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Breakdown on the Polish crop market 2022-2023. Possible reasons and lesson for future

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Abstract. In the period 2022–2023, an unprecedented triad of phenomena profoundly disrupted the Polish crop market: (1) oversupply of crops due to abundant harvests in preceding years, (2) heightened crop price volatility on the international market, and (3) an influx of low-priced crops from Ukraine via the EU's solidarity transit corridors. This paper aims to identify the impact of these shocks on the Polish crop market during 2022–2023 and to delineate their trajectories. Based on a segmented analytical model, we examine the following dependencies within the Polish crop market: 1. The relationship between MATIF wheat futures prices and domestic wheat prices in Poland; 2. The influence of cereal stocks on price formation in Poland; 3. The effects of fodder consumption and on-farm use of cereals on cereal price levels in Poland; 4. The interplay between the volume of Polish cereal exports and domestic cereal prices during the farming years 2020/2021 to 2023/2024. We conclude that the complex interplay of these phenomena, as observed during the period under review, is likely to become a persistent feature of the Polish crop market. The ongoing development of the European Union, particularly in light of Ukraine's accession as a major European and global cereal "granary," presents significant challenges for Poland. As an agricultural country with the fifth highest Gross Value Added

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(GVA) in the sector within the EU, Poland faces considerable threats to the livelihoods and welfare of its more than one million farmers and their households. For these producers, Ukraine's accession would critically extend a chain of interdependent and highly vulnerable variables such as grain harvest volumes, grain prices, and crop derivatives market prices that collectively determine their economic prosperity.

Keywords: Polish crop market, armed conflict in Ukraine, crop price formation in Poland

JEL Classification: D40, Q10, R10

1. INTRODUCTION

To outline a broader context of the analysed issue we stress that unlike other economy sectors, agricultural sector is more vulnerable to exogenous shocks with uncertain output depending on Nature forces. This feature affects the price, a fundamental economic category, a key mechanism that influences resource allocation, production decisions, and overall economic activity. Agricultural production depends on the production cycles of plants and animals. The output, supply and agricultural products availability depends on numerous factors that are effectiveness-neutral in other economy sectors. Prices for agricultural products are the most dynamic character of the agricultural market. They are sensitive to the influence of numerous economic, technological, social and political factors. The peculiarity of pricing and prices for agricultural products is that most of its species show seasonal price fluctuations. During good harvest, oversupply pushes price down, but other seasons when supply shallows the prices rise. Crop prices volatility is mainly determined by supply-side factor changes. Natural disasters, weather uncertainties affecting harvests and other phenomena behind crop supply shortages make prices go up. Market oversupply of unsold crop with high levels of closing stock make price level go down. Agricultural sector characterizes with numerous factors devastating the success in larger scale than observable in other sectors. The main is natural risk (storm, hail, overflood, drought), unpredictable as Nature has become, with impacts and capability to damage any projects and efforts taken by farmers-producers. Equally important is general business environment with its numerous exogenous impact variables (armed conflicts, international price volatility, speculation on commodity markets, transporting routes disruptions) with capability to ruin any prospects and efforts taken by farmers-producers as well. Also stronger exchange rates would put downward pressure on foreign currency-denominated prices. Within the European Union, crop prices follow commodity futures in Euro and crop price formation in countries outside the Euro Area is also affected by depreciation or appreciation of their home currencies against Euro (Zegunis & Balezentis, 2024; Eidukaitis & Balezentis, 2022). In Poland in the period 2020/2021-2023/2024 we observed from mentioned above risks, a probable complex of variables – internal and exogenous as well that might put farm gate price to the edge. Farm gate price, the market price of agricultural product a farmer-producer can receive is a mean of success, as in agriculture price is the most important factor for farmers-producers harvest-dependent and their households, rewarding hard work to collect financial resources for living and investment. Price is the main factor that has a direct impact on the main results of the farmer-producer enterprise and household – profit and sales, also the mean of competitiveness and stability. Scale of agricultural production is an important factor as well to price risk. Small-scale crop business and low-income farmers-producers are more risk averse. They can reduce or cease production when faced with a drop in prices or climate risks. The same concerns countries. Crop producing and cereal-oriented agricultural economies like Poland face more

risk to shockwaves affecting economy via supply level and price level of crops erupted by internal and exogenous variables we observed in the period 2020/2021/-2023/2024. Generally then, overall developments of small-scale crop and larger crop farmer-producers' business are important as much as agricultural development is important for economics in this country and improved, resilient to shock food value chain (Eurostat, 2020; Morgan et al.,; EC, 2025; Kmytiuk, 2023; Praburaj, 2018; OECD/FAO, 2016; Fitria et al., 2019; Satoła et al., 2019; Klank, 2008; Hamulczuk et al., 2011; Koester et al., 2023; Gilbert et al., 2014; Kang et al., 2006). The importance, vital issue of price formation in agricultural sector for farmers-producers population and the "breakdown" reflecting crop market price drop in Poland in 2022-2023, meant farmers-producers losses and unrest in many regions of a country. Understanding the phenomena behind this breakdown, pointing variable risk impacts would make it easier in our opinion to find solutions to cushion negative impacts in future.

2. METHODOLOGY

In this paper we analyse the following dependencies on the Polish crop market: 1/ MATIF wheat futures prices and wheat prices in Poland; 2/ cereals in stock and cereals price formation in Poland; 3/ fodder consumption and farm use of cereals and cereal price level in Poland; 4/ volume of Polish cereal export and cereal prices in Poland.

The period under analyse covers farming years 2020/2021 – 2023/2024 in Poland and farming years statistics.

Methodological approach in this paper we based on a segmented model. It is used when the connection between the explained variable and the explanatory variables on different subsets of the set of observations is different. This model is used when the connection between these variables is partially stable. This means that it is stable separately in each subset of the set of observation results and changes between these subsets. The change in the connection may concern the analytical form, explanatory variables, or parameters.

The general form of the segmented model can be written using the formula:

$$y = f_i(X_i, b_i)_{i=1, 2,\ldots, M} \quad (1)$$

on sets L_i, where the sets L_i are nonempty and mutually disjoint subsets of the set of observation numbers $\{1, 2, \ldots, T\}$.

In practice, segmented econometric models are most often encountered with turning points, which mainly concern time series. A segmented model with turning points is a segmented model for which each segment describes the connections between the explained variable and the explanatory variables for sets of subsequent, successive moments of time. A single segment describes a specific development phase of the phenomenon (Guzik, 2003).

A turning point in a segmented econometric model is understood as a moment at which a significant change in the connection between the explained variable and the explanatory variables occurs. This change may concern the analytical form, the list of explanatory variables, as well as the values of structural parameters. Locating turning points means looking for instability in the connection between the explained variable and the explanatory variables.

In a one-dimensional time series, a turning point is considered to be the moment when a clear change in the development trend of the explained variable took place (Guzik, 2005).

Turning points divide the observed set of time points $\{1,\ldots, T\}$ into subsets of subsequent moments of time L_m, m=1, … , M, each of which begins with "its own" turning point:

$$L_m=\{t_m, t_{m+1}, \ldots , t_{m+1}-1\} \text{ for } m = 1, 2,\ldots,M-1 \quad (2)$$

$$L_M=\{t_M, t_{M+1}, \ldots , T\} \text{ for for the last set} \quad (3)$$

The sets of L_m are called successive development phases (Guzik, 1993).

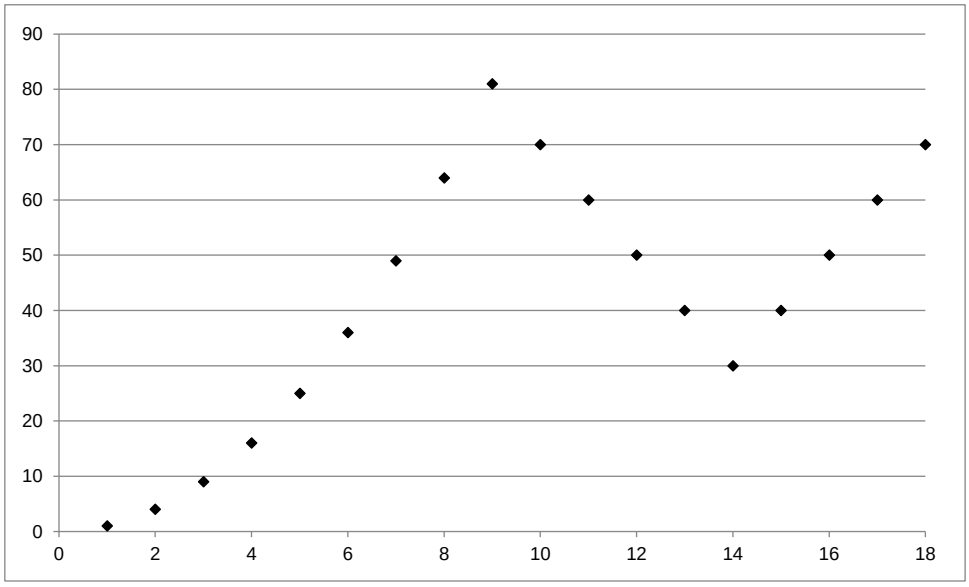

Figure 1. Example time series with two turning points.
Source: Authors' own calculations.

Figure 1 shows three development phases in a time series: the first is exponential and increasing, the second and third are linear development phases, decreasing and increasing respectively.

Turning points can be determined using one of two approaches:

- based on an intuitive procedure, based on the analysis of the course of the explained variable in relation to the explanatory variables,

- based on statistical procedures, consisting in checking whether the parameters of the function describing the relationship between the explained variable and the explanatory variables on neighboring sets are similar. Within these procedures, the Chow test, the large error test and the Perron test are used, among others (Guzik, 2005; Gasek et al. 2006).

The Chow test is used to verify the hypothesis of the stability of the parameters of an econometric model, it can also be used to locate turning points in one-dimensional time series. The lack of stability over time is usually associated with a change in the relationships between variables - sudden changes in the trend may mean the occurrence of turning points. This test belongs to the group of methods for locating turning points due to the comparison of parameters (Gruszczyński et al. 2003; Guzik, 2005).

The location of turning points carried out in this way consists in checking whether the parameters describing the connection of the explained variable with the explanatory variables for moments preceding time t* are significantly different from the parameters of the function describing these connections for moments occurring after time t*. If this is indeed the case, point t* is considered a turning point.

Chow's test can be used to locate turning points when:

- the explained variables of the functions determined on both sets are the same;

- both functions are linear with respect to the parameters;

- the assumptions of classical normal linear regression are correct with respect to the linear form of the model.

The procedure to verify whether point t* is a turning point is as follows: based on the preliminary analysis, the moment t* should be determined, which divides the series of observations L_o into two subsets L_d and L_g as follows:

$$L_d = \{..., y_{t^*-2}, y_{t^*-1}\}$$
$$L_g = \{y_{t^*}, y_{t^*+1}, ..., y_T\}$$
$$L_o = L_d \cup L_g \quad (4)$$

Then, for each set, we need to build models whose parameters are estimated using the classical least squares method and determine the sums of squared residuals (SRS) for each of them:

$$F_d = \alpha_d t + \beta_d;\ SKR_d;\ t = ..., t^*-2, t^*-1$$
$$F_g = \alpha_g t + \beta_g;\ SKR_g;\ t = t^*, t^*+1, ..., T$$
$$F_o = \alpha_o t + \beta_o;\ SKR_o \quad (5)$$

The Chow test verifies the null hypothesis of the form:

$$H_0 : \alpha_d = \alpha_g = \alpha_o \wedge \beta_d = \beta_g = \beta_o$$

to the alternative hypothesis:

$$H_1 : \alpha_d \neq \alpha_g \neq \alpha_o \vee \beta_d \neq \beta_g \neq \beta_o$$

The next step is to determine the empirical value of the testing statistic:

$$F = \frac{SKR_o - SKR_s}{K} \cdot \frac{\nu}{SKR_s} \quad (6)$$

Where:

$$\nu = T_o - 4$$
$$SKR_s = SKR_d + SKR_g \quad (7)$$

T_o – number of observations in the set L_o.

The statistic given by formula 80 has a Fischer–Snedecor distribution $F(\alpha, 2, \nu)$. If $F \geq F(\alpha, 2, \nu)$ then the null hypothesis that point t* is not a turning point should be rejected. Otherwise, we conclude that point t* is a turning point.

The Chow test is a good tool for verifying points considered to be turning points based on a preliminary analysis of the data presented on the graph. It can also be used in the so-called sequential location of turning points, which consists in checking whether the next observation added is or is not a turning point (Guzik, 2004).

The paper analyses the narrow segment of the agricultural sector in Poland, the crop market. We limit the meaning ”crop market” to wheat and rye market. Collected, used and calculated data in this paper is strictly Polish computed by the Central Statistical Office, the National Bank of Poland, and experts of the Agricultural and Food Economics Institute – National Research Institute. MATIF commodity futures have been taken from dedicated Internet sites.

Rye futures prices are not available on the MATIF which the Authors also had to accept.

3. EMPIRICAL RESULTS AND DISCUSSION

The volume of Polish cereal exports and the level of cereal prices in Poland

Based on data from the Table 1 and Table 2 (see the Appendix) we present the volume of Polish cereal exports and the level of cereal prices: wheat and rye (in Polish zloty) in Poland from July 2020 to June 2024 (Figure 2).

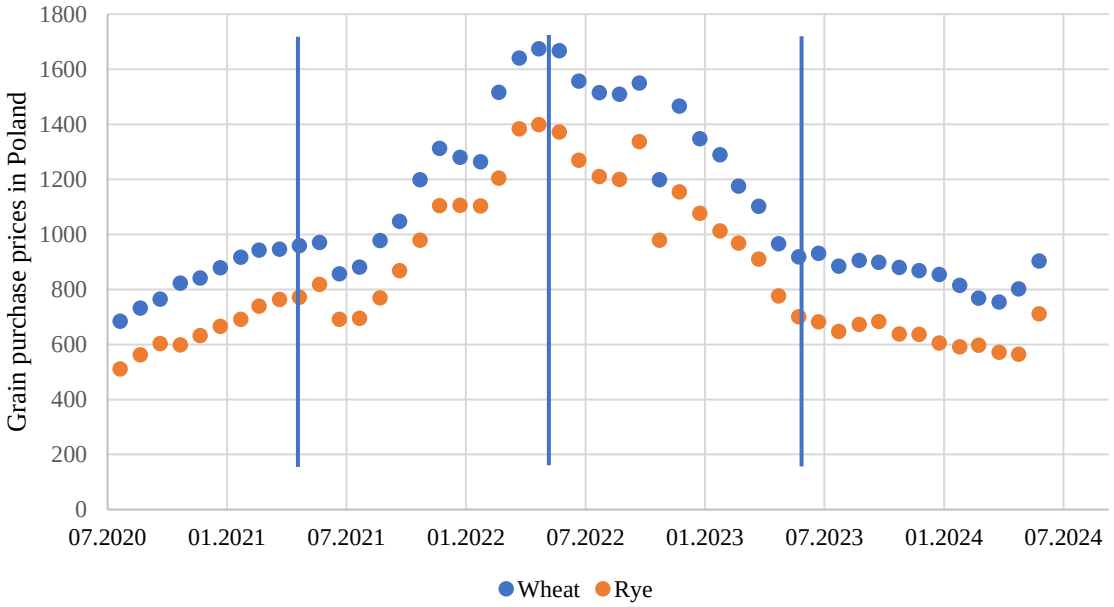

Figure 2. Changes in the level of wheat and rye prices in the months for the period July 2020 – June 2024

Source: Authors' own calculations

We then, upon data from Table 1 and Table 2 (see the Appendix) calculate the annual average rate of price change in the period from July to June. It is determined as the geometric mean of chain price indices from individual months under study. It informs how much the average price has changed on average in July/June (Table 1). General observation is that cereal market characterized with quite a stiff demand for goods and any shift in supply makes deeper price fluctuations. Cereal price level in a third quarter of 2023 was lower in a range 34-46% than in a previous year. First and second quarter of 2024 was far from liquidity on the Polish cereal market. Expecting price rise did not occur. Weighted average cereal prices in 2023/2024 were lower in a range of 34-45% than in 2022/2023 (Dzwonkowski, 2023).

Table 1

Annual average rate of changes in wheat and rye prices in the years under study along with the volume of exports

Period	Annual average rate of change in price		Export (k tonnes)	
	Wheat	Rye	Wheat	Rye
2020/2021	1,028	1,036	5032	1449
2021/2022	1,062	1,064	3600	680
2022/2023	0,953	0,947	5751,9	507,2
2023/2024	0,997	1,004	6796,4	809,8

Source: Authors' own calculations

The values in Table 1, for instance 1.028, informs that the price of wheat in June 2021 increased by 2.8% compared to July 2020 price. A farming year 2021/2022 marked in general with rising cereal prices due to excessive demand during lockdown COVID-19, and then armed conflict in Ukraine. Also upward

trend of cereal prices in Poland was connected with depreciation of Polish zloty to US dollar and Euro[1]. The end of farming year, June 2022 marked with strong upward trend in cereal prices in Poland. Wheat price was 71.8% higher and rye price 67.8% higher than in previous year (Łopaciuk, 2023). The value of 0.953 on the Table 1 informs that the price of wheat in June 2023 compared to July 2022 decreased by 4.7%. That decrease might have been connected with the development of excessive Ukraine's export of crops to Poland. Between February 2022 and May 2023, Ukraine exported corn, wheat, rapeseed and sunflower to the EU with a total value of EUR 10.2 billion, of which EUR 4.03 billion was exported to five EU countries and close to 12% of the total value to Poland (NIK 2023). The aggregate impact of the EU's liberalization measures towards trade with Ukraine in the period 2022 - 2023 was the export of Ukrainian grain of nearly 49 million tons. Between March 2022 and March 2023, Ukraine exported 10 million tons to five "frontier" countries: Poland, Slovakia, Hungary, Romania and Bulgaria. More than 4 million tons of grain and oilseeds entered Poland. 0.7 million tons were transited, and 3.4 million tons remained in Poland. In 2022 - 2023, approximately 2.8 million tons of grain entered Poland[2] (NIK 2023). We statistically confirmed that June 2022 was a turning point in wheat and rye price formation in the analyzed time series upon farming years July 2020-June 2024 (Figure 1). This point was extracted on the basis of the theory of segmental models, in particular the Chow test was used for this purpose. The Chow test was used to verify hypotheses to check whether there was a breakdown or a change in trend at the designated turning point. The study assumed a significance level of 5%. The results of verification with the aforementioned test and the parameters of the trend function for individual segments broken down by agricultural products (Table 2).

Table 2

Values for function parameter evaluations for individual segments for wheat_price and rye_price and values of the F statistic in the Chow test

t*	Set	Start	End	A	b	F	F(0,05; 2;n)
01.06.2022 / wheat	L_d	1	24	40,4	557,4	3,8938	3,20928
	L_g	25	48	-36,3	2401,7		
	L_o	1	48	1,1	139,4		
01.06.2022 / rye	L_d	1	24	37,0	395,8	9,513	
	L_g	25	48	-32,9	2041,8		
	L_o	1	48	1,1	139,4		

Source: Authors' own calculations

The results obtained from the calculations allow the time series to be divided into two subsets: 6.2021-6.2025 and 7.2022-6.2024. In the first sub-period, an increasing developmental tendency was distinguished, while in the second – a decreasing tendency. The turning point responsible the change of direction was June 2022. Again we emphasize and connect that development with grain inflows from Ukraine to Poland. In 2021, before the armed conflict was estimated at 0.06 million tonnes, while in 2022, after the outbreak of armed conflict – 2.45 million tonnes. Imports from Ukraine to Poland in case of wheat in 2021 was estimated at 3.1 thousands of tonnes, while in 2022 it was 523 thousands of tonnes. In 2022, grain worth PLN 5.3 billion was imported into Poland, of which the highest share was from Ukraine, with a value of PLN 2.8 billion. Grain imports from Ukraine were the highest in 2022, with 2.4 million tons of grain

[1] Archiwum kursów średnich NBP. https://nbp.pl/statystyka-i-sprawozdawczosc/kursy/archiwum-tabela-a-csv-xls/

[2] The volume of grain "flooded" to Poland was only 7.1% of domestic production. OSW (2023). The EU increases its agri-food imports from Ukraine: causes and reactions from Central European states. *OSW Commentary*, *507, 2-8*.

imported. To compare, in 2021 it was 65.3 thousand of tonnes, and in 2020, 18.2 thousand of tonnes (NIK, 2023; Business Insider, 2024). In the period under analyze, there were no other exogenous or internal phenomena in the Polish crop market responsible for such price developments.

The impact of the volume of cereal stocks in Poland on the formation of cereal prices

Based on the data form Table 1, Table 3 and Table 5 (see Appendix), we matched calculated annual average rate of change in price of wheat and rye in a period 2020/2021 – 2023/2024 with the values of initial and closing stock measured in k tonnes (Table 3).

Table 3

Annual average rate of changes in wheat and rye prices in the years under review, together with the initial and final volume of stocks

Period	Annual average rate of change in price		Initial stock (k tonnes)		Closing stock (k tonnes)	
	Wheat	Rye	Wheat	Rye	Wheat	Rye
2020/2021	1,028	1,036	768	166	654	212
2021/2022	1,062	1,064	654	212	1924	640
2022/2023	0,953	0,947	1924	640	2261	1061
2023/2024	0,997	1,004	2261	1061	1235	1119

Source: Authors' own calculations

Comparing the average annual rate of change in wheat and rye prices, the 2022/2023 and 2023/2024 seasons were different from the previous ones. At that time, we observe a decrease in the prices of both types of cereals with a simultaneous increase in the level of their stocks. The farming year 2022/2023, once again turns our attention to the armed conflict in Ukraine, the EU transit solidarity corridors supporting Ukraine's export of goods when logistic routes through Black Sea were closed, but also to the developments on the Polish crop market blooming with extraordinary abundant harvest in a farming year 2021/2022. No account was taken by the Polish authorities of the fact that the stock of grain in warehouses and silos after a very good harvest, which in 2022 amounted to approximately 7 million tonnes, may increase and easily exceed the country's stock capacity when Polish entrepreneurs succeed to buy cheap, dumped Ukrainian grain that was being transported "in transit" through Poland. Practice showed, they did. On June 30, 2021, Poland's grain in stock was estimated at approximately 3.8 million tonnes, in 2022, at 7 million tonnes, to reach 9.7 million tonnes in 2023 (Center for Strategic and International Studies, 2024). The oversupply of grain in stock as a sum of Polish harvested amount and imported from Ukraine, exceeded stock and disposal capabilities. Crop prices went down (GUS, 2023; Matuszak, 2021). Using data from Table 2, we present annual average rate of changes in wheat and rye prices in the period 2020/2021-2023/2024 together with their initial and closing volume of stocks (Figure 3).

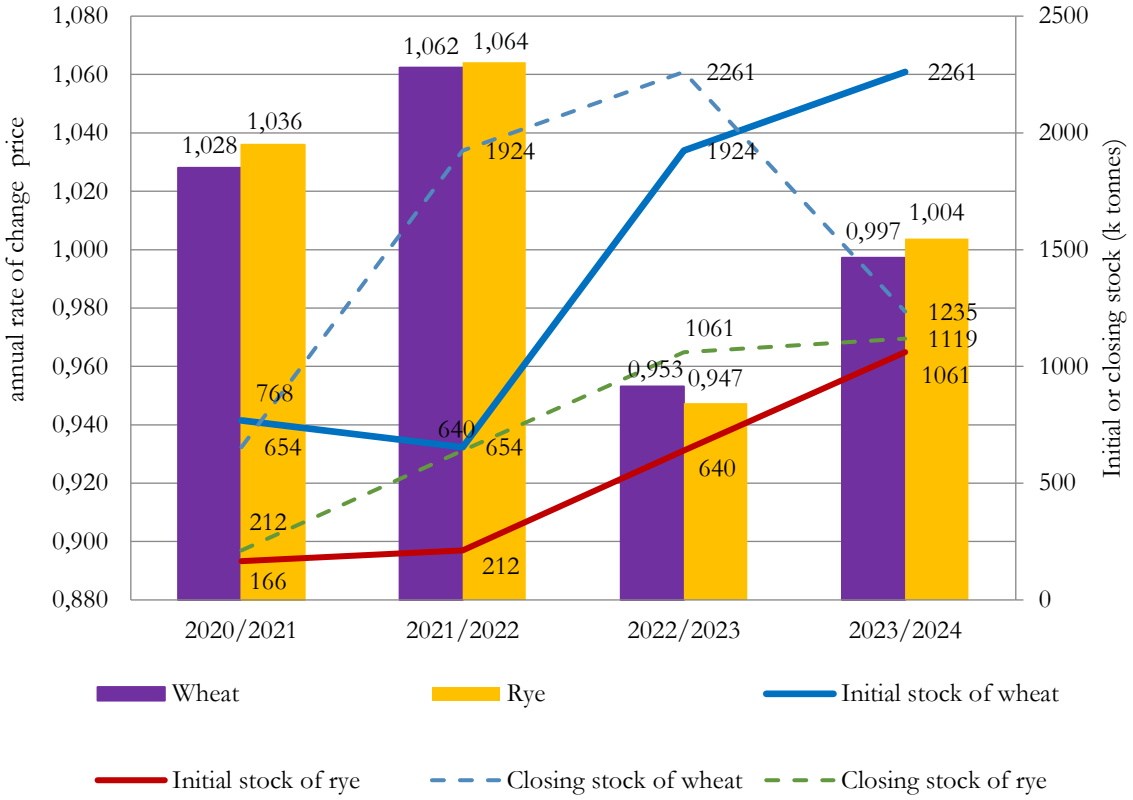

Figure 3. Annual average rate of change in wheat and rye prices in the farming years 2020/2021-2023/2024 and the initial and closing volume of stocks

Source: Source: Authors' own calculations

The figure clearly shows decline of prices the more, the more closing stock of wheat rises, especially in farming year 2022/2023. It began with high volume of cereal internal surplus. These were harvested cereals exceeded internal consumption by 9.9 million tonnes against 10.2 million tonnes of cereal surplus from the previous period. Initial stock of cereals in general in 2023/2024 was estimated 31.2% higher than in 2022/2023 (Łopaciuk, 2024).

Internal conditions: consumption of cereal products and feed consumption and the level of cereal prices

Based on the data from Table 1, Table 5, Table 6 (see the Appendix), we matched the annual average level of cereal prices in Poland with analysed fodder consumption of cereal products and feeding (Figure 4).

There is annual seasonal regularity that during harvest time crop prices fall shallowly for a short period. After that changes prices usually go back following the dominant trend in crop price formation. For example during 2022 harvest was accompanied with wheat, rye and barley price drop, then came back to follow upward trend – in the third quarter of 2022 crop price level was higher at about 70-84% than in previous period. Upward crop price trend reflected market concerns due to shrinking cereal supply after trading routes from Ukraine and these via Black Sea have been torn or closed. In 2023 harvest, prices fell down for a short time and came back in third quarter of 2023 at lower level by 34-46%. In a farming year 2023/2024 crop prices were at lower level than in previous year by 34-46%. In a period from July 2023 to April 2024 wheat price dropped by 38.8% and rye price by 45.8% (Łopaciuk, 2024).

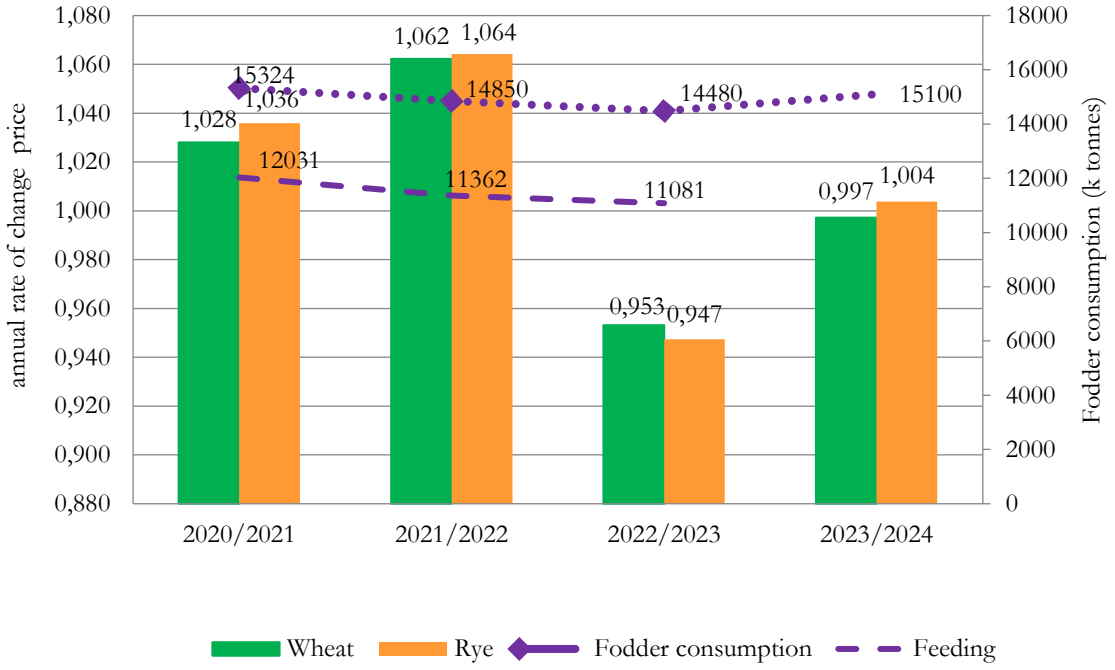

Figure 4. Annual average rate of change in wheat and rye prices in the period 2020/2021-2023/2024, fodder consumption and feeding folder

Source: Authors' own calculations

In the analysed period of the farming years, the level of fodder consumption and feeding remained essentially unchanged, without statistically significant changes to the annual average price level of wheat and rye.

Internal conditions: consumption of cereal products and feed consumption in stocks

Based on the data from Table 4, Table 5 and Table 6 (see the Appendix) we matched initial and closing grain in stock with fodder consumption and feeding in farming years 2020/2021-2023/2024 in Poland. We then compared the volume of initial and closing stock for wheat and rye with fodder consumption and feeding (Figure 5, 6).

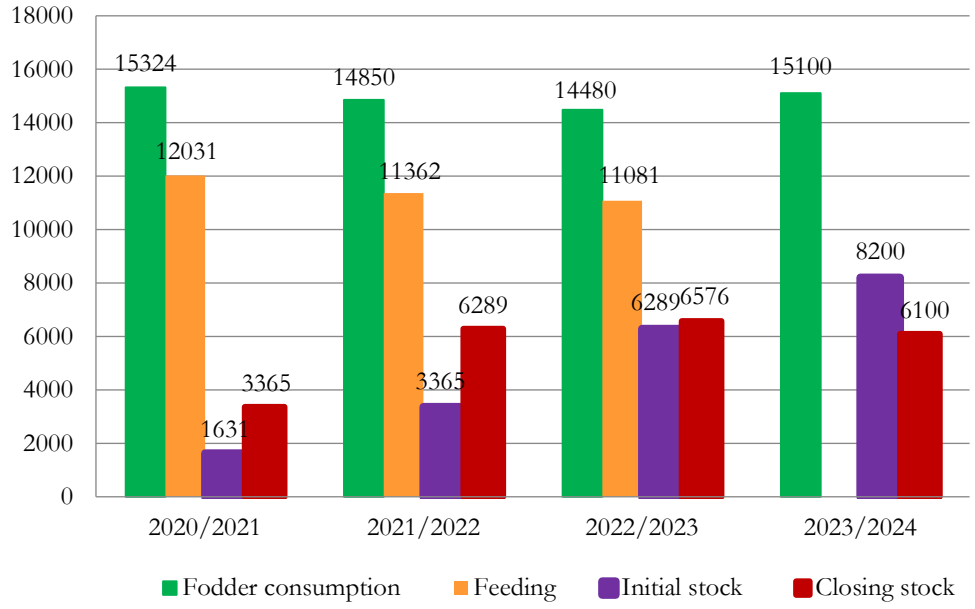

Figure 5. Initial and closing stock of grain with fodder consumption and feeding in farming years 2020/2021-2023/2024

Source: Authors' own calculations

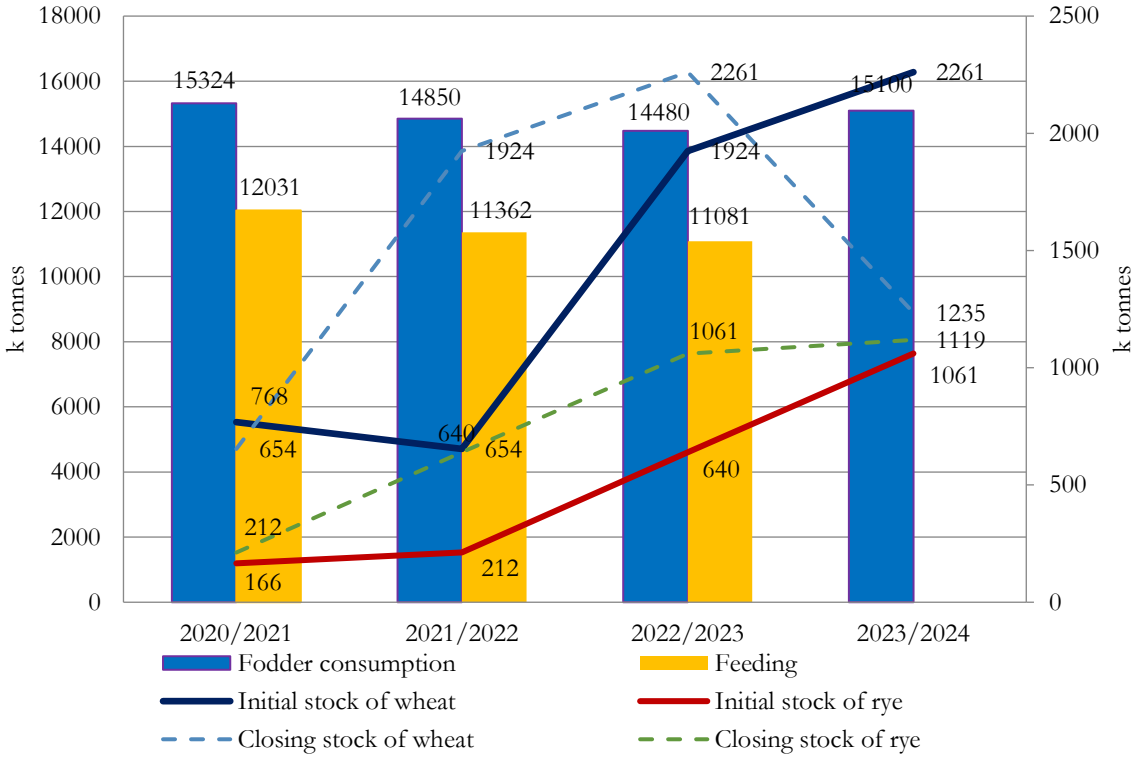

Figure 6. Comparison of the volume of inventories: starting and ending separately for wheat and rye with the fodder consumption and feeding folder

Source: Authors' own calculations

The farming years 2020/2021 - 2023/2024, as we already mentioned showed rising volume of grain in initial stock. Closing stock in a farming year 2022/2023 were on a higher level than in 2021/2022. Closing stock volume in 2022/2023 depended not only on import of crops from Ukraine, but also was connected with very high, almost doubled initial stock volume due to very god harvest in previous year. Many farmers kept their crop harvested last seasons in storage guided by uncertainty on the crop market after the outbreak of military conflict in Ukraine[3] (Figure 4). In 2022/2023 grain supply from 2022 harvest exceeded domestic consumption by about 10.3 million tonnes. It was a second season in a row that began with huge domestic surplus of grain and cereals. Initial stock in Poland in 2022/2023 was estimated at 6.5 million tonnes against 3.4 million tonnes in a previous year. General supply of cereals in Poland reached 41.9 million tonnes in 2022/2023. Closing stock was estimated at 9033 thousand tonnes against 6489 thousand tonnes in 2021/2022 (Łopaciuk, 2023).

The level of fodder consumption and feeding did not show statistically significant changes through the whole period under analysis. Fodder consumption and feeding volume changes are connected with the volume of livestock, poultry and pig population in farms and households. For example, in a farming year 2022/2023 pig population lowered by 1.8%, but livestock poultry production raised by 2.6% in comparison with 2021/2022. In December 2023 pig population census showed a reverse in this trend. Optimistic prospects for 2024 were not confirmed in reality – pig population fell by 3.2% in a period June 2023-June 2024 (Dzwonkowski, 2024). First half of 2023 marked with decreased by 8.6% fodder production than in a previous period. Any changes in these areas as well as outbreaks of bird flu make adverse shocks affecting fodder consumption and feeding. Generally, the ongoing concentration of animal breeding in Poland, efforts to increase milk yield of cows make rising demand for animal feeding stuff - crop feeding stuff, fodder consumption to rise (Dzwonkowski, 2024; GUS, 2021) (Figure 4). Animal feeding stuffs price formation naturally depends on cereals supply and harvest outcome as well as business external factors like COVID-19 or excessive demand for animal stuffs feeding in China (GUS, 2024). Decline in raw crop feeding stuffs in 2020/2021 and 2022/2023 seen on the Figure 4 was for example caused by decreased volume of pigs and cattle production. Nevertheless 2022 marked with very high growth of value in animal production – milk and eggs by 45%, poultry production by 55%, cattle by 38% and pig production by 26% in comparison with 2021 (Dzwonkowski, 2023; GUS Warszawa 2023). The end of farming year 2023/2024 marked with decline of cereals in stock. About 70% of cereals in stock characterized with limited mobility as fodder that was not supplied to open market sales statistics. Farming year 2022/2023 harvest was unusual. It exceeded domestic consumption with 10.4 million tonnes against 9.4 million tonnes in 2021/2022. Initial stock was estimated at 6.6 million tonnes, the doubled volume against the 2021/2022. The overall volume of wheat rose by 17.3% and rye by 11.2%. the overall supply of cereals in Poland in 2022/2023 was estimated at 46.8 million tonnes – 14.4% more than in a previous year (Łopaciuk, 2023).

Upward trend in cereal in stock in Poland from initial level of 3365 thousand tonnes in 2021/2022 to 6289 thousand tonnes in 2022/2023 (Table 4 Appendix) – marking a 86.9% rise together with depreciation of Polish zloty opened a window for competitiveness of export in this area. Export volume of cereals from Poland had its consequences more on closing stock of wheat than closing stock of rye. 2022/2023 marked with 70% increase in export volume of cereals by sea through Gdańsk, Gdynia, Świnoujście and Szczecin harbours (see Table 2 Appendix). In a period July 2022 to June 2023 sea exports estimated at 6.6 million tonnes of grain against 3.9 million tonnes in a previous year. In a period January-July 2023 the volume of grain exported was 57% more than in the same period in 2022. In first nine months of 2023, wheat export

[3] Rynek zbóż – zapasy, ceny skupu i rekordowy eksport z Polski. https://www.topagrar.pl/articles/rynek-zboz/rynek-zboz-zapasy-ceny-skupu-i-rekordowy-eksport-z-polski-2492612

by sea estimated at 4.2 million tonnes against 1.9 million tonnes in a previous year in the same period[4]. High export volumes from Poland of 12.9 million tonnes in 2022/2023 raised in 2023/2024 to 14.3 million tonnes, by 10%. This trend lowered closing stock of cereals from 8.2 million tonnes to 6.1 million tonnes in 2023/2024 (Table 4 Appendix).

Export of cereals and grain products from Poland in 2023/2024 was recorded at 14.6 million tonnes of product weight, and reached higher level by 6.7% than in 2022/2023. Export of grain from Poland reached 12.7 million tonnes in 2023/2024, 7.6% more than in previous farming year. Wheat export 6.8 million tonnes with a major share in overall crop grain export of nearly 55% was 18.2% higher than in 2022/2023 (Łopaciuk, 2024).

The impact of MATIF cereal prices on the Polish cereal price formation

Based on data from Table 7 (Appendix) monthly MATIF milling wheat futures prices from the period January 2020 – December 2024, Paris (EUR), monthly average exchange rate EUR/PLN, and Table 1 (Appendix), we calculate and match together grain price on MATIF (Euronext) and grain purchase prices for wheat and rye in a period of 2020/2021 – 2023/2024 in Poland (Figure 7).

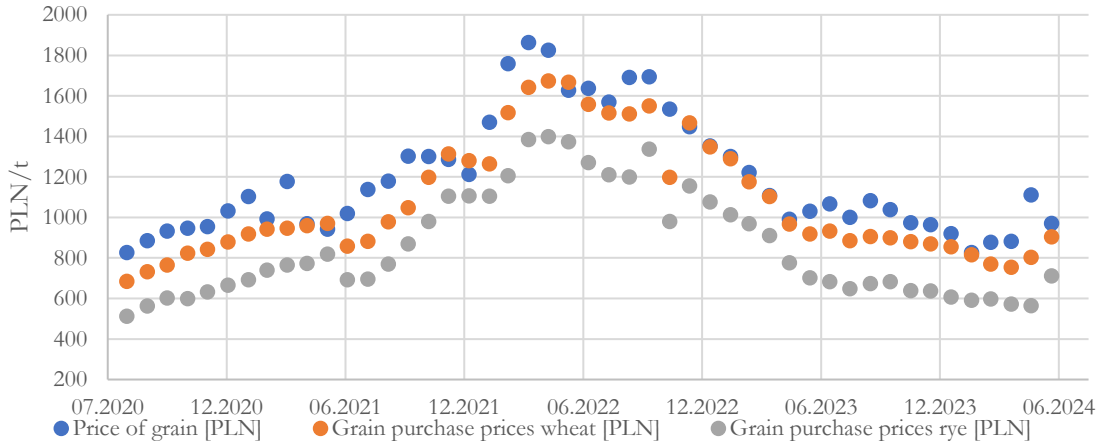

Figure 7. Monthly changes in the price level of wheat and rye in the period July 2020 – June 2024 and the monthly price of grain on MATIF calculated in PLN

Source: Authors' own calculations

The Figure 7 shows clearly the declining trend of MATIF wheat prices together with wheat and rye prices in Poland from October 2022. Average monthly exchange rate EUR/PLN in these periods was almost tranquil with no sign of excessive volatility to justify price level drop (Table 7, Appendix). However, October 2022 was a breaking point for cereal prices on the French exchange MATIF (*Marché à Terme International de France*) as they started dropping. We present that point in time in a shorter period from October 2022 to March 2023 (Table 4).

[4] Eksport zbóż z Polski drogą morską w sezonie 2022/2023 wzrósł o 70 proc. PAP 13-07-2023, 07:37 | Aktualizacja: 13-07-2023, 08:03 https://www.farmer.pl/produkcja-roslinna/zboza/eksport-zboz-z-polski-droga-morska-w-sezonie-2022-2023-wzrosl-o-70-proc,133668.html

Table 4

MATIF wheat prices in the period October 2022 to March 2023 (EUR)

	October 2022	November 2022	December 2022	January 2023	February 2023	March 2023
Wheat	350,50	314,50	306,25	284,00	278,00	266,75

Source: *To Matif czy import z Ukrainy wpłynął na spadek cen zbóż w Polsce?* 30.03.2023. https://www.cenyrolnicze.pl/wiadomosci/rynki-rolne/zboza/30589-to-matif-czy-import-z-ukrainy-wplynal-na-spadek-cen-zboz-w-polsce.

As we show on Figure 6 within the European Union Common Single Market Polish cereal price formation reflects regularities from international market prices, Euronext/MATIF prices. We confirm this regularity once more presenting short period of time from October 2022 to March 2023 to show the price of wheat and rye in Poland clear drop (Table 5).

Table 5

The average price of wheat and rye in Poland in the period from October 2022 to March 2023 (PLN)

Cereal	October 2022	November 2022	December 2022	January 2023	February 2023	March 2023
Wheat	1541.61	1437.86	1350.38	1235.19	1189.63	984.55
Rye	1165	1142.50	1050.88	950	938.67	769.17

Source: *To Matif czy import z Ukrainy wpłynął na spadek cen zbóż w Polsce?* 30.03.2023. https://www.cenyrolnicze.pl/wiadomosci/rynki-rolne/zboza/30589-to-matif-czy-import-z-ukrainy-wplynal-na-spadek-cen-zboz-w-polsce.

Cereal price formation in Poland was in analysed period of farming years 2020/2021 – 2023/2024 non-linear, so the existence of a statistically significant relationship was examined using the Spearman rank correlation coefficient (Table 6).

Table 6

Spearman rank correlation coefficients between the prices of wheat, rye and monthly price of wheat on MATIF in euros calculated to Polish zloty

	Price of grain [PLN]	Grain purchase prices wheat [PLN]	Grain purchase prices rye [PLN]
Price of grain [PLN]	1,000	0,986	0,905
Grain purchase prices wheat [PLN]	0,986	1,000	0,892
Grain purchase prices rye [PLN]	0,905	0,892	1,000

Source: Authors' own calculations

By the calculated values of the correlation coefficients in Table 6 we indicate once more a very clear positive relation between Euronext/MATIF wheat prices and the level of wheat and rye prices in Poland.

4. CONCLUSION

Analysing the following dependencies on the Polish crop market: 1/ MATIF wheat futures prices and wheat prices in Poland; 2/ cereals in stock and cereals price formation in Poland; 3/ fodder consumption and farm use of cereals and cereal price level in Poland; 4/ volume of Polish cereal export and cereal prices in Poland – we showed the shocked, decreased price level formation in the Polish cereal market in the period 2022-2023 – the breakdown. We proved statistically that this trend had two exogenic origins. *First*

was the European Initiative to open solidarity transit corridors for Ukraine's export following the outbreak of an armed conflict in Ukraine and disturbances on the Black Sea trading routes. Sudden increase of cereal supply shock caused by cereal cargo that did not transit through Poland to further final destinations, but stayed settled in Poland was responsible for excessive initial and closing stock of cereals in Poland, especially after very good harvest in previous periods that led to cereal price drop and farmers-producers protests. This phenomenon of uncontrolled *de facto* presence of Ukrainian cereals in the Single Common European market before this country official membership in the EU triggers fear and uncertainty among Polish farmers-producers. After Ukraine's membership in the EU and free access to Single Common Market they would loose their competitiveness as cereal, crop producers. The scale of losses in this group would be equal to the share of Polish GVA in the European agriculture. *Second* was the regularity defining by cereal price formation that mirrors the trends set by international commodities market. Of such importance for Central and Eastern European countries is Euronext/MATIF in Paris and its quotes in EUR currency. We proved a significant correlation between MATIF cereal price formation in Euro and price formation in Polish zlotys for wheat and rye in Poland in time period under study. Among these two exogenic shocks that impact Polish cereal market in the period 2022-2023, the former is far more dangerous. As it is childish to act against market economic rules within the EU like for example market-based floating exchange rates of PLN/EUR, we suggest a very close attention of Polish governing bodies to act precisely how to obtain market liquidity and avoid excessive, unsold cereals in initial and closing stock. Nevertheless, we once more express our deep concern about the market performance of Polish farmers-producers of crops and cereals after Ukraine's official participation in the European Union.

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APPENDIX

Table 1

Grain purchase prices (wheat and rye) in Poland 2020/2021 – 2023/2024 (PLN/t)

Period	Wheat	Rye
2020/2021		
VII 2020	716.1	554.6
VIII 2020	684	240.5
IX 2020	731.8	562.1
X 2020	764.2	602.4
XI 2020	823	598.8
XII 2020	841.5	631.6
VII 2020	716.1	554.6
VIII 2020	684	511.5
IX 2020	731.8	562.1
X 2020	764.2	602.4
XI 2020	823	598.8
XII 2020	841.5	631.6
I 2021	878.8	665.5
VII 2020	716.1	554.6
VIII 2020	684	511.5
IX 2020	731.8	562.1
X 2020	764.2	602.4
XI 2020	823	598.8
XII 2020	841.5	631.6
I 2021	878.8	665.5
II 2021	917.1	691.4
III 2021	942	738.8
IV 2021	945.8	764
V 2021	959.3	771.8
VI 2021	970.3	817.7
2021/2022		
VII 2021	857	691.9
VIII 2021	880.8	695.3
IX 2021	977.4	769.7
X 2021	1046.9	868.4
XI 2021	1198	978.6
XII 2021	1312.7	1103.9
I 2022	1279.4	1104.9
II 2022	1263.8	1103.6
III 2022	1515.9	1204.6
IV 2022	1640.9	1383.6
V 2022	1673.6	1398.6
VI 2022	1666.6	1372.2
2022/2023		
VII 2022	1556.8	1269.9
VIII 2022	1514.2	1209.5
IX 2022	1509.5	1199.4
X 2022	1550.1	1336.7

XI 2022	1198	978.6
XII 2022	1465.5	1154.8
I 2023	1347.5	1076.1
II 2023	1289.5	1012.5
III 2023	1175.4	968.3
IV 2023	1102.4	910.1
V 2023	966.1	775.7
VI 2023	917.8	700.7
2023/2024		
VII 2023	931.3	682
VIII 2023	884.6	647.7
IX 2023	905.1	672.9
X 2023	898.9	683
XI 2023	879.4	637.9
XII 2023	867.9	637
I 2024	853.7	605.7
II 2024	815	591
III 2024	768.5	596.8
IV 2024	753.9	572
V 2024	802	564
VI 2024	903.2	711.2

Source : „Rynek rolny. Analizy, tendencje, oceny". Nr 3/ 2025. IERiGŻ-PIB Warszawa, str. 9; „Rynek rolny. Analizy, tendencje, oceny". Nr 7/8 2024. IERiGŻ-PIB Warszawa, str. 7; Łopaciuk W. (red.) (2024). Rynek zbóż. Stan i perspektywy Nr 67, Analizy Rynkowe. IERiGŻ październik 2024, str. 45; Łopaciuk W. (red.) (2024). Rynek zbóż. Stan i perspektywy Nr 66, Analizy Rynkowe. IERiGŻ czerwiec 2024, str. 46; Łopaciuk W. (red.) (2023). Rynek zbóż. Stan i perspektywy Nr 65, Analizy Rynkowe. IERiGŻ październik 2023, str. 49; Źródło: Łopaciuk W. (red.) (2023). Rynek zbóż. Stan i perspektywy Nr 64, Analizy Rynkowe. IERiGŻ czerwiec 2023, str. 46

Table 2

Export and import of grain (wheat and rye) in 2020/2021 – 2023/2024 (k tonnes)

Period	**Wheat**		**Rye**	
	eksport	**import**	**eksport**	**import**
2020/2021	5032	1256	1449	31
2021/2022	3600	1189	680	58
2022/2023	5751.9 6397*	1227.3	507.2 522*	11.8
2023/2024**	6796.4 7830***	608.7	809.8 847***	7.3

** estimates

Source: „Rynek rolny. Analizy, tendencje, oceny". Nr 7/8 2024. IERiGŻ-PIB Warszawa, str. 8; Łopaciuk W. (red.) (2024). Rynek zbóż. Stan i perspektywy Nr 67, Analizy Rynkowe. IERiGŻ październik 2024, str. 34, 36, 41, 51*, ***

Table 3

Wheat and rye in stock in Poland 2020/2021 – 2023/2024 (k tonnes)

Period	**Initial stock**			**Closing stock**		
	total	**wheat**	**rye**	**total**	**wheat**	**rye**
2020/2021	1631	768	166	3419	654	212
2021/2022	3419	654	212	6283	1924	640
2022/2023	6283	1924	640	8245	2261	1061
2023/2024*	8245	2261	1061	6083	1235	1119

* estimate

Source: Źródło: Łopaciuk W. (red.) (2024). Rynek zbóż. Stan i perspektywy Nr 67, Analizy Rynkowe. IERiGŻ październik 2024, str. 40-43

Table 4

Grain in stock in Poland 2020/2021 – 2023/2024 (k tonnes)

Period	**2020/2021**	**2021/2022***	**2022/2023****	**2023/2024**
Initial stock	1631	3365	6289	8200
Closing stock	3365	6289	6576	6100

* estimate; ** forecast

Source: Łopaciuk W. (red.) (2024). Rynek zbóż. Stan i perspektywy Nr 67, Analizy Rynkowe. IERiGŻ październik 2024, str. 6; Łopaciuk W. (red.) (2023). Rynek zbóż. Stan i perspektywy Nr 63, Analizy Rynkowe. IERiGŻ październik 2022, str. 17

Table 5

Feeding in Poland 2020/2021-2023/2024 (k tonnes)

period	2020/2021	2021/2022	2022/2023*	2023/2024**
Feeding	12031	11362	11081	-

Source: Rocznik Statystyczny Rolnictwa, GUS Warszawa 2024, str. 296

Table 6

Fodder consumption in a period 2020 – 2024 (k tonnes)

period	2020/2021	2021/2022	2022/2023	2023/2024*
Fodder consumption	15324	14850	14480	15100

* estimates

Source: Łopaciuk W. (red.) (2024). Rynek zbóż. Stan i perspektywy Nr 67, Analizy Rynkowe. IERiGŻ październik 2024, str. 18, 23; Łopaciuk W. (red.) (2024). Rynek zbóż. Stan i perspektywy Nr 66, Analizy Rynkowe. IERiGŻ czerwiec 2024, str. 23

Table 7

Milling wheat N2 futures MATIF January 2020- December 2024 (EUR)

Date	"Price"	Date	"Price"
12/01/2024,	"237.25"	05/01/2022,	392.25"
11/01/2024,	209.50",	04/01/2022,	400.75"
10/01/2024,	218.00"	03/01/2022,	369.50"
09/01/2024,	222.25"	02/01/2022,	322.50"
08/01/2024,	205.75",	01/01/2022,	266.00"
07/01/2024,	220.25"	12/01/2021,	278.50"
06/01/2024,	224.75"	11/01/2021,	279.50"
05/01/2024,	259.25"	10/01/2021,	283.25"
04/01/2024,	205.00"	09/01/2021,	258.00"
03/01/2024,	203.50"	08/01/2021,	248.75"
02/01/2024,	190.75"	07/01/2021,	223.25"
01/01/2024,	210.75"	06/01/2021,	209.25"
12/01/2023,	222.50"	05/01/2021,	213.75"
11/01/2023,	221.00"	04/01/2021,	257.75"
10/01/2023,	229.50"	03/01/2021,	215.50"
09/01/2023,	235.50"	02/01/2021,	245.00"
08/01/2023,	224.25"	01/01/2021,	227.00"
07/01/2023,	240.00"	12/01/2020,	213.25"
06/01/2023,	230.75"	11/01/2020,	210.25"
05/01/2023,	218.25"	10/01/2020,	205.25"
04/01/2023,	238.50"	09/01/2020,	197.75"
03/01/2023,	260.25"	08/01/2020,	187.75"
02/01/2023,	274.25"	07/01/2020,	182.75"
01/01/2023,	287.75"	06/01/2020,	180.50"
12/01/2022,	309.25"	05/01/2020,	188.25"
11/01/2022,	326.50"	04/01/2020,	195.75"
10/01/2022,	352.25"	03/01/2020,	196.25"
09/01/2022,	356.75"	02/01/2020,	187.50"
08/01/2022,	332.25"	01/01/2020,	191.00"
07/01/2022,	343.00"		
06/01/2022,	350.25"		

Source: https://www.investing.com/commodities/milling-wheat-n2-historical-data