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Drivers of Cereal Production Efficiency Improvement in Kazakhstan – the Case of the Kostanay Region

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ABSTRACT

The COVID-19 outbreak has seriously affected the global food security at a time when it was significantly compromised by the effects of climate change and armed conflicts. The impact of the pandemic and quarantine restrictions imposed in response to the deadly virus brought humanity face-to-face with a new threat – that of food insecurity – which contributed to a high social demand for state-of-the-art methods of improving the cereal production efficiency. The aim of the study is to develop and implement a methodological approach to enhancing the cereal production efficiency. The methodology of the study relies on time series that made it possible to determine the main trends in regional cereal production and make projections. Application of the suggested approach in the Kostanay region revealed that this region was among the key cereal producers in the country. In 2019, the region was affected by extreme weather, which caused a sharp decline in cereal production. The present study, however, projects large opportunities for cereal production growth in the region and a significant increase in cereal production in the future. In addition, the paper suggests the following action plan to improve efficiency of the cereal production sector in the Kostanay region: streamlining of state support arrangements for cereal producers; development of affordable crop insurance products; systemic steps to increase cereal yields; development of logistic infrastructure; comprehensive monitoring of cereal production to develop a system of rapid response to changes in the external environment.

Keywords: cereal production, food security, crop yield, food insecurity, cereal crops, wheat.

INTRODUCTION

The global economy is facing multiple challenges. According to an official UN statement, the COVID-19 pandemic emerged at a time when global food security had already been significantly compromised by armed conflicts, natural disasters, climate change and the emergence of pests and epidemics on a transcontinental scale [United Nations Secretary-General 2020]. In this context, the COVID-19 pandemic itself, along with measures to prevent the spread of the virus, made a devastating impact on global food security, putting humanity face to face with a new threat: the global food insecurity. The UN statement emphasized that regional food security is of particular importance in the current context due to the partial or complete disruption of supply chains, both as a consequence of the COVID-19 pandemic itself and subsequent quarantine measures [United Nations Secretary-General 2020]. Therefore, in view of the current economic developments, improving the cereal production efficiency is of high priority, since cereals play a key role in ensuring food security.

External challenges, which impaired the global food security, also changed the economic environment for most economic agents. As a result, the real demand for state-of-the-art, resilient and adaptable tools to improve the cereal production efficiency soared. This demand is particularly high in Kazakhstan, where the production of cereal crops accounts for a significant part of the country's exports [Kazakh Grain Union 2019;

2020; 2021]. At the time of the study, Kazakhstan was one of the world's major exporters of cereals, and increasing the cereal production efficiency is an essential condition for improving Kazakhstan's competitiveness in the global market for cereal crops. As there is a need to raise the cereal production efficiency to ensure food security, the present paper appears as a timely contribution, especially given the increasing demand for time-sensitive solutions for efficient cereal production.

The enormous value of cereals for the food security on a regional or global scales sparked interest in efficient cereal production among researchers. The multi-dimensionality of the problem gives rise to multiple approaches to its solution.

Chinese scholars investigated the potential yield of soybeans in the food security context in China under COVID-19 outbreak. Using mathematical programming methods, in particular distribution models and scenario analysis, they developed four scenarios incorporating the degree of the COVID-19's impact on possible imports of cereal crops, including soybeans, and suggested possible options for ensuring food security for each of the scenarios [Yao et al. 2020].

The objectives of Chinese researchers overlap with those of Russian researchers, who studied food security through increased cereal production efficiency in the case of Kazakhstan [Tireuov et al. 2018]. However, their research is more descriptive in nature due to differences in research methodologies. Hence, the efficiency improvement proposals in their paper are less specific. The strengthening of state support, primarily regarding supply of businesses with human resources and promotion of their products on the market are named as priorities [Tireuov et al., 2018].

Yeszhanova et al. (2021), suggested a comprehensive approach to assess food security in Kazakhstan amid the COVID-19-induced crisis using economic, statistical and rating methods. Unfortunately, the study does not specify sufficiently the issues of improving the cereal production efficiency, although the evaluation methodology suggested by Yeszhanova et al. (2021) deserve attention.

Mukhametgaliev et al. (2020) focused directly on streamlining cereal production and improving distribution efficiency on a regional scale. Based on research findings, the authors suggested to:

- establish decent, fair, feasible and stable cereal prices;
- improve cereal distribution channels, expand sustainable distribution channels; sell cereals through the republican commodity exchange;
- establish a system of public contracts for specific quantities and quality of cereals;
- increase government subsidies for fuels and lubricants, fertilizers, crop protection chemicals, etc;
- establish an agency that sets and controls cereal prices and facilitates sale of cereals by agribusinesses [Mukhametgaliev et al. 2020].

Their study used an approach somewhat similar to that suggested by Morkovkin (2019), who considered regulation of the cereal market as a key condition for improving the cereal production efficiency on a national scale. Shramenko et al. (2019) approached the issue of improving the cereal production efficiency from the market infrastructure streamlining perspective, in particular cereal transportation logistics issues. Economic and statistical methods, which were the main methods of the analysis, allowed authors to provide recommendations to improve the cereal transportation efficiency [Shramenko et al. 2019].

Ogorodnikov et al. (2020) consider the possibility of improving the cereal production efficiency using the clustering method. Parameters for the cluster analysis included areas under cereal crops, cereal yields, gross output, physical quantities of sold cereal crops, and the average monthly wage of agricultural workers [Ogorodnikov et al. 2020, Zhang et al. 2021]. On the other hand, Parshukov et al. (2020) focused entirely on the impact of government subsidies.

Vasylieva's (2020) methodology for analyzing regional cereal production is of considerable interest. In order to assess the quantities of produced cereals on a regional scale, Vasylieva (2020) suggests using time series analysis. This analysis allows users not only to monitor cereal production in the region, but also to project cereal production with a high degree of reliability, which is especially important in the context of the global food insecurity threat [Vasylieva 2020].

Therefore, the issues of improving the cereal production efficiency draw more attention from researchers. However, recognizing the significant contribution made by the previous studies, it turns out that a significant portion of these papers is descriptive [Smertina et al. 2019, Tireuov et al. 2018, Tireuov et al. 2019] and does not consider the volatile external environment [Sidorenko

2020], limiting the search to logistic solutions [Shramenko et al. 2019], lease [Ozerova and Sharopatova 2020], and other narrow aspects.

The study aims to develop and implement a methodological approach to enhancing cereal production efficiency. The objectives of the study are to develop methodology for cereal production quantification, provide recommendations for improving cereal production efficiency, and implement the suggested approach in the Kostanay region.

MATERIALS AND METHODS

The study uses econometric methods based on time series models. The methodological rationale for applying the time series model for econometric analysis of cereal production in the region was suggested by Vasylieva (2020). This methodology, which is based on the time series, allows its users to:

- identify trends in gross output, cultivated areas and cereal yields on a regional scale; compare trends in production of specific cereals with the national scale indicators;
- identify changes in the main indicators describing cereal production on a regional scale [Vasylieva 2020].

The authors relied on reports from the National Statistics Bureau of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, including statistical data on:

- the revised areas under the major crops in Kazakhstan [Area under crops of the basic agricultural crops 2021a]; the revised areas under the major crops in the Kostanay region [Area under crops of the basic agricultural crops 2021b];
- major crop yields in Kazakhstan [Productivity of the basic agricultural crops 2021a];
- major crop yields in the Kostanay region [Productivity of the basic agricultural crops 2021b];
- gross outputs of major crops in Kazakhstan [Total gathering of the basic agricultural crops 2021a];
- gross outputs of major crops in the Kostanay region [Total gathering of the basic agricultural crops 2021b];
- Cereal Market Reviews prepared by the Kazakh Grain Union (2019; 2020; 2021).

The samples used to build the time series were cut to those used for 2013–2020 taking into account the special aspects of agriculture, including cereal-farming specifics. The latter cause the sector's significant dependence on a number of uncontrollable factors (weather, natural disasters, etc.). The increasing adverse effects of the global climate change have also been treated as uncontrollable factors in recent years [United Nations Secretary-General 2020].

At the preparatory stage of the study:

- the main cereal production parameters (cultivated areas, yields, gross output) were selected;
- the boundaries of the time series (2013–2020) were set;
- software tools for calculations (Microsoft Excel) were selected.

Microsoft Excel was chosen due to the widespread use of Microsoft Office software in Kazakhstan. Software availability significantly increases the practical value of the suggested methodology for econometric monitoring of cereal production in the region.

To analyze the main cereal production trends in the Kostanay region, additional indicators were calculated.

The mean μ was calculated using the following formula:

$$\mu = \frac{1}{n}\sum_{i=1}^{n} x_i \tag{1}$$

where: x was the value of the analyzed indicator;
n is the quantity of values in the time series.

The average increment rate $\overline{\Delta y}$ is calculated with formula 2:

$$\overline{\Delta x} = \frac{x_n - x_1}{n-1} \tag{2}$$

The average growth rate $\overline{T}$ was calculated with formula 3:

$$\overline{T} = \sqrt[n-1]{\frac{x_n}{x_1}} \times 100\% \tag{3}$$

The average increment rate $\overline{K}$ was calculated with formula 4:

$$\overline{K} = \overline{T} - 100\% \quad (4)$$

The coefficient of variation c_v was calculated with formula 5:

$$c_v = \frac{\sigma}{\mu} \quad (5)$$

where: σ is standard deviation;
μ is the mean value.

The standard deviation σ was calculated with formula 6:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^2} \quad (6)$$

where: x is the value of the analyzed indicator;
n is the quantity of values in the time series;
μ is the mean value.

The polynomial trend of the time series was constructed using the Microsoft Excel tools.

The coefficient of determination R^2 of the polynomial model was calculated with formula 7:

$$R^2 = \frac{\sum_i (a(x_i) - \overline{y})^2}{\sum_i (y_i - \overline{y})^2} \quad (7)$$

where: $X^n = (x_i, y_i)_{i=1}^{n}$ is the data set of n observations;
x_i is the feature vector of the i-th observation $y_i \in Y$.

The projection period for cereal production in the Kostanay region was reduced to 3 years (2021–2023) due to significant dependence on uncontrollable factors. The current volatile economic environment also had to be taken into account.

Quantitative indicators of cereal production in the Kostanay region were obtained by means of Microsoft Excel.

On the basis of the projected values, the main ways to improve the cereal production efficiency in the Kostanay region were suggested.

RESULTS

Table 1 shows the time series used to analyze the cereal production trends in the Kostanay region in 2013–2020 [Area under crops of the basic agricultural crops, 2021a; 2021b; Productivity of the basic agricultural crops 2021a; 2021b, Total gathering of the basic agricultural crops, 2021a; 2021b]. Table 2 shows the estimated cereal production trends in the Kostanay region, obtained through an econometric analysis of the time series.

The results shows that the Kostanay region and Kazakhstan in general have different trends in cereal production. This aspect requires special attention when conducting research. The average area under cereals in Kazakhstan amounted to 15,423.15 thousand hectares. The minimum areas under cereals were observed in 2015, followed by a stable growth of cultivated areas until the end of the study period. The areas under cereals in Kazakhstan reach their maximum (15,878.38 thousand hectares) at the end of the study period (2020). This fact allows us to put forward a hypothesis regarding the sustainable growth of areas under cereals in Kazakhstan (average annual increment of 0.12 thousand hectares).

The average value of areas under cereals in the Kostanay region was 4,126.36 thousand hectares, with the maximum value (4,395.02 thousand hectares) recorded in 2013 and minimum value (3,965.12 thousand hectares) recorded in 2019. Therefore, during the study period the areas under cereals in the Kostanay region showed a downward trend, which was reversed only in 2020.

The areas under cereals in the Kostanay region fell at annual average increment rate of 49.55 thousand hectares, in contrast to the positive trends on a national scale. The average increment rate for areas under cereals in the Kostanay region during the study period amounted to 0.9883, which confirms the downward trend.

It should be mentioned that the reduction of areas under cereals does not necessarily constitute an adverse event, as the reduction in the areas under crops with yield growth is in line with the best industry practices [Kazakh Grain Union 2020].

We studied the main trends in cereal yields in Kazakhstan and the Kostanay region. During the study period, the average cereal yield in the Kostanay region amounted to 1,031 kg/hectare, which is 18.02% lower than the nationwide average (1,258 kg/hectare). The average increment

Table 1. The time series used to analyze the cereal production trends in the Kostanay region in 2013–2020

Cultivated area	2013	2014	2015	2016	2017	2018	2019	2020
Kazakhstan	15,877.57	15,291.50	14,982.20	15,403.50	15,405.36	15,150.04	15,396.63	15,878.38
Kostanay region, including wheat	4,395.02	4,109,30	4,018.80	4,213.90	4,194.50	4,066.06	3,965.12	4,048.15
Kazakhstan	13,088.70	12,387.60	11,771.10	12,437.00	11,976.57	11,409.84	11,413.94	12,182.63
Kostanay region	4,014.40	3,747.40	3,579.70	3,810.40	3,704.90	3,464.02	3,264.62	3,436.59
Yield								
Kazakhstan	11.62	11.70	12.70	13.50	13.40	13.49	11.40	12.80
Kostanay region, including wheat	9.73	9.90	11.40	10.80	11.60	11.56	7.39	10.10
Kazakhstan	10.76	10.90	11.90	12,10	12.40	12.28	10.10	11.80
Kostanay region	9.60	9.90	11.40	10.50	11.30	11.36	7.27	10.20
Gross output								
Kazakhstan	18,231.10	17,162.20	18,672.80	20,634.40	20,585.10	20,273.65	17,428.59	20,065.31
Kostanay region, including wheat	4,267.50	3,987.50	4,541.90	4,535.90	4,857.80	4,679.18	2,872.44	4,015.78
Kazakhstan	13,940.80	12,996.90	13,747.00	14,985.40	14,802.90	13,944.11	11,451.65	14,257.95
Kostanay region	3,844.90	3,616.70	4,061.30	3,991.30	4,193.80	3,923.59	2,330.63	3,454.98

Note: Developed by the author according to Area under crops of the basic agricultural crops (2021a; 2021b); Productivity of the basic agricultural crops (2021a; 2021b); Total gathering of the basic agricultural crops (2021a; 2021b).

Table 2. Cereal production trends in the Kostanay region

Cultivated area	Average value	Annual trend	Standard deviation	Average growth rate	Coefficient of variance, %	Minimum	Maximum
Kazakhstan	15,423.15	0.12	316.57	1.0000	2.05	14,982.20	15,878.38
Kostanay region	4,126.36	-49.55	137.37	0.9883	3.33	3,965.12	4,395.02
Kostanay region	3,627.75	-82.54	239.24	0.9780	6.59	3,264.62	4,014.40
Yield							
Kazakhstan	12.58	0.17	0.89	1.0139	7.08	11.40	13.50
Kostanay region	10.31	0.05	1.4	1.0053	13.58	7.39	11.60
Gross output							
Kazakhstan	19,131.64	262.03	1,431.65	1.0138	7.48	17,162.20	20,634.40
Kostanay region	4,219.75	-35.96	625.07	0.9914	14.81	2,872.44	4,857.80

Note: Developed by the author according to Area under crops of the basic agricultural crops (2021a; 2021b); Productivity of the basic agricultural crops (2021a; 2021b); Total gathering of the basic agricultural crops (2021a; 2021b).

rate, although showing a positive trend (5 kg/hectare), is more than 3 times lower in absolute terms than the nationwide average (15 kg/hectare). The average yield increment rate in the Kostanay region (1.0053) is also lower than the nationwide average (1.0139).

The low increment of cereal yields was largely due to: drought in 2019, which significantly reduced yields and impaired cereal class in the south of the Kostanay region, north-west of the Akmola and Karaganda regions, and long rains in the fall that prevented harvesting in the less drought-affected areas of the region [Kazakh Grain Union 2020].

On average, the gross output of cereal crops in Kazakhstan amounted to 1376.584 thousand tons, having demonstrated the average annual increment of 4.531 thousand tons. Average gross output in the Kostanay region amounted to 367.715 thousand tons, falling on average by 5.57 thousand tons per year. Reduced cultivated areas in the studied region definitely played a significant role in reducing the gross output. A sharp decline in the gross output in the Kostanay region during the study period was provoked largely by adverse weather in 2019. The minimum gross output (233.063 thousand tons in 2019) is almost half of the maximum output (55.5% of the maximum of 419.380 thousand tons in 2017). As regards Kazakhstan, the average minimum output (1,145.165 thousand tons in 2019) is less than a quarter behind the maximum output (23.58% of 1,498.540 thousand tons in 2017).

In this case, the values of the coefficient of variation point out to sufficient homogeneity of the time series and the possibility of using the data for further analysis. The analysis of the Kostanay region's role in the gross cereal output (Figure 1a), and particularly wheat output (Figure 1b), shows that, given the major economic threats, the revealed negative trends in cereal production cannot be ignored.

Figure 1a and Figure 1b show that despite the negative trends, the Kostanay region remains not just one of the leading producers of cereal crops, accounting for 22% of the total output. It is also the main producer of the premium quality wheat, accounting for 27% of the total gross output. The percentage of areas under cereals in the Kostanay region in the total cultivated areas is even more impressive. Despite the significant reduction, the Kostanay region accounts for 27% of the areas under cereals and 30% of the areas under wheat, which points out to the high capacity of the Kostanay region in the production of cereal crops [Area under crops of the basic agricultural crops 2021a; 2021b].

To make cereal output projections for the Kostanay region for 2021–2023, degree 4 polynomial regression was used for the selected time series (Figure 2). The polynomial regression was built using Microsoft Excel.

Figure 2 shows that, despite the negative trends in production of cereal crops, including extreme weather in 2019, the outlook for output in the Kostanay region remains positive. The suggested model of the gross cereal output in the Kostanay region is as follows: $y = 5.2611x^4 - 99.7x^3 + 644.69x^2 - 1652.9x + 5507.4$. The approximation's reliability indicator, $R^2 = 0.9394$, points out to a high degree of correspondence of the trend model to the input data.

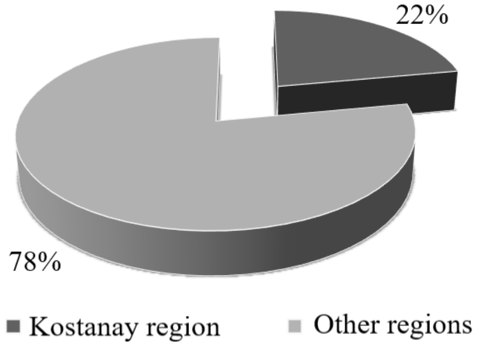
According to the projection, the positive trend of gross revenue will continue throughout the forecast period. Expected gross cereal output in the Kostanay region will reach 468.797 thousand tons in 2021, 553.897 thousand tons in 2022 and 969.162 thousand tons in 2023.

To make cereal yields projections for the Kostanay region for 2021–2023, degree 5 polynomial regression was used for the selected time series (Figure 3). The projections were made using Microsoft Excel.

Figure 3 shows that the main increase in gross output in the Kostanay region is projected due to improved yields. The suggested model of crop yields in the Kostanay region is as follows: $y = 0.0195x^6 - 0.5019x^5 + 5.0636x^4 - 25.364x^3 + 65.533x^2 - 80.495x + 45.477$. The approximation's reliability indicator, $R^2 = 0.9991$, points out to a high degree of correspondence of the trend model to the time series.

The results of the analysis allow authors to conclude that the Kostanay region is one of the most important producers of cereal crops in Kazakhstan (22% of the total output), including high grade wheat (30% of the total output). The analysis also revealed that the Kostanay region was more affected, as compared to other regions, by adverse weather in recent years, which significantly reduced gross outputs and wheat yields in the region. It should be mentioned that small-scale farmers, many of which cannot recover after a difficult year of 2019, also contribute to a portion of these figures. This fact refreshes the need for state support to improve the cereal production efficiency in the Kostanay region [Kazakh

a



b

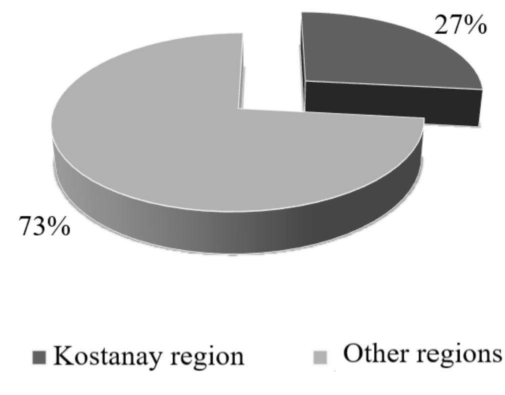


Figure 1. (a) Structure of gross cereal output; (b) Structure of gross wheat output

Note: Developed by the author based on Total gathering of the basic agricultural crops (2021a; 2021b).

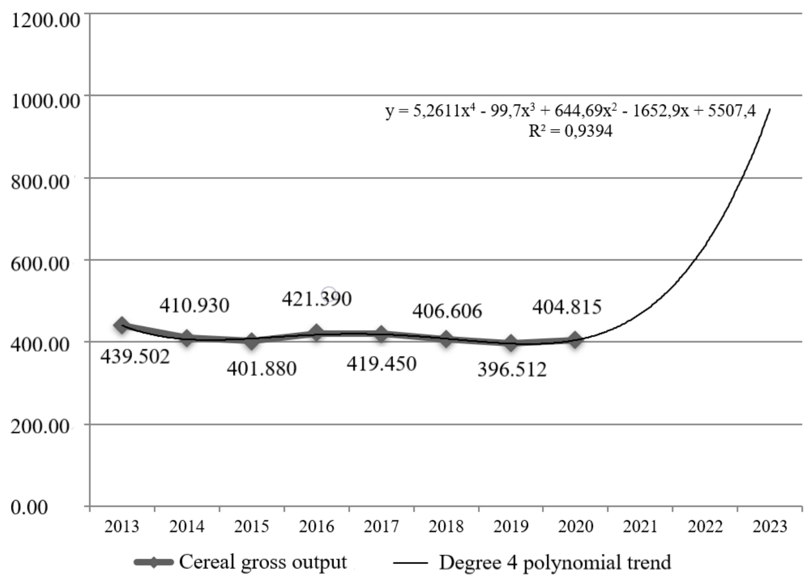


Figure 2. Projected gross outputs of cereal crops in the Kostanay region in 2021–2023, thousand tons

Note: Developed by the author based on Total gathering of the basic agricultural crops (2021a; 2021b).

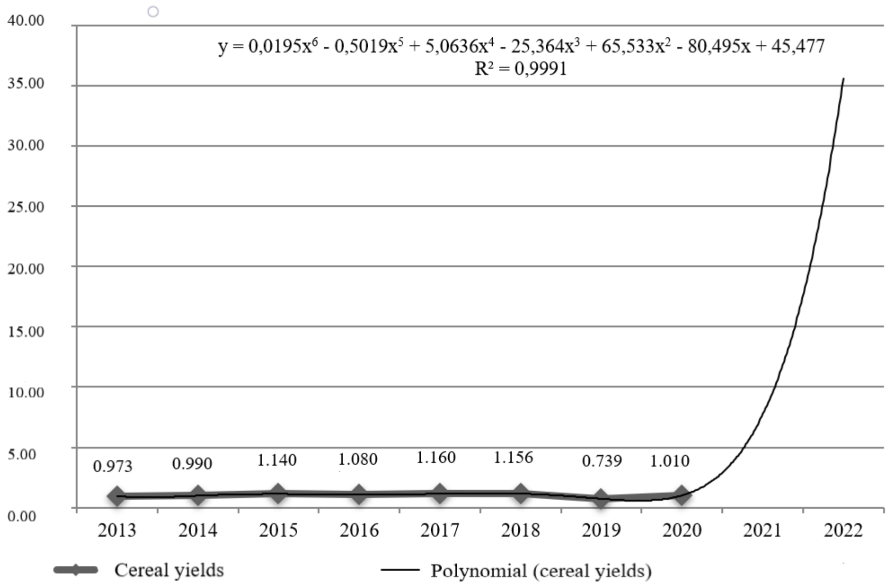


Figure 3. Projected cereal yields in the Kostanay region in 2021–2022

Note: Developed by the author based on Productivity of the basic agricultural crops (2021a; 2021b).

Grain Union 2020]. Projections showed that in 2021–2022 cereal outputs in the Kostanay region could be increased by improving the yields. Such strategy is in line with the global farming trends [Kazakh Grain Union 2019].

Based on this, the efforts to improve the cereal production efficiency in the Kostanay region should primarily focus on:

- state support for cereal producers; development of insurance products, which would provide coverage against adverse weather;
- systemic steps to increase cereal yields, including improving the soil quality and the cereal farming technology, reliable crop protection, etc.;
- improving the logistic infrastructure to reduce crop losses due to adverse weather during harvesting and reduce losses during transportation and storage;
- comprehensive monitoring of crop production using innovative technologies, including mathematical modeling, scenario analysis, etc., to develop a system of rapid response

to changes in the external environment in order to ensure food security of the region and throughout Kazakhstan.

DISCUSSION

As mentioned earlier, there are a few studies focusing on cereal production efficiency. Lukhmanova et al. (2018), Lukhmanova et al. (2019), Svanidze and Gőtz (2019), Sidorenko (2020) focus on the global perspective of the problem. Kaigorodtsev (2019) considers the problem only as part of the food security issue. In contrast to those studies, this paper focuses on cereal production in the Kostanay region. Cereal production trends in Kazakhstan are studied mainly in terms of the Kostanay region's role in the cereal production in the country, as well as the comparison of the regional and nationwide indicators. Ozerova and Sharopatova (2020) view the crop farming efficiency solely in terms of vehicle and equipment availability and their effect on efficiency through lease arrangements. Therefore, the present study has a broader perspective Smertina et al. (2019) conducted statistical analysis and cereal market forecasts for the southern part of Russia. Despite the fact that this study deals with the regional aspect of the problem, the research is merely only an overview, without proper statistical estimates. They primarily attempted to assess the region's export opportunities, with a rather meager analysis of cereal production on the regional scale.

Research made by Chinese authors in 2020–2021 should be highlighted in particular. Food security issues have always been important in China. Being the first to face the COVID-19 pandemic, Chinese researchers were probably the first to realize the hidden threats of the pandemic itself, as well as the quarantine restrictions that disrupt sustainable supply chains. As the world's largest wheat producer (with 134.3 million tons of gross output in 2020/21), China is also among the top three wheat importers (10.5 million tons in 2020/21 marketing year). This fact definitely greatly enhances the importance of increased cereal production efficiency for China as the COVID-19 pandemic continues. The studies by Chinese authors spark more interest, both in terms of information availability and methodological approaches.

The study by Yao et al. (2020) impresses with its depth, the innovative methodological approach, and a strong database covering:

- weather monitoring data, particularly data on precipitation and accumulated temperature;
- land management data retrieved from the remote sensing database and the land utilization monitoring system;
- data on cultivated areas and yields, imports and exports;
- data on soybean outputs by country and COVID-19 outbreaks from FAO and WHO.

Yao et al. (2020) used a distribution model to estimate the suitability of cultivated areas in China for soybean farming. A spatial distribution map of temperature suitability for soybean farming was developed using the Kriging interpolation method in ArcGIS spatial analysis function. The soybean-cereal constraint-based model was then developed, followed by four main scenarios:

1. Scenario A: China cannot import soybeans because of the COVID-19 outbreak.
2. Scenario B: China can import a quarter of the original amount.
3. Scenario C: China can import a half of the original amount.
4. Scenario D: China cannot import food, including soybeans (Yao et al., 2020).

The study by Yao et al. (2020) is definitely one of the most profound and comprehensive studies of this problem. However, in order to implement their findings in Kazakhstan, a system should be adopted to monitor the required core indicators.

CONCLUSIONS

This study produced an econometric analysis of the cereal production trends in the Kostanay region. The analysis revealed a number of adverse trends, including a reduction in the average cereal yield in the Kostanay region, and, as a consequence, a significant decrease in the gross cereal output caused by 2019 drought, as well as long rains in the fall, which made the harvesting difficult.

The econometric analysis showed that, despite the adverse trends, the Kostanay region remains not only one of the nation's main producers of cereal crops, but also the main producer of the premium quality wheat. This fact necessitates the need to develop steps to improve the cereal production efficiency in the Kostanay region.

The projections made in the study using the polynomial regressions reveal a high probability of a positive development scenario for cereal production in the Kostanay region.

Based on the findings, the following growth options for cereal production were suggested:

- state support for cereal producers; development of insurance products, which would provide coverage against adverse weather;
- systemic steps to increase cereal yields, including improving the soil quality and the cereal farming technology, reliable crop protection, etc.;
- improving the logistic infrastructure to reduce crop losses due to adverse weather during harvesting and reduce losses during transportation and storage;
- comprehensive monitoring of crop production using econometric analysis, mathematical modeling, scenario analysis to develop a system of rapid response to changes in the external environment in order to ensure food security of the region and throughout Kazakhstan.

The methodological approach presented in the study opens up new opportunities for the introduction of integrated monitoring of cereal production in the region. Econometric parameters of cereal production will help take proper management steps to reduce the adverse impact of the external environment and maximize the sector's efficiency. The suggested methodological approach only requires the knowledge of Microsoft Excel, which greatly increases its practical value, especially on the regional scale.

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