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由于生态学和遗传学而培育欧洲荷斯坦牛的效率  
**EFFICIENCY OF THE EUROPEAN HOLSTEIN BREEDING DUE  
TO ECOLOGY AND GENETICS**

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注解。总结了黑白荷斯坦牛多年繁殖工作的成果。已经确定了荷斯坦奶牛的生态起源和线性隶属关系对其终生产奶量，牛奶中脂肪和蛋白质含量以及经济使用条件的影响。终身生产力指标之间的高表型和基因型相关系数 ( $r = + 0.92-0.98$ ) 表明任何特征的选择将对其他特征产生积极影响。显示了使用优质生产线制造商的可行性，这些生产线将高育种价值与女儿的生产力相结合，并改善其经济使用的持续时间。奶牛生产性质的遗传系数 ( $h^2 = 0.18-0.23$ )，有理由认为基于终身生产力特征的选择将对奶牛育种的进展产生积极影响。然而，缩短工业技术中动物生产使用的时间应该成为深入研究和寻找解决这一问题的方法的动力。

关键词：奶牛，荷斯坦奶牛品种，育种背景，终生产奶量，乳脂和蛋白质，相关性，遗传力。

**Annotation.** *The results of many years of breeding work with black-and-white Holstein cattle are summarized. The influence of ecogenetic origin and linear affiliation of Holstein cows on the value of their lifetime milk yield, fat and protein content in milk, as well as terms of economic use has been established. High phenotypic and genotypic correlation coefficients between indicators of lifetime productivity ( $r=+0.92-0.98$ ) indicate that the selection of any feature will have a positive effect on others. The*

*feasibility of using manufacturers of outstanding lines, which combine a high breeding value on the productivity of daughters with an improving effect on the duration of their economic use, is shown. The coefficients of heredity of the productive qualities of cows ( $h^2=0.18-0.23$ ), give reason to believe that the selection based on the features of lifetime productivity will positively affect the progress in dairy cattle breeding. However, shortening the period of productive use of animals in industrial technology should serve as an incentive for in-depth study and finding ways to solve this problem.*

**Keywords:** cows, Holstein breed, breeding background, lifetime milk yield, milk fat and protein, correlation, heritability.

### Introduction

In contrast to Western Europe and North America, where small family-cooperative farms traditionally dominate, Ukraine's dairy cattle breeding relies on the development of livestock industry [3, 5, 10]. Preference is given to the construction of high-tech dairy complexes, which provide for the loose keeping of a sufficiently large population of dairy cows. At the same time, there is a problem of completing such farms with highly productive animals, which, as a rule, is solved by importing the black-and-white Holstein breed from EU countries. However, in the new conditions, the adaptation of introduced animals is not always successful and is characterized by short periods of economic use [2, 4]. The premature retirement of dairy cows not only reduces the breeding resources of the breeds, but also causes economic damage to the industry as a whole. This leads to large economic losses in foreign currency, which do not always pay off due to the high productivity of animals [8]. It is important to search for effective breeding methods to increase the duration of economic use due to the selection of animals for important economically useful characteristics [6, 7, 9, 11].

The aim of the study was to analyze the productivity of Holstein cows of European breeding and their progeny of the first generation in the conditions of the Steppe of Ukraine. We have summarized the results of many years of breeding work with black-and-white Holstein cattle on a large industrial dairy complex.

### Material and methods

We studied the productive longevity of Holstein cattle of Danish, German and Hungarian ecogenetic origin (import - IG) and the progeny obtained from it (first generation - FG) in the temperate continental climate of the center of Ukraine at the industrial dairy complex of PrJSC Agro-Soyuz. The data of the Orsek dairy cattle breeding management system was taken into account, which included lifetime milk yield, content (%) and yield (kg) of milk fat and protein, productive longevity (number of completed lactations). Groups of animals were formed according to the principles adopted in zootechnology [1], followed by mathematical processing in STATISTICA 10 (StatSoft, Inc., USA).

## Results

Productive longevity of cows is a rather complex integral feature, which is determined by both genetic factors and environmental factors. The complexity of breeding on the basis of longevity is that the evaluation of the actual characteristics of these features is possible only after the departure of the cows from the herd, and, consequently, from the selection process. It was established that the average lifetime duration of the lactation period in FG compared with IG was reduced by 394 days - from 1441 to 1047 ( $P < 0.001$ ). At the same time, the lifetime yield was lower by 7167 kg (having decreased from 34245 to 27078 kg) or by 20.9% ( $P < 0.01$ ). In FG, the yield of milk fat and protein decreased by 758 and 229 kg or 23.0 and 24.1% ( $P < 0.001$ ) and its content in milk was 0.1%. The duration of economic use of FG decreased by 1.0 lactation ( $P < 0.001$ ), averaging 2.6 lactations (Table 1).

**Table 1** - Indicators of lifetime productivity of Holstein cows of different ecogenetic origin

Group	n	Indicators of lifetime productivity				
		yield, tone	milk fat yield, tone	milk protein yield, tone	average content for all lactations,%	
					fat	protein
Danish origin						
Import	52	35.6±2.62	1.2±0.08	1.0±0.07	3.4±0.07	2.9±0.06
I generation	23	24.0±2.77	0.9±0.11	0.7±0.09	3.6±0.09	3.1±0.08
German origin						
Import	47	31.3±2.07	1.0±0.07	0.8±0.06	3.3±0.07	3.3±0.13
I generation	29	23.6±2.50	0.7±0.07	0.6±0.06	2.7±0.06	2.7±0.08
Hungarian origin						
Import	49	35.7±2.16	1.1±0.08	1.0±0.06	3.2±0.07	2.8±0.06
I generation	28	33.2±3.43	1.0±0.11	0.8±0.09	2.9±0.09	2.5±0.08
herd average						
Import	148	34.2±1.33	1.1±0.04	0.9±0.03	3.3±0.04	2.8±0.03
I generation	80	27.1±2.41	0.9±0.07	0.7±0.05	3.2±0.05	2.7±0.05

The differences in the value of the lifetime productivity depending on the origin and linearity of animals are revealed. Lifetime milk yield, IG of Danish origin exceeded the average herd by 1336 kg or 3.9%. By the amount of milk fat and protein by 73.4 and 60.7 kg or 6.5 and 9.5%, and by its content - by 0.1%.

However, in terms of industrial technology in FGs of Danish breeding, the lactation period was shortened by 514 days or by 34.7% ( $P < 0.001$ ), and the duration of productive use by 0.9 lactations ( $P < 0.01$ ). For lifetime milk production,

FG cows conceded the IGs by 11,556 kg or 32.5% ( $P < 0.001$ ). The yield of fat - by 321 kg ( $P < 0.05$ ) and protein by 268 kg ( $P < 0.05$ ) or 26.8 and 26.5%. Although the average content of these components in milk has slightly increased (by 0.2%).

The cows of the IG of the German selection for lifetime milk yield were lower than the average for the herd by 2969 kg (8.7%), the yield of milk fat by 85 kg (7.6%) and protein by 81 kg (11.3%). The lactation period was shorter by 47 days (3.3%), and the number of lactations was 0.2%. The FG of the German selection also showed a significant reduction in the lactation period by 436 days or 31.3% ( $P < 0.01$ ). Lifetime milk yield was lower by 7725 kg or 24.7% ( $P < 0.05$ ), fat yield by 295 kg or 28.4% ( $P < 0.01$ ) and protein - by 229 kg or 27.2% ( $P < 0.01$ ). Its content in milk has not changed. The period of productive use was reduced by 1 lactation ( $P < 0.001$ ).

The cows of the Hungarian selection for lifetime milk yield exceeded the average figure for the herd of IG by 1,429 kg (4.2%). They produced a little more milk fat (by 4.1 kg or 0.4%) and protein (by 39.4 kg or 4.1%). However, the fat content was lower - by 0.1%. The *maintenance* period of the IG cows exceeded the average value of the herd by 0.2 lactation. For lifetime milk yield, they conceded to IG by 2,435 kg (6.2%), to the amount of fat by 145 kg (12.9%) and protein by 174 kg (17.6%). The average fat and protein content in milk decreased by 0.3 ( $P < 0.05$ ). The lactation period of FG decreased by 246 days (17.1%), and the *maintenance* period - by 0.9 lactation (23.7%) ( $P < 0.01$ ).

However, among the cows of the Holstein breed, it was FGs of Hungarian origin that turned out to be more adapted to the conditions of the industrial complex, differing in relatively high productive longevity. Their lactation period was 228 and 238 days longer than in animals of Danish and German selection. For lifetime milk yield, they surpassed the cows of Danish and German selection by 9213 and 9688 kg or 38.3 and 41.1% ( $P < 0.95$ ). On the yield of milk fat - by 106 and 239 kg (12.2 and 32.1%) and milk protein - by 72 and 202 kg (9.7 and 32.9%). For productive longevity, advantage was 0.4 and 0.5 lactation.

Of great importance in the breeding of imported animals is the study of the heritability of economically useful traits in the progeny obtained from them. We have evaluated the productive qualities and heritability of individual economically useful traits in IG and FG in mother-daughter pairs. It was established that the productivity of the cow-daughter of FG in the industrial complex conditions was significantly inferior to the imported mothers. The value of lifetime milk yield - by 9711 kg or 26.4% ( $P < 0.001$ ); lifetime milk fat yield — by 351 kg or 28.8% ( $P < 0.001$ ); lifetime milk protein yield- by 294 kg or 28.9% ( $P \geq 0.001$ ). At the same time, there was also a tendency to a decrease in the average content of fat and protein in milk - by 0.1%.

Despite the general trend in the reduction of indicators of lifetime productivity

of Holstein cattle, we identified significant intrabreed (ecogenetic) differences in individual traits. In particular, among cow daughters, FGs of Danish and German origin, the magnitude of lifetime milk yield compared with imported mothers was lower by 14405 and 11075 kg or 37.5 ( $P < 0.01$ ) and 32.0% ( $P < 0.01$ ), respectively. The lifetime yield of milk fat decreased by 434 and 420 kg or 33.1 ( $P < 0.05$ ) and 36.1% ( $P < 0.001$ ). On the yield of milk protein, they were inferior to their mothers by 343 and 325 kg or by 31.5 ( $P < 0.05$ ) and 34.6% ( $P < 0.01$ ), respectively. At the same time, in cows-daughters of Danish origin the content in fat and protein in milk increased by 0.1 and 0.2%.

In animals of the first generation of Hungarian origin, there was only a tendency to decrease in the indicators of lifetime productivity - milk yield by 4442 kg or 11.8%, and milk fat yield by 210 kg (17.6%) and protein - 222 kg (21.4%). The fat content in milk fell (0.2%). Hungarian FG exceeded Danish and German life expectancy by 38.3 ( $P < 0.05$ ) and 41.1% ( $P < 0.05$ ), milk fat yield by 12.2 and 32.1%, milk yield protein - by 9.7 and 32.9%. However, progeny of Danish selection turned out to have more fat and protein-milk yields. In terms of the average fat content for all lactations, they exceeded animals of the German and Hungarian selection by 0.3 ( $P < 0.05$ ) and 0.7% ( $P < 0.05$ ) and milk protein - by 0.4 ( $P < 0.05$ ) and 0.6% ( $P < 0.05$ ), respectively.

Given the fact that heritability always appear in specific environmental conditions, it is very important to determine this very important parameter of population genetics directly in the economy. One-factor analysis of variation (ANOVA) showed that the heritability of economically useful traits in daughters of imported cows was rather low. The average index of heritability coefficient for cows has been as follows: in terms of lifetime milk yield - 0.09; lifetime yield of milk fat and protein - 0.11; the average fat and protein content for all lactations is only 0.005.

At the same time, we identified differences in the inheritance of these indicators depending on the origin of the cow mothers. So, cows-daughters of German and Danish-born FGs had a relatively highest heritability coefficient ( $h^2$ ) for lifetime milk yield (0.17 and 0.18); the lifetime yield of milk fat (0.23 and 0.15) and the lifetime yield of milk protein are 0.19 and 0.15, respectively. At the same time, the average fat and protein content in milk was characterized by a very low index ( $h^2 = 0.05 - 0.0001$ ). It should be noted that cow daughters of Hungarian origin had a very low rate of heritability of all economically useful traits ( $h^2 = 0.02 - 0.05$ ) except the average protein content for all lactations, whose heritability on this basis was 0, 11 ( $P < 0.05$ ).

It should be noted that in FG animals of German origin, the negative relationship between the value of life-long milk yield and the fat and protein content in milk increased compared to IG - to  $r = -0.30 \dots -0.31$ . The FG of Hungarian origin was very low ( $r = -0.05 \dots + 0.07$ ), while the FG of Danish origin the value of life-time milk yield and fat content correlation was positive  $r = + 0.30$ .

The herd, formed from the IG imported from Europe by heifers, was represented by such lines of seed bulls: Ivanhoe 1189870.50; Bell 1667366.74; Valiant 1650414.73; Elevation 1491007.65; Chevalier 1620273.72; Starbuck 352790.79; Hanover 1629391.72 and Chifa 1427381.62. We have identified significant differences in productivity between the individual lines. The highest lifetime profit was at the Starbuck line, which exceeded its imported peers of other lines: Cavalier - by 2,818.7 kg or 8.2%; Bell - by 3404.5 kg or 10.1%; Valiant - by 5553.8 kg or 17.5%; Elevation - by 7368.9 kg or 24.6%; Chifa - by 5,500.5 kg or 17.3%.

Starbuck cows differed in their relatively high fat content in milk. They exceeded the Cavalier - by 0.5% ( $P < 0.05$ ); Bell - 0.2%; Valiant - by 0.6% ( $P < 0.05$ ); Elevation - 0.4% ( $P < 0.01$ ); Chifa - by 0.2%. Bell's line of milk in protein content exceeded cows of the Cavalier line - by 0.2%; Starbuck - by 0.1%; Valiant - by 0.5%; Elevation - by 0.2% and Chifa - by 0.1%.

The productive longevity of cows (Table 2) averaged 3.1–3.9 lactations. Starbuck's daughters conceded Cavalier's daughters - by 0.1 or 2.6%; Bell - by 0.5 or 14.7%; Valiant - by 0.8 or 25.8%; Elevation - by 0.8 or 25.8%; Chifa - by 0.5 or 14.7%.

**Table 2 - Productive longevity of Holstein cows of European breeding, lactation**

Line	Group					
	IG, n=119	Cv, %	FG, n=69	Cv, %	Reliability of difference	
					<i>T</i> test	<i>P</i>
Cavalier 1620273.72	3.8±0.52	45.7	-	-	-	-
Bell 1667366.74	3.4±0.40	42.2	3.2±0.50	51.9	0.36	>0.05
Valiant 1650414.73	3.1±0.36	41.1	2.7±0.26	36.6	1.07	>0.05
Elevation 1491007.65	3.1±0.21	39.3	2.3±0.56	67.8	1.31	>0.05
Starbuck 352790.79	3.9±0.36	42.8	2.4±0.36	52.9	2.94	<0.01
Chifa 1427381.62	3.4±0.24	40.6	2.4±0.29	49.1	2.43	<0.05

Only in cows of FG of the Valiant and Elevation lines there was a positive relation between life time milk yield and fat and protein content in milk ( $r = + 0.17 \dots + 0.40$ ), which may indicate the possibility of carrying out selection work in the direction of improving these characteristics.

The influence of linear affiliation on the average content of milk fat and protein for all lactation was: in IG - 13.2 ( $P < 0.01$ ) and 9.9% ( $P < 0.05$ ), in FG animals - slightly higher - 23, 1 and 32.6% ( $P < 0.01$ ), respectively. At the same time, it is appropriate to say about the influence of linear affiliation on lifetime milk yield only for animals of the first generation, the impact force of which was reliably 19.5% ( $P < 0.05$ ). This indicates a weakening of the environmental factors in the conditions of year-round loose keeping and similar feeding.

### Summary

1. In the studied herd, the coefficient of variation of productive indicators of purebred Holstein cows has a sufficient level for effective breeding work.

2. The obtained coefficients of heredity ( $h^2$ ) features of lifetime productivity in Holstein cattle, give reason to believe that the selection on these grounds will have a positive impact on the progress in dairy cattle breeding.

3. High phenotypic and genotypic correlation coefficients between the duration of productive life show that selection of any of these features will have a positive effect on other features.

4. It is advisable to use manufacturers of outstanding lines that combine high breeding value for the productivity of daughters with an improving effect on the duration of their economic use.

5. In order to increase the genetic potential of the productivity of animals of the Holstein breed of domestic generation, producers and imported breeding stock should continue to be used in the selection work of Ukraine.



## References

1. Antonenko, P. P., Dorovskych, A. V., Vysokos, M. P., Mylostyvyi, R. V., Kalinichenko, O. O., & Vasilenko, T. O. (2018). *Methodological bases and methods of scientific research in veterinary hygiene, sanitary and expertise (Educational and methodical manual)*, Dnipro, "Svidler A.L.", p. 276.
2. Armengol, R., & Fraile, L. (2018). *Descriptive study for culling and mortality in five high-producing Spanish dairy cattle farms (2006–2016)*. *Acta Veterinaria Scandinavica*, 60(1). doi:10.1186/s13028-018-0399-z
3. Britt, J. H., Cushman, R. A., Dechow, C. D., Dobson, H., Humblot, P., Hutjens, M. F., & Stevenson, J. S. (2018). *Invited review: Learning from the future—A vision for dairy farms and cows in 2067*. *Journal of Dairy Science*, 101(5), 3722–3741. doi:10.3168/jds.2017-14025
4. Chernenko, O. M., Chernenko, O. I., & Sanjara, R. A. (2017). *The quality of colostrum and vitality of calves, born from cows with different reaction to stress experiences*. *Regulatory Mechanisms in Biosystems*, 8(2), 299–303. doi:10.15421/021747
5. Gieseke, D., Lambert, C., & Gault, M. (2018). *Relationship between herd size and measures of animal welfare on dairy cattle farms with freestall housing in Germany*. *Journal of Dairy Science*, 101(8), 7397–7411. doi:10.3168/jds.2017-14232
6. Mazur, N. P., Fedorovych, Y. I., & Fedorovych, V. V. (2018). *Useful features of dairy cows and their connection with productive longevity*. *Animal Breeding and Genetics*, 56, 50–64. doi:10.31073/abg.56.07
7. Milostiviy, R. V., & Karlova, L. V. (2017). *Productive longevity of Holstein cows of European selection of different lines under industrial technology conditions*. *Animal Breeding and Genetics*, 54, 65–74. doi:10.31073/abg.54.09
8. Milostiviy, R. V., Kalinichenko, O. O., Vasilenko, T. O., Milostiva, D. F., & Gutsulyak, G. S. (2017). *Problematic issues of adaptation of cows of Holstein breed in the conditions of industrial technology of milk production*. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies*, 19(73), 28–32. doi:10.15421/nvlvet7306
9. Milostiviy, R. V., Karlova, L. V., & Sanzhara, R. A. (2017). *Qualitative composition of milk of Holstein cows depending on the paratype's and genetic factors*. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies*, 19(82), 125–131. doi:10.15421/nvlvet8226
10. Milostiviy, R. V., Vysokos, M. P., Kalinichenko, O. O., Vasilenko, T. O., & Milostiva, D. F. (2017). *Productive longevity of European Holstein cows in conditions of industrial technology*. *Ukrainian Journal of Ecology*, 7(3), 169–179. doi:10.15421/2017\_66
11. Mylostyvyi, R., & Kozyr, V. (2017). *Productive longevity of Holstein cattle of different ecogenesis in the conditions of the Steppe of Ukraine*. *Foothill and mountain agriculture and stockbreeding*, 62, 195–209.