Monitoring of the feed base and provision of dairy cattle with adequate feeding

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Abstract. At the current stage of dairy cattle breeding, one of the most pressing problems is monitoring of the feed base, which includes the procurement of high quality feed. Solution of this problem also requires a focus on ration formulation, since unbalanced feeding can cause metabolic disorders, which ultimately affects realization of the genetic potential of dairy breeds. In this regard, to increase the production of cows, it is necessary to constantly improve and optimize their feeding rates, since feeding is the most important factor to advance dairy cattle breeding. Appropriate feeding ensures cow production amounting to 6,000–8,000 kg of milk and more, with a milk fat content of 3.7–4.2%. The paper provides data on monitoring of the state of the feed base on the studied farm to ensure adequate feeding of cows. Within the stated problem, the study also focuses on the analysis and assessment of the rations of cow feeding with regard to the physiological state of the animal, which was confirmed through the use of the targeted ration. The basis of the practice-oriented study was the decision to use the information and analytical system RATIONS to calculate balanced feed rations for adequate feeding of dairy cows. In the future, the farm needs to pay special attention to introduction of adapted feeding norms for black-motley cows to satisfy their need for nutrients.

1. Introduction

World practice in the development of livestock industries and many researchers, including M.T Moroz et al. [1], A. Francesio et al. [2], R.Z. Zhong et al. [3], M. Munnich et al. [4], and L. Grille et al. [5], confirmed that increase in dairy cow production requires organization and optimization of conditions for adequate feeding. At the same time, high production is always associated with intensive metabolism. To maintain active metabolic processes in the animal’s body, it is necessary to provide an optimal amount of normalized substances and elements in feed rations. Lack or excess of even one of them causes various metabolic disorders. Practice has confirmed that all normalized substances and elements are crucial for activation of metabolic processes that affect reproduction functions, the level of production of animals, their vital activity, growth and development. Due regard to the features of metabolism, monitoring and elimination of possible violations will increase the efficiency of dairy farming.

According to a number of authors [1, 5, 6, 7, 8], rations of animals, including dairy cows, should contain a specified amount of nutrients and biologically active substances in compliance with the requirements.

Calculation and balancing of feed rations, formation of high-grade feeding of dairy cows can be facilitated by means of the information and analytical system (IAS) RATIONS. The modern version of the software and hardware complex for an automated system used to calculate feed rations provides a
solution to various problems in animal feeding. The software for IAS RATIONS was developed by RC PLINOR OOO. In practice, practitioners need effective and convenient methods and tools to calculate feed rations for dairy cows with regard to their physiological state, production and live weight. Feed rations should be formulated depending on the annual cycle and natural and climatic conditions of keeping dairy cows, which actualizes the direction of this study.

At the same time, a number of authors [9, 10, 11, 12] confirm that specialists of new generation are required, since their insufficient qualification is the main obstacle to transition to a new technological system, introduction of innovations in agricultural production, including active use of information and analytical systems for formulation of rations for dairy cows. With this, the authors believe that only joint efforts of people engaged in agricultural education, employers and agribusiness governing bodies can enhance training of competitive specialists for the livestock industries in the modern labor market.

2. Objects and methods of study
The object of this study was the factors of formulation of adequate feeding for black-motley cows and development of adapted norms for calculating feed rations.

The study was carried out in Rossiya APC in Novgorod region. In the study, monitoring of the fodder base was performed, and fodder crops used in the preparation of self-produced fodder were investigated. Nutritive value analysis of self-produced feed was carried out in accordance with GOST R 55452-2013 Hay and haylage. Specifications and GOST R 55986-2014 Silage from fodder plants. General specifications. The nutritive value of the rations used for feeding cows was assessed with regard to actual and reference norms and rations of feeding using the SELEX program Feed rations.

In the study, general scientific approaches were used - analysis and methods of statistical observation, dynamic comparison, structural analysis, correlation-regression analysis, and methods of graphical and tabular reflection of empirical information.

A theoretical analysis of sources, publications by foreign authors [2, 3, 4, 5, 6], was chosen as one of the methods to improve and optimize cow feeding standards, since feeding is the most important factor to affect the development of milk production.

3. Results and discussion
To increase the production of dairy cows, it is necessary to contentiously improve and optimize their feeding standards, since the development of milk production strongly depends on feeding. Agricultural land of Rossiya APC in Novgorod region accounts for 3,700 hectares of the total land area (Table 1) and thus provides livestock (2,009 heads of black-motley breed, including 900 cows) with self-produced fodder. Analysis and assessment of zootechnical data showed that the average annual milk yield in 2019 amounted to 5,306 kg of milk per cow, which is 4% lower than that in 2015 and 18% higher than that in 2018. One of the objective reasons for an increased average annual milk yield is an increase in the annual feed consumption per 1 conventional head by 2.4 centners. In 2019, it amounted to 47.7 centners, which is 5% higher than that in 2018 (45.3 centners).

The farm has tested and used crop rotations with a significant amount of fodder crops (79 %) included, and employed advanced technologies for their cultivation. The data presented in Table 1 show that crop production areas occupied by agricultural crops increased in 2019 by 56% compared to 2018. For silage production, the farm has cultivated maize over the past four years.

Table 1. The structure of crop production areas occupied by agricultural crops.

| Culture               | Crop production areas |
|-----------------------|-----------------------|
|                       | 2014 % of the total | 2015 % of the total | 2016 % of the total | 2017 % of the total | 2018 % of the total | 2019 % of the total | 2020 % of the total |
| Perennial herbs, ha   | 2,709    73   | 2,646    71   | 2,611    70   | 2,718    73   | 2,792    75   | 2,700    73   |
At present, the farm is self-sufficient with bulky and concentrated forage. Several years ago, the farm launched the Finnish ANTTI grain drying complex with a seed and grain forage line. Concentrated forage consists of the following components (per one ton of the finished product): wheat grain (25%); barley grain (30%); oat grain (12.5%); barley bran (12.5%); sunflower cake (15%); feed chalk (2%); salt (2%); premix Premivit Formulation No. 9.5 (1%).

The farm uses tethered housing of cows, without division of animals into groups according to their physiological state, which hinders balanced feeding. Animals should be divided into physiological groups, and arranged so that each cow receives a targeted ration. The ration primarily provides for the ratio of rough and green forage with regard to the lactation period. Bulky forage is mixed and distributed to all animals using the feed dispenser, while concentrated forage is provided individually depending on the physiological state and production of cows.

Ration formulation for dairy cows is presented in two versions. The first ration is used from the calving to the dry period, and the second one is used during the dry period only. Tables 2 and 3 show the formulation and nutritive value of the feed ration for dairy cows in Rossiya APC.

**Table 2. Feed ration for dairy cows.**

| Fodder | Feed |
|--------|------|
| Daily milk yield – 16 kg, fat content – 3.6%, live weight – 560 kg | 1.90 |
| KK 60-1-75 for dairy cows (Podberezye), kg | 2.00 |
| Feed mixture Luzhskiy, kg | 4.50 |
| Forage of own production (Rossiya APC), kg | 4.00 |
| Grass-legume hay, kg | 35.00 |
| Grass-legume silage (Rossiya APC), kg | Mass – 47.4 kg |

**Table 3. Nutritive value of the feed ration for dairy cows.**

| Nutrients | Feeding rate | Ration | Deviation of the nutritive value of the feed ration from the feeding rate of cows |
|-----------|--------------|--------|---------------------------------------------------------------------------------|
| General nutrients | absolute | relative, % |
| Feed units, FU | 15.47 | 13.34 | -2.12 | -14 |
| Energy metabolism, MJ | 182.78 | 176.35 | -6.43 | -4 |
| Dry matter, kg | 17.35 | 19.75 | 2.40 | 14 |
| Crude protein, g | 2107.86 | 2744.57 | 636.71 | 30 |
| FP, g | 1420.82 | 1215.41 | -205.41 | -14 |
| By-pass protein, g | 687.04 | 468.90 | -218.14 | -32 |
| Protein digested, g | 1370.11 | 1489.17 | -119.07 | -9 |
| Crude fat, g | 526.86 | 907.80 | 380.94 | 72 |
| Crude fiber, g | 4018.36 | 4178.97 | -160.61 | 4 |
| NDF, G | - | - | - | - |
| Starch, g | 2065.45 | 2074.04 | 8.59 | - |
| Sugar, g | 1375.49 | 456.44 | -919.05 | -67 |
| NFE, g | - | 8287.59 | - | - |

**Macronutrients**
Sodium, g 39.74 94.18 54.44 137
Calcium, g 130.73 163.61 32.98 25
Phosphorus, g 73.58 58.59 -14.99 -20
Magnesium, g 47.04 31.75 -15.29 -33
Potassium, g 158.30 214.61 56.31 36
Sulphur, g 40.40 22.31 -18.09 -45

**Micronutrients**
Iron, mg 1042.42 1991.31 948.89 48
Copper, mg 151.95 98.02 -53.93 -35
Zinc, mg 1502.14 570.53 -931.61 -62
Manganese, mg 905.20 1505.31 600.11 40
Cobalt, mg 11.57 5.17 -6.4 -58
Iodine, mg 10.75 15.02 4.27 40

**Vitamins**
Carotin, mg 808.98 447.18 -361.79 -45
Vitamin D, TIU 16.81 8.20 -8.61 -51
Vitamin E, mg 2 3 1 33
Vitamin A, TIU 524.40 725.39 200.99 28

**Amino acids**
Lysin, g 84.20 108.51 24.31 29
Methionine, g 61.48 42.75 -18.73 -30
Tryptophane, g 32.68 21.71 -10.97 -34

At the same time, the dry period is very important in adequate feeding of cows. The duration of the dry period, on average, should be 60 days to provide redistribution of nutrients for the growth of the fetus (the last third of pregnancy – an increase in weight by 70–75%), as well as to prepare the body for subsequent lactation.

The formulation and nutritive value of the feed ration for dry cows in Rossiya APC are presented in tables 4 and 5.

**Table 4.** Feed ration formulation for dry cows.

| Fodder | Feed |
|--------|------|
| Daily milk yield – 5300 kg, live weight – 560 kg | |
| Fodder of own production (Rossiya APC), kg | 2.00 |
| Grass-legume hay, kg | 4.00 |
| Grass-legume silage (Rossiya APC), kg | 20.00 |
| Mass – 26.0 kg | |

**Table 5.** Nutritive value of the feed ration for dry cows.

| Nutrients | Feeding rate | Ration | Deviation of the nutritive value of the feed ration from the feeding rate of cows |
|-----------|--------------|--------|--------------------------------------------------------------------------------|
| **General nutrients** | | | absolute | relative, % |
| Feed units, FU | 11.36 | 9.85 | -1.51 | -13 |
| Energy metabolism, MJ | 13.26 | 118.87 | -17.39 | -13 |
| Dry matter, kg | 13.44 | 14.00 | 0.56 | 4 |
| Crude protein, g | 1787.52 | 1583.35 | -204.17 | -11 |
| FP, g | 1005.37 | 1003.27 | -2.09 | - |
| By-pass protein, g | 782.15 | 417.98 | -364.18 | -47 |
| Protein digested, g | 1161.89 | 1031.58 | -130.31 | -11 |
| Crude fat, g | 386.51 | 551.80 | 165.29 | 43 |
The analysis and assessment of feed rations showed that the farm does not employ the system for calculating rations with regard to nutrients, which hinders achievement of the desired results.

Considering the animal’s need for nutrients during the production cycle, the ration should be balanced for all nutrients depending on the physiological state. A deviation from the norm in one or another nutrient indicates unbalanced feeding, which further affects the state of the animal’s body. The above tables show deviations in organic and mineral substances, as well as in vitamins, which requires revision of the current feed rations using the information and analytical system RATIONS.

4. Conclusion
In modern conditions of the development of dairy cattle breeding, one of the urgent problems is monitoring the feed base, which includes the procurement of high-quality forage. Thus, particular attention should be paid to the formulation of rations with regard to the physiological state of the animal, since unbalanced feeding can cause metabolic disorders, which ultimately affects realization of the genetic potential of dairy breeds. At the same time, constant improvement and optimization of feeding rates are required to increase the production of cows.

The study showed that an increase in milk production is only possible if the animals are divided into physiological groups, depending on the lactation period, in order to receive a targeted ration.

The practice-oriented study was based on the decision to use the information and analytical system RATIONS for calculating balanced feed rations when formulating adequate feeding for dairy cows. In the future, the farm needs to pay particular attention to the introduction of adapted feeding norms for black-motley cows to meet nutrient needs.

Balanced rations will ensure good health and proper functioning of physiological processes in animals, and increase their production and service life.

| Crude fiber, g | 3474.24 | 3282.60 | -19.16 | -6 |
|---------------|---------|---------|--------|----|
| NDF, G        | -       | 6341.25 | -      | -  |
| Starch, g     | 764.74  | 907.64  | 142.90 | 19 |
| Sugar, g      | 1028.16 | 693.22  | -334.95| -33|
| NFE, g        | -       | 6658.30 | -      | -  |

**Macronutrients**

| Sodium, g     | 26.88   | 26.63   | -0.25  | -1 |
| Calcium, g    | 59.14   | 117.94  | 58.80  | 99 |
| Phosphorus, g | 39.42   | 39.42   | -      | -  |
| Magnesium, g  | 33.60   | 33.60   | -      | -  |
| Potassium, g  | 82.66   | 222.35  | 139.69 | 169|
| Sulphur, g    | 27.69   | 27.69   | -      | -  |

**Micronutrients**

| Iron, mg      | 814.46  | 1401.55 | 587.09 | 42 |
| Copper, mg    | 116.26  | 116.26  | -      | -  |
| Zinc, mg      | 806.40  | 806.40  | -      | -  |
| Manganese, mg | 420.67  | 878.49  | 457.82 | 53 |
| Cobalt, mg    | 8.47    | 8.47    | -      | -  |
| Iodine, mg    | 8.27    | 11.94   | 3.67   | 31 |

**Vitamins**

| Carotin, mg   | 580.61  | 488.52  | -92.08 | -16|
| Vitamin D, TIU| 11.96   | 11.96   | -      | -  |
| Vitamin E, mg | 434.60  | 655.73  | 221.13 | 51 |
| Vitamin A, TIU| -       | 3.20    | -      | -  |

**Amino acids**

| Lysin, g      | 86.04   | 52.51   | -33.53 | -39|
| Methionine, g | 43.22   | 43.22   | -      | -  |
| Tryptophane, g| 30.92   | 13.23   | -17.69 | -57|

The analysis and assessment of feed rations showed that the farm does not employ the system for calculating rations with regard to nutrients, which hinders achievement of the desired results. Considering the animal’s need for nutrients during the production cycle, the ration should be balanced for all nutrients depending on the physiological state. A deviation from the norm in one or another nutrient indicates unbalanced feeding, which further affects the state of the animal’s body. The above tables show deviations in organic and mineral substances, as well as in vitamins, which requires revision of the current feed rations using the information and analytical system RATIONS.
Acknowledgments
The authors would like to express their gratitude to Nikolai Vasilievich Andreev, the director of Rossiya APC, for his assistance in the study.

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