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AGRICULTURAL LAND USE IN THE NORTHERN REGIONS OF THE REPUBLIC OF KAZAKHSTAN: SPECIFICS AND FACTORS FOR INCREASING PROFITABILITY

ҚАЗАҚСТАН РЕСПУБЛИКАСЫНЫҢ СОЛТҮСТІК ОБЛЫСТАРЫНДАҒЫ АГРАРЛЫҚ ЕГІНШІЛІК: РЕНТАБЕЛЬДІЛІКТІ АРТТЫРУДЫҢ ЕРЕКШЕЛІКТЕРІ МЕН ФАКТОРЛАРЫ

АГРАРНОЕ ЗЕМЛЕДЕЛИЕ В СЕВЕРНЫХ ОБЛАСТЯХ РЕСПУБЛИКИ КАЗАХСТАН: ОСОБЕННОСТИ И ФАКТОРЫ ПОВЫШЕНИЯ РЕНТАБЕЛЬНОСТИ

D. KALDIYAROV [1]
Dr.E.Sc., Professor
O. LEMECHSHENKO[1]*
Master of Economic Sciences
S. ERALIEV [2]
Ph.D
[1] *I. Zhansugurov Zhetysu University, Taldykorgan, Kazakhstan*
[2]*Lund University, Lund, Sweden*
**corresponding author e-mail: lemolvit1992@gmail.com*
Д.А. КАЛДИЯРОВ[1]
э.ғ.д, профессор
О.В. ЛЕМЕЩЕНКО[1]*
экономика ғылымдарының магистрі
S. ERALIEV [2]
Ph.D
[1]*І. Жансүгіров атындағы Жетісу университеті, Талдықорған, Қазақстан*
[2]*Лунд университеті, Лунд, Швеция*
**автордың электрондық поштасы: lemolvit1992@gmail.com*
Д.А. КАЛДИЯРОВ[1]
д.э.н., профессор
О.В. ЛЕМЕЩЕНКО[1]*
магистр экономических наук
S. ERALIEV [2]
Ph.D
[1]*Жетысуский университет им. И. Жансугурова, Талдыкорган, Казахстан*
[2]*Лундский университет, Лунд, Швеция*
** электронная почта автора: lemolvit1992@gmail.com*

Abstract. The rational use of agricultural land is of particular importance in the context of global challenges, including climate change, limited natural resources, instability of agricultural markets, and the need to ensure food security. This issue is especially relevant for the northern regions of Kazakhstan, which have high agricultural development potential but face institutional, financial, and infrastructural constraints. *The goal* is a comprehensive assessment of the effectiveness of land use in the northern territories of the republic with a focus on economic, digital, and organizational-legal factors. *Methods* – statistical analysis was used to determine indicators of the economic profitability of the agricultural sector, such as gross regional product, profitability, and investments; comparative-structural analysis was applied to evaluate the distribution of land among different categories of economic entities; the structural-dynamic approach made it possible to trace transformations in coordination and functional processes and in the level of digitalization using the example of the state platform Qoldau.kz. *Results* – high land concentration in large enterprises was identified, along with limiting barriers, a mismatch between the volume of investment and actual outcomes, significant impact of climatic conditions, and the positive effect of digital services on procedure transparency, access to state support, and agroanalytics. *Conclusions* – the authors recommend strengthening government support measures, improving legal regulation of land relations, enabling equal access of agricultural entities to digital platforms,

expanding the use of sustainable agricultural technologies, and reinforcing organizational management mechanisms to increase the efficiency of land turnover in the northern regions of the country. Many issues related to the research topic remain underexplored and require further development and refinement at the methodological, methodical, and practical levels.

Аңдатпа. Ауыл шаруашылығы жерлерін ұтымды пайдалану климаттың өзгеруін, табиғи ресурстардың шектелуін, аграрлық нарықтардың тұрақсыздығын және азық-түлік қауіпсіздігін қамтамасыз ету қажеттілігін қоса алғанда, жаһандық сын-қатерлер жағдайында ерекше маңызға ие болады. Бұл проблема Аграрлық дамудың жоғары әлеуеті бар, бірақ институционалдық, қаржылық және инфрақұрылымдық шектеулерге тап болған Қазақстанның солтүстік өңірлері үшін ерекше өзекті болып табылады. *Мақсаты* – экономикалық, цифрлық және ұйымдық-құқықтық факторларға баса назар аудара отырып, республиканың солтүстік аумақтарында жер пайдалану тиімділігін кешенді бағалау. *Әдістері* – статистикалық талдау жалпы аймақтық өнім, кірістілік және инвестиция сияқты аграрлық сектордың экономикалық кірістілігін анықтау үшін қолданылды; салыстырмалы құрылымдық – шаруашылық жүргізуші субъектілердің әртүрлі санаттары арасында жердің бөлінуін талдау кезінде; құрылымдық-динамикалық тәсіл Qoldau.kz мемлекеттік платформасының мысалында үйлестіру және функционалдық процестер мен цифрландыру деңгейіндегі өзгерістерді бақылауға мүмкіндік берді. *Нәтижелер* – ірі шаруашылықтарда кедергілерді шектейтін жер алқаптарының жоғары шоғырлануы, инвестициялық салымдар көлемі мен нақты нәтижелер арасындағы сәйкессіздік, Климаттық жағдайлардың елеулі әсері, сондай-ақ цифрлық сервистердің рәсімдердің ашықтығына, мемлекеттік қолдау мен агроаналитикаға қолжетімділігіне оң әсері анықталды. *Қорытындылар* – авторлар мемлекеттік көмек шараларын күшейтуді, жер қатынастарын құқықтық реттеуді жетілдіруді, ауыл шаруашылығы құрылымдарының цифрлық платформаларға тең қолжетімділігін қамтамасыз етуді, орнықты агротехнологияларды қолдануды кеңейтуді және елдің солтүстік облыстарындағы жер алаңдарының айналымының тиімділігін арттыру үшін басқарудың ұйымдастырушылық тетіктерін нығайтуды ұсынады. Зерттеу тақырыбына қатысты көптеген сұрақтар жеткіліксіз әзірленген және әдістемелік, әдістемелік және практикалық тұрғыдан әрі қарай зерттеу мен жетілдіруді қажет етеді.

Аннотация. Рациональное использование сельскохозяйственных земель приобретает особую значимость в условиях глобальных вызовов, включая изменение климата, ограниченность природных ресурсов, нестабильность аграрных рынков и необходимость обеспечения продовольственной безопасности. Особенно актуальна данная проблема для северных регионов Казахстана, обладающих высоким потенциалом аграрного развития, но сталкивающихся с институциональными, финансовыми и инфраструктурными ограничениями. *Цель* – комплексная оценка эффективности землепользования в северных территориях республики с акцентом на экономические, цифровые и организационно-правовые факторы. *Методы* – статистический анализ применялся для определения показателей экономической доходности аграрного сектора, таких как валовой региональный продукт, рентабельность и инвестиции; сравнительно-структурный – при анализе распределения земель между различными категориями хозяйствующих субъектов; структурно-динамический подход позволил проследить преобразования в координационных и функциональных процессах и уровне цифровизации на примере государственной платформы Qoldau.kz. *Результаты* – выявлены высокая концентрация земельных угодий в крупных хозяйствах, ограничивающие барьеры, несоответствие между объемами инвестиционных вложений и фактическими результатами, значительное влияние климатических условий, а также позитивное воздействие цифровых сервисов на прозрачность процедур, доступ к господдержке и агроаналитику. *Выводы* – авторы рекомендуют усилить меры государственной помощи, совершенствовать правовое регулирование земельных отношений, сделать возможным равный доступ сельхозформирований к цифровым платформам, расширить применение устойчивых агротехнологий и укрепить организационные механизмы управления для повышения результативности оборота земельных площадей в северных областях страны. Многие вопросы, относящиеся к теме исследования являются недостаточно разработанными и требуют дальнейшего изучения и совершенствования в методологическом, методическом и практическом плане.

Keywords: agricultural land use, land consolidation, precision farming, environmental monitoring, digitalization, investment activity, profitability, gross regional product.

Түйінді сөздер: аграрлық жерді пайдалану, жерді шоғырландыру, нақты егіншілік, экологиялық мониторинг, цифрландыру, инвестициялық белсенділік, рентабельділік, жалпы өңірлік өнім.

Ключевые слова: аграрное землепользование, консолидация земель, точное земледелие, экологический мониторинг, цифровизация, инвестиционная активность, рентабельность, валовой региональный продукт.

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Introduction

The rational use of land resources is one of the fundamental conditions for the sustainable development of the agricultural sector, particularly against the backdrop of increasing climate risks, the limited availability of arable land, and the growing need to ensure food security. In the context of the Republic of Kazakhstan, which possesses vast areas of agricultural land, the issue of effective land use is of particular relevance due to the strategic importance of agriculture for the national economy. The northern regions of Kazakhstan play a leading role in shaping the overall volume of agricultural production, which is attributable to their significant natural resource potential, developed infrastructure, and large-scale engagement in agricultural activities.

Ongoing transformations in agricultural land use are driven by digital innovations, institutional reforms, and changes in the organizational structure of agricultural production. Under these circumstances, there is an increasing need for a comprehensive evaluation of land use efficiency that takes into account not only economic indicators, but also factors such as digitalization, investment dynamics, and the condition of infrastructure. Particular attention should be given to analyzing the impact of digital platforms, specifically Qoldau.kz on land management practices and the performance outcomes of agricultural enterprises.

Despite the accumulated body of academic and practical research, gaps remain in regional studies on the efficiency of agricultural land use, especially with regard to the northern regions of Kazakhstan. Unresolved issues include the correlation between investment activity and agricultural performance outcomes, the relationship between digital technologies and profitability, and the impact of institutional constraints on agricultural operations. Insufficient focus on these aspects hinders the development of well-informed policies and effective management decisions.

The aim of this study is to conduct a comprehensive assessment of the efficiency of agricultural land use in the northern regions of Kazakhstan, with an emphasis on economic, digital, and institutional-legal factors. To achieve this goal, the following tasks are addressed: the structure of the agricultural sector is analyzed, including the dynamics of gross regional product, profitability, and investment levels; the degree of digitalization and the functional capabilities of the Qoldau.kz platform are assessed; and the main constraints affecting land use efficiency are discussed.

The findings of the study make it possible to identify key trends and structural imbalances that characterize agricultural land use in the northern part of the country and to propose directions for further modernization through the use of digital tools and improvements in the institutional environment.

Literature Review

The relevance of effective land use, particularly in the context of global challenges, is reflected in a number of domestic and international studies that focus on digitalization, institutional reforms, and organizational changes in the agricultural sector.

One of the key directions in recent research is the implementation of digital platforms and innovative solutions in the sphere of agricultural land use. For instance, the study by Ualieva M.A., Maydirova A.B. [1] emphasizes the importance of the Qoldau.kz platform as a tool for increasing transparency, accessibility of state support, and agri-analytics. However, a quantitative assessment of its effectiveness remains lacking. In their publication, Imanbayeva Z., Mussirov G., Nurgaliyeva A. et al. [2] examine information systems for land resource management, but without assessing their impact on the northern regions of Kazakhstan. The technological dimension of digitalization is also highlighted in the study by Shulenbayeva F., Daribayeva A., Chakeyeva K. et al. [3], which explores the potential of geoinformation systems, though institutional and financial barriers for small agricultural enterprises are not addressed.

The issue of improving the cadastral system and its influence on the investment attractiveness of the region is raised in the work by (Kurmanaliyeva M.B., Abdeshev K.B., Dzhumabekova I.D. et al.) [4]. The authors underscore the need to modernize land assessment and accounting for agricultural purposes, yet

the direct relationship with investment activity and management efficiency is not clearly established. These studies contribute to the understanding of the technical and regulatory foundations of sustainable land use.

A substantial body of research is devoted to the institutional transformation of the agricultural sector. Kurmanova G.K., Bayandin M.A. [5], for example, analyze the process of land reforms and institutional restructuring, though issues of land monitoring and the effectiveness of rental mechanisms remain unexplored. Another study by Shaimerdenova A.A., Glushan L.A. [6] describes the existing system of agricultural land monitoring, but lacks focus on its integration with regional governance and economic performance.

The study by Pashkov S.V. [7] examines the econological prerequisites for agro-landscape zoning in Northern Kazakhstan. It notes changes in agroclimatic indicators such as increased active temperatures, precipitation, and humidity. These shifts suggest improved competitiveness of agricultural land through higher productivity, better yields, and optimized crop structure for grains, oilseeds, forage, and perennials.

A systemic approach to land resource management from the standpoint of food security is presented in the study by Tleshpayeva D., Bondarenko N., Leontev M. et al. [8]. The authors highlight the need to integrate economic and digital mechanisms, yet regional distinctions, including those specific to northern Kazakhstan, are not sufficiently addressed. The work by Ussipbayev G., Omarbekova A., Aidarova A. et al. [9] focuses on the ecological and economic dimensions of sustainable land use, emphasizing the principles of balanced development, though the effectiveness of state policy at the regional level is not thoroughly examined.

Thus, despite the existence of a substantial body of research on agricultural land use, several gaps remain. These include the lack of regionally focused analysis, insufficient quantitative evaluation of digital platforms, limited exploration of institutional constraints, and a scarcity of studies on inefficient management practices. The present study seeks to address these gaps using the example of the northern regions of Kazakhstan, combining statistical and institutional analysis with a focus on digital technologies and economic performance.

Materials and methods

The methodological framework of this study is based on an integrated approach, involving the use of statistical, comparative, and structural-analytical methods to assess the efficiency of agricultural land use in the northern regions of the Republic of Kazakhstan. The analysis draws on official data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, as well as sectoral reports from the Ministry of Agriculture.

The empirical base includes indicators such as gross regional product (GRP) in the agricultural sector, investment volumes in fixed capital, profitability levels, the structure of agricultural land use, the degree of digitalization, and the distribution of economic entities. Additional data were obtained from the national digital platform Qoldau.kz, which provided insights into its functional features and the effectiveness of its digital services.

The analysis was conducted at the regional level, focusing on the Akmola, Kostanay, Pavlodar, and North Kazakhstan regions. Structural-dynamic and comparative methods were applied to identify prevailing trends, interregional disparities, and correlations between investment activity, digitalization, and the economic performance of agricultural production.

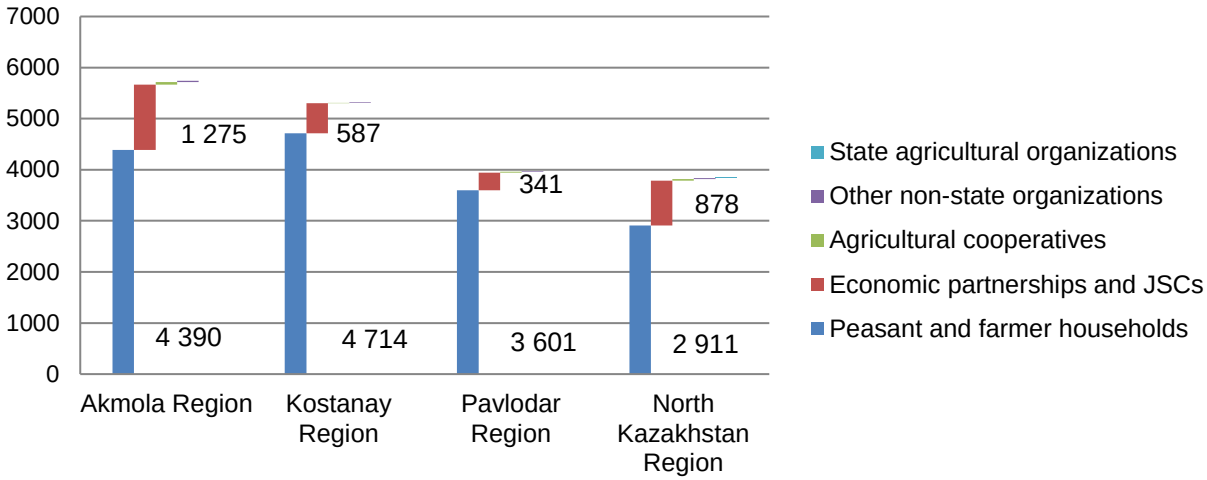
To provide a comprehensive assessment, the study also considered external and internal factors limiting land use efficiency, institutional constraints, and the technological capacity of agricultural producers.

Results

The analysis of the efficiency of agricul-tural land use in Northern Kazakhstan encompasses several key aspects: the economic performance of the agricultural sector, the structure and distribution of agricultural land, institutional transformations, and the digitalization of land resource management. The main findings of the study are structured according to the stated objectives and include both quantitative and qualitative indicators of efficiency.

First, the analysis of the composition of agricultural entities indicates a high degree of organizational diversification in the region. The majority are represented by peasant and private farms, which play a critical role in ensuring food security and providing employment for the rural population (figure 1).

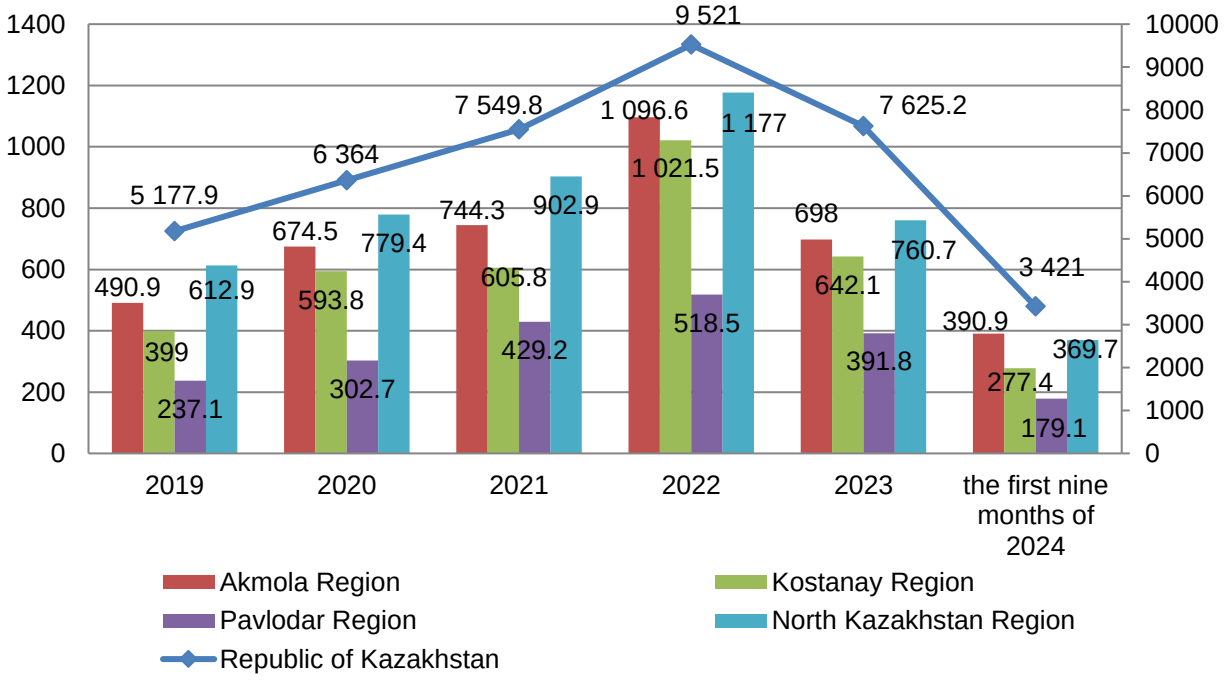
However, despite their numerical predominance, the largest share of agricultural land is concentrated in the hands of partnerships and joint-stock companies, indicating an ongoing process of land consolidation and the growing influence of corporate forms of farming. State-owned agricultural enterprises currently exist only in the North Kazakhstan region, where eight such entities are still operational. Against the backdrop of a nationwide decline in the number of state-owned organizations, this trend reflects a deliberate state policy aimed at improving the efficiency of the agricultural sector by supporting private forms of ownership.



Note: source (Consolidated analytical report…) [10]

Figure 1 – Structure of Agricultural Sector Economic Entities in Northern Kazakhstan

Second, the analysis of the dynamics of gross regional product (GRP) in the "Agriculture" sector highlights the key role of the northern regions in Kazakhstan's agro-industrial complex (figure 2). In 2023, the GRP for the sector reached KZT 2 492.6 billion, accounting for 32.7% of the national total. The North Kazakhstan region led the way with KZT 760.7 billion (9.98% of the total), followed by Akmola (KZT 698.0 billion, 9.15%), Kostanay (KZT 642.1 billion, 8.42%), and Pavlodar (KZT 391.8 billion, 5.14%) regions. These figures underscore the northern region's substantial contribution to national agricultural production and its strategic importance in ensuring the country's food security.



Note: source (Bureau of National Statistics of the Agency...) [11]

Figure 2 – Dynamics of Gross Regional Product in the Agricultural Sector of Northern Kazakhstan, billion tenge

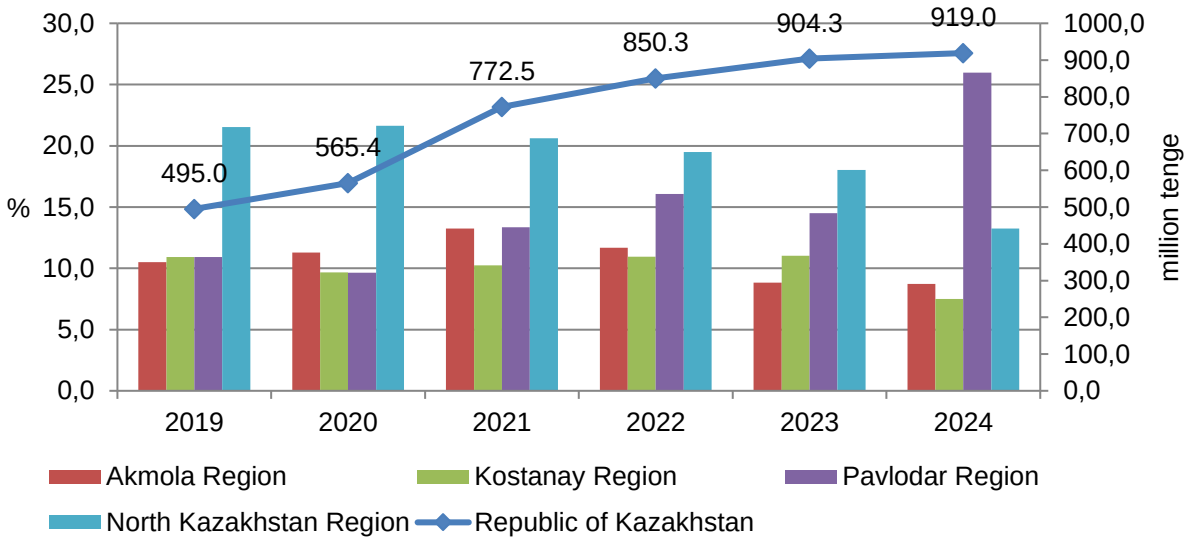
At the same time, in the first nine months of 2024, the total GRP in the republic amounted to KZT 3 421.0 billion, of which KZT 1 217.1 billion was generated by the northern regions. This represents 35.6% of the national agricultural GRP for the period. Specifically, the shares of Akmola, North Kazakhstan, Kostanay, and Pavlodar regions were 11.4%, 10.8%, 8.1%, and 5.2%, respectively. Despite a slight decrease in absolute values, the share of the

northern regions in the sectoral GRP increased compared to 2023, confirming their stable position and significance in the country's agro-industrial system.

The decline in GRP volumes over the first nine months of 2024 can be attributed to several factors. First, adverse weather conditions, including large-scale flooding in the spring of 2024, affected the Akmola, Kostanay, and North Kazakhstan regions, causing significant damage to arable land and agricultural infrastructure. Second, rising production costs, including prices for fuel, fertilizers, and machinery, led to a decline in profitability for several enterprises. Additionally, insufficient state support in the early months of the year, combined with delays in the delivery of equipment and spare parts, slowed the pace of modernization. Collectively, these factors negatively impacted the volume of agricultural output and, consequently, the GRP indicators.

The third focus of the analysis is investment activity (figure 3). In 2023, the northern region accounted for more than half (52.4%) of all national investments in fixed capital in agriculture. In 2024, this figure rose to 55.4%, confirming the sustained interest of investors in the agricultural infrastructure of northern regions. This growth reflects both the region's high investment attractiveness and the active support provided by the government and private sector.

The growth of investment is attributed to several key factors. First, the region is implementing large-scale projects for the construction and modernization of grain storage facilities, elevators, and livestock complexes, particularly in the Kostanay and North Kazakhstan regions. Second, a government program is in place to subsidize agricultural machinery and promote the adoption of precision farming technologies, which is especially relevant for the Akmola and Pavlodar regions. Third, investments are being driven by the formation of agro-industrial clusters and the development of agricultural export logistics, including the construction of logistics hubs and digital platforms for agribusiness.



Note: source (Bureau of National Statistics of the Agency...) [11]

Figure 3 – Dynamics of Investments in Fixed Capital for the Development of Agriculture in the Regions of Northern Kazakhstan, million tenge

These investments are aimed at modernizing production infrastructure and introducing digital platforms for resource management and agri-analytics, which contribute to increased labor productivity and enhance the competitiveness of domestic agricultural products.

Despite the ongoing growth in investment activity, a comparative analysis of GRP and investment volumes in the northern regions of Kazakhstan reveals a certain imbalance: while investments in fixed capital are increasing, the gross regional product has shown a noticeable decline in recent periods.

First, this is related to the time lag between the moment of investment and the actual results. Agricultural investment projects, such as the construction and modernization of livestock complexes, elevators, grain storage facilities, and the implementation of precision farming systems, require a prolonged period before reaching full operational capacity. Accordingly, the positive effect of increased capital injections may only become evident after one or more agricultural seasons, when the upgraded infrastructure, equipment, and technologies begin to generate substantial returns.

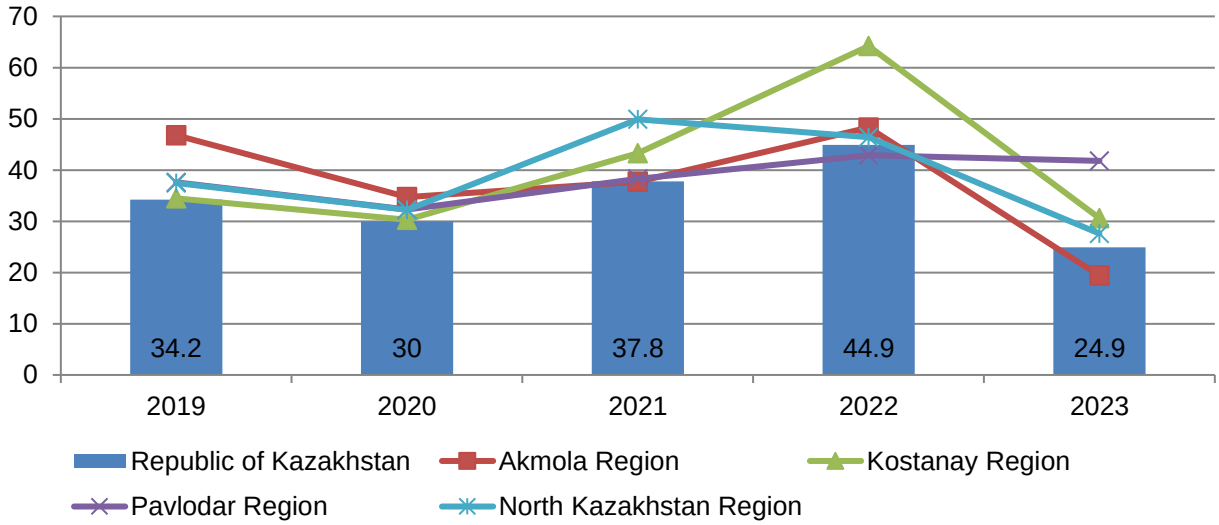
Second, the GRP dynamics in 2024 were affected by unfavorable weather conditions and rising production costs (including prices for fuel, fertilizers, and machinery). These factors led to reduced yields and profitability across several farms, which was immediately reflected in the sector's performance indicators, despite the growth in investment.

Third, the overall financial burden, including loans and servicing costs of new projects, may temporarily constrain economic growth in the sector. A portion of the attracted funds is allocated to covering current expenses, restructuring production systems, and upgrading outdated equipment, which does not necessarily translate into short-term GRP growth but lays the foundation for future development.

Finally, constraints in state support, particularly at the beginning of 2024 and disruptions in the supply of agricultural machinery and components also hindered rapid production growth. Nevertheless, long-term investment programs remain relevant, as they ensure the modernization of the agro-industrial complex and can strengthen the region's position in the medium and long term.

Thus, the current decline in GRP alongside increasing investment volumes can be explained by structural and external factors. The anticipated effects of investments in the agro-industrial sector are expected to become more visible as modernization projects are completed and weather and market conditions stabilize. Ultimately, if the implemented initiatives continue to receive support from both the government and the private sector, their cumulative impact could lead to the recovery and further growth of the gross regional product.

The fourth important indicator is the level of profitability and unprofitability in agricultural production (figure 4). According to recent years' assessments, the sector has shown a steady increase in profitability. The highest growth rates in profitability are observed among limited partnerships and joint-stock companies, while individual farms remain more vulnerable to market and climatic risks. A positive sign is the declining share of unprofitable farms, indicating an overall stabilization of the agricultural sector and the effectiveness of government support measures.



Note: source (Bureau of National Statistics of the Agency…) [11]

Figure 4 – Profitability of Agricultural Production in the Northern Regions of Kazakhstan, %

According to international studies, the economic approach to land use continues to dominate, while environmental and social aspects often remain secondary considerations (Anarbaev E., Aitkhozhaeva G., Pentaev T. et al.) [12]. At the same time, international scholars Zhou L., Tong G. [13] in their assessment of the competitiveness of agricultural trade among the countries participating in the "Belt and Road Initiative", classify Kazakhstan among the countries with relatively low competitiveness in this domain alongside Russia, China, Saudi Arabia, the Czech Republic, and Slovakia. However, when focusing specifically on Central Asian countries, it becomes evident that Kazakhstan holds the largest share of the agricultural export market (over 0.1%), accounting for 57.14% of the total exports of the three regional countries (Kazakhstan, Uzbekistan, and Kyrgyzstan). This highlights Kazakhstan's relative competitiveness within the Central Asian subgroup.

The fifth area of analysis concerns the structure and utilization of land resources. The

total land area of Northern Kazakhstan amounts to 56 477 thousand hectares, of which 63.9% (36 078 thousand hectares) is used for agricultural purposes. This represents 31.1% of all agricultural land in the country, underscoring the region's strategic significance in Kazakhstan's national agricultural balance (Consolidated analytical report….) [10]. A major achievement is the high level of digitalization: as of 2024, 76.35% of the region's land has already been digitized (Ualieva M.A., Maydirova A.B.) [1]. This contributes to increased transparency in land transactions, improved monitoring of land conditions, and greater efficiency in land management.

A key driver of digitalization in the agri-cultural sector is the national online platform Qoldau.kz, which was developed to automate and digitally support agricultural operations. According to the study by Ualieva M.A., Maydirova A.B. [1], the platform offers a wide range of services, including an electronic registry of subsidy applications, a map of agribusiness entities, a grain receipt registry, agriinsurance tools, satellite monitoring, a geoinformation portal, and integration with government and financial institutions. The platform has become an essential tool for facilitating access to state support, increasing transparency, and accelerating managerial decision-making

Research indicates that the use of Qoldau.kz contributes to attracting investment, improving yields, and modernizing agricultural production. The authors identified a positive correlation between credit activity facilitated through the platform and the growth of gross agricultural output. However, to further enhance the platform's effectiveness, it is recommended to address technical shortcomings, improve the accuracy of digital maps, simplify application procedures, strengthen data security, and train agricultural producers in the use of the platform.

Alongside digitalization, the system of remote environmental monitoring is also being developed. According to data from the Kazakh National Agrarian Research University and the Academy of Agricultural Sciences (Shaimerdenova A.A., Glushan L.A.) [6], Northern Kazakhstan hosts 369 environmental monitoring stations (EMS) and semi-stationary environmental monitoring stations (SEMS), servicing 32.4 million hectares of agricultural land an average of 87.9 thousand hectares per site.

In the future, the goal is to reduce the workload to 10 thousand hectares per EMS in arable zones and 20-50 thousand hectares in haymaking and pasture areas. Monitoring based on satellite imagery and remote sensing data enables the generation of accurate yield forecasts and the tracking of land degradation processes, including the loss of humus and deficiencies in mobile nitrogen and phosphorus. An important institutional factor is the moratorium on the sale of agricultural land, introduced in 2016 and extended until the end of 2026. This measure contributes to the development of lease relations and limits the potential for speculative transactions.

However, as noted by experts, the problem of underutilized or idle land plots persists, which calls for improvements to the regulatory framework and enhanced land monitoring. At the same time, state control over land use has intensified, which stimulates increases in gross agricultural output and attracts additional investment.

Kazakhstani agricultural economists also emphasize the need to revise the procedures for land and cadastral operations, including intra-farm land use planning projects. Amendments have been proposed to the "Land Code of the Republic of Kazakhstan" and the "Rules for the Rational Use of Agricultural Land." According to experts, the timely development of intra-farm land use planning projects would help prevent systemic issues such as deterioration of the ameliorative condition of agricultural land, declining soil fertility, increased weed infestation, the spread of pests and diseases, and degradation of pasture and haymaking areas (Kurmanova G.K.) [14]. It is proposed that the funding for such projects be the responsibility of the agricultural entities themselves.

The need for an integrated and rational approach to land use is also emphasized in the FAO methodology Land Resource Planning for Sustainable Land Management. The transition to sustainable agriculture implies adherence to five interrelated principles that enable the harmonization of economic, environmental, and social interests and provide a solid foundation for the long-term development of the agricultural sector (Ziadat F., Bunning S., De Pauw E.) [15].

In this context, recent quantitative studies on agricultural sustainability in Central Asia emphasize that although economic efficiency has improved significantly, social and ecological aspects remain underdeveloped. In particular, persistent water and soil problems, insufficient capital investment in ecological restoration, and widening social disparities between rural and urban populations hinder long-term sustainability. Advanced technologies and targeted management policies are recommended as effective tools for reversing land degradation and improving rural livelihoods (Qin Y., He J., Wei M. et al.) [16].

Thus, Northern Kazakhstan demonstrates not only leadership in production indicators but also a steady transformation toward digitally enabled and environmentally managed land use. These processes form a solid foundation for improving the efficiency of the agricultural sector, ensuring the rational use of resources, and promoting the sustainable rural development of the region.

Discussion

The analysis reveals a growing scholarly interest in digitalization, sustainable land use, and institutional transformations in the agricultural sector of Northern Kazakhstan. Contemporary studies emphasize that integrating economic, environmental, and social factors with digital solutions fosters more efficient and resilient agricultural production models.

Digital platforms such as Qoldau.kz positively influence investment attraction, subsidy allocation, and land resource management. However, technical and procedural limitations remain, such as the accuracy of cartographic data and the complexity of the user interface, which hinder their full effectiveness.

Historical factors also play a significant role, as current land use patterns reflect stages of territorial development, organizational types, and previous land policies. Retrospective analysis is thus essential for understanding current trends in land use.

Certain aspects remain insufficiently studied, especially the application of technologies such as artificial intelligence, machine learning, remote sensing, and IoT in land management and agricultural productivity. These gaps highlight the need for further research into intelligent decision-support systems tailored to the regional context.

Overall, sustainable agricultural development in Northern Kazakhstan requires expanded digital transformation efforts, integration of advanced technologies, and careful consideration of historical and institutional factors. Combined, these measures can enhance land use efficiency and support the creation of a competitive, environmentally focused, and adaptive regional agricultural model. Strengthening applied research and ensuring policy coherence between local and national strategies will be essential to translate these technological and institutional advances into measurable outcomes.

Conclusion

1. The northern regions of Kazakhstan play a strategic role in agricultural production and national food security.

2. Despite increased investment and digitalization, institutional constraints, climatic risks, and profitability challenges persist.

3. Digital platforms such as Qoldau.kz enhance management efficiency but require further development and adaptation to the needs of diverse user groups.

4. Improving land use efficiency is achievable through the integration of technological solutions, targeted state support, and the advancement of the institutional framework.

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Information about authors:

Калдияров Данияр; Doctor of Economic Sciences, Professor; Professor of the Department of Public Administration and Management; I. Zhansugurov Zhetysu University; 040009 Zhansugurov str., 187a, Taldykorgan, Kazakhstan; e-mail: 77da@bk.ru; https://orcid.org/0000-0002-0181-2962

Lemechshenko Olessya - **The main author**; Master of Economic Sciences; Lecture of the Department of Public Administration and Management; I. Zhansugurov Zhetysu University; 040009 Zhansugurov str., 187a, Taldykorgan, Kazakhstan; e-mail: lemolvit1992@gmail.com; https://orcid.org/0000-0002-8907-9768

Eraliev Sherzod; Ph.D; Researcher of the Department of Sociology of Law; Lund University; Box 117, 221 00, Lund, Sweden; e-mail: sherzod.eraliev@soclaw.lu.se; https://orcid.org/0000-0001-7766-0961

Авторлар туралы ақпарат:

Калдияров Данияр Алтаевич; экономика ғылымдарының докторы, профессор; «Мемлекеттік басқару және менеджмент» кафедрасының профессоры; І. Жансүгіров атындағы Жетісу университеті; 040009 І. Жансүгіров көш., 187а, Талдыкорган қ., Қазақстан; e-mail: 77da@bk.ru; https://orcid.org/0000-0002-0181-2962

Лемещенко Олеся Витальевна – **негізгі автор**; экономика ғылымдарының магистрі; «Мемлекеттік басқару және менеджмент» кафедрасының оқытушы-дәріскері; І. Жансүгіров атындағы Жетісу университеті; 040009 І. Жансүгіров көш., 187а, Талдыкорган қ., Қазақстан; e-mail: lemolvit1992@gmail.com; https://orcid.org/0000-0002-8907-9768

Eraliev Sherzod; Ph.D; «Құқық социологиясы» кафедрасының ғылыми қызметкері; Лунд университеті; Box 117, 221 00, 221 00, Лунд қ., Швеция; e-mail: sherzod.eraliev@soclaw.lu.se; https://orcid.org/0000-0001-7766-0961

Информация об авторах:

Калдияров Данияр Алтаевич; доктор экономических наук, профессор; профессор кафедры «Государственное управление и менеджмент»; Жетысуский университет им. И. Жансугурова; 040009 ул. И.Жансугурова, 187а, г.Талдыкорган, Казахстан; e-mail: 77da@bk.ru; https://orcid.org/0000-0002-0181-2962

Лемещенко Олеся Витальевна – **основной автор**; магистр экономических наук; преподаватель-лектор кафедры «Государственное управлене и менеджмент»; Жетысуский университет им. И. Жансугурова; 040009 ул. И.Жансугурова, 187а, г.Талдыкорган, Казахстан; e-mail: lemolvit1992@gmail.com; https://orcid.org/0000-0002-8907-9768

Eraliev Sherzod; Ph.D; научный сотрудник кафедры «Социология права»; Лундский университет; Box 117, 221 00 г.Лунд, Швеция; e-mail: sherzod.eraliev@soclaw.lu.se; https://orcid.org/0000-0001-7766-0961