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**INNOVATIVE TECHNOLOGIES FOR IMPROVING EFFICIENCY  
OF MILK PRODUCTION IN DAIRY CATTLE BREEDING:  
TECHNICAL AND ECONOMIC ASPECTS**

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**Summary.** The article examines current trends in the development of innovative technologies in dairy cattle breeding, with an emphasis on technical and technological solutions aimed at increasing productivity, improving milk quality, and reducing production costs. Particular attention is paid to automated milking systems, precision livestock farming technologies, digital monitoring of animal health and productivity, as well as energy-saving solutions on dairy farms. The research results confirm that the integrated application of innovative technologies contributes to sustainable growth of milk production and enhances the competitiveness of dairy farms in the context of modern agribusiness.

**Key words:** dairy cattle breeding; innovative technologies; milk production; automation; digitalization; economic efficiency; agribusiness.

**Formulation of the problem.** In recent decades, dairy cattle breeding has been undergoing significant transformations driven by technological progress, increasing competition in agricultural markets, and growing requirements for product quality and production sustainability. Traditional methods of milk production are gradually losing their effectiveness due to rising production costs, labor shortages, and the need to comply with

stricter environmental and animal welfare standards. In this context, the introduction of innovative technologies becomes a key factor in improving the efficiency and competitiveness of dairy enterprises.

The agribusiness field faces the challenge of balancing technical modernization with economic feasibility. While advanced technologies such as automated milking systems, sensor-based monitoring, and digital farm management platforms offer substantial potential benefits, their implementation requires significant capital investments and organizational changes. Therefore, it is essential to assess not only the technical advantages of innovations but also their economic justification and long-term impact on production efficiency.

In the Republic of Belarus and other countries with developed dairy sectors, innovative technologies are increasingly recognized as a strategic tool for sustainable development of dairy cattle breeding. However, the pace of their adoption remains uneven, often limited by insufficient financial resources, lack of qualified personnel, and uncertainty regarding economic returns. This situation necessitates comprehensive research into the technical and economic aspects of innovative technologies in dairy farming, as well as the identification of key trends and prospects for their development within the agribusiness.

***Basic research materials.*** The development of innovative technologies in dairy cattle breeding is closely associated with the concept of precision livestock farming, which is based on the use of digital tools to monitor, analyze, and manage production processes in real time. One of the most significant technological innovations in this field is the introduction of automated milking systems (AMS). These systems allow for the automation of the milking process, reducing dependence on manual labor and ensuring stable milking quality. Automated milking systems also provide detailed data on milk yield, milking frequency, and animal health indicators, which enables more informed management decisions.

The technical advantages of automated milking systems include increased milking efficiency, reduced labor costs, and improved animal welfare due to more flexible milking schedules. From an economic perspective, the implementation of AMS can lead to higher productivity per cow and lower operating costs in the long term. However, the high initial investment required for these systems remains a major barrier for many dairy farms, particularly small and medium-sized enterprises. Therefore, economic evaluation of such technologies should consider not only direct financial indicators but also indirect benefits such as improved herd health and reduced veterinary expenses.

Another important area of innovation in dairy cattle breeding is the use of digital monitoring systems based on sensors and data analytics. These technologies enable continuous monitoring of physiological parameters, feeding behavior, and locomotor activity of animals. By detecting deviations from normal behavior patterns at an early stage, farmers can promptly identify health problems and reduce losses associated with diseases and decreased productivity. The integration of sensor data into farm management software allows for the optimization of feeding rations, reproduction management, and overall herd performance.

Energy-saving technologies also play a crucial role in improving the efficiency of milk production. Modern dairy farms increasingly adopt energy-efficient equipment, heat recovery systems, and renewable energy sources such as biogas plants and solar panels. These solutions not only reduce energy costs but also contribute to environmental sustainability, which is becoming an increasingly important criterion for agricultural enterprises. The economic justification of energy-saving technologies is often supported by reduced operating expenses and, in some cases, government incentives aimed at promoting sustainable agricultural practices.

In addition to technical innovations, organizational and management innovations are essential for maximizing the benefits of technological modernization. The successful implementation of advanced technologies requires qualified personnel capable of working with digital systems and interpreting analytical data. Therefore, investment in human capital and professional training is an integral part of innovative development in dairy cattle breeding. Without adequate organizational support, even the most advanced technologies may fail to deliver the expected economic results.

An important trend in the innovative development of dairy cattle breeding is the integration of digital technologies into a unified farm management system. The use of specialized software platforms enables the aggregation and analysis of large volumes of production data, including information on milk yield, feed consumption, reproductive performance, and animal health. Such systems support data-driven decision-making and contribute to the optimization of production processes. As a result, dairy farms gain the ability to quickly respond to changes in internal and external conditions, improving overall operational efficiency.

The economic effect of digitalization in dairy farming is manifested not only in cost reduction but also in increased transparency and controllability of production processes. Digital tools allow farm managers to identify inefficient operations, reduce resource losses, and improve planning accuracy. In the long term, this leads to more stable financial performance and increased investment attractiveness of dairy enterprises. At the same time, the effectiveness of digital solutions largely depends on the level of their integration into existing production systems and the readiness of personnel to use them effectively.

Innovative feeding technologies also play a significant role in increasing milk production efficiency. Precision feeding systems based on automated ration formulation and controlled feed distribution ensure optimal nutrient supply for each group of animals. This approach

contributes to higher milk productivity, improved feed conversion efficiency, and reduced environmental impact due to lower nutrient losses. From an economic standpoint, optimized feeding reduces feed costs, which traditionally account for a significant share of total production expenses in dairy farming.

The introduction of innovative technologies in dairy cattle breeding should be considered as a complex process that combines technical, economic, and organizational components. Isolated implementation of individual technologies often does not provide the expected results, whereas an integrated approach allows for the synergistic effect of innovations. For example, the combination of automated milking systems, digital monitoring, and precision feeding creates a unified technological environment that maximizes production efficiency and improves product quality.

Despite the evident advantages, the dissemination of innovative technologies in dairy cattle breeding faces several constraints. Among the most significant barriers are high capital intensity, limited access to investment resources, and insufficient state support mechanisms. Therefore, the development of effective economic incentives, including subsidies, soft bank lending, and public-private partnerships, is essential for accelerating the adoption of innovations in the agribusiness field. In this context, economic justification of innovative projects becomes a key factor in decision-making at both enterprise and policy levels.

**Conclusion.** The research confirms that innovative technologies are a critical factor in improving the efficiency and sustainability of milk production in modern dairy cattle breeding. Automation, digitalization, precision feeding, and energy-saving solutions significantly enhance productivity, reduce production costs, and improve milk quality. At the same time, the economic effectiveness of innovations depends on a comprehensive approach to their implementation, taking into account

technical feasibility, organizational readiness, and investment capacity of dairy enterprises.

The analysis shows that the integration of innovative technologies into a unified management system provides the greatest economic effect, ensuring stable development and competitiveness of dairy farms within the agro-industrial complex. However, the widespread adoption of innovations requires overcoming financial and institutional barriers through targeted state support and the development of human capital. In the long term, innovative development of dairy cattle breeding will contribute to strengthening food security and achieving sustainable growth of agribusiness.

### **References**

1. Náglová Z., Rudinskaya T. Factors Influencing Technical Efficiency in the EU Dairy Farms. [Electronic resource]. – URL: <https://ideas.repec.org/a/gam/jagris/v11y2021i11p1114-d675306.html>, open. – (date of access: 07.02.2026).
3. Alem H. The Role of Technical Efficiency Achieving Sustainable Development: A Dynamic Analysis of Norwegian Dairy Farms. [Electronic resource]. – URL: <https://ideas.repec.org/a/gam/jsusta/v13y2021i4p1841-d495671.html>, open. – (date of access: 07.02.2026).
4. FAOSTAT. Food and Agriculture Organization of the United Nations' Statistical Database. [Electronic resource]. – URL: <https://www.fao.org/faostat/en/#home>, open. – (date of access: 07.02.2026).