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Automated system of optimal cattle selection for breeding (part 1)

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***Abstract*–According to studies by various authors from countries with developing and underdeveloped economies, the main stumbling block in the field of animal husbandry is the lack of methods for selecting the optimal breed of cattle on the basis of ecological and geographical characteristics of the region. The need can be solved by developing a multiparameter automated system capable of taking into account exogenous and endogenous factors. The base of indicators to be processed takes into account biological and economically significant characteristics of animals, which in turn will allow to identify a balance between high productivity, economic feasibility, regional needs, quality of dairy products. No less important function of the program is the prediction of the specified characteristics, which will allow breeders to select the types of animals depending on the dynamics of indicators. The article considers: the experience of dairy cattle breeding in different countries of the world, as well as the risks specific to the industry; the method of determining the economically optimal for breeding cattle in different ecological and geographical conditions. The result of the research is the developed core of the information system, which contains a database, a set of algorithms, methods for determining the number of livestock of different breeds of cattle to cover the need for dairy products.**

Keywords—cattle, neural network, algorithm, productivity, program.

I. INTRODUCTION

The beginning of intensive animal husbandry can be considered in 1973, during this period there was a global fuel crisis. On the basis of this situation, countries had a need in lower quantity animals, but with a total yield above existing one.

Gradually, with the support of the state, there were appeared highly productive breeds of cattle, which were introduced into production [1].

However, over time, a number of problems have arisen, which are widely covered in modern research. A study conducted in France found that government subsidies have a negative impact on the technical and technological efficiency of farms (1). It is emphasized that the high technical and technological equipment of farms makes them more vulnerable and makes them dependent on the financial situation in the country [2]. And at the same time, it is noted that most of the research in the dairy industry is devoted to the technological transformation of farms [3].

Brazilian studies on the management of the dairy industry show that small-scale farmers are able to cope with the technique and with the calculations of financial support.

In Brazil, it was found that due to the different conditions of the country's regions different cattle breeds, the production system should be adjusted to the rgion's conditions.

At the same time, there are a number of features in Africa that are not typical for the modern world system of intensive cattle breeding, namely:

1. Breeders select animals with a high fertility rate [4];
2. Local breeds are adapted to the existing ecological and geographical conditions [4];
3. Animals should be chosen so that the potential in all respects was high [4];
4. Small-scale production is proposed to be commercialized [4].

But at the same time, the authors from Tunisia indicate that the problems of dairy production are not solved with the help of conventional financial instruments [5].

Kenyan experience in the management of dairy cattle shows that the breeding of animals adapted to local conditions is an important factor to meet the needs of the local population [6].

In India, there is a lack of a unified system for the management of the livestock sector, but it is emphasized that developed cattle breeding can solve a number of problems in rural areas, but all the research is aimed at studying the existing development programs, and not at creating new ones [7].

A number of authors from the United States are noted that due to climate change on the planet will increase the cost of dairy products and the industry itself will undergo strong changes due to the fact that existing animals will need to adapt to new conditions [8].

In the United States, agricultural policy in the field of dairy farming is a hot dispute, as small farms have completely different preferences, unlike large ones. For example, large farmers want to give up fuel subsidies, but do not change the policy of subsidizing. Small farmers prefer to buy fuel from

direct subsidies. As shows, the American practice, the sales results are much better if the farmer interacts directly with the buyers market. For the dairy industry of the United States, with a view to maintaining prices for milk, the characteristic policy of the supply chain [9].

The Chinese system of dairy cattle management involves a network of agents who move around the country, buy milk and take it for processing. The zoning system in China allows small farmers to exist on a par with large ones. This system is actively supported by the state. At the same time, agents are not responsible for the quality of milk and it is impossible to control the mixing of milk of different quality. Alliances have been established between processors and producers of milk [10].

In China, at the same time, there is a system of renting cattle from small businesses by large corporations [11].

Typical of Israel the dairies processors next to a farm, milk price – protected prices. The oligopoly of producers does not allow to lower the cost of production [12].

In dairy cattle breeding in South Korea, it is noted that the profitability of the dairy industry is tied to cattle diseases, that the financial component of the industry is closely related to the biological conditions of the animal [13]. In the Czech Republic and Ireland, it is noted that the financial condition of the industry depends on the scale of animal culling, which is mainly associated with fertility rates and limb diseases.

In Europe, it is noted that the buyer can not influence the situation in the market where many other buyers, as each of them wants to buy the best quality product, which is not enough [14]. This statement shows that in European market the goods have different quality, that there is no unified quality management system.

It should be noted that situation in European countries in the dairy industry has worsened since the introduction of the food embargo by Russia. And first of all, the dairy and meat industry suffered. But at the same time, Russia depends on Western financing and technology.

Another evidence of the absence abroad of a system for the stability of the management of the dairy industry is the fact that the contract sign for the international supply of milk affects the inward prices decline for raw materials from the importer. Obviously, the dependence of the milk state of the industry on sales is very significant.

According to British studies in Armenia, the trust of large companies, to the members of various association, and at the same time the preference is given to highly competitive markets [15].

As the history of Slovak dairy farming shows, milk production is declining at a faster rate than consumption. The competitiveness of an individual farm in a given country is assessed on the basis of direct subsidies [16].

Based on the above facts, it can be argued that the subsidy policy is not a fundamental system for the stable functioning of the industry.

Polish experience in optimizing the dairy industry since joining the European Union has not been very successful. By 2013, at the time of 10 years of EU membership, the cost of milk increased by an average of 61% [17].

When trading internationally and on the local level - there price imbalances [18]. Based on this fact, we can assume that there are some corrective actions in the pricing system based on the manipulation of cash flows.

In the US and Brazil, it is noted that economic efficiency increases with good herd reproduction. Separately, it is emphasized that the lower the cost of the animal, the better its economic return in the ratio of received and spent money. This statement is also followed by British researchers [19].

However, this opinion contradicts with the opinion of the researchers from Croatia, who argue that the problems of the dairy sector it is possible to solve the selection achievements.

Summarizing the foreign experience of developed countries, we can assume that there is no single system that would satisfy the interests of consumers in different regions. It is for this reason that very often there are antagonistic solutions to the issue.

At the same time, in countries with difficult social conditions and different local population densities, there is a tendency to adapt the means of production to the given conditions, which seems to be a more universal solution.

Summing up, it is necessary to identify a number of problems.

1. Lack of tools to manage types of production facilities;
2. Individual selection animals focus;
3. Lack of methodology for the analysis of statistical data specific to different breeds of cattle in a particular region;
4. The emphasis shifted from control of the means of production in the financial and biotech instrumentation;
5. Lack of consideration of density, population paying capacity of the region, the need for dairy products.

It should be noted that in order to meet the needs of the population in dairy products, it is necessary to develop a methodology for the selection of the optimal breed of cattle for specific ecological and geographical conditions of the region.

The solution to this problem is the creation of an automated computer program running on the basis of datascience technology.

II. MATERIALS AND METHODS

The data provided by the agriculture of the Volgograd region, which are in the same ecological and geographical conditions, were used as analytical information. The farms breed cattle Holstein, black-and-white Holstein, red steppe and Ayrshire breeds. Microsoft Office software package was used to analyze statistical data.

Mathematical tools: correlation analysis, which shows the relationship between the values; coefficient of variation.

Data used: number of animals studied by year, milk yield per feed cow, book value per head, average price of milk sales,

level of subsidies per liter of milk, profitability with subsidies and profitability without subsidies..

III. RESULTS

The development purpose of the system: providing the population with dairy products of good quality in sufficient quantities and at a minimum cost.

Modern dairy industry is based on individual selection, namely the use of specific lines of breed animals or biological material belonging to these animals. This approach is not correct, because it does not take into account the introduction of animals in uncharacteristic conditions for a certain breed of cattle, which entails a change in productivity indicators.

In our work we used the method of mass selection, which allows us to analyze the characteristics of the population as a whole.

This approach allowed to develop the main core of the system, which allows to combine both economic and biological characteristics of animal populations to analyze the quality of relationships between different indicators.

The core of the developed program is shown in figure 1.

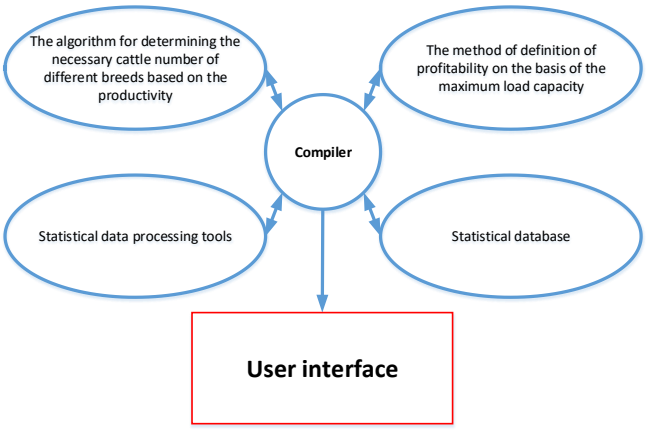

Fig.1 The core of the Automated optimal cattle selection for breeding

The designated algorithmic basis of the automated system allows to analyze large amounts of information, to use various tools of data analysis. On the basis of the built-in algorithm for the selection of cost-effective breeds of cattle on the "User interface" displays a list of objects under study, according to the given priorities.

Algorithm for determining the required number of cattle of different breeds based on productivity.

The main algorithm, on the basis of which the optimal breeds selection is made taking into account the sample of economic characteristics of animals, is presented below

$$\begin{cases} \frac{S*P*N}{A} \le K \\ \frac{Sx}{Z} \ge K \end{cases} \quad (1)$$

being:
S - Area square;
P - Average population density in the territory;
N - Rate of human milk consumption per year (N);
Sx - The surface area occupied by dairy farming;
Z - Area utilization factor of one milking cow (coefficient, which includes the area necessary to ensure the life of one animal);
A - Yield from one head (A);
K - The number of cows that will be contained on the proposed site.

Dynamic coefficient of environmental influence on cattle of a certain breed

In the presence of certain statistical information on the manifested characteristics of certain breeds of cattle in a particular region, it is possible to calculate a certain coefficient that reflects the degree of influence of ecological and geographical conditions of the region on specific animal populations.

It should be noted that the derived coefficient is not the same for each breed and is calculated by the maximum number of matches of breeding conditions.

$$C = \sum \frac{Ai}{Ti} \quad (2)$$

being:
A – declared characteristics of the i-th indicator;
T – real characteristics of the i-th indicator.

There are three possible outcomes when calculating this coefficient.

1.the resulting value is less than one – the discrepancy between the declared characteristics of the real;

2.the resulting value is equal to one – the compliance of the values declared;

3.the resulting value is greater than one – the actual values exceed the stated.

It is worth noting that the calculated parameters are always several and the resulting value will be an integral indicator for the population as a whole, which averages the results for all parameters.

The calculated indicator will be unique for each animal population in unique conditions. However, when it is taken into account, the probability of an error that may occur on the basis of breeding a certain breed of cattle with low rates will be reduced.

Consideration of ecological and geographical characteristics of the region

In the automated system of selection of breed of cattle favorable to cultivation processing of the statistical information saved up for the certain period is carried out.

The claim that the influence of the environment is included in the statistical data is justified by the long-term residence of the population in the territory under the influence of very specific conditions. Thus, statistical information displays

physiological and economic indicators, taking into account the adaptation.

It should be noted that the fewer generations of a certain population of cattle lived in a certain territory, the higher the probability of an unfavorable financial situation that may arise when choosing a breed that has not previously been bred in the considered ecological and geographical conditions.

The projected system will allow to reveal the terms of adaptation of cattle breeds introduced in certain ecological and geographical conditions.

The information module of adaptability allows to calculate the coefficient of adaptability of different breeds of cattle to the conditions of a particular region, as well as to keep records of the funds spent on covering the negative coefficient of adaptability.

IV. Conclusion

The developed tools to assess the economic efficiency of breeding different breeds of cattle in different ecological and geographical conditions is an additional tool to reduce the likelihood of errors, the consequences of which will have a negative impact on the financial condition of the organization.

The considered automated complex allows to structure the information and to find not always obvious interrelations between parameters, and also to predict fluctuations of the parameters inherent in a certain breed.

The proposed method of choosing the optimal breed of animals for breeding in certain ecological and geographical conditions, basically contains the principle of providing the population with high quality products at a minimum cost. The achievement of this approach is based on the mass selection of animals, which involves the comparison, determination of the dependence and time stability of indicators of different populations of animals contained in the same ecological and geographical conditions.

V. Conflict of interests

The authors confirm that the presented data do not contain a conflict of interests.

VI. Gratitude

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