SCIENTIFIC HORIZONS

Journal homepage: https://sciencehorizon.com.ua
Scientific Horizons, 26(12), 158-168

UDC 631.1:332.2
DOI: 10.48077/scihor12.2023.158

Innovative methods of organising the work of the AIC in market conditions (world experience and Kazakhstan)

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Article's History:
Received: 22.07.2023
Revised: 6.11.2023
Accepted: 27.11.2023

Abstract. The relevance of this issue lied in the need to explore new methods of organizing the agro-industrial complex, both in the global market and in the specific context of Kazakhstan. This exploration contained analysis of the benefits and challenges of the agricultural industry in Kazakhstan by drawing lessons from leading countries. The aim of this research was to identify the most effective approaches to enhance agricultural operations, unveil upcoming trends in the agro-industrial complex, establish the organizational and economic foundations for innovative development, and determine the socio-economic

Suggested Citation:
Kuralbayeva, R., Aitmukhanbetova, D., Itekeyeva, G., Kuatpekova, A., & Abdikulova, P. (2023). Innovative methods of organising the work of the AIC in market conditions (world experience and Kazakhstan). *Scientific Horizons*, 26(12), 158-168. doi: 10.48077/scihor12.2023.158.

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factors driving agricultural production. To achieve the goal, a systematic analysis of innovative processes in the agro-industrial complex was employed as the primary research method. Additionally, various analytical techniques such as synthesis, systematization, generalization, and comparison were utilized, including structural-functional and historical-legal approaches. The research presents innovative development pathways observed in advanced countries, including Kazakhstan, focusing on areas such as horticulture, animal husbandry, agricultural product processing, market development, agricultural cooperation, infrastructure development, scientific and personnel support, land resource management, digitalization of the agro-industrial complex, and government support. The study also addresses the shortcomings in the implementation of innovations within Kazakhstan's agro-industrial complex. Specifically, it provides detailed insights into methods for enhancing the efficiency of the agro-industrial sector, with particular emphasis on the digitalization of agricultural processes, precision farming systems, and smart farms. The research can be useful for professionals in various fields of the agro-industrial sector, policymakers involved in agricultural affairs, as well as businesspeople and investors interested in agricultural ventures

Keywords: agribusiness; agriculture; advanced countries; precision farming systems; smart farm; digitalisation

INTRODUCTION

The significance of employing innovative approaches in organizing the agro-industrial complex (AIC) cannot be overstated, as they contribute to enhancing labour productivity, production efficiency, and the overall effectiveness of the agricultural sector. These innovations encompass a wide range of advancements, including new technologies, equipment, crop varieties, animal breeds, fertilizers, and plant and animal protection products. They also involve novel methods of animal prevention and treatment, as well as innovative approaches to organizing, financing, and crediting agricultural production, and modern strategies for training, retraining, and developing skilled personnel.

The experience of Uzbekistan, as explored by I. Smanova and U. Sangirova (2018), proves particularly valuable due to the similarity in natural conditions between Uzbekistan and the subject country. Uzbekistan's successful implementation of reforms within a relatively short span of time resulted in significant progress in ensuring food security for its population and even establishing food exports. This highlights the importance of innovative infrastructure development, improved production and labour organization, and the establishment of robust institutional frameworks. The anticipated outcomes include advancements in scientific research, environmental preservation, information and communication capabilities, technological advancements, and the development of both industrial and social infrastructure. These efforts are essential for harnessing and preserving the natural resources of the agricultural sector (Myrzabek *et al.*, 2022).

In their paper S. Smagulova *et al.* (2022) analyses the management efficiency of the energy industry and the agro-industrial complex in Kazakhstan based on the introduction of digitalization to stimulate economic growth. The study highlights the energy-intensive and costly nature of Kazakhstan's economy, the deterioration of electrical equipment and agricultural machinery, and the seasonal shortage of fuel and lubricants. It also emphasizes the need for qualified engineering and agro-technical personnel, the critical importance of the availability of investment in the agro-industrial complex, and the low degree of use of scientific, innovative, and digital approaches in the energy and agro-industrial sectors.

In a separate study conducted by O.V. Kruglyak *et al.* (2020), the focus is specifically on a narrow area of innovation related to genetic engineering, using dairy cattle breeding in Ukraine as an example. This research delves into innovations in breeding practices aimed at increasing dairy productivity. The study suggests that the foundation for the development of the dairy cattle industry in Ukraine should be the adoption of new specialized dairy breeds with genetic potential comparable to the best European counterparts. These breeds should surpass them in terms of reproduction and health, ultimately leading to economic profitability.

The research conducted by G. Madiyev *et al.* (2018) highlights the significance of providing financial support to small farms, which collectively contribute the majority of agricultural products to the market. To foster effective agricultural development and encourage the adoption of innovations, changes in macroeconomic regulations are necessary. This entails increasing government expenditure on agricultural development and revising the tax system in conjunction with its fiscal function.

In a separate study by Z. Sadykova & G. Rakhimzhanov (2020), the focus is on the need to reform the implementation of state functions, with strategic ones remaining under the purview of the state apparatus. This is due to the limited capacity of the state apparatus to independently make responsible decisions in an unstable institutional environment. Key qualitative indicators of this environment include bureaucratic hurdles, inadequate legal support for lending and risk insurance, low levels of business and professional qualifications, and a relatively stringent tax system. Additionally, this issue assumes importance in terms of attracting increased investments to the agricultural industry.

In light of these considerations, it is imperative that the government focuses on several key policy areas to drive innovative reforms (Organisation for Economic Co-operation and Development, 2013). Firstly, there should be a sustained commitment to improving the nation's road and railway infrastructure, ensuring efficient transportation networks. Streamlining procedures for construction permits is also crucial to promote business development and construction projects. Moreover, facilitating access to financing for enterprises in the food industry will bolster economic growth and job creation. Encouraging profit repatriation and providing enhanced incentives for investments in food processing cooperatives and technologies will further stimulate this vital sector. Lastly, the establishment of higher quality standards for food industry enterprises will enhance product safety and consumer confidence, ultimately contributing to economic progress.

Significant emphasis is placed on the digitalization of the agro-industrial complex, precision farming systems, smart farms, smart greenhouses, and other cutting-edge technologies. An illustrative example is the data laboratory that utilizes artificial intelligence to provide novel data sources, enabling timely assessments of food losses and land degradation levels. The Hand in Hand initiative has established a geospatial data platform containing a wealth of statistics from the Food and Agriculture Organization of the United Nations (FAO) (2020) and its partners. This platform offers numerous applications, including the acquisition of valuable information for monitoring agricultural systems at risk due to human impacts on land and water resources, as well as for analysing weather-related trends.

The analysis also considered Decree of the Government of the Republic of Kazakhstan No. 960 (2021). While this Concept offers a comprehensive examination of the innovative organization of the agro-industrial complex both globally and in Kazakhstan, it lacks detailed coverage of the pathways to digitalize agriculture. The study draws conclusions regarding the shortcomings within Kazakhstan's agricultural system. However, the agricultural industry in Kazakhstan harbours substantial unexplored potential and domestic competitive strengths in contrast to other nations. By implementing efficient agricultural policies, it can attain enduring growth and generate noteworthy economic benefits, ultimately enhancing the welfare of its population.

The study aimed to gather insights into the main trends in global agriculture, compare them with corresponding trends in Kazakhstan, and determine the strategies through which Kazakhstan can enhance the performance indicators of its agro-industrial complex.

MATERIALS AND METHODS

The primary approach employed in this study involved conducting a systematic analysis of innovative processes within the agro-industrial complex. Various methods such as analysis, synthesis, systematization, generalization, and comparison were utilized, including structural-functional and historical-legal approaches. In order to underpin the analysis, statistical information sourced from the Ministry of Agriculture of Kazakhstan (n.d.), along with research studies investigating innovation dynamics and the integration of scientific and technological advancements, were assimilated.

System analysis formed the foundation of this study. It involved a series of actions aimed at establishing the structural relationships among variables or elements within the system under investigation. The analytical framework relied upon a combination of general scientific, experimental, natural, statistical, and mathematical methods. A diverse range of agribusiness domains were examined using system analysis, encompassing various innovative approaches, each associated with a distinct aspect of agro-industrial activity. The analysis encompassed both numerous advanced countries worldwide and Kazakhstan specifically.

The method of synthesis involves studying an object as a whole, considering its interconnected parts. In scientific research, synthesis works in conjunction with analysis, as it enables the integration of dissected components of a subject (object or phenomenon), establishing their connections, and understanding the subject in its entirety. Through synthesis, common trends were identified within each area under investigation. Systematization, on the other hand, is the process of consolidating diverse knowledge about objects (phenomena) into a unified scientific system, recognizing their interconnectedness. It reflects the unity of the world and is rooted in exploring the essential connections that bind these objects (phenomena) together. Generalization serves as a method of scientific cognition, allowing for the determination of shared features and properties among a specific category of objects. It involves moving from the particular to the general, from less comprehensive to more comprehensive perspectives.

Through the analysis of statistical data, the study revealed the quantifiable benefits associated with specific innovative methods. Various sources were examined to provide a comprehensive understanding of agricultural innovations from diverse perspectives. These sources encompassed a range of topics, including the compatibility protocol ISOBUS, which facilitates the use of attachments from different manufacturers, and the TRACES system, an online platform by the European Commission for sanitary and phytosanitary certification. The method of comparison, a scientific approach to investigating and comprehending reality, was employed to establish both commonalities and distinctions among processes, phenomena, and objects. By using the comparison method, the study juxtaposed the implementation of innovations in Kazakhstan with their utilization in advanced countries worldwide. This approach allowed for the identification of areas where

Kazakhstan should strive to align itself with global advancements in agriculture.

RESULTS

Examination of global practices in utilizing innovative approaches in the agricultural industry. Developed countries have embraced innovative approaches in crop production to mitigate the adverse effects of global climate change and promote sustainable agricultural development. These methods include resource-efficient practices and organic technologies aimed at enhancing ecological well-being and environmental preservation. Strategies such as diversification, precision farming, and the digitalization of technological processes have gained prominence. Molecular biology and genetic engineering are utilized to optimize the selection and production of new plant varieties. By leveraging these advanced techniques, breeders can accelerate the breeding process, leading to the regular development of high-yielding crop varieties that exhibit stress resistance and disease resilience. Swiss breeders, for instance, have successfully combined classical breeding methods with molecular approaches, enabling early identification of resistance genes in plants and shortening the selective breeding cycle (Roth *et al*., 2023).

Another significant aspect is the improvement of weather forecasting accuracy, achieved through the establishment of an extensive network of weather stations and the creation of a comprehensive database of long-term meteorological observations. In many countries, phytosanitary controls and permit issuance are carried out through a fee-based system, which effectively mitigates the risks of corruption. The revenue generated from these fees contributes to the national budget and supports the remuneration of inspectors, as well as the enhancement of inspection facilities and equipment. To facilitate trade, the European Union (EU) has introduced the TRACES system, an online platform developed by the European Commission. This platform serves as a unified traceability system for obtaining sanitary and phytosanitary certifications required for the import and export of animals, animal-derived products, non-animal food and feed, and plants within the EU and for external trade.

The TRACES system, which is currently utilized in 90 countries with over 55,000 users, plays a crucial role in simplifying the issuance of sanitary and phytosanitary certificates and official documents for the import, export, and movement of live animals and animal products within the European Union (EU). In advanced countries, the inclusion of a significant portion of forage crops in crop rotation is key to the successful development of animal husbandry. For instance, in the United States of America (USA), forage crops occupy 65% of the cultivated area, and the production of feed grain surpasses that of food grain by a factor of four (Fuglie *et al*., 2021). Innovative methods are also being employed to enhance the genetic potential of livestock. Biotechnology, genomic and DNA analysis, and accelerated reproduction techniques are applied within animal breeding, leading to the consolidation of the entire livestock population. Extensive breeding efforts have resulted in dairy cows in developed cattle-breeding nations achieving milk productivity levels of 8.0-10.0 thousand kg or more over a lactation period exceeding 305 days (Lee *et al*., 2020).

Since May 2021, the Eurasian Economic Union (EAEU) countries have been unifying their selection and breeding work through a relevant agreement. The European Union (EU) and the USA prioritize environmental sustainability and green growth principles in their livestock policy. Advanced nations emphasize the accelerated modernization of machinery and technologies in the processing sector, thereby ensuring high efficiency in meeting the population's food needs. Producers and processors in the EU benefit from low-interest loans and favourable repayment terms, while the USA encourages companies to invest in scientific advancements based on new technologies that enhance labour productivity.

Developed countries have implemented various strategies to boost agricultural product sales, such as the utilization of cooperatives, which account for 70% of agricultural product sales in Europe (Candemir *et al*., 2021). In Canada and the USA, the figure stands at 60. Cooperatives are instrumental in enabling the efficient transportation of large quantities of products and ensuring their timely delivery by establishing robust trade and logistics infrastructure throughout the entire supply chain. Prominent instances of well-functioning distribution networks include the Rungis wholesale market in Paris, France, the Mercasa wholesale market network in Spain, and the Bronisze wholesale market in Warsaw, Poland. Developed countries have widely adopted international standards and regulations such as Sanitary and Phytosanitary Measures (SPS), Hazard Analysis Critical Control Point system (HACCP), and Good Laboratory Practice (GLP). These standards enhance consumer confidence in the safety and quality of agricultural products. In the face of globalization, climate change, and intensive agriculture, the resilience of agricultural production systems has diminished, making them more susceptible to harmful organisms, diseases, and hazardous substances. To address these threats and mitigate their adverse impact on agricultural and food product trade, SPS measures have been consistently emphasized by the FAO (2020). Cooperatives serve as a foundational component of agriculture in most countries worldwide. The European Union (EU) boasts a substantial network of around 22,000 cooperative enterprises (Roth *et al*., 2023), while across the OECD (2013) nations, cooperatives have carved out distinctive niches encompassing sales, processing, and the provisioning of production facilities.

Wholesale purchasing cooperatives in the United States play a significant role in procuring seeds, chemicals, fuel, animal preparations, and facilitating various activities such as compound feed production, quality control of feed ingredients, logistics, equipment repairs, and spare parts delivery. In terms of fiscal incentives, US farmers who sell their products to cooperatives were granted tax breaks in 2017, with the possibility of tax exemption under specific conditions. The proportion of high-tech products and science expenditures in the gross domestic product (GDP) serves as a crucial indicator of a country's economy. On average, advanced countries allocate around 3% of their total GDP to knowledge-intensive products and science expenditures. It is noteworthy that in Kazakhstan, per capita expenditures amount to 10.27 US dollars, which is 87 times lower than in the USA (Amirbekova *et al*., 2022).

In advanced countries, 70-85% of GDP is attributed to innovations, new technologies, upgraded products, and equipment that embody new knowledge and solutions. However, in Kazakhstan, this proportion is approximately 1% (Fuglie *et al*., 2021). The management of innovation activity takes place at both territorial (regional) and industrial levels. Territorial priorities are associated with innovation clusters and the establishment of university-industry collaborations. Industry priorities align with the goals set by government programs for the specific sector. The interconnectedness of territorial and sectoral management of innovation in the agro-industrial complex helps identify areas of concern and develop tools for modernizing agricultural enterprises (Galeano-Barrera *et al*., 2022). The efficient functioning of the agro-industrial complex heavily relies on the effective governmental control and management of land resources. Many countries have legislation in place that prohibits the division of agricultural land into small plots, thus preventing fragmentation. Other countries aim to prevent excessive accumulation of agricultural land and impose requirements for landowners to reside near their land and possess the necessary expertise. Additionally, regulations exist to limit the maximum size of land plots. In Denmark, for instance, such a restriction applies to plots larger than 150 hectares (Hjalager *et al*., 2022).

Digitalization in agriculture refers to the adoption and integration of digital technologies and data-driven solutions to enhance various aspects of agricultural practices, management, and decision-making. It encompasses a wide range of technologies and applications aimed at increasing productivity, efficiency, and sustainability in farming. Digitalization in agricultural holdings typically involves three stages (Table 1).

Table 1. *Digitalization process and implementation of precision farming systems*

Stage	Precise farming systems	Description
Stage 1: Initial	Accounting systems integration	This involves seamlessly incorporating financial and budgetary data into precision farming operations
	Electronic records management	Electronic records management in precision farming allows for the efficient storage, retrieval, and analysis of critical data related to crop yields, soil quality, equipment maintenance
	Dashboards	Dashboards provide a visual representation of KPIs and real-time data related to precision farming activities
	Key Performance Indicators (KPI) database	A KPI database in precision farming stores and organizes essential metrics and benchmarks related to crop productivity, resource utilization, and operational efficiency
Stage 2: Innovation	Global Positioning System (GPS)/GNSS	Enables precise tracking of machine operators and accurate field processing. Real-time data collection and accurate location information streamline farm tasks such as planning, mapping, soil sampling, tractor management
	Mobile devices	Utilized for microelement calculations, weather forecast tracking, field mapping, and GPS navigation, enhancing decision-making and on-field efficiency
	Robotics	Robotics technology is employed for tasks such as crop planting, crop monitoring, and weed control, automating labour-intensive processes and improving accuracy
	Irrigation systems	Facilitate remote monitoring and control of irrigation, leading to water conservation, time efficiency, fuel savings, and reduced vehicle wear and tear
	Internet of Things (IoT)	Involves connecting field sensors and satellite monitoring to transmit data to a centralized source, enabling data-driven insights and decision-making
Stage 3: Training	IT specialist training	It refers to the essential education and skill development programs aimed at equipping agricultural professionals with the knowledge and expertise required to effectively manage and leverage digital technologies and data-driven solutions in farming practices

Source: *compiled by the authors based on S. Rolandi et al. (2021), O. Ermetin et al. (2022), K. Bondal (2021)*

Smart farming, also known as precision agriculture or digital farming, indeed involves the application of cutting-edge information and communication technologies (ICT) in agricultural practices. It aims to optimize various aspects of farming operations by using data, sensors, automation, and connectivity (Fig. 1).

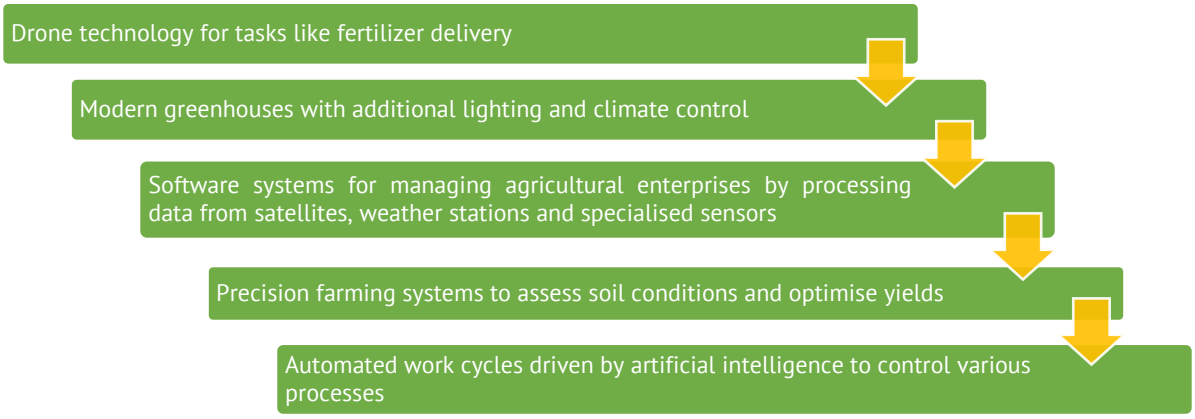

Figure 1. *The key components of smart farming*
Source: *compiled by the authors based on M. Dhanaraju et al. (2022)*

In New Zealand, drones have been multiply applied in agriculture, including field mapping, monitoring crop growth, and aiding shepherds in herding livestock. These drones utilize recorded dog barking and loudspeakers to facilitate the gathering of herds. JBM North America has developed a solution that enables the monitoring of animal conditions within herds, including their location, well-being, and nutritional levels, thereby enhancing herd management. Smart farming practices allow for more efficient utilization of pastures, forests, and fields, preventing soil depletion and the need for deforestation to create new grazing lands. Notably, the Integrated Crop Livestock Forestry Systems (ICLFS) program, implemented in Brazil, where approximately 23% of the world's cattle is raised, has proven effective in restoring degraded farmland (Glatzle *et al.*, 2021). Swiss researchers have highlighted the environmental benefits of smart farms, as they enable precise application of fertilizers and pesticides, mitigating the negative impact of agriculture.

Globally, state regulation plays a crucial role in the agro-industrial complex, particularly through economic measures aimed at supporting producers. These measures commonly involve price maintenance, cost compensation, subsidies for production structures, and the implementation of various programs. The specific application of these measures depends on each country's unique natural and climatic conditions. For instance, the United States subsidizes the profitability of agricultural production, while in Europe, subsidies are provided per hectare of agricultural land. In the Cairn countries, which are located in the subtropical zone, agricultural subsidies are non-existent (Hopewell & Margulis, 2023). The Cairn Group includes Argentina, Australia, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Guatemala, Indonesia, Malaysia, New Zealand, Pakistan, Paraguay, Peru, Philippines, South Africa, Thailand, Uruguay, and Vietnam.

Analysis of the application of innovative methods in the agricultural sector of Kazakhstan. The adoption of agricultural innovations in Kazakhstan has been slow, particularly in crop production. Challenges include the dominance of monoculture, slow progress in expanding irrigated lands and implementing moisture-saving technologies, and limited use of mineral and organic fertilizers. The technological capabilities of the industry are lagging behind advanced countries, leading to yield fluctuations and inadequate processing and marketing of agricultural products. The budget constraints have resulted in insufficient support for veterinary organizations, shortage of veterinary specialists, and inadequate environmental monitoring. The renewal rate of agricultural machinery is below optimal levels, affecting medium and small farms' access to technical resources and energy. The government has implemented measures to support cooperatives, such as investment subsidies and simplified registration processes, along with improved oversight through the establishment of a state register and statistical service.

Cooperatives in Kazakhstan have limited effectiveness, with a significant number being inactive or fictitious for fraudulent subsidy purposes. However, there are still successful cooperatives that offer advantages such as bulk purchasing and streamlined crop sales. The adoption of digital technologies in the agricultural sector is relatively low, resulting in inefficient resource allocation. Pilot farms and livestock enterprises that have implemented digital technologies have experienced cost reductions, increased yields, and improved livestock outcomes. However, obstacles such as limited and unreliable rural connectivity, lack of digital literacy among employees, shortage of trained specialists, and

absence of a unified digital agricultural ecosystem hinder the widespread adoption of digital innovations in the industry. The Ministry of Agriculture of Kazakhstan (n.d.) has delineated a three-tiered approach to the integration of digital technologies within the agricultural sector. At the fundamental level, traditional farms leverage basic electronic field maps and soil analysis. Advancing to the next stage, farms embrace a higher degree of automation, incorporating technologies like fuel consumption sensors, GPS trackers, meteorological stations, electronic weed mapping, and business process management software. The pinnacle of this digital transformation is the Digital Farm, where an exceptionally automated agro-industrial system operates with minimal human intervention, making extensive use of advanced digital tools and technologies (Mukhammedov *et al*., 2021).

In Kazakhstan, there are already more than 20 digital farms and approximately 170 advanced farms in operation. The Ministry of Agriculture (n.d.) has plans to establish at least 20 additional digital farms and four thousand advanced farms by 2023, completing the digitalization of the agricultural industry. The goal is to achieve 100% automation of processes and public services. Currently, the majority of farms in the country are still at the fundamental level, but the process of agricultural digitalization is underway. According to official data, almost all sown areas in Kazakhstan have been digitized, covering a total area of 24 million hectares. Pastures are also being analysed through digital means. New technologies in animal husbandry enable livestock monitoring and automated care. The use of GPS trackers allows for the tracking of herd movements and facilitates locating stray animals using smartphones. Saparkhan Omarov, the Minister of Agriculture of Kazakhstan, highlighted at the Astana Economic Forum that precision farming has led to a 2.5-fold increase in grain yield while reducing farmers' costs by over 20%.

A smart greenhouse represents an advanced indoor farming system that integrates information and communication technologies with agricultural practices. By utilizing ICT, smart farms are equipped to automatically monitor and analyse factors such as temperature, humidity, and sunlight, allowing farmers to cultivate crops without being reliant on unpredictable weather conditions (Kim, 2021). In Kazakhstan, where dry pastures and deserts are predominant, the implementation of smart greenhouses becomes particularly relevant. These greenhouses can be remotely controlled through smartphones, leading to reduced labour costs and increased production efficiency. Compared to conventional greenhouses, a smart greenhouse with a one-hectare area has the capacity to yield 400-450 tonnes of vegetables and berries annually, surpassing the 300-tonne production of a traditional greenhouse. This project not only contributes to the advancement of technology but also provides educational opportunities for students and university staff to engage in research, seminars, and training sessions for rural entrepreneurs.

DISCUSSION

Drawing upon extensive research literature, various aspects of innovation within the agro-industrial sector have been examined. Many studies have concentrated on specific areas aimed at enhancing agricultural efficiency, such as genetic engineering, digitalization, and the development of cooperatives. This paper provides comprehensive coverage of these diverse areas. In their study G. Madiyev *et al.* (2018) highlight that while agribusiness represents a leading sector in Kazakhstan's economy, the industry currently faces challenges such as underutilization of resources, outdated equipment and technologies, limited competitiveness, and a prevalence of small-scale management and private subsidiary farms within the agricultural production structure. The study also identifies deficiencies in the agricultural market, infrastructure, and economic relationships among related enterprises. O.V. Kruglyak *et al.* (2020) emphasized the economic significance of cattle breeds and the importance of meticulous intensive selection work for achieving favourable economic outcomes in dairy cattle breeding.

Among Central Asian countries, Uzbekistan is a good example of the effective implementation of the principles of the digital transformation concept. Kh.Z. Rajamurodov *et al.* (2022) discusses the digitalization processes in Uzbekistan's agriculture, emphasizing the need for digital solutions and transformation due to economic improvements, resource-efficient technologies, and environmental compliance. The authors' highlights the role of digital platform ecosystems in this transformation, defining their significance. A study demonstrates a farm's implementation of a digital platform, resulting in increased profits and reduced costs. The study concludes that while digital platforms may not entirely eliminate intermediaries, they are effective in wholesale and retail food markets, projecting substantial additional profits for various agribusiness sectors. The creation of a national digital platform is proposed, with potential economic benefits and indirect advantages such as improved product quality and environmentally friendly practices.

V. Kvartiuk and M. Petrick (2021) examines the impact of Kazakhstan's 2003-2005 agricultural land reform on land rental and credit market participation, aiming to determine whether the reform facilitated efficient land allocation and access to credit for agricultural producers. However, the reform resulted in significant land concentration, failed to stimulate land sales, and reorganized the land-rental market in favor of the state as the primary landlord. It did not achieve the goal of providing access to land for skilled producers or improve land use as collateral. The reform had limited success in achieving its objectives, and further, more

substantial steps are needed to enhance Kazakhstan's agricultural land markets. According to the authors, Kazakhstan's current reliance on cheap rental land and inadequate progress in liberalizing land relations pose economic sustainability challenges, necessitating more comprehensive reforms to bridge the gap between productivity and land accumulation.

The issues of the organization of the electric power industry and the agro-industrial complex in Kazakhstan considered by S. Smagulova *et al.* (2023). The study employs econometric modeling to examine the impact of electricity production and digital farms on agricultural growth, presenting medium-term forecasts for the agricultural sector with digitalization. The work identifies challenges such as outdated equipment, lack of funding, and non-transparent tariffs in the energy sector, along with issues related to fuel supply and energy shortages. To address these challenges, the authors suggest modernizing existing power stations, promoting renewable energy, improving fuel distribution, enhancing digitalization, and reorienting the oil and gas industry toward high-value products. These measures are expected to contribute to economic growth, environmental preservation, and national security for sustainable development in Kazakhstan's digital energy and agro-industrial sectors.

In turn, M. Toguzova *et al.* (2023) studied the development and implementation of modern geoinformation technologies in agricultural production. This study conducted in the Eastern region of Kazakhstan analyzed the use of digital technologies in farms and identified key factors hindering their implementation and prospects for further development. The study found that larger farms have a higher degree of digitalization development compared to smaller enterprises, mainly due to financial opportunities and objective reasons related to the lack of need for digital technologies at a low level of production. The authors concluded that the level of identifying patterns for more accurate and effective forecasting will increase the yields and profitability of agriculture in the region, increasing productivity, reducing material costs, and more efficient allocation of funds and preservation of the environment.

In his study, A. Nurgozhayev (2021) discusses the digitalization of the agriculture sector in Kazakhstan and aims to determine the associated risks. The author found that five regions have low risk, while the Kostanay region has a high-risk rate in five risk categories, and the Almaty region has no plan for risk mitigation, monitoring, or management in case of digitalization-related risks. Risks were calculated for each region separately, and regions with low, moderate, and high risks were identified. The author also notes that farmers are more aware of other types of uncertainties than the risks associated with the digitalization of the agriculture sector, and regional designation authorities are knowledgeable and can assist in mitigating risks.

These studies emphasize the need for comprehensive reforms to address issues such as resource underutilization, outdated technologies, land reform inefficiencies, and energy sector challenges. Digitalization emerges as a promising avenue for increasing efficiency and sustainability, with success stories in Uzbekistan showcasing the potential of digital platforms to enhance profitability. Furthermore, geoinformation technologies offer pathways to boost agricultural productivity and reduce costs. However, it is crucial to recognize and manage the associated risks of digitalization. Overall, these findings offer valuable guidance for stakeholders and policymakers seeking to foster growth and resilience in the agro-industrial sector of Central Asian economies.

CONCLUSIONS

The agro-industrial sector in Kazakhstan requires systematic efforts towards innovation and improvement. This entails widespread adoption of precision farming systems, smart farms, and smart greenhouses, as well as land diversification and tax optimization. It is crucial to establish effective systems for land and water utilization. The consolidation of small farms into cooperatives would streamline the procurement of necessary goods and services, as well as the marketing of agricultural products. Government support, accessible financing, and comprehensive training programs are needed to enhance the digital skills and knowledge of agricultural workers, thereby strengthening the human capital in the sector. The integration of digital technologies helps minimize corruption by reducing the influence of human factors on decision-making processes.

Significant innovations in agribusiness would involve simplifying licensing procedures, transitioning them to electronic platforms, and fully automating business processes. Encouraging farms to embrace digitalization through state subsidies and establishing clear and transparent criteria would greatly enhance efficiency. This includes investment subsidies, expanded financing options, lending instruments, and loan insurance. Furthermore, comprehensive breeding work is necessary to improve the productivity of agricultural goods. Innovations in phytosanitary and veterinary control contribute to product quality and enhance their appeal in domestic and international markets. Adequate attention should be given to new scientific developments. As outlined in the Concept for the development of the agro-industrial complex of the Republic of Kazakhstan for 2021-2030, funding for agricultural science should reach a minimum of 1% of the GDP of the agro-industrial sector.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

The authors have no conflict of interest to disclose.

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Інноваційні методи організації роботи АПК в ринкових умовах (світовий досвід та Казахстан)

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Анотація. Актуальність даного питання полягало в необхідності вивчення нових методів організації агропромислового комплексу як в умовах глобального ринку, так і в специфічному контексті Казахстану. Це дослідження містить аналіз переваг та викликів сільськогосподарської галузі Казахстану на прикладі провідних країн світу. Метою дослідження було визначення найбільш ефективних підходів до підвищення ефективності сільськогосподарської діяльності, виявлення майбутніх тенденцій в агропромисловому комплексі, створення організаційно-економічних засад інноваційного розвитку, а також визначення соціально-економічних факторів, що стимулюють сільськогосподарське виробництво. Для досягнення поставленої мети основним методом дослідження був системний аналіз інноваційних процесів в агропромисловому комплексі. Крім того, використовувалися різні аналітичні прийоми, такі як синтез, систематизація, узагальнення та порівняння, а також структурно-функціональний та історико-правовий підходи. У дослідженні представлені інноваційні шляхи розвитку, що спостерігаються в передових країнах, включаючи Казахстан, з акцентом на таких сферах, як садівництво, тваринництво, переробка сільськогосподарської продукції, розвиток ринку, сільськогосподарська кооперація, розвиток інфраструктури, наукове та кадрове забезпечення, управління земельними ресурсами, діджиталізація агропромислового комплексу та державна підтримка. У дослідженні також розглядаються недоліки у впровадженні інновацій в агропромисловому комплексі Казахстану. Зокрема, в ньому детально розглядалися методи підвищення ефективності агропромислового сектору, з особливим акцентом на діджиталізацію сільськогосподарських процесів, системи точного землеробства та «розумні» ферми. Дослідження може бути корисним для фахівців різних галузей агропромислового сектору, політиків, які займаються питаннями сільського господарства, а також бізнесменів та інвесторів, які цікавляться аграрними підприємствами

Ключові слова: агробізнес; сільське господарство; розвинені країни; системи точного землеробства; смарт-ферми; діджиталізація