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Clusters as a tool for improving the efficiency of the dairy industry

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ABSTRACT

Unbalanced relations between all participants of the food chain in the dairy business hinder the development of the livestock sector. Implementation of cluster policy in dairy cattle breeding enables the development of a competitive reference standard using benchmarking analysis. For the full and comprehensive development of the dairy cluster, it is necessary to observe organisational independence to meet the economic interests of all participants. The developed mechanism acts as the basis of a new area of economic analysis that measures synergetic results possible only within the framework of cluster system economic interaction in dairy cattle breeding.

Keywords*: Dairy cluster; productivity; benchmarking analysis; competitiveness factors; cow-keeping.*

1 Introduction

One of the most important components of the agro-industrial complex is the sphere of milk production and processing. Milk and its processed products are valuable and in high demand among the population. Population growth leads to an increase in the consumption of dairy products. Milk is one of the main products of the agricultural market and a key agricultural product. In this regard, the problem of providing the population with food is very relevant and an important place here is given to the dairy industry (Chernyakov, 2007).

The development and application of an organisational and economic mechanism, substantiation of methodological and practical recommendations, lead to the development of a competitive dairy cluster by creating effective cooperative ties between all participants in the dairy chain. Accordingly, it is necessary to investigate the theoretical and methodological ways of developing cluster theory in the context of the features of the dairy business, to assess the impact of regional agricultural policy on the integration of clustering processes, to justify the strategy for the development of a dairy cluster in the chain of livestock breeding, feeding, dairy products, waste disposal (Perova et al., 2020).

Cluster theory appeared in Porter's studies on various types of clusters, in his works, the causal relationship between the association of economic entities into a cluster and the growth of their competitiveness is highlighted. The cluster is a complex of interconnected economic entities (industry manufacturers of products, suppliers, service enterprises, infrastructure enterprises, and research institutes (Porter, 1998a).

The cluster is a form of consulting, organisational and informational interaction of milk producers in a certain region of the country (Shnitko and Khomenko, 2019). Cluster dairy cattle breeding is the production of livestock products of the progressive future; therefore, it should develop dynamically, but today the key principles of integration and clustering of the dairy industry are implemented at a fairly low level (Rautela et al., 2019). Existing enterprises in the regions are aiming toward cluster development, but they do not consider market conditions and organisational and financial relations, so clusters in the dairy industry are in their infancy (Dobson et al., 2007).

Today, economic growth requires an increase in the efficiency of dairy production, feeding and keeping highly productive dairy cows. Improvement of the conditions of keeping animals on the farm increases profits and reduces costs associated with health and low pasture yields, which raises the sustainability and efficiency of pasture-type dairy farming (Yushina, 2010). Only well-managed animals can meet the required level of productivity, the rest are submitted to early culling. The main risk factors for culling are assisted calving, abortion, mastitis, older age, low conception rates, and poor milk productivity (Ahlman, 2014). Cow-keeping is a multifactorial task that is difficult to manage in the current conditions, especially because reproduction, feeding, milking, veterinary control and care of cattle are considered separately (Adenuga et al., 2020).

The following breeds represent breeding work and genetic potential of highly productive animals: Ayrshire, Dutch, Holstein, Jersey, Red Steppe, Simmental, Kholmogory, Black Pied, and Yaroslavl, but it is impossible to separate any breed and call it the best. Recommendations for the selection of livestock depend on the natural and climatic conditions of the region and on the area of work of the enterprise, namely meat, dairy, or meat-dairy (Grelet et al., 2021). Breeds have a lot of positive characteristics: high productivity potential (about 10 thousand kg of milk per lactation), excellent adaptive properties, and positive meat qualities: most animals are distinguished by a strong, dense constitution (Andersson et al., 2010). High productivity in the cattle breeding area is the receipt of 7-8 thousand kg of milk per lactation with a high fat and protein content – 3.8% and 3.3%, respectively. In addition, they achieve the duration of economic use of cows for at least 4 lactations (Buller et al., 2018).

A major area of cluster intensification of agriculture is the introduction of scientific achievements. The use of qualitatively new production methods and technologies is necessary to reduce greenhouse gas emissions and restore fertile soils. The creation of a biogas complex allows effectively transforming dairy production waste into renewable electricity, heat, and organic fertilisers (Cockburn, 2020).

In recent decades, clusters have served as the most successful tool for the development of regional economies in Western countries. The creation of clusters in the dairy industry allows implementing new management solutions. All the components of the farm cluster are different in size of livestock, technologies, and genetic characteristics of animals (Ferova, 2010). Each of them has individual climate conditions and quality of harvested feed, also, a lot depends on the conscientiousness of the service personnel. The world practice of creating clusters shows that at such small enterprises there are more opportunities to ensure the longest period of economic use of animals (Awan et al., 2022).

The purpose of the study is to provide a comprehensive examination of dairy clusters, their advantages and challenges, and their potential impact on the dairy industry and regional development.

2 Materials and methods

System analysis in industrial and economic relations on the prospects of creating clusters in the dairy industry is a component of the general methodology of studies. The methods of this study begin with the identification of a purpose and the solution of tasks to achieve it. During the investigation of clustering in dairy farming, general scientific methods were applied: logical, comparative, monographic, computational and constructive, balance (Porter, 1998b).

The method, which is based on a detailed analysis of other people's experience with the introduction of the best practices to optimise and improve business efficiency, is a benchmarking analysis, in other words, a standard obtained by expert means and used as a reference. Benchmarking is classified depending on the object and subject of comparison:

- comparative, collation of data on the activities of one's own enterprise with the indicators of competitors' enterprises;
- strategic, combination of planning processes to discover exceptional opportunities to gain competitive advantages;
- commodity, comparison of own-made goods with competitors' goods;
- process-based, in-depth investigation of the activity as one's own.

In applying benchmarking analysis, it is necessary to create a flexible circle of dairy cluster participants capable of introducing and developing progressive changes in it and strengthening the overall competitiveness of cluster enterprises. The following analysis has a special specificity in the development of the composition of enterprises and types of activities, based on the methods of: multiplicativity, which allows determining the positive effects of work; emergence, the presence of special opportunities with which the enterprises involved in it do not exist separately; synergy, unidirectional actions of its constituent enterprises, which ensures an increase in the results of their economic activities.

It is possible to manage the activity of a dairy cluster by organising it into a well-functioning integrated system with certain structural elements. The scheme of the cluster methodology is described in detail in Table 1.

Table 1.
Structure of cluster methodology elements

Methodology of the dairy cluster		
Characteristics of the activity	Logical structure	Temporary structure of activity
Features, principles, conditions, standards of activity	Subject, object, forms, means, methods, result of activity	Phases and stages of activity

When elaborating methods for the practical implementation of cluster development of dairy business in regional agrarian policy, it is worth considering the features in the field of milk and dairy products production at the moment and the competitiveness of the region. A cluster in dairy farming is an agreement concluded for the production of dairy products, improvement of the quality of products by rural households, modernisation of equipment, laboratory assessment of the quality of purchased dairy products and feed raw materials, logistics development of a system for promoting marketable products to the market.

The cluster's work is aimed at meeting the needs of the population for high-quality and affordable products, ensuring promising work of existing processing enterprises of various capacities, and eliminating shortcomings. Based on the scientific approach, Table 2 presents the characteristics of the main activity of the dairy cluster, on the development of its management system and structure.

Table 2.
Characteristics of the milk cluster

Category	A high stage of development of the complex (creation of a technological chain), assuming territorial and social proximity
Place in the structure of the region's economy	It occupies an important place in the economy of the region, is the locomotive of the development of the agro-industrial sector of the agro-industrial complex of the region and the economy
The main goal	Improvement of the competitiveness of the region by producing high-quality dairy products and selling them outside the region
System management results	Efficiency of functioning of all subjects of the cluster for the implementation of joint projects

In the development of a dairy cluster, the following methods are used: economic, administrative, and socio psychological. Optimisation of the economic mechanisms of the agrarian policy of the state creates a reliable mechanism for the functioning of the cluster – it is pricing, taxation, planning, and financial support of enterprises. Administrative methods consist of solving specific cluster tasks. An increase in motivation and uniting of all cluster participants in joint projects on trust-based interactions, allows using socio-psychological methods.

The cluster as the highest form of integration and economic development has recently been reflected in many sectors, therefore it is necessary to elaborate schemes and mechanisms for the implementation of this form of entrepreneurship. Integration relationships for the exchange of information are a considerable factor of competitiveness, which has an impact on productivity and can fulfil territorial advantages in the production of dairy products and satisfaction of the population with the food of domestic production.

3 Results

Agro-industrial clustering in dairy production is the concentration and specialisation of business with the development of closed food chains "production – storage – processing – sale of agricultural products" in a certain territory based on integration and acquisition of competitive products by cluster participants, increase of their profits. To date, there is information about the existence of 833 clusters of various types of activities in 25 developed and 24 developing countries of the world (Zharikov et al., 2018). Clusters, according to researchers and specialists, are one of the tools to ensure the competitiveness of countries in the global economy.

In the technological chain, small and medium-sized businesses operating independently and with "all against all" competition remain poorly effective. The lack of profit growth with an increase in production hinders the inflow of investments and requires a constant increase in support for the dairy business. As a result, dairy production is naturally declining even in regions with conventionally developed dairy farming. In addition, dairy processing plants poorly maintain cooperative ties with agricultural producers, and as a result, they face a shortage of raw materials, which are often exported to foreign markets. The development of a cluster in the dairy business is part of the agro-industrial complex of a certain region, acting as a source of production and sale of various dairy products consumed by the population. A cluster is developed when combining territorial and intersectoral management, which should be reflected in the agrarian policy of this region, without hindering the improvement and increase in the productivity of products (Kolomytseva et al., 2020). The dairy cluster differs considerably from agricultural holdings and farms, since its main mechanism is the coordination of activities in the cooperative through the formal coordination of the interests of all participants, without competition in the dairy market.

Principles of developing a cluster dairy business:

- association of dairy agricultural organisations to expand mutual opportunities for the development of a cluster;
- joint work with the state to accelerate the processes of a special cluster-oriented agrarian policy;
- the need to accumulate common social capital;
- focus on the development of competitive advantages of all cluster members in working in foreign markets.

The dairy cluster can work effectively by forming management tools. The management organisation of the dairy cluster consists of the following activities: finance, economics, scientific and technical support, production of commercial activities, personnel management, product quality, creation of information and organisational methodological techniques, and security (Popkov et al., 2010).

The initial stage includes the establishment of the information base that forms the milk cluster management system. The information base includes information about the dairy cluster and the development of strategic tasks about the resource management system that affect the state of the internal and external environment. The accumulation of information leads to an awareness of the problems in the activities of an economic entity that need to be resolved and overcome for the further successful development of the cluster. The next stage is the identification of problems in the activities of the enterprise and its constituent farms, the analysis of monitoring and evaluation of the sustainable development of the dairy cluster. After passing the preliminary stages, the method of the management tool and its control are marked for use. Determination and implementation of the goal and the management method through which the working personnel of the cluster will be interested. The final stage is to investigate the deviations and the possibilities of correcting the mistakes made since the stability of work is very important for each enterprise (Wen et al, 2019). Modern and effective technology for establishing cooperation between the participants of the dairy cluster is a subcontracting mechanism that allows optimising time and labour costs and increasing the efficiency of production. Based on the experience gained, favourable conditions for the sale of dairy products for agricultural producers can be created, the development of large batches of milk for processors, and the supply of means of production to all members of the cluster.

Table 3 describes in detail the stages of development of a dairy cluster and the stages of change in its life cycle: origin, development, maturity, decline, and transformation.

Table 3.
Stages of development of the dairy cluster

Stages	Content of the stages	Clustering processes of the dairy business
Origin of the milk cluster (protocluster)	There is a localisation of potential cluster members, without links between them. A prospect of development through implementation within cluster projects is observed.	Development of intra-cluster connections between potential cluster members. Achievement of a balanced product movement chain.
Development of milk cluster (latent cluster)	The cluster has been developed, but it is not competitive enough; therefore, the need for recognition of the cluster in the foreign market increases.	Creation of institutional conditions for cluster self-development (creation of cluster development centres).
Maturity of the milk cluster (mature cluster)	A working chain of movement of dairy products has been established. The cluster functions efficiently and is popular in the foreign market.	Preservation of effective interaction of cluster members and its competitive advantages.
Decline of the dairy cluster	Slowdown of cluster development	Introduction of changes to the cluster development programme
Transformation of the milk cluster	Restoration of the pace of cluster development	Overcoming the internal inflexibility of the cluster, the development of new competitive advantages

Source: The table is developed according to Guidelines for the implementation of cluster policy in the northern regions of the Russian Federation (2022) and M. Porter (1998a).

The development of dairy clustering is a long way from the localisation of potential cluster participants without connections to a mature formed chain for the production of dairy products. Cluster development and its recognition in foreign markets are possible by creating institutional conditions for self-development (for example, the creation of cluster development centres in the region).

There is a widespread situation when the production income is received not by the cluster management company, but by its individual participant. While abroad, similar financial assistance is provided specifically to joint initiatives, that is, the targeting of directed funds prevails. Limited access to the best global business practices is a considerable barrier to the search and investigation of prospects for the implementation of new long-term strategic areas for the development of the dairy cluster. In 2000, based on the creation of innovative dairy clusters, it became possible to ensure competitiveness by means of the national clustering programme of the the European Union Lisbon Summit countries (Kizim et al., 2010).

The cluster principle of economic development of dairy farms in the countries of the European Union is classified considering the selected features of the production potential. Medium and large specialised dairy clusters play a key role in milk production. Five types of dairy clusters were proposed, differing in production potential, data analysis was based on FADN (Farm Accounting Data Network), the study covered 25 countries of the European Union by average values over three years (Table 4).

European dairy clusters differ greatly from each other in the scale and intensity of production. The III group of dairy clusters is characterised by high overall labour intensity and large areas of agricultural land; while the IV group has a high cost of fixed assets and a large number of dairy cows. Thus, the best production efficiency of dairy clusters was noted in groups III and IV; average in V; and low in I and II.

Table 4.
The production potential of dairy clusters in the European Union countries in 2020-2022

Country	EU-27					
Commodity	Dairy, Milk (1000 Head, 1000 MT)					
	2020		2021		2022	
	USDA Official	New	USDA Official	New	USDA Official	New
Calendar year begin	01/2020		01/2021		01/2022	
Cows in milk	20,766	20,766	20,565	20,536	20,300	20,219
Cow's milk deliveries to dairies	145,415	145,436	145,700	145,034	146,700	144,600
Other milk production	4,260	4,296	4,350	4,350	4,450	4,400
Total milk production	149,675	149,732	150,050	149,384	151,150	149,000
Extra EU27 imports	718	719	660	590	630	600
Total supply	150,393	150,451	150,710	149,974	151,780	149,600
Extra EU27 exports	1,477	1,483	1,560	1,563	1,560	1,500
Fluid use dom. consumption	23,912	24,106	23,900	23,937	23,950	23,550
Factory use consumption	127,004	124,862	125,250	124,474	126,270	124,550
Feed use dom. consumption	0	0	0	0	0	0
Total dom. consumption	148,916	148,968	149,150	148,411	150,220	148,100
Total distribution	50,393	150,451	150,710	149,974	151,780	149,600

Source: the table is developed according to Polet (2022).

In today's realities, the improvement of the dairy industry is also influenced by Green Deal. The Green Deal is a European Union initiative that aims to make the EU's economy sustainable and climate-neutral by 2050. The dairy industry is one of the sectors affected by the Green Deal. The European and US dairy industries are committed to reducing their environmental impact and have set goals to achieve greenhouse gas neutrality, optimize water usage, and improve water quality by 2050 (Boguniewicz-Zablocka et al., 2019). The dairy industry is working to minimize its environmental footprint by reducing greenhouse gas emissions, improving water usage, and conserving natural resources. Specific measures include reducing water consumption, improving water quality, and reducing greenhouse gas emissions. The industry is also exploring regenerative agriculture practices to protect soil health, enhance carbon sequestration, and enhance the nutrient density of dairy products (Peterson & Mitloehner, 2021).

Clusters can be a useful tool for improving the efficiency of the dairy industry in the context of the Green Deal. By dividing dairy farms into groups based on their characteristics, it is possible to identify best practices and areas for improvement. For example, a study of EU dairy farms found that farms with higher subsidies per cow tend to have higher efficiency. Additionally, regenerative agriculture practices, which aim to protect soil health, enhance carbon sequestration, and improve the nutrient density of dairy products, can be beneficial for both dairy farms and the environment (Pope et al., 2021). Other measures that can improve the efficiency of the dairy industry include reducing water consumption, improving water quality, and reducing greenhouse gas emissions. By implementing these measures, the dairy industry can work towards achieving its goals of greenhouse gas neutrality, optimized water usage, and improved water quality by 2050, as outlined in the Green Deal.

4 Discussion

The cluster principle of the development of the national economies of the world is reflected in special state initiatives and programmes. The construction of cluster policy is developing with priority state support for innovative cluster initiatives that have the potential for global competitiveness, including dairy producers who are able to increase their own food independence (Katukov, 2014). A distinctive feature of the dairy cluster from the general model of production-

cooperative and other interacting entities consists of farming on the principle of territorial localisation. It is necessary to understand that the geographical scale of cluster development in dairy farming can vary from one city and region to the level of states with common borders on the territory.

Digital technologies are also well developed in the dairy cluster. Milk is a perishable product and milk losses increase with improper storage and transportation. It is particularly important to develop methods of management of supply and cost reduction processes, to be able to properly store products and efficiently distribute them between their centres. It should be emphasised that digital technologies in the field of procurement in dairy farming are currently poorly developed (Polyanskaya and Rein, 2015).

A cluster approach is a progressive tool for increasing the profitability of the region and ensuring the employment of the population. It is worth noting the provision of the cluster in dairy cattle breeding with professional personnel, primarily zootechnicians, breeders, and workers who ensure daily constant accounting of production and the sale of milk per each animal on a dairy farm. According to American researchers, there is even a difference in milk yields of about 50% between farms, depending on management under the same conditions and technologies for keeping animals and feed raw materials. This problem, primarily, requires a systematic approach to staffing innovative transformations. Modern clusters tend to be developed near universities and research institutes since successful modernisation of the dairy industry is impossible without a system of additional professional education. In this regard, the legislative and regulatory framework for additional vocational education should become part of the current personnel policy. Vocational education can provide an increase in the performance and effective introduction of equipment and technologies, along with the training of the personnel reserve (Taneja et al, 2019). The expanded field of investigation is the optimal condition for the integration of branch science into enterprises, which as a result creates the possibility of developing an innovative scientific and methodological centre. Considerable attention in the organisation of the educational process is paid to the practice of students. The implementation of fundamental and applied research in the field of dairy farming and dairy production is conducted using an instrument-analytical and material-technical base at a high level.

The latest herd management systems, feeding, milking, and animal husbandry that include microclimate management systems can improve the health and productive longevity of animals, and lead to the development of a sustainable business in the cluster management system. The use of modern resource-saving technologies in the organisation of feed production primarily depends on the quality of harvested, produced, and used feed. In the formed dairy clusters, innovative technologies of animal retention and feeding with high-quality feed resources are additionally applied (Sinelnikov et al., 2017). Biotechnological products are enzymes, probiotics and prebiotics, premixes, and other feed additives that reduce losses during harvesting and increase feed conversion. Special attention in dairy clusters should be paid to the quality and quantity of compound feeds produced. The cultivation of fodder and grain-forage crops from high-quality seed material ensures an increase in the yield of grain-forage and, accordingly, feed. In the structure of rations, expensive components are replaced with cheaper ones. The structure of rations for highly productive cows provides at least 60-65% of bulky feeds, the rest is supplemented with concentrated ones. The effective ration of highly productive cows consists of: 3.76 tonnes of silage, 5.36 tonnes of haylage of cereals and legumes, 0.23 tonnes of hay, 6.5 tonnes of green and pasture feed and 2.34 tonnes of compound feed, and provides average milk yields of about 6500-7000 kg of milk per cow per year. Harvesting high-energy, high-quality herbal feeds can considerably increase the nutritional value of the bulk part of the rations, and the actual content of nutrients and energy in them can be brought closer to the physiological needs of animals, reducing the consumption of concentrated feeds. As a result, the higher the concentration of energy per dry matter unit of grass feed, the less concentrates are required. In addition, protein-vitamin-mineral concentrates of industrial production and own high-protein feed are widely used in feeding livestock.

Active breeding work in the dairy cluster is a priority area of the innovative dairy cluster business in cattle breeding. For effective reproduction, it is necessary to reduce unproductive cows and replacement heifers and ensure the yield of calves per 100 cows of at least 95 heads. In addition, the problem of cattle breeding is unreasonably high culling of cows from the main herd, which can be of two types: zootechnical in selection and breeding work and keeping technology; unproductive as a result of various livestock diseases. They are culled from the herd primarily for the following main reasons: lameness, mastitis, reproductive dysfunction, and low productivity. The quality of breeding work and the management of the composition of the dairy herd are prerequisites for maximising the potential of new technologies.

The efficiency of many dairy processing enterprises is practically at zero today, therefore it is necessary to develop high-margin segments as part of the dairy cluster for the production of whole milk and fermented milk products, processed and packaged cheeses, milk powder, butter, spreads, canned milk. Interactions within the cluster, quite unexpectedly, lead to the emergence of new ways to compete and produce certified products for quality and food safety management systems — Hazard Analysis, Critical Control Point, HACCP (Poczta et al., 2020).

Not the last place in the introduction of a large-scale agricultural business is occupied by bioenergy; in the European Union and the United States, renewable energy sources are an integral part of the green energy transformation. Admittedly, sugar beet processors and poultry and pig farming enterprises are the most active. Enterprises are launching

biogas plants (using agricultural raw materials) with a total capacity of 31.3 MW of electricity (Makarchuk et al., 2007). Dairy clusters, as participants in this process, are also able to generate a large amount of biomass annually (by-products of cattle breeding) and considerably increase capacity for the production of green energy. This industry is extremely efficient, but it is not at the stage of initial development in the dairy cluster system.

The authors' approach to dairy clusters involves conceptualizing them as specialized economic entities focused on milk and dairy product production. These clusters offer a range of advantages, including coordinated strategies, healthy competition, and cooperative relationships among firms within the dairy industry. They promote dairy products through consumer-oriented advertising, foster the development of processing industries, and attract foreign investments, ultimately contributing to socio-economic growth. Dairy clusters also address deficiencies in feed production, reduce risks associated with external factors, and support innovation in animal husbandry and production technologies. However, defining the boundaries of clusters can be challenging due to their complex nature, which includes various organizations and government agencies. Nevertheless, well-developed dairy clusters have the potential to expand production, increase profitability, strengthen competitiveness, and play a vital role in regional development.

5 Conclusions

It is established that the dairy cluster occupies an important position in the product structure of the agro-industrial complex, milk is a valuable livestock product in the structure of nutrition of the population, developing the economic potential of the region. An important feature of creating a cluster as a business is dairy products that have a limited shelf life, while well-coordinated work can ensure a consumer orientation. With the intensification of the production of milk and dairy products, enterprises get the opportunity to increase the volume and quality of products, focusing not only on personal provision but also on the supply of products to other regions.

The conducted study allows stating the fact that today in the dairy industry there is a need for a cluster management system. The transition of cooperative and private structures in the cluster can help fulfil the potential of the entire dairy industry and all its components.

It has been established that, on the scale of the European Union, medium and large highly specialised intensive farms play a key role in milk production. Despite the fact that their profitability is somewhat limited, they demonstrate a high level of productivity. In turn, insufficient capacity is one of the main constraints faced by other dairy clusters.

The classification conducted and the stages of its development can be used as a basis for further forecasting of the level of efficiency of dairy production for various types of activities at agricultural enterprises.

Therefore, the main way to develop a dairy cluster is to trust the state and other participants to gain positive experience in implementing joint projects.

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