

**SCIENTIFIC-THEORETICAL FOUNDATIONS OF THE DEVELOPMENT OF THE DAIRY INDUSTRY**

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**Abstract**

The article describes the importance, essence and scientific and theoretical foundations of the development of the dairy cattle breeding industry. As a result of the conducted scientific research, a system of theoretical approaches was developed based on the study of the scientific works of foreign and domestic economists in order to study the economic efficiency of milk production in the cattle breeding industry.

**Keywords:** Animal husbandry, cattle breeding, milk, efficiency, economic efficiency, production, productivity, classification, ecological milk, smart farm.

**Introduction**

Climate change poses new threats and constraints to agriculture. Rising temperatures, water scarcity, and declining feed supplies are negatively impacting milk production and productivity. Therefore, creating climate-resilient dairy systems is a key area of agroecological sustainability. In this regard, measures such as conserving local breeds, improving feed efficiency, and using biogas and renewable energy sources are of great importance.

**Relevance of the topic**

The use of energy and water-efficient technologies in the dairy industry not only provides economic benefits, but also reduces environmental impact. Such approaches allow dairy farming to adapt to the principles of the "green economy" and become an integral part of national food security policies.

It is worth emphasizing that improving the efficiency of the dairy system directly contributes to the UN Sustainable Development Goals of "Zero Hunger" and "Good Health and Well-being". Dairy products are an affordable and nutritious food source for various segments of the population, and play an important role in ensuring healthy nutrition for children and the elderly. Therefore, the production of sufficient quantities of dairy products and strict control over their quality are the main conditions for strengthening the country's food security.

Research shows that dairy products are increasingly important in shaping a healthy lifestyle and developing a healthy eating culture among young people and children in modern society. From this point of view, it is very important to ensure sanitary and hygienic safety, quality standards, and logistics efficiency at all stages, from production to consumer.

### **Literature review**

Foreign scientists Nan Jiang, Basil Sharp, Birhanu Addisu Adamie, Helena Hansson, Tauer LW, Belbase KP Dhakal, SC Savickienė, R.; Galnaitytė, A. Christian Grovermann, and domestic economists S.Abdullaeva, S.Adilov, U.Sadullaev, and U.Khudayberdiev conducted extensive research on the development of the scientific and theoretical foundations of the dairy cattle breeding industry and increasing economic efficiency in the industry.

### **Analysis and results**

In general, improving the system of milk production, processing and delivery to the consumer not only increases economic efficiency, but also serves to ensure strategic goals such as environmental sustainability, food security and healthy nutrition. In the context of climate change, the introduction of innovative approaches, resource-saving technologies and science-based management methods in this area remains a key factor in building sustainable food systems.

The development of dairy farming in rural areas is of great importance not only as an integral part of agricultural production, but also as a strategic factor ensuring socio-economic stability. The economic impact of this sector is multifaceted and is closely related to increasing employment levels, diversifying sources of income for the population, and improving the standard of living in rural areas.

inclusive economic growth in rural areas - that is, the results of growth are delivered to a wide range of society, especially to groups with fewer resources (women, youth, small farmers). This approach is important for creating sustainable jobs in the national economy, reducing poverty, and ensuring social stability.

Also, the improvement of the dairy sector will also improve the rural infrastructure. Investments in road, water supply, cooling and storage infrastructure will also have a positive impact on other sectors. This serves to ensure balanced territorial development.

The dairy sector accounts for a large share of the total agricultural output. In world practice, dairy products (milk, yogurt, cheese, butter, curd, etc.) account for 18–25 percent of the total agricultural output. In developing countries, this figure is around 10–15 percent, while in developed countries it exceeds 30 percent [1].

In addition, the dairy industry, due to its close links with a number of related sectors, such as feed production, veterinary medicine, transport, and food processing, has a multiplier effect on the entire agrarian economy. That is, the growth of milk production increases production in other agricultural sectors, expands employment, and strengthens the agricultural sector's share in gross domestic product.

Based on the above considerations, dairy farming, as one of the strategic sectors of agriculture, has been the focus of constant attention of economists. Because the dairy sector not only ensures food security for the population, but is also an important indicator of resource turnover, labor efficiency, and market stability in agricultural production. In scientific research, the study of this sector is mainly associated with assessing its economic efficiency, rational use of production resources, expanding sources of income for the rural population, and developing sustainable development strategies.

In modern economic theory, the dairy sector is considered not only as a production activity, but also as an economic mechanism for a sustainable food system. Therefore, many researchers (FAO, OECD, World Bank, etc.) are studying the efficiency of dairy production in relation to resource efficiency, energy balance, climate change, and market competitiveness. According to national and international economists, the dairy sector, in addition to ensuring food security, also provides diversification of income sources for the rural population, therefore, a deep analysis of its efficiency is a priority task in economic policy.

From this point of view, the study of the economic efficiency of dairy farming serves not only to evaluate the pure economic results, but also to determine the social and ecological effects of the forms of economic management. In other words, scientists see this field as a multifaceted element of the economic system and strive to develop scientifically based approaches for its sustainable development. This situation is the reason to look at the dairy industry as an object of integrative analysis, and reinforces the need for a harmonious study of economic, social and ecosystem factors.

Nan Jiang and Basil Sharp [2], studying the efficiency of dairy farming, emphasize that the most efficient use of resources (capital, livestock quality, volume) in dairy farming is the most important condition, and emphasize that these factors should be taken into account when evaluating indicators.

B.A. Adamie and H. Hansson (Birhanu Addisu Adamie and Helena Hansson, 2022) also conducted research in this area, and scientists emphasize that inefficiency is not always a negative situation when analyzing the efficiency of dairy production over time [3]. In their opinion, the inefficiency observed in some livestock is actually a strategic process in which the results of market adaptation or investments have not yet fully manifested themselves. Therefore, the need to take into account time and crisis periods when assessing efficiency is scientifically justified.

Loren W. Tauer and Krishna P. Belbase (2017) analyzed the technical efficiency of dairy farms in New York State and estimated the average efficiency at 69 percent [4]. The authors scientifically substantiated that technologically advanced methods are the main factor in high efficiency on large-scale dairy farms. Thus, advanced technologies and innovative solutions are the main factor in increasing efficiency in milk production.

of S.S. Dhakal (SC Dhakal, 2022). According to the results of a study conducted in Nepal, the factor that has the greatest impact on the efficiency of dairy production is the level of utilization of labor resources [5]. According to the scientist, even under the conditions of existing technology and feed base, it is possible to significantly increase the output of dairy farms by effectively organizing human labor and organizational activities. He also sees increasing labor productivity in dairy farming as a priority.

Laure Latruffe and József Fogarasi (2012) compared dairy farms in Central and Western Europe and analyzed their technical efficiency and the rate of technological change [6]. According to the results of the study, it was found that the level of efficiency of French and Hungarian farmers depends mainly on the scale of production and the level of technological innovation. According to scientists, the introduction of advanced technologies and economies of scale are the main criteria determining the efficiency of dairy farming.

R. Savitskene and A. Galnaitytė (Rūta Savickienė and Aistė Galnaitytė, 2024) Using the example of the milk exporting countries of the European Union, Denmark, the Netherlands and Ireland, the highest results were found in farms with high economic efficiency [7]. The authors emphasize that farms with high input–output efficiency in dairy farming operate efficiently. Therefore, ensuring the balance of production scale and resources is seen as a guarantee of sustainable efficiency in dairy farming.

A. Wilczynski, E. Koloszytz and M. Switlyk (2020) assessed the efficiency of dairy farms in Poland and proved that there is a direct relationship between the number of cows on the farm and their increased productivity and overall production efficiency [8]. They believe that the efficiency of resource use in production can be increased by maintaining a sufficient number of livestock, improving genetic potential and breed quality.

In his research [9], Christian Grovermann (Christian Grovermann, 2022) analyzed organic certified dairy farms in European countries and emphasized that this system has a positive impact on technical efficiency, in addition to economic benefits. In his opinion, organic certification not only increases market competitiveness, but also ensures sustainable development through efficient resource management. Therefore, in modern dairy farming, environmental and economic efficiency should be seen as important, complementary criteria.

Scientists in our country have also conducted extensive research in this regard. Z. Akhmedova, Z. Shodiev, and Z. Jalilova, in their research, consider digital technologies to be the main factor influencing the efficiency of dairy farming today, and believe that the integration of advanced technologies in dairy farms will contribute to achieving sustainable development goals, improving animal welfare, and meeting the needs of modern society for high-quality and safe dairy products [10].

N.Hamdanova et al. [11] came to the scientific conclusion that dairy farming is an effective form of agribusiness for peasant farms, but that veterinary services have a significant impact on its effectiveness, which serves as a basis for fully revealing the biological potential of livestock and thereby assessing its economic efficiency. They concluded that the level of efficiency in dairy farming is directly related to the efficiency of services.

[12], an Uzbek scientist who conducted dissertation research on the economic efficiency of dairy farming, provided scientific conclusions that milk production efficiency is more complicated in peasant farms due to the lack of cost accounting and the ambiguity of numbers, and that the optimal solution for increasing milk efficiency is to focus on producing "ecological milk". S. Adilov [13], based on her dissertation research, scientifically substantiated the inconsistencies in determining milk production efficiency and proposed methods for calculating the efficiency of the livestock sector, taking into account the specific features of peasant farms. In addition, Uzbek economist U. Sadullaev [14], based on his research, discussed the effectiveness of modernizing the meat and dairy production system, noting that two different approaches have been formed in assessing the efficiency of dairy production in the world, in particular, in developed countries it is assessed based on the protein content of milk, while in developing countries the fat content remains the main indicator, and he substantiated his scientific views on the fact that this leads to two different criteria for determining efficiency.

O.Khudaiberdiev emphasizes that “currently, livestock products are mainly produced in peasant farms, and the breed and genetic characteristics of cattle do not allow for a sharp increase in milk and meat products. Therefore, it is important to improve the mechanisms for improving the breed of livestock in peasant farms, to improve the breed of livestock in this direction, and to increase the efficiency of milk production by creating an economic and legal incentive to create a system for supplying pedigree cattle to the population” [15].

### Conclusions and Suggestions

Having deeply analyzed the scientific views of the above scientists, we believe that the following scientifically based conclusions and approaches can be presented to ensure the efficiency of milk production (table). In particular:

**Table A system of theoretical approaches formed by scientists in studying the efficiency of milk production**

Approach name	Main content	Scientific significance and performance indicator
<b>Economic-resource approach</b>	Reduce costs and increase production through efficient use of labor, capital, feed and land resources.	Achieving economic efficiency by optimizing the allocation of resources.
<b>Biological-technological approach</b>	Ensuring biological efficiency by improving milk quality, breed productivity, fat and protein content.	Evaluation of the effects of genetic potential and nutrient balance on performance.
<b>Ecological and sustainable development approach</b>	Reducing methane emissions, saving water and land resources, recycling waste.	Formation of environmentally friendly and sustainable production model.
<b>An innovative and digital approach</b>	Application of "Smart Farm", sensor technologies, digital monitoring and data analysis.	Strengthening production efficiency and control through technological innovations.
<b>Institutional and market approach</b>	Consider the impact of public policy, cooperation, market infrastructure and the economic environment.	Ensuring macroeconomic stability and market efficiency in dairy farming.

- the main criterion for the efficiency of dairy farming is the rational use of resources and the level of implementation of advanced technologies. Through the effective management of production volumes, capital and livestock potential, farm productivity can be significantly increased. This situation indicates the need to introduce digital and automated systems on a national scale.

- efficiency in dairy farming largely depends on the management of labor resources, the level of organization and the correct orientation of innovative strategies. Therefore, improving the organizational activity and strengthening the system of training in farms is one of the important factors of increasing efficiency.

- the modern dairy system not only on the basis of economic, but also on the basis of environmental criteria. The concept of "ecological milk" production represents a new stage of sustainable development in dairy farming. This will not only increase competitiveness in the market, but also ensure resource efficiency.

- the efficiency of dairy farming is directly related to the genetic potential of the cattle breed, the development of veterinary and service systems. Therefore, promotion of breeding by the state, improvement of veterinary infrastructure and development of services market is an important strategic direction that ensures efficiency in the field.

- In developed countries, in developing countries, the criteria for evaluating milk efficiency differ. This is one of the current directions of revising the methods of national economic analysis and developing indicators based on local characteristics.

Thus, increasing the efficiency of dairy production is not just about achieving economic results, but also a multifaceted, systemic process that requires the rational use of resources, the introduction of advanced technologies, and the harmonious development of ecology and breeding systems.

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