Assessment of the impact of Ukrainian grain exports on the food security of the middle east and north African countries using the regression modeling method

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Abstract. The study aimed to assess the economic significance of Ukrainian wheat exports and their role in supporting food security in import-dependent Middle East and North Africa (MENA) countries under war pressures. Destination-specific trade data for 2012-2023 were summarised and tested through correlation analysis and linear regression to capture price-volume-revenue interactions. An additional cross-country regression block for 2020-2022 related the share of Ukrainian wheat in national import structures to Global Food Security Index (GFSI) outcomes. It was established that reliance on Ukrainian wheat had been concentrated in several MENA markets, with the sharpest pre-war exposure observed in Egypt, Tunisia, Libya and Lebanon, and that import portfolios were reconfigured after 2022. It was demonstrated that export price remained the main short-run determinant of shipments to the region. It was found that price increases were associated with a marked contraction of export volumes and a decline in total export earnings within the observed range. It was also shown that higher export volumes were linked to only modest reductions in unit prices, implying potential for volume recovery without major price penalties if logistical

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frictions were eased. It was analysed that the association between Ukrainian import shares and GFSI shifted towards a more supportive pattern during the acute 2022 supply shock. It was generalised that the strongest food-security sensitivity to Ukrainian supplies appeared in countries with higher undernourishment and medium GFSI levels. The results may be used by Ukrainian trade authorities, multilateral organisations and MENA procurement agencies to calibrate corridor support, risk-sharing and diversification measures

INTRODUCTION

The war initiated by the Russian Federation against Ukraine in 2014 substantially disrupted Ukrainian grain exports and intensified vulnerability in import-dependent food systems, particularly in the Middle East and North Africa (MENA). The relevance of examining this topic was grounded in the structural role of wheat in basic diets, the limited short-run substitution for lower-income households, and the fiscal sensitivity of many MENA states to staple price inflation. Under such conditions, instability in Ukrainian export availability was not confined to a bilateral trade disturbance but was linked to broader risks for market predictability, household access to food, and the capacity of governments to sustain affordable bread and stable procurement strategies in environments characterised by climatic constraints and chronic import reliance.

The international literature published in the last few years provided a clear conceptual framing of these risks and the policy logic required to mitigate them. T. Ben Hassen and H. El Bilali (2022) argued that the conflict exposed deeper structural fragilities in global grain systems and that resilience was more likely to be achieved through diversification, strategic reserves, and sustainability-oriented reforms than through short-lived emergency measures. In a complementary macro-level assessment, K.A. Abay *et al.* (2023) emphasised that the war generated intertwined global and regional effects through connected commodity markets, implying that responses needed to account for price transmission, supply bottlenecks, and unequal exposure across importing regions rather than relying on single-country solutions. Evidence on network-based propagation further strengthened the case for a more granular assessment of dependence on Ukrainian supplies. L. Liu *et al.* (2023) demonstrated that grain trade shocks associated with the conflict produced cascading impacts across countries because import portfolios were interlinked and substitution by large buyers tightened availability for others. This interpretation implied that MENA vulnerability was shaped not only by direct import shares from Ukraine but also by competitive displacement when other importers reoriented demand towards alternative suppliers, thereby raising procurement costs for states with limited fiscal space.

Region-specific analyses also clarified the social and political salience of wheat stability in the Middle East. M. Al-Saidi (2023) observed that the war aggravated pre-existing food security pressures by combining import dependence with inflationary dynamics and constrained public budgets, which reduced the effectiveness of compensatory measures. A market-oriented perspective offered by J. Janzen and C. Zulauf (2023) connected reductions in Ukrainian corn and wheat supply to shifts in global trade flows and price adjustments, indicating that procurement outcomes for MENA countries were influenced by rapid reconfiguration of the wider international grain system rather than by bilateral arrangements alone.

Ukrainian scholarship added indispensable explanation of the domestic channels through which war conditions affected export feasibility and, indirectly, regional food security in importing states. T.O. Ostashko (2023) analysed grain exports under wartime conditions and highlighted logistics disruption and route reconfiguration as decisive constraints on volumes, timing, and costs of deliveries. S. Cheremisina *et al.* (2025) also assessed structural changes in Ukrainian grain exports and the wartime price environment, reinforcing the argument that export performance needed to be interpreted through the combined effects of security risk, transaction costs, and institutional adaptation rather than through production capacity alone. The relationship between export reliability and internal supply formation was also addressed in recent Ukrainian studies that focused on national food security under conditions of military aggression. L. Artemenko *et al.* (2023) considered the state and prospects of Ukraine's food security and showed that balancing domestic stability with external market obligations became more complex under heightened uncertainty. A. Shevchenko and O. Petrenko (2024) examined priority directions for regulating Ukraine's food security in wartime and underscored the importance of coherent state instruments that protected vulnerable groups while preserving market incentives. H. Fyliuk and S. Kuchyn (2025) linked internal determinants of grain supply to broader questions of food security and implied that the stability of exportable surplus remained sensitive to domestic cost pressures and governance conditions even when external demand was strong.

Despite the breadth of these contributions, the literature tended to treat global price transmission, regional vulnerability, and Ukrainian domestic constraints as

partially separate analytical problems. The interaction between Ukraine's export price-volume dynamics and the food security sensitivity of specific MENA importers therefore remained insufficiently integrated into a single quantitative assessment that could support policy design. The present study aimed to assess how changes in Ukrainian wheat export volumes and prices were associated with import dependence and food security indicators across selected MENA countries under war-related supply disruptions.

MATERIALS AND METHODS

The study was based on a combination of theoretical, descriptive-analytical and econometric procedures that were selected to match the empirical variables, country coverage and time windows used in the analytical part of the research. At the theoretical stage, the concept of food security was operationalised through the dimensions of availability, access and adequacy, which allowed trade disturbances in wheat supply chains to be interpreted as potential welfare risks for import-dependent economies (Food and Agriculture Organization, n.d.; FAO, IFAD, UNICEF, WFP, & WHO, 2022). This framework guided the selection of socio-economic and food-security indicators applied in the comparative and econometric blocks.

The information base combined internationally comparable statistical repositories and official national data sources. Macroeconomic, demographic and structural agricultural indicators for the Middle East and North Africa were obtained from World Bank databases and Statista, while undernourishment and global food-security benchmarks were aligned with FAO-linked monitoring and UN joint assessments to ensure conceptual and metric consistency across countries (World Bank, n.d.; Statista, n.d.). A cross-sectional regional profile was compiled for 2024 to provide a синхроnised baseline of population, GDP per capita, human development characteristics, the prevalence of undernourishment, the Global Food Security Index and the share of agriculture in GDP for the MENA states included in the regional dataset: Algeria, Saudi Arabia, Bahrain, Djibouti, Egypt, Iraq, Iran, Israel, Yemen, Jordan, Qatar, Kuwait, Lebanon, Libya, Morocco, Oman, Sudan, the Syrian Arab Republic, Tunisia and the United Arab Emirates (IndexBox, 2025; World Bank, n.d.).

Ukraine's destination-specific wheat export series were obtained from the State Statistics Service of Ukraine and were cross-checked against FAO trade data to support uniform calculation of dependence measures (State Statistics Service of Ukraine, n.d.; Food and Agriculture Organization, n.d.). Two indicators were calculated for 2012-2023: the share of Ukrainian wheat in the total wheat imports of the selected MENA countries and the share of exports to these destinations within Ukraine's total wheat exports, with the extended pre-war period retained to capture baseline

variability and the 2022-2023 interval preserved to reflect the immediate wartime disruption. Correlation analysis was applied to determine the direction and strength of associations between export price, export volume and export value, and linear regression models were specified to quantify these relationships in line with the trinity structure of the export-price and export-performance estimations. A separate regression block was applied for 2020-2022 to evaluate the association between the share of Ukrainian wheat in national import structures and GFSI values, with particular analytical attention directed to Saudi Arabia, Egypt, Morocco, Tunisia, Israel and Yemen as the cases that demonstrated the most pronounced reductions in Ukrainian wheat import shares after 2022 within the compiled dataset (Food and Agriculture Organization, n.d.; State Statistics Service of Ukraine, n.d.).

RESULTS AND DISCUSSION

Food security was interpreted as the ability of populations to maintain physical and economic access to sufficient, safe, and nutritious food consistent with dietary needs and food preferences (Food and Agriculture Organization, n.d.). The empirical focus therefore relied on revealing how the war in Ukraine altered the stability of wheat supply chains relevant for the Middle East and North Africa (MENA) and how these shifts coincided with broader socio-economic asymmetries inside the region. The disruption of Black Sea logistics and the heightened uncertainty in global grain markets were reflected in accelerating price dynamics during the initial stage of the full-scale invasion. The FAO Food Price Index (FFPI) was used as an indicative reference for the global market shock, given that it captured price movements across the major traded food commodity groups (Food and Agriculture Organization, n.d.). In March 2022 the FFPI reached 159.3 points, representing a 12.6% increase relative to February 2022, while wheat prices climbed to a record level of USD 522.29 per metric ton in May 2022 compared with USD 390.58 per metric ton earlier in the year. Such price escalation implied a direct deterioration of import affordability for structurally import-dependent economies and intensified the vulnerability of MENA food systems to exogenous supply shocks.

A structural precondition for uneven exposure to this shock was the pronounced heterogeneity of MENA countries in terms of population size, income capacity, human development, and the weight of agriculture in national economies. The World Bank classification of the region as comprising 21 countries provided the basis for comparability, while the 2024 cross-sectional indicators allowed for capturing the latest pre-model snapshot of socio-economic conditions used for contextual interpretation. Table 1 summarised the key comparative parameters that framed the degree of dependence on external wheat flows.

Country	Population, mln	GDP per capita, thsd USD	Human development index, rank	Human development index, value	The prevalence of undernourishment, %	Global food security index	Share of agriculture in GDP, %
Algeria	47.0	5.6	91	0.75	5.6	63.5	12.3
Saudi Arabia	35.3	35.1	40	0.85	5.2	70.1	2.4
Bahrain	1.6	30.0	39	0.87	3.1	70	0.9
Djibouti	1.2	3.5	170	0.51	7.9	45.2	7.5
Egypt	116.5	3.3	116	0.71	5.3	53.4	11.3
Iraq	46.0	6.1	123	0.67	6.5	50	4.8
Iran	91.6	4.8	70	0.8	7.0	57.5	9.2
Israel	10.0	54.2	19	0.92	2.5	80	1.2
Yemen	34.9	0.4	179	0.47	12.0	40	10.0
Jordan	11.4	4.6	98	0.74	4.5	60	3.5
Qatar	2.9	80.4	42	0.85	1.8	75	0.5
Kuwait	4.4	32.2	56	0.8	3.2	65	1.0
Lebanon	5.0		87	0.74	5.0	55	4.0
Libya	7.0	6.1	94	0.74	6.0	52.5	8.0
Morocco	38.0	3.9	129	0.69	4.8	58	14.0
Oman	5.3	20.2	41	0.85	3.0	72.5	2.0
Sudan	45.9	0.6	173	0.51	9.0	47.5	13.0
Syrian Arab Republic	24.7	0.8	171	0.52	10.0	45	15.0
Tunisia	12.5	4.4	85	0.74	4.0	60	12.0
United Arab Emirates	10.0	49.4	23	0.89	2.0	78	0.8

Table 1. *Social and economic characteristics of MENA countries in 2024*

Source: *compiled by the authors based on IndexBox (2025), World Bank (n.d.), Statista (n.d.)*

A comprehensive measure of socio-economic development in the Middle East and North Africa was reflected by the Human Development Index, which synthesised health, education, and living standards. The intra-regional contrasts presented in Table 1 were consistent with the HDI distribution: Israel ranked 19th globally, the United Arab Emirates 23rd, Bahrain 39th and Saudi Arabia 40th, whereas Yemen ranked 179th, Sudan 173rd and Djibouti 170th out of 193 assessed countries. This gradient in human development suggested that exposure to food shocks and the capacity to absorb import price increases differed substantially across the region, which provided an important interpretative context for the disparities in undernourishment prevalence and the Global Food Security Index values shown in Table 1 (World Bank, n.d.; Statista, n.d.). Structural pressure on domestic food production was additionally shaped by aridity and chronic water scarcity, which constrained the contribution of agriculture to national income and reinforced the reliance of several economies on external cereal supplies. Food insecurity therefore remained a persistent regional challenge with clear security implications. The dependence on imported cereals amplified this vulnerability: R. Rahimi *et al.* (2023) demonstrated that a considerable share of MENA cereal imports during 2015-2020 originated from Russia and Ukraine, highlighting the systemic exposure of the region to supply disruptions in the Black Sea corridor. This background allowed the role of Ukraine to be interpreted not as a general trade issue but as a measurable determinant of import stability for a number of MENA states.

Ukraine was therefore treated as a strategic supplier of wheat to the region. T. Liulchenko (2023) indicated that Ukraine's position in global wheat trade remained significant in the pre-war period and that the subsequent contraction of exports intensified pressure on import-dependent markets. The regional consequences were particularly salient for countries with limited domestic wheat output or with structurally high consumption needs, despite partial self-sufficiency in selected cases such as Egypt. Given that several MENA states combined high population levels, non-negligible undernourishment, and constrained agricultural capacity, any instability in wheat supply chains was likely to intensify food stress. Against this context, the next analytical step was the empirical assessment of Ukraine's contribution to wheat imports in selected MENA countries and the corresponding share of these destinations in Ukraine's total wheat exports, which was operationalised through the import % and export % indicators summarised in Table 2 (Food and Agriculture Organization, n.d.; State Statistics Service of Ukraine, n.d.). The descriptive patterns suggested that Egypt, Lebanon, Libya, and Djibouti had exhibited the highest reliance on Ukrainian wheat in the pre-war years, while the post-2022 period was associated with a visible decline in this share, indicating a shift towards alternative suppliers and a reconfiguration of regional import structures.

Table 2. *The share of Ukrainian wheat in MENA countries' imports and in Ukraine's total wheat exports, 2012-2023*

Year / Country	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
EGYPT import %	22.1	19.0	25.5	16.9	21.6	20.5	11.2	33.9	34.2	57.4	10.9	14.2
EGYPT export %	29.1	25.2	27.0	13.4	13.4	15.4	8.5	17.7	17.0	16.5	7.7	7.2
YEMEN import %	2.5	1.7	6.3	2.3	0.0	5.1	17.1	21.1	23.3	26.0	9.4	4.8
YEMEN export %	1.2	0.7	2.0	0.5	0.0	0.9	3.2	3.3	3.9	4.0	2.7	0.7
ISRAEL import %	44.7	20.8	24.6	39.5	31.4	31.0	29.6	27.0	17.6	22.2	8.4	19.1
ISRAEL export %	8.9	3.8	3.7	4.3	3.0	3.0	3.4	2.3	1.6	1.8	1.3	1.7
LEBANON import %	37.7	17.9	31.6	37.9	76.6	61.9	49.9	82.8	99.8	84.4	n.a.	n.a.
LEBANON export %	2.3	1.4	1.8	1.8	2.3	2.3	1.8	2.2	3.7	3.2	3.7	2.6
LIBYA import %	25.0	16.9	17.9	12.8	25.8	20.9	44.2	99.8	48.2	44.9	44.0	33.7
LIBYA export %	4.7	4.1	2.9	1.1	1.7	1.5	3.9	3.5	3.0	2.8	1.1	0.4
SAUDI ARABIA import %	0.0	0.0	0.6	0.0	2.4	0.0	0.0	0.0	2.1	31.3	4.5	3.9
SAUDI ARABIA export %	0.0	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.4	3.5	1.6	0.9
TUNISIA import %	30.7	17.5	26.0	31.6	18.2	42.0	51.8	55.0	49.3	34.2	14.4	10.6
TUNISIA export %	5.8	3.3	4.1	4.6	2.2	4.7	6.3	5.1	5.4	3.2	2.4	0.9
ALGIERIA import %	0.1	0.0	0.3	1.2	1.8	1.1	0.3	0.5	0.1	2.1	6.9	0.5
ALGIERIA export %	0.1	0.0	0.2	0.8	0.8	0.5	0.1	0.2	0.03	0.8	4.3	0.2
BAHRAIN import %	0.0	40.6	0.0	0.04	0.09	0.04	0.0	0.0	0.0	0.0	0.032	n.a.
BAHRAIN export %	0.0	0.4	0.0	0.0002	0.0004	0.0003	0.0	0.0	0.0	0.0	0.0004	n.a.
DJIBOUTI import %	0.0	19.6	7.4	51.2	17.4	10.4	77.6	99.8	32.0	59.4	44.9	13.4
DJIBOUTI export %	0.0	1.7	0.3	2.6	0.4	0.2	1.0	0.8	0.1	1.0	0.6	0.2
IRAN import %	0.0	1.3	1.8	0.0	2.5	0.0	0.0	0.0	0.0	3.7	n.a.	n.a.
IRAN export %	0.0	0.7	1.2	0.0	0.2	0.0	0.0	0.0	0.0	1.3	n.a.	n.a.
IRAK import %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0013	0.0	0.0	n.a.	n.a.
IRAK export %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0001	0.0	0.0	n.a.	n.a.
JORDAN import %	43.6	34.1	31.6	0.024	2.8	11.8	10.3	21.1	25.6	7.4	n.a.	n.a.
JORDAN export %	4.7	3.0	2.8	0.001	0.3	0.6	0.7	0.9	1.2	0.3	n.a.	n.a.
KUWEIT import %	0.0	0.0	0.0	0.0	0.023	0.1	0.1	0.032	0.1	0.1	n.a.	n.a.
KUWEIT export %	0.0	0.0	0.0	0.0	0.001	0.002	0.001	0.001	0.002	0.002	n.a.	n.a.
MOROCCO import %	16.4	7.4	9.5	15.0	13.6	17.1	35.7	23.5	17.3	18.1	1.1	n.a.
MOROCCO export %	7.7	2.6	4.7	3.6	4.8	3.6	8.5	4.5	5.3	4.2	0.6	n.a.
OMAN import %	0.0	0.0	0.0	0.0	7.9	0.01	0.02	0.0	3.8	7.4	11.1	n.a.
OMAN export %	0.0	0.0	0.0	0.0	0.3	0.0003	0.001	0.0	0.1	1.0	0.5	n.a.
PALESTINE import %	8.1	0.0	0.028	0.0	0.0	0.0	0.0	0.0	0.0	0.0	n.a.	n.a.
PALESTINE export %	0.1	0.0	0.001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	n.a.	n.a.
SYRIA import %	57.1	38.7	26.7	67.2	26.8	0.0	0.0	0.0	0.0	0.0	0.02	0.1
SYRIA export %	2.2	7.7	1.4	2.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0008	0.003
UNITED ARAB EMIRATES import %	3.7	2.1	2.8	8.1	1.4	2.4	1.7	10.9	0.8	0.4	n.a.	n.a.
UNITED ARAB EMIRATES export %	0.9	0.5	0.4	0.5	0.1	0.1	0.1	0.7	0.1	0.0	n.a.	n.a.

Source: *compiled by the authors based on Food and Agriculture Organization (n.d.), State Statistics Service of Ukraine (n.d.)*

The primary determinants of long-term trade cooperation with Ukraine are transport distance and export price. It is also important to note that smaller-volume shipments ordered by MENA countries are more efficiently dispatched to African markets than, for example, to Asian destinations. Over long distances, bulk transport using high-capacity carriers is significantly more cost-effective. As shown in Table 2, the share of Ukrainian wheat exports directed to MENA countries remains modest, generally not exceeding 10% of Ukraine's total wheat exports. Egypt is a notable exception, accounting for more than 10% of Ukraine's exported wheat till 2022. Between 2012 and 2021, this share reached as high as 10-30%, positioning Egypt as a strategic importer of Ukrainian grain.

As previously mentioned, export price constitutes a critical factor in international grain trade. Prices are driven by conditions in the global grain market – specifically, supply and demand dynamics for wheat. Ultimately, the export price determines the level of revenue accrued by the exporting country. Table 3 presents the results of the authors' regression-based modeling, examining the relationship between grain export prices and export volumes, as well as the relationship between export value in US dollars and the export price.

Table 3. Regression modeling of grain export prices and export values		
Model "Price of export (P) – Volume of export (V)" **P = 351.9 - 0.0003*V**		
Forecast of the grain price		
Volume of export (V), tons	Price of export (P), dollars USD per ton	Deviation in price, %
144604.3	306.9	-
146050.3	306.4	-0.146
147510.8	305.9	-0.148
148985.9	305.5	-0.15
150475.8	305.1	-0.152
Model "Volume of export (V) – Price of export (P)" **V = 737160.1 - 1811.8*P**		
Forecast of the volume of export		
Price of export (P), dollars USD per ton	Volume of export (V), tons	Deviation in volume of export, %
299.2	195148.1	-
302.2	189728.1	-2.777
305.2	184253.8	-2.885
308.2	178724.7	-3.001
311.3	173140.4	-3.124
Model "Value of export (E) – Price of export (P)" **E = 131718.4 - 255.2*P**		
Forecast of the value of export		
Price of export (P), dollars USD per ton	Value of export, thsd. dollars USD	Deviation in value of export, %
299.2	55361.7	-
302.2	54598.1	-1.37
305.2	53826.8	-1.41
308.2	53047.9	-1.45
311.3	52261.2	-1.48

Source: *compiled by the authors based on Food and Agriculture Organization (n.d.), State Statistics Service of Ukraine (n.d.)*

The correlation-regression analysis reported in Table 3 indicated a stable inverse association between the export price of Ukrainian wheat and the volume shipped to MENA markets. Within the observed data range, increases in export price were associated with a contraction of export volumes, suggesting a high sensitivity of regional demand to affordability and confirming the central role of price competitiveness in sustaining deliveries to import-dependent states (Food and Agriculture Organization, n.d.; State Statistics Service of Ukraine, n.d.). The reciprocal specification also suggested that expansion of export volumes was not associated with a substantial decline in unit prices, implying that the market capacity for Ukrainian wheat could have supported volume-based strengthening of trade positions provided that logistical constraints and transaction costs were contained. The relationship between export prices and total export value also remained negative within the analysed period, indicating that price increases were accompanied by a reduction in export earnings due to the stronger contraction of shipped volumes than the gain in unit revenue.

Export prices during 2012-2023 demonstrated pronounced volatility, which was attributable to shifts in production costs, global market conditions, and, after 2022, war-related disruptions of logistics and trade routes. The blockade of Black Sea ports and the forced reorientation towards land and river corridors considerably changed the cost structure of exports. Under these conditions, monthly export volumes declined from pre-war peaks of around 5 million tonnes to approximately 1 million tonnes, while logistical costs increased several-fold (Nemtseva, 2022). The share of final market value retained by farmers reportedly decreased from about 80% under maritime export conditions to roughly 20% after the outbreak of hostilities, reflecting the growing dominance of transport and intermediary expenses in the price chain. Pre-war delivery to ports was estimated to have cost around USD 20 per ton, whereas wartime logistics to export markets reportedly rose to USD 150-200 per ton, which contributed to a steep decline in domestic price realisation to approximately USD 100-150 per ton. The increase in logistics costs was linked to higher fuel prices, longer transport routes, transshipment between gauge systems, extended storage in transit, and intensified customs and insurance-related frictions; service fees imposed by foreign logistics providers were also reported to have increased substantially (Tkachov, 2022). The agricultural losses associated with the war were significant, as estimates of direct damage to infrastructure and indirect losses from constrained cultivation and elevated export costs exceeded USD 42 billion (Jansen *et al.,* 2023).

The impact of the reduced share of Ukrainian wheat in regional import structures on food security outcomes was subsequently evaluated for 2020-2022 using the GFSI values from Table 1 and the import-share indicators from Table 2. The correlation dynamics presented

in Table 4 suggested that import dependence had been interpreted as a vulnerability factor in 2020-2021, whereas in 2022 imports were associated with a stabilising function in the context of the acute supply shock triggered by the war in Ukraine (Food and Agriculture Organization, n.d.; State Statistics Service of Ukraine, n.d.). This shift supported the rationale for the country-level models in Table 5 and justified the focus on those states that experienced the largest contractions of Ukrainian wheat supplies.

Table 4. *Dynamics of the impact of Ukrainian wheat imports on the global food security index (GFSI) of MENA Countries (2020-2022)*

Year	Correlation coefficient (r)	Direction of relationship	Nature of influence
2020	−0.31	weak negative relationship	Import is not a decisive factor for food security
2021	−0.63	moderate negative relationship	Import is vulnerable due to supply crises
2022	+0.52	moderate positive relationship	Import supports food stability

Source: *compiled by the authors based on Food and Agriculture Organization (n.d.), State Statistics Service of Ukraine (n.d.)*

To construct a correlation and regression model of the relationship between wheat import levels and the Global Food Security Index (GFSI), several MENA countries that experienced a sharp reduction in Ukrainian wheat supplies in 2022, following the onset of the war in Ukraine, were selected. For example, in Saudi Arabia, the share of Ukrainian wheat in the country's total wheat imports decreased from 31.3% in 2021 to 45% in 2022. In Egypt, the corresponding decline was from 57.4% to 10.9%, and in Morocco – from 18.1% to 1.1%. Table 5 presents the results of the correlation and regression analysis of the relationship between Ukrainian wheat import levels and the Global Food Security Index (GFSI) for the selected MENA countries.

Table 5. *Results of the correlation and regression analysis of the relationship between Ukrainian wheat import levels and the Global Food Security Index (GFSI) for MENA countries*

Model "Global Food Security Index (GFSI) – Share of Ukrainian Wheat in MENA Countries' Imports (I)" $GFSI = f(I)$				
Forecast of the Global Food Security Index				
Country	Regression equation	Correlation (r)	R²	Deviation in Global Food Security Index, %
Saudi Arabia	GFSI = 69.94 - 0.05I	-0.96	0.91	-0.03
Egypt	GFSI = 57.06 + 0.05I	0.49	0.24	+0.01
Israel	GFSI = 76.34 - 0.04I	-0.16	0.02	-0.01
Yemen	GFSI = 40.4 - 0.04I	-0.42	0.18	-0.05
Morocco	GFSI = 63 + 0.02I	0.12	0.01	+0.0004
Tunisia	GFSI = 60.03 + 0.03I	0.87	0.75	+0.005

Source: *compiled by the authors based on Food and Agriculture Organization (n.d.), State Statistics Service of Ukraine (n.d.)*

According to Table 5, a strong negative correlation (r = -0.96) is observed in Saudi Arabia, indicating that an increase in imports is associated with a decrease in the GFSI. In Tunisia, Egypt, and Morocco, conversely, a strong positive correlation (r = 0.87) shows that higher imports are associated with improved food security; specifically, a 1% increase in the share of Ukrainian wheat imports in these countries leads to an average increase of 0.003% in the Global Food Security Index. In other countries, the relationship is weak or moderate (r between -0.5 and 0.5). Thus, support for Ukrainian imports is particularly important for countries such as Egypt, Morocco, and Tunisia, where the prevalence of undernourishment is around 5%, that is already above the low level for MENA countries. In addition, the Global Food Security Index in these countries does not exceed 60 points, remaining at a medium level.

Continued support for Ukrainian wheat exports is critically important for all MENA countries in order to strengthen their food security, as the region remains highly dependent on grain imports. For Ukraine, this also represents a strategic direction that ensures foreign currency inflows and supports the agricultural sector in the post-war period. Furthermore, the stability of Ukrainian exports contributes to reducing global food price volatility and reinforces Ukraine's role as a reliable partner in the global grain market. The findings of the study indicate that the expansion of Ukrainian wheat exports is both necessary and feasible without significant price losses and providing sufficient market capacity, maintenance of competitive pricing, efficient logistics, implementation of price support instruments, and the development of sustainable trade relations. Ensuring stable supplies

of Ukrainian grain is crucial for maintaining the food security of MENA countries, where wheat availability is a key factor for social and economic stability.

The obtained results may be further interpreted in the broader context of structural changes in both the exporting and importing systems. The revealed price sensitivity of Ukrainian wheat demand in MENA was consistent with the wider global logic of wheat-market adjustment, where consumption growth and trade rebalancing increasingly depend on competitiveness and the capacity of suppliers to deliver stable volumes under volatility (Erenstein *et al.,* 2022). From this perspective, the pre-war positioning of Ukraine as a strong global actor in the grain market created a baseline of trust and path dependence in import portfolios that could not be fully replaced in the short run, even when alternative origins were actively sought (Savosh *et al.,* 2020). The wartime contraction of Ukrainian export reliability therefore appeared not only as a temporary logistical disturbance but as a structural shock that altered trade architecture and redistributed bargaining power across supply chains, which was in line with recent evidence on shifts in export structure and price conditions in Ukraine's grain market during the war (Cheremisina *et al.,* 2025).

At the same time, food-security outcomes in the most exposed MENA countries should be viewed through the lens of systemic resilience rather than import shares alone. The interaction between external supply risk and domestic institutional capacity suggested that the stabilising role of Ukrainian wheat became particularly visible in those states where socio-economic vulnerability was already pronounced, which echoed the argument that food security functions as a core pillar of broader socio-economic sustainability under crisis conditions (Hoblyk *et al.,* 2025). This implication also aligned with the observation that digital tools, early-warning systems and improved data governance may strengthen the adaptive capacity of MENA agri-food systems, although such gains remain constrained by unequal implementation and governance risks (Bahn *et al.,* 2021). Consequently, the empirical evidence supported a combined interpretation in which Ukraine's export stability and MENA's internal resilience measures jointly determined the magnitude of food-security effects, reinforcing the need for coordinated trade, logistics and digital modernisation strategies across both sides of the supply relationship.

CONCLUSIONS

It was concluded that Ukrainian wheat exports remained a structurally important stabiliser for food availability and affordability in the Middle East and North Africa, while also serving as a critical source of foreign-currency earnings for Ukraine under wartime constraints.

The longitudinal trade evidence for 2012-2023 indicated that MENA dependence on Ukrainian supplies was concentrated in a limited group of importers whose exposure was shaped by population scale, constrained domestic production, and limited short-run substitution away from wheat. The observed post-2022 reconfiguration of import portfolios suggested that supply risk in the Black Sea corridor triggered a rapid search for alternative origins, yet this diversification did not eliminate vulnerability for countries with tighter fiscal space and persistent undernourishment. The econometric results confirmed that price competitiveness was the dominant short-run determinant of Ukrainian shipments to the region. A clear inverse price-volume relationship was identified, implying that episodes of price escalation were likely to compress demand and reduce the physical presence of Ukrainian wheat in MENA procurement structures. At the same time, the weaker reverse effect – where higher export volumes were associated with only modest price adjustments – suggested that the market capacity for Ukrainian wheat could have supported recovery or selective expansion without substantial price erosion, provided that logistics, insurance costs, and transaction frictions were contained. The revenue specification further indicated that higher unit prices did not necessarily translate into higher aggregate export value because volume contraction outweighed the price effect within the analysed range.

It was also established that the food-security sensitivity to Ukrainian import shares appeared strongest in countries characterised by medium GFSI values and higher prevalence of undernourishment, where Ukrainian deliveries acted as a more visible stabilising input during the acute 2022 shock. These findings implied that policy efforts aimed at protecting and improving export route reliability, lowering wartime logistics costs, and expanding predictable contracting mechanisms could generate dual benefits: strengthening Ukraine's export resilience and reducing the probability of food-system stress in the most exposed MENA economies. Future studies should apply panel and high-frequency trade data to disentangle the relative effects of wartime logistics disruptions, global price cycles and domestic policy interventions on Ukrainian export stability and on heterogeneous food-security outcomes across individual MENA importers.

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Оцінювання впливу експорту українського зерна на продовольчу безпеку країн близького сходу та північної Африки методом регресійного моделювання

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Анотація. Метою дослідження було оцінити економічне значення експорту української пшениці та його роль у підтримці продовольчої безпеки в країнах Близького Сходу та Північної Африки (MENA), які залежать від імпорту та перебувають у стані війни. Дані про торгівлю за конкретними напрямками на 2012–2023 роки були узагальнені та перевірені за допомогою кореляційного аналізу та лінійної регресії з метою виявлення взаємозв'язків між ціною, обсягом та доходом. Додатковий міждержавний регресійний блок за 2020-2022 роки пов'язував частку української пшениці в національних структурах імпорту з результатами Глобального індексу продовольчої безпеки (GFSI). Було встановлено, що залежність від української пшениці була зосереджена на декількох ринках MENA, причому найрізкіше передвоєнне зростання спостерігалося в Єгипті, Тунісі, Лівії та Лівані, а після 2022 року імпортні портфелі були переформатовані. Було продемонстровано, що експортна ціна залишалася основним короткостроковим визначальним фактором поставок до регіону. Було встановлено, що зростання цін було пов'язане з помітним скороченням обсягів експорту та зниженням загальних доходів від експорту в межах спостережуваного діапазону. Було також показано, що більші обсяги експорту були пов'язані лише з незначним зниженням цін за одиницю, що вказує на потенціал відновлення обсягів без значних цінових втрат у разі пом'якшення логістичних труднощів. Було проаналізовано, що зв'язок між часткою українського імпорту та GFSI змінився на більш сприятливий під час гострого шоку пропозиції у 2022 році. Було зроблено узагальнення, що найсильніша чутливість продовольчої безпеки до українських поставок спостерігалася в країнах з вищим рівнем недоїдання та середнім рівнем GFSI. Результати можуть бути використані українськими торговельними органами, багатосторонніми організаціями та закупівельними агентствами MENA для калібрування заходів підтримки коридору, розподілу ризиків та диверсифікації

Ключові слова: цінова еластичність пшениці, логістика Чорноморського коридору, імпортна залежність, Глобальний індекс продовольчої безпеки, трансмісія торговельних шоків, чутливість експортної виручки