

FOOD SECURITY OF THE REPUBLIC OF KAZAKHSTAN:
TRENDS AND ECONOMETRIC ASSESSMENT

ҚАЗАҚСТАН РЕСПУБЛИКАСЫНЫҢ АЗЫҚ-ТҮЛІК ҚАУІПСІЗДІГІ:
ТРЕНДТЕР ЖӘНЕ ЭКОНОМЕТРИКАЛЫҚ БАҒАЛАУ

ПРОДОВОЛЬСТВЕННАЯ БЕЗОПАСНОСТЬ РЕСПУБЛИКИ КАЗАХСТАН:
ТРЕНДЫ И ЭКОНОМЕТРИЧЕСКАЯ ОЦЕНКА

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Abstract. Food security is the provision of the population with the necessary quantity of high-quality, safe, and affordable food products in accordance with individual needs on a long-term basis. *The objective* is to study the prospects for balanced supply of agricultural products in the republic, expressed through three levels: availability, accessibility, and stability. *Methods* include the study of scientific publications by domestic and foreign authors, the use of data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, and the Food and Agriculture Organization of the United Nations. Expert assessment, comparative and economic-statistical analysis made it possible to identify the main trends and changes in issues of food sustainability. Econometric modeling reflects the influence of three factors affecting food supply from the perspective of its measurement dimensions. *Results* – the country demonstrates strong positions in import substitution of poultry meat and apples; however, some indicators for basic food products show high volatility ranging from 31% to 51%. The developed economic forecasting model revealed a number of significant indicators. The coefficient of physical accessibility amounted to 0.8 (80% of fluctuations under the influence of factors), for price accessibility – 0.6, system equilibrium – 0.4. *Conclusions* – food security is directly related to the increase in arable land area and the growth of purchasing power parity. Economic accessibility depends on the land fund of the agricultural sector. The reliability of the functioning of the food market mechanism increases with the strengthening of investment activity in the agro-industrial complex and the expansion of agricultural land. Nevertheless, the comparability of real incomes acts as a stabilizer, minimizing sharp changes in calorie consumption among rural residents.

Аңдатпа. Азық-түлік қауіпсіздігі-халықты ұзақ мерзімді негізде жеке қажеттіліктерге сәйкес жоғары сапалы, қауіпсіз, бағасы бойынша қолайлы тамақ өнімдерінің қажетті санымен қамтамасыз ету. *Мақсаты* – республикада ауыл шаруашылығы өнімдерін теңгерімді қамтамасыз етудің үш деңгеймен көрсетілген перспективаларын зерттеу: болуы, қолжетімділігі, тұрақтылығы. *Әдістер* – отандық және шетелдік авторлардың ғылыми жарияланымдарын зерделеу, Қазақстан Республикасы стратегиялық жоспарлау және реформалар агенттігінің Ұлттық статистика бюросының, Біріккен Ұлттардың Азық-түлік және ауыл шаруашылығы ұйымының деректерін пайдалану. Сараптамалық бағалау, салыстырмалы және экономикалық-статистикалық талдау азық-түлікке тұрақтылық мәселелері бойынша негізгі үрдістер мен өзгерістерді анықтауға мүмкіндік берді. Эконометрикалық модельдеу оны өлшеу тұрғысынан азық-түлікпен қамтамасыз етуге әсер ететін 3 фактордың әсерін көрсетеді. *Нәтижелер* – ел құс еті мен алманың импортын алмастыру бойынша мықты позицияларды көрсетеді, алайда негізгі азық-түлік тауарлары бойынша кейбір көрсеткіштер 31% - дан 51% - ға дейін жоғары құбылмалылыққа ие. Экономиканы болжаудың дамыған моделі бірқатар маңызды көрсеткіштерді көрсетті. Физикалық қолжетімділік коэффициенті 0,8 құрады (факторлардың әсерінен 80% ауытқу), баға қолжетімділігі үшін-0,6, жүйенің тепе-теңдігі-0,4. *Қорытындылар* - азық-түлік қауіпсіздігі егістік алқаптарының ұлғаюымен және сатып алу қабілетінің паритетінің өсуімен тікелей байланысты. Экономикалық қолжетімділік аграрлық сектордың жер қорына байланысты. Азық-түлік нарығы тетігінің жұмыс істеу тұрақтылығы агроөнеркәсіптік кешендегі инвестициялық белсенділікті нығайту және ауыл шаруашылығы алқаптарының көлемін ұлғайту арқылы артады. Дегенмен, нақты кірістердің салыстырмалылығы тұрақтандырғыш рөлін атқарады, бұл ауыл тұрғындарының калория тұтынуындағы күрт өзгерістерді минимумға дейін төмендетеді.

Аннотация. Продовольственная безопасность - обеспечение населения необходимым количеством высококачественных, безопасных, приемлемых по цене продуктов питания в соответствии с индивидуальными потребностями на долгосрочной основе. *Цель* – исследование перспектив сбалансированного снабжения сельскохозяйственной продукцией в республике, выраженного тремя уровнями: наличие, доступность, стабильность. *Методы* – изучение научных публикаций отечественных и зарубежных авторов, использование данных Бюро национальной статистики Агентства по стратегическому планированию и реформам Республики Казахстан, Продовольственной и сельскохозяйственной организации Объединенных Наций. Экспертная оценка, сравнительный и экономико-статистический анализ позволили выявить основные тенденции и изменения по вопросам продовольственной устойчивости. Эконометрическое моделирование отражает влияние 3-х факторов, влияющих на продовольственное обеспечение с точки зрения его измерений. *Результаты* – страна демонстрирует прочные позиции по импортозамещению мяса птицы и яблок, однако некоторые показатели по основным пищевым товарам имеют высокую волатильность от 31% до 51%. Разработанная модель прогнозирования экономики показала ряд значимых индикаторов. Коэффициент физической доступности составил 0,8 (80% колебаний под влиянием факторов), для условий ценовой доступности – 0,6, равновесие системы – 0,4. *Выводы* – продовольственная безопасность напрямую связана с увеличением площади пахотных земель и ростом паритета покупательной способности. Экономическая доступность зависит от земельного фонда аграрного сектора. Надежность функционирования механизма продовольственного рынка повышается с укреплением инвестиционной активности в агропромышленном комплексе и наращиванием размеров сельхозугодий. Тем не менее, сопоставимость реальных доходов играет роль стабилизатора, снижая до минимума резкие изменения в потреблении калорий жителями сельской местности.

Keywords: agro-industrial complex, arable land, gross production, labor productivity, physical and economic accessibility, food security, competitiveness.

Түйінді сөздер: агроөнеркәсіптік кешен, егістік жерлер, жалпы өндіріс, еңбек өнімділігі, физикалық және экономикалық қолжетімділік, азық-түлік қауіпсіздігі, бәсекеге қабілеттілік.

Ключевые слова: агропромышленный комплекс, пахотные земли, валовое производство, производительность труда, физическая и экономическая доступность, продовольственная безопасность, конкурентоспособность.

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Introduction

In the modern world, food security is an important factor in the issue of social stability, a fundamental element of national security and one of the keys to the sustainable development of every country. It is commonly understood that food security means providing the population with a sufficient amount of high-quality, safe, affordable food products in accordance with their individual needs on a long-term basis.

The development of the agro-industrial complex plays an important role in ensuring food security. After all, its high indicators have a direct impact on the country's food independence. The agricultural sector of the Republic of Kazakhstan is developing rapidly and shows high performance. According to the results of 11 months of 2025, the volume of gross agricultural output amounted to 9.2 trillion tenge, of which 3.3 trillion tenge accounted for livestock, and 5.8 trillion tenge for crop production (Gross agricultural output increased...) [1].

Today, the Republic of Kazakhstan holds a leading position among the world's wheat and flour exporters. This position indicates to us a high degree of stability in the grain sector. This industry not only meets domestic demand, but also generates a significant portion of export revenue, which indicates the high competitiveness of domestic products. At the same time, the grain industry mainly exports raw materials rather than final products, which in the future sets the goal of producing more complex products with high added value. The state makes a great contribution to the development of the agricultural sector. In the form of financing the modernization of elevators, the introduction of advanced storage technologies, as well as subsidizing seeds, fertilizers and agricultural machinery.

The relevance of the topic covered in this article is accompanied by the UN (United Nations) SDG (Sustainable Development Goals). Since January 1, 2016, the UN has put the 2030 Sustainable Development Plan on the World's Agenda. In total, 17 goals were reflected and 169 tasks were set. Food security and its targets are included in the 2nd SDG. It reads as: "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" (United Nations Department of Economic...) [2].

Research design includes the following research procedures, such as searching and reviewing literature over the past 5 years based on the keywords "agro-industrial complex", "food security", "domestic producers", "food production", the presentation of a methodological framework, including methods for col-

lecting and analyzing information, determining results and discussions, conclusion.

Literature review

Looking through the prism of scientific research, both domestic and foreign authors, it is worth noting that in most cases the food security of the Republic of Kazakhstan is considered as a complex and multilevel system. It reflects the availability of the country's food resources and the level of satisfaction of the needs of its population (Adelbayeva A.K., Kasen K.R., Duisenbekuly A.) [3].

The authors set themselves the goal of finding ways to improve the food security of the Republic of Kazakhstan. Some sources point out that this can be done by increasing the competitiveness of the agro-industrial complex. This will increase interest in responsible products, as well as reduce dependence on imported goods (Ydyrys S.S., Duisenbekuly A., Pazilov G.A.) [4].

Nevertheless, studies believe that the level of food security depends not only on the competitiveness of the agricultural sector and the subsidies allocated to it. In this situation, it is worth considering the issue comprehensively. In particular, food independence can be achieved by developing an integrated mechanism that includes the country's production, infrastructural, socio-economic and institutional features (Shalgimbayeva K.B., Togzhigitova K.B., Karymsakova Z.K.) [5].

Scientific research focuses on a number of problems that the Republic of Kazakhstan faces in ensuring food security. The key one is the existing regional disparity, for example, Atyrau and Mangystau regions are experiencing a shortage of socially significant food products compared to other regions, which may cause social tension in the future (Tleuberdinova A., Nurlanova N., Alzhanova F.) [6].

Moreover, the reasons for this situation are low income and lack of a healthy food culture, unstable food prices, inefficient infrastructure, especially in rural areas, and exposure to climate shocks, which leads to instability in the supply of raw agricultural products (Kulbaeva A.A.) [7].

Despite government support and strong positions in certain segments, vulnerabilities remain in other areas. For example, dependence on the import of certain types of dairy products, such as cheeses and powdered milk. To minimize these risks, Kazakhstan implements programs to create and develop dairy farms, acquire and maintain of breeding livestock, reduce the cost of milk and feed production, and other (Belgibayeva A.S.) [8].

Notwithstanding, the agro-industrial complex has stable growth, it faces a number of specific challenges. These include a marked decrease in government support in recent years, a decrease in demand for domestic products, a low level of government regulation, and strained economic relations between international market participants (Jumabayeva A., Tuleubayeva M., Kanagatova D. et al.) [9].

To summarize the literature review shows that there is a need to create a scientifically based mechanism to ensure food security in the Republic of Kazakhstan. Provided that it would help reduce the impact of current problems in the agro-industrial sector, increase the attractiveness and accessibility of domestic products, both on local and foreign markets, as well as increase the level of government regulation on the rational and effective use of subsidies.

Materials and methods

In the process of studying the level of food security in the Republic of Kazakhstan, the following methods were used: expert assessment, economic and statistical analysis, comparative analysis, econometric modeling.

An expert assessment of statistical data was applied to assess the current situation in the agro-industrial sector. Comparative and economic-statistical analysis provided an opportunity to identify the main trends and changes in the issue of food security over the past 10 years.

Econometric modeling allowed to deduce 3 factors of influence on food security in terms of its measurements. There are 3 dependent variables in the model, each of which reflects the measurements indicated above. Availability is represented by the GPI variable is the Gross Production Index Number; Access is represented by the IMINEX variable and is expressed in Value of food imports in total merchandise exports (percentage) (3-year average); stability is represented by the VAR variable and reflected as the Per capital food supply variability (kcal/cap/day). Other influencing factors in the model are PPP and expressed as Gross domestic product per capital, EXP and reflected as Agriculture, forestry, fishing (central government expenditure) and LAND, which is Arable land.

The theoretical part was based on scientific research of the last 5 years, includes publicly available publications by domestic and international authors, accessible through various information resources and databases. The

search for sources was based on keywords such as, "agro-industrial complex", "food security", "domestic producers", "food production". In additionally, the collected secondary, time series data provided by the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, as well as the FAO (Food and Agriculture Organization of the United Nations), served as the basis for building an econometric model in the STATA MP 14-2 program.

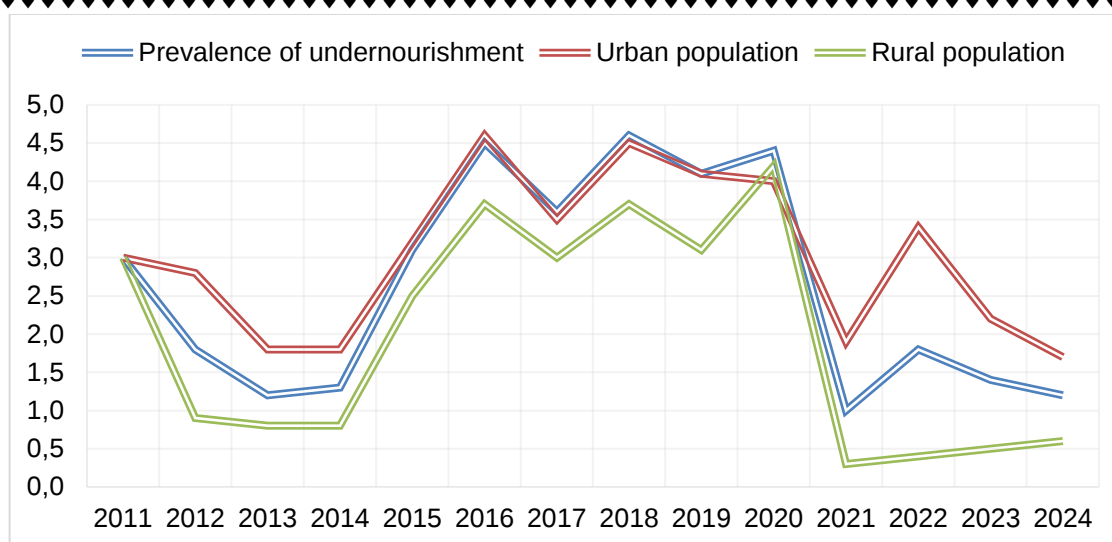
During the compilation of the research results, such general scientific research methods, as analysis and synthesis, deduction and generalization were applied. Using the above methods, constructive, reasoned, generalized conclusions on the research topic were provided.

Results

In recent years, the assessment of food security has received special attention from domestic and international organizations. Some of the most significant indicators are presented below, which are published by the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. Figure 1 presents the results of the analysis of the PoU (Prevalence of undernourishment) in the Republic of Kazakhstan. PoU is one of the key indicators of food security, measured as a percentage. It reflects the proportion of the population who receive insufficient energy from food for normal functioning.

The malnutrition rate of the urban population during the period from 2012 to 2024 was significantly higher than that of the rural population. The most noticeable gaps between the indicators are noticeable in 2012 and 2022. At the same time, it can be seen from the data in the figure that the "maximum" and "minimum" occurred synchronously with the line of the general PoU, which indicates the influence of impact factors on all population groups at the same time. In additionally, the overall PoU indicator has been trending downward since 2022, but the urban population still shows a higher value than the rural one.

The Labor productivity in agriculture indicates the important role of small-scale food producers in ensuring the country's food security. The indicator reflects the progress of the agricultural sector in the form of increased productivity. For the period from 2010 to 2024, there has been a significant increase from 428.8 thousand to 5. 000+ thousand tenge per person.

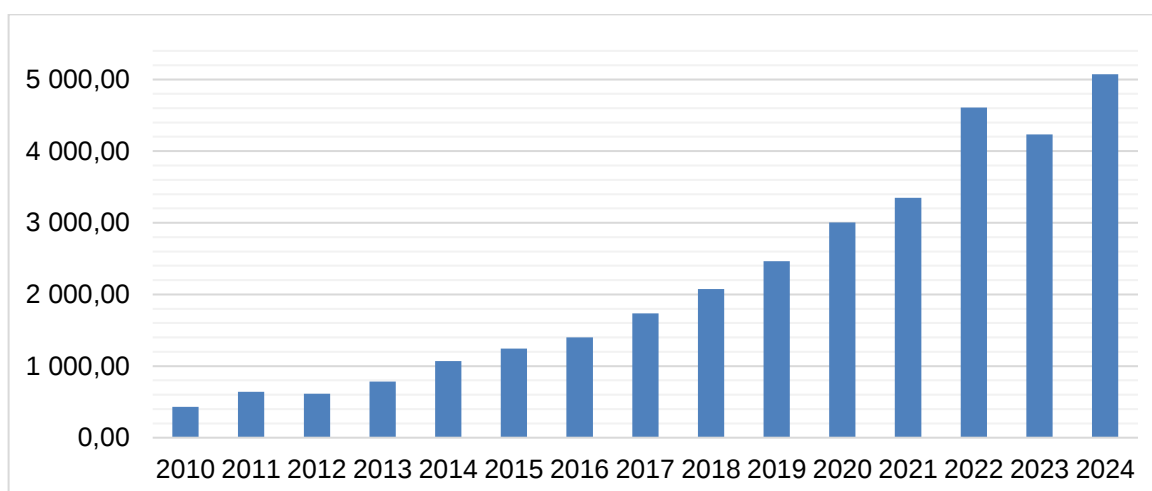


Note: based (Bureau of National Statistics of the Agency...) [10]

Figure 1 - Prevalence of undernourishment, %

The reasons for this increase may be the introduction of new technologies, automation, and modernization of the production process. It is worth noting that the decrease in the value of

PoU since 2021 coincides with an increase in Labor productivity in agriculture, which indicates the high efficiency of the agro-industrial complex (figure 2).

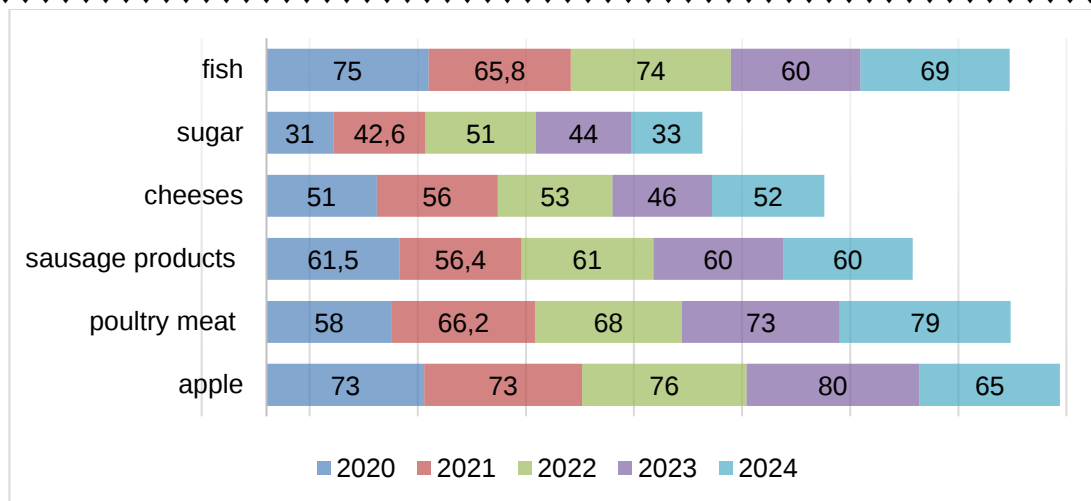


Note: based (Bureau of National Statistics of the Agency...) [10]

Figure 2 - Labor productivity in agriculture, thousand tenge

Proportion of domestic market supply with domestically produced food products, percentage indicates the level of self-sufficiency of the country's domestic market. The main types of food products include fish, sugar, poultry meat, sausage products, cheese and apples. The proportion of domestic market supply with domestically produced food products, percentage of poultry meat has been steadily increasing from 58% to 79%, which indicates a successful policy to support domestic products by the Republic of Kazakhstan. Apples have had fairly high rates for 4 years, the "maximum" occurred

in 2023, after which there was a sharp decline, presumably due to unfavorable climatic conditions. The most unstable position is noted for the sugar indicator, the value ranged from 31% to 51%. Moderate stability was demonstrated by fish, cheeses and sausages, the "maximum" values of which reached 75%, 56%, 61.5% accordingly. On the one hand, the agro-industrial complex of the Republic of Kazakhstan pursues a successful strategy for import substitution and maintenance of domestic products. On the other hand, a significant dependence remains on such a position as sugar (figure 3).



Note: based (Bureau of National Statistics of the Agency...) [10]

Figure 3 - Proportion of domestic market supply with domestically produced food products, %

Data from The Food and Agriculture Organization of the United Nations was used to build the econometric model. Table 1 provides summary statistics for each variable, including the number of observations (Obs.) in this situation 24.

GPI: The average GPI is 89.6 with a standard deviation of 15. This means that the average indicator has assumed the value of 89.6 but it may deviate by 15. The minimum GPI is 66.64 and the maximum is 115.2.

IMINEX: The average Value of food imports in total merchandise exports in the current year is 5.2 with a standard deviation of 1.3. The minimum is 4 and the maximum is 7.

VAR: The average Per capita food supply variability is 41.9 with a standard deviation of 17.2. The minimum is 7 and the maximum is 87.

PPP: The average Gross domestic product per capital is 27 347.2 with a standard deviation of 6 249.8. The minimum is 14 612 and the maximum is 35 905.

EXP: The average Agriculture, forestry, fishing (central government expenditure) is 140 539.3 with a standard deviation of 84 359. The minimum is 15 087 and the maximum is 341 213.

LAND: The average Arable land is 29 136.3 with a standard deviation of 504.6. The minimum is 28 343.6 and the maximum is 29 748 (table 1).

Table 1 - Summary statistics on independent and dependent variables

Variables	Obs	Mean	Std.Dev	Min	Max
GPI	24	89.6	15.0	66.64	115.2
IMINEX	24	5.2	1.3	4	7
VAR	24	41.9	17.2	7	87
PPP	24	27 347.2	6 249.8	14 612	35 905
EXP	24	140 539.3	84 359.0	15 087	341 213
LAND	24	29 136.3	504.6	28 343.6	29 748

Note: calculated by the authors based on data from (The Food and Agriculture Organization...) [11]

Table 2 presents the results of correlation analysis. The dependent GPI has a strong relationship with the independent variables PPP, LAND, which suggests that GPI grows in direct to the growth of PPP, Arable land. The independent variables are also highly correlated and can replace each other.

There is a moderate significant direct relationship between the dependent variables GPI and IMINEX and the independent variable EXP. The dependent variable IMINEX has the

same relationship with the independent variable LAND. The independent variables LAND with PPP, EXP have similar values.

VAR has a stabilizing significant inversely relationship with the independent variable PPP and the dependent GPI. This indicator shows that as the variable increases, the second one will reduce the negative effects of the first one.

The remaining values reflect a weak relationship, which indicates a minimal relationship between the indicators.

Table 2 - Correlation analysis of the dependence of independent and dependent variables

Variables	GPI	IMINEX	VAR	PPP	EXP	LAND
GPI	1.0					
IMINEX	0.6	1.0				
VAR	-0.3	-0.1	1.0			
PPP	0.8	0.7	-0.4	1.0		
EXP	0.6	0.4	-0.1	0.6	1.0	
LAND	0.8	0.7	-0.1	0.7	0.5	1.0

Note: calculated by the authors based on data from (The Food and Agriculture Organization...) [11]

The developed model based on secondary, Time Series data has demonstrated a number of significant results. R-sq for GPI was 0.8, about 80% of the GPI changes are explained by the model, the remaining 20% are due to random factors that we did not consider, they will be described below. The R-sq for IMINEX was 0.6, about 60% of its changes are explained by the model, the remaining 40% are due to random factors. R-sq for VAR – 0.4 was 40%, 60% remains for random factors. A high Chi2 value at $p < 0.001$ indicates the statistical significance of the model.

The independent variable PPP has demonstrated high performance in 2 equations, it has a significant positive effect on the dependent variable GPI, and an absolute negative effect on VAR. The independent variable EXP has a positive effect only on the dependent variable VAR. The independent variable LAND demonstrated a high positive effect on all three dependent variables. The effect on GPI and IMINEX is particularly high.

The results of the model must be checked with a multicollinearity test, which will determine the relationship between the independent variables. This test is necessary to exclude their interchangeability. The norm of the critical threshold of VIF is 5, in the study, the values are within the normal range from 1.9 to 3.2, which indicates the absence of multicollinearity.

The Breusch-Pagan test was conducted in the study to check for heteroskedasticity. This indicator indicates the standard errors of the coefficients, thereby confirming the significance of $P > [z]$. All values of Prob> Chi2 is higher than the standard value of $0.5 \cdot 10^{-1}$, which indicates the absence of heteroscedasticity, all values of the coefficients are calculated correctly.

Thus, the econometric model showed the absence of multicollinearity and heteroscedasticity, which confirms the correctness of its results.

Discussions

The food security as a comprehensive indicator provides a large sample of the factors influencing it. The study examined three levels

of food security, such as Availability, Access and Stability. This comprehensive approach made it possible to determine the influence of independent variables on each of the above levels. A similar method of information analysis was previously used in the framework of determining food security in 4 dimensions, where the fourth dependent variable was the Utilization (Bopushev S., Tokobaev N., Sultakeev K) [12]. We excluded him from the study, because in the process of building an econometric model, he showed results that indicate the need to study him in a separate model with other independent variables.

The results of the scientific research allowed us to look at the food security of the Republic of Kazakhstan from a different perspective. Arable land is one of the key indicators in this issue. In all three equations, the independent variable LAND showed high statistical significance, in particular with the Gross Production Index Number. This result confirms the well-established opinion that the presence of Arable land plays a key role in the activities of the agro-industrial sector, which ensures the country's food security (Akmal F. A., Mohammadi Y.) [13].

The study found a stabilizing relationship between VAR and PPP, which indicates a decrease in variable and reflected as the Per capita food supply variability (kcal/cap/day) due to an increase in Gross domestic product per capita. Thus, the economic development of the country reduces the impact of food supply volatility. The high importance of PPP as a factor in ensuring food security is emphasized in previous studies (Hernández-Pérez N., Castillo-Díaz F.J., Soto-Domínguez A.P.Y. et al.) [14].

The results of the scientific research revealed a significant positive relationship between the dependent variable VAR and the independent EXP, which indicates that Agriculture, forestry, fishing (central government expenditure) is a tool for the stability of food availability in the country. The results are consistent with previous scientific studies where central government expenditure acted as the main

factor in ensuring food security (Soko N.N., Kaitibie S., Ratna N.N.) [15].

Conclusion

1. Food security is a comprehensive indicator that implies providing the population with a sufficient amount of high-quality, safe and affordable food products in accordance with their individual needs on a long-term basis. The issue of ensuring food security needs to be considered comprehensively, ideally at 4 levels such as availability, accessibility, utilization, and stability. The study proved the dependencies of three of them.

2. The food security of the Republic of Kazakhstan has undergone a number of transformations over the past 10 years, according to economic and statistical data. Despite the high growth of labor productivity in the agro-industrial complex by more than 10 times, the country is experiencing a decrease in the Prevalence of malnutrition and a persistent gap between the urban and rural populations. At the same time, there is a critical dependence on imports for a number of food products.

3. The Availability of food security is directly dependent on an increase in arable land and an increase in purchasing power parity. Access also depends on the development of its own agricultural sector land fund, which reduces dependence on imports, thereby strengthening the country's food independence.

4. The stability of food security shows an increase with the growth of investments in the agro-industrial complex and the growth of arable land. As a consequence, purchasing power parity plays the role of a stabilizer, minimizing drastic changes in the consumption of calories by the population.

5. The successes achieved in the agro-industrial complex should be complemented by government measures to stabilize prices, develop infrastructure, especially in rural areas, and increase the country's food independence.

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