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OPTIMIZATION OF HERD MOVEMENT AND COMPOSITION IN LIVESTOCK THROUGH ECONOMIC-MATHEMATICAL METHODS

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ABSTRACT. The article deals with the issues of increasing meat and milk production in livestock as a result of economic-mathematical modeling and optimization of mathematical methods to determine the movement and composition of cattle on farms specializing in animal husbandry. In addition, a numerical economic-mathematical model of the problem was developed on the basis of the initial data of a specific diversified farm, solved on a computer using a standard program using a mathematical method, and as a result of solving the problem of optimizing the movement and composition of livestock for each age group. or sold, transferred from one group to another, the number of head of cattle at the end of the year, as well as the indicators of maximum milk and meat production were determined and thoroughly analyzed in economics.

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Key words and phrases. herd movement, composition, age and sex of livestock, groups, live weight, offspring, write-off, loss indicators, target function, optimality criteria, system of constraints, system of variables, numerical, matrix, structural models extended matrix, optimal solution, standard program, write-off, loss, mathematical methods.

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1. INTRODUCTION

In his speeches, the President of Uzbekistan fully supported the entrepreneurial initiatives of our people in the development of animal husbandry, the widespread introduction of scientific approaches and advanced modern digital and innovative technologies in this area, increasing the number of high-yielding livestock, import-substituting and export-oriented livestock. It emphasizes the need to further develop and stimulate the production and processing of products, thereby improving the welfare and income of the population by providing our people with cheap and quality meat and other food products and increasing employment in rural areas.

It is known that in livestock breeding, which is one of the main branches of agriculture, special attention is paid to the development of the livestock sector, the demand for livestock products is constantly growing with the growth of the population, so with the rapid development of animal husbandry - It will be possible to supply the food industry with raw materials.

In order to improve the organization and planning of agricultural production, special attention is paid to determining the most rational turnover and structure of the livestock herd, breed, level of production and, ultimately, production, in which the development of the livestock sector is of great importance. The demand for products is also growing steadily, so with the rapid development of animal husbandry it will be possible to increase the supply of the population with livestock products, and the light and food industries with raw materials.

Based on this, one of the important issues is to improve the movement and composition of cattle herds in agricultural enterprises, diversified farms specializing in animal husbandry. The future effective development of the livestock sector depends on many factors, including the improvement of the annual movement of livestock on farms owned by agricultural enterprises by sex and age on the basis of specific goals. Also, the level of expanded reproduction and herd turnover on farms, the volume of products produced and sold, the cost of production, the amount of profit and the level of profitability of the farm directly depend on the structure of the herd [4–10].

In the current situation, it is important to follow the norms and requirements set by the science of zootechnics, regardless of the form of management mechanism in the livestock sector. Therefore, in the composition of livestock, it is

required to ensure the correlation of the composition of their groups by sex and age.

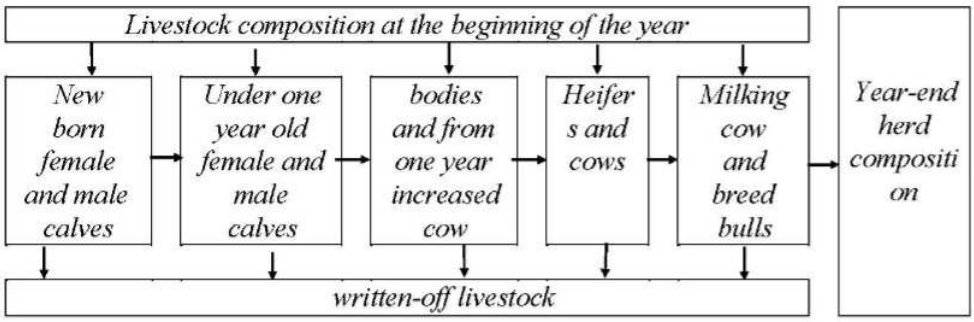

FIGURE 1. Annual movement of livestock schematic representation.

Figure 1 below symbolically represents the annual livestock behavior in terms of livestock composition, their gender and age groups.

2. OBJECT AND METHOD OF RESEARCH

Livestock farms are mainly specialized in the production of cut, meat products, which differ by sex and age groups of livestock. The effective development of the industry will depend on the fulfillment of the main product production indicators, depending on the number of cattle in the herd, and the provision of expanded reproduction.

The issue of optimizing the movement of livestock requires finding such an optimal annual herd movement of livestock that, taking into account the end of the planned year, the number of head of cattle for each sex and age group is determined. The goal is to determine the number of head of cattle at the end of the year and the indicators of dairy and meat production, which are written off or sold for each age group of cattle, transferred from one group to another. In general, taking into account the direction of production, natural and economic characteristics of the farm, the level of livestock reproduction, the state of the fodder base, the type of livestock, etc., the farm to achieve the best economic efficiency of production efficiency the problem of optimizing the composition and movement of the herd, which allows [5].

In order to determine the number of cattle at the end of the year, milk and meat production indicators, which are written off or sold, transferred from one

group to another for each sex and age group of cattle on the farm, Parkent-Agro diversified farm in Parkent district was the object of research.

To solve the problem of optimization, first of all, its economic-mathematical model is created [3, 6–8, 13]. In making the economic-mathematical model of determining the optimal movement and composition of livestock, we have made the following definitions:

j - index of sex-age groups of livestock;

i - index of types of products produced;

j' - index of sex-age groups of livestock in small groups;

j'' - index of sex-age groups of livestock in large groups;

$z_{j'j}$ - variable, head numbers of livestock moving from small groups of j-sex-age to groups of j-age;

$z_{jj''}$ - variable, from j-sex-age groups j''- head numbers of livestock transferred to older age-sex groups;

y_j - the number of head of livestock at the end of the year in variable, j-sex-age groups;

z_j - the number of livestock excluded from the variable, j-sex-age groups;

B_j -j- the number of livestock in the sex-age groups at the beginning of the year;

D_j -j - year-on-year head losses of livestock in sex-age groups;

$K_j^{\min}$, $K_j^{\max}$-j- the limits of the minimum and maximum possible number of livestock to be excluded from the sex and age groups;

Y - the total number of cattle at the end of the auxiliary variable year;

X - auxiliary variable, the total number of livestock transferred to other groups during the year;

Z - auxiliary variable, the total number of livestock to be written off during the year;

a_{ij} -j-type of product obtained from livestock of young sex groups;

Q_i - annual plan for the production of i-type products;

$R_j^{\min}$, $R_j^{\max}$- limits of the minimum and maximum possible number of head of livestock at the end of the year in j-sex-age groups;

$W_{jj'}$, $W_{jj''}$ - coefficients representing the sex-age ratio of cattle in the herd;

p_j -j - live weight of one head of cattle in sex-age groups;

N - a collection containing the numbers of young sex groups of livestock;

M - a set containing the numbers of the types of products produced;

M'- a package containing the number of milk production. Problem statement: it is required to find the values of unknown variables y_j, z_j, $z_{j'j}$, $z_{jj''}$ in which the objective function reaches its maximum value under boundary conditions.

The objective function of the economic-mathematical model is the maximum meat or milk production.

Objective function of the model:

$$f(z) = \sum p_j z_j \to \max \text{ - maximum meat production}$$
$$f(z) = 0.5a_{ij}B_j + 0.5a_{ij}y_j \to \max \text{ - maximum milk production}$$

under the following conditions:

1) On the implementation of the balance of movements of livestock in each age group during the year:
$$B_j + z_{j'j} - z_{jj''} - D_j - z_j = y_j, \quad (j \in N);$$
2) On the transition of livestock from small age groups to large groups:
$$Z_{jj''} = B_j - D_j - z_j, \quad (j \in N);$$
3) Restrictions on losses (plague) of livestock in young sex groups:
$$K_j^{\min} \le z_j \le K_j^{\max}, \quad (j \in N);$$
4) On the relationship between livestock and young sex groups at the end of the year:
$$y_j(\le\ge)w_{jj'}y_{j'}, \quad (j \in N);$$
5) On the change in the total number of livestock and separate age groups:
$$\sum y_j \underset{\le}{\overset{\ge}{=}} P_j; \quad R_j^{\min} \le y_j \le R_j^{\max}, \quad (j \in N);$$
6) On the implementation of the annual production plan:
$$\sum_{j \in N} a_{ij} z_j \ge Q_i, \quad (i \in M).$$

Non-negatives of variables:

$$y_j \ge 0; \ z_j \ge 0; \ z_{j'j} \ge 0; \ z_{jj''} \ge 0.$$

Based on the initial data and definitions, as well as the above structural model, a numerical economic-mathematical model of the problem of determining the movement and composition of the herd is created.

Based on the results of the information technology application package, the following figures show the loss of agricultural livestock in livestock, which is an indicator of the movement and composition of livestock in Figure 2, poor

quality of the herd for slaughter, the availability of calving heifers, breeding rates of females. it will be possible to analyze the factors [9].

For this purpose, on the basis of data from the farm of a diversified farm specializing in the production of dairy and meat products, a numerical economic-mathematical model of optimizing the movement and composition of the herd by age and sex of 320 cattle and an expanded matrix based on it.

The system of constraints in the numerical economic-mathematical model of the problem is a group of constraints representing the number of cattle for each sex-age group and the balance for newborns, a constraint group on the transfer of livestock from one group to another by sex-age group, - a group of restrictions on the possible range of age groups, a group of restrictions on the ratio of cattle by sex and age groups, a group of restrictions on the total number of livestock at the end of the year, a group of restrictions on the implementation of the annual production plan and the composition of cattle will be written off, transferred to other groups, and a group of restrictions on the determination of head counts at the end of the year. The criterion of optimality, i.e., the indicators of maximization of milk and meat production as the target function of the issue, was obtained [11, 12].

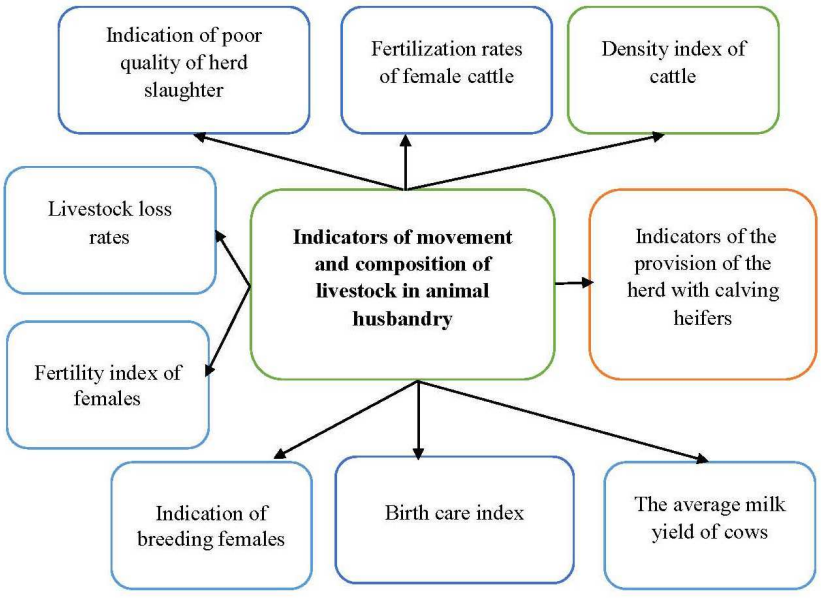

FIGURE 2. Indicators of movement and composition of livestock in animal husbandry.

3. Results of the research

A numerical economic-mathematical model of the problem of optimizing the movement and composition of the herd and an extended matrix based on it was developed and solved on a computer on the basis of a standard program. According to the analysis of the optimal solutions obtained from the computer, the plan for milk production on the farm is 2340.8 quintals, and meat production is 201.9 quintals [1, 2].

The results obtained from the computer when the problem was solved to maximize milk production are given in Table 1 below.

Table 1. Composition and movement of livestock on the results of maximizing milk production in animal husbandry

Composition of cattle by sex-age groups	Number of cattle at the beginning of the year, head	Income, head		Expenses, head					Number of cattle at the end of the year, head
		new generation	jump from small groups	transition to large groups	loss	write-off			
						head	live weight of a head of cattle, s	total, s	
Pedigree bulls	2		$Z_1=1$	-		$X_1=1$			$Y_1=2$
Cows	126		$Z_2=24$	-		$X_2=10$	4.8	48	$Y_2=140$
Heifers	24		$Z_3=25$	24		$X_3=0$	3.3	0	$Y_3=25$
Bodies	38		$Z_4=39$	25		$X_4=13$	2.8	36.4	$Y_4=39$
Cows over the age of one	30		$Z_5=46$	1		$X_5=29$	3.0	87	$Y_5=46$
Female calves that are one year old	54		$Z_6=55$	39		$X_6=15$	1.6	24	$Y_6=55$
Male calves that are one year old	46		$Z_7=55$	46		$X_7=0$	1.6	0	$Y_7=55$
Newborn female calves	-	56	-	55	1	$X_8=0$	0.6	0	
Newborn male calves	-	56	-	55	1	$X_9=0$	0.6	0	
Total	320	112	$Z_8=245$	245	2	$X_{10}=43$	-	$X_{11}=202$	$Y_8=362$

The results obtained from the computer when the problem was solved to maximize meat production are given in Table 2 below.

TABLE 2. Composition and movement of livestock according to the results of maximization of meat production in animal husbandry.

Composition of cattle by sex-age groups	Number of cattle per year, head	Income, head		Expenses, head					Number of cattle at the end of the year, head
		new generation	switch to small groups	transition to large groups	loss	write-off			
						head	1 head live weight, s	Total, s	
Pedigree bulls	2		$Z_1=1$	-		$X_1=1$	5.8	5.8	$Y_1=2$
Cows	126		$Z_2=24$	-		$X_2=15$	4.8	72	$Y_2=135$
Heifers	24		$Z_3=23$	24		$X_3=0$	3.3	0	$Y_3=23$
Bodies	38		$Z_4=37$	23		$X_4=15$	2.8	42	$Y_4=37$
Cows over the age of one	30		$Z_5=33$	1		$X_5=29$	3.0	87	$Y_5=33$
One year. female calves	54		$Z_6=55$	38		$X_6=17$	1.6	27.2	$Y_6=55$
One year. male calves	46		$Z_7=55$	27		$X_7=13$	1.6	20.8	$Y_7=55$
Newborn female calves	-	56	-	55	1	$X_8=0$	0.6	0	
Newborn male calves	-	56	-	55	1	$X_9=0$	0.6	6	
Total	320	112	$Z_8=228$	228	2	$X_{10}=90$	-	$X_{11}=254$	$Y_8=340$

From the data in the table above, it can be seen that when the problem is solved to maximize milk production, the number of cattle will increase to 362 heads, ie to 42 heads, and when it is solved to maximize meat production, it will increase to 20 heads.

4. CONCLUSIONS

Analysis of the results obtained from solving the problem of optimizing the movement of livestock, the problem of maximizing milk production shows that one head of two breeding bulls on the farm is removed from the farm, respectively, one head is transferred to this group at the end of the year. the number

is two heads. Of the 126 head of cows available at the beginning of the year, 10 head are written off during the year, while 24 head of heifers are added to the group of cows, resulting in 140 head of cows at the end of the year. At the beginning of the year, of the 38 head of carcasses available on the farm, 13 are counted during the year, the remaining 25 head are transferred to the heifer group, and 39 head from the group of female calves under one year of age to the carcass group.

The results also show that at the beginning of the year, 15 out of 54 female calves under one year of age were excluded, and 39 heads were transferred to the body group during the year, and 55 newborn calves were transferred to this group. There are 46 male and 56 female calves and 56 newborn male calves on the farm.

Thus, 68 out of 320 head of cattle at the beginning of the year are written off during the year (loss 2 head), the number of cattle at the end of the year at the expense of 112 head of newborns is 362 heads, the number of movements of cattle from small to large groups by age and sex It would be expedient to have 245 heads.

In general, genetic and structural assessment of livestock based on the results and analysis of the solution of the problem of maximizing meat and dairy production in the optimization of herd movement and composition to achieve high production of milk and meat products in livestock using innovative and digital technologies To study the results of breeding stock of young cattle, to determine the cost of feed with the growth rate of cows and the amount of colostrum, and to study the reproductive capacity of young cattle in terms of methods of growing new stocks indicates compatibility.

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