

PRODUCTIVE QUALITIES OF COWS OF THE HOLSTEIN BREED OF DIFFERENT ORIGIN

Alexandra KONSTANDOGLO¹, Valentin FOKSHA¹, Vasily TIKLENKO²,
Vasily KURULYUK¹, Radu KARAMAN³,

¹Scientific and Practical Institute of Biotechnologies in Zootechny and Veterinary Medicine,
v. Maximovka, Anenii Noi District, Republic of Moldova

²Society of Limited Liability "Holstein", v. Roshkan, Anenii Noi District, Republic of Moldova

³Society of Limited Liability "Dastocom", v. Styrcha, Glodeni District, Republic of Moldova

Corresponding author email: aliek55@mail.ru

Abstract

There are presented the results of the studying productive qualities of Holstein cows of various origins. The material for the research was cattle of the Holstein breed of German selection- Society of limited liability "Dastocom" and French selection - Society of limited liability "Holstein". Milk yield of cows in the herd of LLC "Dastocom" for the first lactation averaged 8851 kg of milk. The milk productivity of Holstein cows of French selection (LLC "Holstein") for the first lactation averaged 6334 ± 34.7 kg of milk. At cattle of the Holstein breed of German selection (LLC "Dastocom"), a high level of heritability for milk yield (mother-daughter) was found, which amounted to 0.756. The greatest influence on the fat content in the milk of the first-calving cows of LLC "Dastocom" was exerted by paternal ancestors ($h^2 = 0.39$). For the entire analyzed population of cows-keepers of LLC "Holstein", milk yield and fat content in milk were largely determined by heredity ($h^2 = 0.24-0.49$) and ($h^2 = 0.44-0.32$), respectively.

Key words: correlation, fat content, heritability, milk yield, variability.

INTRODUCTION

In dairy cattle breeding of developed countries of the world, the highly productive Holstein breed occupies a leading position. The use of highly productive animals in breeding work contributes to the accumulation of the most valuable genetic potential of cows, increases the possibility of obtaining even more highly productive breeding herds (Nemtseva, 2019; Stepanov et al., 2019; Zernina, 2019; Zyryanova, 2018).

Of great importance for the theory and practice of breeding is the use of heritability coefficients (Kibkalo et al., 2004). Currently, there are enough reports in the zootechnical literature about the limits of variation in the coefficient of heritability of milk productivity traits (Kuznetsov et al., 2002; Lepekhina, 2012; Nazarchenko, 2012).

In the course of the work of these researchers, a very important conclusion follows that if a single lactation, in relation to which it is known that it has a relatively small heritability coefficient, it says little about the breeding value of a cow, then the information about her milk yields, generalized for five lactations, already

give a fairly complete representation for judging its breeding value. It was also noted that with an increase in the level of herd productivity, the heritability coefficient also increases, and as the age of cow's increases, heritability tends to decrease (Mistzal et al., 1993).

Evaluation of the influence of mother cows on the yield and quality composition of offspring milk is one of the leading prerequisites for breeding cattle (Damarov et al., 2018; Kozlov, 2019; Kulikova et al., 2016; Piotrovskaya et al., 2018; Titova, 2018;).

For the last decades, Holstein cattle have been imported to the Republic of Moldova from such European countries as Holland, Germany, France, Austria and Hungary. These animals are distinguished by increased productivity, good health and are able to acclimatize and adapt to the conditions of various climatic zones of the republic. Holstein cattle purchased from Holland and Germany have successfully adapted to the conditions of the south of the Republic of Moldova, in particular in the herds of Joint-Stock Company "Aydyn" and Society of Limited Liability "Doksancom". It should be

noted that under the conditions of free-range maintenance and balanced feeding, the milk of Holstein cows of Dutch breed in the herd of Society of Limited Liability “Doksancom” averages 9085 kg of milk with a fat content of 3.88% after the first lactation (Foksha et al., 2021). Milk yields of breeding cows of the Holstein breed in the herd of Joint-Stock Company “Aydyn” produced 10,560 kg of milk with a fat content of 3.85% (Dutch breed) and 10,102 kg of milk with a fat content of 3.92% (German breed) in the third lactation (Foksha et al., 2020).

The aim of the research is to study the genetic and population processes at cows of German and French breed and to reveal the correlations and heritability of the main economically useful traits.

MATERIALS AND METHODS

The research material was Holstein cattle of German breed – Society of Limited Liability “Dastocom”, v. Styrcha, Glodyany district and French breed – Society of Limited Liability “Holstein”, v. Roshkan, Aneniy Noy district. The milk yield for 305 days of lactation, the fat content in milk and the amount of milk fat were studied, the variability of these indicators (Cv) was determined.

The genetic potential of the productivity of primiparous cows was determined on the basis of the parental index of cows (PIC). Parental indices were calculated by the Wright path coefficient (Krasota & Dzhaparidze, 1999) according to the formula: according to the formula: $PIC = (2M + MM + MO)$; 4, where: M

– mother's productivity; MO - the productivity of the father's mother; MM is the productivity of the mother's mother. Realization of the genetic potential (RGP) was determined by the formula: $RGP = \text{actual productivity/expected productivity according to PIC} \times 100\%$.

To study the variability and heritability of milk production traits for the first lactation, mother-daughter pairs were selected. Each sample consisted of 47 cows and 47 offspring of German breed (Society of Limited Liability “Dastocom”), 110 cows and 110 offspring of French breed (Society of Limited Liability “Holstein”). The milk yield for 305 days of lactation, the fat content in milk and the amount of milk fat were studied, the variability of these indicators (Cv) was determined. The correlation coefficient (r) was calculated on a computer using the CORREL function in the Excel program environment. The heritability coefficient was found to be equal to twice the correlation coefficient between mothers and daughters ($h^2 = 2rM/F$). Student's t-test (t-test) was used to determine the significant difference between the data.

RESULTS AND DISCUSSIONS

Research in both herds began with a study of the productivity of the female ancestors of imported heifers. In Society of Limited Liability “Dastocom” pregnant heifers were brought from Germany.

The milk yield of mothers of fathers according to the highest finished lactation in Society of Limited Liability “Dastocom” (Table 1), averaged 12636 kg of milk, fat content 3.93%, amount of milk fat - 497 kg.

Table 1. Productivity of female ancestors of Holstein cows of German breed, Society of Limited Liability “Dastocom”

Indicators	Number of cows, heads	Milk yield, kg		Fat content, %		Amount of milk fat, kg	
		X ± Sx	Cv, %	X ± Sx	Cv, %	X ± Sx	Cv, %
Mothers	47	9832±181.7	17.9	3.86±0.05	10.3	379±7.5	17.5
Father's mother	45	12636±355.1	18.5	3.93±0.07	13.1	497±17.3	17.7
Mothers of mothers	45	10025±282.9	16.7	3.88±0.07	11.1	390±15.0	16.9

The milk yield of mothers of pregnant heifers on average per lactation amounted to 9832 kg of milk, the fat content was 3.86%.

The coefficients of variability in milk yield for all analyzed groups of mothers in the population of Society of Limited Liability “Dastocom” were slightly lower than the literature data and

varied within 16.7% (mothers of mothers) and 18.5% (mothers of fathers), which characterizes a high concentration of female ancestors for this sign. According to the content of fat in milk, all female ancestors have a high coefficient of variability.

The results of the study of the milk productivity of the female ancestors of the Holstein breed, imported pregnant heifers from France (breeding farm Society of Limited Liability

“Holstein”), showed that the average milk yield of mothers was 8413 kg of milk with a fat content of 3.75% (Table 2).

Table 2. Productivity of female ancestors of Holstein cows of French breed, Society of Limited Liability “Holstein”

Indicators	Number of cows, heads	Milk yield, kg		Fat content, %		Amount of milk fat, kg	
		X ± Sx	Cv, %	X±Sx	Cv, %	X ± Sx	Cv, %
Mothers	120	8413±167.1	27.6	3.75±0.05	14.5	312±6.5	22.8
Father's mother	138	11215±189.9	27.6	3.92±0.05	27.6	440±9.7	25.8
Mothers of mothers	125	9299±141.6	27.6	3.79±0.04	12.4	350±5.9	18.8

The milk yield of mothers of fathers for the highest lactation averaged 11215 kg of milk with a fat content of 3.92%, the amount of milk fat was 440 kg.

The coefficients of variability (Cv) for milk yield were the same for all analyzed groups of mothers - 27.6%. In terms of the content and amount of milk fat, the values of this trait on average for the sample were high and varied within 14.5-27.6% and 18.8-25.8%,

respectively. Consequently, the imported population of French Holstein cattle has a large range of variability and high genetic diversity. The results of the study of the milk productivity of the population of cows of the Holstein breed of the German selection of the breeding farm Society of Limited Liability “Dastocom” for the first two completed lactations are shown in Table 3.

Table 3. Dynamics of milk productivity of cows of Society of Limited Liability “Dastocom”

No	Indicators	The first lactation		The second lactation		Population average	
		X ± Sx	Cv, %	X ± Sx	Cv, %	X ± Sx	Cv, %
1.	Number of cows, heads	47		23		70	
2.	Milk yield, kg	8851 ± 81.5	6.3	9508 ± 211.0*	10.6	9067 ± 95.0	8.8
3.	Fat content, %	3.91 ± 0.01	1.1	3.95 ± 0.01	1.4	3.92 ± 0.01	1.3
4.	Amount of milk fat, kg	346 ± 3.1	6.1	358 ± 17.9	24.0	350 ± 6.2	14.8

Note: * - P<0.05

It was established that the milk yield of cows for the first lactation averaged 8851 kg of milk. An analysis of the milk yield of cows in the dynamics of lactations showed that during the second lactation, milk productivity was by 651 kg more than in the first lactation, the difference is significant at P<0.05.

The coefficient of variability (Cv) for milk yield per lactation was lower than the literature data and fluctuated within 6.3% and 10.6%, respectively, the first-second lactation, or an increase trend is observed in the dynamics of lactations. Low rates of variability characterize the high consolidation of animals in the development of the trait and reduce the possibility of selection when breeding them in a closed population. It should be noted that, on average, for the sample, the coefficients for milk yield, fat content in milk and the amount of milk fat amounted to 8.8%, 1.3% and 14.8%,

respectively, which indicates good selection opportunities for the studied traits and is confirmed by the results of a comparative analysis of the level of milk productivity with the requirements of the standard for the Holstein breed (Figure 1).

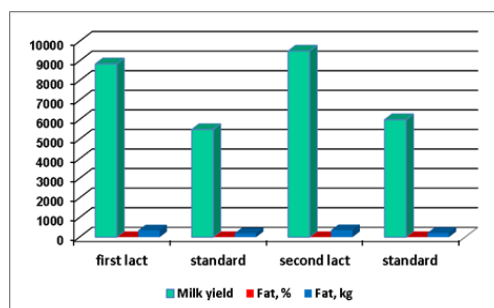


Figure 1. Comparative assessment of the milk productivity of cows of Society of Limited Liability “Dastocom” with the standard of the Holstein breed

Thus, the milk yields of cows for the to the first lactation compared to the breed standard were by 3351 kg more milk, the fat content - 0.31% and the amount of fat - 148 kg, for the second lactation the excess was by 3508 kg, 0.35% and 142 kg, respectively.

As a result of studying the productive qualities of cows of the Holstein breed of French selection (Society of Limited Liability "Holstein"), it was found that the milk yield of the analyzed number of cows increased with each subsequent lactation (Table 4).

Table 4. Characteristics of cows of the Holstein breed of French selection in terms of milk production for 305 days of lactation, Society of Limited Liability "Holstein" ($X \pm Sx$)

Lactation	Number of cows, n	Indicators					
		Milk yield, kg	Cv, %	Fat content, %	Cv, %	The amount of milk fat, kg	Cv, %
the first	152	6334±34.7	6.8	3.97±0.004	1.1	252±1.3	6.5
the second	144	6547±31.8***	5.8	3.98±0.004	1.1	276±16.3	71
the third	97	6641±46.7***	6.9	3.97±0.005	1.2	264±1.7	27.6
the fourth	97	6881±40.2***	5.8	3.94±0.005	1.1	271±1.5	5.3
the fifth	64	6649±51.9***	6.2	3.95±0.005	1.1	262±1.9	27.6

Note: *** - $P < 0.001$.

Thus, if on the first lactation the cows produced an average of 6334 kg of milk, then on the second, third and fourth lactation they were by 213, 307 and 547 kg of milk more, respectively, the difference is significant at $P < 0.001$. Milk yields on average for the fifth lactation decreased slightly compared to the previous three lactations, however, compared to the first lactation, the yields were by 315 kg of more milk, a significant difference $P < 0.001$. Thus, the milk yields of the cows of the herd of Society of Limited Liability "Holstein" in the dynamics of lactation gradually increased including the fourth lactation, which is clearly shown in the figure of the diagram (Figure 2).

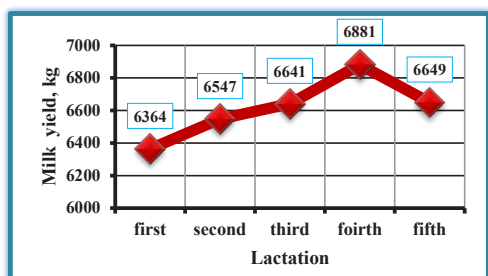


Figure 2. Milk productivity of cows of the breeding farm Society of Limited Liability "Holstein" in the dynamics of lactation

It should be noted that, depending on lactation, the lowest coefficient of variability in milk yield per lactation was at cows in the second and third lactations - 6.9%. The same is observed for the content of milk fat in milk, the coefficients of

variability did not correspond and were lower than the literature data.

In terms of the amount of milk fat, the coefficient of variability for the first (6.5%) and fourth (5.3%) lactations was low. For other lactations, it was within the normal range (third and fifth lactations - 27.6%), or above the norm by 53-39%. Thus, in the population of Holstein cattle of French selection, the genetic diversity is reduced, an indirect expression of this is the low value of the coefficients of variability for all analyzed indicators.

One of the factors determining the value of imported livestock is the genetic potential of the acquired animals. As it is known, the genetic potential is determined by the productivity of maternal ancestors. In order to assess the potential capabilities of animals for all indicators of female ancestors in the analyzed populations, upon completion of their first lactation, the parental index of cows was calculated, which shows the genetic capabilities of the animal and the degree of transmission of productive qualities to offspring. For this, the parental index of cows was calculated, as well as the indicator of the realization of the genetic potential, the results are shown in Tables 5-6.

As it can be seen from the data in Table 5, the parental index of cows of Society of Limited Liability "Dastocom" for milk yield was 10581 kg of milk at primiparous cows. The implementation of the genetic potential for milk yield for 305 days of lactation was at the level of 83.6%, for fat - 100.7%.

Table 5. Realization of the genetic potential of cows in 305 days of the first lactation, Society of Limited Liability "Dastocom"

Indicators					
Parent index of cows (PIC)		Own productivity		Realization of genetic potential (RGP), %	
Milk yield, kg M ± m	Fat, % M ± m	Milk yield, kg M ± m	Fat, % M ± m	Milk yield	Fat
10581 ± 250.4	3.88 ± 0.06	8851 ± 81.5	3.91 ± 0.01	83.6	100.7

Table 6. Realization of the genetic potential of primiparous cows for 305 days of lactation, Society of Limited Liability "Holstein"

Indicators					
Parent index of cows (PIC)		Own productivity		Realization of genetic potential (RGP), %	
Milk yield, kg M ± m	Fat, % M ± m	Milk yield, kg M ± m	Fat, % M ± m	Milk yield	Fat
9335 ± 166.4	3.86 ± 0.09	6334 ± 34.7	3.97 ± 0.004	67.8	102.8

It was established that the parental index of cows in the population of the herd of Society of Limited Liability "Holstein" was at the level of 9335 kg in terms of milk yield, and in terms of fat content - 3.86%. The implementation of the genetic potential for milk yield was 67.8%, for the fat content in milk it was 102.8%. As is known, the correlation between the amount of milk yield and the content of fat in milk depends on many factors, including between the signs of

the productivity of daughters and their maternal ancestors.

As it is known, most of the traits by which cattle's breeding is carried out are interconnected. Communication can be expressed only by a correlation relation. The results of the study of the relationship between individual indicators of productivity at cows of Society of Limited Liability "Holstein" depending on lactation are shown in Table 7.

Table 7. Correlation between productivity indicators, $r \pm m$ (Society of Limited Liability "Holstein")

Indicators	First lactation	Second lactation	Third lactation	Fourth lactation	Fifth lactation
Milk yield (X) - Fat, % (Y)	-0.397 ± 0.07	-0.617 ± 0.06*	-0.696 ± 0.05***	-0.489 ± 0.08	-0.438 ± 0.01
Milk yield (X) - Fat, kg (Y)	+0.972 ± 0.02	+0.0669 ± 0.08	+0.990 ± 0.002	+0.982 ± 0.04	+0.987 ± 0.003

Note: * - $P < 0.05$; *** - $P < 0.001$

The relationship between milk yield and the percentage of fat in milk of cows of the first to fifth lactation was in a negative correlation from moderate (-0.397, first lactation, -0.438 - fifth lactation), to noticeable (-0.617, second lactation) and high (-0.696, third lactation). A comparative analysis of the results of the relationship between milk yield and percentage of fat it is found a significant difference between the third and first lactations - 0.299 at $P < 0.001$, and between the second and first lactations - 0.220 at $P < 0.05$.

As it can be seen, one-sided selection for the level of milk yield in the herd of Society of Limited Liability "Holstein" led to an increase of the negative relationship between these traits,

which makes it difficult to conduct successful selection and indicates the need for simultaneous selection for milk yield and fat content in milk.

The nature of the dependence of the productive qualities of daughters and their mothers on the first lactation in the livestock population of Society of Limited Liability "Dastocom" was studied, the results of the studies are given in Table 8.

A negative relationship was established for milk yield for 305 days of lactation between mothers and their daughters (-0.378), the tightness of the relationship is moderate. According to the fat content, the correlation is positive, the closeness of the relationship is weak (+0.140).

Table 8. Correlation between the main productivity indicators of mothers and their daughters (Society of Limited Liability "Dastocom"), $r \pm m_r$

Indicators	Livestock mothers-daughters, n	Milk yield, kg	Fat content, %	The amount of milk fat, kg
Mothers - daughters	47-47	-0.378±0.01	+0.140±0.1	-0.143±0.1

A negative relationship was established for milk yield for 305 days of lactation between mothers and their daughters (-0.378), the tightness of the relationship is moderate. According to the fat content, the correlation is positive, the closeness of the relationship is weak (+0.140).

For assessment of the indicators of heritability, the method of correlation of the productivity indicators of daughters and their mothers was used, the results obtained are shown in Table 9.

Table 9. Heritability (h^2) of productivity indicators (mother-daughter) of the Holstein breed, Society of Limited Liability "Dastocom"

Indicators	Livestock mother-daughter, n	$h^2=2r_{m/f}$	$h^2=2r_{m/f}$, %
By milk yield	47	0.756	75.6
By fat content in milk	47	0.280	28.0
According to the amount of milk fat	47	0.286	28.6

As a result of the analysis, was revealed a high level of heritability for milk yield (mother-daughter) at cattle of the Holstein breed of German selection, which amounted to 0.756. It should be noted that the milk yield of mother cows is 75.6% due to heredity, which was inherited by their daughters. The content of fat in milk ($h^2 = 0.280$) was more affected by paratypic factors, as the heritability coefficients were quite low.

Of particular interest for the breeding process is the study of the dependence of the productive qualities of the offspring and its closest ancestors - M (mother), FM (father's mother) and MM (mother's mother). The results of the study of the dependence of productivity indicators between maternal ancestors and daughters in the herd of Society of Limited Liability "Dastocom" are shown in Table 10.

Table 10. Correlation of the main productive indicators of the offspring and its closest ancestors, $r \pm m_r$

Indicators	Daughter - Mother (M)	Daughter - mother's mother (MM)	Daughter - father's mother (FM)
Milk yield, kg	-0.378 ± 0.14***	-0.247 ± 0.15	-0.047 ± 0.15
Fat, %	+0.280 ± 0.14	+0.194 ± 0.15	-0.124 ± 0.15
Fat, kg	-0.140 ± 0.15	-0.026 ± 0.15	-0.111 ± 0.15

Note: *** - $P < 0.001$.

As it can be seen by milk yield between maternal ancestors (M) and daughters, a negative moderate relationship was revealed - (-0.3780 ± 0.14). Between paternal ancestors (FM) and daughters, the correlation by milk yield is weakly negative (-0.047 ± 0.15). According to the content of fat in milk, the relationship between maternal ancestors is weakly positive +0.280 (M) and +0.194 (MM), between paternal ancestors (MO) - weakly negative -0.124. A comparative analysis of the relationship between the group of daughters of paternal ancestors (FM) and maternal ancestors

(M) revealed the superiority of maternal ancestors at $r = -0.331$, the difference is significant ($P < 0.001$).

Therefore, when selecting animals in the herd of Society of Limited Liability "Dastocom" it is necessary to attach great importance to milk yield and fat content in the milk of maternal ancestors.

The effectiveness of the selection cattle on productivity is determined by the degree of hereditary improvement of each new generation compared to the previous one. The results of the study of the share of the influence of genetic

factors on the productive qualities of primiparous cows in the herd of Society of

Limited Liability "Dastocom" are shown in Table 11.

Table 11. Heritability of the main productive features at primiparous cows, h^2 (Society of Limited Liability "Dastocom")

No	Indicators	Daughters - Mothers (M)	Daughter - mother's mother (MM)	Daughter - father's mother (FM)
1.	Milk yield, kg	0.76	0.10	0.49
2.	Fat, %	0.28	0.25	0.39
3.	Fat, kg	0.29	0.22	0.05

As it can be seen, the heritability of the size of the milk yield of analyzed animals is higher than the content of fat in milk and the amount of milk fat. Mothers had the greatest influence on milk yield - on average, the heritability coefficient $h^2 = 0.76$, paternal ancestors (father's mother) had a slightly lesser influence - $h^2 = 0.49$. The fat content in the milk of primiparous cows was largely due to heredity, where paternal ancestors $h^2 = 0.39$ had the greatest influence. Thus, a high

coefficient of heritability for milk yield indicates the uniformity and stability of the conditions for keeping and feeding animals in the herd of Society of Limited Liability "Dastocom".

The results of the study of the share of the influence of genetic factors on the productive qualities of primiparous cows, and also the correlation between the main indicators of the productivity of cows and their maternal ancestors in the herd of Society of Limited Liability "Holstein" are shown in Table 12.

Table 12. Correlation and heritability of the main productive traits of daughters and close ancestors, Society of Limited Liability "Holstein"

No	Indicators	Daughter - Mother (M)	Daughter - mother's mother (MM)	Daughter - father's mother (FM)
1.	Milk yield	r	+0.119 ± 0.08	+0.247 ± 0.07
		h^2	0.24	0.49
2.	Fat	r	+0.219 ± 0.08	-0.159 ± 0.08
		h^2	0.44	0.32

As it can be seen from the data in Table 12, the correlation on the milk yield of daughters and close female ancestors is positive, the tightness of the relationship is weak, the greatest relationship was found between paternal ancestors (FM) - ($r = +0.247$). According to the content of fat in milk, the correlation between daughters and mothers was ($r = +0.219$).

Based on the obtained results, presented in Table 12, it can be concluded that for the entire population, milk yield and fat content in the milk of primiparous cows, was largely due to heredity ($h^2 = 0.24-0.49$) and ($h^2 = 0.44-0.32$), respectively.

Paternal ancestors had the greatest influence on milk yield - the average heritability coefficient was 0.49. And the maternal ancestors had the greatest influence on the fat content, in which the heritability coefficient was $h^2 = 0.44$, and paternal ancestors had a slightly lesser influence

- $h^2 = 0.32$. Thus, the realization of the genetic potential of the heifers of Society of Limited Liability "Holstein" was mainly influenced by genetic factors.

CONCLUSIONS

1. Analysis of the milk yield of cows of the Holstein breed of German selection (Society of Limited Liability "Dastocom") in the dynamics of lactation showed that during the second lactation, milk productivity was by 651 kg of milk more than during the first lactation, the difference is significant at $P < 0.05$.

2. It was established that the milk yield of cows of the Holstein breed of French selection (Society of Limited Liability "Holstein") increased with each subsequent lactation. So, if in the first lactation milk yields averaged 6334 kg of milk, then in the second, third and fourth

lactations they were 213, 307 and 547 kg of milk more, respectively, the difference is significant at $P < 0.001$.

3. The relationship between milk yield and percentage of fat in milk of cows of the first - fifth lactation in the herd (Society of Limited Liability "Holstein") was in a negative correlation from moderate (-0.397, first lactation, -0.438 - fifth lactation), to noticeable - (-0.617, second lactation) and high (-0.696, third lactation).

4. At cattle of the Holstein breed of German selection (Society of Limited Liability "Dastocom"), a high level of heritability for milk yield (mother-daughter) was found, which amounted to 0.756. The milk yield of cows-mothers is 75.6% due to heredity, which was inherited by their daughters. The content of fat in milk ($h^2 = 0.280$) was more affected by paratypic factors, since the heritability coefficients were quite low.

5. The heritability of milk yield magnitude at primiparous cows of Society of Limited Liability "Dastocom" is higher than the fat content in milk and the amount of milk fat. Mothers had the greatest influence on milk yields - on average, the heritability coefficient $h^2 = 0.76$, paternal ancestors (father's mother) had a slightly lesser influence - $h^2 = 0.49$. The fat content in the milk of primiparous cows was largely due to heredity, where paternal ancestors had the greatest influence $h^2 = 0.39$.

6. For the entire analyzed population of primiparous cows of Society of Limited Liability "Holstein", milk yield and fat content in milk were largely determined by heredity ($h^2 = 0.24-0.49$) and ($h^2 = 0.44-0.32$), respectively. Paternal ancestors had the greatest influence on milk yield - the average heritability coefficient was 0.49. The maternal ancestors had the greatest influence on the fat content, at which the heritability coefficient was $h^2 = 0.44$, and the paternal ancestors had a slightly lesser influence - $h^2 = 0.32$.

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