Intelligent methods for assessing the productivity of dairy cattle based on a comprehensive study of elemental status

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Abstract. This article is devoted to the study of the problem of increasing productivity in the field of dairy cattle breeding. Literature analysis showed that in practice, productivity is rarely studied as a complex characteristic of the state of animal husbandry. For mutual coordination of the complex of different format data, it is proposed to consider the entire process of animal life as an exchange of substances consisting of elements. In this case, all changes in the balance of the living system of dairy production can be assessed through the entry and disposal of elements, which is reflected in the elemental status of animals. Using this approach allowed us to formulate an algorithm for the productivity of dairy cattle breeding, which includes all stages of assessing elemental status, collecting data on the feed base and groups of animals, correlating the data and calculating corrective norms for feed additives. Further application of the generated algorithm made it possible to develop a decision support system in the field of dairy cattle breeding, which also includes all the basic elements of assessing and adjusting the feed base, through the assessment of elemental status.

1. Introduction

The most important management task at present is to achieve a maximum effect. The effect can have a different degree of severity, but in most cases it is expressed through an indicator of productivity. Productivity management is a very urgent task, which includes the search for management factors, their comprehensive assessment and the most efficient use.

One of the most important sectors for the whole world is agriculture, since agriculture is responsible for the food security of each state. A significant and valuable industry in the field of agriculture is dairy farming [1]. The systemic problems faced by this industry can be solved only with the help of new, modern methods of managing dairy cattle breeding, based on a combination of factors affecting productivity, the development of mathematical control models and their further implementation in the form of decision support systems.

One of the problems of management in dairy cattle breeding is the rapid assessment of data that allows you to analyze key characteristics of the condition of animals and adjust them to achieve maximum productivity. A key aspect of this problem is that the indicated data is of different formats, belonging to different objects, which complicates their complex characterization [2].

Today, an important way to assess the state of wildlife is the elemental composition defined by the 25 most important chemical elements [3]. The elemental composition of plants has a significant effect on their growth [4], the composition of the feed significantly affects mineral metabolism [5], and the
digestibility of feeds in general [6], and the elemental composition of the biosubstrates of the animal can be a characteristic of its state of health and productivity [7].

We note that the elemental status of the animal organism has a significant effect on the overall productivity of dairy cattle breeding [8]. In addition, other factors affect the productivity, including the breed of animals, state of health, norms of maintenance, etc. [nine]. To assess the influence of these factors, there are special systems for dividing animals into different groups [10].

Thus, the task of increasing the productivity of dairy cattle breeding is reduced to finding combinations of elements in feed and in biosubstat animals, in which productivity becomes maximum.

The feed base for dairy cattle breeding is usually represented by a certain set of feed crops and also includes various feed additives. The elemental status of feed crops is subject to measurement, the composition of feed additives is known a priori, which can be used to adjust the nutrition of animals in order to regulate the elemental composition in the body of the latter.

The aforementioned provides a basis for reducing the problem of increasing the productivity of dairy cattle breeding to the multicriteria problem of optimizing elemental status in animal feed and animal organisms with a number of limitations associated with the norms of element content.

In the multicriteria problem posed, the utility function in contains both internal and external variables; therefore, optimization of the elemental composition regulation process may involve the use of a system of mathematical models. An analysis of the studies of various authors revealed that most of the models proposed in the works are given in a stationary form, without taking into account changes in indicators over time, which does not reflect real reality. In some works, the productivity of dairy cattle breeding is evaluated only from the point of view of unregulated processes, which does not allow their use for management needs.

Also, there is no comprehensive model for evaluating productivity in a living system, taking into account heterogeneous data belonging to various elements of this system. The development of such an integrated model can be implemented for management purposes, while to simplify its use, it is also necessary to create a decision support system for the productivity of dairy cattle.

2. Materials and methods
All studies were conducted at the Federal Research Center of Biological Systems and Agrotechnologies of the Russian Academy of Sciences.

The basis was taken of well-known methods and approaches proposed by a number of domestic scientists. The choice of combinations of feed crops was determined based on the work [4, 5]. The division of animals into groups was carried out in accordance with the recommendations [9, 10]. Assessment of elemental status was carried out on the basis of [6, 7]. General recommendations for the construction of mathematical models in the field of elemental status and cattle breeding in general are taken from [2]. Evaluation of the productivity of dairy cattle breeding in accordance with [8].

The construction of an algorithm for assessing the productivity of dairy cattle based on elemental status was based on the above methods and procedures, using a formal logic of actions. The development of the decision support system scheme was carried out by the universal method, without reference to a specific programming language, and can be implemented on any of them.

3. Results and discussion
In the standard statement of the problem of assessing the productivity of dairy cattle breeding by linking the various elements of the state of animals and the feed base, the problem of combining information arises since feeds, additives and groups of dairy cattle are measured in different units and scales. However, if you imagine the whole process as the movement of trace elements, then this problem can be successfully solved.

Metabolism occurs in the body of the animal, and, with a rough approximation, it consists in the intake and disposal of various substances. Substances contain various chemical elements, including key trace elements that determine the productivity of dairy farming. Then the productivity model is reduced to the dynamics of the inflow and outflow of substances and microelements into the animal
organism. To implement the approach described above, we will draw up an algorithm for evaluating productivity based on elemental status (Figure 1).

**Figure 1.** Algorithm for assessing the productivity of dairy cattle based on elemental status

Bringing the general algorithm for the interaction of different format data to the final productivity allows you to develop a decision support system to increase the productivity of dairy cattle. The block diagram of the decision support system is shown in Figure 2.

**Figure 2.** Block diagram of a decision support system to increase dairy farming productivity

4. Conclusion
As a result of a review and analysis of literary sources, a concept was formed for assessing the productivity of dairy cattle breeding by combining diverse and different-formatted data related to various elements of a living system, which allows maximum efficiency in managing the productivity
of dairy cattle breeding. Based on the developed concept, an algorithm for assessing the productivity of dairy cattle breeding based on elemental status has been formed, which allows us to break down the method of evaluating productivity into specific and clear steps. The productivity assessment algorithm has become the basis for the development and implementation of a decision support system that allows you to quickly monitor changes in the productivity of dairy cattle breeding and make certain adjustments to the process of managing dairy cattle breeding.

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