

The digital transformation concept of sustainable development in dairy cattle breeding

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Abstract. Dairy cattle breeding is a strategically important sub-sector for ensuring food security in Russia, respectively, the sustainable development of the sub-sector is a global task of the Russian economy. Nowadays, it is possible to identify a variety of factors that are dependent and independent of commodity producers, affecting the sustainable development of dairy cattle breeding. Within the framework of the digital agriculture project being implemented in Russia, the systemic and integrated application of digital innovations of industry importance should be considered as the primary factors affecting, first of all, the economic stability of the sub-sector. The importance of the digital transformation of dairy cattle breeding is undeniable and requires closer study, including from the perspective of forming the concept of digital transformation within the framework of its sustainable development, that is, considering three areas of sustainability: economic, social and environmental.

1 Introduction

Sustainable development of agriculture is impossible without the introduction of scientific achievements. From this point of view, the problems of production modernization, including digital, and the sustainable development of agriculture as a whole, and its individual sub-sectors, should be considered synchronously, since they help to solve the strategic task of the Russian economy - ensuring food consumption at the recommended level and the required quality, in particular the "organic" standard. This task is one of the priority national interests of the state in the field of food security. The application of ESG criteria provides a number of advantages to commodity producers aimed at long-term development. In addition, it should be borne in mind that the widespread use of integrated solutions and individual digital tools in the sub-sector is directly related to solving the tasks of the "green economy" - increasing the production of organic livestock products, which is also a long-term task, since it requires a period of "preliminary preparation" for clean organic production, in terms of meeting technological conditions and standards, including international ones.

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2 Materials and methods

The key purpose of this article is to assess the state of dairy cattle breeding in the Krasnoyarsk region, systematize the main factors that have a direct impact on its sustainable development, as well as develop a concept for the digital transformation of the sub-sector, considering the economic, social and environmental areas of sustainability.

The methodological basis of the research presented in this article is presented by the works of foreign and Russian scientists in the field of sustainable development and the application of digital innovations in dairy farming, such as N. Repar, P. Jan, T. Nemecek, D. Dux, R. Doluschitz (2018), O. Nezamova, J. Olentsova (2021), E. Stepanova, A. Rozhkova, M.A. Fedorova and M.G. Ozerova, M.G. et al.

In order to solve food problems and improve the standard of living of the population, the state agrarian policy is applied, which determines the directions for development of branches of the agro-industrial complex in Russia [1]. The development of the dairy cattle sub-sector at the regional level should be based on the all-Russian priority areas of agricultural development. Present data on milk production by agricultural organizations of the Krasnoyarsk region, based on official information from the Federal State Statistics Service (fig. 1) [2, 3].

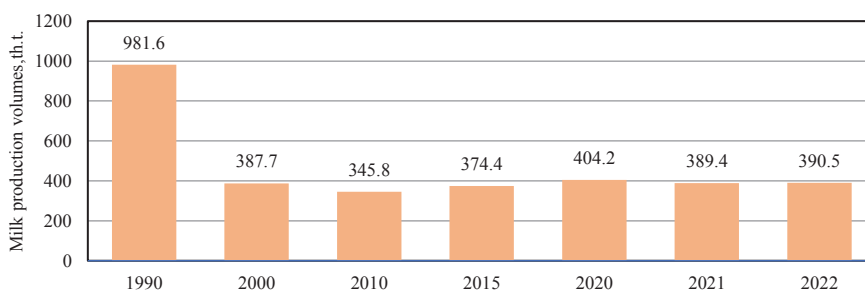


Fig. 1. Milk production volumes in agricultural organizations of the Krasnoyarsk region.

It should be noted that at the regional level, milk production in 2022 amounted to 390.5 thousand tons, which is 2.5 times lower than the level achieved in the region in 1990. At the same time, agricultural organizations are the main producers of raw milk in the Krasnoyarsk region, accounting for 62.12% of the gross volume. At the same time, the average per capita consumption of milk and dairy products in 2021 in the Krasnoyarsk region amounted to 236 kg/person per year, or 27.38% less than the recommended norm (325 kg per year per person). It should be noted that gross milk production depends on two main factors: the number of dairy cattle and the productivity of cows [4]. Imagine the dynamics of the number of cows in fig.2.

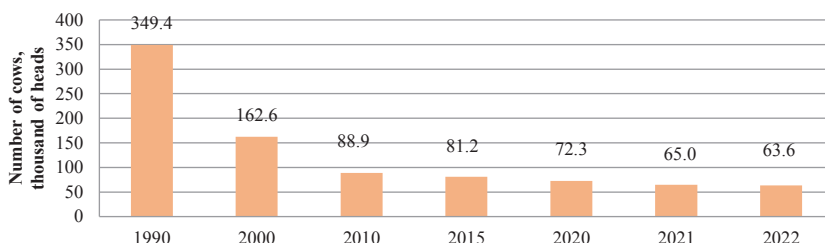


Fig. 2. The number of cows in agricultural organizations of the Krasnoyarsk region.

The number of dairy cows in agricultural organizations of the Krasnoyarsk region decreased during the analyzed period and in 2022 amounted to 63.6 thousand heads, which is 5.5 times lower than the number formed in 1990. The reduction in the number of cows is due to the high labor intensity and insufficiently fast payback period of the resources used in production, which significantly affects the level of development of the sub-sector. Agricultural producers tend to use more productive livestock breeds, which helps them to save resources necessary for the maintenance of a large herd and for ensuring the reproductive process, for example, to reduce costs in the formation of a feed base. Next, imagine the dynamics of the average annual milk yield from one cow, which has the opposite trend (fig.3).

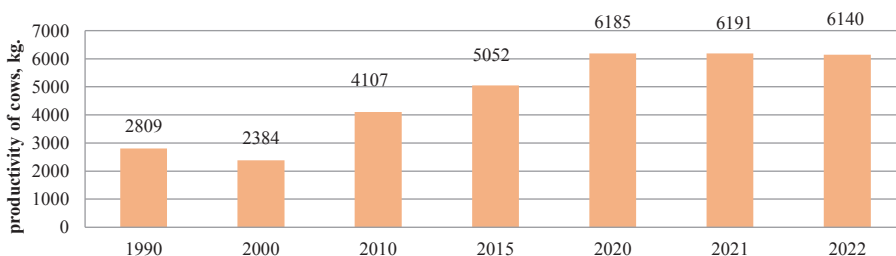


Fig. 3. Dairy productivity of cows in agricultural organizations of the Krasnoyarsk region.

The level of average annual milk yield from one cow in agricultural organizations increased 2.2 times during the analyzed period. This growth is due to the widespread introduction of diverse innovations into production, which contributes to the intensification of the development of the sub-sector. Thus, the volume of gross milk production in the Krasnoyarsk region over the past decade has been maintained solely by increasing the productivity of cows and using their genetic potential.

The above changes have a significant impact on the economic results of milk production. Consider the indicators characterizing the economic efficiency of running a sub-industry in modern conditions, the data will be presented in the table 1.

Table 1. Economic results of milk production in the Krasnoyarsk region

Indicator	2020	2021	2022
Production cost of 1c, rub.	2119.3	2350.4	2526.4
The selling cost of 1 ts, rub.	2414.3	2604.6	2991.7
The average selling price of 1c, rub.	2963.6	3079.2	3635.8
Profit per 1 cent, rub.	549.3	474.6	644.1
Cost-effectiveness level (without subsidies), %	22.7	18.2	21.5
Cost-effectiveness level (with subsidies), %	34.0	28.2	30.3

Over the past three years, there has been an increase in the production and sales cost of 1 kg of milk by 19.21% and 23.92 %, respectively, which is partly due to rising prices for consumed resources and the need to invest in innovations that ensure a high level of production intensity in the sub-sector. In 2020-2022, milk production in the Krasnoyarsk region brought positive financial results to agricultural organizations. The average profit in 2022 was 644.1 rubles per 1 cent of production, which is 17.26 % higher than the level of 2020 and 35.71 % higher than the level achieved in 2021, as a result, cost-effectiveness in 2022 amounted to 30.3%.

In modern conditions, the state agrarian policy, including those aimed at the development of dairy cattle breeding, should consider the concept of sustainable development or the concept of ESG transformation, and, therefore, is based on the principles of sustainability. The concept of sustainable development is conditioned by "the manifestation of a shortage of resources, the deterioration of the natural environment, the presence of food problems and a deep gap in the standard of living between rich and poor" and became the subject of widespread discussion in the world community in the 60s of the twentieth century [5]. Traditionally, this concept develops as a synthesis of three areas of research: economic sustainability, social sustainability, environmental sustainability, while each area is based on its own prerequisites, for example, economic sustainability is based on the "theory of maximum flow of total income under the condition of optimal use of limited resources, considering the use of environmentally friendly technologies" [6].

The World Commission on Ecology and Development at the United Nations identifies the concept of "increasing the sustainability of society" - this is "the ability to meet the needs of those living without compromising the ability of future generations to also meet their needs", this concept is directly related to the sustainable development of production. In addition, in 1996, at the FAO session in Rome, "the main task of sustainable agricultural development was identified, which sounds like increasing the level of food production in a sustainable way that ensures the necessary level of national food security" [7].

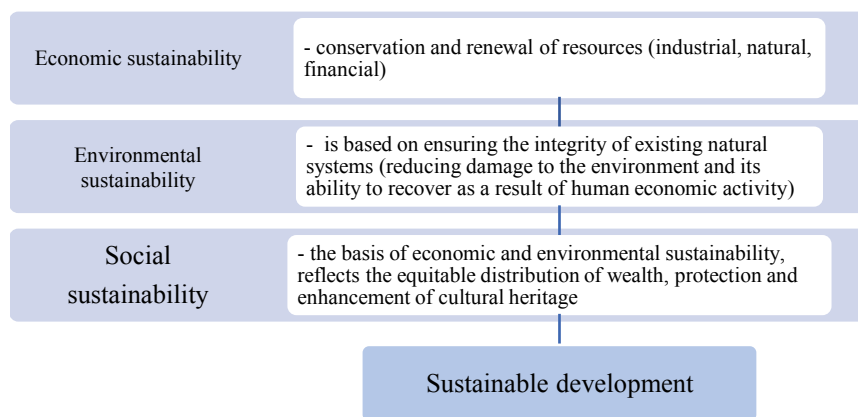


Fig. 4. The main areas of the concept of sustainable development.

To date, the basic regulatory documents in the Russian Federation that consider the concept of sustainability can be considered the "Strategy for sustainable development of rural territories of the Russian Federation for the period up to 2030" (2015), which considers the issues of dynamic development in branches of the agro-industrial complex, and on this basis, improving the level and quality of the population life, and the "Strategy for the development of organic food production products in the Russian Federation for the period up to 2030", focusing on environmentally safe friendly agriculture. At the same

time, a number of foreign and Russian scientists give interpretations characterizing the areas of the concept of sustainable development, we will reflect them in fig.4 [5, 8].

3 Results

Considering the current trends in economic development and the announced priorities for the development of agriculture, producers engaged in dairy cattle breeding should consider the issues combined by the ESG criteria model when developing their development strategy.

Analyzing the possibilities of sustainable development of the dairy cattle sub-sector in agricultural organizations of the Krasnoyarsk region, as well as relying on the works of foreign scientists, in particular the joint work of the authors Repar, N., Jan, P., Nemecek, T.; Dux, D., Doluschitz, we note that the growth of economic efficiency indicators in dairy cattle breeding (economic sustainability of the development of the sub-sector), it depends on numerous factors [9]. In table 2, we systematize the factors that have a direct impact on all areas of sustainable development of the sub-sector, dividing them into two groups: factors dependent on the producer (internal) and factors independent of the producer (external) [3-5, 8, 10-15].

Table 2. Factors influencing the sustainable development of dairy cattle breeding in modern conditions.

Area	Factors	
	Dependent on the producer	Independent of the producer
Economic development (economic sustainability)	<ul style="list-style-type: none"> - the level of production potential (the volume of raw milk production), formed on the basis of selection and genetic work. - increasing the number of livestock and optimality of the structure of the herd of animals. - the breed composition of the herd. - reduction of the period of non-productive using cows. - the level of resource potential (human resources, food supply). - conditions for keeping animals. - the level of technical and technological development of the industry, including comprehensive modernization and reconstruction of production facilities and production lines. - the level of application of resource-saving and digital technologies. - rational organization and management of technological business processes in the industry. 	<ul style="list-style-type: none"> - economic instability under the conditions of the sanctions regime and the complexity of the geopolitical situation in the world. - formation of import-substituting production. - tax and budgetary policy, the activity of state regulation of the sub-sector, in particular regulatory support and state support. - investment and innovation policy, ensuring an increase in the innovation and investment attractiveness of the industry based on the construction of large dairy complexes. - the perfection of the consulting system and the level of information support in the sub-sector. - the policy of digital transformation of dairy cattle breeding. - formation of interaction between business entities within the framework of agricultural cooperation. - implementation of marketing activities, including those aimed at popularization of dairy products - "organic".

Social progress (social sustainability)	<ul style="list-style-type: none"> - the level of qualification and competence of personnel, including in the field of advanced technologies. - organization, rationing and payment there. - the system of stimulating the work of employees. - working conditions of dairy cattle workers. 	<ul style="list-style-type: none"> - development of social infrastructure in rural areas. - the level of quality of life in rural areas and the availability of a social package for dairy cattle workers.
Responsibility for the environment (environmental sustainability)	<ul style="list-style-type: none"> - the progressiveness of the technology of keeping dairy cattle, including compliance with the principles of organic animal husbandry. - compliance with the principles of environmental friendliness in the formation of the feed base and the preparation of the animal feeding diet. - introduction of a model of circular (waste-free) production in dairy cattle breeding. 	<ul style="list-style-type: none"> - natural and climatic conditions. - conservation of biodiversity. - certification of organic dairy cattle breeding. - changing the quality standards of the final product, defining it as an "organic" product.

Ensuring the sustainable economic development of dairy cattle breeding requires the selection of priority areas for the development of the sub-sector, which are able to ensure the return of resources, increased efficiency and competitiveness of products in a short time. First of all, the sustainable development of dairy cattle breeding presupposes "the ability of the sub-sector to adapt to changes in the number of dairy herds and the production potential of the sub-sector, ensuring the environmental safety of the territory in the long term" [10].

For the purpose of sustainable economic development, it is necessary to transform the existing agro-food system based on the introduction of innovative technologies, including digital ones, within the framework of the fourth industrial revolution - Industry 4.0 [16-19]. For example, the robotic technologies of Industry 4.0 make it possible to transfer almost all machinery and equipment to a "deserted mode", which reduces the labor intensity of production. Consequently, one of the modern directions of sustainable development of dairy cattle breeding is the digitalization of the main business processes characteristic of dairy cattle breeding, which contributes to increased labor productivity, cost reduction, and increased profitability of the production of final products. Thus, we consider it appropriate to propose a concept of digital transformation of dairy cattle breeding, which should consider the solution of strategic tasks aimed at sustainable development of the sub-sector based on the use of modern digital tools (fig. 5). Today, in the sub-sector, the most relevant application of digital technologies in management, integrated systems for direct use - "Smart farm", "Digital herd" and indirect use - "Smart warehouse" and "Smart agrooffice" [20].

4 Conclusion

Over the past decades, an ambiguous situation has developed in the Krasnoyarsk region in the dairy cattle industry. Gross milk production in the region has remained stable over the past three years and remains at the level of 389-404 thousand tons, however, this is significantly lower than the level achieved in 1990. This level of milk production is ensured by an increase in the productivity of the dairy herd of cows, while there is an annual

reduction in the number of cows in agricultural organizations. Keeping a large herd of cows is labor-intensive despite the automation of a number of business processes [21-23].

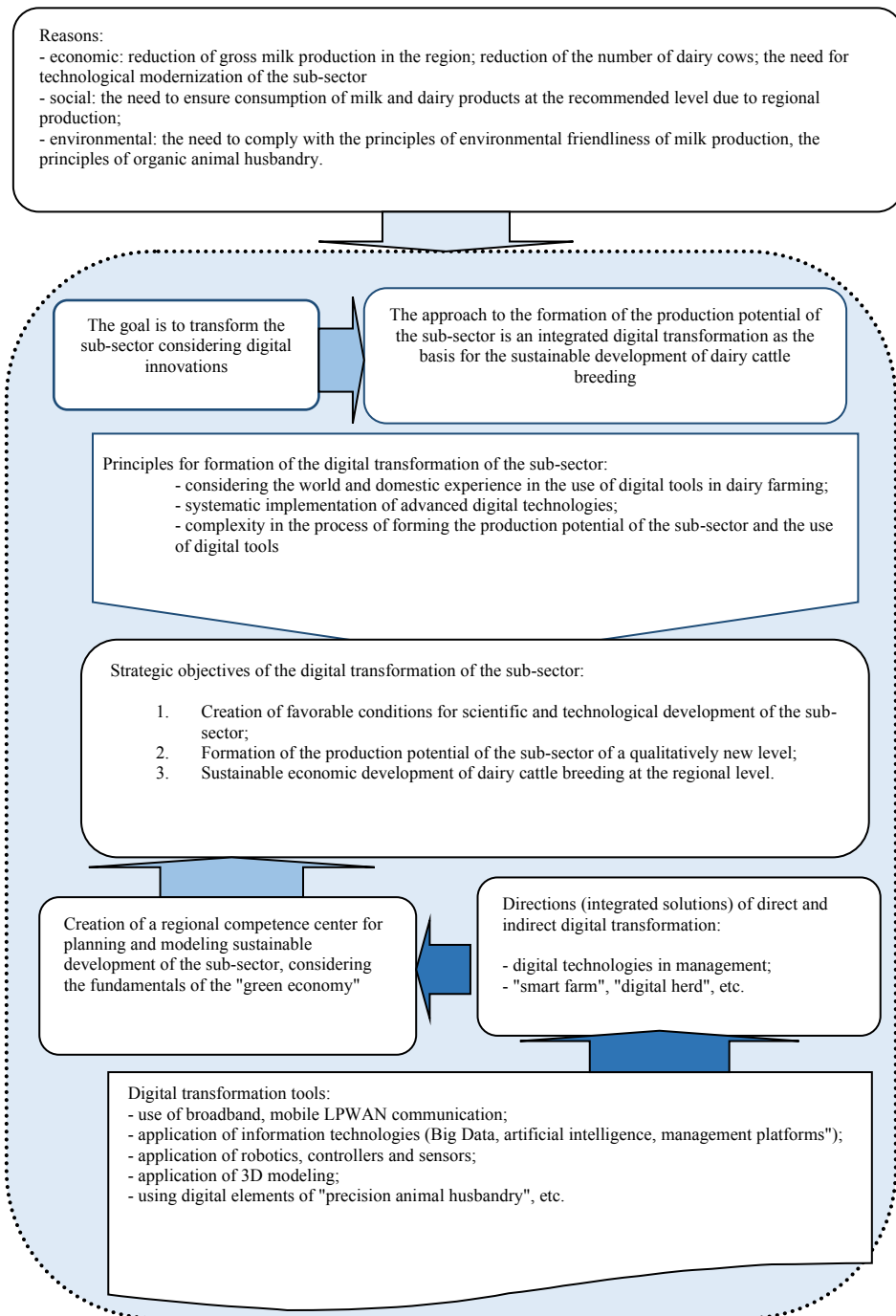


Fig. 5. The concept of digital transformation of dairy cattle breeding

As the practice of the dairy cattle industry in the Krasnoyarsk region shows, a number of factors can be identified that are dependent and independent of agricultural producers,

which have a direct impact on the sustainable development of the sub-sector in modern conditions.

One of the key factors should be considered the introduction of a wide range of digital innovations into technological business processes, which in turn requires the formation of a concept for the digital transformation of dairy cattle breeding in the region. Understanding and correctly constructing the concept of digital transformation of the sub-sector will ensure compliance with the basic principles necessary for the modernization of production: complexity and consistency, as well as compliance with the principles of sustainability, in particular environmental friendliness of production.

References

1. Zinina O.V., Dalisova N.A., Pyzhikova N.I., Olentsova J.A. IOP Conference Series: Earth and Environmental Science, **315(2)** 022068 (2019)
2. Agro-industrial complex of the Krasnoyarsk region in 2022 - Krasnoyarsk: Ministry of Agriculture and Trade of the Krasnoyarsk region, 206 p. (2023)
3. Ozerova M.G., Fedorova M.A. IOP Conference Series: Earth and Environmental Science, **1112(1)**, 012070 (2022)
4. Gorodov A.A., Fedorova M.A., Gavrilova O. Yu. IOP Conference Series: Earth and Environmental Science, **315(2)**, 022041 (2019)
5. Gavrilova O. Yu., Fedorova M.A., Baikal Research Journal, **13**, 3 (2022)
6. Vorobey E.K. Sochi Journal of Economy **17(1)**, 69-78. (2023)
7. Shevtsov V.V. Bulletin of the V.N. Tatishchev Volga State University, **2**, 1, 130-137 (2022)
8. Boyer R. H. W., Peterson N.D., Arora P., Caldwell K. Sustainability, MDPI, **8 (9)**, 1–18 (2016)
9. Repar N., Jan P., Nemecek T., Dux D., Doluschitz R. Sustainability, MDPI, **10 (8)**, 2940 (2018)
10. Malygin A.A. Regional Appendix, **1(57)**, 54-59 (2019)
11. Nezamova O., Polukarov N., Zdrestova-Zakharenkova S., Yamshchikov A., E3S Web of Conferences, **402**, 09013 (2023)
12. Rozhkova A.V., Stepanova E.V., IOP Conf. Series: Earth and Env. Science, **981(2)**, 022087 (2022)
13. Nezamova O.A., Olentsova J.A., IOP Conference Series: Earth and Environmental Science, **839(2)**, 022060 (2021)
14. Ozerova M.G., Pyzhikova N.I., Filimonova N.G., IOP Conference Series: Earth and Environmental Science, **421(3)**, 032058 (2020)
15. Nezamova O A and Olentsova J A IOP Conference Series: Earth and Environmental Science **677(2)** 022034 (2021)
16. Nezamova O.A., Olentsova J.A. IOP Conference Series: Earth and Environmental Science, **981(3)**, 032018 (2022)
17. Stupina A.A., Rozhkova A.V., Olentsova J.A., Rozhkov S.E., IOP Conference Series: Earth and Environmental Science, **839(2)**, 022092 (2021)
18. Rozhkova A V and Olentsova J A, IOP Conf. Ser.: Earth Environ. Sci. **421(2)** 022035 (2020)

19. Stepanova E V IOP Conference Series: Earth and Environmental Science **677(2)** 022084 (2021)
20. Fedorova M.A., Ozerova M.G., Socio-economic and Humanitarian Journal **3(29)**, 38-50 (2023)
21. Stepanova E V IOP Conference Series: Earth and Environmental Science **548(2)** 022098 (2020)
22. Rozhkova A and Olentsova J E3S Web of Conferences **161** 01086 (2020)
23. Stepanova E *Innovative development of the export oriented regional agro-industrial cluster* ACM International Conference Proceeding Series 3444479 (2020)