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THE ROLE OF THE GRAIN MARKET IN ENSURING FOOD SECURITY OF THE REPUBLIC OF KAZAKHSTAN

ҚАЗАҚСТАН РЕСПУБЛИКАСЫНЫҢ АЗЫҚ-ТҮЛІК ҚАУІПСІЗДІГІН ҚАМТАМАСЫЗ ЕТУДЕГІ АСТЫҚ НАРЫҒЫНЫҢ РӨЛІ

РОЛЬ ЗЕРНОВОГО РЫНКА В ОБЕСПЕЧЕНИИ ПРОДОВОЛЬСТВЕННОЙ БЕЗОПАСНОСТИ РЕСПУБЛИКИ КАЗАХСТАН

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Abstract. Kazakhstan is one of the world's leading wheat exporters and performs a strategic function in ensuring global food security. The country's grain sector shows stable growth, self-sufficiency, an increase in export revenues and employment in rural areas. However, factors such as climate risks, high regional concentration of production, infrastructure constraints and institutional barriers have a significant impact on the sustainability of this agricultural segment. The *goal* is to assess the contribution of the grain industry to the domestic economy, determine its effective functioning and competitiveness on the basis of statistical indicators and an integral index. *Methods* - econometric, study of the dynamics of production processes by time series using official data of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan for 2015-2024, normalization of indicators when comparing them, calculation of the integral index taking into account the position of an integrated approach, comparison and generalization for studying price trends and regional infrastructure. The methodology relies on the scientific approaches of the FAO. *Results* - positive growth rates of output, productivity and exports are shown. The grain self-sufficiency coefficient was 1.26, the share of exported goods – 31.2%, the Consumer Price Index - 9.92%, and the integral Balance Index - 0.87. *Conclusions* - a stable grain complex, but vulnerable to natural-climatic and territorial challenges. Measures are needed to diversify the territory, improve infrastructure, manage instability factors and adapt to climate change.

Particular attention should be paid to the introduction of innovative technologies in grain farms in compliance with the rules of agricultural technology, as well as control over the supply of agricultural producers with fertilizers, plant protection products and new equipment. The results obtained can be used in long-term systemic planning to improve agrifood policy. This article is of an applied scientific and analytical nature and contributes to a comprehensive discussion of the problems of food self-sufficiency.

Аңдатпа. Қазақстан бидайдың әлемдік жетекші экспорттаушыларының қатарына кіреді және жаһандық азық-түлік қауіпсіздігін қамтамасыз етуде стратегиялық функцияны орындайды. Елдің астық секторы тұрақты өсуді, өзін-өзі қамтамасыз етуді, экспорттық түсімнің және ауылдық жерлерде жұмыспен қамтудың ұлғаюын көрсетеді. Алайда Климаттық тәуекелдер, өндірістің жоғары аймақтық шоғырлануы, инфрақұрылымдық шектеулер және институционалдық кедергілер сияқты факторлар осы ауылшаруашылық сегментінің тұрақтылығына айтарлықтай әсер етеді. *Мақсаты* - астық саласының отандық экономикаға қосқан үлесін бағалау, оның тиімді жұмыс істеуін және статистикалық индикаторлар мен интегралдық индекс негізінде бәсекеге қабілеттілігін анықтау. *Әдістер* - эконометрикалық, Қазақстан Республикасы Стратегиялық жоспарлау және реформалар агенттігінің Ұлттық статистика бюросының 2015-2024 жылдардағы ресми деректерін пайдалана отырып, уақыт қатарлары бойынша өндірістік үдерістердің динамикасын зерттеу, оларды салыстыру кезінде көрсеткіштерді қалыпқа келтіру, кешенді тәсіл ұстанымын ескере отырып интегралдық индексті есептеу, баға үрдісін және өңірлік инфрақұрылымды зерделеу үшін салыстыру және жалпылау. Әдістеме ФАО-ның ғылыми тәсілдеріне сүйенеді. *Нәтижелер* - шығарылатын өнім көлемінің, өнімділіктің және экспорттың оң өсу қарқыны көрсетілген. Астықпен өзін – өзі қамтамасыз ету коэффициенті 1,26, экспортталатын тауарлардың үлесі – 31,2%, тұтыну бағаларының индексі - 9,92%, теңгерімділіктің интегралдық индексі - 0,87 құрады. *Қорытындылар* - тұрақты астық кешені, бірақ табиғи-климаттық және аумақтық сын-қатерлерге осал. Аумақтық әртараптандыру, инфрақұрылымды жетілдіру, тұрақсыздық факторларын басқару және климаттың өзгеруіне бейімделу бойынша шаралар қажет. Агротехника ережелерін сақтай отырып, астық шаруашылықтарында инновациялық технологияларды енгізуге, сондай-ақ ауыл шаруашылығы өндірушілерін тыңайтқыштармен, өсімдіктерді қорғау құралдарымен және жаңа техникамен қамтамасыз етуді бақылауға ерекше назар аудару қажет. Алынған нәтижелер агроазық-түлік саясатын жетілдіру үшін ұзақ мерзімді жүйелік жоспарлауда қолданылуы мүмкін. Бұл мақала қолданбалы ғылыми-аналитикалық сипатқа ие және азық-түлік өзін-өзі қамтамасыз ету мәселелерін жан-жақты талқылауға ықпал етеді.

Аннотация. Казахстан входит в число ведущих мировых экспортеров пшеницы и выполняет стратегическую функцию в обеспечении глобальной продовольственной безопасности. Зерновой сектор страны демонстрирует устойчивый рост, самообеспеченность, увеличение экспортной выручки и занятости в сельской местности. Однако такие факторы, как климатические риски, высокая региональная концентрация производства, инфраструктурные ограничения и институциональные барьеры, оказывают значительное влияние на стабильность этого сельскохозяйственного сегмента. *Цель* – дать оценку вклада зерновой отрасли в отечественную экономику, определить ее эффективное функционирование и конкурентоспособность на основе статистических индикаторов и интегрального индекса. *Методы* – эконометрический, сравнения и обобщения с использованием официальных данных Бюро национальной статистики Агентства по стратегическому планированию и реформам Республики Казахстан за 2015-2024 годы для исследования динамики производственных процессов по временным рядам, нормализации показателей при их сопоставимости, расчета интегрального индекса с учетом позиции комплексного подхода, изучения ценовой тенденции и региональной инфраструктуры. Методология опирается на научные подходы ФАО. *Результаты* – показаны положительные темпы наращивания объемов выпускаемой продукции, урожайности и экспорта. Коэффициент самообеспеченности зерном составил 1,26, доля экспортируемых товаров – 31,2%, индекс потребительских цен – 9,92%, интегральный индекс сбалансированности - 0,87. *Выводы* – зерновой комплекс константный, однако уязвим к природно-климатическим и территориальным вызовам. Необходимы меры по территориальной диверсификации, совершенствованию инфраструктуры, управлению факторами нестабильности и адаптации к изменению климата. Требуется уделять особое внимание внедрению инновационных технологий в зерновых хозяйствах, следуя правилам агротехники, а также контроль снабжения сельхозпроизводителей удобрениями, средствами защиты растений и новой техникой. Полученные результаты могут быть применены в долгосрочном системном планировании для совершенствования агропродовольственной политики. Данная статья носит прикладной научно-аналитический характер и способствует всестороннему обсуждению вопросов продовольственной самодостаточности.

Key words: agricultural sector, grain market, food resources, grain export, import dependence, risk assessment, price stability, food security strategy.

Түйінді сөздер: аграрлық сектор, астық нарығы, азық-түлік ресурстары, астық экспорты, импортқа тәуелділік, тәуекелдерді бағалау, баға тұрақтылығы, азық-түлік қауіпсіздігі стратегиясы.

Ключевые слова: аграрный сектор, зерновой рынок, продовольственные ресурсы, экспорт зерна, импортозависимость, оценка рисков, ценовая стабильность, стратегия продовольственной безопасности.

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Introduction

Ensuring food security has become one of the most pressing global challenges of the 21st century, especially against the backdrop of climate change, geopolitical tensions, and increased volatility in agricultural markets. In this context, grain production plays a pivotal role, as cereals remain the foundation of human nutrition and national food security systems. According to OECD-FAO, grain crops account for more than 50% of global calorie intake and are key strategic commodities in both domestic markets and international trade (OECD. OECD-FAO Agricultural…) [1].

Kazakhstan, with its vast land resources and agro-climatic potential, is one of the leading grain producers in Central Asia and among the top ten global wheat exporters. The grain sector not only ensures the country's internal food self-sufficiency but also contributes significantly to export revenues and rural employment (Tleubayev A., Syzdykov Y.) [2]. In recent years, Kazakhstan has repeatedly faced both opportunities and challenges in this field: growing global demand and favorable prices have spurred export development, while climate risks, infrastructure limitations, and institutional barriers have revealed systemic vulnerabilities.

The grain sector's importance has sharply increased amid recent global shocks –such as the COVID-19 pandemic, the disruption of logistics chains, and geopolitical conflicts – which have triggered spikes in food prices and raised concerns about the resilience of national agricultural systems. The FAO has repeatedly emphasized the need for countries to develop sustainable, climate-resilient, and inclusive grain production systems to strengthen food security and stabilize global markets (FAO. The State of Food Security…) [3]. For Kazakhstan, this implies not only increasing physical volumes of production but also ensuring that grain supply chains are stable, efficient, and responsive to both domestic needs and international obligations (Rakhimbekova A., Mukhamejanova A., Babassov A. et al.) [4].

This research is driven by the need to comprehensively assess the performance of Kazakhstan's grain sector in the context of national food security goals. It aims to examine production trends, regional disparities, export dynamics, and systemic risks that may affect the sector's ability to respond to internal consumption demands and external shocks. Special attention is given to wheat as the core crop in the country's grain balance, and to the dominant role played by northern regions in grain output.

Moreover, this study evaluates the degree to which Kazakhstan meets key food security criteria, such as self-sufficiency, price stability, diversification, and sector sustainability. Using a set of diagnostic indicators and official statistical data for the period 2015–2024, the paper seeks to identify critical trends and formulate evidence-based conclusions that can support strategic decision-making and policy development in the agricultural sector. In doing so, this work contributes to the broader academic and policy discussion on how resource-rich economies like Kazakhstan can develop sustainable grain systems that not only feed their populations but also enhance global food security in an increasingly uncertain world.

Literature Review

Numerous recent studies emphasize that Kazakhstan's grain sector is at a strategic crossroads due to climate variability, infrastructure bottlenecks, and changing trade flows. For instance, Romanovska P., Schauberger B., Gornott C. [5] developed a weather-based statistical model to accurately forecast wheat yields in Kazakhstan up to two months before harvest, supporting food security planning in Central Asia with high reliability and accessibility. Similarly Wang Y., Huang P., Khan Z. et al. [6] documented Kazakhstan's strong revealed comparative advantage in wheat, barley, and buckwheat exports, indicating robust export competitiveness despite a modest global share.

Infrastructure-related constraints have also been analytically examined. Syzdykova

A.O., Azretbergenova G. [7] underscored profound transport and logistical risks in grain export routes, due to overreliance on rail corridors and limited transit options. More recently, interdisciplinary research by the OECD identifies initiatives for climate-resilient agribusiness investment as vital for enhancing food security and long-term sustainability in Central Asia (OECD. Climate-resilient agribusiness…) [8].

Other studies focus on agronomic and environmental challenges. Wang D., Gao G., Li R. et al. [9] found significant water scarcity and soil salinization constraints on wheat yields, suggesting optimized planting distribution and irrigation reforms as solutions. Additionally, Savin T., Morgounov A. [10] notes that Kazakhstan's cereal output in 2024 exceeded the five-year average by approximately 40%, confirming a resilient post-pandemic rebound.

Trade dynamics are addressed in USDA and FAO reports, affirming that Kazakhstan's wheat production in 2024 reached record highs while export volumes remained above average, with stable retail prices and supportive stocks. Gafarova G., Perekhozhuk O., Glauben T. [11] further stressed that Kazakhstan is a net exporter with a competitive edge across multiple grain types.

Several works also explore rural labor issues. Kuatova D. Y., Blinov O. A, Tyulegenova A. T. [12] examined depopulation trends in the Akmola region, concluding that while CSR initiatives can ameliorate rural exodus, broader rural development efforts are essential for sustaining agricultural labor supply.

Finally, global assessments such as the OECD-FAO Agricultural Outlook 2024-2033 emphasize the importance of introducing nexus-driven investments and resilient supply chains to uphold cereal food systems.

Collectively, this body of literature underscores the multifaceted nature of Kazakhstan's grain sector, blending technological innovation, trade competitiveness, infrastructure limitations, environmental constraints, and labor dynamics. The present study builds on these insights to critically assess national food security indicators using a robust, multidimensional framework. These studies show that Kazakhstan's grain sector is competitive and resilient, yet faces notable infrastructural and environmental challenges.

Materials and methods

This study employs a quantitative analytical approach to assess the role of the grain sector in ensuring national food security in Kazakhstan over the period 2015–2024. The analysis is based on official statistical data obtained from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan.

The research methodology includes time series analysis of production volumes, yields, sown areas, and export levels for the main grain crops, with a focus on wheat as the dominant component of the national grain balance. Indicators were selected based on relevance to food security dimensions–availability, accessibility, price stability, and resilience.

Key indicators such as grain self-sufficiency ratio, share of exports in total production, price stability index, regional production concentration, and sector sustainability index were calculated using standardized formulas, following FAO and national guidelines. The integral sustainability index was compiled by normalizing selected indicators and applying weighted averaging, reflecting expert-based prioritization of risk factors.

Descriptive statistics, percentage changes, and comparative ratios were used to highlight interannual trends. The chosen approach allows for both retrospective assessment and forward-looking evaluation of systemic vulnerabilities in the grain sector in relation to food security outcomes.

Results

Table 1 presents a detailed overview of grain and wheat production metrics from 2015 to 2024. The analysis is based on statistical indicators over a 10-year period, emphasizing trends in production volumes, yields, and sown areas. Special attention is paid to the performance of wheat as the dominant crop in the country's grain balance.

Table 1 - Dynamics of grain and wheat production in Kazakhstan, 2015–2024

Year	Total grain production, thousand tons	Wheat production, thousand tons	Average yield, c/ha	Wheat yield, c/ha	Total adjusted sown area, thousand ha	Adjusted sown area for wheat, thousand ha
2015	18 672.8	13 747.0	12.7	11.9	14 982.2	11 771.1
2016	20 634.4	14 985.4	13.5	12.1	15 403.5	12 437.0
2017	20 585.1	14 802.9	13.4	12.4	15 405.4	11 976.6
2018	20 273.7	13 944.1	13.5	12.3	15 150.0	11 409.8
2019	17 428.6	11 451.6	12.3	10.1	15 396.6	11 413.9

2020	20 065.3	14 258.0	12.8	11.8	15 878.4	12 182.6
2021	16 375.9	11 814.1	10.4	9.3	16 108.0	12 932.6
2022	22 030.5	16 404.5	13.8	12.8	16 114.4	12 889.8
2023	17 096.6	12 110.9	10.3	9.2	17 525.5	13 761.1
2024	25 204.8	18 576.7	15.2	14.2	16 746.5	13 199.6
Change in 2024 compared to 2015 (±)	6 532.0	4 829.7	2.5	2.3	1 764.3	1 428.5
Change in 2024 compared to 2015 (%)	35.0	35.1	19.7	19.3	11.8	12.1
10-year average	19 836.8	14 209.5	12.8	11.6	15 871.1	12 397.4
Note: based on the data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan for 2015-2024.						

Table 1 shows a generally positive trend in Kazakhstan's grain sector over the last decade. The total grain production increased from 18.67 million tons in 2015 to 25.2 million tons in 2024, which represents a 35% growth. Wheat production, which forms the core of the grain balance, also rose substantially - from 13.7 million tons to 18.6 million tons, demonstrating a 35.1% increase over the same period.

The average yield of grain crops improved from 12.7 to 15.2 centners per hectare, while the wheat yield rose from 11.9 to 14.2 c/ha, reflecting enhancements in both crop management and agricultural technologies. These improvements occurred despite occasional climate shocks, such as the drought-affected years 2019 and 2021, which saw sharp declines in both production and yields.

In terms of land use, the total adjusted sown area increased modestly by 11.8%, from 14.98 million ha to 16.75 million ha, while the sown area for wheat expanded by 12.1%. This gradual expansion signals a stable or moderately growing land base allocated to grain crops, with wheat continuing to dominate the sown area structure.

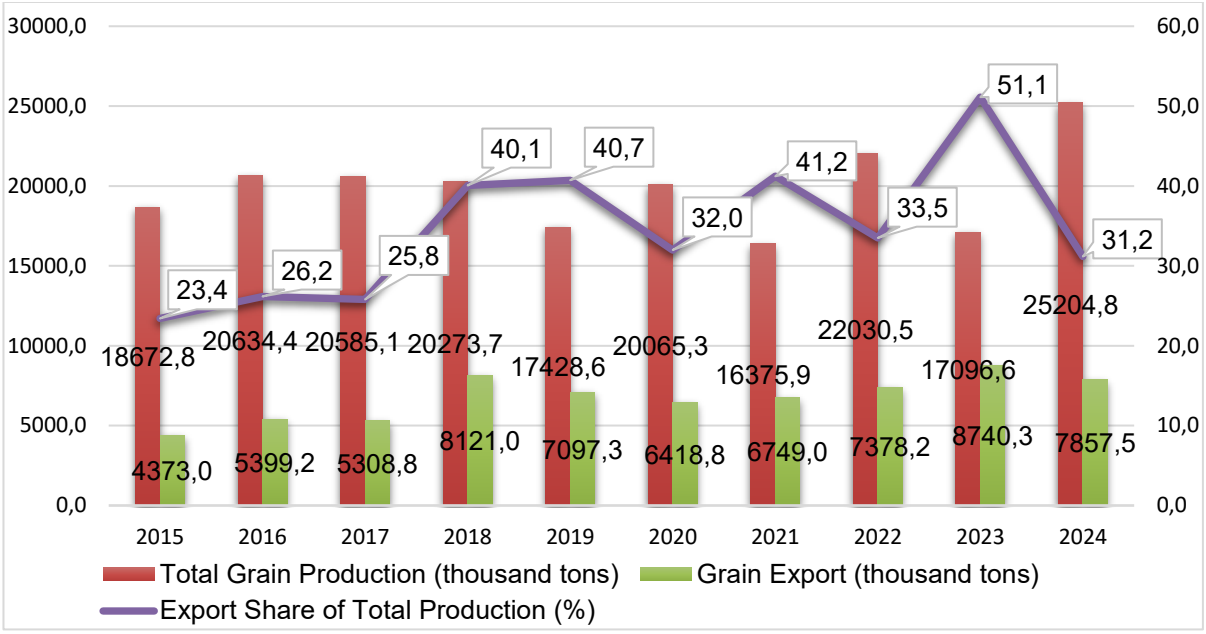
The 10-year average values further confirm stability and growth in the grain sector: average grain production was 19.8 million tons, and average wheat production stood at 14.2 million tons, with an average yield of 12.8 c/ha for all grains and 11.6 c/ha for wheat.

These dynamics suggest a resilient and steadily improving sector, which plays a key role in both domestic food provision and export potential. The observed growth in production and yield indicators contributes to national food security and underpins Kazakhstan's position as a major grain-producing country in Central Asia.

However, despite the sector's overall robustness, the spatial distribution of wheat production reveals a high degree of regional concentration. In 2024, wheat production was heavily dominated by three northern regions: Akmola (26.1%), Kostanay (25.6%), and North Kazakhstan (25.4%). Combined, these regions accounted for 77.1% of the country's total wheat output. While this concentration facilitates economies of scale and logistical advantages, it also introduces systemic risks–particularly climatic and infrastructural–should any disruptions occur in these key territories.

In addition to production dynamics, price volatility remains an important factor influencing both farmer incomes and market stability. The producer price index for cereals has shown considerable fluctuations over the past decade, peaking at 127.9 in 2019 and dropping to a low of 93.6 in 2023. Encouragingly, the index for 2024 increased slightly to 96.8, suggesting a relative stabilization in price dynamics compared to the previous year. This trend reflects a more balanced pricing environment, reducing uncertainty for producers and reinforcing market confidence. Figure 1 illustrates the evolving relationship between total grain production, export volumes, and the share of exports in total production in Kazakhstan over the 2015–2024 period.

Accoding to figure 1, total grain output rose from 18.7 million tons in 2015 to 25.2 million tons in 2024, reflecting a 35% increase. This growth trend, with some fluctuations, indicates Kazakhstan's capacity to scale production despite periodic challenges such as droughts or market instability. Export volumes also increased–from 4.4 million tons in 2015 to 7.9 million tons in 2024 – confirming the country's strategic position as a grain exporter in the region. Notably, 2024 marked the highest grain production of the decade, ensuring improved availability for both domestic consumption and international trade.



Note: based on the data from Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan for 2015-2024

Figure 1 – Grain production and export dynamics as a factor of food security in Kazakhstan, 2015–2024

At the same time, the export share of total grain output varied significantly, peaking at 51.1% in 2023. Such a high proportion suggests potential strain on domestic grain availability during that year, especially if internal reserves were insufficient. However, in 2024, the share fell to 31.2% despite robust export volumes, due to the record-high overall harvest. This shift indicates a more favorable internal balance and highlights the importance of harvest size in mitigating export-related risks. Ensuring a stable domestic supply while maintaining export potential remains critical for Kazakhstan's food security strategy, especially in light of global grain market volatility and regional food system resilience.

While production and export data point to a generally positive trajectory, it is essential to examine the systemic risks that may undermine the stability of Kazakhstan's grain sector and its role in ensuring national food security. Table 2 presents a structured overview of six key categories of risk–climatic, economic, institutional, logistical, geopolitical, and social-along with their potential impacts.

Table 2 - Key risks affecting the stability of the grain sector and food security in Kazakhstan

Risk Category	Specific factor	Impact on the grain sector	Potential threat to food security
Climatic	Droughts in North Kazakhstan, Akmola, and Kostanay regions	Decrease in yield and gross grain production	Shortage of domestic supply, price increase
Economic	Volatility of global grain prices	Loss of farmers' income, reduced investment	Threats to production stability
Institutional	Reduced government support, bureaucratic barriers	Lack of subsidies, slowdown in modernization	Decrease in efficiency and sustainability of agri-production
Logistical	Deterioration of storage and transport infrastructure	Post-harvest losses, delays in transportation and export	Regional supply disruptions, increase in prices
Geopolitical	Transit restrictions and export barriers	Limited market access, reduced foreign currency earnings	Disruption of grain balance, dependence on external channels
Social	Rural depopulation and labor shortages	Lower productivity, lack of qualified agricultural personnel	Long-term sustainability risk for the sector
Note: compiled by the authors			

According to table 2, climatic risk remains one of the most pressing challenges, especially given the reliance on three northern regions – Akmola, Kostanay, and North Kazakhstan – for over 77% of national wheat output. Droughts in these areas can lead to significant declines in yields, threatening domestic supply and triggering price surges. Economic risks, such as global price volatility, directly affect farmer incomes and future investment capacity, potentially reducing long-term production levels. Institutional and logistical factors, including weakened government support and infrastructure degradation, further exacerbate inefficiencies, increasing post-harvest losses and regional supply bottlenecks. In addition, geopolitical constraints, such as export restrictions and transit barriers, pose risks to market access and foreign currency earnings. Finally, social risks, especially labor shortages due to rural depopulation, undermine the sector's productivity and long-term sustainability.

Recognizing and addressing these interlinked vulnerabilities is crucial for developing targeted policies that reinforce both the resilience of grain production and Kazakhstan's broader food security framework. To conduct a comprehensive evaluation of the grain sector's contribution to national food security, a set of integrated indicators was selected based on relevance, measurability, and alignment with international and national standards for agricultural sustainability and food system resilience. The indicators presented in table 3 encompass key dimensions such as production sufficiency, market stability, regional diversification, and socioeconomic importance of grain products.

Table 3 - Indicators for assessing the role of the grain sector in ensuring national food security in Kazakhstan

Indicator	Unit of measurement	Optimal value / threshold	Value in 2024	Interpretation
Grain self-sufficiency ratio	0 to 1	≥ 0.8	**1.26**	Full coverage of domestic demand; potential for export surplus
Share of grain export in total production	%	≤ 50%	**31.2%**	Export level is acceptable and does not threaten domestic supply
Grain price stability index	%	≤ 10%	**9.92%**	Price levels are stable; low price volatility risk
Share of wheat in total grain production	%	≥ 60%	**73.7%**	Wheat is the strategically dominant grain crop
Share of three leading regions in wheat production	%	≤ 70%	**77.1%**	High regional concentration; potential dependency risk
Share of grain in total consumer food expenditures	%	≥ 5%	**7.6%**	Grain products are an essential part of the food basket, but not dominant in cost structure
Integral index of grain sector sustainability	0 to 1	≥ 0.8	**0.87**	High level of sustainability in the grain sector

Note: calculated by the authors

The grain self-sufficiency ratio reflects the balance between domestic grain production and internal consumption needs. A value above 1 indicates the country's ability not only to meet its own demand but also to generate a surplus for export. The 2024 value of 1.26 highlights a strong surplus capacity, reinforcing Kazakhstan's export potential and buffer against external shocks. This indicator was calculated as the ratio of total grain production to domestic grain consumption, using national food balance data.

The share of grain export in total production is critical for assessing whether export activities threaten internal food availability. The 2024 share of 31.2%, well below the threshold of 50%, confirms that current export levels are sustainable. This figure was derived by dividing the volume of exported grain by total production and expressing the result as a percentage.

To evaluate price volatility, the grain price stability index was used. It represents the coefficient of variation of annual producer prices for grain over the past 10 years. With a

2024 value of 9.92%, this indicator falls within the acceptable threshold (≤10%), suggesting relatively stable price trends and a low inflationary burden for consumers and producers alike.

The share of wheat in total grain production serves as a proxy for the strategic weight of wheat in Kazakhstan's grain economy. With a 2024 share of 73.7%, it confirms wheat's dominant role. This was computed by dividing the volume of wheat production by the total grain output.

The share of the top three regions in wheat production reveals the level of regional concentration, a factor that may indicate vulnerability to localized shocks. In 2024, Akmola, Kostanay, and North Kazakhstan jointly contributed 77.1% of national wheat output, exceeding the optimal diversification threshold of 70%. This metric was calculated by aggregating the regional production volumes of these three oblasts and expressing the sum as a percentage of total national wheat production.

The share of grain in total consumer food expenditures, recorded at 7.6% in 2024, illustrates the affordability and importance of grain-based products within household diets. This share was calculated using data from national household surveys on food consumption structure.

Finally, the integral index of grain sector sustainability, with a value of 0.87, reflects a comprehensive assessment of its capacity to ensure national food security. The index enables monitoring of sustainability dynamics over time, identification of vulnerable areas, and serves as a tool for strategic decision-making in agri-food policy. A value above 0.8 signals a high degree of resilience and adaptability within the sector. The index was calculated based on the normalization of values for six selected individual indicators, followed by their weighted averaging. This is a standard approach in index methodologies, aligned with FAO recommendations and composite index construction techniques.

Together, these indicators offer a multidimensional perspective on the grain sector's current role in ensuring food security, while also identifying areas requiring policy attention, particularly in terms of regional concentration and climate risk adaptation.

Discussions

The findings of this study highlight both the strengths and vulnerabilities of Kazakhstan's grain sector in the context of national food security. The steady growth in production volumes and yields over the past decade reflects improvements in agronomic practices, technological modernization, and moderate expansion of the cultivated area. The consistent dominance of wheat, with a share of over 70% in total grain output, confirms its strategic importance in the food supply chain and export policy of the country (Halecki W., Bedla D.) [13].

However, the high geographic concentration of wheat production in three northern regions – accounting for more than 77% of total wheat output – raises concerns about systemic risk exposure. Droughts or infrastructure disruptions in these areas could severely affect the entire national supply. This spatial imbalance calls for policies aimed at geographic diversification and climate adaptation (Tarraf Ibrahem N.) [14].

The grain sector's sustainability is supported by a self-sufficiency ratio of 1.26 in 2024, indicating full domestic coverage and export potential, while stable grain prices reflect favorable market conditions and resilience to external shocks. (Mkumbukiy A., Loghmani-Khouzani T., Madani K. et al.) [15].

Nonetheless, structural risks such as labor shortages, logistics issues, and weak government support may threaten long-term stability (Galanakis C. M., Daskalakis M., Galanakis I. et al.) [16]. Addressing them requires a combined focus on technology, institutional reform, and rural development.

In this context, the integral index of grain sector sustainability, calculated at 0.87, validates the sector's overall strength. However, to maintain and improve this level, further attention must be given to environmental sustainability, infrastructure renewal, and export policy stability. Ensuring that grain exports do not compromise internal reserves–especially during global supply disruptions–remains a strategic priority.

Conclusion

1. Kazakhstan's grain sector demonstrated positive growth over the past decade, with a 35% increase in production volumes and improved yields, enhancing national food security and export potential.

2. The sector remains vulnerable to structural risks, including climatic shocks, regional concentration of production, and infrastructure limitations, which require proactive policy responses.

3. The integral sustainability index (0.87) confirms the sector's high resilience, but regional over-dependence on three northern oblasts suggests a need for spatial diversification strategies.

4. Key food security indicators such as grain self-sufficiency (1.26) and export share (31.2%) fall within optimal thresholds, indicating a healthy domestic grain balance with room for export.

5. Future policies should focus on climate adaptation, rural development, and investment in logistics, to strengthen the sector's stability and safeguard food security under global uncertainties.

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