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Socio-Economic Efficiency of Investments in Kazakhstan's Agro-Industrial Complex

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ABSTRACT

Kazakhstan's agro-industrial complex is a key sector that ensures food security and the country's sustainable economic development. The study aims to assess the impact of investments on agricultural productivity and their share in gross domestic product, accounting for lag effects. The initial data includes annual statistical indicators of the Bureau of National Statistics of the Republic of Kazakhstan for the period 2015-2024. The methodological basis consists of correlation analysis, calculation of Pearson correlation coefficients, and multidimensional analysis of variance (MANCOVA), followed by a univariate decomposition of effects. The results showed that investments in the non-resource sector demonstrate the strongest positive relationship with labor productivity in agriculture (r = 0.959), while private investments also have a high correlation (r = 0.882). On the contrary, the agricultural investment index has no significant impact on production indicators (r = -0.116) and output dynamics (r = 0.120). At the same time, the share of agriculture in GDP decreased from 4.8% to 3.8% over the study period, despite total investments increasing by more than 2 times. MANCOVA's results confirmed a statistically significant impact of investments in the non-resource sector on productivity alone ($p < 0.001$), whereas the impact of investments directly in agriculture and of private investment was statistically insignificant. Thus, a gap has been identified between investment volume and economic returns, indicating a need to improve the effectiveness of investment policy and to focus on structural and technological factors in agricultural sector development.

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Қазақстанның агроөнеркәсіптік кешеніне инвестициялардың әлеуметтік-экономикалық тиімділігі

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ТҮЙІН

Қазақстанның агроөнеркәсіптік кешені азық-түлік қауіпсіздігін және елдің тұрақты экономикалық дамуын қамтамасыз ететін негізгі сала болып табылады. Зерттеу инвестициялардың ауыл шаруашылығының өнімділігіне және олардың жалпы ішкі өнімдегі үлесіне әсерін бағалауға бағытталған, лагтық әсерлерді ескере отырып. Бастапқы деректер Қазақстан Республикасы Ұлттық Статистика Бюросының 2015-2024 жылдарға арналған жылдық статистикалық көрсеткіштерін қамтиды. Әдістемелік негіз корреляциялық талдаудан, Пирсонның корреляция коэффициенттерін есептеуден және дисперсияның көпөлшемді талдауынан (MANCOVA) тұрады, содан кейін әсерлердің бір айнымалы ыдырауы жүреді. Нәтижелер шикізаттық емес секторға инвестициялар ауыл шаруашылығындағы еңбек өнімділігімен ең күшті оң байланысты көрсететінін көрсетті (r = 0,959), ал жеке инвестициялар да жоғары корреляцияға ие (r = 0,882). Керісінше, ауылшаруашылық инвестицияларының индексі өндіріс көрсеткіштеріне (r = -0.116) және өндіріс динамикасына (r = 0.120) айтарлықтай әсер етпейді. Сонымен бірге, инвестициялардың жалпы көлемі 2 еседен астам өскеніне қарамастан, ЖІӨ-дегі ауыл шаруашылығының үлесі зерттеу кезеңінде 4,8% - дан 3,8% - ға дейін төмендеді. MANCOVA нәтижелері шикізаттық емес секторға инвестициялардың тек өнімділікке статистикалық маңызды әсерін растады (p < 0,001), ал тікелей ауыл шаруашылығына және жеке инвестицияларға инвестициялардың әсері статистикалық тұрғыдан шамалы болды. Осылайша, инвестициялар көлемі мен экономикалық кірістер арасында алшақтық анықталды, бұл инвестициялық саясаттың тиімділігін арттыру және агроөнеркәсіптік кешенді дамытудағы құрылымдық және технологиялық факторларға назар аудару қажеттілігін көрсетеді.

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Социально-экономическая эффективность инвестиций в агропромышленном комплексе Казахстана

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АННОТАЦИЯ

Агропромышленный комплекс Казахстана является ключевым сектором, обеспечивающим продовольственную безопасность и устойчивое экономическое развитие страны. Целью исследования является оценка влияния инвестиций на производительность сельского хозяйства и его долю в структуре валового внутреннего продукта с учетом лаговых эффектов. Исходные данные включают статистические показатели Бюро национальной статистики за период 2015–2024 гг. Методологическую основу составляют корреляционный анализ, расчет коэффициентов Пирсона, а также многомерный дисперсионный анализ (MANCOVA) с последующей универиантной декомпозицией эффектов. Полученные результаты показали, что инвестиции в несырьевой сектор демонстрируют наиболее сильную положительную связь с производительностью труда в сельском хозяйстве ($r = 0.959$), в то время как частные инвестиции также имеют высокую корреляцию ($r = 0.882$). Напротив, индекс инвестиций в сельское хозяйство не оказывает значимого влияния на производственные показатели ($r = -0.116$) и динамику выпуска ($r = 0.120$). При этом доля сельского хозяйства в ВВП снизилась с 4,8% до 3,8% за исследуемый период, несмотря на рост совокупных инвестиций более чем в 2 раза. Результаты MANCOVA подтвердили статистически значимое влияние только инвестиций в несырьевой сектор на производительность ($p < 0.001$), тогда как влияние инвестиций непосредственно в сельское хозяйство и частных инвестиций оказалось статистически незначимым. Таким образом, выявлен разрыв между объемами инвестиций и их экономической отдачей, что указывает на необходимость повышения эффективности инвестиционной политики и ориентации на структурные и технологические факторы развития аграрного сектора.

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1. Introduction

Food security remains crucial to economic stability. Food security is linked to the state of the agro-industrial complex, which controls production, processing, and distribution of products to consumers. International data showed that the agricultural sector's contribution is generated not only by agriculture but also by related industries. Thus, the combined share of agriculture and related industries in the USA accounted for approximately 5-5.5% of GDP in 2023 (U.S. Department of Agriculture, 2024).

Kazakhstan's agro-industrial complex supports food production, rural employment, and the country's participation in international agricultural trade. Development of the sector is considered a priority area of state policy, according to the Concept for the Development of the Agro-Industrial Complex of the Republic of Kazakhstan for 2021–2030, which envisages increased labour productivity, increased investment, expanded processing, and increased self-sufficiency in food products (Government of the Republic of Kazakhstan, 2021; Yessimkhan & Sartanova, 2024). This Concept sets the objectives of increasing investment in agricultural capital, modernising the material and technical base, introducing technologies, and developing sustainable production and logistics systems (Ministry of Agriculture of the Republic of Kazakhstan, 2024; Baiterek National Managing Holding, 2024). Furthermore, the development of the agro-industrial complex through international cooperation focuses on increasing productivity and the sector's long-term sustainability, as well as on developing mechanisms to scale up successful practices at the regional level (UNDP, 2024).

Despite the measures implemented, the development of the agro-industrial complex faces several limitations stemming from the gap between investment volumes and their outcomes. With growing investment activity, it is necessary to determine the nature of the relationships among investment, productivity, and agriculture's position in the economic structure, which requires quantitative analysis and an assessment of the effectiveness of investment processes.

The agro-industrial complex is essential because it powers the entire economy. First, when agriculture is functioning normally, prices are stable, and people have access to food. Second, agriculture employs a large number of people, especially in developing countries. The sector's growth means increased income for the population. Third, increased productivity in the agro-industrial complex leads to a portion of the workforce shifting to other sectors, such as manufacturing and services. This changes the structure of the economy. Fourth, the agro-industrial complex includes processing, logistics, and trade, which generate a significant portion of added value. Thus, the agro-industrial complex serves as the foundational system through which employment, income, and economic development are generated.

Therefore, the study aims to assess the impact of investments on agricultural productivity and their share in gross domestic product, accounting for lag effects.

2. Literature review

Agriculture is the fundamental mechanism for initiating industrialisation through labour release, reduced food costs, and expansion of the production base outside the agricultural sector. The agro-industrial complex forms the foundation of economic development through production volumes and inclusion in global value chains. Increased efficiency and industrialisation of the agricultural sector ensure increased output and expanded markets.

Increased agricultural productivity reduces the share of agricultural employment, freeing up labour that was previously viewed as resulting from expanding employment, income, and intersectoral linkages in the rural economy (Irz et al., 2001). In contrast, Gollin et al. (2002) showed that labour release becomes a key factor in structural transformation, as this labour is reallocated to industry and services, where additional economic growth is generated. Moreover, agricultural productivity growth in developing countries is the largest contributor to growth in GDP per worker (approximately 54%). In comparison, labour reallocation between sectors accounts for 29%, reflecting the crucial importance of agricultural productivity in the initial phase of economic structural transformation (Gollin et al., 2002). Moreover, Moon and Lee (2013) link agricultural productivity to the transformation of demand and agrifood markets, which, in turn, lead to changes in other sectors of the economy.

Existing studies focus on the mechanisms by which investments affect the agricultural economy. The influx of financing into the agricultural sector increases regional output by approximately €300 million, with approximately 14% of this effect being distributed to related industries (Loizou et al., 2019). The authors showed that investments increase agricultural production volumes and further boost production in related industries. On the contrary, El Bilali et al. (2021) showed that changes in agricultural policy, including subsidy mechanisms, are transmitted throughout the economy via production linkages, generating direct and indirect effects on employment, income, and access to food. The authors showed that investments are implemented through subsidy mechanisms that redistribute resources and alter employment and income.

The importance of the agricultural sector in the global economy is determined by its contribution to added value, food security, and environmental impacts. The further development of the agricultural sector depends on the sector's ability to adapt to resource constraints and changes in demand (Webb & Buratini, 2018). As economic development increases, the share of farmers in the final value of food declines. The bulk of added value is concentrated in the processing, logistics, and marketing segments. However, the formation of added value at different stages of agro-food chains shows the importance of the agro-industrial complex in the global economy (Santeramo et al., 2024).

The agricultural sector, as a driver of employment and poverty reduction, has a greater impact than other sectors, especially in low-income countries. Agricultural growth engages households through employment and self-employment and affects food prices. As the economy undergoes structural transformation, this effect weakens, and the contribution of non-agricultural sectors increases (Christiaensen et al., 2011). Thus, agriculture influences poverty reduction at different stages of structural transformation. As a result, persistent income and efficiency gaps develop, and institutional and market constraints hinder labour reallocation. However, McCullough (2017) showed that productivity growth cannot be achieved solely through labour reallocation. There is a need to simultaneously improve efficiency within agriculture itself, since agricultural growth is, on average, 2–3 times more effective in reducing poverty than non-agricultural sectors, especially in low-income countries with high agricultural employment. In contrast, Felipe et al. (2014) show that similar poverty reductions are also generated in non-agricultural sectors, where trade, transport and processing act through inter-sectoral linkages and cost reductions, and Christiaensen and Martin (2018) showed that such an outcome depends

not only on the sectoral structure but also on the employment patterns through which the labor force moves from agriculture to other sectors.

Thus, a high level of employment in the agricultural sector does not, in itself, indicate efficiency. In contrast, an increase in employment outside the agricultural sector indicates that the economy is becoming more productive. High employment in agriculture reflects the concentration of labour in a lower-productivity sector, creating a gap between employment and the value added generated. In Asian countries, agriculture accounts for approximately 9.8% of value added, employs 24.4% of the labour force, and has productivity approximately 0.4 times the economic average (Awaliyyah et al., 2020). There is a mismatch between the share of employment and its contribution to output, with a significant portion of the labour force concentrated in a sector that is inefficient. In EU countries, although employment in agriculture is high, its contribution to gross value added is only 1.8% (Kołodziejczak, 2025). A decrease in contribution to value added, while maintaining employment, indicates structural limitations on productivity. Thus, as development levels increase, the share of employment in the agricultural sector declines. The decline in employment is accompanied by a reallocation of labour to more productive activities and an increase in the overall efficiency of the economy.

Investments in the agro-industrial complex drive productivity growth and reduce labour requirements. While direct investment is focused on productivity issues, investments in technology or R&D in agriculture have a stronger impact. Therefore, Fugile (2018) stated that technological development, land use, and investment in agricultural research are the main factors. Thus, developed countries demonstrate higher productivity than developing countries (Megyesiova, 2021). Consequently, direct investments have the effect of direct investment short-term support (Mogues et al., 2015; Stads et al., 2023). Additionally, uneven access to capital among private entities increases the gap. Therefore, investing in farms strengthens their positions while others exit the market (Czubak & Pawłowski, 2024).

The investment flows into the agricultural sector do not yield the expected results. Clapp (2017) demonstrated that the key problem lies in the very nature of modern agricultural investment: financial flows are separated from actual production and function through complex instruments (funds, derivatives, indices). As a result, process control is reduced, and requirements are unclear. Clapp (2017) explained the lack of expected results by the fact that investments function as financial instruments, separated from the production process, which reduces control over project implementation. In contrast, Antwi-Bediako et al. (2019) showed that inefficiencies arise at the investment decision-making stage, where expectations, rather than production conditions, drive investment.

Consequently, projects are implemented with a mismatch between financial inputs and actual utilisation capacity, resulting in land degradation, reduced food security, and loss of household income. Nolte (2020) stated that the likelihood of a project's failure increases with increasing project scale and the use of agrofuel crops. Thus, confirming that expanding investment does not eliminate but rather amplifies the risk of inefficiency. According to Cochrane et al. (2024), a mismatch between investor expectations and local conditions, along with problems with market access, logistics, and labour, contributes to the failure of foreign investments. As a result, projects prove financially unsustainable.

Methodological approaches to analysing the agricultural sector vary depending on the type of data and the identification mechanisms used. Analysis of the impact of contract farming and

the income structure is based on regression models using household data, which allow for accounting for information asymmetries, imperfect monitoring, and selection into participation, as well as for assessing the redistribution of income between agricultural and non-agricultural activities (Bellemare, 2010; Bellemare, 2018). The use of lagged variables allows for accounting for time dynamics and delayed effects in economic processes (Bellemare et al., 2017). The analysis uses panel and regression models to identify robust relationships and account for differences between short- and long-term effects (Zafeiriou et al., 2023; Yaqoob et al., 2023; Larik et al., 2024).

Kazakhstan's experience shows that investment in the agricultural sector faces the same constraints as in other countries. Significant resource potential does not necessarily lead to the expected economic results, and the effectiveness of investments depends on the conditions under which they are formed and used. It is expected that the availability of resources provides the basis for economic development and, therefore, is attractive to investment, especially in Kazakhstan's agriculture sector (Zhanaltay, 2023). However, Alibekova et al. (2023) found that the agricultural sector relies primarily on its own funds and has limited access to credit mechanisms. Therefore, resource availability does not provide investment. According to Bekbossinova and Doszhan (2025), fixed capital investments have a statistically significant impact on economic indicators. Nevertheless, the effect is heterogeneous and depends on the regional structure and resource distribution.

Existing studies examine the impact of investments through resource availability and access to finance, as well as through institutional constraints in the agricultural sector. This study shows how investment inputs affect output volume and production results. An analysis of empirical studies in agricultural economics identified key indicator groups used to assess the sector's quantitative development. The first group includes investment parameters reflecting the volume and dynamics of investment. The second group comprises indicators characterising productivity and resource efficiency. The third group includes macroeconomic indicators that reflect agriculture's position in the economy. The identification of these groups determined the structure of the methodological approach, in which indicators are grouped by functional characteristics and used to assess the relationships among investment, productivity, and the sector's structural characteristics.

3. Research methods

The analysis is based on annual data from the Bureau of National Statistics (2025). The data covered 10 years, from 2015 to 2024. The indicators include investment activity, economic structure, and productivity in the agro-industrial complex. The analysis is based on three groups of indicators: investment activity, economic structure, and productivity. The variables were coded to ensure consistency in subsequent statistical analysis.

Table 1. Variables and their coding.

Variable	Description	Unit of measurement
INV_NS	Investment in fixed capital of the non-resource sector	billion tenge
INV_AGR_IND	Index of physical volume of investment in agriculture	% compared to the previous year
INV_PRIV	Private investment in fixed capital	billion tenge
INV_AGR	Investment in agriculture, forestry, and fisheries	million tenge.
INV_TOTAL	Total investment in fixed capital	billion tenge
GDP_AGR_SH	Share of agriculture in GDP	%

GDP_SH	GDP (production method)	%
GDP_IND	GDP volume index	% compared to the previous year
GDP_AGR_IND	Agricultural output index	% compared to the previous year
GVA_EMP	Gross value added per employee (total economy)	thousand inhabitants/person
GVA_AGR_EMP	Gross value added per employee in agriculture	thousand inhabitants/person

Note: compiled by the authors.

In the first stage, pairwise correlation analysis was conducted using Jamovi software. The Pearson correlation coefficient was applied to assess the strength and direction of relationships between variables by formula (1):

$$r = \frac{\sum(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum(x_i-\bar{x})(y_i-\bar{y})^2}} \quad (1)$$

where:

x_i , y_i – observed values of variables;

$\bar{x}$, $\bar{y}$ – mean values;

r – Pearson correlation coefficient.

Based on the correlation analysis, relationships of varying strength (weak, moderate, and strong) were identified, enabling the selection of key variables for subsequent analysis. To account for temporal delays in the impact of investment, a one-year lag structure was applied, comparing investment indicators at time t with performance indicators at time t+1. The lagged relationship can be formally represented as follows (2):

$$Y_{t+1}=f(X_t) \quad (2)$$

where:

X_t – investment indicator in year t;

Y_{t+1} – resulting indicator in year $t + 1$.

The lagged relationship analysis showed that the effect of investments is not immediate and may appear in subsequent periods. Lagged correlation estimation was conducted for each selected pair, and Pearson correlation coefficients were calculated using lagged variables by formula (3):

$$r_{lag}=\frac{\sum(X_t-\bar{X})(Y_{t+1}-\bar{Y})}{\sqrt{\sum(X_t-\bar{X})(Y_{t+1}-\bar{Y})^2}} \quad (3)$$

The analysis allowed assessing whether relationships become stronger, weaker, or remain unchanged when time delay is considered.

Multivariate analysis (MANCOVA). To assess the combined effect of explanatory variables on multiple dependent variables, a multivariate analysis of covariance (MANCOVA) was applied. The general form of the model is given by equation (4):

$$Y=XB+E \quad (4)$$

where:

Y – matrix of dependent variables;

X – matrix of independent variables;

B – matrix of coefficients;

E – matrix of residuals.

At the first stage, multivariate test statistics (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root) were used to determine whether the set of independent variables has a statistically significant effect on the group of dependent variables. At the second stage, univariate tests were conducted to assess the effect of each explanatory variable on each outcome indicator. To assess the model's validity, the assumption of normality of the residuals was evaluated using a Q–Q plot.

4. Results

The development of Kazakhstan's agro-industrial sector is accompanied by increased investment activity and growth in certain economic indicators. Resources are directed into the sector, productivity is increasing, and macroeconomic indicators are changing. However, existing data do not allow for a definitive determination of how investments are linked to agricultural performance and the extent to which they influence the sector's position in the economy. To assess the current state, an analysis of investment, structural, and production indicators was conducted. The results demonstrate growth across several parameters, but reveal a discrepancy between investment volumes, the rate of change, and the resulting economic indicators.

Figure 1 presents the dynamics of investment indicators in Kazakhstan's agricultural sector.

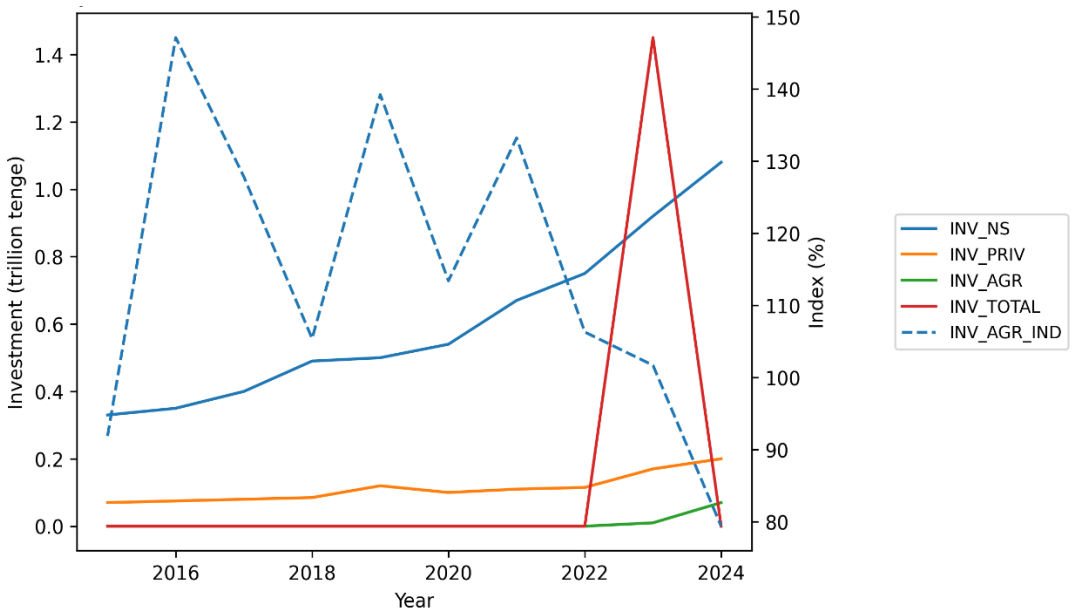


Figure 1. Dynamics of investment indicators in the agricultural sector of Kazakhstan for 2015–2024.

Investment in the non-resource sector and private investment increased throughout the period, both demonstrating a steady upward trend. Over 2015–2024, INV_NS grew more than threefold (from 3.26 to 10.87 trillion tenge), while INV_PRIV increased approximately 2.7 times (from 0.72 to 1.98 trillion tenge), indicating a sustained expansion of investment activity outside the agricultural sector. In contrast, investment in agriculture exhibited less stable dynamics. It increased significantly until 2023 (from 163,000 to 904,000), then declined to 694,000 in 2024, reflecting the volatility and sensitivity of investment flows in the agricultural sector. Similarly, total investment rose from 7.02 to 17.65 trillion tenge over the period but decreased to 13.61 trillion tenge in 2024, suggesting a general slowdown in investment activity in the final year.

The investment index for agriculture does not align with the observed dynamics of investment volumes. Its values fluctuate irregularly, alternating between periods of growth and decline. Over the study period, the index ranges from 147.1 to 79.4, indicating high volatility in investment growth rates. While absolute investment volumes generally increase, their growth rates remain unstable. The simultaneous increase in investment volumes and decline in the index in 2024 indicates a deceleration in investment dynamics.

Investment trends showed that the bulk of investment is concentrated outside the agricultural sector and is more stable. Investments in agriculture remain less significant and more sensitive to change. Consequently, the agricultural sector is perceived as less stable. A general slowdown in investment activity is expected in 2024, with agricultural investment becoming dependent on external conditions and exhibiting limited sustainability.

Figure 2 shows changes in the structure of GDP and agricultural output.

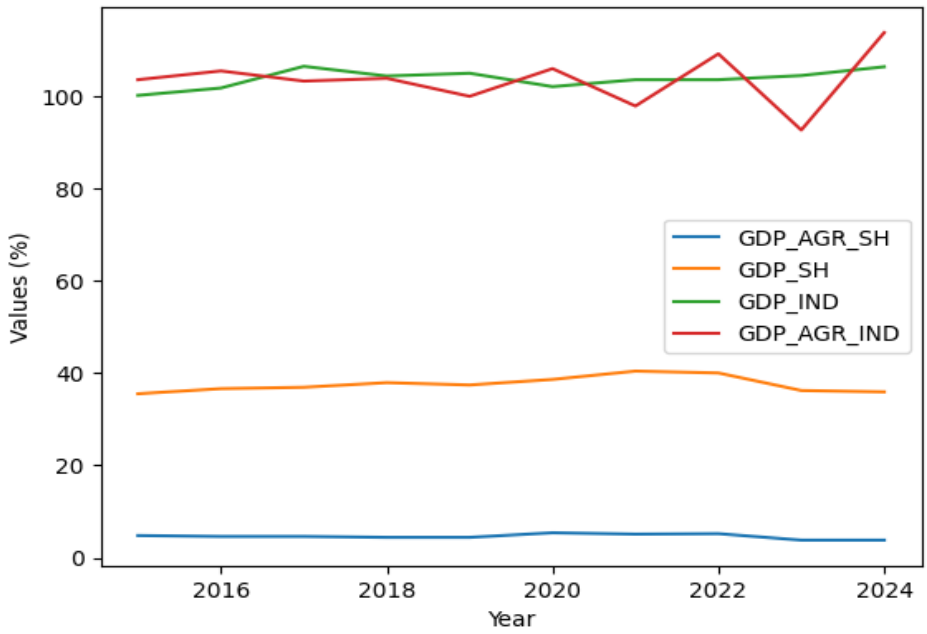


Figure 2. Dynamics of GDP structure and agricultural output in Kazakhstan for 2015–2024.

The share of agriculture in GDP declines from 4.8% to 3.8%, with a temporary increase to 5.4–5.2% in 2020–2022. The share of GDP by production method (GDP_SH, %) rises from 35.5% to 40.0% by 2022, then falls to 35.9% in 2024. The GDP volume index increases from 100.1 to

106.3. The agricultural output index ranges from 92.6 to 113.7. The dynamics of the GDP structure and agricultural output showed that agriculture is sensitive to external factors, including climatic conditions, production costs, and market conditions. Moreover, the growth of agricultural output is not associated with its share of GDP. Despite overall economic growth, with the GDP index rising from 100.1 to 106.3, agriculture did not recover in 2024; its share of GDP remained at 3.8%.

Figure 3 illustrates the dynamics of labor productivity in the overall economy and in agriculture.

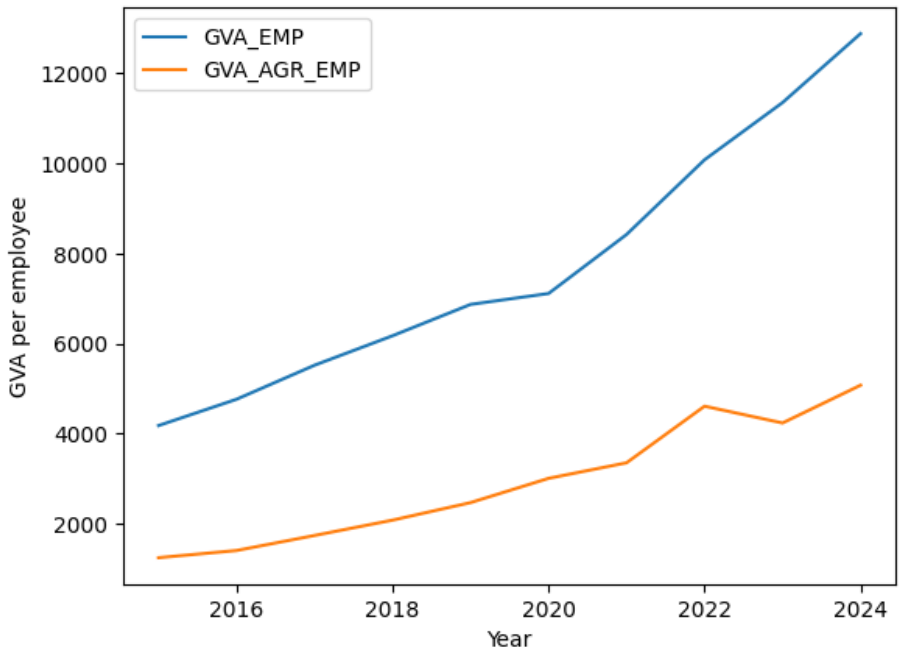


Figure 3. Dynamics of labor productivity in Kazakhstan and the agricultural sector for 2015–2024.

The gross value added per employed person in the economy and agriculture increases over the period. However, for agriculture, the dynamics are less uniform. A decline is observed in 2023, followed by an increase in 2024. The gap between GVA_EMP and GVA_AGR_EMP remains constant throughout the period and widens. Agricultural productivity growth is lagging the overall economy. Therefore, it is necessary to determine the nature of the relationship between investments and sector performance. To this end, a correlation analysis between key indicators was conducted to determine the presence and direction of statistical relationships (Figure 4).

The first block examined investment. Investment in the non-resource sector, private, total, and agricultural investments exhibit highly synchronized dynamics, with increases in the non-resource sector accompanied by simultaneous growth across all other investment categories. Correlation coefficients between the indicators range from 0.67 to 0.73, while those between INV_NS and INV_PRIV reach 0.95, indicating a synchronous change in investment flows. These funding sources are interconnected and respond to the same economic conditions. Investment growth occurs simultaneously across all sectors, without identifying the agricultural sector as a separate investment area.

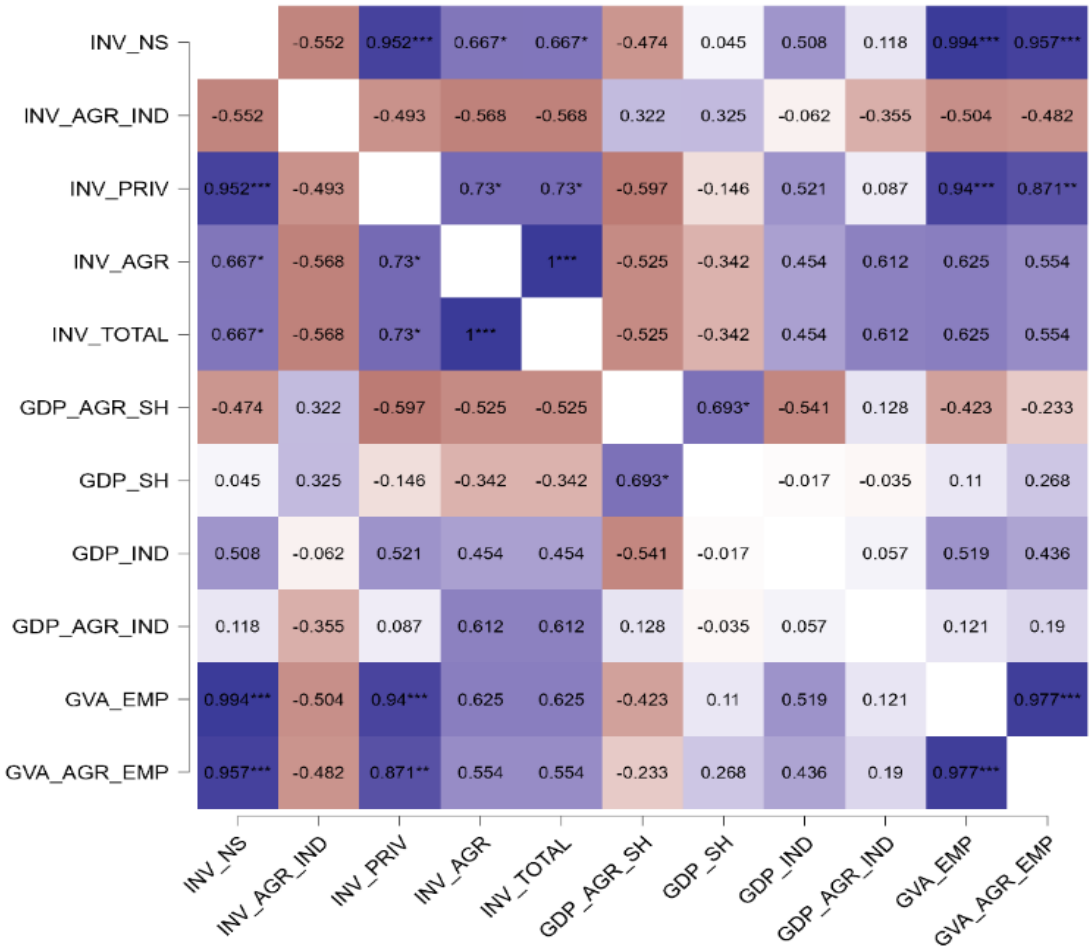


Figure 4. Correlation matrix of investment indicators, economic dynamics and productivity of the agro-industrial complex of Kazakhstan.

In contrast, the agricultural investment index exhibits weak or negative correlations with other investment indicators, indicating a divergence between investment growth rates and overall investment dynamics. Coefficient values range from -0.49 to -0.56, indicating an inverse or weak relationship with investment volumes. The growth rate of investment in agriculture does not correspond to actual investment volumes. Investment rates do not match investment dynamics. Consequently, increased investment is not accompanied by a stable expansion of real activity. Increased investment does not ensure uniform production growth.

The second block examined economic indicators. As overall GDP increases, the share of agriculture decreases. The coefficient is -0.54, reflecting a decline in the sector's share as the economy grows. This means that industry and services are growing faster than agriculture. Economic growth is accompanied by faster development of other sectors.

The third block examined productivity and shows an increase in the GVA_AGR_EMP indicator. The relationship between investment and productivity is moderate (0.55–0.87), indicating a partial impact of investment on productivity. However, the increase in output per worker does not occur simultaneously across all farms. Productivity growth is not uniform. Similarly, productivity growth does not lead to a significant increase in agriculture's share of GDP.

The coefficient of the relationship with GDP_AGR_SH is negative (-0.23), indicating the absence of a structural effect.

After constructing the correlation matrix, a time-lag analysis was performed to verify whether the impact of investments manifests itself in the current period or with a time lag. Pairs of variables for which weak, ambiguous, or absent relationships have previously been identified were used. The investment indicator values in year t were compared with the performance indicators in year t+1. Table 2 presents a comparison of the agricultural investment index and gross value added per employee with a 1-year lag.

Table 2. Lagged investment–productivity relationship in agriculture.

Year (t → t+1)	Agricultural Investment Index, t	Labor Productivity in Agriculture (t+1)
2015 → 2016	91.9	1401.9
2016 → 2017	147.1	1735.9
2017 → 2018	127.8	2076.6
2018 → 2019	105.4	2466.0
2019 → 2020	139.2	3004.8
2020 → 2021	113.4	3350.7
2021 → 2022	133.2	4608.2
2022 → 2023	106.3	4235.3
2023 → 2024	101.7	5074.1

Note: compiled by the authors.

INV_AGR_IND values fluctuate widely (91.9–147.1), while GVA_AGR_EMP increases almost throughout its entire trajectory, with a distinct decline in 2023. There is no direct correlation between changes in the investment index and subsequent changes in productivity. High index values (2016, 2019, 2021) are not accompanied by proportionally higher growth in GVA_AGR_EMP the following year. Changes in the investment rate do not lead to a comparable change in output per employee. For example, after a sharp rise in the index in 2016 (147.1), an increase in GVA_AGR_EMP in 2017 does occur, but it continues the general trend and is not attributable to an investment impulse. This pattern indicates the absence of a consistent relationship between investment dynamics and labour productivity in agriculture.

Table 3 presents a comparison of private investment (INV_PRIV) and gross value added per employee (GVA_AGR_EMP) with a 1-year lag.

Table 3. Lagged relationship between private investment and labor productivity in agriculture.

Year (t → t+1)	Private Investment, t	Labor Productivity in Agriculture (t+1)
2015 → 2016	7,25E+08	1401.9
2016 → 2017	7,52E+08	1735.9
2017 → 2018	7,77E+08	2076.6
2018 → 2019	8,08E+08	2466.0
2019 → 2020	1,2E+09	3004.8
2020 → 2021	1,02E+09	3350.7
2021 → 2022	1,12E+09	4608.2
2022 → 2023	1,15E+09	4235.3
2023 → 2024	1,66E+09	5074.1

Note: compiled by the authors.

INV_PRIV shows a general increase with a temporary decline in 2020, while GVA_AGR_EMP increases almost linearly until 2022. The relationship between the indicators is evident, but not

straightforward. Increased private investment in 2019 is accompanied by an increase in GVA_AGR_EMP in 2020, but the decline in investment in 2020 does not lead to a decline in the indicator in 2021. The impact of private investment on productivity is indirect and not in every period. Coincidence in the directions of change can be observed in certain areas, but there is no clear correlation. Consequently, private investment is associated with productivity growth, but this relationship is not consistent.

Table 4 presents a comparison of non-resource-sector investment and gross value added per employee with a 1-year time shift.

Table 4. Lagged relationship between the non-resource investment and labor productivity in agriculture.

Year (t → t+1)	Non-Resource Investment, t	Labor Productivity in Agriculture (t+1)
2015 → 2016	3,26E+09	1401.9
2016 → 2017	3,45E+09	1735.9
2017 → 2018	4,03E+09	2076.6
2018 → 2019	4,9E+09	2466.0
2019 → 2020	5E+09	3004.8
2020 → 2021	5,4E+09	3350.7
2021 → 2022	6,69E+09	4608.2
2022 → 2023	7,57E+09	4235.3
2023 → 2024	9,33E+09	5074.1

Note: compiled by the authors.

INV_NS, variable, the investment in the non-resource sector increases throughout the period. GVA_AGR_EMP also shows growth, except for a brief decline in 2023. This is where the direction of change in the indicators most closely coincides. The increase in investment in 2018–2021 is accompanied by an increase in GVA_AGR_EMP in 2019–2022. However, even in this case, a strict correlation cannot be concluded, as productivity growth continues even during periods of slowing investment. Investment in the non-resource sector is associated with productivity growth in agriculture, but does not fully determine it.

Table 5 presents a comparison of the agricultural investment index and the physical agricultural production index, with a 1-year lag.

Table 5. Lagged relationship between the agricultural investment index and agricultural output growth.

Year (t → t+1)	Agricultural Investment Index, t	Agricultural Output Growth (t+1)
2015 → 2016	91.9	105.4
2016 → 2017	147.1	103.2
2017 → 2018	127.8	103.8
2018 → 2019	105.4	99.9
2019 → 2020	139.2	105.9
2020 → 2021	113.4	97.8
2021 → 2022	133.2	109.1
2022 → 2023	106.3	92.6
2023 → 2024	101.7	113.7

Note: compiled by the authors.

INV_AGR_IND and GDP_AGR_IND variables change unevenly, without a consistent direction. There is no consistent pattern between the indicators. A high investment index in 2016 does not lead to an increase in GDP_AGR_IND in 2017, while in 2021, despite a high index value, a decrease in GDP_AGR_IND is observed in 2022. A change in the rate of investment does

not lead to a corresponding change in the rate of agricultural output. There is no clear link between investment and output in the short term.

Table 6 presents a comparison of the agricultural investment index and the share of agriculture in GDP, with a 1-year time lag.

Table 6. Lagged relationship between the agricultural investment index and the share of agriculture in GDP.

Year (t → t+1)	Agricultural Investment Index, t	Share of Agriculture in GDP (t+1)
2015 → 2016	91.9	105.4
2016 → 2017	147.1	103.2
2017 → 2018	127.8	103.8
2018 → 2019	105.4	99.9
2019 → 2020	139.2	105.9
2020 → 2021	113.4	97.8
2021 → 2022	133.2	109.1
2022 → 2023	106.3	92.6
2023 → 2024	101.7	113.7

Note: compiled by the authors.

The results showed no consistency between INV_AGR_IND and GDP_AGR_SH. GDP_AGR_SH declined from 5.4 to 3.8 after 2020. An increase in the investment index in 2019 did not lead to an increase in agriculture's share in 2020. Investments do not have a noticeable impact on agriculture's position in the economic development structure.

To assess the strength of the identified lagged relationships between investment and performance indicators, Pearson correlation coefficients were calculated, and the results of which are presented in the table (Table 7).

Table 7. Lagged Pearson Correlation between investment indicators and agricultural performance.

Lag pair variables	r
INV_AGR_IND → GVA_AGR_EMP	-0.116
INV_PRIV → GVA_AGR_EMP	0.882
INV_NS → GVA_AGR_EMP	0.959
INV_AGR_IND → GDP_AGR_IND	0.120
INV_AGR_IND → GDP_AGR_SH	0.539

Note: compiled by the authors.

The results revealed differences in the strength and direction of the relationship between investment and agricultural indicators. The INV_NS indicator showed the strongest positive correlation with GVA_AGR_EMP (0.959), which indicated that increased investment in the non-resource sector is associated with higher output per person employed in agriculture the following year. The result for INV_PRIV (0.882) indicated that a 1-unit increase in private investment is associated with an increase in output per person employed in agriculture the following year. The INV_AGR_IND indicator showed no significant correlation with productivity (-0.116) or output dynamics (0.120). However, the correlation with the share of agriculture in GDP (0.539) is moderate, indicating that investment has only a partial influence on the sector's position in the economic structure.

To clarify the nature of the identified relationships, an analysis is then conducted of the dependence of investment indicators on the structure of agriculture in the economy and the

level of productivity, to assess how investments are reflected not only in dynamics, but also in the position of the sector in GDP and the efficiency of resource use.

Table 8. Correlation of investment indicators with agricultural structure and productivity.

Investment indicators	GDP_AGR_SH	GVA_AGR_EMP
INV_NS	-0.474	0.957***
INV_AGR_IND	0.322	-0.482
INV_PRIV	-0.597	0.871**
INV_AGR	-0.525	0.554
INV_TOTAL	-0.525	0.554
Investment indicators	GDP_AGR_SH	GVA_AGR_EMP
INV_NS	-0.474	0.957***

Note: compiled by the authors.

The obtained values demonstrate differences in the impact of investment on the structure of the economy and agricultural productivity. Negative coefficients between investment indicators and GDP_AGR_SH (from -0.474 to -0.597) indicate that as investment increases, agriculture's share of GDP decreases. Increased investment is accompanied by faster output growth in other sectors of the economy. As a result, even with investment, agriculture accounts for a smaller share of overall GDP.

The GVA_AGR_EMP indicator shows a different picture. The correlations with INV_NS (0.957) and INV_PRIV (0.871) are high and positive; greater investment is associated with higher output per person employed in agriculture. Labour productivity has increased. The correlation with INV_AGR and INV_TOTAL (0.554) is moderate, indicating an effect, but it is not consistently evident across periods. The INV_AGR_IND indicator demonstrates a weak positive correlation with the share of agriculture (0.322) and a negative correlation with productivity (-0.482). Changes in investment rates do not strengthen the sector's position in the economy.

In Table 9, there are results for multivariate tests.

Table 9. Multivariate Tests

Independent variable	Test	value	F	df1	df2	p-value
INV_NS	Pillai's Trace	0.9828	143.173	2	5	<.001
	Wilks' Lambda	0.0172	143.173	2	5	<.001
	Hotelling's Trace	57.2692	143.173	2	5	<.001
	Roy's Largest Root	57.2692	143.173	2	5	<.001
INV_AGR_IND	Pillai's Trace	0.0636	0.170	2	5	0.849
	Wilks' Lambda	0.9364	0.170	2	5	0.849
	Hotelling's Trace	0.0679	0.170	2	5	0.849
	Roy's Largest Root	0.0679	0.170	2	5	0.849
INV_PRIV	Pillai's Trace	0.3093	1.120	2	5	0.396
	Wilks' Lambda	0.6907	1.120	2	5	0.396
	Hotelling's Trace	0.4479	1.120	2	5	0.396
	Roy's Largest Root	0.4479	1.120	2	5	0.396

Note: compiled by the authors.

The conducted correlation analysis revealed the presence and direction of relationships between investment indicators, productivity, and structural characteristics of the agro-industrial complex. However, correlation only reflects the degree of joint change in variables

and does not allow for assessing their impact when multiple factors are taken into account simultaneously. Therefore, to clarify the identified relationships, a regression analysis was conducted to assess the impact of investment indicators on agricultural productivity and its share of the economy.

A multivariate analysis of variance (MANOVA) revealed that the impact of investment indicators on the dependent variables is heterogeneous. The most pronounced effect is demonstrated by the INV_NS indicator, for which all multivariate criteria are statistically significant ($p < 0.001$). The relationship between investment in the non-resource sector and the set of productivity and economic structure indicators is stable. The INV_AGR_IND ($p = 0.849$) and INV_PRIV ($p = 0.396$) indicators showed a statistically insignificant effect.

In Figure 5, a Q-Q plot for the MANCOVA model is illustrated.

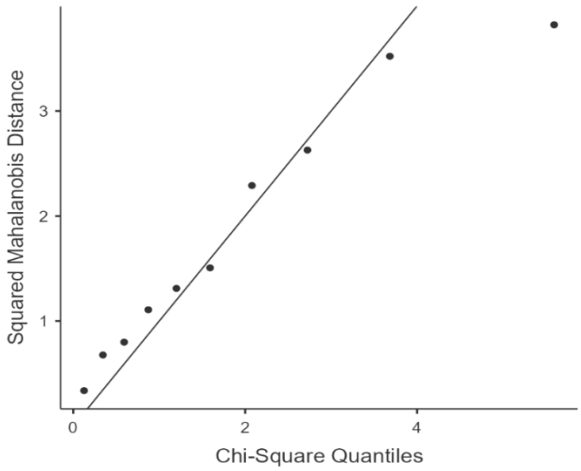


Figure 5. Q–Q Plot for Residual Normality in MANCOVA Model.

The Q–Q plot showed that the residuals are normally distributed, and the model assumptions are met. This confirms the validity of the hypotheses tested regarding the impact of investment indicators on agricultural productivity (GVA_AGR_EMP) and its share of GDP (GDP_AGR_SH). Therefore, the results of testing the hypotheses that investment in the non-resource sector impacts productivity, while investment in agriculture and private investment show no significant effect, are statistically valid.

In Table 10, the results for univariate tests are presented.

Table 10. Univariate Tests

Independent variable	Dependent Variable	Sum of Squares	df	Mean Square	F	p-value
INV_NS	GVA_AGR_EMP	1.54e+7	1	1.54e+7	86.2728	<.001
	GDP_AGR_SH	0.5955	1	0.5955	2.55	0.162
INV_AGR_IND	GVA_AGR_EMP	51672.0133	1	51672.0133	0.2891	0.610
	GDP_AGR_SH	0.0139	1	0.0139	0.0591	0.816
INV_PRIV	GVA_AGR_EMP	308388.5172	1	308388.5172	1.55	0.237
	GDP_AGR_SH	0.6305	1	0.6305	2.48	0.152
Residuals	GVA_AGR_EMP	1.07e+6	6	178727.1323	-	-
	GDP_AGR_SH	1.41	6	0.2349	-	-

Note: compiled by the authors.

The results of the univariate analysis clarify the nature of the identified relationships. A significant effect remains only for the INV_NS variable on agricultural labour productivity (GVA_AGR_EMP, $p < 0.001$), while the effect on the share of agriculture in GDP (GDP_AGR_SH) is not statistically significant ($p = 0.162$). The INV_AGR_IND and INV_PRIV indicators do not have a statistically significant effect on any of the dependent indicators. The observed effect of investment is limited to productivity growth and does not extend to agriculture's structural position in the economy.

6. Conclusion

The study aimed to determine the nature of the relationships among investment in the agro-industrial complex, productivity indicators, and agriculture's position in the structure of the Kazakh economy, while accounting for possible lagged effects of investment.

The analysis revealed that increased investment volumes are not accompanied by sustained improvements in agricultural production indicators or their share of GDP. The correlation matrix revealed strong relationships within the investment cluster, whereas the index of physical investment in agriculture shows weak, negative relationships with other investment indicators. There is a discrepancy between the volume of investments and their actual results. It was revealed that the strengthening of agriculture's position does not accompany economic growth. The indicator for agricultural production dynamics does not form a stable relationship with investment.

A lagged relationship analysis revealed that investment has an uneven impact on performance indicators. A significant positive correlation was found between total investment and labour productivity in agriculture, while the agricultural investment index showed no significant impact on output. This confirms that the impact of investment is partial and does not translate into sustainable production growth.

The situation in Kazakhstan's agro-industrial complex doesn't appear critical, but it's also far from sustainable. Investment volumes are growing, and output and productivity indicators are generally improving, but there is no direct, stable link between investment and results.

Investments must be tied to specific production results. It is important to improve access to financing for producers themselves, not just for large projects. Next, it is important to develop processing, logistics, and marketing to ensure added value remains within the sector. Technological upgrading and a stable environment for producers are more effective than large, one-time investments. Reducing dependence on external factors through more sustainable production solutions and diversifying activities within the agricultural sector remains key.

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