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EFFECTIVE USE OF LABOR RESOURCES IN AGRICULTURE IN KAZAKHSTAN IN THE CONTEXT OF DIGITAL TRANSFORMATION

Abstract

The study addresses the problem of low labor productivity in Kazakhstan's agricultural sector under conditions of digital transformation and structural changes in the economy. Agriculture remains an important component of national economic development and food security; however, the sector continues to face persistent challenges associated with technological constraints, workforce aging, labor outflow from rural areas, and insufficient investment activity. The purpose of this study is to assess the dynamics and efficiency of labor resource utilization in Kazakhstan's agriculture during 2018–2024 and identify the main factors limiting productivity growth. The methodological framework includes statistical, comparative, structural, and econometric analysis using official national statistical data and analytical materials. The results reveal a reduction in agricultural employment, structural changes in workforce composition, low wage competitiveness, and substantial productivity gaps compared with high-performing sectors of the economy. The econometric assessment confirms statistically significant relationships between labor productivity, gross output, and wage levels, indicating that productivity growth remains predominantly driven by extensive and scale-related factors. The scientific novelty of the study lies in the development and empirical testing of an econometric model that quantifies the influence of agricultural output and wage levels on labor productivity in Kazakhstan's agricultural sector under conditions of digital transformation. Unlike previous studies, the proposed approach provides an assessment of productivity elasticities with respect to key economic factors and identifies the predominance of extensive growth drivers. The authors' contribution consists in integrating structural labor market analysis with econometric modeling of productivity determinants for the period 2018–2024 and developing evidence-based recommendations aimed at improving labor efficiency and strengthening the long-term competitiveness of Kazakhstan's agricultural sector.

Keywords: agriculture; labor resources; labor productivity; digital transformation; employment; technological modernization; human capital

INTRODUCTION

Agriculture in Kazakhstan represents a strategically important sector of the national economy, ensuring food security, employment, and sustainable rural development. For a significant proportion of the rural population, agricultural activity remains a primary source of income and an important factor supporting socio-economic stability. Therefore, improving the efficiency and competitiveness of the agricultural sector remains one of the key priorities of national development policy.

Agriculture currently faces climate, technological, and labor market challenges. At the same time, digitalization creates opportunities for improving productivity through artificial intelligence, precision farming, and digital monitoring systems (Padhiary et al., 2024; Raj, 2025; Choruma et al., 2024; Manman, 2025).

Despite the growing body of research on digital transformation and labor productivity in agriculture, several important research gaps remain. Existing international studies primarily focus on the adoption of

digital technologies, automation, artificial intelligence, and smart farming systems, emphasizing their effects on production efficiency and labor transformation (Padhiary et al., 2024; Raj, 2025; Choruma et al., 2024; Manman, 2025). At the same time, considerably less attention has been paid to the combined influence of labor resources, wage incentives, and productivity dynamics in agricultural sectors of transition economies, where institutional and structural constraints significantly affect technological adaptation (Daum, 2025; Berdegué et al., 2025).

In Kazakhstan, previous studies mainly examine agricultural productivity, employment trends, labor resource utilization, and general issues of agricultural modernization from a descriptive or macroeconomic perspective (Tinkai et al., 2024; Government of the Republic of Kazakhstan, 2021; Halyk Finance Analytical Center, 2025). However, there is still a lack of comprehensive empirical research that simultaneously evaluates structural changes in agricultural employment, labor productivity dynamics, and the impact of key economic factors under conditions of digital transformation. Existing studies pay insufficient attention to the effects of workforce aging, labor shortages, migration from rural areas, and the mismatch between workforce qualifications and the requirements of digital agriculture (Tinkai et al., 2024; Halyk Finance Analytical Center, 2025). In addition, limited research has been devoted to assessing how wage incentives and production expansion influence labor productivity in the agricultural sector. Furthermore, econometric evidence on the determinants of labor productivity in Kazakhstan's agriculture remains scarce, while quantitative assessments of the relationships between labor productivity, agricultural output, and wage levels are largely absent. The influence of digital transformation on labor efficiency and workforce utilization has also not been sufficiently investigated within the context of Kazakhstan's agricultural development (Government of the Republic of Kazakhstan, 2021; World Bank, 2026).

Thus, the key research gap lies in the absence of an integrated analytical approach that combines labor market analysis with econometric assessment of productivity determinants in the context of agricultural digitalization. Unlike existing studies, the present research not only examines the dynamics of labor resource utilization in Kazakhstan's agriculture during 2018–2024 but also develops and tests an econometric model that quantifies the effects of agricultural output and wages on labor productivity. This approach makes it possible to identify the relative contribution of production and labor-related factors to productivity growth and provides new empirical evidence for improving labor efficiency and agricultural development policies.

LITERATURE REVIEW

Recent studies indicate that digital transformation significantly affects agricultural productivity and labor organization. Technologies such as artificial intelligence, robotics, precision agriculture, and digital platforms improve operational efficiency, optimize resource utilization, and contribute to productivity growth (Padhiary et al., 2024; Raj, 2025; Choruma et al., 2024; Manman, 2025). From this perspective, digitalization is considered one of the key drivers of sustainable agricultural development and competitiveness.

However, the literature presents differing views on the impact of digital technologies on labor productivity. Some studies argue that automation and smart farming technologies improve production efficiency and reduce labor costs by replacing routine operations (Padhiary et al., 2024; Raj, 2025). Others emphasize that technological modernization does not automatically increase productivity and may even widen inequalities between agricultural producers due to unequal access to finance, infrastructure, and digital competencies (Daum, 2025; Berdegué et al., 2025). These findings suggest that productivity gains depend not only on technology adoption but also on investments in human capital and institutional support.

The relationship between digitalization and employment remains equally debated. While some authors associate automation with labor displacement (Daum, 2025), others argue that digital transformation mainly changes employment structures by increasing demand for workers with digital and technological skills (Choruma et al., 2024; Omotayo, 2025). Therefore, the literature provides no consensus on whether digitalization reduces employment or creates new forms of agricultural work and specialization.

Kazakhstani studies mainly focus on labor resource utilization, employment dynamics, labor shortages, and productivity trends in agriculture (Tinkai et al., 2024). Existing research confirms the presence of structural challenges associated with workforce aging, labor migration from rural areas, insufficient attractiveness of agricultural employment, and low labor productivity. At the same time, empirical studies assessing the impact of digital transformation on labor efficiency remain limited. Insufficient attention has been paid to the quantitative assessment of relationships between labor productivity, agricultural output, and wage incentives, as well as to the econometric evaluation of productivity determinants under conditions of agricultural modernization (Tinkai et al., 2024; Halyk Finance Analytical Center, 2025).

Therefore, despite substantial progress in understanding the role of digital technologies in agriculture, several unresolved issues remain. Existing international studies provide mixed evidence regarding the effects of digitalization on productivity and employment, while Kazakhstani research remains largely descriptive and lacks comprehensive econometric assessments. This creates the need for further investigation of labor productivity determinants and labor resource efficiency in Kazakhstan's agricultural sector under conditions of digital transformation.

METHODOLOGY AND METHODS

The study applies a combination of quantitative and qualitative research methods to examine the efficiency of labor resource utilization in Kazakhstan's agricultural sector under conditions of digital transformation.

Content analysis – a review of scientific publications, regulatory acts, strategic development documents, and analytical reports, including the Concept for the Development of the Agro-Industrial Complex of the Republic of Kazakhstan for 2021–2030 and policy documents defining priorities for agricultural modernization and digital transformation (Government of the Republic of Kazakhstan, 2021).

Statistical analysis – processing and analysis of official data from the Bureau of National Statistics of the Republic of Kazakhstan, the Ministry of Agriculture, and analytical reports covering employment dynamics, labor productivity, wages, agricultural output, and labor market indicators (Bureau of National Statistics, 2025; Halyk Finance Analytical Center, 2025).

Comparative and structural analysis – used to identify structural changes in agricultural employment, workforce composition, labor efficiency indicators, and sectoral trends during 2018–2024.

Correlation and regression analysis – applied to evaluate the relationships between labor productivity and selected economic factors and to quantify their impact through econometric modeling.

The empirical database consists of official annual statistical data for the period 2018–2024 obtained from the Bureau of National Statistics of the Republic of Kazakhstan, sectoral reports, government development programs, and analytical publications (Bureau of National Statistics, 2025; Government of the Republic of Kazakhstan, 2021).

To assess the determinants of labor productivity, an econometric model was developed using the Ordinary Least Squares (OLS) method. Labor productivity (output per employed person) was selected as the dependent variable because it represents the key indicator of labor resource efficiency in agriculture. Gross agricultural output was included as an explanatory variable reflecting the scale of production activity, while the average monthly wage was used as an indicator of labor incentives and workforce quality. The selection of these variables is supported by previous studies emphasizing the importance of production scale, labor remuneration, and human capital for productivity growth (Daum, 2025; Berdegué et al., 2025; Tinkai et al., 2024).

RESULTS

The efficient utilization of labor resources contributes to productivity growth, improves competitiveness, reduces production costs, and strengthens the financial sustainability of agricultural enterprises. In the agricultural sector, labor efficiency plays a critical role in ensuring sustainable development, improving resource allocation, and increasing the effectiveness of technological and organizational innovations. Under conditions of digital transformation, the rational use of labor resources becomes increasingly important for strengthening the resilience and long-term competitiveness of the agro-industrial sector.

The analysis of employment indicators allows the identification of key structural changes in Kazakhstan's agricultural labor market and the assessment of labor resource utilization efficiency. Table 1 presents the main indicators of the number of people employed in agriculture in the Republic of Kazakhstan.

Table 1. Population employed in agriculture in the Republic of Kazakhstan for 2018–2024

Name	2018	2019	2020	2021	2022	2023	2024	Deviation of 2024 relative to, %	
								2020	2023
Labor force in Kazakhstan, thousand people	9,138.6	9,221.5	9,180.8	9,256.8	9,429.8	9,534.1	9,664.0	5.3	1.4
Employed population in agriculture in Kazakhstan, thousand people	1,027.9	1,184.7	1,175.1	1,176.4	1,108.9	1,075.4	1,027.9	-12.5	-4.4
Share of employed population in agriculture, %	14.1	13.5	13.5	13.4	12.4	11.3	11.2	-17.0	-0.9
Including by age group, years									
15	0.3	0.3	0.6	0.2	0.5	0.6	0.2	-66.7	-66.7
16–24	147.6	144.4	144.5	141.8	113.4	125.1	108.9	-24.6	-12.9
25–54	841.0	804.1	784.3	775.5	753.5	710.5	690.2	-12.0	-2.9
55–64	201.3	199.1	202.5	207.5	191.9	185.3	184.2	-9.0	-0.6

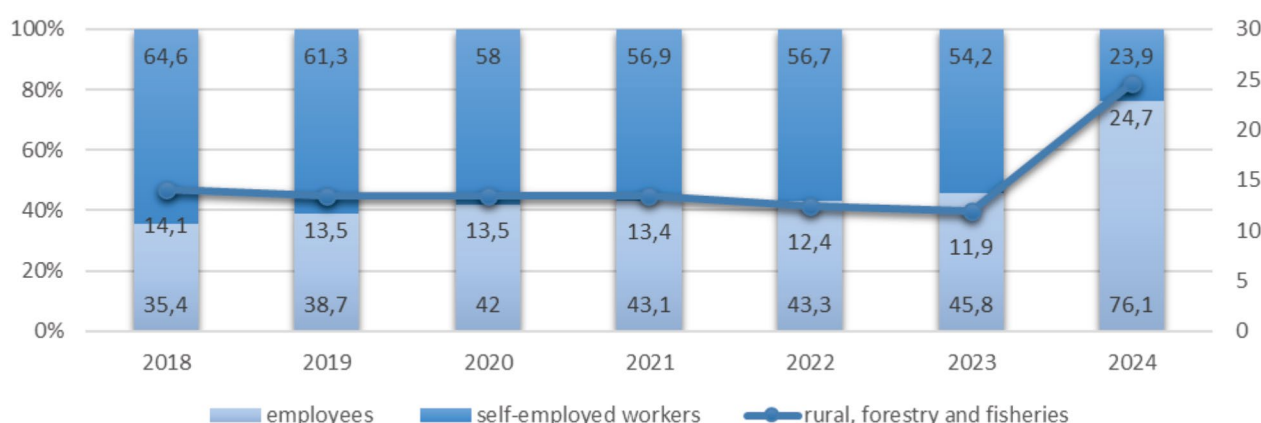
65 and older	38.1	36.8	43.2	51.3	49.5	53.9	44.4	+2.8	-17.6
By employment status									
Employees	434.6	458.4	493.1	507.4	480.1	492.0	383.5	-22.2	-22.1
Share of hired workers in agriculture, %	35.4	38.7	42.0	43.1	43.3	45.8	33.8	-19.5	-26.2
Self-employed workers	793.6	726.3	682.0	669.0	628.8	583.4	547.9	-19.7	-6.1
Share of self-employed workers in agriculture, %	64.6	61.3	58.0	56.9	56.7	54.2	53.0	-8.6	-2.2
Unemployment rate, %	4.9	4.8	4.9	4.9	4.9	4.7	4.6	-6.1	-6.1

Note: Compiled by the authors based on data from the Bureau of National Statistics of Kazakhstan (2024)

Employment in agriculture declined from 1.23 million to 1.03 million people, while the share of agricultural employment decreased from 14.1% to 11.2%. The reduction in youth employment and the growing share of older workers indicate workforce aging and declining attractiveness of agricultural occupations.

The structure of the agricultural workforce is shown in Figure 1.

Figure 1. Structure of agricultural employment in Kazakhstan, 2018–2024 (%)



Note: Compiled by the authors based on data from the Bureau of National Statistics of Kazakhstan (2025)

According to Figure 1, self-employed workers continued to dominate agricultural employment; however, their share declined from 64.6% in 2018 to 53.0% in 2024, while the share of hired workers increased to 45.8% by 2023 before falling to 33.8% in 2024. These changes reflect a gradual shift toward formal employment alongside instability in labor demand and structural adjustments within agricultural enterprises.

Demographic trends reveal persistent labor market challenges. The number of workers aged 16–24 declined by 26.2%, while employment among those aged over 65 increased by 16.5%, indicating workforce aging and declining attractiveness of agricultural occupations for younger generations. In addition, the sector faces a shortage of approximately 3,500 qualified specialists, limiting the effective adoption of digital technologies and modern production systems.

Agriculture plays a strategic role in Kazakhstan's economy, ensuring food security, employment, and a raw material base for related industries. However, an analysis of the indicators (Table 2) shows mixed trends in the dynamics of labor resource efficiency.

Table 2. Efficiency of labor resource utilization in agricultural organizations of the Republic of Kazakhstan

Name	2018	2019	2020	2021	2022	2023	2024	Deviation of 2024 relative to, %	
								2020	2023
Gross output of agricultural products (services) at current prices, billion tenge	4.474,1	5.151,2	6.334,7	7.515,4	9.481,2	8.732,1	8.363,6	32.03	-4.22
Average number of employees during the reporting period, thousand people.	77.2	72.4	72.1	70.6	68.2	66.4	64.3	-10.82	-3.16
Total number of thousand man-hours worked, total	130,995.4	122,320.3	122,753.9	122,552.6	122,558.3	122,550.0	115,100.4	-6.23	-6.08
Total labor costs, billion tenge	87.595	102.766	109.560	127.539	158.570	168.501	215.363	96.57	27.81
Total wage fund, billion tenge	80.762	89.158	101.150	115.888	143.155	142.511	183.615	81.53	28.84
Output, thousand tenge/person.	57,954.7	71,149.2	87,859.9	106,407.9	139,020.5	131,507.5	130,070.0	48.04	-1.09
Output, tenge/man-hour	0.0342	0.0421	0.0516	0.0613	0.0774	0.0713	0.07266	1.91	1.91
Employee productivity, tenge	57.95	71.15	87.86	106.45	139.02	131.51	130.07	48.04	-1.09
Salary return, tenge	51.08	50.13	57.82	58.93	59.79	51.82	38.83	-32.84	-25.07

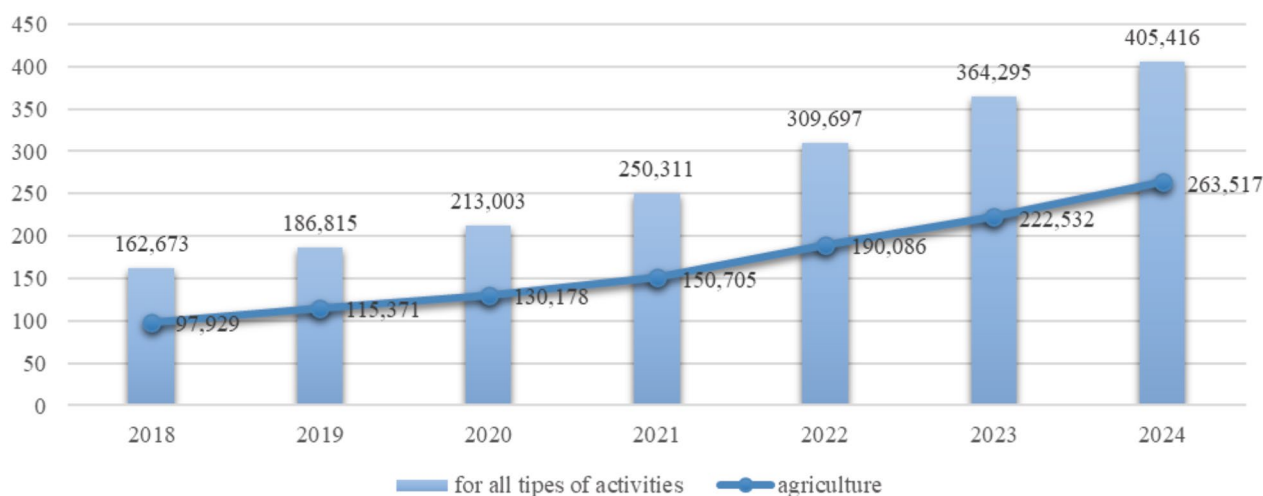
Note: Compiled by the authors based on data from the Bureau of National Statistics of Kazakhstan (2025)

According to Table 2, Kazakhstan's agricultural sector in 2018–2024 experienced rising output but declining labor efficiency. Gross output increased from 4,474.1 to 8,363.6 billion tenge, although it decreased by 4.22% compared to 2023. The number of employees fell by 16.8%, while labor costs grew by 81.53%.

Labor productivity increased by 48.03% during 2020–2024, reaching 130,070 tenge per employee, and output per man-hour rose by 1.91%. However, wage returns declined by 32.84% (from 57.82 to 38.83 tenge), indicating inefficient use of growing labor expenditures and the need for technological modernization of the sector.

Currently, the average monthly wage in the agricultural sector is less than two-thirds of the national average (Figure 2).

Figure 2. Average monthly wages in agriculture for 2018–2024 (tenge)



Note: Compiled by the authors based on sources (Bureau of National Statistics, 2025)

According to Figure 2, average monthly wages in Kazakhstan increased steadily during 2018–2024; however, agricultural incomes remained consistently below the national average. Average wages across the economy rose from 162,673 to 405,416 tenge, while agricultural wages increased from 97,929 to 263,517 tenge. Despite this growth, the wage gap remained substantial, with agricultural earnings accounting for only 65% of the national average in 2024, indicating the sector’s relatively low income competitiveness.

The persistent wage gap reduces the attractiveness of agricultural employment, contributes to labor outflow from rural areas, and limits the sector’s ability to attract qualified personnel required for technological modernization and digital transformation. Similar trends, including declining wage competitiveness and employment risks, have been identified in recent assessments of Kazakhstan’s labor market (Halyk Finance Analytical Center, 2025). Between 2018 and 2023, agricultural employment declined by 12.5%, reflecting both production constraints and the shift of part of the population to subsistence farming. Addressing these challenges requires stimulating quality employment, supporting farms and cooperation, expanding the adoption of modern agricultural technologies, and strengthening vocational training systems (Tinkai et al., 2024).

In recent years, Kazakhstan has expanded digital and skills-oriented employment support mechanisms. The Enbek ecosystem integrates employment services, vocational training, entrepreneurship support, and online labor market platforms, contributing to workforce development and labor mobility, particularly among young people and rural residents (Enbek.kz, 2026).

Although government programs prioritize technological modernization, digitalization, and productivity growth, implementation gaps continue to limit their effectiveness. Therefore, improving policy continuity and monitoring mechanisms remains essential for sustainable agricultural development (Government of the Republic of Kazakhstan, 2021). According to Table 3, despite the multiple growth in the total value of agricultural output, the physical volume index remained relatively unstable and demonstrated only moderate annual growth rates.

Table 3. Indicators of gross agricultural output and labor productivity in Kazakhstan

Years	Gross agricultural output, million tenge	Physical volume index, % compared to the previous year	Including		Share of agriculture in GDP, %	Labor productivity, thousand tenge
			Plant growing	Animal husbandry		
2015	3 307 010	103,4	104,0	102,7	4,7	1242
2016	3 684 393	105,4	107,5	102,8	4,6	1402
2017	4 070 917	103,0	102,2	103,9	4,5	1736
2018	4 474 088	103,5	103,2	103,9	4,4	2077
2019	5 151 163	99,9	96,4	104,0	4,5	2466
2020	6 334 669	105,7	107,8	103,1	5,4	3005

2021	7 515 434	97,7	93,4	103,6	5,4	3351
2022	8 407 512	109,1	115,1	100,8	5,2	4608
2023	7 625 151	91,7	85,9	104,5	4,0	4378
2024	8 363 603,2	113,6	121,1	103,6	5,0	5074

Note: Calculated by the authors based on Halyk Finance analytical data (2025)

Agricultural performance in 2023 was negatively affected by adverse weather conditions and market disruptions, resulting in reduced crop yields and lower production volumes. In 2024, the sector demonstrated partial recovery; however, dependence on climatic conditions remains significant.

Data for 2024 show a recovery in agriculture after the crisis of 2023 caused by unfavorable climatic conditions. The gross output of the industry amounted to KZT 8,363.6 billion, which is 9.7% higher than in 2023, but remains below the maximum value of 2022 (KZT 8,407.5 billion). The physical volume index grew by 13.6% thanks to a 21.1% increase in crop production and a 3.6% increase in livestock production. This indicates a partial recovery from the effects of the drought and the decline in grain and oilseed yields in 2023.

The share of agriculture in GDP remained stable at 5%, which is in line with the long-term trend of the last ten years (4-5%). Labor productivity in the industry increased to 5,074 thousand tenge, exceeding the 2023 level (4,378 thousand tenge) by 15.9%. Nevertheless, the gap with high-performance sectors of the economy remains: productivity in the mining industry is 12.6 times higher.

To deepen the empirical analysis and identify the elasticity effects of key economic factors, an econometric assessment of labor productivity determinants in Kazakhstan's agricultural sector was conducted.

Labor productivity was defined as output per employed person (thousand tenge) and used as the dependent variable. Given the non-linear nature of production processes and the need to interpret elasticities, a log-log specification was applied.

Model specification

The following regression model was estimated for the period 2018–2024 using the Ordinary Least Squares (OLS) method:

$$\ln LP_t = \alpha + \beta_1 \ln Q_t + \beta_2 \ln W_t + \varepsilon_t \quad (1)$$

where:

LP_t – labor productivity in agriculture

Q_t – gross agricultural output

W_t – average monthly wage in agriculture

ε_t – error term

In this specification, the estimated coefficients directly represent elasticities, showing the percentage change in labor productivity resulting from a 1% change in the explanatory variable.

To evaluate the magnitude and direction of relationships between labor productivity and the selected explanatory variables, the estimated regression coefficients were analyzed. The obtained parameters allow assessment of the sensitivity of labor productivity to changes in agricultural output and wage levels, thereby providing empirical evidence on the relative contribution of production and income-related factors. The estimation results are presented in Table 4.

Table 4. Results of log-log regression for labor productivity in agriculture (2018–2024)

Variable	Coefficient (elasticity)	Std. Error	t-statistic	p-value
Constant	-1.842	0.613	-3.01	0.039
ln Gross output (ln Q_t)	0.62	0.11	5.64	0.005
ln Average wage (ln W_t)	0.31	0.09	3.44	0.026

Note: authors' calculations based on official statistical data

Model statistics:

$R^2 = 0.964$;

Adjusted $R^2 = 0.946$;

F-statistic = 53.9 ($p < 0.01$)

The estimated model demonstrates a high explanatory capacity and indicates statistically significant relationships between labor productivity and the selected explanatory variables. The results suggest that productivity dynamics in Kazakhstan's agricultural sector are influenced by both production expansion and income-related factors, although the magnitude of these effects differs substantially.

The elasticity of labor productivity with respect to gross agricultural output is 0.62, which means that a 1% increase in production volume leads to an average increase in labor productivity of 0.62%. This result indicates the presence of scale effects; however, the elasticity is less than one, suggesting diminishing returns and confirming that productivity growth is largely driven by extensive factors rather than technological intensification.

The elasticity of labor productivity with respect to the average wage level equals 0.31, implying that a 1% increase in wages is associated with only a 0.31% increase in productivity. This confirms the weak transmission mechanism between income growth and efficiency gains. In other words, wage increases are not sufficiently supported by improvements in technology, work organization, or skills development.

The high coefficient of determination ($R^2=0.96$, $R^2=0.96$) indicates strong explanatory power of the model, although the results should be interpreted with caution due to the short time series and volatility of agricultural production caused by climatic and market shocks.

The econometric results indicate that labor productivity growth remains primarily scale-dependent and driven by output expansion rather than technological intensification. This confirms the need for investment in digitalization, capital modernization, and human capital development.

DISCUSSION

The obtained results generally support international studies emphasizing the importance of technological modernization and digital transformation for improving agricultural productivity (Padhiary et al., 2024; Raj, 2025). Similar to Choruma et al. (2024), the findings suggest that productivity growth increasingly depends on the adoption of digital technologies and modern management practices. At the same time, the study confirms that technological advancement alone is insufficient to ensure sustainable productivity growth without adequate human capital and institutional support, which is consistent with the conclusions of Daum (2025) and Berdegué et al. (2025).

The econometric analysis shows that labor productivity in Kazakhstan's agriculture is more responsive to increases in production output than to wage growth. Unlike evidence from technologically advanced agricultural economies, where productivity is more strongly associated with innovation and workforce skills (Daum, 2025; Omotayo, 2025), the results indicate that productivity growth in Kazakhstan remains largely driven by extensive factors rather than technological intensification.

The findings also support concerns raised in international literature regarding unequal access to digital technologies and innovation resources (Berdegué et al., 2025). Similar patterns are observed in Kazakhstan, where labor shortages, workforce aging, insufficient investment, and limited access to advanced technologies continue to constrain productivity growth, particularly among small and medium-sized agricultural enterprises.

Furthermore, the results are consistent with World Bank (2026) assessments highlighting human capital limitations and uneven technological diffusion as major barriers to productivity growth. The analysis also identifies structural constraints, including dependence on climatic conditions, fragmented production structures, and high depreciation of agricultural machinery. These findings reinforce international evidence that the benefits of digital transformation are greatest when supported by investment, institutional development, and workforce modernization (Daum, 2025; Berdegué et al., 2025; Omotayo, 2025).

Therefore, strengthening human capital, improving access to financial instruments, expanding digital infrastructure, increasing technological modernization, and enhancing workforce competencies should be considered key priorities for long-term agricultural development. The results suggest that sustainable productivity growth in Kazakhstan's agricultural sector requires not only expansion of production volumes but also a transition toward a more technology-intensive and knowledge-based development model.

CONCLUSION

The study demonstrates that labor productivity in Kazakhstan's agricultural sector is constrained by a combination of structural, technological, and institutional factors. The empirical results indicate a continuing decline in agricultural employment, workforce aging, relatively low wage competitiveness, and unequal regional distribution of labor resources. Despite the partial recovery of production indicators in 2024 following the agricultural downturn of 2023, the sector continues to exhibit significant inefficiencies and high sensitivity to external shocks.

The econometric analysis confirms that labor productivity growth remains predominantly dependent on production expansion rather than on qualitative improvements in labor efficiency. The stronger elasticity of productivity with respect to output compared with wage growth suggests limited technological diffusion and weak transmission mechanisms between labor incentives and productivity gains. These findings indicate that the existing model of agricultural development relies largely on extensive growth factors.

Long-term improvement of labor productivity requires a transition toward technologically intensive and knowledge-based development. Priority areas include modernization of agricultural machinery and infrastructure, wider adoption of digital and intelligent technologies, expansion of financial accessibility for small and medium-sized agricultural enterprises, and stronger interaction between education, research institutions, and production systems. Implementation of these measures may improve labor efficiency, increase resilience of rural economies, and strengthen the competitiveness and sustainability of Kazakhstan's agro-industrial sector.

The scientific contribution of this study lies in providing one of the first integrated assessments of labor resource efficiency and labor productivity determinants in Kazakhstan's agricultural sector under conditions of digital transformation. The proposed econometric framework quantifies the elasticity effects of production and wage factors, thereby expanding the empirical evidence available for policy design and agricultural labor market regulation.

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ЦИФРЛЫҚ ТРАНСФОРМАЦИЯ ЖАҒДАЙЫНДА ҚАЗАҚСТАННЫҢ АУЫЛ ШАРУАШЫЛЫҒЫНДА ЕҢБЕК РЕСУРСТАРЫН ТИІМДІ ПАЙДАЛАНУ

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Аңдатпа

Зерттеуде экономиканың құрылымдық өзгерістері мен цифрлық трансформация жағдайындағы Қазақстанның ауыл шаруашылығы секторындағы еңбек өнімділігінің төмендігі мәселесі қарастырылады. Ауыл шаруашылығы ұлттық экономикалық дамудың және азық-түлік қауіпсіздігін қамтамасыз етудің маңызды құрамдас бөлігі болып қала береді, алайда бұл сала технологиялық шектеулер, жұмыс күшінің қартаюы, ауылдық жерлерден еңбек ресурстарының кетуі және инвестициялық белсенділіктің жеткіліксіздігі сияқты тұрақты мәселелермен бетпе-бет келуде. Зерттеудің мақсаты – 2018–2024 жылдар аралығындағы Қазақстан ауыл шаруашылығындағы еңбек ресурстарын пайдалану динамикасы мен тиімділігін бағалау, сондай-ақ еңбек өнімділігінің өсуін шектейтін негізгі факторларды анықтау. Зерттеудің әдіснамалық негізіне ресми ұлттық статистикалық деректер мен аналитикалық материалдарды пайдалана отырып жүргізілген статистикалық, салыстырмалы, құрылымдық және эконометриялық талдау әдістері енгізілді. Зерттеу нәтижелері ауыл шаруашылығындағы жұмыспен қамтудың қысқаруын, жұмыс күшінің құрылымдық өзгерістерін, жалақының төмен бәсекеге қабілеттілігін және экономиканың жоғары өнімді салаларымен салыстырғандағы елеулі өнімділік алшақтығын көрсетті. Эконометриялық бағалау еңбек өнімділігі, жалпы ауыл шаруашылығы өнімі көлемі және жалақы деңгейі арасындағы статистикалық маңызды байланыстарды растады және өнімділік өсімінің негізінен экстенсивті әрі өндіріс ауқымына тәуелді сипатқа ие екенін анықтады. Зерттеудің ғылыми жаңалығы цифрлық трансформация жағдайында Қазақстанның аграрлық секторындағы еңбек өнімділігіне ауыл шаруашылығы өндірісінің көлемі мен еңбекақы деңгейінің ықпалын сандық тұрғыдан бағалауға мүмкіндік беретін эконометриялық модельді әзірлеу және эмпирикалық апробациялау болып табылады. Бұрынғы зерттеулерден айырмашылығы, ұсынылған тәсіл еңбек өнімділігінің негізгі экономикалық факторларға қатысты икемділік деңгейін бағалауға және экстенсивті өсу факторларының басымдығын анықтауға мүмкіндік береді. Авторлардың үлесі 2018–2024 жылдар кезеңіндегі еңбек өнімділігі факторларын эконометриялық модельдеумен еңбек нарығының құрылымдық талдауын біріктіруде, сондай-ақ еңбек ресурстарын пайдалану тиімділігін арттыруға және Қазақстанның ауыл шаруашылығы секторының ұзақ мерзімді бәсекеге қабілеттілігін нығайтуға бағытталған ғылыми негізделген ұсынымдар әзірлеуде көрініс табады.

Түйін сөздер: ауыл шаруашылығы; еңбек ресурстары; еңбек өнімділігі; цифрлық трансформация; жұмыспен қамту; технологиялық жаңғырту; адами капитал

ЭФФЕКТИВНОЕ ИСПОЛЬЗОВАНИЕ ТРУДОВЫХ РЕСУРСОВ В СЕЛЬСКОМ ХОЗЯЙСТВЕ КАЗАХСТАНА В УСЛОВИЯХ ЦИФРОВОЙ ТРАНСФОРМАЦИИ

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Аннотация

В исследовании рассматривается проблема низкой производительности труда в сельскохозяйственном секторе Казахстана в условиях цифровой трансформации и структурных изменений экономики. Сельское хозяйство остается важной составляющей национального экономического развития и обеспечения продовольственной безопасности, однако сектор продолжает сталкиваться с устойчивыми проблемами, связанными с технологическими ограничениями, старением рабочей силы, оттоком трудовых ресурсов из сельской местности и недостаточной инвестиционной активностью. Целью исследования является оценка динамики и эффективности использования трудовых ресурсов в сельском хозяйстве Казахстана в период 2018–2024 гг., а также выявление основных факторов, ограничивающих рост производительности труда. Методологическая основа исследования включает статистический, сравнительный, структурный и эконометрический анализ с использованием официальных национальных статистических данных и аналитических материалов. Результаты исследования выявили сокращение занятости в сельском хозяйстве, структурные изменения в составе рабочей силы, низкую конкурентоспособность заработной платы и значительный разрыв в производительности по сравнению с высокоэффективными секторами экономики. Эконометрическая оценка подтверждает статистически значимые взаимосвязи между производительностью труда, объемом валовой сельскохозяйственной продукции и уровнем заработной платы, показывая, что рост производительности носит преимущественно экстенсивный и масштабозависимый характер. Научная новизна исследования заключается в разработке и эмпирической апробации эконометрической модели, позволяющей количественно оценить влияние объема сельскохозяйственного производства и уровня оплаты труда на производительность труда в аграрном секторе Казахстана в условиях цифровой трансформации. В отличие от предыдущих исследований, предложенный подход обеспечивает оценку эластичности производительности труда по отношению к ключевым экономическим факторам и позволяет выявить преобладание экстенсивных факторов роста. Вклад авторов состоит в интеграции структурного анализа рынка труда с эконометрическим моделированием факторов производительности труда за период 2018–2024 гг., а также в разработке научно обоснованных рекомендаций, направленных на повышение эффективности использования трудовых ресурсов и укрепление долгосрочной конкурентоспособности сельскохозяйственного сектора Казахстана.

Ключевые слова: сельское хозяйство; трудовые ресурсы; производительность труда; цифровая трансформация; занятость; технологическая модернизация; человеческий капитал