209,4	-1,9	2,7	-110,2	34,5
Cherkasy	54,8	45,9	228,6	140,5	-8,9	16,2	-88,1	38,6
Chernivtsi	18,3	19,4	67,3	66,6	1,1	+6,0	-0,7	1,0
Chernihiv	21,5	23,5	85,0	68,6	2,0	+9,2	-16,4	19,3
Ukraine	**2472,1**	**1678,9**	**9437,0**	**5015,7**	**-793,2**	**32,1**	**-4421,3**	**46,9**

Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022

According to our calculations, the reduction of the gross output of the grain market in 2022 compared to 2021 is almost 40% (from 271.4 to 169.2 billion UAH). Gross production will decrease the most for such grain crops as millet (by 55%), sorghum (by 54.1%), barley (by 46.9%), rye (by 46.3%), wheat (by 39.5%), corn (by 34.3%) (Table 6).

Table 6

Calculation of the gross output of the grain market of Ukraine for 2022

Types of grain crops	Production, thsd. t			Constant prices of 2016, UAH/t	Cost in constant prices of 2016, UAH million			2022 to 2021, %	2022 to 2020, %
	2020	2021	2022 (forecast)		2020	2021	2022 (forecast)		
Total	**64932,9**	**86010,4**	**53610,9**	**3156,9**	**204984,1**	**271351,1**	**169244,3**	**62,4**	**82,6**
wheat	24877,4	32151	19465,6	3117,2	77547,9	100221,2	60678,2	60,5	78,2
Rye	456,8	593,2	318,7	2954,1	1349,4	1752,2	941,5	53,7	69,8
buckwheat	97,6	105,8	84,3	12277,5	1198,8	1298,7	1035,0	79,7	86,3
Corn	30290,3	42109,9	27667,1	3179,7	96314,2	133896,7	87973,1	65,7	91,3
barley	7636,3	9437	5015,7	2966,7	22654,7	27996,8	14880,1	53,1	65,7
pea	478,9	566,3	290,3	4891	2342,2	2769,6	1419,9	51,3	60,6
oat	510	467,9	419,5	3081,5	1571,6	1441,8	1292,7	89,7	82,3
millet	256,1	205	92,2	3196,8	818,5	655,3	294,7	45,0	36,0
sorghum	106,6	173,2	79,4	3424	364,9	592,9	271,9	45,9	74,5
rice	60,7	49,5	28,5	5936,9	360,3	293,8	169,2	57,6	47,0
other cereals	162,2	151,8	149,6	2846	461,7	432,1	425,8	98,5	92,2

Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022 and Lupenko, Nechiporenko et al., 2022.

Regarding the forecast estimates of the actual losses of products of the grain market of Ukraine in the current 2022, the decrease will amount to UAH 204 billion, or almost EUR 7 billion. The biggest losses will be experienced by the production of corn – EUR 3 billion, wheat – EUR 2.7 billion, barley – EUR 0.9 billion (Table 7).

Table 7

Calculation of actual losses of products of the grain market of Ukraine in 2022, million UAH/million EUR

Types of grain crops	Production, thsd. t		Average prices in 2021, UAH/t	Cost in actual prices of 2021, UAH million		Market losses, UAH million	Market losses, EUR million
	2021	2022 (forecast)		2021	2022 (forecast)		
Total	**86010,4**	**53610,9**	**6296,1**	**541530,1**	**337539,6**	**-203990,5**	**-6799,7**
wheat	32151	19465,6	6433,6	206846,7	125233,9	-81612,8	-2720,4
rye	593,2	318,7	4470,5	2651,9	1424,7	-1227,2	-40,9
buckwheat	105,8	84,3	17909,2	1894,8	1509,7	-385,0	-12,8
corn	42109,9	27667,1	6245,5	262997,4	172794,9	-90202,5	-3006,8
barley	9437	5015,7	5862,6	55325,4	29405,0	-25920,3	-864,0
pea	566,3	290,3	5608,5	3176,1	1628,1	-1547,9	-51,6
oat	467,9	419,5	4948,1	2315,2	2075,7	-239,5	-8,0
millet	205	92,2	6559	1344,6	604,7	-739,9	-24,7
sorghum	173,2	79,4	7018,1	1215,5	557,2	-658,3	-21,9
rice	49,5	28,5	9007,7	445,9	256,7	-189,2	-6,3
other cereals	151,8	149,6	5622,2	853,4	841,1	-12,4	-0,4

Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022 and Lupenko, Nechiporenko et al., 2022.

Actual (for 2020 and 2021) and prognostic for 2022 production balances were made to determine the extent of destructive shifts occurring in the grain market of Ukraine (Table 8).

Table 8

Grain market product balances for 2020-2022, thsd. t

Balance sheet figure	2020			
	Cereal crops	Wheat	Corn	Barley
Total offer	**65126**	**24986**	**30315**	**7645**
Production	64933	24877	30290	7636
Import	193	109	25	9,2
Total demand	**71395**	**26228**	**35166**	**8332**
Domestic demand	20082	8168	7220	3286
Industrial processing	1040	128	632	264
Consumption fund	5379	4473	156	159
Seeds for sowing	2247	1416	197	527
Using for animal feed	11416	2151	6235	2336
Export	51313	18060	27946	5046
Changes of stocks +, -	-6269	-1242	-4851	-686,8
Production per person, kg	1555,3	595,9	725,5	182,9
	2021			
Total offer	**86195**	**32169**	**42129**	**9477**
Production	86010	32151	42110	9437
Import	185	18,1	18,8	39,7
Total demand	**71302**	**28944**	**29634**	**9129**
Domestic demand	20505	8873	4959	3473
Industrial processing	1456	263	473	501
Consumption fund	5684	5033	154	69
Seeds for sowing	2229	1082	131	565
Using for animal feed	11136	2495	4201	2338
Export	50797	20071	24675	5656
Changes of stocks +, -	14893	3225	12495	348
Production per person, kg	2078,5	777,0	1017,6	228,1
	2022 (forecast)			
Total offer	**53335**	**19483**	**27688**	**5029**
Production	53210	19465,6	27667,1	5015,7
Import	125	17,5	21,1	12,8
Total demand	**47402**	**19292**	**19026**	**4994**
Domestic demand	17732	7567	4614	2608
Industrial processing	1264	179	435	275
Consumption fund	5215	4365	147	87
Seeds for sowing	2117	928	125	328
Using for animal feed	9136	2095	3907	1918
Export	29670	11725	14412	2386
Changes of stocks +, -	5933	191	8662	35
Production per person, kg	1404,7	513,9	730,4	132,4

Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022 and Cheremisina, Pedorchenko, 2021.

Based on balances, the unlimited supply of grain will decrease by almost 33 million tons in 2022, in particular: wheat – by 12.7, corn – by 14.4, barley – by 4.4 million tons. Accordingly, grain production per person will decrease to 1,405 kg (compared to 2,079 kg in 2021). Industrial processing of grain crops will decrease by 13.2% (from 1,456 to 1,264 thousand

tons), the consumption fund will decrease by 8.3% (from 5,684 to 5,215 thousand tons), and animal feed costs by 18% (from 11,136 up to 9136 thousand tons).

The leading factors that will influence the more isolated formation of internal consumption of grain crops currently obtain the following:

- further development of military events on the territory of Ukraine;
- setting up logistics for raw materials and finished products within the country and ensuring export and import in critical segments;
- the current state and level of realization of the capacity potential of grain processing enterprises by the present military situation;
- provision of state support to enterprises in the grain processing industry;
- formation of demand in the livestock industry;
- the present level of risks of damage to objects of the grain storage system;
- the more isolated activity of migration processes in the country. In most cases, there will be no shortage in the grain market in Ukraine.

Accordingly, no significant problems are expected with providing Ukrainians with grain processing products. The available fodder base will be sufficient to support a functioning livestock industry. However, the military risks remain exceptionally considerable, and the situation can change at any moment.

At the same moment, the following negative trends are taking place. Like so, against the background of export problems, the price of wheat in Ukraine on EXW (own delivery) terms for the period from May 23 to June 27 decreased by 31.1% - from 5.9 to 4.5 thousand UA/t. During a similar period, the price of EXW corn decreased from UA 5,750 to UA 4,750/t, or by 17.4%, and barley – from UA 6.4 to 4,500/t, or by 29.7% (Agropravda, 2022).

The current price policy for grain crops in Ukraine is extremely unfavourable for farmers. The costs of growing grain crops have increased and surpassed sales prices. Production is below the profitability limit, and farmers receive significant losses. However, notwithstanding at such minimum prices, it is challenging to sell grain products. Without the unblocking of Ukrainian seaports, the losses of participants in the grain market will be scarcely greater.

The export of grain from Ukraine in the recent marketing season, which begins in July, may reach 30 million tons, provided that the throughput capacity of crossings at the borders of Ukraine is doubled and the ports are unblocked. Without this, Ukraine can count on no more than 12-18 million tons in the 2022/2023 marketing year. As experts note, without the complete unblocking of the ports, the surplus of grain will amount to 55 million tons (LandLord, 2022).

Shipping in the Black Sea ports of Ukraine stays extremely dangerous. The Russian Navy can prevent and capture civilian vessels. Even the release of Island Zmeiny does not ensure the unblocking of the ports, subjected to rocket and artillery fire every day, especially in the

city of Mykolaiv, where the largest logistics facilities are concentrated, and the entrance to the Dnipro-Buzky estuary remains under Russian control.

Turkey is ready to provide 20 vessels for the safe export of grain from Ukraine through "grain corridors." Lithuania, Romania, and other countries are equally making efforts so that Ukraine can transport food by rail. Greece offered its vessels to export Ukrainian grain. British reconnaissance planes can patrol "grain corridors." This will help ensure sea routes for the export of Ukrainian grain.

According to the Ministry of Agrarian Policy and Food, since the beginning of the full-scale war, the invaders have already taken more than 500,000 tons of seed from the occupied territory of Ukraine. The EU's decision to develop markets for Ukraine is a significant gesture of support for the state in wartime conditions.

However, residents of the European Union will also benefit from it. The war in Ukraine caused a global disruption of agricultural supply chains. As a result, prices for this product have risen sharply. Thus, the cost of wheat in European countries has increased by 50% since February. Other crops are also becoming more expensive, and all this will cause other food products to rise in price.

4. Conclusions

Because of the above, we state that the functioning and further stabilization of the grain market in Ukraine will depend on the following factors:

- further development of the situation in Ukraine due to Russia's armed aggression;
- conducting active hostilities in the southern, eastern, and northern regions and constantly changing front lines;
- mining of a significant part of territories, including agricultural land;
- the possibility of setting up logistics, the level of road destruction and the shortage of fuel and drivers, as a result of which the delivery of seeds, plant protection products, and fertilizers is significantly complicated;
- financing, as many agricultural commodity producers expected to sell present stocks of grain and oil crops in the spring before the sowing campaign to replenish circulating resources. This issue is extremely acute in regions close to the front line, where trade is significantly slow;
- availability of resources – not having the opportunity to properly prepare for the situation and taking into account logistical problems, farmers will use the limited number of resources available in their regions;
- the terms and scope of solving the problem of unblocking Ukrainian ports and establishing export corridors for the export of grain.

Ukraine has sent the European Union a specific list of the aid it needs to preserve its agricultural sector. The European Commission will coordinate the assistance. First of all, the European Commission proposes creating so-called "solidarity routes" for the export of grain from Ukraine.

Such routes should alleviate the difficulties currently arising at the borders between Ukraine and the EU. On this day, thousands of wagons and trucks expect 16-30 days for permission to span the border. A relatively serious problem is the different way widths of the Ukrainian railway network and the EU, so most of the cargo needs to be transshipped onto trucks or wagons that conform to the standard EU track. This process takes a long time, and there are few transhipment facilities along the borders.

The European Commission offers the following practical solutions:

- to provide other vehicles to Ukraine as EU market participants;
- create a logistics platform on which partners will be sought and special contact points will be appointed;
- to give priority status to Ukrainian grain export flows at transhipment terminals;
- to ensure prompt and urgent movement of mobile grain loaders by market participants to relevant border terminals to speed up grain transportation;
- to ensure the acceleration of customs procedures at checkpoints.

The EU also plans to increase capacity for the temporary storage of Ukrainian grain exports. The construction of temporary elevators in Poland near Ukraine (where the broad tracks from Ukraine end) will facilitate the process of overloading and increase the carrying capacity of vehicles. In the medium and long term, the Commission will also work on extending the throughput and infrastructure development of new export grain corridors.

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