Problems of dairy cattle herd reproduction in Novgorod region and set of measures to solve them

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Abstract. The article presents the results of the study on conditions of dairy cattle reproduction in commodity farms and pedigree breeding units. Ways of solving the problems of reproduction in the conditions of the Novgorod region are proposed.

1. Introduction
Dairy cattle breeding, as the most important livestock industry, currently provides a significant proportion of the consumed milk and meat in the country, and other products necessary for the national economy [1, 2].

The transfer of dairy cattle to the conditions of intensive use in industrial farms and complexes with double machine milking and group housing significantly affected the broodstock ability to reproduce progeny. As a result, the period of economic use of cows and the calf yield has decreased, other problems of the dairy herd reproduction have arisen [3,4].

To solve the arising problems, it is necessary to summarize the scientific research data and best practices on the broodstock reproduction and introduce advanced technologies into practice [5].

Publications of the past years were devoted to the analysis of reproduction of the dairy cattle bred in the Novgorod region and to the main measures to stabilize the broodstock reproduction, targeted raising of young animals, and improving methods to increase the reproductive capacity of cows [6]. Our task was to examine the current state of dairy cattle reproduction in the studied region.

2. Materials and methods
The object of the research was the state and methods of improving the cattle reproduction system in commodity farms and pedigree breeding units of the Novgorod region. The study was conducted from 2010 to 2019. We studied the data of primary animal science and breeding recordings and livestock judgements during the study period. The research results were processed on a computer using generally accepted methods.

3. Results and discussion
The main purpose of dairy cattle breeding and reproduction is the production of milk. Therefore, we analyze the milk production in the Novgorod region farms over the past ten years (table 1).
Table 1. Milk production in Novgorod region farms during the studied period.

| Indicator                      | 2010   | 2011   | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | 2018   | 2019   |
|--------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Cow population, animals        | 16299  | 15325  | 13976  | 12490  | 10868  | 10466  | 10039  | 9234   | 8886   | 7736   |
| Milk yield per cow, kg         | 3836   | 3942   | 4196   | 4032   | 4108   | 4422   | 4554   | 4479   | 4517   | 4847   |
| Mass fraction of fat, %        | 3.74   | 3.73   | 3.73   | 3.74   | 3.77   | 3.76   | 3.7   | 3.67   | 3.77   | 3.72   |
| Mass fraction of protein, %    | -      | -      | -      | -      | 3.05   | 3.04   | 3.04   | 3.12   | 3.07   | 3.05   |

The table data analysis shows that milk production in farms decreased from 62.3 to 35 thousand tons. The decrease in milk production is caused by a more than two-fold decrease in broodstock from 16299 to 7736 animals, which is inconsistent with optimistic forecasts of some authors [7].

It should be noted that milk yield per cow increased by a thousand kilograms, but this did not compensate for the overall decline in milk production.

The same indicators are much better represented in the breeding units of the region (table 2). With a decrease in the broodstock by 451 animals, milk production decreased by only 3% due to a significant increase in the milk production per cow – to 6451kg

Table 2. Milk production in Novgorod region breeding units during the studied period.

| Indicator                      | 2010   | 2011   | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | 2018   | 2019   |
|--------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Cow population, animals        | 2612   | 2662   | 3851   | 3152   | 2712   | 2960   | 2965   | 2970   | 2116   | 2161   |
| Milk yield per cow, kg         | 5506   | 5481   | 5599   | 5617   | 5347   | 5826   | 5998   | 6015   | 6484   | 6451   |
| Mass fraction of fat, %        | 3.99   | 3.86   | 3.86   | 3.8    | 3.79   | 3.77   | 3.81   | 3.85   | 3.89   | 3.89   |
| Mass fraction of protein, %    | 3.10   | 3.05   | 3.11   | 3.07   | 3.06   | 3.03   | 3.00   | 3.02   | 3.10   | 3.11   |

The significant decrease in milk production in the farms of the region can be explained by various objective and subjective factors: unstable weather, problems with food and housing, lack of exercise, lack of data on homeostasis [8], low purchase prices and a dozen more reasons. We and other authors studied the dairy cattle reproduction problem [9, 10], fundamental for dairy cattle breeding intensification, increasing the animals productivity and their long-term use. Table 3 shows that the broodstock average age is 2.84–2.94 calvings, and the cows retirement average age is 3.7–4.1 calvings. The given data show the reduction in the broodstock use, and accordingly, for simple reproduction, it is necessary to increase the heifers input into the herd. But farm’s own rearing livestock is not sufficient...
to replace the retiring cows. There is an annual decline in the number of the main herd. These data are consistent with the views of domestic and foreign scientists [11, 12].

Table 3. Main indicators of dairy cattle reproduction in the studied period.

| Year | Average age in calving | Input of heifers to the herd, animals | Yield of calves per 100 cows, % | Average daily gain, g | Age at first calving, days | Service period, days | Number of inseminations per one fruitful | Average age of retiring cows, years |
|------|------------------------|--------------------------------------|---------------------------|-----------------------|--------------------------|---------------------|-----------------------------------------|----------------------------------|
| 2009 | 2.9                    | 21.0                                 | 73.0                      | 437                   | 933                      | 135                 | -                                       | -                                |
| 2017 | 2.94                   | 20.3                                 | 75.7                      | 455                   | 876                      | 145                 | 1.9                                    | 1.7                              |
| 2018 | 2.84                   | 24.2                                 | 69.3                      | 435                   | 899                      | 135                 | 1.9                                    | 1.6                              |
| 2019 | 2.87                   | 21.3                                 | 63.6                      | 459                   | 870                      | 141                 | 2.1                                    | 1.6                              |

Data on the calves yield per 100 cows (63.6%) prove that it is currently impossible to provide the dairy cattle production without its purchasing. And it is almost impossible to grow a healthy and developed rearing heifer highly productive in the future, with an average daily gain in live weight of 435–459 grams.

The analysis of the service period duration indicators shows significant problems with artificial insemination in the farms of the region. A service period of 135–145 days is more characteristic for highly productive dairy cattle populations, and a number of inseminations per one fruitful 1.9–2.1 at this service period duration shows the necessity for advanced training of biotechnicians in the farms of the region.

At low rates of average daily growths of rearing young animals, the first fruitful insemination occurs at the age of 21 months, which is 4–6 months later than in generally accepted world practices. This negatively affects the growth and development of various organs of rearing young animals, especially the mammary gland.

A decrease in the age of retired cows to 3.7 lactations suggests that for the simple reproduction of the herd it is necessary to introduce 27–30% heifers. It is impossible to achieve this by own reproduction at 63.6% of the calf yield per 100 cows (we divide by sex approximately in half, minus the natural waste during the rearing period, so we can no longer talk about selection). The annual introduction of 21.3% of heifers into the herd, if there is no purchase of heifers from outside, guarantees a further decrease in the number of dairy cattle in the region. It should be noted that the average indicators do not show the full picture of the dairy cattle reproduction state in the commodity farms of the region; there the indicators are much worse. The statistics is improved due to breeding units which accumulate about 30% of broodstock. There are currently five pedigree breeding units in the region, four in black-motley breed and one in Ayrshire breed. Six breeding units are represented in our study (table 4). One of them, SPC “Russia”, two years ago, lost its breeding status, primarily due to herd reproduction problems. But during the research period it worked as pedigree breeding.

Table 4. Main indicators of dairy cattle reproduction in breeding units of Novgorod region.

| Breeding unit      | Year | Milk yield, kg | Input of heifers to the herd, % | Yield of calves per 100 cows, % | Average daily gain, g | Service period, days | Average age of retiring cows, years |
|--------------------|------|----------------|---------------------------------|-------------------------------|-----------------------|----------------------|----------------------------------|
| LLC Peredolskoye   | 2017 | 7748           | 22.2                            | 84                            | 617                   | 128                  | 3.3                              |
Table 4 data analysis shows that in breeding units the indicators of milk yield and reproduction are much higher than the average indicators in the region. The leaders in milk yield per cow are pedigree reproducers LLC Peredolskoye and SPC Levochsky crossed the seven thousandth milestone, and OJSC Ermolinskoye and LLC Novgorod Bacon are steadily milking over six thousand kilograms per cow over the past 3 years. In the breeding unit CJSC Savino and SPC Russia which had lost the status of the breeding farm, the milk yield exceeds 5300 kg per cow.

The reproduction rates of dairy herds in the above pedigree breeding units comply with the requirements for them. So the calves yield per 100 cows is from 83% to 92%, which allows to stably replenish the herd with young animals having an average daily growth of 630–716 grams. Adding heifers to the herd ranges from 27.8% in the SPC Levochsky to 33.3% in the LLC Peredolskoye. With a lack of rearing young stock of the required quality, these farms practice their purchase in pedigree factories. In other breeding farms, the period of economic use generally exceeds 4 calvings and allows rearing from their own reproduction. Of particular note is CJSC Savino whose indicators differ significantly. The average daily live weight gain in this farm is about 500 grams, the introduction of heifers into the herd over the past 3 years was 11.6–18.5%, but the period of economic use of cows is 4.6–6.7 lactations with 80–84% calves per 100 cows. The indicators of this farm can be a guideline for regional commodity farms when resolving herd reproduction issues and increasing animal productivity, since extending the period of broodstock use will allow solving other problems of dairy cattle reproduction.

A study of the service period duration in breeding unit populations showed that the minimum value of this indicator was found in Ermolinskoye OJSC (100 days) and Levochsky SPC (107 days) with an average milk yield in the herds of 6194 kg and 7062 kg of milk per cow. With high milk yields in these farms, they were able to optimize the preparation and timely fruitful insemination of cows, practically reaching the theoretically recommended 60-110 days. In other breeding units, the service period are in the range of 141–160 days, which indicates the need to improve the reproduction in these dairy cattle populations.

The most important breeding characteristics are: the yield of milk, the mass fraction of fat and protein in milk and the live weight of the animals [13, 14]. It should be also noted that, according to a number of researchers, it is necessary to improve not only individual parts of the production process (reproduction), but a whole selection and breeding work and its results. According to several authors
[15, 16] the improvement of these breeding characteristics and the implementation of high-quality breeding work as a whole is not possible without the use of quality breeding animals.

4. Conclusion
The study has shown that dairy farming in the Novgorod region has the resources for further development. The best results and the desire for further improvement can be seen in the pedigree breeding units of the region. There are opportunities for development in the commodity farms either, but for this it is necessary to use the available internal reserves, namely:
- to improve selection and breeding work to increase the genetic potential of the animals;
- to use the sperm of high-value bulls-improvers;
- to introduce intensive technologies of young cattle breeding
- to equip the artificial insemination points in accordance with applicable veterinary and sanitary standards, to provide necessary equipment and tools;
- constantly improve the skills of specialists in artificial insemination of animals.

The following indicators for all categories of farms should become guidelines for improving the dairy herd reproduction: calves yield 85–95% per 100 cows, period between calvings – 12–13 months, service period – 60–110 days, insemination index 1.8, average age at the first calving – 24–27 months, average term for the economic use of cows – 5 calvings.

References
[1] Fedorenko V F, Mishurov N P, Kuzmina T N, Tikhomirov A I, Gus’kov S V, Svinaryov I Yu, Bekenev V A, Kolosov Yu A, Frolova V I and Bol’shakova I V 2018 Best practices in domestic livestock breeding: scientific-analytic overview (Moscow, Rosinformagrotech) p 72
[2] Amerlhanov Kh A 2017 State and development of dairy farming in the Russian Federation Dairy and beef cattle breeding 1 2–5
[3] Dunin I M and Amerlhanov Kh A 2017 Selection and technological aspects of dairy cattle breeding development Zootechnics 6 2–8
[4] Sudarev N P, Abylkasymov D, Kamynin P S and Sukhareva N A 2015 The problem of reproduction and cost recovery in highly productive herds Dairy and beef cattle breeding 1 16–19
[5] Fedorenko V F, Mishurov N P, Marinchenko T E and Tikhomirov A I 2019 Analysis of state and prospects for improving genetic potential of dairy cattle: scientific-analytic overview (Moscow, Rosinformagrotech) p 108
[6] Emelyanov E G, Makievsky V M and Botvinova S L 2015 Features of black-motley cattle reproduction in pedigree enterprises of the Novgorod region Bulletin of Yaroslav-the-Wise Novgorod State University 3 (86) 54–57
[7] Trukhachev V I, Zlydnev N Z and Selionova M I 2016 Selection of dairy cattle in Northern Europe: strategy, methods, results (part 1) Dairy and beef cattle breeding 1 2–5
[8] Lam T J, Ruegg P L and McDougall 2015 Good veterinary practices on udder health: what to do, what not to do and opportunities Entorno Ganadero 71 24–31
[9] Trukhachev V I, Zlydnev N Z and Selionova M I 2016 Selection of dairy cattle in Northern Europe: strategy, methods, results (part 2) Dairy and beef cattle breeding 4 2–5
[10] Surovtsev V N and Nikuliva Yu N 2018 Realization of regional and local advantages for sustainable development of dairy cattle breeding Dairy and beef cattle breeding 2 12–16
[11] Chinarov V I 2018 The potential of breeding dairy cattle Dairy industry 11 69–71
[12] Khan M H, Manoj K, Pramod S 2016 Reproductive disorders in dairy cattle under semi-intensive system of rearing in North-Eastern India Veterinary World 9 (5) 512–18
[13] Berry D P, Kearney J F, Twomey K and Evans R D 2013 Genetics of reproductive performance in seasonal calving dairy cattle production systems Irish J. agr. Food Res 52 (1) 1–16
[14] Dennis N A, Stachowicz K, Visser B, Hely F S, Berg D K, Friggens N C, Amer P R, Meier S and Burke C R 2018 Combining genetic and physiologic data to identify predictors of lifetime
reproductive success and the effect of selection on these predictors on underlying fertility traits
Journal of Dairy Science 101 (4) 3176–92
[15] Gaworski M and Rocha A G F 2016 Effect of management practices on time spent by cows in
waiting area before milking Engineering for Rural Development: 15th international scientific
conference proceedings (Jelgava) 15 1300–04
[16] Kudinov A A, Saksa E I, Smaragdov M G, Juga J, Uimari P, Mäntysaari E A and Strandén I 2018
Developing a genetic evaluation system for milk traits in Russian black and white dairy cattle
Agricultural and Food Science 27 (2) 85–95