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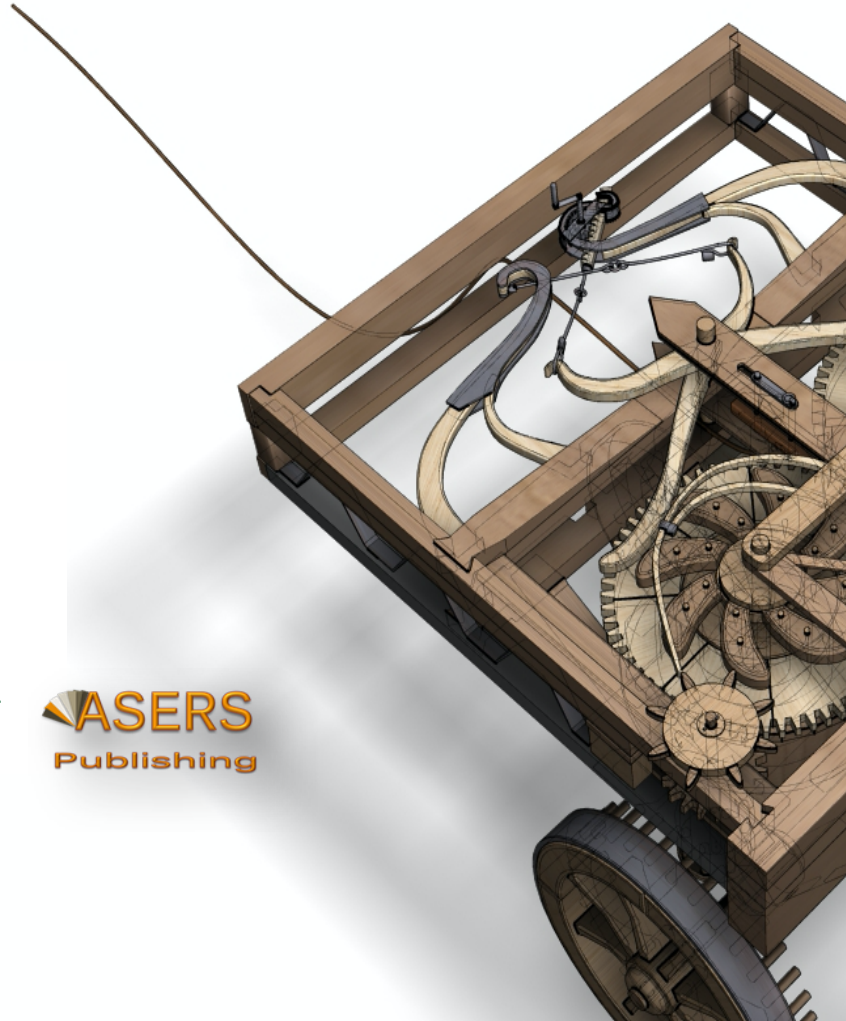
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A Sustainable Dairy Industry in Kazakhstan. Enterprises' Insights Upon Environment Management and Innovation

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Abstract:

This research paper debates some issues concerning a sustainable dairy industry in Kazakhstan in straight relation with environment management and innovation management. The qualitative and quantitative growth of the dairy industry, the production of milk and dairy products, increasing the profitability of production is based on the active use of the innovative component. Environmental factors and other issues as profitability decrease of production, the risks of not mastering innovations make this industry subsidized and unattractive for attracting investment. In order to assure the sustainable functioning of the dairy industry, mechanisms are needed to improve the implementation of priority areas for its innovative development, to ensure a decrease in the volume of imports of dairy products. The active use of environmentally friendly technologies that reduce the negative impact on soil and water, as well as technologies and infrastructure for the disposal of animal by-products, should become the basis for the sustainable development of the dairy industry.

Keywords: dairy industry; innovation; environmentally; sustainability.

JEL Classification: Q56; Q57; R11.

Introduction

Over the past twenty years, environmental issues have increasingly affected the people of Central Asia, especially the most vulnerable, poor and geographically isolated segments of the population. Sources of pollution are industrial and agricultural production, untreated waste, radioactive waste, soil salinization, etc. In addition, Central Asia is already experiencing the impact of climate change, which is expected to worsen significantly over

the next decade. Agricultural production is one of the main causes of environmental degradation. Failure to meet fallow periods, over exploitation of insufficiently fertile land, expansion of crop production into fragile and marginal areas, and lack of measures to control soil erosion have caused significant damage to drylands. Changes in livestock production, which had to be concentrated on smaller areas due to growing market demand and urbanization, exacerbated this problem.

The dairy industry has a huge impact on the level of food security of the country, and therefore on the health of the nation, is aimed at meeting the nutritional needs of a growing population. The expected demand of a growing world population for increased food production necessitates the use of innovative technologies with less use of resources while reducing the impact of negative production factors on the environment. The introduction of innovative technologies will lead to the control of the impact of agro-industrial activities on the environment, soil and air quality, thereby providing long-term economic, environmental and social benefits.

The priority areas for the development of the agro-industrial complex of Kazakhstan are to increase the efficiency of dairy farming with innovative technological re-equipment of processing enterprises. Kazakhstan imports large volumes of milk and dairy products, lagging far behind developed countries in terms of cow productivity, and is characterized by low competitiveness of dairy products.

The allocated budget funds for many years aimed at supporting dairy farming have not solved the problem of increasing milk production and the quality of dairy products. Kazakhstan's membership in the WTO has put domestic dairy producers in even tougher competitive conditions. Weak incentives for innovative development by the state, unsystematic support for inefficient programs, and the lack of an innovative focus have become the determining vector for the negative development of the dairy industry. High risks of mastering innovations, low profitability of production have made the dairy industry unattractive for investors. In this regard, in order to increase the efficiency of the production of milk and dairy products, it is necessary to activate its innovative component.

The issues of greening business, solving environmental problems in an environmentally oriented state policy related to the formation of a market for environmentally friendly products also require full scientific coverage. Relevant and necessary are the development and justification of organizational and economic mechanisms to support dairy production in the sale of environmentally friendly products.

The production and trade of environmentally friendly products will help improve the quality of life of the population, protect and improve the quality of the environment, attract investment in environmentally friendly technologies in the dairy industry and become the most important priority for sustainable development. Practice shows that the environmental activities of business organizations is a tool to increase the competitiveness of dairy products. Investments in greening are becoming factors for increasing the sustainable development of production.

1. Literature Review

The global dairy industry continues to face sustainability challenges, requiring action on food production and consumption patterns to reduce by-products affecting the environment, increase the production of nutrient-dense dairy products, which requires innovation in production (Granato *et al.* 2022). Ensuring sufficient levels of food for the population (dairy supply in the UK) must have a circular food supply chain through the introduction of sustainable innovative practices such as the use of food waste management technologies, which remains a challenge in supply chains through the lens of cultural hegemony and the concept of discursive coalition (Else *et al.* 2022).

Six countries such as Germany, France, Italy, Poland, Spain and the Netherlands, producing more than 73% of dairy products and the EU-27 being the world's second largest producer of milk, as well as the main exporter of cheese in the world, have introduced the best available technologies for dairy industries to monitor wastewater generated, reduce water consumption and improve resource efficiency. For the dairy industry, which consumes large amounts of water and produces highly polluted wastewater that adversely affects the environment, an important strategy for the dairy industry should be the introduction of new innovative closed-loop processes (Glavas and Fitzgerald 2020).

The US dairy markets are also showing volatility patterns with the pricing system and the commodity market as a whole, with the COVID-19 pandemic increasing the volatility of dairy products amid uncertainty from innovation performance. The pandemic has also significantly reduced the impact of information uncertainty on volatility (Ellis *et al.* 2020). The development of the US dairy industry, where the dairy industry remains the fourth leading agricultural sector with a turnover of \$38 billion, has been affected by changes in the number of dairy farms, herd size, milk quality and management practices that have affected the overall sustainability of dairy farms (Owusu-Sekyere *et al.* 2018).

Water scarcity, which has become a serious problem for the sustainable development of the economies of many countries, requires a detailed assessment of the dairy value chain, including the economic efficiency of feed production and packaging design. The added value of water resources in manufactured dairy products throughout the entire production chain of products should take into account the environmental impact on the environment (Lindena and Hess 2022).

World experience once again confirms that the development of the dairy industry will make a sustainable contribution to global food security, even if its production globally pollutes the environment. This study is aimed at conducting a review of foreign and domestic scientific literature on the study of the theoretical and methodological foundations of managing innovative activities of dairy industry enterprises, which shows its relevance and timeliness. The expansion of the corporate social responsibility strategy of companies (dairy processors, civil society initiatives and government support), as well as economic, political and social networks, influenced the development of the organic dairy sector of the Dutch social network, was a breakthrough in the production of dairy products in the Netherlands as a result of close interaction economic, state and public actors' farms (Feil *et al.* 2020).

Theoretical and methodological aspects of innovative processes in the dairy and food subcomplex are considered in the following works: (Feil, Schreiber and Haetinger 2020, von Keyserlingk 2019, Martin 2019, Augustin, Udabage, Juliano and Clarke 2018, Martinelli and Damasceno 2022, Gorton, Angell and Dries 2019, Bourlakis and Maglaras 2019, Abbate, Centobelli and Cerchione 2023, Aimurzina, Kamenova and Omarova 2018, 2019).

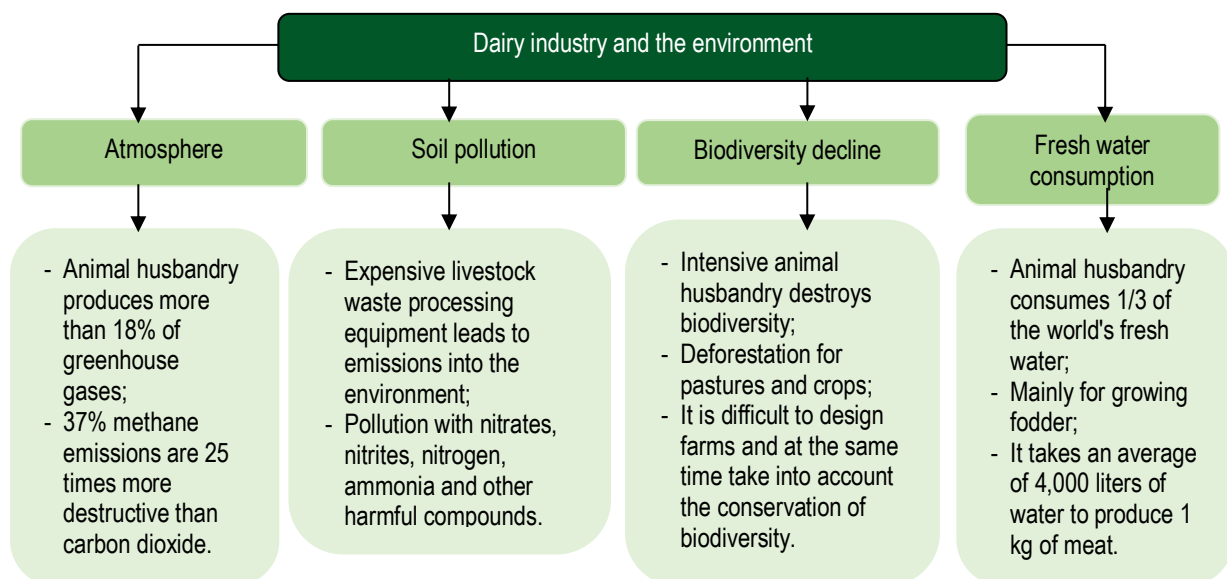
The development of management greening processes in business processes requires the development and implementation of state policy mechanisms focused on sustainable development and green growth. In this regard, when preparing the article, the theoretical aspects of the implementation of state support for the production of environmentally friendly products of the dairy industry were studied, which were reflected in the works of (Alekseev 2018, Rubaeva and Kachurina 2020, Anciferova 2018, Gavriilyuk, Kazantseva, Novikova and Plotnikov 2019, Nechitaylov 2019). These researchers have made a significant contribution to solving the problems of the dairy industry, analyzed the main directions of development of the dairy industry. At the same time, it is necessary to expand the theoretical and methodological base for the study of this subject area, taking into account innovative competitive factors of the domestic dairy market.

2. Factors Characterizing the Impact of the Dairy Industry on Ecology and Environment

The realization of processing raw milk and the production of dairy products are inextricably linked. The efficiency of processing enterprises depends on farms or raw milk production organizations. The following factors affect the quality of raw milk:

- genetic (breed, breed, heredity);
- physiological (milk yield, age, stage of lactation);
- environmental factors: milking system; milking hygiene; feed and feeding; care; season of the year.

Figure 1. Environmental impact of the dairy industry

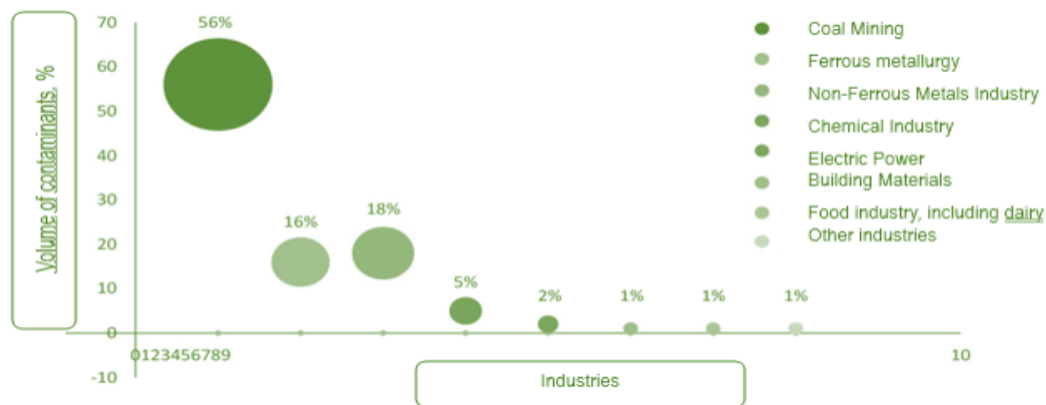


The sum of technologies of any milk processing enterprise located on the territory of the Republic of Kazakhstan is inevitably accompanied by some amount of waste, mainly in liquid form, highly diluted with drinking water during various rinsing, flushing, washing. In the form of a contaminated aqueous solution, no longer suitable for economic activity, they enter the general, external to a particular plant, sewerage system (Figure 1). Quantitative and qualitative analysis of dairy waste discharges into the environment indicates their exceptionally low specific value compared to other industries and the absence of a critical situation with water basin pollution from milk processing enterprises.

Therefore, traditional ways of producing dairy products, in general, do not meet modern environmental requirements. Cottage cheese and cheese remain, perhaps, the only product groups whose production technologies urgently require a radical and immediate implementation of modern technology available on the market, both in terms of the primary capture of protein and lactose at the beginning of milk processing, and in terms of processing the resulting whey. Working with whey, as a recyclable material, is naturally unprofitable and unattractive, therefore, it requires enhanced legislative enforcement, which contains a “carrot and stick” at the same time.

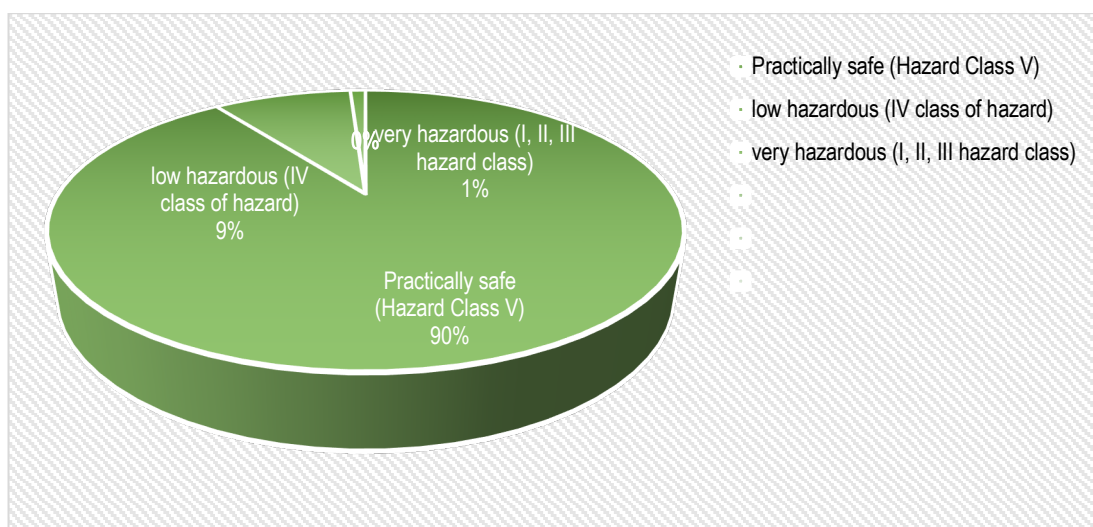
If we consider the impact of the dairy industry on ecology and the environment in relation to other sectors of the economy, the negative activity from the presence of the dairy industry in the country is calculated in fractions of a percentage, *i.e.*, it is negligible in terms of the amount of environmental damage (Figure 2).

Figure 2. Environmental pollution



Having applied in the analysis the general structure of pollution for all industries with a reflection of their hazard class, for the dairy industry we obtain negligible values of really dangerous ones (Figure 3).

Figure 3. Classification of waste by hazard classes, including the dairy industry, in %

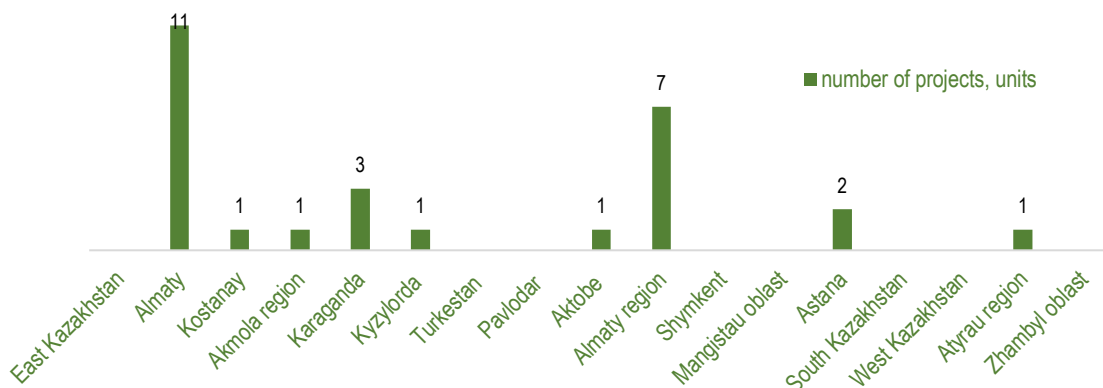


Of course, a small (but measurable) value is not a reason for complacency. More alarming here is the situation with the consumption of drinking water by dairies in proportions from 4.5 to 11 m³/t of processed milk, while world practice is approaching a minimum of 1.8–2 m³/t. With such large ratios between products and waste,

it is just right to say that domestic dairies are most likely water pollution enterprises with a small dairy production subsystem. Moreover, clean water is withdrawn most often from underground sources, and dirty water is discharged to the surface.

The consumption of drinking water by dairy plants per ton of processed raw materials is excessively high and demonstrates the general technical backwardness of the industry as a whole, where the depreciation of old enterprises has crossed the 70% mark. Food security depends on the preservation of agricultural resources, thus being of strategic importance to the state and financing in the form of investments in the greening of the dairy industry (Figure 4).

Figure 4. Regional PPP profile of the dairy industry in 2021



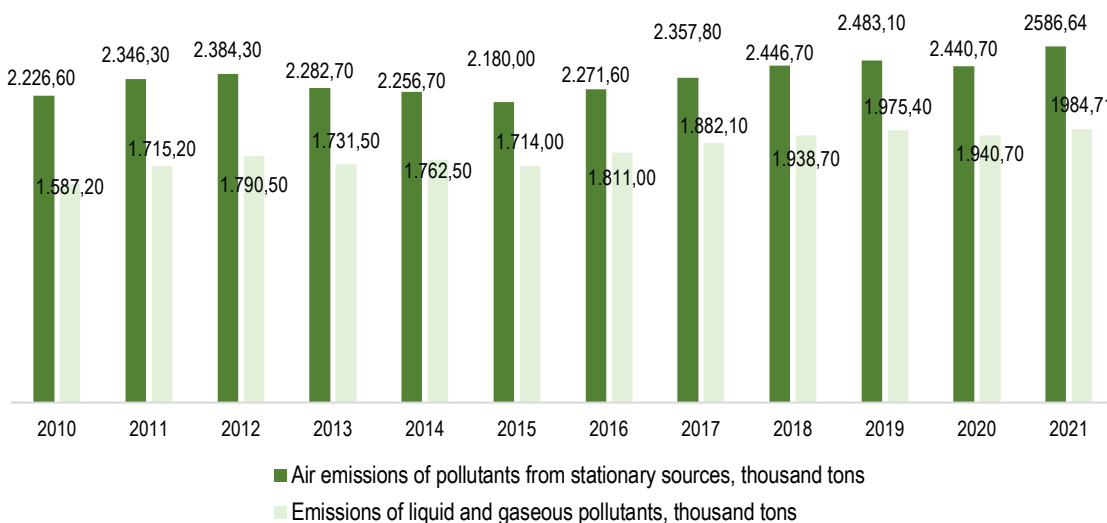
Source: compiled by authors

Considering the impact of the dairy industry on the environment, measures must be taken to mitigate the changing situation in terms of emissions of hazardous pollutants, as livestock influences:

- destruction of large areas of natural vegetation and desertification due to overgrazing;
- degradation of natural vegetation on pastures;
- destruction of vegetation and erosion of the land surface;
- pollution of surface water by animal excrement near slaughterhouses and processing plants, in livestock breeding areas, and in natural irrigation areas of reservoirs and rivers.

Efforts are already underway in other countries to develop products that reduce and neutralize methane emissions from livestock production. For example, Zelp in the UK has developed a muzzle for cattle that neutralizes methane emitted by animals, helping to reduce methane emissions by more than 50%, as about 95% of cattle emit methane through their vomit and nose. Obviously, Kazakhstan needs a proper strategy of adaptation to climate change, but this requires a competent and effective policy regarding ecology and environmental protection. (Figure 5).

Figure 5. Indicators affecting the change for environment



Source: compiled by authors according to <http://www.stat.gov.kz>

3. Environment Management and Innovation in Dairy Industry

The purpose of the paper is to clarify the theoretical and methodological provisions and develop proposals for improving the strategic directions of innovative development of the domestic dairy industry in relation with environment management. To achieve this goal, it is necessary to solve the following tasks:

- to explore, on the basis of scientific literature, the main elements of the innovative development of dairy industry enterprises;
- to analyze the development of the domestic dairy market, to identify problems affecting the efficiency of milk and dairy products production, as well as the features of the subject area under study to justify the priority areas for innovative development of the dairy industry;
- to develop a medium-term forecast for the innovative development of the dairy industry based on the performance indicators of dairy cattle breeding and processing enterprises.

The dairy industry is a source of emissions, effluents and industrial waste, which can be subdivided as follows:

- emissions from energy production and from the use of products with internal combustion engines;
- emissions associated with the main technological processes;
- emissions from auxiliary shops and industries.

The main sources of air pollution in the dairy industry are:

- production of powdered milk and dairy products (dryers, fire heaters);
- tin cans (tinning, varnishing, etching, soldering), washing department, containers and equipment.

Table 1. Characteristics of the sources of formation of substances polluting the atmosphere in the dairy industry

Production, workshop, department, equipment	Volume ejection, thousand m^3_{h-1}	Temperature, C	Concentration, mg_{Nm^3}
Production of powdered milk and dairy products	2-100	70-85	3000-50000 4-1000
Rennet dispensers	113	-	20-900
Fire heaters	0,5-10,0	150-300	112
Tin and can shop Cutting, stamping, assembly	113	25-40	0,1-4,5
Tinning, varnishing, etching, soldering	113	25-40	0,001
Cardboard printing shop	0,8-18,0	40-45	1,5-2,0; 400-500
Repair and mechanical shop mechanical equipment	0,5-15,0	18-25	0,5-2,0 0,6-1,17
Cupola furnace, non-ferrous casting furnace	3-15	200	300-1200; 54-150; 700-1400
Enterprise boiler room	5-100	130-300	112
Washing containers and equipment	113	30-40	0,07-0,6; 0,1-1,0
Wastewater treatment plant biological stations	114	10-25	0,1-30,0; 2-50 to 1 %
Chlorination	113	18-25	0,05-0,50

Source: compiled by authors according to www.ekolog.ucoz.kz

The main sources of pollution and clogging of water bodies are insufficiently treated wastewater from dairy industrial enterprises. Pollutants, getting into water bodies, lead to qualitative changes in water. They are mainly manifested in a change in the chemical composition of water, in particular, the appearance of unpleasant odors, tastes, harmful substances that float on the surface of the water and are deposited at the bottom.

The dairy industry is a source of emissions, discharges and industrial waste. Air emissions can be subdivided in emissions from energy production and from the use of products with internal combustion engines; emissions associated with the main technological processes; emissions from auxiliary shops and industries.

Measures to prevent pollution of the biosphere by emissions from dairy industry enterprises consist of the following measures:

- development and adoption of low-waste and waste-free technological processes, machinery and equipment that ensure the rational use of material and raw materials, reduce the specific consumption of raw materials, waste disposal;
- development, production and use of gas cleaning and steam trapping equipment to protect the air basin from emissions;
- equipping existing industrial enterprises with efficient wastewater treatment systems;

- development of substantiated maximum allowable emissions of harmful substances into the atmosphere and maximum allowable effluents.

The use of progressive methods of manure cleaning (repeated removal of manure with automated scrapers during the day) and composting in the canal will reduce losses at the stage of manure utilization, increase production and improve the environmental situation in general. An increase in nitrogen losses during manure disposal leads to a proportional increase in ammonia emissions. Nitrous oxide emissions depend on the amount of nitrogen produced by the animals. The existing ideas about the efficiency of production with an increase in the productivity of animals are also confirmed by a decrease in the environmental hazard from its production. The solution to the issue of improving the quality of milk and the level of marketability of its production, taking into account environmental factors, will depend on a set of measures aimed at improving the quality at each stage of production and processing of milk with the direct participation of the state.

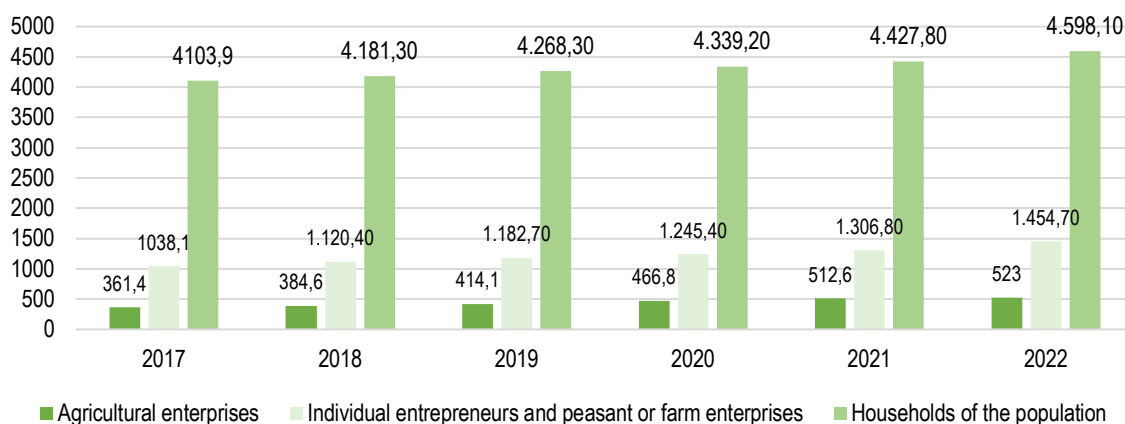
The dairy industry, which has significant advantages, is unable to adapt to the changing social and environmental landscapes. Under the conditions of globalization changes as a result of scientific and technological technology, climate change, changes in society and its values, the factors that affect the sustainability of the dairy industry are expanding. All this requires synchronization of industry significance with the values of society, the interest of all participants in the process, including researchers, consumers and the general public. The efficiency of dairy products production depends not only on the interaction of agents in production chains, but also with the environment. Competitiveness indicators were: production capacity, institutional knowledge (innovation), agility and perception of market operations and incentives, logistics, marketing.

There is an urgent need to improve many key sustainability performance indicators, which shows the critical role of large dairy producers in driving the implementation of many sustainability initiatives, such as:

- development and adoption of low-waste and waste-free technological processes, machinery and equipment that ensure the rational use of material and raw materials, reduce the specific consumption of raw materials, waste disposal;
- development, production and use of gas cleaning and steam trapping equipment to protect the air basin from emissions;
- equipping existing industrial enterprises with efficient wastewater treatment systems;
- development of substantiated maximum allowable emissions of harmful substances into the atmosphere and maximum allowable effluents.

The use of progressive methods of manure cleaning (repeated removal of manure with automated scrapers during the day) and composting in the canal will reduce losses at the stage of manure utilization, increase production and improve the environmental situation in general. An increase in nitrogen losses during manure disposal leads to a proportional increase in ammonia emissions. Nitrous oxide emissions depend on the amount of nitrogen produced by the animals.

Figure 7. Production of milk and dairy products for 2017-2022 in the Republic of Kazakhstan, thousand tons



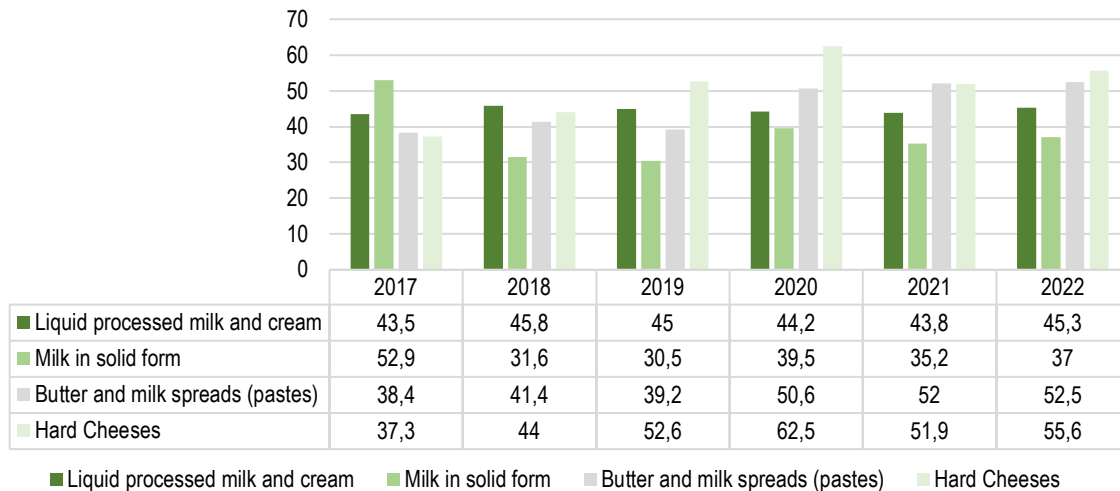
Source: compiled by authors according to www.stat.gov.kz

A fairly stable trend of stable growth in the production of milk and dairy products has developed on the domestic market. Milk production in Kazakhstan ended in 2022 with an increase in the output of marketable

products by 15.2%. At the same time, households produced 4,598.1 thousand tons of milk and dairy products, which is more than 80.5% of the total output (Figure 7).

The production capacity of Kazakhstan's dairy industry is not sufficient to meet the needs of the domestic market, one of the reasons for this state of the dairy industry in Kazakhstan is high competition from imports. Thus, the data in Figure 8 show that the average annual capacity of milk production enterprises is on average 44.6%, milk in solid form - 37.8%, butter - 45.7% and cheese – 40.6%.

Figure 8. Use of the average annual capacity of dairy industry enterprises, %



■ Liquid processed milk and cream ■ Milk in solid form ■ Butter and milk spreads (pastes) ■ Hard Cheeses

Source: compiled by authors according to www.stat.gov.kz

Thus, the dairy industry does not show significant changes in its development, a large proportion of dairy products are imported from other countries or produced from powdered milk and various substitutes. Reducing import substitution should be a priority for the sustainable development of the dairy industry in Kazakhstan. More than 60% of milk is produced in the households of the population and is of a low-intensive small-scale commodity nature. Large dairy farms should become points of economic growth for the dairy industry.

For this, in our opinion, mechanisms are needed to introduce strategic guidelines for the innovative development of the dairy industry (Table 2).

Table 2. Strategic guidelines for the innovative development of the dairy industry

Guides	Suggestions
Organizational and economic	<ul style="list-style-type: none"> State subsidization of production infrastructure for breeding breeds of dairy cows. Consolidation of farms through the creation of collective farms (cooperatives) for the processing of milk and dairy products.
Innovative	<ul style="list-style-type: none"> Application of genetic engineering for the development of dairy cattle breeding with high milk yield, automation of all milk production processes through the introduction of IT technologies and management. Increasing the awareness of commodity producers by creating a bank of industry-specific innovative developments.
Environmentally	<ul style="list-style-type: none"> The use of environmentally friendly technologies that reduce the negative impact on soil and water, as well as the creation of technology and infrastructure for the disposal of animal by-products should become the basis for the sustainable development of the dairy industry.

Source: compiled by authors

Conclusion

The dairy industry supplies food products that are vital to humans and are rich in animal protein. The sustainable development of domestic dairy farming should involve a quantitative increase in milk production along with an increase in its quality, as well as the mandatory introduction of mechanisms for the strategic development of the innovative component of the dairy industry. The solution to the issue of improving the quality of milk and the level of marketability of its production, taking into account environmental factors, will depend on a set of measures aimed at improving the quality at each stage of production and processing of milk with the direct participation of the state.

The development of high-intensity dairy production with the maximum use of the biological potential of animals, together with innovative technologies to increase the productivity of dairy cattle, will become the foundation for the sustainable development of the dairy industry.

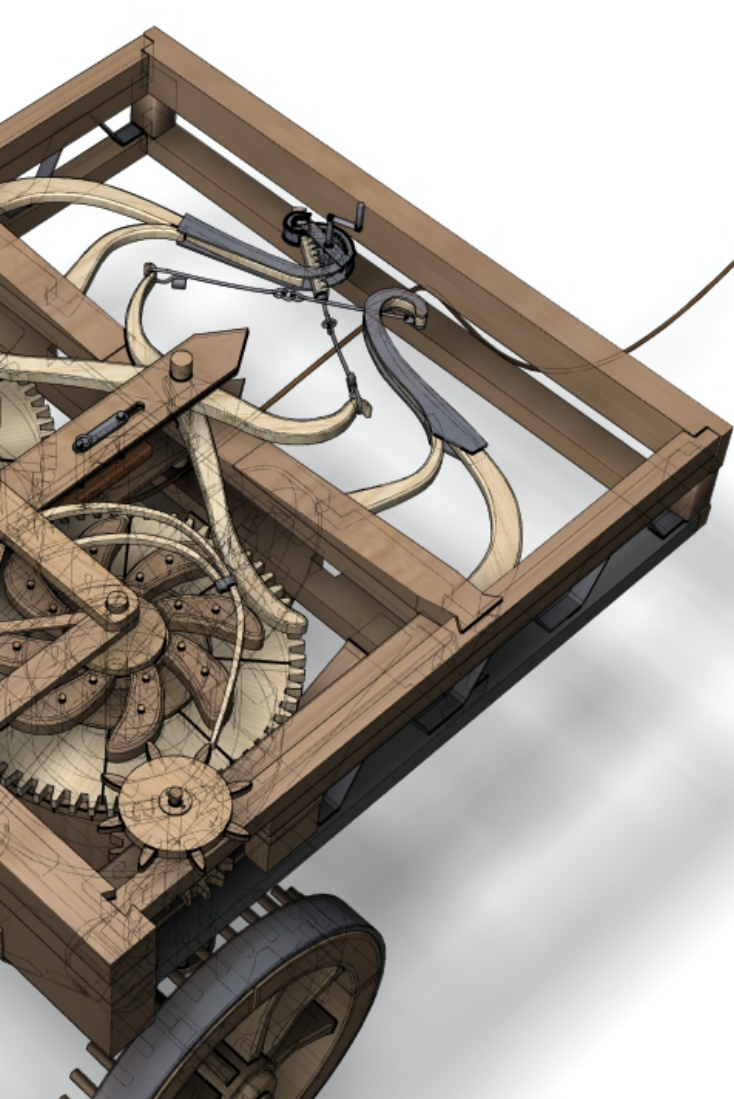
The introduction of innovations with an environmental component should become an incentive for the development of the market for environmentally friendly dairy products. State support for environmentally oriented industries can be manifested in the form of co-financing the introduction of environmental management, which will help attract technological eco-innovations, reduce environmental pollution, improve product quality and competitiveness.

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