Innovative approaches to the development of dairy cattle breeding in the Kaluga region

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Abstract. The use of innovative approaches to the development of breeding cattle in the region has significantly increased and improved the productivity of animals. So, over the past 5 years, gross milk production has increased by 192 thousand tons or 171%, milk yield per cow by 2705 kg and amounted to 8745 kg in 2021. The breed composition of cows has changed, the Holstein breed with a specific gravity of about 80% has become the predominant breed of dairy cattle in the Kaluga region. The selection of bulls is aimed only at the bulls-leaders of the Holstein breed and their sons. IT technologies are actively used in the management of regional dairy cattle breeding in the region.

1 Introduction

The efficiency of cattle breeding development is determined by increasing the productivity of cows and the introduction of intensive technologies that provide an optimal level of costs for the housing and exploitation of animals [1, 2]. The main factors are carrying out breeding work at a high level, balanced feeding, the use of modern equipment and animal welfare [3, 4, 5, 6]. Effective breeding work, a solid feeding area and modern industrial technology of milk production, while the highest effect is achieved if all these factors act in an integrated manner and the level of development of each of these factors is high enough. In the new economic conditions, the increase in the volume of gross livestock production will be carried out not only by increasing the number of livestock, but mainly by increasing its productivity. Under these conditions, the role of breeding is particularly increasing, which provides from one third to one half of the increase in the level of dairy productivity of cows.

Improving the quality of the dairy herd, and consequently increasing the productivity of cows, which leads to a reduction in feed costs and a quick return on investment has a great national economic importance. But intensive use of cows, with a high body burden, leads to a reduction in their longevity, so the term of productive use in many farms, especially those breeding Holstein breed, does not exceed three lactations, which from an economic point of

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view, the maintenance of such cows is not profitable [7, 8]. In dairy cattle breeding, under the influence of many factors, one of the problems is the realization of the already created sufficiently high genetic potential of dairy productivity of cows [9, 10]. In recent decades, great results have been achieved in animal genetics, as well as the use of sexed seed, which has helped to expand the selection possibilities of bulls with high genetic productivity potential and, accordingly, accelerate the pace of genetic improvement of entire populations [11-13].

The intensification of dairy cattle breeding in the Kaluga Region is carried out on the basis of the construction of industrial livestock complexes by large and medium-sized businesses and the improvement of the breed composition of cattle through the use of both domestic and the world's best genetic resources [14-15].

Due to the need to increase the number of dairy cows, the question of choosing breeds for intensive breeding is relevant, ensuring the efficiency of production while maintaining high reproductive qualities and productive longevity of animals.

In this regard, breeding work with cattle in the Kaluga region will be aimed at continuing the process of improving the breeding and productive qualities of animals of zoned cattle breeds.

2 Materials and Methods

The material for the work was the data of breeding records from the SELEX program in dairy cattle breeding in the Kaluga region as of the beginning of 2022, as well as data from our own experimental and analytical studies. The regression analysis methodology was used for the calculations. Biometric methods of statistical analysis with the calculation of averages were used.

3 Results and Discussion

In 2021, agricultural organizations of all forms of management in the Kaluga region contained 232.0 thousand heads of cattle, including 107.8 thousand dairy and meat cows.

Table 1. Livestock (dairy and meat) and milk production in the Kaluga region (2016-2021)

Period	Number of cattle, (thousand heads)				Milk production, thousand tons		Milk yield per cow, kg
	all categories of farms		agricultural enterprises		all categories of farms	agricultural enterprises	
	total cattle	including cows	total cattle	including cows			
2016	147.5	59.8	124.2	48.1	269.1	225.2	6040
2018	168.3	74.0	147.8	64.8	345.8	310.5	7358
2019	199.9	86.9	179.0	77.9	398.6	366.2	8056
2020	222.4	99.4	202.4	90.1	428.2	396.5	8070
2021	232.0	107.8	212.8	99.1	460.7	432.4	8745

In the Kaluga Region, a bet has been placed on the development of dairy cattle breeding in large agricultural enterprises.

In recent years, the development of the dairy cattle industry in the region has been increasing for all the indicators. Over the past 5 years, gross milk production has increased by 192 thousand tons or 171%, milk yield per cow by 2705 kg. The main task of breeding

work is the cultivation of highly productive animals, the continuous improvement of existing and the creation of new, more economical, livestock breeds. Moreover, animals must have high adaptive properties, suitability for use in modern conditions of industrial-type farms and robotization.

One of the factors affecting the dairy productivity of cows is the breed, in connection with the inventory of breeds in 2021 in the Kaluga region there were significant changes. The predominant breed of dairy cattle in the region is now the Holstein, its specific weight in the breed composition was about 80%. The smallest share belongs to the Swedish red breed - 0.5% (Fig. 1).

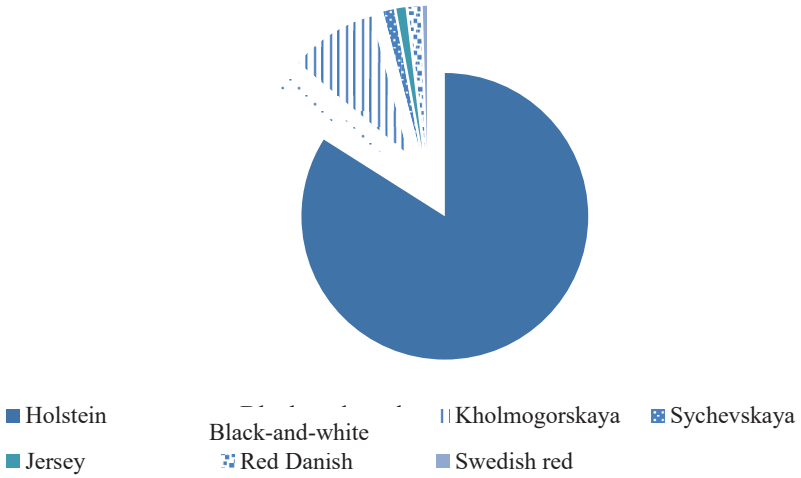

Fig. 1. The structure of the breed composition of dairy cattle in the Kaluga region

The presence of highly productive cows in the herd testifies to the competent work of a zootechnic breeder and proper management using high technologies in breeding work. Record milk yield in the region was obtained from black-and-white cows belonging to the farm of LLC "Antey Agro". The animal with the number 217 had a milk yield of 16562 kg of milk, with a fat of 4.89 and protein of 3.13%. 16241 kg of milk with 3.69% fat and 3.38% protein was produced from a 9357968073 Holstein cow of Kaluga Niva LLC for 305 days of the third lactation, while the fifth lactation is the maximum. The best indicator for the Kholmogorsky breed of cow 8837, owned by the farm LLC "Green Lines - Kaluga" - milk yield was 14902 kg with a fat content of 3.28% and protein-milk content of 3.0%.

In each breed, the best cows with high milk productivity were identified, so in the Holstein breed, the milk yield of the best cows varied from 11924 to 16968 kg of milk, in the Kholmogorskaya – from 8070 to 15778 kg, in the black-and–white – from 10031 to 15698 kg, in the brown Schwyz breed – from 13708 to 14575 kg, in the Sychevskaya breed - from 8752 to 9780 kg, in the Swedish red breed – from 11395 to 11790 kg, in Jersey – from 10375 to 11543 kg, in red Danish – from 10651 to 13182 kg of milk. Cows (12.8%) of the total probonitized livestock with a high fat content of 4% or more are allocated, the number of cows with a milk yield above 10,000 kg of milk increases.

The longest period of use characterizes animals of Sychevskaya (4.6 calving) and black-and-white (3.6 calving) breeds.

An important component of increasing the productivity and efficiency of dairy cattle breeding in the region is the indicator of the concentration of cows per hectare of agricultural land (x2), this is confirmed by the results of studies conducted in a number of breeding farms in the region using regression analysis techniques. According to the

concentration of cows per 100 hectares of agricultural land, conclusions can be drawn regarding the intensification of farming, the development of own feed production, and the availability of feed (Table 2).

Table 2. Estimated milk yield per forage-fed cow on the example of individual breeding farms

Farms	Output of calves per 100 cows	Availability of livestock per 100 hectares of agricultural land, head.	Estimated milk yield per 1 feed cow, kg	Milk yield per 1 cow with an increase in the number of livestock per 100 hectares, %
PAO "Krivskoe"	83	62.1	13076.3	143.0
OOO " Molochnaya Ferma"	83	68.3	14068.9	119.6
SX OOO "Swiss milk "	83	85.3	16790.6	133.7
OOO " Agrofirma "PZ Zarya"	83	58.8	12547.9	94.8
OOO "Krasny Kombinat"	83	32.1	8273.3	181.3
OOO "AF Detchinskoe "	81	44.9	10305.2	208.8
AO " Breeding plant named after V.N.Tsvetkov "	83	56.1	12115.7	145.7
OOO "Kaluzhskaya Niva"	84	224	18005.1	42.2
OOO "Moloko Group"	98	26.2	7458.7	329.8
OOO " Vorobyovo"	83	37.3	9105.8	236.6

Thus, the data in Table 2 allow us to draw some conclusions, an increased yield of calves per 100 cows by one percent leads to an increase in milk yield from one cow by 8.7 kg, and an increase in cows per 100 hectares of agricultural land by one percent will increase the yield by 217 kg of each cow.

Dairy cattle breeding in the region is developing in an intensive and modern way using innovations. Intensification of dairy cattle breeding is a complex and multifaceted economic process. Using the example of several farms in the region, we will present the impact of innovations in dairy cattle breeding on animal productivity (Table 3). With the use of innovations in dairy cattle breeding of individual farms, the milk yield of cows increased in the range from 2253 kg to 5408 kg, and in the whole region by 4216 kg.

Table 3. Rates of change in cow productivity using new technologies

Economy	Cow productivity		± new to old
	without implementation	with the introduction of innovations	
SX OOO "Swiss milk	5998	11406	5408
PAO "Krivskoe"	6630	8883	2253
OOO " Vorobyovo "	6115	8827	2712
By region	4529	8745	4216

Calculations show that an innovative approach to the development of dairy cattle breeding in the region has significantly affected the dairy productivity of cows. The highest milk yields from one cow per year are obtained with the timely implementation of organizational and economic, zootechnical and veterinary preventive measures.

Many farms in the region, including breeding farms, use innovations in reproduction, technological modernization of farms of different sizes with the introduction of a loose housing system, with milking robots and modern milking machines; the use of sperm divided by sex, new cow feeding systems, etc.).

The main method of selection for the planned period in the breeding farms of the region adopted a homogeneous corrective group and individual selection using the best Holstein bulls with the possibility of obtaining additional effects due to the compatibility of genotypes and non-additive inheritance.

The main method of improving the herd is the use of the best bulls, foreign and Russian breeding with a lifetime profit index of at least - + 500. With an index of type and production qualities of TRI not lower than +2400 and the content of somatic cells less than 2.9, the fertility of daughters is more than 1 and productive longevity is more than 3, having an increase in productivity in milk, fat and protein, only positive values.

According to the results of the use of bulls in the herd, an assessment is carried out annually. To do this, a database with four rows of ancestors is transferred, for example, to the SELEX program and results are given on the use of these bulls in the herd and the selection of new bulls for further use.

More than 40 indicators are taken into account, and a model of genetic improvement of the herd is being built. This program allows you to predict genetic improvement for a long time, through a more accurate selection from the entire database of Holstein bulls of all breeding services. As before, the pedigree of breeding herds of the Holstein breed will be formed taking into account the established lines: Vis Back Ideal 933122 - branches of R.O.R.E. Eleveishna 1491007 and S.H. Tradition 1682485 and the new branch of Manfred 2183007, Ramos 25342; Montwick Chieftain line 95679- branches of Osborndel Ivanhoe 1189870, Reflection Sovering line 198998- Glendl branch Arlinda Chief 1556373, Valiant 1650414, Chief Mark 1773417.

The selection will be aimed only at the use of bulls-leaders of the Holstein breed and their sons.

With such a selection, based on the breed leader, the optimal ratio of improver bulls and young tested bulls is considered to be the ratio of 80:20 or 70:30. It is necessary to take into account the characteristics of the manufacturer in the transmission of their hereditary qualities. If offspring with low variability in productivity are obtained from a bull, then such a bull can only be assigned to animals with productivity equivalent to the indicators of his daughters. If the daughters of a bull are characterized by a sufficiently wide variability, and there are outstanding cows in his offspring that differ sharply in terms of productivity in the upward direction, then this producer can be fixed on more productive cows. In addition, the analysis of heritability coefficients in the herd is used - milk and fat, milk and protein, and fat and protein. After analyzing the compatibility of the genotypes that have developed in the herds and choosing the most productive combinations, as well as having the best indicators for the rate of milk production, an individual selection will be made for the herds, that is, fixing in the herds of bulls will be done individually for each cow and heifer.

At the intrafarm level, a fairly wide range of programs are currently being successfully applied, designed to improve the performance of all management functions both at the level of individual technological operations and processes, and at the level of the agricultural organization as a whole. In our region, milking cows is carried out with the help of robotic voluntary milking units (the manufacturer is the companies "Fullwood", "DeLaval", "LeLy", "Westfalia", "SAC", etc.) In these installations, foreign automated cattle herd management systems Dairy Plan, ALPRO, Afimilk, Crystal are used, AgroMilk, Afifarm. In farms for herd management, all of them have been adapted, studied, installed exchange modules with the domestic SELEX program, which allow you to upload daily reports of

any complexity in automatic mode, as well as compatibility with imported equipment, which significantly increases competitive opportunities. The use of automatic programs depends and will give the greatest effect only on healthy animals, with a high level of feeding and keeping of animals, an increased level of comfort and advanced training of specialists.

4 Conclusion

The general development trend of dairy cattle breeding in the Kaluga region in dynamics for a number of years is given. With the use of innovations in dairy cattle breeding of individual farms, the yield of cows increased from 2253 kg to 5408 kg, and in the whole region by 4216 kg. The strategy of selection and breeding work with dairy cattle in the conditions of the Kaluga region has been developed. The directions of the introduction of IT technologies in the management of dairy cattle breeding are proposed.

References

1. S.Y. Harlap, A.S. Gorelik, M.A. Bitkeeva, N.A. Demina, G.M. Mullagulova, *Dynamics of correlation coefficients of economic and productive characteristics depending on the age of cows*, E3S Web of Conferences, **254** (2021) https://doi.org/10.1051/e3sconf/202125408023.
2. O.E. Likhodeevskaya et at., *Comparative assessment of productive qualities of holsteinized black-and-white cattle by lines*, IOP Conference Series: Earth and Environmental Science, **848 (1)** (2021) https://doi.org/1 0.1088/1755-1315/848/1/ 012082
3. N.A. Fedoseeva, O.V. Gorelik, O.E. Likhodeevskaya, I.V. Knysh, G.A. Likhodeevskij, *Productive qualities of holsteinized black-and-white cattle*, IOP Conference Series: Earth and Environmental Science, **848 (1)** (2021) https://doi.org/10.1088/1755-1315/848/1/012068.
4. M. Aspandiyarova, *Productive insemination is a success key to farm profit,* Animal Husbandry of Russia, 30-33 (2017) https://zzr.ru/zzr-2017-sk-010 (In Russian)
5. G.F. Medvedev, N.I. Gavrichenko, S.K. Sorokina, Animal husbandry and veterinary medicine, **2 (5)**, 36 – 40 (2012) https://www.elibrary.ru/item.asp?id=28133833 (In Russian).
6. G.S. Nikitin, International Journal of Veterinary Medicine, **(3)**, 192-205 (2021) https://doi.org/10.17238/issn2072-2419.2021.3.192 (In Russian)
7. D.S. Ukrozhenko, D.S. Temnikov, O.V. Chepushtanova, *Classification of sperm production of stud bulls*, Theoretical, practical and safe aspects of farming: a collection of abstracts during roundtable discussion, (Ural State Agrarian University. Ekaterinburg. 2021) 230-232. http://elib.timacad.ru/dl/full/fr12.09.22.pdf/dow nload/fr12.09.22.pdf (In Russian)
8. Z.S. Sanova, Dairy and beef cattle breeding, **6**, 26-28 (2019)
9. O.V. Buzunova, *Artificial insemination of cows*, Youth and science, 27 –30 (2019) https://www.elibrary.ru/item.asp?id=42500561 (In Russian)
10. N.A. Malygina, O.A. Popova, Bulletin of the Altai State Agrarian University, **9 (167)**, 102-109 (2018) https://cyberleninka.ru/article/n/sravnitelnaya-harakteristika-gormon-programm-pri-iskusstvennom-osemenenii-krupnogo-rogatogo-skota/viewer (In Russian)

11. G.A. Sharkaeva, Theory and practice of modern science, **2(68)**, 93-98 (2021) https://sciup.org/itogovye-dannye-po-osemenenijam-krupnogo-rogatogo-skota-v-razreze-zarubezhnyh-i-140275992-en (In Russian)
12. K.Z. Zhumanov, T.N. Karymsakov, M.A. Kineev, A.D. Baimukanov, Agrarian science, **(2)**, 33-36 (2021) https://doi.org/10.32634/0869-8155-2021-345-2-33-36 (In Russian)
13. D.P. Berry, B. Coughlan, B. Enright, S. Coughlan, M. Burke, J.D. S., **96**, 5943-5953 (2013) https:// DOI: 10.3168/jds.2012-6162.
14. O.V. Gorelik, O.E. Lihodeevskaya, N.N. Zezin, M.Y. Sevostyanov, O.I Leshonok *Biological correlation of productive qualities of holstein black-and-white cattle by lactation*, AIP Conference Proceedings, Proceedings of the II International Conference on Advances in Materials, Systems and Technologies, CAMSTech-II 2021, 070054 (2022)
15. O.V. Gorelik, A.S. Gorelik, M.A. Tokoreva, N.I. Sorokina, G.V. Mkrtchyan, O.M. Mukhtarova, *Comparative evaluation of russian black pied and holstein cattle breeds of foreign breeding*, E3S Web of Conferences, International Conference "Ensuring Food Security in the Context of the COVID-19 Pandemic" (EFSC2021), Doushanbe, Republic of Tadjikistan, 03009 (2021)